X2Rail-5

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D6.2
VB Train Positioning Updated Test Scenarios

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1 Executive Summary

In the frame of TD2.4, i.e. the Fail-Safe Train Positioning, the WP6 within the X2Rail-5 project is aimed at developing technological demonstrators which are able to prove the feasibility of the Virtual Balise detection by consolidating state-of-the-art technologies for satellite positioning, augmentation network and kinematic sensor technologies. In total WP6 will produce three different demonstrators with related testbeds in order to test the virtual Balise concept.

The AZD’s demonstrator represents an implementation of Virtual Balise resulting from both X2Rail-2 and X2Rail-5 research activities. The aim of the demonstrator is to confirm the feasibility of the concept and also to assess the performance of the implementation in the real railway environment. AZD defines two types of test scenarios for its demonstrator, laboratory test scenarios and on-site (field) test scenarios. In the case of lab tests, the authenticity of the railway environment is solely ensured by the real data which were collected during the measurement campaign in the railway environment. The corresponding test bench therefore does not simulate any environmental impacts on GNSS signals, only those already recorded in the input dataset are used during laboratory testing. Over 67 hours of real railway data were selected and preprocessed. These are used as input for the laboratory tests. In the case of on-site tests, the authenticity of the railway environment is intrinsically ensured. Note, that the laboratory tests use a different representation of the railway line than that upon which the actual real world data was collected.

The goal of Hitachi Rail STS demonstrator developed within the X2R5 WP6 is to prove the effectiveness of the fail-safe train positioning (hereafter FSTP) solution by applying the Virtual Balise concept on an existing ERTMS environment. The primary goal of the HSTS demonstrator is to highlight the potential of emerging technologies, for instance, satellite-based positioning, by integrating them into widely-used systems like ERTMS. Its key attribute is this seamless blending with ERTMS. The pilot line is a an in operation ERTMS commercial line, with tight scheduled rail traffic and therefore not freely available for all the tests needed, especially for the development and tuning phases. For this purpose, the Hitachi Laboratory has been set up with Hardware and Software instruments which constitute the Demonstrator Testbed aimed at including the capability to perform testing of equipment under both nominal and extreme conditions, including support for fault-injection testing. The testbed complements field testing, allowing conditions that are statistically unlikely to be observed in the field to be simulated in a highly controlled and repeatable environment. The rigorous processes of development, installation, commissioning, and verification are in alignment with European Standards, such as EN 50126-1 and EN 50129. The system will undergo lifecycle phases to assure proper specification of system requirements and their compliance with intended use or application. In terms of system integration, the assembly and installation of the integrated system, the demonstration of working subsystems, and the initiation of system support arrangements are primary objectives. The VBTS (Virtual Balise Transmission System), a critical part of this system, is designed to meet the Safety Integrity Level 4 (SIL4) requirements, maximizing installation and maintenance efficiency. The system validation process will include both laboratory and field tests to assess integration and functionality, following naming conventions for identification clarity. These test specifications align with requirements established in the X2Rail-2 Work Package 3 (WP3) and refined during the course of Work Package 5 (WP5). The aim is to ensure that all subsystems and components interact correctly and perform their intended function without performing unintended functions. This detailed overview showcases the meticulous approach to developing an ERTMS that is future-ready, high-performing, safe, and adaptable to evolving technologies, with a focus on cost-effectiveness and conformity to the required standards.

The demonstrator developed by MERMEC for X2Rail 5 WP6 implements a Virtual Balise solution as a result of what was done during the X2Rail-2 project and the activities carried out in X2Rail-5 project. It is fed with real data from real acquisitions. The entire demonstrator will be tested in the laboratory, the receiver will be installed also on the vehicle even when the test runs are performed. The receiver outputs are collected during real trips. The activities in the laboratory will be used to evaluate the deviation from an independent a very precise Ground Truth.

2 Table of Contents

3 Abbreviations and acronyms

Abbreviation / Acronyms	Description
ATP	Automatic Train Protection
B3 R2	Baseline 3 Release 2
BACC	Blocco Automatico a Correnti Codificate
BCPW	BTM CPU and Watch dog
BG	Balise Group
BINEX	BInary EXchange format
BTM	Balise Transmission Module
BTM2G	Balise Transmission Module – 2 Generation
CBS	Communication Based Signalling
CENELEC	Comité Européen de Normalisation Électrotechnique
CMD	Cold Movement Detector
CPU	Computer Processor Unit
CTODL	Current Time Odometric Data Line
DB	Date Base
DIVA	Dynamic Integrated Vital and Available system
EoM	End of Mission
ERSAT	ERTMS on SATELLITE
ERTMS	European Rail Traffic Management System
ESTP	Estimate Safe Train Position
ETCS	European Train Control System
EVC	European Vital Computer
FN	Full Navigation (VBR Operational Mode)
FNAV	F-Type Navigation (Galileo Message)
FS	Full Supervision (ERTMS Operational Mode)
GAD	GNSS Augmentation Dissemination
GBAS	Ground-Based Augmentation System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GSM-R	GSM-Railway
HR	High Resolution
HSTS	Hitachi Rail STS
ICD	Interface Control Document
IETO	Integrated Electronic Train Order
IP	Internet Protocol
LC	Level Crossing
LNAV	Lateral Navigation
MA	Movement Authority
MLCP	Multi-Link Communication Platform
NGTC	Next Generation Train Control
NMEA	National Marine Electronics Association
NP	No Power (VBR Operational Mode)
OBSC	On Board Signalling Core
OBU	On Board Unit
PDU	Protocol Data Unit
PEST	GNSS Position ESTimator
PPOS	Processing in the POSition domain
PPSR	Processing in the Pseudo Range

PVT	Position, Velocity, Time
RAMS	Reliability, Availability, Maintainability and Safety
RBC	Radio Block Centre
SATR	SATellite Receiver
SB	Stand By (VBR Operational Mode)
SBR	Section of Block Radio
SBS	Space Based Services for Railway Signalling
SC	Start-up Configuration (VBR Operational Mode)
SCMT	Sistema Controllo Marcia Treno (National System)
SF	System Failure (VBR Operational Mode)
SFE	Safe Front End
SIL	Safety Integrity Level
SMA	Simple Moving Average
SoM	Start of Mission
SSB	On Board Subsystem
SRS	System Requirements Specification
TCP	Transport Control Protocol
TD	Track Discrimination (VBR Operational Mode)
TIU	Train Interface Unit
TSI	Technical Specification of Interoperability
TV	Trackside Verification
UNISIG	Union Industry OF Signalling
VAL	Validation
VB	Virtual Balise
VBD	Virtual Balise Detection
VBM	Information generated by the VBR that emulates the output message of a real BTM, when the position on the track may be associated with the specific reference mark of a balise virtually placed on the track. The structure of the message is identical to the message that would be sent to the on-board signalling core from a BTM reading a physical Eurobalise (including time and odometer stamping information with uncertainties, balise ID and other possible packets)
VBR	Virtual Balise Reader
VBTS	Virtual Balise Transmission System

4 Background

The development of Virtual Balise (VB) Train Positioning technology is a significant step towards improving the safety and efficiency of railway systems. This technology replaces physical balises that have traditionally been used to identify train locations.

Several railway companies, including Hitachi Rail STS, AZD, and MerMec, have developed and tested the VB Train Positioning technology as part of the X2Rail-5 project (WP6), funded by the European Union.

Task 6.3 of the X2Rail-5 Work Package 6 (WP6) aims to define a set of test scenarios and related activities for testing the VB Train Positioning technology. These tests will integrate and complete the activities carried out during the X2Rail-2 project Work Package 3 Task 3.7, in which the first layer of the overall Verification and Validation (V&V) Specification was designed.

This Public Deliverable provides comprehensive Test Specifications and Test Scenarios for each of the three VB Train Positioning demonstrators developed by Hitachi Rail STS, AZD, and MerMec.

5 Objective / Aim

The purpose of this deliverable is to create comprehensive test specifications and test scenarios for three distinct fail-safe train positioning demonstrators developed by Hitachi Rail STS, AZD, and MerMec, and all of them utilize Virtual Balise Reader (VBR) technology. The Deliverable is divided into three main sections that correspond to the three demonstrators. Each section is further divided into subsections that provide detailed descriptions of the testing process for each phase of the testing, along with a summary of the overall testing process.

6 Hitachi Demonstrator Test Specifications and Scenarios

This section provides a comprehensive Test Specification and Test Scenario for the Fail-Safe Train Positioning demonstrator, which is based on the Virtual Balise Reader (VBR) technology developed by Hitachi Rail STS. The testing process and specifications are grounded in the overall V&V procedures outlined in the deliverable D3.7 from the X2Rail-2 project [3], with the goal of conducting a thorough testing process in compliance with the CENELEC norms for RAMS, specifically the EN50126 and EN50129 standards.

The testing process described hereafter is divided into two main phases: validation subsystem – with a particular focus on the Feared Events – of the VBR and ETCS Onboard, and integration of both systems. Each phase has specific subsections that provide detailed descriptions of the testing process. The integration phase is particularly important as it aims to validate the solution fully integrated into the European Rail Traffic Management System (ERTMS) standard. This phase ensures that the Fail-Safe Train Positioning system can effectively communicate and interact with other ERTMS-compliant systems and technologies, thereby providing a more robust and reliable solution.

For the sake of completeness and transparency, it's important to note that these requirements have their roots in the X2Rail-2 Work Package 3 (WP3) project. They were subsequently refined during the course of Work Package 5 (WP5). Therefore, where applicable and permissible, each test specification will indicate the corresponding requirement as detailed in the deliverable D5.1 [18], a result of WP5's comprehensive work.

The testing process aims to ensure that the Fail-Safe Train Positioning system is reliable, available, maintainable, and safe (RAMS), and to identify any potential hazards or risks that could impact its performance. The following subsections provide a more detailed description of each phase of the testing process.

6.1 Aim of V&V and Integration activities in the system lifecycle

Verification activities ensure that all system requirements, i.e. functional or non-functional (technical and contextual) requirements (Ref.[4]), have been apportioned and implemented correctly when the system is designed. These requirements are safety-related or non-safety-related.

Validation activities ensure that the overall implementation matches all specified requirements, which implicates the safety requirements derived from the hazard analysis.

For describing the V&V process and its relationship with the design activities, it is necessary to refer to a process. The process used in this document is the System Lifecycle (Ref. Figure 6-1) taken from the EN 50126-1 (Ref.[4]). Safety activities also appear in this scheme: risk assessment, and implementation and demonstration of compliance with RAMS requirements.

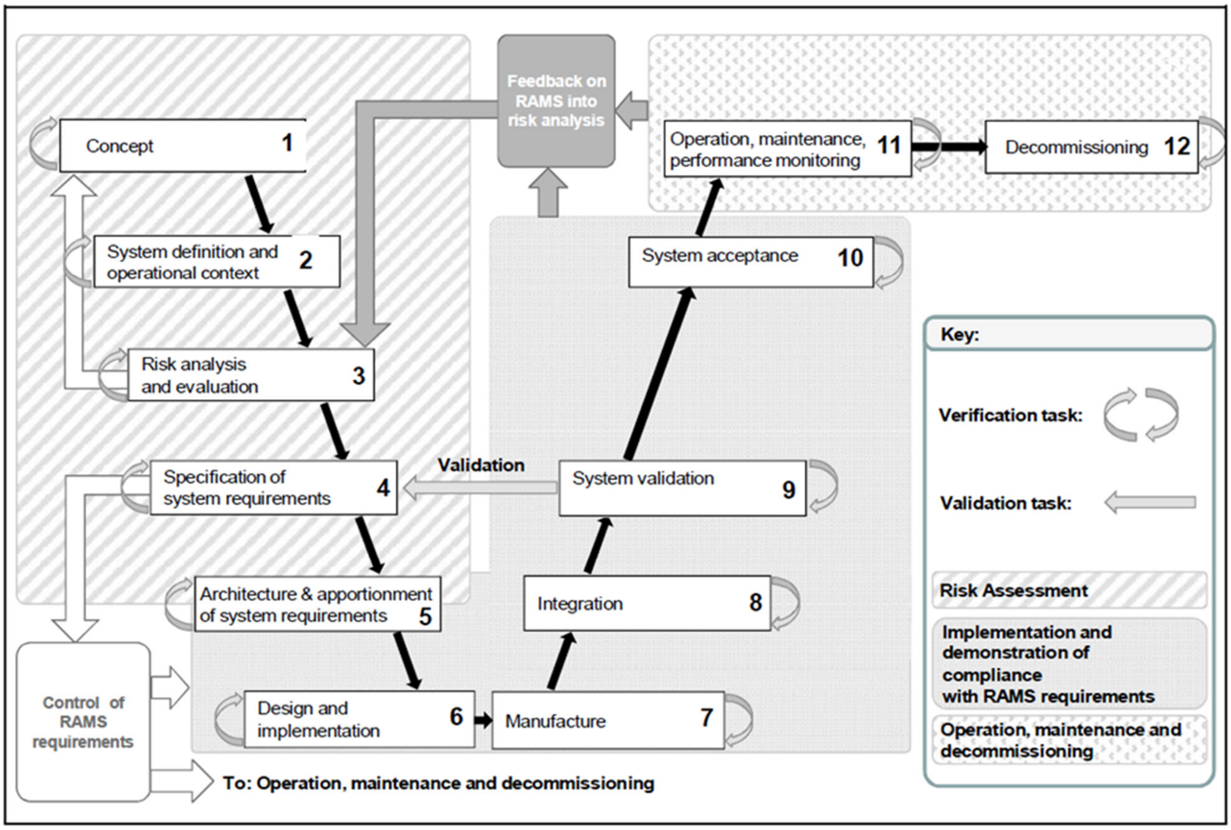

Figure 6-1: 50126 V-model of the System Lifecycle

6.1.1 Verification Process

As required by the European Standard EN 50126 (Ref.[4];[5]) verification of activities and deliverables is foreseen within every lifecycle phase (Ref. Figure 6-1), in order to demonstrate that the requirements of each lifecycle phase have been fulfilled.

Verification process, applied throughout the system lifecycle (Ref. Figure 6-1), shall include the following tasks (Ref.[4];[5];[6]):

- evaluation of the correctness and adequacy of the deliverables;
- verification of the deliverables of the phase for compliance with the deliverables of former phases;
- verification of the deliverables and inspection of the documentation, for compliance with the requirements for the phase in question;
- evaluation of the adequacy of the methods, tools and techniques used within the phase;
- evaluation of the correctness, consistency and adequacy of test cases and executed tests.

Documental review and testing are the main activities within verification process.

The techniques and measures recommended by the European Standards (EN 50129 -Ref.[6]) for carrying out the verification process in order to meet the SIL4 are reported in the §6.1.4.

6.1.2 Validation Process

As required by the European Standard EN 50126 (Ref.[4];[5]) validation activities are foreseen in:

- lifecycle phase 4 “Specification of System Requirements” (Ref. Figure 6-1), to assure that system requirements (including RAMS requirements) have been properly specified.
- lifecycle phase 9 “System Validation” (Ref. Figure 6-1), to assure that the system under consideration is compliant with the specified requirements (including RAMS requirements) for the intended use or application.

The validation process aims to evaluate the processes of development, installation, commissioning and verification in order to assure that the system under consideration is fit for its intended use in the defined environment, in particular with respect to safety.

The techniques and measures recommended by the European Standards (EN 50129 - Ref.[6]) for carrying out the validation process to meet the SIL4 are applied for the VBTS.

6.1.3 Integration Process

As required by the European Standard EN 50126-1 (Ref.[4]) the objectives of this life cycle phase are to:

a) assemble and install the integrated system, total combination of subsystems and components required to form the complete system.
b) demonstrate that integrated system, subsystems and components work together as defined by the interfaces.
c) demonstrate that integrated system, subsystems and components meet their RAMS requirements.
d) initiate system support arrangements.

The input to this phase shall include all relevant information, and where appropriate, data, necessary to meet the following requirements:

e) Requirement 1 of this phase shall be to assemble and install the total combination of sub-systems, components and external facilities required to form the complete system, according to the Installation Plan.
f) Requirement 2 of this phase shall be to document the installation process, including:
    a. review plans in the context of requirement 3 of the design and implementation phase.
    b. installation tasks;
    c. action taken to resolve failures and incompatibilities.
g) Requirement 3 of this phase shall be to review and update the Safety Plan following completion of installation to ensure that any changes to either system or procedures are recorded and effectively managed in future lifecycle tasks.
h) Requirement 4 of this phase shall be to:
    a. start staff training;
    b. make support procedures available;
    c. establish spare parts provision;
    d. establish tool provision.

The subsystems and components shall be integrated according to the integration planning. The system shall be tested and analysed in accordance with the system integration planning. These tests and analyses shall show that all subsystems and components of the system interact correctly as specified in the interface specifications to perform their intended function and do not perform unintended functions.

6.1.4 Techniques and measures for the V&V

The techniques/measures to use for the verification and validation of the system are reported in the European Standard EN 50129 (Ref. [6]) and can be summarized in the following table:

Techniques/Measures	SIL 1	SIL 2	SIL 3	SIL 4
1 Simulation	-	R	R	R
2 Formal verification	-	-	R	R
3 Functional testing of the system	HR	HR	HR	HR
4 Functional testing under environmental conditions	HR	HR	HR	HR
5 Design audit	R	R	HR	HR
6 Design review	HR	HR	HR	HR
7 Statistical confidence demonstrated by use (field experience)	R	R	R	R
8 Inspection of documentation	HR	HR	HR	HR
9 Ensure design assumptions are not compromised by manufacturing process				
10 Test facilities				
11 Ensure design assumptions are not compromised by installation and maintenance processes				

Figure 6-2: V&V Techniques/Measures

The above table describes the various techniques/measures and makes recommendations regarding their use depending on the SIL of the system under analysis. In particular, the column related to SIL4 systems in Figure 6-2 the has to be considered applicable to the VBTS.

The recommendations are tagged as:

- "HR", when the measure or technique is Highly Recommended for this safety integrity level
- "R", when the measure or technique is Recommended for this safety integrity level
- "-", when the technique or measure has no recommendation for or against being used
- “Blank”, when the technique or measure is deepened in other sections of the EN 50129 (Ref.[6]).

A technique or measure tagged as "HR" has to be considered as mandatory, in case it is not used the rationale behind not using it shall be properly detailed.

6.2 System and Interfaces description

The Regional low traffic ERTMS system is the technological evolution designed to meet the essential requirements of safety, reliability, availability, health, environmental protection, technical compatibility and the economical target reduction necessary to the subsistence of the secondary lines. Secondary lines are identified as passenger transport lines with minimum time between trains considered between 20 and 30 minutes, maximum speed up to 120-150km/h and length up to 80-100km mainly single track. Lines equipped with obsolete signalling systems or none at all without automatic train protection (ATP) legacy system as for example Italian BACC or SCMT.

Regional low traffic ERTMS system will be applied on secondary lines composed by several intermediate small stations managed by relay based interlocking where the movement of the train between two adjacent station is often allowed with manual electric block to guarantee the movement of only one train on the inter station section.

Regional low traffic ERTMS system will centralise the management of station and line level crossing (LC).

Regional low traffic ERTMS system architecture will be modular configurable architecture able to minimize installation and maintenance costs. Starting from a basic architecture the Regional low traffic ERTMS system may interface additional/innovative subsystems as GNSS localisation system.

The primary objective of the Hitachi Rail STS demonstrator, developed as part of the X2Rail-5 WP6 project, is to validate the efficacy of the fail-safe train positioning (FSTP) solution through the implementation of the virtual Balise concept. One of the key outcomes is to evaluate the performance of the FSTP solution on a real ERTMS railway line by utilizing the European public augmentation network (EGNOS) to enhance satellite positioning, which the virtual Balise relies on.

However, a fully suitable EGNOS version for railway applications, capable of handling safety railway certification processes and supporting multi-frequency and multi-constellation use, is not expected to be available for at least four years. As a result, the chosen approach for incorporating EGNOS service within the FSTP architecture involves a stepwise strategy. This begins with utilizing the current version of EGNOS (despite its limitations) and preparing to transition to the updated version once available. In the meantime, the IP2.4 and European Space Agencies (ESA and EUSPA) can mutually benefit by sharing intermediate results from experiments and developments.

Another goal of the Hitachi Rail STS demonstrator is to showcase the feasibility of commissioning a fully integrated and compliant ERTMS system. To achieve this, the demonstrator has been enhanced by pairing the current EGNOS version with a dedicated augmentation network, utilizing dedicated reference stations based on the avionic LAAS model.

Building on the outcomes of other European projects such as ERSAT GGC and STARS, Hitachi Rail STS developed an "alternative" augmentation network architecture. These enhanced architecture aims to implement and test communication channels from wayside to onboard for transmitting GNSS corrections and implementing additional safety mechanisms within a fully integrated ERTMS environment, which would have been impossible using the current EGNOS version. This additional experimentation will also enable comparisons between positioning results using EGNOS and those utilizing the dedicated augmentation network.

The two architectures (illustrated in the provided pictures Figure **6-3**, Figure **6-5**) are alternatives and do not function in a combined manner. The demonstrator consists of two separate hardware products: one using EGNOS and the other employing the Local Area Augmentation network (i.e., Reference Stations). For clarity, all subsequent test specifications will generically refer to the "augmentation network," although related tests should be executed for both hardware setups.

6.2.1 Background

The basic Regional low traffic ERTMS/ETCS system is composed partly on the trackside and partly on board the trains [8].

This defines two segments, the on-board segment and the trackside segment.

The environment of ERTMS/ETCS system is composed of:

a) the train, which will then be considered in the train interface specification;
b) the driver, which will then be considered via the driver interface specification;
c) other onboard interfaces,
d) external trackside systems (interlockings, control centers, etc.), for which no interoperability requirement will be established.

The trackside segment can be composed of:

a) balises
b) lineside electronic unit (LEU)
c) the radio communication network (GSM-R)
d) the Radio Block Centre (RBC)
e) Key Management Centre (KMC)
f) Public Key Infrastructure (PKI)

The on-board segment can be composed of:

a) the ERTMS/ETCS on-board equipment;
b) the on-board part of the GSM-R radio system;

6.2.2 Regional low traffic ERTMS functional architecture based on GNSS localisation

The regional low traffic ERTMS architecture based on GNSS localisation plans to minimize the use of physical balises guaranteeing the localisation functionality through the use of virtual balises and the geo localization concepts.

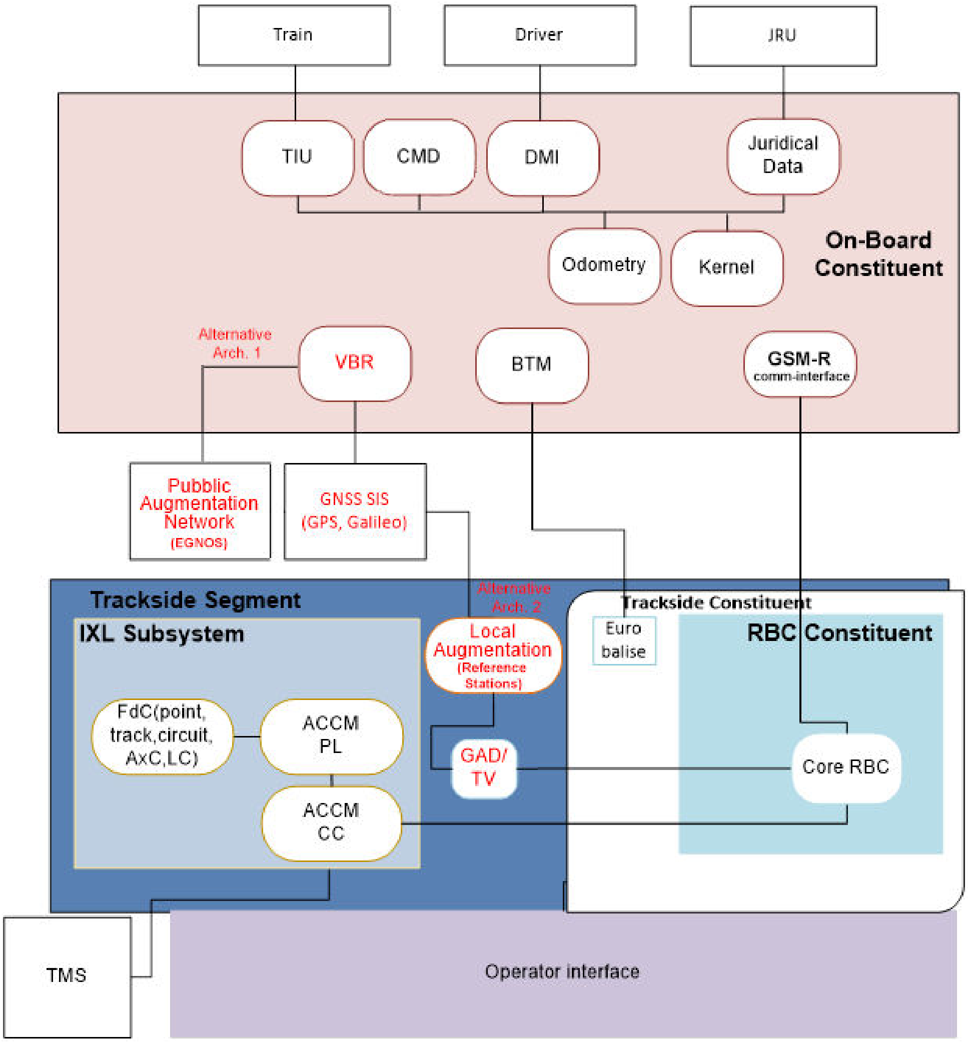

Figure 6-3: Regional low traffic functional architecture

The additional functionality to be added to the basic Regional low traffic ERTMS system is the GNSS positioning system.

This functionality is implemented through the Virtual Balise Transmission System (VBTS).

The VBTS is composed by:

1. the Virtual Balise Reader (VBR) sub-system as part of On-Board Constituent;
2. GNSS Augmentation Dissemination/Trackside Verification (GAD/TV);
3. GNSS Augmentation Network as Trackside Constituent.

The GNSS Augmentation Network can be both local augmentation specifically designed for railways application or public augmentation network through EGNOS satellite network.

The Virtual Balise (VB) concept and the functional Regional low traffic ERTMS system architecture defined in this document take into account the functional architecture proposed by ERSAT project and it is compatible with the architecture proposed in NGTC and X2RAIL-2 project.

The use of the Cold Movement Detector (CMD) as a On Board Constituent is taken into account in order to minimize time consuming, manual procedures, and moreover, to provide an additional support to the GNSS positioning system.

6.2.3 Pilot Line Novara Rho

The Novara-Rho Pilot-Line has been selected from RFI and STS to be an application of a Regional low traffic ERTMS system based on GNSS localisation. The long term RFI renewal program foresees the development of a system able to allow the technological upgrade of low traffic secondary line of the national network.

STS Regional low traffic ERTMS system based on GNSS solution applied on the Pilot Line represents the technological solution designed to meet the RFI requirements in term of technical compatibility safety and economical target reduction requested.

The Pilot Line proposed architecture will be an ERTMS B3 R2 standard solution able to guarantee the conformity to the applicable TSI with the addition of the innovative technology of the GNSS localisation system based on local augmentation for railway application.

The additional innovative elements will not compromise the compatibility with the TSI specification and will no compromise the interoperability of the ERTMS railway system.

The ERTMS based on GNSS localisation first important milestone will focus the revenue service of the ERTMS GNSS system based on local augmentation for railway application system. GSM-R TSI compliant solution will be used to guarantee radio communication between trackside and on-board equipment.

The ERTMS based on GNSS localisation further goal to be achieved on the Pilot Line will be to test the ERTMS GNSS system based on public EGNOS augmentation system to be used instead of the local augmentation system.

The GNSS localisation will be implemented through the VBTS system (§6.2.4).

Public Augmentation network i.e. EGNOS v2 will be used by detecting the signal directly on board by means of the GNSS antennas on the roof.

Local augmentation network will be realized with two Reference Station (RS) installed on Trecate and Vittuone.

The dissemination of the GNSS Augmentation information to the on board will be in charge to the GAD/TV (GNSS Augmentation Dissemination/Trackside Verification) device.

The On Board will be equipped with the Virtual Balise Reader (VBR) that, in analogy with BTM, provides the “Virtual Balises” to the ETCS Kernel.

Moreover, to improve the system availability it will be added to the On-Board Constituent the CMD, a safety device that detects the movement of the train while the train is Powered OFF.

The System will take into account all the ERTMS functionalities and customer requirements foreseen for the Novara-Rho, integrated with the GNSS localisation (Movement Authority management, Level Crossing Management, Level Transition from NTC to L2 etc.).

Below is the functional architecture of the system under consideration:

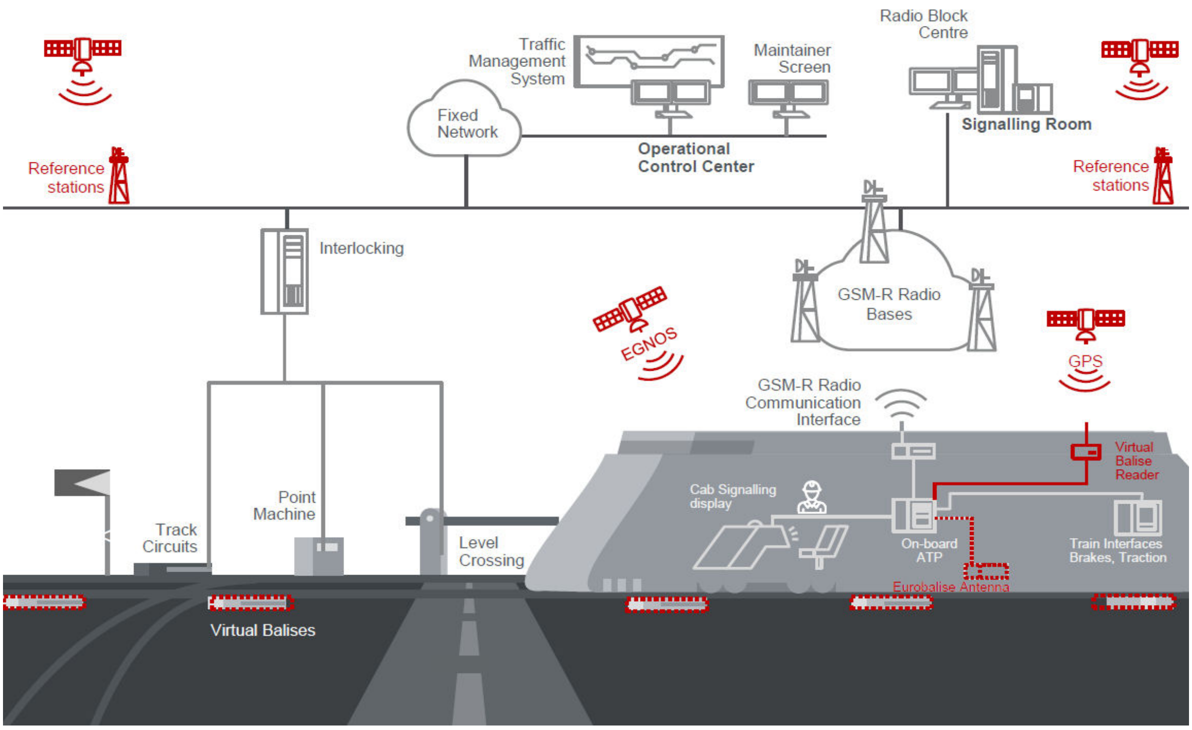

Figure 6-4: Functional architecture Novara-Rho

6.2.4 VBTS sub-system

Coherently with NGTC, ERSAT and X2Rail-2 projects the Regional low traffic ERTMS system based on GNSS localisation will include on the ERTMS/ETCS reference architecture a new element to introduce the Virtual Balise Concept.

The Virtual Balise Transmission System (VBTS) is a safe spot transmission based system used in addition to the ERTMS reference transmission system (Eurobalise, Euroloop and Radio).

This system continuously estimates the Safe Train Position Information, based on GNSS Technology in order to “detect” the Virtual Balises and, in analogy with BTM, provide the related User Bits (telegram) to the ETCS Kernel.

In order to minimize costs, VBTS goal is to reducing the use of physical balises and then the reduction of the elements along the track to be maintained.

The Virtual Balise Reader (VBR) is part of the VBTS system and represents a new on-board module. It has to compute periodically the estimated GNSS-based position, compare it to the stored on board track data-base information and provides both the user bits associated with the VB and the VB’s reference position to the ERTMS/ETCS Kernel.

VBR has to provide to the on board European Vital Computer (EVC) an error detecting the position reference of the balise, error calculated dynamically because it not known a priori as for the BTM in case of physical balises use.

Because of possible poor coverage of the Geostationary Augmentation SIS measured on railway lines, in order to enhance Safe Train position estimation in accordance with the required THR and then to select the virtual balises at the proper position, the approach foresees the distribution of the Ground-Based Augmentation System (GBAS) information to each train, individually, using the communication between RBC and the ETCS On-Board through the Euroradio Protocol that guarantees the protection of all the exchanged data.

The GNSS Augmentation Dissemination / Trackside Verification (GAD/TV) device is responsible for disseminating the GNSS augmentation information GBAS to the on-board and takes part in the position estimation without any track-route ambiguity (Track Discrimination).

The GNSS Augmentation Network is a Railway Augmentation System suitable for providing the Safe-Of-Life service compliant with safety, performance and quality railway requirements.

The VBTS system is mainly composed by the following elements described on the following high level functional architecture:

a) VBR,
b) GAD/TV
c) GBAS GNSS augmentation network based on Railway local Augmentation Network.
d) Trackside and on board GNSS antennas

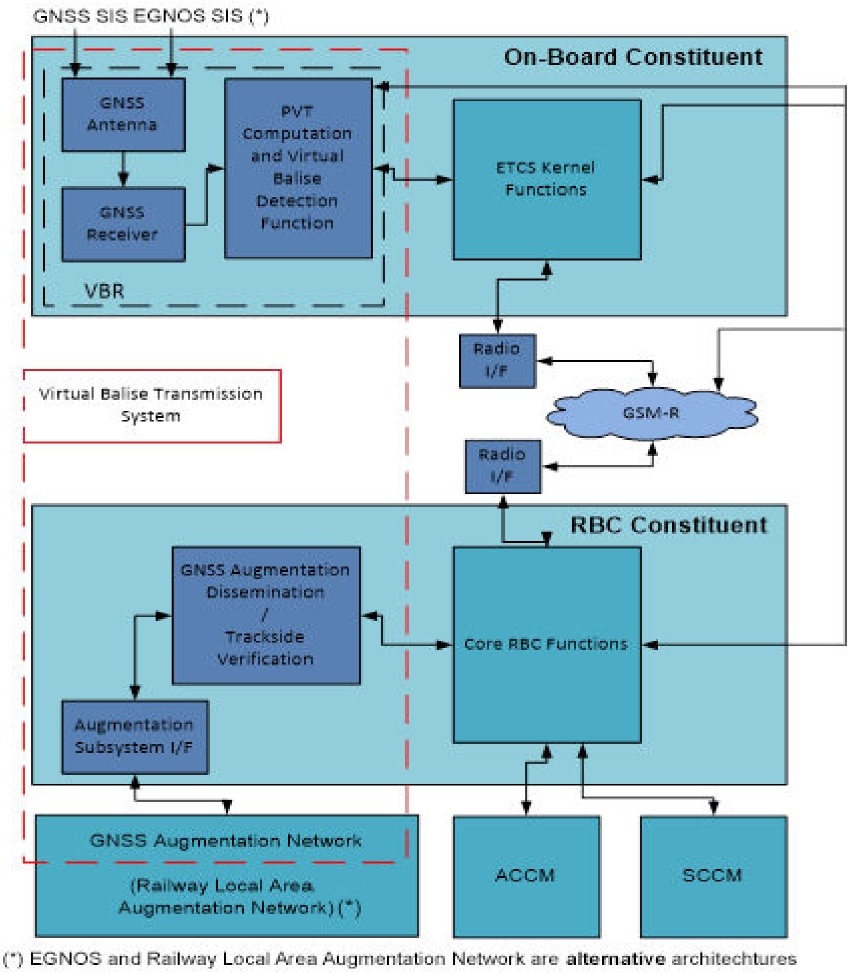

Figure 6-5: VBTS functional architecture Layout

The overall STS VBTS system is simplified in the following picture:

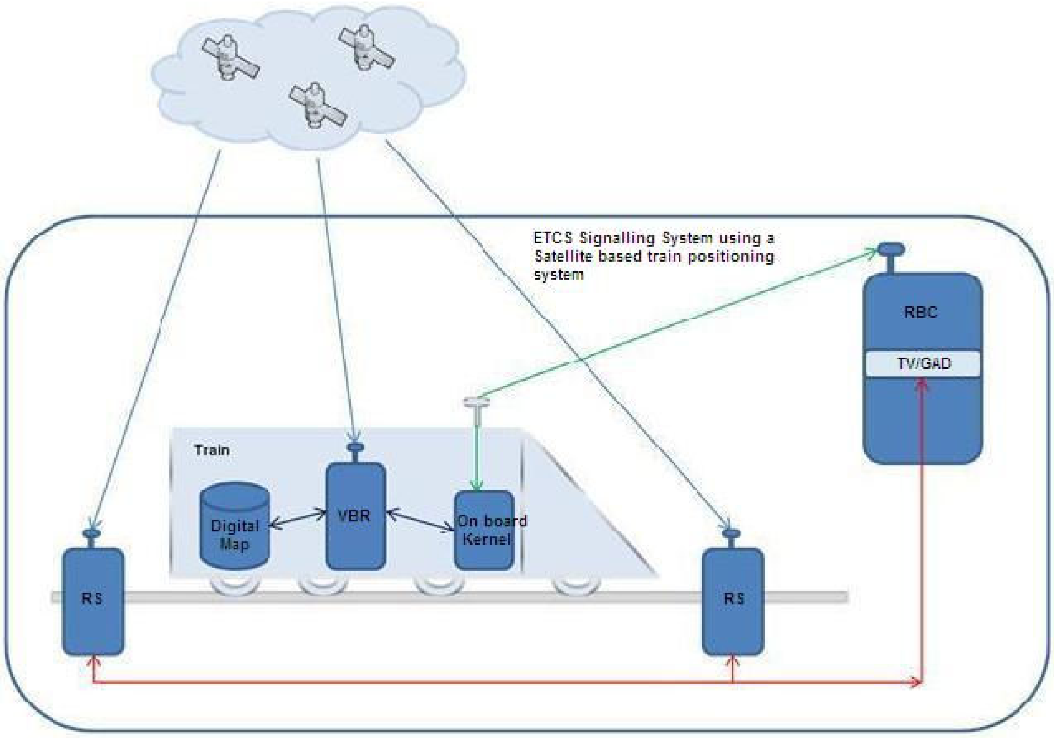

Figure 6-6: VBR System Description

The main functionality of the VBTS system is to estimate the PVT (Position, Velocity and Time) on the basis of the reference satellite signals and the navigation data broadcasted by the Space segment and to provide the Virtual Balises associated to specific GNSS coordinates with the related balise location accuracy.

The VBTS is mainly composed of two parts:

1) The VBR:
   -it is the trainborne subsystem that provides to OBSC the telegrams of the virtual balises stored in its internal track database and correlated with their location information. The detection of the virtual balises is performed using the PVT information calculated starting from the elaborated GNSS data and the corrective information provided by the Augmentation Network.

2) The VBTS Wayside Segment that includes all the VBTS components installed wayside:
   -The GNSS Augmentation Dissemination (GAD) that collects from the Local Augmentation Network the differential corrections and the navigation data locally produced. Then, the calculated augmentation data, are distributes to each VBR via RBC using the communication between the OBU and the RBC;

   -The Trackside Verification (TV) is a module that:

      -Makes the RBC acting as a Gateway, in order to forward to each VBR all the augmentation data received by the GAD and Vice-Versa.

      -Uses signaling data received by the RBC (e.g., train position and the point status) in order to provide the Track Discrimination to the VBR

-The Reference Stations (RS) that compose the GNSS Local Augmentation Network. The RSs send the locally elaborated differential corrections to the GAD unit, together with the locally received navigation data.

6.2.5 Virtual Balise concept

For the VBR, the concept of "virtual balise" is useful to identify the element whose functionality is equivalent with respect to the traditional BTM.
More precisely, like a BTM based on physical balises performs the following major functions:

- The detection of up-link balises (based on signal strength threshold)
- The extraction of user data from the detected balises
- The time and odometer stamping of output data

Similarly the "virtual balise" VBR functionality performs:

- The detection of the virtual balises based on the GNSS antenna entering the zone of the Digital Map at which a virtual balise has been inserted.
- The extraction of user data for that specific virtual balise from the Digital Map.
- The time and odometer stamping of output data (based on the same CTODL provided by the EVC via the redundant RS-485 lines).

The virtual balise reports will be provided to the EVC using the same protocol used by the actual BTM also for the application layer; this allows re-use of ERTMS/ETCS principles, architectures, and components. Proceeding in this manner, the integration of the VBTS system into the already existing ERTMS/ETCS architecture is ensured with a minimum effort. Besides, preserving the physical interfaces required by the classical BTM, the VBR results in a versatile module to manage also, the traditional signalling systems.
The STS implementation of the VBR may include an integrated BTM function to manage detection of Eurobalises in accordance with ERTMS/ETCS requirements (see Subset-036 [9]) to cope with situations in which the GNSS signals are not available (e.g., along the tunnels) or where existing Eurobalises are already installed,

6.2.6 Digital Map

The STS ERTMS L2/L3 System based on VBTS requires different databases:

- The Wayside ERMTS RBC Database, that is the traditional database managed by the ERTMS systems which includes:
    - the RBC Configuration DB
    - the Wayside Track Line Graph
- The GAD Database, which contains the high level information about:
    - the list of Reference Stations;
    - the geo-referenced location of each Reference Station Antenna;
    - the configuration data to be used for implementing the GAD GNSS algorithms.
- The RS Database, which contains the high level information about:
    - the Reference Station unique identifier;
    - the geo-referenced locations of both Reference Station Antennas;
    - the configuration data to be used for implementing the RS GNSS algorithms and the cooperation model between the Reference Station and RBC/GAD.
- The VBR Database, which contains the following high level information:
    - High Resolution Track Line Graph: this graph contains more details than the RBC Wayside Track Line Graph, but, with the level of abstraction of the RBC database, the two database must be equivalent;

- Virtual Balise database that must report the location of every balise along with its location accuracy (as required by ERTMS) and associated telegram; the balise might be the virtual balise or the Virtualized Real Balise;
- the configuration data to be used for implementing the OBU GNSS algorithms and the co-operation model between OBU and GAD.

In order to work properly and to meet the safety level required, the ERTMS system based on VBTS must guarantee the information coherence and data consistency between all the databases. Therefore, proper diagnostic mechanisms or design strategies must be adopted for checking the versions and the contents on the different units in order to avoid data misalignments and to detect possible memory corruptions.

6.2.7 VBR /ON-BOARD KERNEL Interface

This section provides a detailed description of the interfaces between VBR and On-Board Kernel, highlighting the data organization and the protocols used for the communication among the different system components (i.e. VBR and EVC) interfaces.

The interface between the VBR and the On-Board Kernel is composed of:

- A redundant link RS-485 with CTODL protocol is used by VBR to receive the odometer-related data from the On-Board Kernel.
- Ethernet links is used by VBR to broadcast CTODL data (based on GNSS information) to the EVC, when it does not use its own odometry.
- Profibus links using the STS Safety Layer PROFIBUS protocol to exchange all the other safety related and relevant information (e.g., Balise messages, Augmentation Data). So, this interface is used for transferring:

a) the VBR's and GAD/TV's packets related to the communication VBTS Wayside Segment - VBR,
b) the Balise Information and the VBR/BTM Status messages to the On-Board Kernel,
c) the orders messages from On-Board Kernel.

The VBTS related data are exchanged from VBTS wayside to VBR (and vice versa) by means of Packets 44, via the On-Board Kernel in the role of gateway.

The VBR remains retro compatible in terms of interfaces with the previous BTM Equipment providing the virtual balises.

6.2.8 VBR /GAD-TV Interface

There is no direct connection between the GAD and the VBR So, the VBTS data are exchanged using the communication between RBC and ON-BOARD KERNEL. Referring to "Data used by applications outside the ERTMS/ETCS system" (see §7.4.3.6 of [8]) the VBTS-related data will be transferred from GAD unit to the VBR (and also in the reverse direction) through the employment of the Packets 44 provided by SUBSET-026 (Ref. [8]) properly included in the ERTMS messages.

Therefore, conforming to the Chapter 8 of [8]:

- The RBC transmits to the VBR the data received from GAD with Packets 44 included in the following messages:
  - 3 "Movement Authority"
  - 33 "MA with Shifted Location Reference"
  - 28 "SH authorized"
  - 24 "General Message"

- Vice-versa the VBR transmits the Packet 44 with the following messages:
  - 136 “Train Position Report”
  - 157 “SoM Position Report”.

The lower levels of the communication protocol must be compliant with EURORADIO standard (Ref. [10]).

6.2.9 GAD /RBC Interface

The interface between GAD Is implemented by the Trackside Verification (TV) module that makes the RBC acting as a Gateway, in order to forward to each VBR all the augmentation data received by the GAD and Vice-Versa.

6.2.10 VBR/EGNOS Interface

The interface between VBR and public augmentation network is implemented by means of the satellite interface for the detection of the EGNOS signal and the subsequent elaboration of the EGNOS correction as per the Minimum Operational Performance Specification (MOPS) defined in the X2Rail-2 Project, Work Package 3 and encompassed in the public deliverable D3.6 [19].

6.2.11 Diagnostic Interface

VBR will send diagnostic information to a diagnostic recorder (DATA LOGGER) using the related interface (Ref. §6.3.2).

6.2.12 Satellite interface

The VBR Satellite Interface is implemented through GNSS Receivers to receive GNSS Signal from Satellites.

Each SATR is made by two GNSS receivers by two different manufacturers to achieve real hardware diversity.

The two receivers are able to deliver pseudo-ranges and the raw binary data received from the Satellites.

6.2.13 Glossary

This section briefly lists in the following tables the variables and data types useful for testing the VBR subsystem (§6.3).

Variable	Description
D_ESTODO_BG	Signed value of the estimated distance given from the ERTMS/ETCS on-board Odometer Function at the location reference of the balise group
D_MAX_EXP_AG_SPACE	Maximum Expiration Space for AuGmentation Validity
L_ADDDOUBTOVER	Quantity to be added to over-reading error related to the NID_LRBG
L_ADDDOUBTUNDER	Quantity to be added to under-reading error related to the NID_LRBG
M_PTID	Point identifier
M_PTSTATUSID	Point status identifier
M_TICAB_STATUS	Cab status
M_USED_PRN	PRN numbers of the satellites used to compute PVT

M_VBR_OB_ORDERS	Used by EVC in order to send commands to VBR
M_VBR_OB_STATUS	VBR Internal Status Information
M_VBR_OB_WARNINGS	Warnings detected by VBR
NID_ENGINE	
NID_VALBG	VBG validated by VBR as a consequence of GNSS Position Integrity and Digital Map Integrity checks
NID_VBRORDER	Tell the VBR order issued by EVC
Q_DBVALIDATE	VBR DataBase Version Validation Result
Q_IFPROTOVERCHKRES	VBTS Interface Version Check Result
Q_MODULATION	Balise Modulation qualifier
Q_PRINTEGRITYCHECK	Position Integrity confirmed by TV/GAD
Q_VBR_OB_OPMODE	VBR Operational Mode sent to EVC at each status change
Q_VIRT_BAL_TLG	It defines if the Balise Information is detected by VBR as Virtual Balise or Virtualized EuroBalise
T_GPS_BAL_PRC	The GPS Time sent by GAD used by VBR to generate the virtual balise
T_GPS_BAL_PVT	The GPS Time in which the OBU made the PVT used to generate the virtual balise
T_GPS_PRC	The GPS Time the calculated PRC are referred to
T_MAX_EXP_AG_TIME	Maximum Expiration Time for AuGmentation Validity

Table 6-1: Variables used in the test phase

Data Type	Description
PKT_BTM_ORDER	EVC sends Configuration Commands to VBR in order to activate it. This PDU shall be also used to configure integrated BTM Function if present.
PKT_STATUS_BTM	VBR sends data related to its behavioral status to EVC whenever its internal status changes

Table 6-2: Data Types used in the test phase

6.3 Validation of VBR and Onboard subsystem

6.3.1 System Validation Test Identification Process

This section presents the strategy and the method used for the validation process

6.3.1.1 Validation Test Strategy

This section presents a comprehensive list of test specifications developed through the application of Verification and Validation (V&V) processes, fully compliant with the CENELEC standards. The primary objective of these specifications is to adequately cover the Hitachi's low-level requirements for the VBR subsystem and the onboard subsystem, as well as the high-level requirements pertinent to system integration.

The test specifications meticulously align with the requirements, demonstrating our commitment to achieving the highest levels of performance and safety. However, please note that these detailed requirements, although integral to the test specifications, are not disclosable due to their sensitive nature.

For the sake of completeness and transparency, it's important to note that these requirements have their roots in the X2Rail-2 Work Package 3 (WP3) project where high-level requirements have been defined. They were subsequently refined during the course of Work Package 5 (WP5). Therefore, where applicable and permissible, each test specification will indicate the corresponding high-level requirement as detailed in the deliverable D5.1 [18], a result of WP5's comprehensive work. In such deliverable the requirements are defined in related and dedicated section (e.g. §8.1.1.1) so that in this Section the covered requirements have the following naming convention:

REQ_{D5.1 Section number}.

This approach underpins the commitment to maintaining the highest levels of consistency, quality, and compliance while ensuring that the specific requirements of each component are thoroughly addressed. By navigating through the following sections, there is a clear evidence on how each test specification reflects the strategic application of CENELEC-compliant V&V processes and the important evolution from X2Rail-2's WP3 to WP5.

The following list of VBR functionalities to be validated was identified:

Functionality	Brief Description	Broad Description
F1	VBR configuration through ON-BOARD KERNEL orders	The VBR performs start-up autotest and configuration procedure according to order received from the ON-BOARD KERNEL.
F2	Digital Map and Interface Protocol Version consistency	When a connection between RBC and OBSC is established, the VBR checks the version consistency of the Interface Protocol and the identifier and version of the Digital Map between the VBR and the RBC/TV.
F3	Position Initialization	During the SoM procedure, when the VBR receives from the EVC or TV a valid train position or a Eurobalise is detected by means of the integrated BTM, the

Functionality	Brief Description	Broad Description
		VBR determines a safe and unique train position information in the Digital Map.
F4	VBR operational mode transitions	Changing of operational mode of VBR under specified conditions.
F5	Digital Map Navigation Integrity Management	Whenever a new VBG is detected the VBR transmits to the TV the information on the switch point positions used to navigate the Digital Map. The TV after the internal elaboration sends to the VBR the Digital Map Navigation Integrity check result The train position can be not integer if Digital Map navigation was based on obsolete information on position of switches.
F6	PVT	GNSS is the primary source for VBR positioning So, the VBR calculates the PVT information, as well as the VBR train orientation with respect to the linear reference system in the Digital Map, on the basis of the signal received from GNSS satellites and the relevant information as augmentation and integrity data received from the GAD. PVT Information is used by the VBR for its own internal processing (e.g., for establishing the virtual balise detection).
F7	GNSS Augmentation data expiration mechanism	Expiration mechanism based on time and space used by VBR, when receives from GAD the augmentation correction and integrity data, in order to consider as invalid the data received after the expected time or space is expired.
F8	Virtual Balise Detection	The VBR provides the Virtual Balise message to the on-board signalling core, when it determines that the estimated GNSS-based position (VBR virtual antenna) passes over a known VB position assigned on the Digital Map.

Functionality	Brief Description	Broad Description
		Moreover, VBR calculates and provide to the on-board signalling core a dynamic Virtual Balise location reference error bound, reports to the OBSC the correct sequence of the Virtual Balises based on the detected train orientation of the vehicle (e.g., Nominal, Reverse relative to the linear reference system in the track).
F9	VBTS Trackside Message Check	Whenever the VBR receives from VBTS trackside new packets it performs a check of consistency. Only If the check is successfully performed the packets are accepted and applicable.
F10	Train Orientation Management	GNSS is the primary source for VBR positioning So, the VBR calculates the PVT information, as well as the VBR train orientation with respect to the linear reference system in the Digital Map, on the basis of the signal received from GNSS satellites and the relevant information as augmentation and integrity data received from the GAD. PVT Information is used by the VBR for its own internal processing (e.g., for establishing the virtual balise detection).
F11	GNSS Position Integrity	Whenever a new VBG is detected the VBR transmits to the GAD the augmentation and integrity data used to compute PVTs used as a basis for detection of Virtual Balises The GAD after the internal verifications sends to the VBR the GNSS Position Integrity check result. In case the GNSS position integrity fails, the VBR can continue to navigate the Digital Map as far as it can rollback to a previous safe reference position (if available).

Table 6-3: VBR Functionalities

Following the identification of the subsystem functionalities, by means of the test method described in §6.3.1.2, for each of the functionalities listed in Table 6-3 the Validation team has identified one or more high level test scenarios grouped by test category (Ref.6.3.3).

The following table reports, for each identified functionality, the related test case categories.

Functionality	Related Test Case Category
F1	VBR system configuration through ON-BOARD KERNEL orders
F2	Digital Map and Interface Protocol version consistency
F3	Position Initialization from GAD
F3	Position Initialization from TV
F3	Position Initialization from ON-BOARD KERNEL
F4	Transition from SC to SB, NP or SF
F4	Transition from SB to FN, TD, SC, SF or NP
F4	Transition from FN to SB, TD, SC, SF or NP
F4	Transition from TD to SB, SC, FN, SF or NP
F4	Transition from NP to SC
F4	Transition from SF to NP
F5	Digital Map Navigation Integrity
F6	PVT
F7	Augmentation data expiration mechanism
F8	Virtual Balise Detection
F9	TV Message Check
F9	GAD Message Check
F10	Train Orientation Management
F11	GNSS Position Integrity and Rollback

Table 6-4: VBR Test Categories

Furthermore, each hi level test case specification provides a list of the low level test cases specifications as reported in the following example:

Test: VBR_SC_001 **Target**: Main Scenario **Description:** The ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to configure the VBR to provide CTODL. The configuration orders are accepted by VBR only in System Configuration mode (SC), so when VBR (in SC mode) receives a different PDU PKT_BTM_ORDER (Turn off the CTODL provided by VBR) from ON-BOARD KERNEL, the new received information becomes applicable for the VBR.

Table 6-5: Low level test case specification detail example

During the identification of the hi level scenarios, in case a set of functional requirements is regarded as not executable due to the limitations of the available test environment, the Validation team will export them to other phases of the Validation Process.

6.3.1.2 Validation Test Method

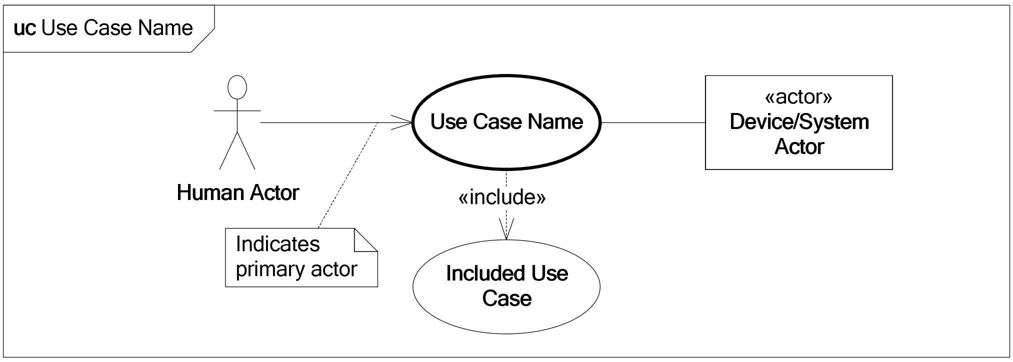

Figure 6-7: Use case

Use case scenarios are specified using numbered lists which detail the order of steps required to perform the use case. Each step is a point of interaction between the system and one of its external actors, an event detected by the system, an internal state transition made by the system, or an instruction to continue the use case elsewhere.

The main scenario is a straightforward numbered list which begins with the use case trigger; e.g.:

Main Scenario 1. The **Customer** inserts his ATM card. 2. The system prompts the **Customer** to enter his PIN. 3. The **Customer** enters his PIN. 4. The system verifies the Customer’s PIN. 5. …

Each alternate scenario is numbered using a hierarchical scheme. The alternate scenario number is prefixed with the number of the step in the main scenario or other alternate scenario at which execution of the use case branches, along with a lower-case letter to denote the scenario. A brief description of the scenario and/or the event that led to its execution is provided. The steps of the alternate scenario are detailed in numbered list, where each item is prefixed with the number of the alternate scenario. The final step in each alternate scenario specifies where the use case continues. For example:

Alternate Scenario 3a

The **Customer** decides to cancel the transaction.

3a1. The **Customer** presses the cancel button.
3a2. The system ejects the Customer's ATM card.
3a3. Use case terminates.

Alternate Scenario 3a2a

The system cannot eject the Customer's ATM card due to a hardware fault.

3a2a1. The system notifies the **Customer** that his ATM card has been withheld.
3a2a2. Use case terminates.

Alternate Scenario 4a

The Customer entered an incorrect PIN.

4a1. The system cannot verify the Customer's PIN.
4a2. The system notifies the **Customer** that the PIN is incorrect.
4a3. Continue at Main Scenario, Step 2.

Alternate Scenario 4b

The Customer entered an incorrect PIN three times.

4b1. The system cannot verify the Customer's PIN and this is the third consecutive failure to verify the PIN.
4b2. The system notifies the **Customer** that the PIN is incorrect and that his ATM card has been withheld.
4b3. Use case terminates.

Asterisks are used to denote alternate scenarios that apply at multiple points in a use case. Alternate scenarios numbered "*a", "*b" etc. apply throughout a use case. Similarly, an alternate scenario numbered "3b*a" (for example) would apply throughout Alternate Scenario 3b.

In longer use cases, the main scenario is divided into a number of parts. Each part is given an uppercase roman number and step numbering continues throughout the sequence of parts. Each part is introduced with a brief description. For example:

Main Scenario – Part I

The **Customer** inserts his ATM card and enters his PIN.

1. The **Customer** inserts his ATM card.
2. The system prompts the **Customer** to enter his PIN.
3. The **Customer** enters his PIN.
4. The system verifies the Customer's PIN.

Main Scenario – Part II
The **Customer** selects a transaction type. 5. The system prompts the **Customer** to select a transaction type. 6. The **Customer** selects a transaction type. **7. ...**

Parallelism of use case performance is used extensively in this document. Unless specified otherwise, all use cases can be performed concurrently with each other (including concurrent performances of the same use case).

In the case that a given use case may not be performed concurrently with another use case (or the same use case) then the trigger of the respective use cases will be conditioned such that the concurrent performance does not occur.

6.3.1.2.1 Notational Conventions

Some use cases are related to other use cases by way of *inclusion*. Use case *U* is included in use case *V* if and only if use case *V* contains one of the following phrases in one or more of its scenarios:

- “Continue at U use case.”
- “Perform U use case.”
- “Begin performing U use case.”

The phrase “Begin performing…” denotes parallel branching: the performance of the use case containing this phrase would continue in parallel to the performance of the use case referred to in the phrase.

6.3.1.2.2 Typographic Conventions

The following typographic conventions are used in this document.

Boldface.

Any reference to the name of an actor in a use case step where the system is interacting with that actor.

The word “shall”.

Italics.

References to entities from the Domain Model excluding actors.

References to use case names.

6.3.2 Test Environments

This section aims at describing the test environments used for the testing activities.

6.3.2.1 Laboratory Test Environment case 2

The following Figure 6-8 depicts the simulation environment that will be used for the formal testing activities related to the VBR subsystem.

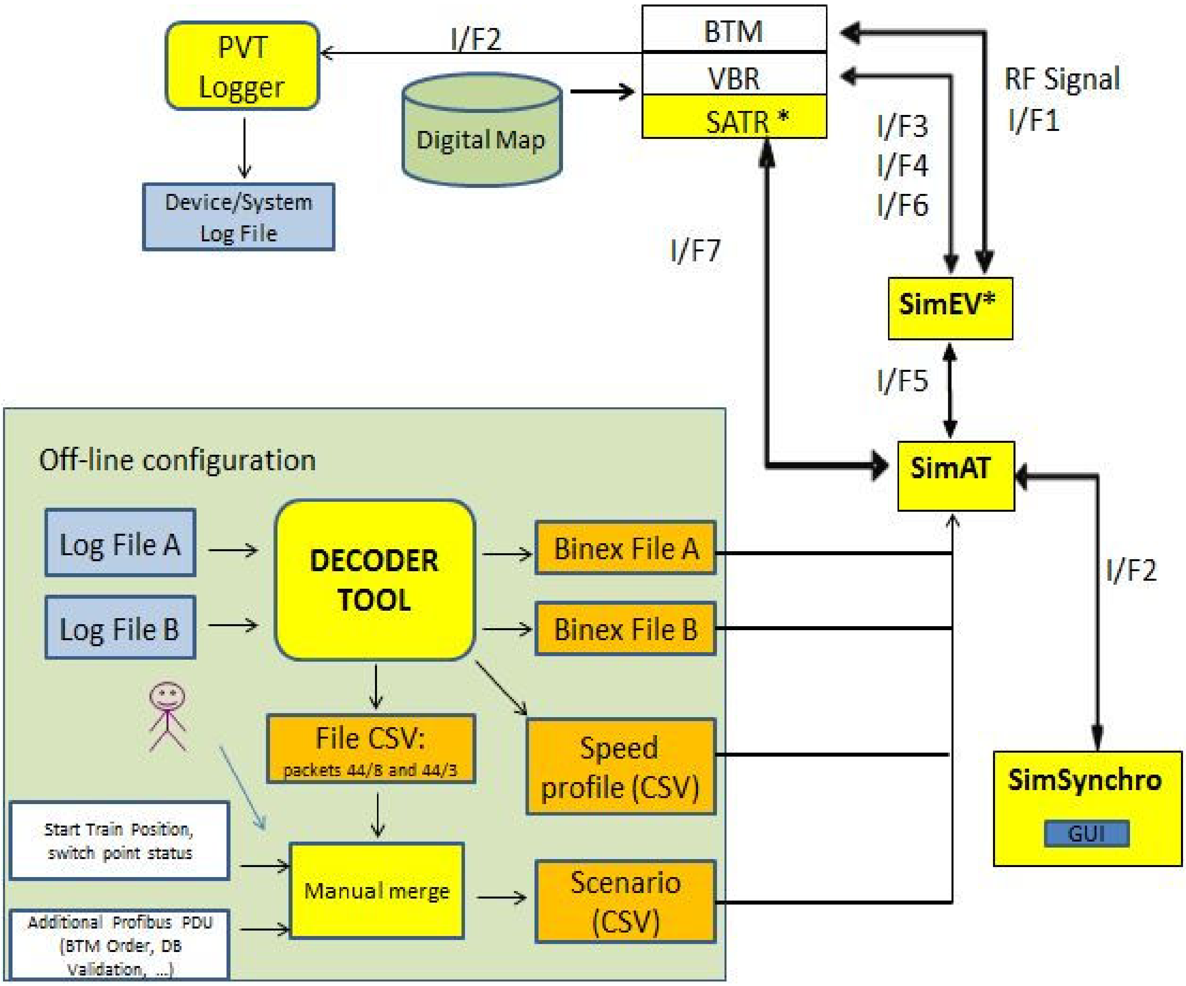

Figure 6-8: Laboratory test execution environment case 2

Interface	Description
I/F1	RF Signal
I/F2	Ethernet link
I/F3	CTODL serial 485 (transmitted to VBR)
I/F4	Profibus serial 485
I/F5	TCP/IP proprietary SimAT-SimEV
I/F6	CTODL on Ethernet (received from VBR)
I/F7	USB interface between SimAT and VBR used for Binex

In which:

- SimAT is a Tool to simulate a train running on a specific line;

In particular SimAT provides to VBR the already decoded satellite data (Binex) and all the information sent by VBTS trackside during the mission.

- SimEV is a system that includes a PC application and a set of boards to interface with VBR in role of gateway.
- SymSinchro is a tool used in order to manage the synchronization between:
  - The decoded signal satellite (raw data)
  - The data from the VBTS wayside
  - The train speed profile.
- VBR/BTM is the target under test.
- PVT LOGGER is a diagnostic recorder.
- DECODER Tool is a proprietary tool used in order to capture all the information (e.g., packets, raw data) during the real run train. In detail this tool is involved in the test scenario generation phase.

It's crucial to highlight that the detailed explanation of the aforementioned tools is beyond the purpose of this deliverable. However, it should be specified that they are components of the demonstrator testbench.

6.3.2.1.1 Test scenario generation case 2

In this chapter is reported a brief description about the generation of the test scenario to be executed using the laboratory test environment.

As depicted in Figure 6-8, the core of the off-line configuration and the preparation of the test scenario start using as input the Log Files obtained during the train run executed in a suitable Trial Site. So, involving the DECODER tool four main output files are generated as reported below:

- A csv file containing the information about the space-speed-time profile of the train run.
- Two files (for receiver A and receiver B) with extension .dat containing the raw data from satellites, in Binex format, suitable for SimAT.
- A csv file suitable to be played in SimAT and containing the differential corrections and navigation data (packets 44/3 and 44/8) that the train received from VBTS Trackside during its train run;
  In this step, the final output file contains Also, the information to be sent to VBR by SimAT, related to the start point and the switch point status. During this phase, the user shall also add the necessary

Profibus PDU to be sent to VBR, according to the test that has to be performed (BTM Order, DB validation, etc.).

By means of the aforementioned actions both nominal and degraded cases can be simulated.

6.3.2.2 Evaluation Performance in case of Feared Events

GNSS satellite signal can be often affected by signal degradation because of particular events (feared events). These events may impact the availability and continuity of the service.

In detail, we can distinguish between two types of feared events:

- System feared events: deriving from the malfunctioning of some system elements;
- Local feared events: these are local threats with respect to the receiver.

Within this context, especially local feared events have been produced and analyzed.

In particular, three cases are considered:

1. Excessive multipath: multipath is the most significant measurement error source which is due to the multiple rays at the receiver antenna input due to the reflection effects of GNSS signals with the surrounding environment. Multipath impacts on the performance of GNSS signal tracking and, consequently, affects the PVT solution. When multipath is excessive a signal loss can be experienced.
2. Non-line-of-sight conditions: this condition occurs when there are large obstacles along the receiver trajectory (like buildings, tunnels). These obstacles can obstruct the GNSS signal from one or more satellites leading to very large errors in tracking and position.
3. Excessive electromagnetic interference: railway environment could be hostile because of several sources of interference. This interference can impact on the raw measurements leading to a total obscuration of satellites.

6.3.2.2.1 Feared Events: Test scenario generation

In this chapter is reported a brief description about the generation of the first scenario to be executed using the laboratory test environment. The feared events scenario uses the same speed profile and train path used for the simulation of Figure 6-8, but the aim of the off-line configuration this time is to produce two different Binex A and B containing degraded raw data (less satellites visibility or corrupted signal).

For this project, feared events scenarios are produced through tools by Radiolabs, GNSSTE and the StellaNGC system.

The first tool, the GNSS Test Environment (GNSSTE) introduces the effects of the local environment to the GNSS signals in terms of:

- Obstruction and multipath;
- RF interference.

The simulation approach chosen for the GNSSTE is based on ray propagation techniques that consist in:

- identify the physical phenomena of the propagation of the electromagnetic signal between satellite and train and between RF interference and train (direct rays, reflected rays from the ground, reflected rays by obstacles and diffracted rays by the edges of the obstacles);
- obtain, from the information related to the rays (delay and amplitude of the field), the multipath channel model or the signal received;
- evaluate the J/S ratio due to intentional or unintentional RFI (i.e. intentional or unintentional jamming).

The GUI permits to the user to:

- create and manage a realistic 3D scenario composed of:
  - orographic terrain;

    - buildings;
    - infrastructures;
- set satellite, train and RFI positions;
- manage the antennas and materials database;
- perform the EM simulation by means of the RayTracer;
- visualize and save the results;
- perform same post-processing operations

At the end of the EM simulation, for every epoch, the results (output quantities) visualized in the main GUI are:

- Ray tracing (Multipath);
- Sky Visibility Map;
- J/S RATIO.

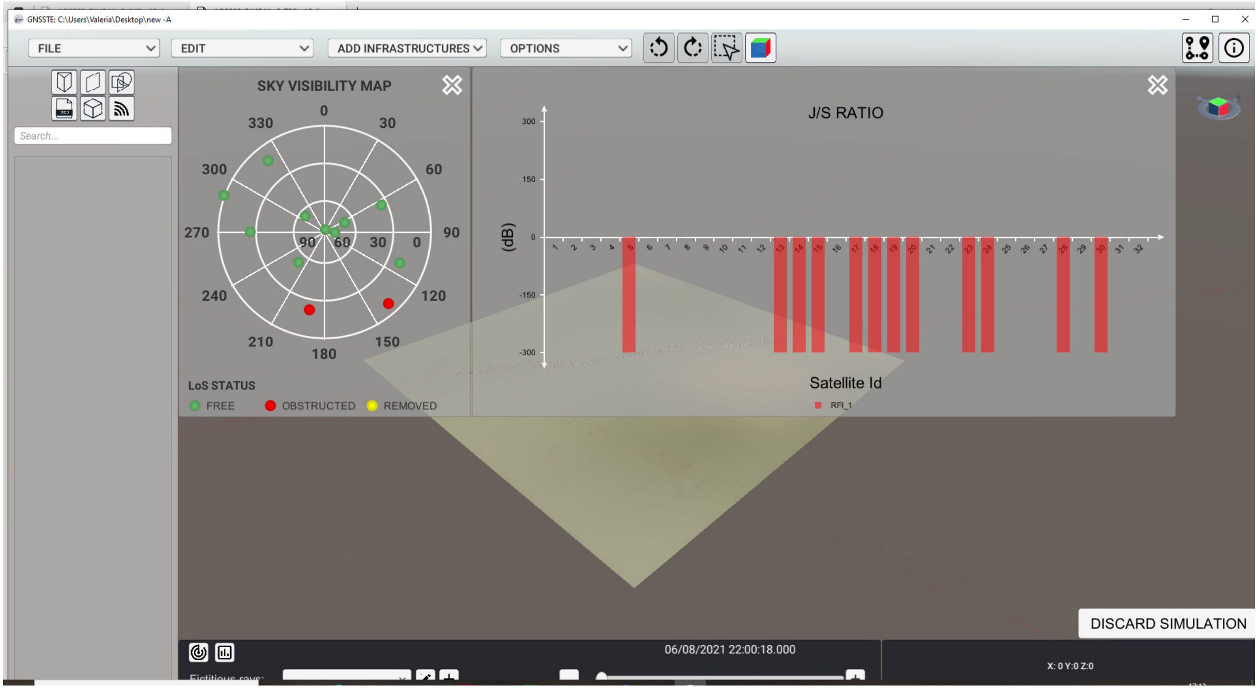

Figure 6-9: The GNSSTE GUI at the end of simulation

While, the StellaNGC system provides to configure scenarios and to complete the simulation.

The StellaNGC system is composed of several functional blocks, as shown in the following figure.

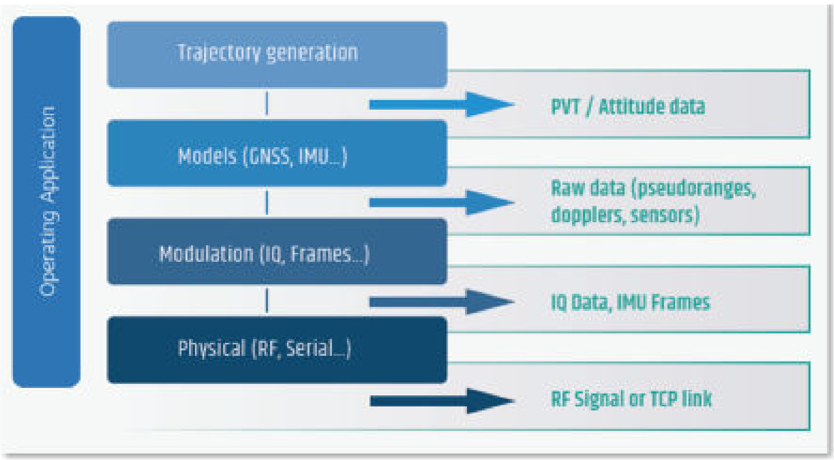

Figure 6-10: StellaNGC System Architecture

These blocks aim to fulfil the following functions:

Operating Application

• Provides the user interface for configuration, monitoring and control

• Handles all the data flows and hardware synchronization

Trajectory

• Handles incoming closed-loop trajectory information

• Configures open-loop trajectories based on NMEA, KML or Ephemeris data

• Handles mobile's evolving attitude in real-time

Models

• Computes constellation parameters: pseudoranges, power, dopplers, etc.

• Computes atmospheric and multipath perturbations

• Handles the effects of the mobile's antenna and its surroundings

• Handles mobile's satellite visibility in real-time

Modulation

• Creates the IQ modulated GNSS signals in a digital format

• Creates the IMU digital frames

Physical

• Modulates the IQ GNSS digital information on an output RF carrier

• Creates the serial data flow for the IMU output

For this project, we first considered a scenario affected by only multipath (produced by adding some buildings of 10-100m height and other wood material elements) and, then, we added the interference source of 10Hz power.

6.3.2.2.2 Test scenario description

The considered scenario refers to the path as depicted in Figure 6-11.

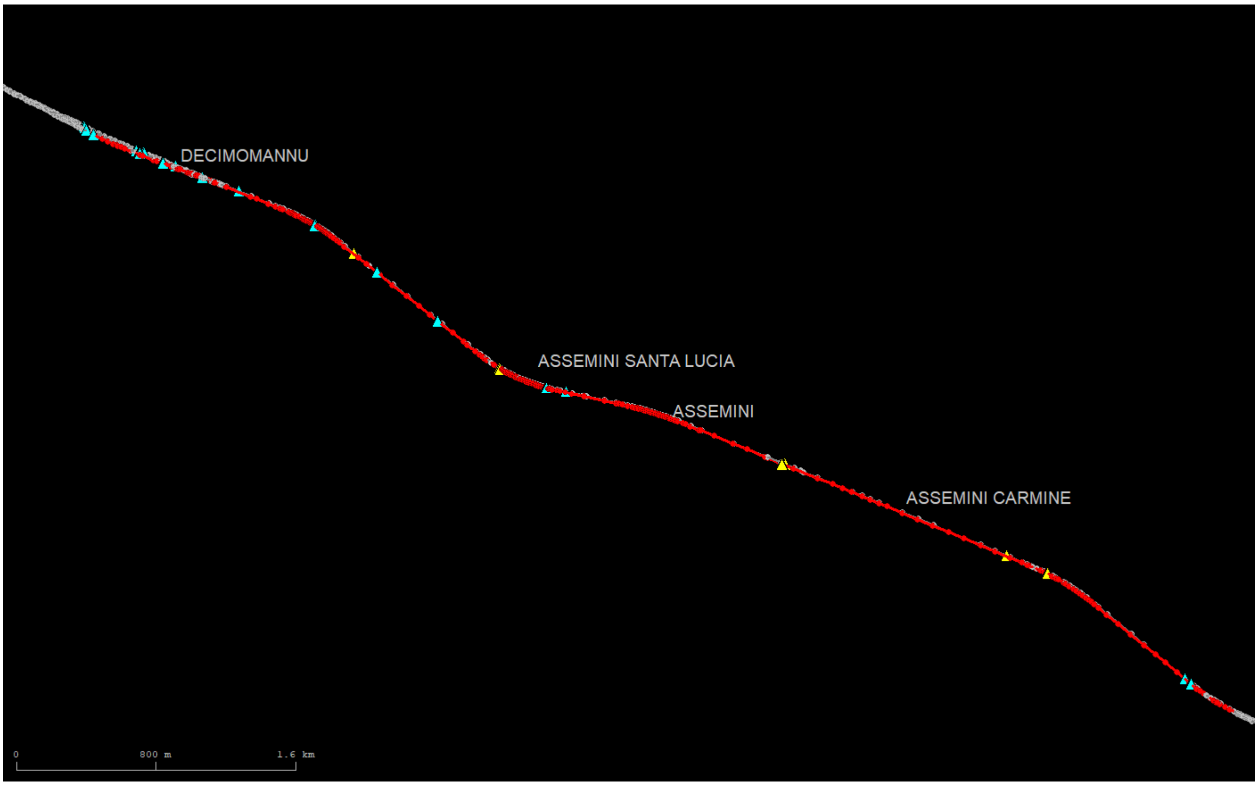

Figure 6-11: The scenario path referred by the test

This scenario follows the speed profile of Figure 6-12, reaching a maximum speed of about 14 m/s with one intermediate stop (of about 60 seconds), for a total time of about 30 minutes.

The train orientation is Nominal (Left-to-Right) and the detected balises are VBGs and Eurobalises with NID_BG= 9088, 9089, 9345, 9045, 9145, 9245, 9047, 9149, 9049, 9052 and 9054, respectively.

This path has been surrounded by buildings between 50-150 m height, in order to simulate the multipath.

For the interference, two RFI (Radio Frequency Interference) are placed. The first, close to VBG with NID_BG = 9045, is a DSSS (Direct Sequence Spread Spectrum) interference; while the second, placed in correspondence to the stop of the train, is a WGN (White Gaussian Noise) interferent. The Power of both interferences is set to 7 W.

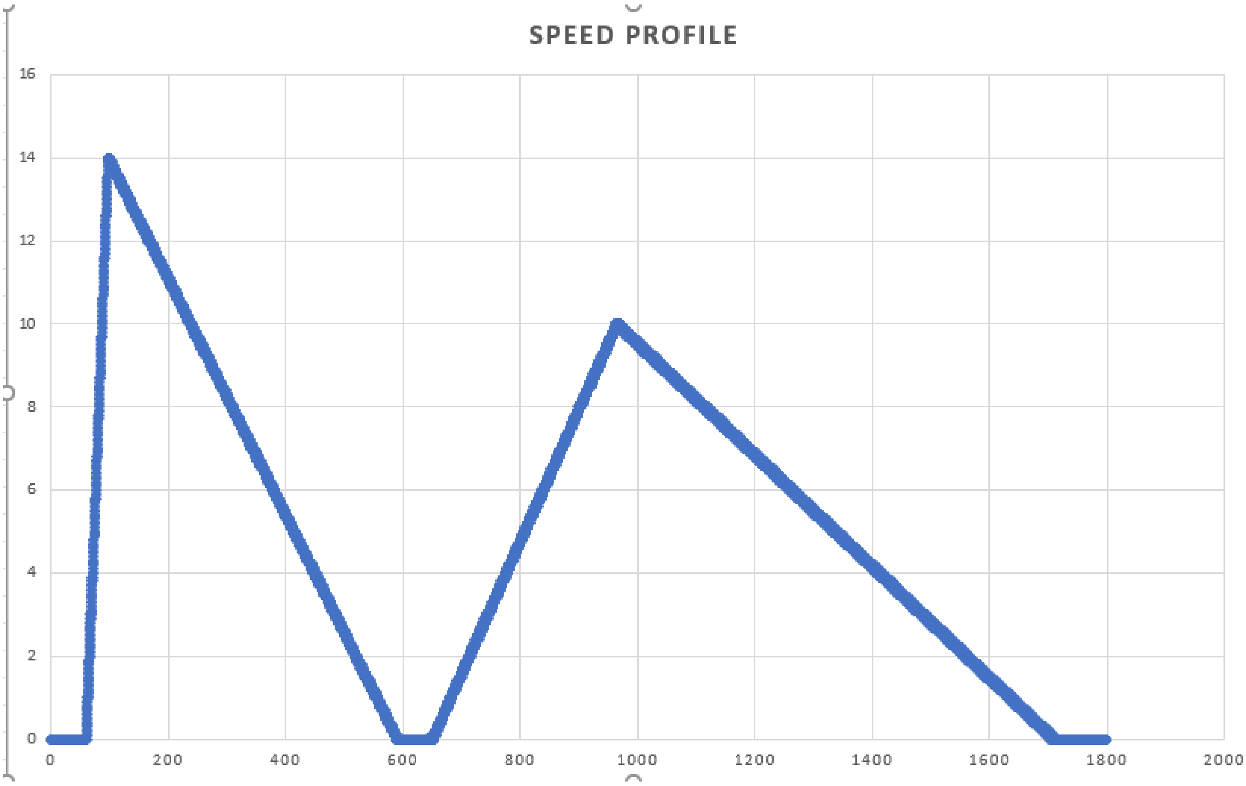

Figure 6-12: Speed Profile Graph. On the abscissa there is time in s, on the ordinate the speed in terms of m/s

6.3.3 VBR Scenarios Suite

This test case suite regards the validation of the subsystem from the VBR point of view. All the other sub-systems involved are considered as an input.

6.3.3.1 VBR and BTM system configuration through ON-BOARD KERNEL orders

The ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to configure the VBR. The VBR terminates the configuration procedure and replies to ON-BOARD KERNEL with the VBR Internal Status Information.

The ON-BOARD KERNEL configures the VBR (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER) to:

• Turn on the CTODL provided by the VBR

• Turn off the CTODL provided by the VBR

• Turn on the Virtualization of EuroBalises function

• Turn off the Virtualization of EuroBalises function

When the configuration procedure is ended, VBR transmits to ON-BOARD KERNEL, through the PDU Number 1 (PKT_STATUS_BTM) the internal status modifications (M_VBR_OB_STATUS).

Trigger

The VBR is configured by ON-BOARD KERNEL to provide CTODL (i.e. message number 208: Odometric Information).

Precondition

VBR is in SC mode.

Postcondition

VBR is in SC, SF or NP mode.

Main Scenario

The ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to configure the VBR to provide CTODL. The configuration orders are accepted by VBR only in System Configuration mode (SC), so when VBR (in SC mode) receives a different PDU PKT_BTM_ORDER (Turn off the CTODL provided by VBR) from ON-BOARD KERNEL, the new received information becomes applicable for the VBR.

1. VBR receives from ON-BOARD KERNEL the PDU Number 3 (PKT_BTM_ORDERS) with M_VBR_OB_ORDERS = Turn on the CTODL provided by VBR.

2. Operational mode of the VBR is SC.

3. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PKT_STATUS_BTM) with Q_VBR_OB_OP-MODE = SC and M_VBR_OB_STATUS = VBR is providing CTODL.

4. VBR sends the Message Number 208 (Odometer Information) to ON-BOARD KERNEL.

5. The EVC performs the following actions to activate EuroBalise detection:

- It shall order that BTM FSM goes in Standby Mode;
- It shall order that BTM FSM goes in BTM_MODE (i.e. *Normal Mode* for BTM part) and, at the same time, it has to properly configure the BTM Antenna.

6. Packet 220 is sent to inform VBR about which BTM (i.e. which BTM’s antenna) has been activated.

7. VBR is in mode SC and receives from ON-BOARD KERNEL another PDU Number 3 (PKT_BTM_ORDERS) with M_VBR_OB_ORDERS = Turn off the CTODL provided by VBR.

8. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PKT_STATUS_BTM) with Q_VBR_OB_OPMODE = SC and M_VBR_OB_STATUS = VBR is NOT providing CTODL and stops to provide the Message Number 208 to ON-BOARD KERNEL.

9. Use case terminates.

Alternate Scenario 1a

VBR is configured to Turn on the Virtualization of EuroBalises function.

1a1. VBR receives from ON-BOARD KERNEL the PDU Number 3 (PKT_BTM_ORDERS) with M_VBR_OB_ORDERS = Turn on the Virtualization of EuroBalises function.

1a2. Operational mode of the VBR is SC.

1a3. VBR sends to ON-BOARD KERNEL the PDU Number 1 and M_VBR_OB_STATUS = Virtualization of EuroBalises function is Turned ON.

1a4. Use case terminates.

Alternate Scenario 1b

VBR is configured to Turn off the Virtualization of EuroBalises function and BTM is just configured to remains in Standby mode.

1b1. VBR receives from ON-BOARD KERNEL the PDU Number 3 (PKT_BTM_ORDERS) with M_VBR_OB_ORDERS = Turn off the Virtualization of EuroBalises function.

1b2. Operational mode of the VBR is SC.

1b3. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PKT_STATUS_BTM) with Q_VBR_OB_OPMODE = SC and M_VBR_OB_STATUS = Virtualization of EuroBalises function is Turned OFF.

1b4. The EVC orders that BTM FSM goes in Standby Mode; but not in BTM_MODE.

1b5. Packet 220 is sent to inform VBR about which BTM (i.e. which BTM's antenna) has been activated.

1b6. While BTM is in Standby mode it is not able to detect Eurobalises.

1b7. Use case terminates.

Alternate Scenario 1c

VBR is configured to provide the CTODL and to Turn On the EuroBalises function Virtualization.

1c1. VBR receives from ON-BOARD KERNEL the PDU Number 3 (PKT_BTM_ORDERS) with M_VBR_OB_ORDERS = Virtualization of EuroBalises function is Turned ON and VBR is providing CTODL.

1c2. Operational mode of the VBR is SC.

1c3. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PKT_STATUS_BTM) with Q_VBR_OB_OPMODE = SC and M_VBR_OB_STATUS = Virtualization of EuroBalises function is Turned ON and VBR is providing CTODL.

1c4. Use case terminates.

Alternate Scenario 1d

VBR receives from ON-BOARD KERNEL the PDU Number 3 (PKT_BTM_ODERS) containing values out of range. For this reason the PDU is rejected and VBR doesn't perform the configuration procedure.

1d1. VBR receives from ON-BOARD KERNEL the PDU Number 3 (PKT_BTM_ORDERS) with M_VBR_OB_ORDERS = Out of Range.

1d2. VBR rejects the PDU Number 3 (PKT_BTM_ORDERS) and doesn't perform the configuration procedure.

1d3. VBR doesn't send to ON-BOARD KERNEL any PDU Number 1 (PKT_STATUS_BTM).

1d4. Continue at Digital Map and Interface Protocol version consistency check (case Alternate Scenario 1a: Step 1).

Alternate Scenario 7a

The ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to configure the VBR to provide CTODL. The configuration orders are accepted by VBR only in System Configuration mode (SC), so when VBR (in SB mode) receives a different PDU PKT_BTM_ORDER (Turn off the CTODL provided by VBR) from ON-BOARD KERNEL, the new received information is not applicable for the VBR.

5a1. VBR in SC mode receives from TV the packet 44/1 (Digital Map and Interface Protocol Version Packet).

5a2. VBR checks successfully the VBR DB and IP version and switches to SB mode.

5a3. VBR is in mode SB and receives from ON-BOARD KERNEL another PDU Number 3 (PKT_BTM_ORDERS) with M_VBR_OB_ORDERS = Turn off the CTODL provided by VBR.

6. VBR ignores the configuration order received in SB, it doesn’t send another PDU Number 1 (PKT_STATUS_BTM) with the last configuration order receveid and continues to provide the Message Number 208.

7. Use case terminates.

Alternate Scenario 7a3a

The ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to configure the VBR to provide CTODL. The configuration orders are accepted by VBR only in System Configuration mode (SC), so when VBR (in SB mode) and then return to SC, it receives a different PDU PKT_BTM_ORDER (Turn off the CTODL provided by VBR) from ON-BOARD KERNEL, the new received information is applicable for the VBR.

5a3a1. VBR is in mode SB and checks unsuccessfully the VBR DB and IP version and switches to SC mode.

5a3a2. VBR receives from ON-BOARD KERNEL another PDU Number 3 (PKT_BTM_ORDERS) with M_VBR_OB_ORDERS = Turn off the CTODL provided by VBR.

5a3a3. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PKT_STATUS_BTM) with Q_VBR_OB_OPMODE = SC and M_VBR_OB_STATUS = VBR is NOT providing CTODL, and stops to provide the Message Number 208 to ON-BOARD KERNEL.

5a3a4. Use case terminates.

Alternate Scenario 1b4a

VBR is configured to Turn off the Virtualization of EuroBalises function and BTM is not configure and remains in Startup mode.

1b4a1. The EVC does not send order for BTM FSM and, hence, the BTM remains in Start-Up Configuration.

1b4a2. Packet 220 is sent to inform VBR about which BTM (i.e. which BTM's antenna) has been activated.

1b4a3. While BTM is in Start up mode it is not able to detect Eurobalises.

1b4a4. Use case terminates.

Alternate Scenario *a

Operational mode of the VBR changes to SF.

*a1. The VBR detects a fault that affects safety.

*a2. Operational mode of the VBR changes to SF.

*a3. Use case terminates.

Alternate Scenario *b

Operational mode of the VBR changes to NP.

*b1. The VBR is switched-off.

*b2. Operational mode of the VBR changes to NP.

*b3. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1.

Alternate Scenario 1a: REQ_8.1.1.1.

Alternate Scenario 1b: REQ_8.1.1.1.

Alternate Scenario 1c: REQ_8.1.1.1.

Alternate Scenario 1d: REQ_8.1.1.1.

Alternate Scenario 5a: REQ_8.1.1.1.

Alternate Scenario 7a3a: REQ_8.1.1.1.

Alternate Scenario 1b4a: REQ_8.1.1.1.

Alternate Scenario *a: REQ_8.1.1.1.

Alternate Scenario *b: REQ_8.1.1.1.

Test: VBR_SC_001

Target: Main Scenario

Description: The ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to configure the VBR to provide CTODL. The configuration orders are accepted by VBR only in System Configuration mode (SC), so when VBR (in SC mode) receives a different PDU PKT_BTM_ORDER (Turn off the CTODL provided by VBR) from ON-BOARD KERNEL, the new received information becomes applicable for the VBR.

Test: VBR_SC_002

Target: Alternate Scenario 1a

Description: VBR is configured to Turn on the Virtualization of EuroBalises function.

Test: VBR_SC_003

Target: Alternate Scenario 1b

Description: VBR is configured to Turn off the Virtualization of EuroBalises function and BTM is just configured to remains in Standby mode.

Test: VBR_SC_004

Target: Alternate Scenario 1c

Description: VBR is configured to provide the CTODL and to Turn On the EuroBalises function Virtualization.

Test: VBR_SC_005

Target: Alternate Scenario 1d

Description: VBR receives from ON-BOARD KERNEL the PDU Number 3 (PKT_BTM_ODERS) containing values out of range. For this reason the PDU is rejected and VBR doesn't perform the configuration procedure.

Test: VBR_SC_006

Target: Alternate Scenario 5a

Description: The ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to configure the VBR to provide CTODL. The configuration orders are accepted by VBR only in System Configuration mode (SC), so when VBR (in SB mode) receives a different PDU PKT_BTM_ORDER (Turn off the CTODL provided by VBR) from ON-BOARD KERNEL, the new received information is not applicable for the VBR.

Test: VBR_SC_007

Target: Alternate Scenario 7a3a

Description: The ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to configure the VBR to provide CTODL. The configuration orders are accepted by VBR only in System Configuration mode (SC), so when VBR (in SB mode) and then return to SC, it receives a different PDU PKT_BTM_ORDER (Turn off the CTODL provided by VBR) from ON-BOARD KERNEL, the new received information is applicable for the VBR.

Test: VBR_SC_008

Target: Alternate Scenario 1b4a

Description: VBR is configured to Turn off the Virtualization of EuroBalises function and BTM is not configure and remains in Startup mode.

Test: VBR_SC_009

Target: Alternate Scenario *a

Description: Operational mode of the VBR changes to SF.

Test: VBR_SC_010

Target: Alternate Scenario *b

Description: Operational mode of the VBR changes to NP.

6.3.3.2 Digital Map and Interface Protocol version consistency

In this category of scenarios is supposed that the following actions have already been successfully performed:

- The connection between RBC and ON-BOARD KERNEL is established (in accordance with the ERTMS/ETCS requirements)

- Start-up self-test execution and VBR System configuration have been successfully performed

- The connection between RBC and GAD on Channel 0 is active

- Databases and the Interface Protocol versions consistency from RBC/TV and GAD has been successfully performed.

The VBR performs:

• Version check between RBC DB version and VBR DB version

• Interface protocol version consistency between TV and VBR

• Sending to TV the result of check consistency.

Trigger

VBR receives from TV the packet 44/1 (Digital Map and Interface Protocol Version Packet).

Precondition

VBR is either in SC, SB, TD or FN mode.

Postcondition

VBR is either in SC, SB, TD or FN mode.

Main Scenario

1. VBR is SC mode receives from TV the packet 44/1 (Digital Map and Interface Protocol Version Packet).

2. VBR checks the VBR DB version with the version identifier of the RBC DB and the Interface protocol version consistency between the Interface Protocol used by TV and VBR.

3. Digital Map Validation and Interface Protocol check version ended successfully.

4. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) with the result of the check performed (Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match).

5. Operational mode of VBR switches from SC to SB.

6. VBR continues to send to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result).

7. Continue at Position Initialization from GAD (case Main Scenario: Step 1).

Alternate Scenario 1a

In this scenario the VBR is in SC mode and the configuration orders have been unsuccessfully performed. The Digital Map Validation and Interface Protocol check version ended successfully, but the operational mode cannot evolve to SB mode.

1a1. VBR is SC mode receives from TV the packet 44/1 (Digital Map and Interface Protocol Version Packet).

1a2. VBR checks the VBR DB version with the version identifier of the RBC DB and the Interface protocol version consistency between the Interface Protocol used by TV and VBR.

1a3. Digital Map Validation and Interface Protocol check version ended successfully.

1a4. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) with the result of the check performed (Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match).

1a5. Operational mode cannot evolve to SB. The VBR is in SC mode.

1a6. Use case terminates.

Alternate Scenario 3a

The Digital Map Version Validation is in download phase.

3a1. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) with Q_DBVALIDATE= In Download and Q_IFPROTOVERCHKRES= Match.

3a2. Operational mode of VBR is SC.

3a3. Continue at Position Initialization from GAD (case Alternate Scenario 1a: Step 1).

Alternate Scenario 3b

In this scenario the Digital Map Validation and Interface Protocol version ended unsuccessfully.

3b1. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE = Not Match and Q_IFPROTOVERCHKRES= Not Match.

3b2. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

3b3. Operational mode of VBR is SC.

3b4. Use case terminates.

Alternate Scenario 3c

In this scenario the Digital Map Version Validation has been unsuccessfully performed.

3c1. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) with Q_DBVALIDATE= Not Match and Q_IFPROTOVERCHKRES= Match.

3c2. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

3c3. Operational mode of VBR is SC.

3c4. Use case terminates.

Alternate Scenario 3d

In this scenario the Digital Map Version Validation has been unsuccessfully performed.

3d1. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Not Match.

3d2. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

3d3. Operational mode of VBR is SC.

3d4. Use case terminates.

Alternate Scenario 5a

5a1. Operational mode is SB.

5a2. VBR continues to send to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) with the result of the check performed (Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match.

5a3. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

5a4. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match.

5a5. Operational mode of VBR is still SB.

5a6. Continue at Position Initialization from GAD (case Main Scenario: Step 1).

Alternate Scenario 5b

5b1. Operational mode of VBR is SB.

5b2. VBR continues to send to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) with the result of the check performed (Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match.

5b3. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

5b4. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Not Match and Q_IFPROTOVERCHKRES= Not Match.

5b5. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

5b6. Operational mode of VBR switches from SB to SC.

5b7. Use case terminates.

Alternate Scenario 5c

5c1. Operational mode of VBR is SB.

5c2. VBR continues to send to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) with the result of the check performed (Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match).

5c3. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

5c4. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Not Match and Q_IFPROTOVERCHKRES= Match.

5c5. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

5c6. Operational mode of VBR switches from SB to SC.

5c7. Use case terminates.

Alternate Scenario 5d

5d1. Operational mode of VBR is SB.

5d2. VBR continues to send to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) with the result of the check performed (Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match).

5d3. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

5d4. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Not Match.

5d5. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

5d6. Operational mode of VBR switches from SB to SC.

5d7. Use case terminates.

Alternate Scenario 1b

1b1. Operational mode of VBR is TD.

1b2. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet).

1b3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match.

1b4. Operational mode of VBR is still TD.

1b5. Use case terminates.

Alternate Scenario 1c

1c1. Operational mode of VBR is TD.

1c2. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

1c3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Not Match and Q_IFPROTOVERCHKRES= Not Match.

1c4. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1c5. Operational mode of VBR switches from TD to SC.

1c6. Use case terminates.

Alternate Scenario 1d

1d1. Operational mode of VBR is TD.

1d2. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

1d3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Not Match and Q_IFPROTOVERCHKRES= Match.

1d4. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1d5. Operational mode of VBR switches from TD to SC.

1d6. Use case terminates.

Alternate Scenario 1e

1e1. Operational mode of VBR is TD.

1e2. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

1e3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Not Match.

1e4. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1e5. Operational mode of VBR switches from TD to SC.

1e6. Use case terminates.

Alternate Scenario 1f

1f1. Operational mode of VBR is FN.

1f2. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

1f3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match.

1f4. Operational mode of VBR is still in FN.

1f5. Use case terminates.

Alternate Scenario 1g

1g1. Operational mode of VBR is FN.

1g2. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

1g3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Not Match and Q_IFPROTOVERCHKRES= Not Match.

1g4. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1g5. Operational mode of VBR switches from FN to SC.

1g6. Use case terminates.

Alternate Scenario 1h

1h1. Operational mode of VBR is FN.

1h2. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

1h3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Not Match.

1h4. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1h5. Operational mode of VBR switches from FN to SC.

1h6. Use case terminates.

Alternate Scenario 1i

1i1. Operational mode of VBR is FN.

1i2. VBR receives the packet 44/1 (Digital Map and Interface Protocol Version Packet)

1i3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Not Match and Q_IFPROTOVERCHKRES= Match.

1i4. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1i5. Operational mode of VBR switches from FN to SC.

1i6. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 1a: REQ_8.1.3.6, REQ_8.1.1.1

Alternate Scenario 3a: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 3b: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 3c: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 3d: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 5a: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 5b: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 5c: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 5d: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 1b: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 1c: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 1d: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 1e: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 1f: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 1g: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 1h: REQ_8.1.1.1, REQ_8.1.3.6.

Alternate Scenario 1i: REQ_8.1.1.1, REQ_8.1.3.6.

Test: VBR_DMIPC_001

Target: Main Scenario

Description: In this scenario VBR is in SC mode and it performs:

• Version check between RBC DB version and VBR DB version

• Interface protocol version consistency between TV and VBR

• Sending to TV the positive result of check consistency.

Operation mode can evolve to SB mode.

Test: VBR_DMIPC_002

Target: Alternate Scenario 1a

Description: In this scenario the VBR is in SC mode and the configuration orders have been unsuccessfully performed. The Digital Map Validation and Interface Protocol check version ended successfully, but the operational mode cannot evolve to SB mode.

Test: VBR_DMIPC_003

Target: Alternate Scenario 3a

Description: The Digital Map Version Validation is in download phase (Future behaviour).

Test: VBR_DMIPC_004

Target: Alternate Scenario 3b

Description: In this scenario the Digital Map Validation and Interface Protocol version ended unsuccessfully.

Test: VBR_DMIPC_005

Target: Alternate Scenario 3c

Description: In this scenario the Digital Map Version Validation has been unsuccessfully performed.

Test: VBR_DMIPC_006

Target: Alternate Scenario 3d

Description: In this scenario the Digital Map Version Validation has been unsuccessfully performed.

Test: VBR_DMIPC_007

Target: Alternate Scenario 5a

Description: In this scenario the Digital Map Validation and Interface Protocol version ended successfully.

Test: VBR_DMIPC_008

Target: Alternate Scenario 5b

Description: In this scenario the Digital Map Validation and Interface Protocol version ended unsuccessfully.

Test: VBR_DMIPC_009

Target: Alternate Scenario 5c

Description: In this scenario the Digital Map Validation has been unsuccessfully performed.

Test: VBR_DMIPC_010

Target: Alternate Scenario 5d

Description: In this scenario the Interface Protocol version has been unsuccessfully performed.

Test: VBR_DMIPC_011

Target: Alternate Scenario 1b

Description: In this scenario the Digital Map Validation and Interface Protocol version ended successfully.

Test: VBR_DMIPC_012

Target: Alternate Scenario 1c

Description: In this scenario the Digital Map Validation and Interface Protocol version ended unsuccessfully.

Test: VBR_DMIPC_013

Target: Alternate Scenario 1d

Description: In this scenario the Digital Map Validation has been unsuccessfully performed.

Test: VBR_DMIPC_014

Target: Alternate Scenario 1e

Description: In this scenario the Interface Protocol version has been unsuccessfully performed.

Test: VBR_DMIPC_015

Target: Alternate Scenario 1f

Description: In this scenario the Digital Map Validation and Interface Protocol version ended successfully.

Test: VBR_DMIPC_016

Target: Alternate Scenario 1g

Description: In this scenario the Digital Map Validation and Interface Protocol version ended unsuccessfully.

Test: VBR_DMIPC_017

Target: Alternate Scenario 1h

Description: In this scenario the Digital Map Validation has been unsuccessfully performed.

Test: VBR_DMIPC_018

Target: Alternate Scenario 1i

Description: In this scenario the Interface Protocol version has been unsuccessfully performed.

6.3.3.3 Position Initialization from GAD

In this category of scenarios is supposed that the following actions have already been successfully performed:

• VBR startup autotest and configuration through ON-BOARD KERNEL orders.

• Interface protocol version consistency check with positive result (VBR has sent to TV a packet 44/100 with Q_IFPROTOVERCHKRES= Match).

• A connection from TV to GAD on the channel relative to the train number is established.

In the nominal case the VBR in SB mode is able to calculate its not-augmented position and provide to GAD this information (packet 44/101 with known value). So, the GAD calculates and sends to VBR the interpolated correction for the approximate position into a 44/3 packet. If this step is properly performed, the VBR change its internal state from SB to TD.

In this category is also verified the correct application in SB\TD mode of the differential corrections expiration mechanism based on time (SB\TD) and space (TD), relating to the packet 44/3 based on Unaugmented Position.

Trigger

VBR receives from GAD the packet 44/11 (GNSS Parameters).

Precondition

VBR is in SC or SB.

Postcondition

VBR is in TD or FN.

Main Scenario

VBR is in SB mode and when satellite and augmentation data are received the VBR switches to TD mode.

1. Operational mode of VBR is SB.

2. VBR sends to GAD the Reference Position (packet 44/101) with:

• NID_LRBG=Unknown.

3. VBR sends to TV the packet 44/103 (Position Report Validation Request) with an empty list (due to SB mode) to request a safe and unique train position information on the Digital Map.

4. VBR receives from GAD the packet 44/11 (GNSS Parameters).

5. VBR receives from GAD the packets 44/8 (GNSS Navigation Data) for each available satellite.

6. VBR is able to calculate an unsafe PVT and it sends to GAD the packet 44/101 (Reference Position) with:

• NID_LRBG=Known.

In order to request augmentation data valid for that area.

7. VBR continues to send to TV the packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

8. VBR receives from GAD the packets 44/3 (GNSS Differential Corrections Packet) with:

• D_ESTODO_BG=Unknown.

(value contained in PDU 7 that transports packet 44/3).

9. VBR considers that augmentation data are valid relating to the expiration mechanisms based on time in SB mode.

10. Operational mode of VBR switches from SB to TD.

11. VBR stops to send the packet 44/100

12. VBR continues to send

• To GAD the packet 44/101

• To TV the packet 44/103 with:

NID_LRBG=known.

13. Use case terminates.

Alternate Scenario 1a

In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode is verified the expiration mechanism based on time to check if the augmentation data are valid for the augmented position computed accordingly.

1a1. Operational mode of VBR is SC.

1a2. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match.

1a3. Operational mode of VBR switches from SC to SB.

1a4. VBR receives from GAD the packet 44/11 (GNSS Parameters).

1a5. VBR receives from GAD the packet 44/8 (GNSS Navigation Data).

1a6. VBR is able to calculate an unsafe PVT and it sends to GAD the packet 44/101 (Reference Position) with:

• NID_LRBG=UnKnown.

In order to request augmentation data valid for that area.

1a7. VBR sends to TV the packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

1a8. VBR receives from GAD the packets 44/3 (GNSS Differential Corrections Packet) with:

• D_ESTODO_BG=Unknown.

(value contained in PDU 7 that transports packet 44/3).

1a9. VBR considers that augmentation data are valid relating to the expiration mechanisms based on time in SB mode

1a10. Operational mode of VBR switches from SB to TD.

1a11. VBR continues to send

• To GAD the packet 44/101 with NID_LRBG=known.

• To TV the packet 44/100

• To TV the packet 44/103 with:

NID_LRBG=known.

1a12. VBR in TD mode considers that augmentation data are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME provided in the Packet 44/11.

1a13. VBR invalidates the differential corrections, because received at the time T = Reference_Time + T_MAX_EXP_AG_TIME (due to expiration mechanism based on the T_MAX_EXP_AG_TIME of the Packet 44/11).

1a14. Operational mode of the VBR changes from TD to SB.

1a15. VBR sends to TV the packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

1a16. VBR in standstill condition continues to send

• To GAD the packet 44/101 with NID_LRBG=known.

1a17. VBR is in SB mode and the unsafe train position isn't available due to the loss of the satellite signal on both reception channels.

1a18. VBR continues to send:

• To GAD the packet 44/101 with NID_LRBG=known and packet 44/103 with N_ITER=0 (empty list based on unaugmented PVT)

1a19. Continues at Position Initialization from TV (case Alternate Scenario 1a).

Alternate Scenario 2a

VBR has received a PDU 7 with a known value of D_ESTODO_BG (So, the LRBG is known to the VBTS trackside). Therefore when VBR switches to SB mode it doesn't send to GAD the pkt 44/101.

The differential corrections received in SB are valid for the expiration mechanism based on time, but in TD mode VBR considers that augmentation data are not valid anymore due to expiration mechanism based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11.

2a1. VBR is SB mode doesn't send to GAD the packet 44/101.

2a2. VBR receives from GAD the packets 44/3 (GNSS Differential Corrections Packet) with:

• D_ESTODO_BG=known.

(value contained in PDU 7 that transports packet 44/3).

2a3. VBR considers that augmentation data are valid relating to the expiration mechanisms based on time in SB mode.

2a4. Operational mode of VBR switches from SB to TD.

2a5.When (|CTODL_CURR - D_ESTODO_BG|) > D_MAX_EXP_AG_SPACE, VBR invalidates the differential corrections related to the satellite 2 (due to expiration mechanism based on the D_MAX_EXP_AG_SPACE of the Packet 44/11).

2a6. Operational mode switches to SB mode.

2a7. Use case terminates.

Alternate Scenario 1a12a

VBR has successfully performed the preliminary time-based differential corrections freshness check in SB mode and it has switched in TD mode. VBR considers that augmentation data are not valid anymore due to expiration mechanism based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11.

1a12a1. VBR invalidates the differential corrections due to expiration mechanism based on the D_MAX_EXP_AG_SPACE of the Packet 44/11. In this scenario the differential corrections received in SB mode have a D_ESTODO_BG = unknown (contained in PDU 7). At current position P2=(X2,Y2,Z2) represented by the augmented PVT, VBR is in TD mode and it considers that augmentation data freshness verification based on space is unsuccessfully performed. In detail is verified the following condition:

P2-P1 > D_MAX_EXP_AG_SPACE

Where P1 is the NID_LRBG Reference Location with ecef coordinates.

1a12a2. Operational mode switches to SB mode.

1a12a3. Use case terminates.

Alternate Scenario 1b

In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode there are no more sufficient satellites in view and the VBR switches to SB mode.

1b1. Operational mode of VBR is SC.

1b2. VBR receives the packet 44/1.

1b3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match.

1b4. Operational mode of VBR switches from SC to SB.

1b5. VBR is able to calculate an unsafe PVT and it sends to GAD the packet 44/101 (Reference Position) with:

• NID_LRBG=Known.

In order to request augmentation data valid for that area.

1b6. VBR sends to TV the packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

1b7. VBR receives from GAD the packets 44/8 and 44/3 (GNSS Differential Corrections Packet) with:

• D_ESTODO_BG=Unknown.

(value contained in PDU 7 that transports packet 44/3).

1b8. VBR considers that augmentation data are valid relating to the expiration mechanisms based on time in SB mode

1b9. Operational mode of VBR switches from SB to TD.

1b10. VBR continues to send

• To GAD the packet 44/101 with NID_LRBG=known.

• To TV the packet 44/103 with:

NID_LRBG=known.

1b11. VBR receives a packet 44/6 with a D_ESTODO_BG=known and stops to send packet 44/101.

1b12. The unsafe train position isn't available due to the loss of the satellite signal on both reception channels

1b13. VBR switches in SB.

1b14. VBR continues to send packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

1b15. VBR VBR receives a packet 44/6 with a D_ESTODO_BG=Unknown and starts to send again packet 44/101.

1b15. Use case terminates.

Alternate Scenario 2b

VBR has received a PDU 7 with a known value of D_ESTODO_BG (So, the LRBG is known to the VBTS trackside). Therefore, it doesn't send to GAD the pkt 44/101.

The differential corrections received in SB are valid for the expiration mechanism based on time, but in TD mode VBR considers that augmentation data are not valid anymore due to expiration mechanism based on the default value of D_MAX_EXP_AG.

2b1. VBR is SB mode doesn't send to GAD the packet 44/101.

2b2. VBR receives from GAD the packets 44/3 (GNSS Differential Corrections Packet) with:

• D_ESTODO_BG=Known.

(value contained in PDU 7 that transports packet 44/3).

2b3. VBR considers that augmentation data are valid relating to the expiration mechanisms based on time in SB mode.

2b4. Operational mode of VBR switches from SB to TD.

2b5. When (|CTODL_CURR - D_ESTODO_BG|) > D_MAX_EXP_AG_SPACE, VBR invalidates the differential corrections related to the satellite 2 (due to expiration mechanism based on the default value of D_MAX_EXP_AG_SPACE).

2b6. Operational mode switches to SB mode and continues to stop sending of packet 44/101.

2b7. Use case terminates.

Alternate Scenario 2c

VBR has successfully performed the preliminary time-based differential corrections freshness check in SB mode and it has switched in TD mode. VBR considers that augmentation data are not valid anymore due to expiration mechanism based on default D_MAX_EXP_AG_SPACE parameter.

2b1. VBR is SB mode doesn't send to GAD the packet 44/101.

2b2. VBR receives from GAD the packet 44/8 (GNSS Navigation Data).

2b3. VBR sends to TV the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result Packet) with Q_DBVALIDATE= Match and Q_IFPROTOVERCHKRES= Match.

2b4. Operational mode of VBR switches from SC to SB.

1a6. VBR is able to calculate an unsafe PVT and it sends to GAD the packet 44/101 (Reference Position) with:

• NID_LRBG=Known.

In order to request augmentation data valid for that area.

2b5. VBR sends to TV the packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

2b6. VBR receives from GAD the packets 44/3 (GNSS Differential Corrections Packet) with:

• D_ESTODO_BG=Unknown.

(value contained in PDU 7 that transports packet 44/3).

2b7. VBR considers that augmentation data are valid relating to the expiration mechanisms based on time in SB mode

2b8. Operational mode of VBR switches from SB to TD.

2b9. VBR continues to send

• To GAD the packet 44/101 with NID_LRBG=known.

• To TV the packet 44/100

• To TV the packet 44/103 with:

NID_LRBG=known.

2b10. VBR invalidates the differential corrections due to expiration mechanism based on the default D_MAX_EXP_AG_SPACE parameter. In this scenario the differential corrections received in SB mode have a D_ESTODO_BG = unknown (contained in PDU 7). At current position P2=(X2,Y2,Z2) represented by the augmented PVT, VBR is in TD mode and it considers that augmentation data freshness verification based on space is unsuccessfully performed. In detail is verified the following condition:

P2-P1 > D_MAX_EXP_AG_SPACE

Where P1 is the NID_LRBG Reference Location with ecef coordinates.

2b11. Operational mode switches to SB mode.

2b12. Use case terminates.

Alternate Scenario 1b11a

In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode there are no more sufficient satellites in view and the VBR switches to SB mode.

1b11a1. The unsafe train position isn't available due to the loss of the satellite signal on both reception channels

1b11a2. VBR switches in SB and continues to send packet 44/101.

1b11a3. VBR continues to send packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

1b11a4. Use case terminates.

Alternate Scenario 1a4a

In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode is verified the expiration mechanism based on time to check if the augmentation data are valid for the augmented position computed accordingly.

1a4a1. VBR receives from GAD the packet 44/11 (GNSS Parameters) with T_MAX_EXP_AG_TIME set on “255” (Never expires).

1a4a2. VBR receives from GAD the packet 44/8 (GNSS Navigation Data).

1a4a3. VBR is able to calculate an unsafe PVT and it sends to GAD the packet 44/101 (Reference Position) with:

• NID_LRBG=UnKnown.

In order to request augmentation data valid for that area.

1a4a4. VBR sends to TV the packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

1a4a5. VBR receives from GAD the packets 44/3 (GNSS Differential Corrections Packet) with:

• D_ESTODO_BG=Unknown.

(value contained in PDU 7 that transports packet 44/3).

1a4a6. VBR considers that augmentation data are valid relating to the expiration mechanisms based on time in SB mode

1a4a7. Operational mode of VBR switches from SB to TD.

1a4a8. VBR continues to send

• To GAD the packet 44/101 with NID_LRBG=known.

• To TV the packet 44/100

• To TV the packet 44/103 with:

NID_LRBG=known.

1a4a9. VBR in TD mode considers that augmentation data are always valid due to the T_MAX_EXP_AG_TIME provided in the Packet 44/11.

1a4a10. VBR never invalidates the differential corrections.

1a4a11. PVT remains valid.

1a4a12. Use case terminates.

Alternate Scenario 1a4b

In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode is verified the expiration mechanism based on space to check if the augmentation data are valid for the augmented position computed accordingly.

1a4b1. VBR receives from GAD the packet 44/11 (GNSS Parameters) with D_MAX_EXP_AG_SPACE set on “0” (No limitation distance).

1a4b2. VBR receives from GAD the packet 44/8 (GNSS Navigation Data).

1a4b3. VBR is able to calculate an unsafe PVT and it sends to GAD the packet 44/101 (Reference Position) with:

• NID_LRBG=UnKnown.

In order to request augmentation data valid for that area.

1a4b4. VBR sends to TV the packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

1a4b5. VBR receives from GAD the packets 44/3 (GNSS Differential Corrections Packet) with:

• D_ESTODO_BG=Unknown.

(value contained in PDU 7 that transports packet 44/3).

1a4b6. VBR considers that augmentation data are valid relating to the expiration mechanisms based on time in SB mode

1a4b7. Operational mode of VBR switches from SB to TD.

1a4b8. VBR continues to send

• To GAD the packet 44/101 with NID_LRBG=known.

• To TV the packet 44/100

• To TV the packet 44/103 with:

NID_LRBG=known.

1a4b9. VBR in TD mode considers that augmentation data are always valid due to the D_MAX_EXP_AG_SPACE provided in the Packet 44/11.

1a4b10. VBR never invalidates the differential corrections and PVT remains valid.

1a4b11. When GNSS augmentation timeout expire, VBR switches to SB.

1a4b12. Use case terminates.

Alternate Scenario 8a

In this scenario the VBR considers that augmentation data are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME provided in the Packet 44/11 sent together with the Packet 44/3.

8a1. VBR is in SB and receives differential corrections,

8a2. VBR invalidates differential corrections because received at the time T = Reference_Time + T_MAX_EXP_AG_TIME (due to expiration mechanism based on the T_MAX_EXP_AG_TIME of the Packet 44/11)..

8a3. VBR cannot switch to TD until it does not receive unexpired differential corrections.

8a4. Use case terminates.

Alternate Scenario 4a

In this scenario the VBR considers that augmentation data are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME default configuration value.

4a1. VBR is in SB mode and receives from GAD the packets 44/8 (GNSS Navigation Data) for each available satellite.

4a3. VBR receives from GAD the packets 44/3 (GNSS Differential Corrections Packet) with:

• D_ESTODO_BG=Unknown.

(value contained in PDU 7 that transports packet 44/3).

4a4. VBR invalidates differential corrections because received at the time T = Reference_Time + T_MAX_EXP_AG_TIME (due to expiration mechanism based on the T_MAX_EXP_AG_TIME default configuration value).

4a5. VBR cannot switch to TD until it does not receive unexpired differential corrections.

4a6. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1a: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 2a: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1a12a: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1b: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.2.9.

Alternate Scenario 2b: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.2.9.

Alternate Scenario 2c: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.2.9.

Alternate Scenario 1b11a: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.2.9.

Alternate Scenario 1a4a: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1a4b: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 8a: REQ_8.1.1.1.

Alternate Scenario 4a: REQ_8.1.1.1.

Test: VBR_PIFGAD_001

Target: Main Scenario

Description: In this scenario the VBR Train Orientation internally calculated is unknown and the odometer reading of the LRBG of the message received from RBC and forwarded by ON-BOARD Kernel to the VBR is unknown.

Test: VBR_PIFGAD_002

Target: Alternate Scenario 1a

Description: In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode is verified the expiration mechanism based on time to check if the augmentation data are valid for the augmented position computed accordingly.

Test: VBR_PIFGAD_003

Target: Alternate Scenario 2a

Description: VBR has received a PDU 7 with a known value of D_ESTODO_BG (So, the LRBG is known to the VBTS trackside). Therefore when VBR switches to SB mode it doesn't send to GAD the packet 44/101.

The differential corrections received in SB are valid for the expiration mechanism based on time, but in TD mode VBR considers that augmentation data are not valid anymore due to expiration mechanism based on D_MAX_EXP_AG_SPACE provided in the packet 44/11.

Test: VBR_PIFGAD_004

Target: Alternate Scenario 1a12a

Description: VBR has successfully performed the preliminary time-based differential corrections freshness check in SB mode and it has switched in TD mode. VBR considers that augmentation data are not valid anymore due to expiration mechanism based on D_MAX_EXP_AG_SPACE provided in the packet 44/11.

Test: VBR_PIFGAD_005

Target: Alternate Scenario 1b

Description:

In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode there are no more sufficient satellites in view and the VBR switches to SB mode.

Test: VBR_PIFGAD_006

Target: Alternate Scenario 2b

Description: VBR has received a PDU 7 with a known value of D_ESTODO_BG (So, the LRBG is known to the VBTS trackside). Therefore when VBR switches to SB mode it doesn't send to GAD the pkt 44/101.

The differential corrections received in SB are valid for the expiration mechanism based on time, but in TD mode VBR considers that augmentation data are not valid anymore due to expiration mechanism based on the default value of D_MAX_EXP_AG.

Test: VBR_PIFGAD_007

Target: Alternate Scenario 2c

Description: VBR has successfully performed the preliminary time-based differential corrections freshness check in SB mode and it has switched in TD mode. VBR considers that augmentation data are not valid anymore due to expiration mechanism based on default D_MAX_EXP_AG_SPACE parameter.

Test: VBR_PIFGAD_008

Target: Alternate Scenario 1b11a

Description: In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode there are no more sufficient satellites in view and the VBR switches to SB mode.

Test: VBR_PIFGAD_009

Target: Alternate Scenario 1a4a

Description: In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode is verified the expiration mechanism based on time to check if the augmentation data are valid for the augmented position computed accordingly

Test: VBR_PIFGAD_010

Target: Alternate Scenario 1a4b

Description: In this scenario the VBR receives the GNSS Navigation Data and GNSS Parameters in SC mode, than the Digital Map and Interface Protocol Compatibility Check version ended successfully.

In TD mode is verified the expiration mechanism based on space to check if the augmentation data are valid for the augmented position computed accordingly.

Test: VBR_PIFGAD_011

Target: Alternate Scenario 8a

Description: In this scenario the VBR considers that augmentation data are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME provided in the Packet 44/11 sent together with the Packet 44/3.

Test: VBR_PIFGAD_012

Target: Alternate Scenario 4a

Description: In this scenario the VBR considers that augmentation data are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME default configuration value.

6.3.3.4 Position Initialization from TV

In this category of scenarios is supposed that the following actions have already been successfully performed:

• Position initialization from GAD

OR

• [Digital Map Navigation Integrity is failed AND VBR is able to calculate a safe 3D GNSS Position]

This is the procedure for the position initialization from TV. It's performed by VBR when the internal state becomes TD. The VBR sends the Position Report Validation Request (packet 44/103) with a list of possible position (the list could be empty if the VBR hasn't this information) and waits for the reply from TV. The reply is delivered from the packet 44/5 with the start position (in terms of Position Report) to use into the Digital Map search.

Trigger

VBR sends to TV the packet 44/103

Precondition

VBR is in SB or TD.

Postcondition

VBR is in FN.

Main Scenario

In this scenario the VBR is in TD mode and it is initialized by the TV (reception of the packet 44/5). .

The VBR in TD mode is initialized by the TV (reception of the packet 44/5).

1. VBR switches to TD mode (from SB or FN mode).

2. VBR sends to TV the packet 44/103 (Position Report Validation Request) containing:

• NID_LRBG=known.

3. VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

4. VBR receives from TV the packet 44/6 (Switch Point Status).

5. VBR considers that the packet 44/5 is valid relating to the expiration mechanisms based on time and space preformed in TD mode.

6. VBR is able to compute a safe and unique train position information on the Digital Map (1D).

7. Operational mode of the VBR changes from TD to FN.

8. VBR detects a BG

9. VBR stops to send pkt 44/103.

10. VBR continues to send pkt 44/101 with NID_LRBG=Known until D_ESTODOBG is unknown.

11. Use case terminates.

Alternate Scenario 1a

In this scenario the VBR in SB mode is initialized by the TV (reception of the packet 44/5).

1a1. GNSS data information (Augmentation data) isn't available and VBR switches to SB mode.

1a2. VBR continues to send to TV the packet 44/103 with:

• N_ITER = 0 (empty list based on unaugmented PVT).

1a3. VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

1a4. VBR considers that the packet 44/5 is valid relating to the expiration mechanisms based on time and space preformed SB.

1a5. VBR is able to compute a safe and unique train position information on the Digital Map (1D).

1a6. Operational mode of the VBR changes from SB to FN.

1a7. VBR receives from TV the packet 44/6 (Switch Point Status).

1a8. Use case terminates**.**

Alternate Scenario 1a4a

While VBR is in SB the packet 44/5 received from TV is considered expired for the expiration mechanism based on time. Therefore the packet 44/5 is discarded and the operational mode of VBR cannot evolve from SB to FN.

1a4a1. When Current_Time - Time_stamp > Time_Out_TracksideVBTS, VBR considers that the Valid Position Report (packet 44/5) is not valid due to expiration mechanism based on time on configuration parameter (Time_Out_TracksideVBTS).

1a4a2. 1a4a3. VBR isn't able to compute a safe and unique train position information on the Digital Map (1D).

1a4a4. VBR mode cannot evolve to FN and remains in SB.

1a4a5. Use case terminates.

Alternate Scenario 1a4c

While VBR is in TD (or SB) mode the packet 44/5 received from TV is valid for the expiration mechanism based on time, but the confidence interval includes a facing point with an unknown or out of control state. So, the operational mode of VBR cannot evolve from SB to FN.

1a4c1. The packet 44/5 received from TV is valid for the expiration mechanism based on time, but the confidence interval includes a facing point with an unknown or out of control state.

1a4c2. VBR mode cannot evolve to FN.

1a4c3. Use case terminates.

Alternate Scenario 5a

While VBR is in TD the packet 44/5 received from TV is considered expired for the expiration mechanism based on time. Therefore, the packet 44/5 is discarded and the operational mode of VBR cannot evolve from TD to FN.

4a1. VBR receives from TV the Valid Position Report (packet 44/5 with time stamp associated).

4a2. Time_stamp + Current_time < Time_Out_TracksideVBTS.

4a3. VBR considers valid the information received with the packet 44/5.

4a4. When Current_time - Time_stamp > Time_Out_TracksideVBTS, VBR considers that the Valid Position Report (packet 44/5) is not valid due to expiration mechanism based on time on configuration parameter (Time_Out_TracksideVBTS).

4a5. VBR isn’t able to compute a safe and unique train position information on the Digital Map (1D).

4a6. Operational mode remains TD.

4a7. Use case terminates.

Alternate Scenario 5b

VBR is initialized by TV, switches to FN mode.

5b1. VBR switches to FN.

5b2. VBR stops to send packet 44/103.

5b3. VBR receives packet 44/3 with D_ESTODO_BG=known.

5b4. VBR stops to send packet 44/100 and 44/101.

5b5. An empty 245 packet is received.

5b6. Use case terminates.

Requirement:

Main Scenario: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3.

Alternate Scenario 1a: REQ_8.1.1.1, REQ_8.1.1.3.

Alternate Scenario 1a4a: REQ_8.1.1.1.

Alternate Scenario 1a4c: REQ_8.1.1.1, REQ_8.1.1.3.

Alternate Scenario 5a: REQ_8.1.1.1.

Alternate Scenario 5b: REQ_8.1.1.1, REQ_8.1.1.3.

Test: VBR_PIFTV_001

Target: Main Scenario

Description: In this scenario the VBRis in TD mode and it is initialized by the TV (reception of the packet 44/5).

The VBR in TD mode is initialized by the TV (reception of the packet 44/5).

Test: VBR_PIFTV_002

Target: Alternate Scenario 1a

Description: In this scenario the VBR in SB mode is initialized by the TV (reception of the packet 44/5).

Test: VBR_PIFTV_003

Target: Alternate Scenario 1a4a

Description: While VBR is in SB the packet 44/5 received from TV is valid for the expiration mechanism based on space, but it is considered expired for the expiration mechanism based on time. Therefore the packet 44/5 is discarded and the operational mode of VBR cannot evolve from SB to FN.

Test: VBR_PIFTV_004

Target: Alternate Scenario 1a4b

Description: While VBR is in SB mode the packet 44/5 received from TV is valid for the expiration mechanism based on time, but it is considered expired for the expiration mechanism based on space. So, the operational mode of VBR cannot evolve from SB to FN.

Test: VBR_PIFTV_005

Target: Alternate Scenario 1a4c

Description: While VBR is in SB mode the packet 44/5 received from TV is valid for the expiration mechanism based on time, but the confidence interval includes a facing point with an unknown or out of control state. So, the operational mode of VBR cannot evolve from SB to FN.

Test: VBR_PIFTV_006

Target: Alternate Scenario 5a

Description: While VBR is in TD the packet 44/5 received from TV is valid for the expiration mechanism based on space, but it is considered expired for the expiration mechanism based on time. Therefore the packet 44/5 is discarded and the operational mode of VBR cannot evolve from TD to FN.

Test: VBR_PIFTV_007

Target: Alternate Scenario 5b

Description: VBR is initialized by TV, switches to FN mode.

6.3.3.5 Position Initialization from ON-BOARD KERNEL

This scenario category is referred to the case of ERTMS Start of Mission procedure with

“Known” train position data.

The position initialization of the VBR is sent by ON-BOARD Kernel in case of valid

SoM PR or PR associated with BTM detection of Eurobalises.

Trigger

ON-BOARD KERNEL is performing a Valid Start of Mission (i.e. when SoM Position Report Message has Q_STATUS variable set to “Valid”)

OR

ON-BOARD KERNEL has received from VBR an EuroBalise Group.

Precondition

VBR is in SB or TD.

Postcondition

VBR is in FN.

Main Scenario

In this scenario the VBR is in SB mode and it is initialized by the ON-BOARD KERNEL (reception of the packet 205).

1. VBR is in SB mode and is sending to TV the packet 44/103 (Position Report Validation Request) with:

• N_ITER = 0 (empty list based on unaugmented PVT).

2. VBR receives from ON-BOARD KERNEL the packet 205 (Valid Position Report) with the known valid position of the train and it is valid relating to the expiration mechanisms based on time and space.

3. The GNSS data (Navigation) are available to compute a safe PVT.

4. The VBR is able to determine a safe and unique train position information.

5. Operational mode of the VBR changes from SB to FN.

6. VBR receives from TV the packet 44/6 (Switch Point Status).

7.VBR remains in FN mode.

8. Use case terminates.

Alternate Scenario 1a

While VBR is in TD the packet 205 received from ON-BOARD KERNEL is valid for the expiration mechanism based on time. Therefore VBR evolves from TD to FN.

1a1. VBR is in TD mode.

1a2. VBR receives from ON-BOARD KERNEL the packet 205 (Valid Position Report) with the known valid position of the train and it is valid relating to the expiration mechanisms.

1a3. VBR evolves from TD to FN.

1a4. VBR receives from TV the packet 44/6 (Switch Point Status).

1a5. Use case terminates.

Alternate Scenario 1b

In this scenario the integrated BTM detects a Balise group, So, the VBR filters Eurobalise marked with specific flags and So, the balise telegram is sent by BTM to ON-BOARD KERNEL.

When VBR receives from ON-BOARD Kernel a proper packet 205 (due to Eurobalise detection) the operational mode switches to FN.

1b1. VBR is in TD mode.

1b2. VBR is sending to RBC/TV the packet 44/103 (Position Report Validation Request) with:

• NID_LRBG=known.

1b3. The integrated BTM detects a Balise Group and sends to ON-BOARD KERNEL the associated telegram.

1b4. VBR receives from ON-BOARD KERNEL the packet 205 (Valid Position Report) with the known valid position of the train and it is valid relating to the expiration mechanisms based on time performed in TD mode.

1b5. The VBR is able to determine a safe and unique train position information.

1b6. Operational mode of the VBR changes from TD to FN.

1b7. Use case terminates.

Alternate Scenario 2a

While VBR is in SB the Valid Position Report (packet 205 tagged with time stamp) received from ON-BOARD KERNEL is considered expired for the expiration mechanism based on time. Therefore the packet 205 (Valid Position Report) is discarded and the operational mode of VBR cannot evolve from TD to FN.

2a1. VBR receives from ON-BOARD KERNEL the Valid Position Report (packet 205 with time stamp associated).

2a2. When Current Time - Time_stamp > Time_Out_ON_BOARD_KERNEL, VBR considers that the Valid Position Report (packet 205) is not valid due to expiration mechanism based on time on configuration parameter (Time_Out_ON_BOARD_KERNEL).

2a3. VBR isn't able to compute a safe and unique train position information on the Digital Map (1D).

2a4. Operational mode remains in SB.

2a5. VBR receives GNSS Augmentation and Corrections data and switches to TD until they are valid for expiration mechanisms based on time and space.

2a6. Use case terminates.

Alternate Scenario 1a2a

While VBR is in TD the packet 205 received from ON-BOARD KERNEL is not valid for the expiration mechanism based on time. Therefore VBR cannot evolve from TD to FN.

1a2a1. VBR receives from ON-BOARD KERNEL the packet 205 (Valid Position Report) with the known valid position of the train and it is not valid relating to the expiration mechanisms based on time.

1a2a2. VBR isn't able to compute a safe and unique train position information on the Digital Map (1D).

1a2a3. Operational mode remains in TD.

1a2a4. Use cases terminate.

Alternate Scenario 3a

In this scenario VBR isn't able to calculate the safe 3D GNSS train position (GNSS differential corrections are not available).

VBR switches to FN mode using the only information received in the packet 205 to determine a safe and unique train position information.

3a1. Operational mode of the VBR changes from SB to FN.

3a2. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1a: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1b: REQ_8.1.1.1, REQ_8.1.2.1, REQ_8.1.2.3.

Alternate Scenario 2a: REQ_8.1.1.1.

Alternate Scenario 1a2a: REQ_8.1.1.1.

Alternate Scenario 3a: REQ_8.1.1.1, REQ_8.1.2.6, REQ_8.1.3.5.

Test: VBR_PIFOBK_001

Target: Main Scenario

Description: In this scenario the VBRis in SB mode and it is initialized by the ON-BOARD KERNEL (reception of the packet 205).

Test: VBR_PIFOBK_002

Target: Alternate Scenario 1a

Description: While VBR is in TD the packet 205 received from ON-BOARD KERNEL is valid for the expiration mechanism based on time. Therefore VBR evolves from TD to FN.

Test: VBR_PIFOBK_003

Target: Alternate Scenario 1b

Description: In this scenario the integrated BTM detects a Balise group, So, the VBR filters Eurobalise marked with specific flags and So, the balise telegram is sent by BTM to ON-BOARD KERNEL.

When VBR receives from ON-BOARD Kernel a proper packet 205 (due to Eurobalise detection) the operational mode switches to FN.

Test: VBR_PIFOBK_004

Target: Alternate Scenario 2a

Description: While VBR is in TD the Valid Position Report (packet 205 tagged with time stamp) received from ON-BOARD KERNEL is considered expired for the expiration mechanism based on time. Therefore the packet 205 (Valid Position Report) is discarded and the operational mode of VBR cannot evolve from TD to FN.

Test: VBR_PIFOBK_005

Target: Alternate Scenario 1a2a

Description: While VBR is in TD the packet 205 received from ON-BOARD KERNEL is not valid for the expiration mechanism based on time. Therefore VBR cannot evolve from TD to FN.

Test: VBR_PIFOBK_008

Target: Alternate Scenario 3a

Description: In this scenario VBR isn’t able to calculate the safe 3D GNSS train position (GNSS differential corrections are not available).

VBR switches to FN mode using the only information received in the packet 205 to determine a safe and unique train position information.

6.3.3.6 Transition from SC to SB, NP or SF

The VBR is in SC and the following functionalities have been successfully performed:

• Start-up self-test execution

• System configuration

• Compatibility check of the Interface Protocol

• Compatibility check of the Digital Map

The operational mode of the VBR changes from SC to SB. After the mode transition, VBR transmits to ON-BOARD KERNEL, through the PDU Number 1 (PACKET_STATUS_BTM) the new operative mode (Q_VBR_OB_OPMODE).

Any configuration order received in other mode than SC shall be refused by VBR, in particular this is verified for SB mode.

Trigger

The VBR has successfully completed start-up testing and checks on configuration data

AND

Verification of Digital Map and interface protocol consistency with trackside VBTS has been successfully performed

AND

The VBR has completed the configuration command handling procedure from the on-board kernel.

Precondition

The VBR is in SC mode.

Postcondition

VBR is in SB, NP or SF.

Main Scenario

Operational mode of the VBR changes from SC to SB.

1. VBR has successfully completed start-up testing and checks on stored/default configuration data.

2. VBR performs successfully Digital Map and interface protocol consistency check.

3. VBR has completed the on-board kernel configuration procedure and has been configured to turn ON the CTODL.

4. Operational mode of the VBR changes from SC to SB.

5. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = 1 (SB).

6. VBR is in mode SB and receives from ON-BOARD KERNEL another PDU Number 3 (PACKET_BTM_ORDERS) with M_VBR_OB_ORDERS = XXXX XXX0 (Turn off the CTODL provided by VBR).

7. VBR ignores the configuration order received in SB, it doesn’t send another PDU Number 1 (PACKET_STATUS_BTM) with the last configuration order received and continues to provide the Message Number 208 to ON-BOARD KERNEL.

Alternate Scenario *a

Operational mode of the VBR changes to SF.

*a1. VBR detects a fault that affects safety.

*a2. Operational mode of the VBR changes to SF.

*a3. Use case terminates.

Alternate Scenario *b

Operational mode of the VBR changes to NP.

*b1. VBR is switched-off.

*b2. Operational mode of the VBR changes to NP.

*b3. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1, REQ_8.1.2.9.

Alternate Scenario *a: REQ_8.1.1.1, REQ_8.1.2.11.

Alternate Scenario *b: REQ_8.1.1.1.

Test: VBR_TSSNS_001

Target: Main Scenario

Description: Operational mode of the VBR changes from SC to SB.

Test: VBR_TSSNS_002

Target: Alternate Scenario *a

Description: Operational mode of the VBR changes to SF.

Test: VBR_TSSNS_003

Target: Alternate Scenario *b

Description: Operational mode of the VBR changes to NP.

6.3.3.7 Transition from SB to FN, TD, SC, SF or NP

VBR can switch from SB mode to:

- FN mode
- TD mode
- SC mode
- SF mode
- NP mode

depending on the events that happen when VBR is in SB mode.

After every mode transition (except the transition to SF and NP), VBR transmits to ON-BOARD KERNEL, through the PDU Number 1 (PACKET_STATUS_BTM), the new operative mode (Q_VBR_OB_OPMODE).

Trigger

VBR receives information to unambiguously determine a unique path in the Digital Map where the train is

AND

VBR confirms the train orientation internally computed

Precondition

VBR is in SB mode.

Postcondition

VBR is in FN, TD, SC, NP or SF.

Main Scenario

Operational mode of the VBR changes from Stand-by (SB) to Full Navigation (FN) with a direct transition when VBR is capable to determine safe and unique train position information on the Digital Map. In this scenario VBR receives the position train initialization from ON-BOARD KERNEL.

1. VBR is in SB mode and it sending to GAD the packet 44/101 (Reference Position) and the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) and the packet 44/103 (Position Report Validation Request).

2. VBR receives from ON-BOARD KERNEL the Valid Position Report (packet 205) with the known valid position of the train.

3. The train orientation autonomously estimated by the VBR is confirmed.

4. VBR is able to compute a safe and unique train position information on the Digital Map (1D).

5. Operational mode of the VBR changes from SB to FN.

6. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = FN.

7. VBR receives packet 44/6.

8. VBR stops to send packet 44/100 and packet 44/103, and continues to send packet 44/101.

9. Use case terminates.

Alternate Scenario 1a

Verification of Digital Map consistency with trackside VBTS is not guaranteed. Operational mode of the VBR switches from SB to SC.

1a1. VBR is in SB mode and unsuccessfully checks the consistency of the track Digital Map.

1a2. Operational mode of the VBR switches to SC.

1a3. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1a4. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SC.

1a5. Use case terminates.

Alternate Scenario 1b

Interface protocol consistency between VBR and VBTS wayside is not guaranteed. Operational mode of the VBR switches from SB to SC.

1b1. VBR unsuccessfully checks the consistency of the track Interface protocol version.

1b2. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1b3. Operational mode of the VBR switches to SC.

1b4. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SC.

1b4. Use case terminates.

Alternate Scenario 2a

The unique path on the Digital Map is not guaranteed due to Valid Position Report (packet 205) not received from ON-BOARD KERNEL. Operational mode of VBR switches from SB to TD.

2a1. VBR does not receive from ON-BOARD KERNEL the Valid Position Report (packet 205).

2a2. VBR detects, for a sufficient number of satellites, valid GNSS Observation Data for which has received from GAD valid GNSS Navigation Data (packet 44/8) and Differential Corrections (packet 44/3) that are still valid.

2a3. VBR is able to compute a safe GNSS position but is not able to determinate safe and unique train position information on the Digital Map.

2a4. Operational mode of the VBR changes from SB to TD.

2a5. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = TD.

2a6. Use case terminates.

Alternate Scenario 2b

Operational mode of the VBR changes from SB to FN with a direct transition when VBR is capable to determine safe and unique train position information on the Digital Map.

VBR receives the position train initialization from TV.

2b1. VBR detects, for a sufficient number of satellites, valid GNSS Observation Data for which has received from GAD valid GNSS Navigation Data (packet 44/8).

2b2. VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

2b3. The train orientation autonomously estimated by the VBR is confirmed..

2b4. VBR is able to compute a safe and unique train position information on the Digital Map (1D).

2b5. Operational mode of the VBR changes from SB to FN.

2b6. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = FN.

2b7. VBR stops the packet 44/100 and the packet 44/103.

2b8. VBR receives from TV the packet 44/6 (Switch Point Status).

2b9. VBR receives Differential Corrections (packet 44/3) that are still valid and PVT becomes valid.

2b10. Use case terminates.

Alternate Scenario 4a

The VBR isn't able to compute a safe constrained PVT (1D) So, the transition from SB to FN is performed using the only information received in the packet Valid Position Report (packet 205). Operational mode of the VBR switches from SB to FN.

4a1. The GNSS data information isn't available.

4a2. The PVT calculated is unsafe.

4a3. The integrated BTM detects a Eurobalise (EB1) contained in the Digital Map.

4a4. VBR receives packet 205 from ON-BOARD KERNEL in which is requested to initialize starting from EB1.

4a5. Operational mode of the VBR changes from SB to FN.

4a6. VBR continue to send the Unaugmented Position (packet 44/101) and the Digital Map and Interface Protocol Compatibility Check Result (packet 44/100).

4a7. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = FN.

4a8. Use case terminates.

Alternate Scenario *a

Operational mode of the VBR changes to SF.

*a1. VBR detects a fault that affects safety.

*a2. Operational mode of the VBR changes to SF.

*a3. Use case terminates.

Alternate Scenario *b

Operational mode of the VBR changes to NP.

*b1. VBR is switched-off.

*b2. Operational mode of the VBR changes to NP.

*b3. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3.

Alternate Scenario 1a: REQ_8.1.1.1.

Alternate Scenario 1b: REQ_8.1.1.1.

Alternate Scenario 2a: REQ_8.1.1.1.

Alternate Scenario 2b: REQ_8.1.1.1.

Alternate Scenario 4a: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario *a: REQ_8.1.1.1, REQ_8.1.2.11.

Alternate Scenario *b: REQ_8.1.1.1

REQ_8.1.1.1.

Test: VBR_TSFTSSN_001

Target: Main Scenario

Description: Operational mode of the VBR changes from Stand-by (SB) to Full Navigation (FN) with a direct transition when VBR is capable to determine safe and unique train position information on the Digital Map. In this scenario VBR receives the position train initialization from ON-BOARD KERNEL.

Test: VBR_TSFTSSN_002

Target: Alternate Scenario 1a

Description: Verification of Digital Map consistency with trackside VBTS is not guaranteed. Operational mode of the VBR switches from SB to SC.

Test: VBR_TSFTSSN_003

Target: Alternate Scenario 1b

Description: Interface protocol consistency between VBR and VBTS wayside is not guaranteed. Operational mode of the VBR switches from SB to SC.

Test: VBR_TSFTSSN_004

Target: Alternate Scenario 2a

Description: The unique path on the Digital Map is not guaranteed due to Valid Position Report (packet 205) not received from ON-BOARD KERNEL. Operational mode of VBR switches from SB to TD.

Test: VBR_TSFTSSN_005

Target: Alternate Scenario 2b

Description: Operational mode of the VBR changes from SB to FN with a direct transition when VBR is capable to determine safe and unique train position information on the Digital Map.

VBR receives the position train initialization from TV.

Test: VBR_TSFTSSN_006

Target: Alternate Scenario 4a

Description: The VBR isn't able to compute a safe constrained PVT (1D) So, the transition from SB to FN is performed using the only information received in the packet Valid Position Report (packet 205). Operational mode of the VBR switches from SB to FN.

Test: VBR_TSFTSSN_007

Target: Alternate Scenario *a

Test: VBR_TSFTSSN_008

Target: Alternate Scenario *b

Description: Operational mode of the VBR changes to NP.

6.3.3.8 Transition from FN to SB, TD, SC, SF or NP

VBR can switch from FN mode to:

• SB mode

• TD mode

• SC mode

• SF mode

• NP mode

depending on the events that happen when VBR is in FN mode.

After every mode transition (except the transition to SF and NP), VBR transmits to ON-BOARD KERNEL, through the PDU Number 1 (PACKET_STATUS_BTM), the new operative mode (Q_VBR_OB_OPMODE).

Trigger

The VBR Digital Map navigation integrity fails

AND

[(The VBR is able to compute a safe 3D GNSS train position OR is not able to compute a safe 3D GNSS train position)].

OR

Verification of Digital Map consistency with trackside VBTS is not guaranteed.

OR

Verification of Interface protocol consistency with trackside VBTS is not guaranteed.

Precondition

VBR is in FN mode.

Postcondition

VBR is either in SB, TD, SC, SF or NP mode.

Main Scenario

VBR is able to determine a safe but not unique train position information on the Digital Map (1D).

Operational mode of the VBR switches from FN to TD.

1. VBR estimates that the most advanced vehicle position has overpassed a facing point with unknown or out of control status.

2. The Digital Map Navigation integrity fails by VBR.

3. The GNSS data information is available and VBR is able to compute the safe 3D GNSS train position.

4. Operational mode of the VBR switches to TD.

5. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = TD.

6. VBR sends to TV the Position Report Validation Request (packet 44/103) which contains the list of the train position reports where the VBR assumes that the train could be localized.

7. Use case terminates.

Alternate Scenario 1a

The GNSS Position Integrity fails and the VBR cannot find any previous safe reference position. For this reason the VBR Digital Map navigation integrity fails.

1a1. The GNSS Position integrity is failed and VBR cannot find any previous safe reference position to allow Digital Map navigation rollback (i.e Virtual Balises whose integrity is confirmed both by the TV and the GAD trackside modules).

1a2. VBR sends to EVC the Confidence Interval Enlargement (Packet 209).

1a3. The GNSS data information isn’t available and VBR is not able to compute the safe 3D GNSS train position.

1a4. Operational mode of the VBR switches to SB.

1a5. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SB.

1a6. VBR sends to GAD the Unaugmented Position (packet 44/101).

1a7. Use case terminates.

Alternate Scenario 1b

VBR receives from TV the Digital Map Navigation Integrity Result (packet 44/9) with Q_PRINTEGRI-TYCHECK = Integrity Not Confirmed data not updated.

1b1. VBR receives from TV the packet 44/9 (Digital Map Navigation Integrity Result) with Q_PRINTEGRI-TYCHECK = Integrity Not Confirmed data not updated.

1b2. Continue at Main Scenario, step 2.

Alternate Scenario 1c

Verification of Digital Map consistency with trackside VBTS is not guaranteed. Operational mode of the VBR switches from FN to SC.

1c1. VBR is in FN and unsuccessfully checks the consistency of the track Digital Map.

1c2. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1c3. Operational mode of the VBR switches to SC.

1c4. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SC.

1c5. Use case terminates.

Alternate Scenario 1d

Interface protocol consistency between VBR and VBTS wayside is not guaranteed. Operational mode of the VBR switches from FN to SC.

1d1. VBR is in FN and unsuccessfully checks the consistency of the track Interface protocol version.

1d2. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1d3. Operational mode of the VBR switches to SC.

1d4. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SC.

1d5. Use case terminates.

Alternate Scenario 3a

VBR isn’t able to determine a safe and unique train position information.

Operational mode of the VBR switches from FN to SB.

3a1. The GNSS data information isn’t available and VBR computes an unsafe train position.

3a2. Operational mode of the VBR switches to SB.

3a3. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SB.

3a4. VBR sends to GAD the Unaugmented Position (packet 44/101).

3a5. Use case terminates.

Alternate Scenario *a

Operational mode of the VBR changes to SF.

*a1. VBR detects a fault that affects safety.

*a2. Operational mode of the VBR changes to SF.

*a3. Use case terminates.

Alternate Scenario *b

Operational mode of the VBR changes to NP.

*b1. VBR is switched-off.

*b2. Operational mode of the VBR changes to NP.

Requirements:

Main Scenario: REQ_8.1.1.3, REQ_8.1.1.1.

Alternate Scenario 1a: REQ_8.1.1.1.

Alternate Scenario 1b: REQ_8.1.1.1.

Alternate Scenario 1c: REQ_8.1.1.1.

Alternate Scenario 1d: REQ_8.1.1.1.

Alternate Scenario 3a: REQ_8.1.1.1.

Alternate Scenario *a: REQ_8.1.1.1, REQ_8.1.2.11.

Alternate Scenario *b: REQ_8.1.1.1.

Test: VBR_TFSTSSN_001

Target: Main Scenario

Description: VBR is able to determine a safe but not unique train position information on the Digital Map (1D).

Operational mode of the VBR switches from FN to TD.

Test: VBR_TFSTSSN_002

Target: Alternate Scenario 1a

Description: The GNSS Position Integrity fails and the VBR cannot find any previous safe reference position. For this reason, the VBR Digital Map navigation integrity fails.

Test: VBR_TFSTSSN_003

Target: Alternate Scenario 1b

Description: VBR receives from TV the Digital Map Navigation Integrity Result (packet 44/9) with Q_PRINTEGRITYCHECK = Integrity Not Confirmed data not updatedd.

Test: VBR_TFSTSSN_004

Target: Alternate Scenario 1c

Description: Verification of Digital Map consistency with trackside VBTS is not guaranteed. Operational mode of the VBR switches from FN to SC.

Test: VBR_TFSTSSN_005

Target: Alternate Scenario 1d

Description: Interface protocol consistency between VBR and VBTS wayside is not guaranteed. Operational mode of the VBR switches from FN to SC.

Test: VBR_TFSTSSN_006

Target: Alternate Scenario 3a

Description: VBR isn’t able to determine a safe and unique train position information.

Operational mode of the VBR switches from FN to SB.

Test: VBR_TFSTSSN_007

Target: Alternate Scenario *a

Description: Operational mode of the VBR changes to SF.

Test: VBR_TFSTSSN_008

Target: Alternate Scenario *b

Description: Operational mode of the VBR changes to NP.

6.3.3.9 Transition from TD to SB, SC, FN, SF or NP

VBR can switch from TD mode to:

• SB mode

• SC mode

• FN mode

• SF mode

• NP mode

depending on the events that happen when VBR is in TD mode.

After every mode transition (except the transition to SF and NP), VBR transmits to ON-BOARD KERNEL, through the PDU Number 1 (PACKET_STATUS_BTM), the new operative mode (Q_VBR_OB_OPMODE).

Trigger

A sufficient number of valid GNSS Observation Data is not available

OR

A sufficient number of valid Differential Corrections from GAD is not available

OR

The safe and unique train position information on the Digital Map (1D) is guaranteed.

OR

Verification of Digital Map consistency with trackside VBTS is not guaranteed.

OR

Verification of Interface protocol consistency with trackside VBTS is not guaranteed.

Precondition

VBR is in TD mode.

Postcondition

VBR is either in SB, SC, FN, NP or SF mode.

Main Scenario

A sufficient number of valid GNSS Observation Data is not available and a safe 3D GNSS train position is not guaranteed.

Operational mode of VBR switches from TD to SB.

1. VBR is in TD and is sending to TV the packet 44/103 (Position Report Validation Request).

2. VBR does not receive from GNSS a sufficient number of valid satellite data.

3. VBR is not able to calculate a safe 3D GNSS train position.

4. Operational mode of the VBR switches to SB.

5. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SB.

6. VBR sends to TV the packet 44/103 (Position Report Validation Request) which contains an empty list based on unaugmented PVT.

7. VBR sends to GAD the Unaugmented Position (packet 44/101).

8. Use case terminates.

Alternate Scenario 1a

Verification of Digital Map consistency with trackside VBTS is not guaranteed. Operational mode of the VBR switches from TD to SC.

1a1. VBR unsuccessfully checks the consistency of the track Digital Map.

1a2. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1a3. Operational mode of the VBR switches to SC.

1a4. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SC.

1a5. Use case terminates.

Alternate Scenario 1b

Interface protocol consistency between VBR and VBTS wayside is not guaranteed. Operational mode of the VBR switches from TD to SC.

1b1. VBR unsuccessfully checks the consistency of the track Interface protocol version.

1b2. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1b3. Operational mode of the VBR switches to SC.

1b4. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SC.

1b5. Use case terminates.

Alternate Scenario 2a

A sufficient number of valid Differential Corrections from GAD is not available a safe 3D GNSS train position is not guaranteed.

Operational mode of VBR switches from TD to SB.

2a1. VBR invalidates the differential corrections due to expiration mechanism, therefore a sufficient number of valid Differential Corrections is no more available.

2a2. Continue at Main Scenario, step 3.

Alternate Scenario 2b

VBR can switch from TD mode to FN mode always coming from previous SB mode (SB ->TD ->FN), both at the system initialization and after Digital Map and Interface Protocol Version check. VBR receives from ON-BOARD KERNEL the Valid Position Report (packet 205) with the known valid position of the train.

2b1. VBR receives from ON-BOARD KERNEL the Valid Position Report (packet205) with the known valid position of the train.

2b2. The train orientation autonomously estimated by the VBR is confirmed.

2b3. The VBR is able to compute a safe and unique train position (1D).

2b4. Operational mode of the VBR changes from TD to FN.

2b5. VBR stops to send the Position Report Validation Request (packet 44/103).

2b6. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = FN.

2b7. Use case terminates.

Alternate Scenario 2c

VBR can switch from TD mode to FN mode always coming from previous SB mode (SB ->TD ->FN), both at the system initialization and after Digital Map and Interface Protocol Version check. In this scenario VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

2c1. VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

2c2. The train orientation autonomously estimated by the VBR is confirmed.

2c3. The VBR is able to compute a safe and unique train position (1D).

2c4. Operational mode of the VBR changes from TD to FN.

2c5. The switch in FN mode leaves unchanged the GNSS Differential Corrections previously received and PVT is still valid.

2c6. VBR stops to send the packet 44/103 (Position Report Validation Request).

2c7. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = FN.

2c8. Use case terminates.

Alternate Scenario *a

Operational mode of the VBR changes to SF.

*a1. VBR detects a fault that affects safety.

*a2. Operational mode of the VBR changes to SF.

*a3. Use case terminates.

Alternate Scenario *b

Operational mode of the VBR changes to NP.

*b1. VBR is switched-off.

*b2. Operational mode of the VBR changes to NP.

*b3. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1.

Alternate Scenario 1a: REQ_8.1.1.1.

Alternate Scenario 1b: REQ_8.1.1.1.

Alternate Scenario 2a: REQ_8.1.1.1.

Alternate Scenario 2b: REQ_8.1.1.1.

Alternate Scenario 2c: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario *a: REQ_8.1.1.1, REQ_8.1.2.11.

Alternate Scenario *b: REQ_8.1.1.1.

Test: VBR_TTSSFSN_001

Target: Main Scenario

Description: A sufficient number of valid GNSS Observation Data is not available and a safe 3D GNSS train position is not guaranteed.

Operational mode of VBR switches from TD to SB.

Test: VBR_TTSSFSN_002

Target: Alternate Scenario 1a

Description: Verification of Digital Map consistency with trackside VBTS is not guaranteed. Operational mode of the VBR switches from TD to SC.

Test: VBR_TTSSFSN_003

Target: Alternate Scenario 1b

Description: Interface protocol consistency between VBR and VBTS wayside is not guaranteed. Operational mode of the VBR switches from TD to SC.

Test: VBR_TTSSFSN_004

Target: Alternate Scenario 2a

Description: A sufficient number of valid Differential Corrections from GAD is not available a safe 3D GNSS train position is not guaranteed.

Operational mode of VBR switches from TD to SB.

Test: VBR_TTSSFSN_005

Target: Alternate Scenario 2b

Description: VBR can switch from TD mode to FN mode always coming from previous SB mode (SB ->TD ->FN), both at the system initialization and after Digital Map Navigation Integrity check failure. VBR receives from ON-BOARD KERNEL the Valid Position Report (packet 205) with the known valid position of the train.

Test: VBR_TTSSFSN_006

Target: Alternate Scenario 2c

Description: VBR can switch from TD mode to FN mode always coming from previous SB mode (SB ->TD ->FN), both at the system initialization and after Digital Map Navigation Integrity check failure. In this scenario VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

Test: VBR_TTSSFSN_007

Target: Alternate Scenario *a

Description: Operational mode of the VBR changes to SF.

Test: VBR_TTSSFSN_008

Target: Alternate Scenario *b

Description: Operational mode of the VBR changes to NP.

6.3.3.10 Transition from NP to SC

The VBR is powered and its operational mode changes to SC. After the mode transition, VBR transmits to ON-BOARD KERNEL, through the PDU Number 1 (PACKET_STATUS_BTM) the new operative mode (Q_VBR_OB_OPMODE).

Trigger

The VBR is powered.

Precondition

The VBR is switched-off and the equipment is in NP.

Postcondition

VBR is in SC mode.

Main Scenario

1. VBR is powered.

2. Operational mode of the VBR changes to SC.

3. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SC.

4. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1.

Test: VBR_TNS_001

Target: Main Scenario

Description: The VBR is powered and its operational mode changes from NP to SC.

After the mode transition, VBR transmits to ON-BOARD KERNEL, through the PDU Number 1 (PKT_STATUS_BTM) the new operative mode (Q_VBR_OB_OPMODE).

6.3.3.11 Transition from SF to NP

The VBR is in SF mode and it is switched off.

Trigger

The VBR is switched-off.

Precondition

The VBR is SF mode.

Postcondition

VBR is switched-off.

Main Scenario

1. VBR is switched-off.

2. Operational mode of the VBR changes to NP.

Requirements:

Main Scenario: REQ_8.1.1.1.

Test: VBR_TSN_001

Target: Main Scenario

Description: The VBR is in SF mode and it is switched off.

Operational mode of the VBR changes from SF to NP mode.

6.3.3.12 GNSS Position Integrity and Rollback

The GNSS Position Integrity is the capability of the VBR to declare a safe estimation of GNSS position and relative accuracy used to perform a right Virtual Balise detection.

After the VBG detection VBR sends to GAD the GNSS Position Integrity (packet 44/105) to verify that the used GNSS information isn't obsolete. The GAD performs a integrity check and sends to VBR the GNSS position Integrity result (packet 44/10). In case of positive check result, the integrity of the VB for the GNSS position is considered confirmed from GAD.

In case of GNSS Position Integrity failed from GAD, the VBR performs a GNSS Position Rollback action to a previous safe reference position (BG whose integrity is confirmed both by the TV and the GAD) and provide to ON-BOARD KERNEL the Confidence Interval Enlargement (related to a specific BG or VBG).

Trigger

New VB detection.

Precondition

FN.

Postcondition

FN, TD or SB

Main Scenario

In this scenario the VBG1 (NID_BG= 9170) previously detected by VBR has been successfully performed (Virtual Balises whose integrity is confirmed both by the TV and the GAD). The VBR detects the VBG2 (NID_BG = 9070) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a positive check result from GAD and without overpassing any switch point after the VBG1 detection, the VBR considers the VBG2 integrity confirmed.

No additional information is needed from TV.

1. VBR detects the virtual balise group VBG2.

2. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of VBG2

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG2

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=VBG2

3. The GAD verifies and confirms the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise (VBG2).

4. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Confirmed

b. NID_VALBG = VBG2.

5. The packet 44/10 with positive check result is received within the GNSS integrity confirmation timeout.

6. VBR considers as confirmed the integrity for the VBG2.

7. VBR considers the VBG2 with integrity confirmed both by TV and GAD trackside modules and it sends to ON-BOARD KERNEL the packet 247 "Validated BG Info" with:

• NID_VALBG=VBG2.

8. Use case terminates.

Alternate Scenario 1a

In this scenario VBR detects the VBG1 (NID_BG=9170) whose integrity is automatically confirmed by TV and the GAD. So when the GNSS position integrity fails on the VBG2 (NID_BG=9070), the VBR can use the VBG1 as safe reference position to perform a GNSS Position Rollback action.

1a1. VBR doesn’t have GNSS data information available from the start of the Mission.

1a2. A switch point is overpassed and its integrity is confirmed by sending packet 44/9.

1a3. VBR detects the virtual balise group VBG1.

1a4. VBR doesn't send to GAD the packet 44/105 (GNSS Position Integrity) associated to the VBG1 (No additional information is needed from GAD).

1a5. VBR considers the VBG1 with integrity confirmed both by TV and GAD trackside modules and it sends to ON-BOARD KERNEL the packet 247 "Validated BG Info" with:

• NID_VALBG=VBG1

1a6. VBR receives a valid packet 44/3 (GNSS Differential Corrections Packet) and it is able to compute a safe constrained PVT (1D).

1a7. VBR detects the virtual balise group VBG2.

1a8. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of VBG2

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG2

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

1a9. The GAD verifies and doesn't confirm the correctness and freshness of augmentation and integrity data used to provide a Virtual Balise (VBG2).

1a10. The GAD sends to VBR the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Integrity Not Confirmed data not updated.

b. NID_VALBG = VBG2.

1a11. VBR considers the GNSS position integrity failed for the VBG2.

1a12. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to the previous safe reference position (VBG1).

1a13. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = VBG2

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG2

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG2.

1a14. Use case terminates.

Alternate Scenario 1a1a

VBR doesn't receive for the VBG1(NID_BG=9060) the GNSS Position Integrity result from GAD.

When the GNSS position integrity fails for VBG1 the VBR can use the EBG1(NID_BG=9062) as safe reference position to perform a GNSS Position Rollback action.

1a1a1. VBR receives a valid packet 44/3 (GNSS Differential Corrections Packet) and it is able to compute a safe constrained PVT (1D).

1a1a2. VBR detects an Eurobalise EBG1.

1a1a3. No facing-point has been overpassed by train.

1a1a4. VBR detects the virtual balise group VBG1.

1a1a5. The information provided by the VBR to the ERTMS/ETCS on-board kernel shall be analogous for both Virtual Balises and Eurobalises

1a1a6. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) associated to the VBG1.

1a1a7. VBR doesn't receive the packet 44/10 within the GNSS integrity confirmation timeout.

1a1a8. VBR considers the GNSS position integrity failed for the VBG1.

1a1a9. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to the last Eurobalise group detected by the integrated BTM.

1a1a10. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG1 with:

a. NID_LRBG = VBG1

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG1

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG1.

1a1a11. Use case terminates.

Alternate Scenario 1a1a10a

The Eurobalise EB1 detected by the integrated BTM during initialization phase (SoM procedure) is considered as valid. When the GNSS Position Integrity fails on the VBG2 (NID_BG=9056) , the GNSS position Rollback is performed using as safe reference position the Eurobalise EB1 (NID_BG=9062) because the previous VBG1 (NID_BG=9060) hasn't integrity confirmed from TV.

1a1a10a1. VBR detects the virtual balise group VBG2.

1a1a10a2. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) associated to the VBG2.

1a1a10a2.The packet 44/10 with negative check result is received within the GNSS integrity confirmation timeout.

1a1a10a3. VBR considers the GNSS position integrity failed for the VBG2.

1a1a10a4. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to the last Eurobalise detected by the integrated BTM.

1a1a10a5. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = VBG2

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG2

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG2.

1a1a10a6. Use case terminates.

Alternate Scenario 1b

In this scenario the VBR is in TD mode and it is initialized by the TV (reception of the packet 44/5) with a Position Report containing a successive VBG1 (NID_BG=9270). When VBR detects VBG1 and its integrity is not confirmed, the rollback procedure cannot be applied and detection of an unlinked BG that provides a text information is simulated.

1b1. VBR receives from TV the packet 44/5 (Valid Position Report) with the known valid position of the train (with respect the VBG1) and it is valid relating to the expiration mechanisms based on time and space.

1b2. The GNSS data (Navigation) are available to compute a safe PVT.

1b3. The VBR is able to determine a safe and unique train position information.

1b4. Operational mode of the VBR changes from TD to FN.

1b5.VBR remains in FN mode and detects VBG1 (NID_BG=9270).

1b6. VBR detects the virtual balise group VBG1 (NID_BG=9270).

1b7. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of VBG1

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG1

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=VBG1

1b8. The GAD verifies and doesn't confirm the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise (VBG1).

1b9. The GAD sends to VBR the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Integrity Not Confirmed data not updated.

b. NID_VALBG = VBG1.

1b10. The packet 44/10 is received within the GNSS integrity confirmation timeout.

1b11. VBR considers the GNSS position integrity failed for the VBG1.

1b12. VBR cannot find any previous safe reference position to allow the Digital Map Navigation rollback.

1b13. VBR considers the Digital Map Navigation Integrity failed.

1b14. VBR reports result of the failed check by sending towards the ERTMS/ETCS on-board kernel a Virtual Balise message that simulates detection of an unlinked BG that provides a text information.

1b15. VBR exits from FN mode.

1b16. Use case terminates.

Alternate Scenario 3a

In this scenario VBG2 cannot be validated from GAD and the VBR considers failed the GNSS position integrity check.

The VBR can continue to navigate the Digital Map as far as it can rollback to a previous safe reference position (VBG1) and as a consequence VBR sends to EVC the NID_LRBG of the last "Affected BG" and the parameters related to the enlargement of the Confidence Interval.

3a1. The GAD verifies and doesn't confirm the correctness and freshness of augmentation and integrity data used to provide a Virtual Balise (VBG2).

3a2. The GAD sends to VBR the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Integrity Not Confirmed data not updated.

b. NID_VALBG = VBG2.

3a3. The packet 44/10 is received within the GNSS integrity confirmation timeout.

3a4. VBR considers the GNSS position integrity failed for the VBG2.

3a5. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to last detected VBG1 whose integrity is confirmed.

3a6. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = VBG2

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG2

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG2.

3a7. Use case terminates.

Alternate Scenario 1a2a

In this scenario VBR detects the VBG1 (NID_BG=9068) whose integrity confirmation is still in pending. So when the GNSS position integrity fails on the VBG2 (NID_BG=9066), the VBR can use the VBG0 (NID_BG=9168) as safe reference position to perform a GNSS Position Rollback action.

1a2a1. The GAD sends to VBR the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Integrity Not Confirmed data not updated.

b. NID_VALBG = VBG2.

1a2a2. . VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = VBG2

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG2

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG2.

1a2a3. VBR considers the GNSS position integrity failed for the VBG2 (NID_BG=9070) for expiration mechanisms.

1a2a4. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to the previous safe reference position (VBG0).

1a2a5. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG1 with:

a. NID_LRBG = VBG1

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG1

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG1.

1a2a6. Use case terminates.

Alternate Scenario 3b

In this scenario VBG2 cannot be validated from GAD and the VBR considers failed the GNSS position integrity check.

The VBR can continue to navigate the Digital Map as far as it can rollback to a previous safe reference position (VBG1) and as a consequence VBR sends to EVC the NID_LRBG of the last “Validated BG” and the parameters related to the enlargement of the Confidence Interval.

3a3a1. The packet 44/10 isn’t received within the GNSS integrity confirmation timeout.

3a3a2. VBR considers the GNSS position integrity failed for the VBG2.

3a3a3. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to last detected VBG1 whose integrity is confirmed.

3a3a4. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = VBG2

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG2

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG2.

3a3a5. Use case terminates.

Alternate Scenario 1c

In this scenario the VBR is in SB mode and it is initialized by the ON-BOARD KERNEL (reception of the packet 205). VBR detects VBG1 and confirms its integrity. Then, it stops to send packets 44/105.

1c1. VBR is in TD mode.

1c2. VBR receives from ON-BOARD KERNEL the packet 205 (Valid Position Report) with the known valid position of the train and it is valid relating to the expiration mechanisms.

1c3. VBR evolves from TD to FN.

1c4. VBR receives from TV the packet 44/6 (Switch Point Status).

VBR detects VBG1 (NID_BG=9270) and send packet 44/105.

The GAD sends to VBR the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Integrity Confirmed.

b. NID_VALBG = VBG1.

1c5. VBR considers the VBG1 with integrity confirmed both by TV and GAD trackside modules and it sends to ON-BOARD KERNEL the packet 247 "Validated BG Info" with:

• NID_VALBG=VBG1

1c6. VBR stops to send packets 44/105.

1c7. Use case terminates.

Alternate Scenario 1d

In this scenario the VBR is in FN mode and it is previously configured to virtualize all the Eurobalises in the Digital Map. VBR detects VBG1 and confirms its integrity. Then, it continues to navigate the Digital Map never confirming the integrity of next VBGs. VBR will store information for the last eight VBGs.

1d1. VBR is in FN mode.

1d2. Satellite data are available and augmentation corrections are sent.

1d3. VBR detects a VBG with NID_BG=9088.

1d4. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of 9088.

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG2

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=9088

1d5. The GAD verifies and confirms the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise (VBG2).

1d6. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Confirmed

b. NID_VALBG = 9088.

1d7. The packet 44/10 with positive check result is received within the GNSS integrity confirmation timeout.

1d8. VBR considers as confirmed the integrity for the VBG with NID_BG=9088.

1d9. Then, VBR detects a VBG with NID_BG=9089.

1d10. The packet 44/10 isn’t received within the GNSS integrity confirmation timeout.

1d11. VBR considers the GNSS position integrity failed for the VBG 9089.

1d12. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to last detected VBG (9088) whose integrity is confirmed.

1d13. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = 9089

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error computed on the basis of odometric information, using last detected BG whose integrity is already guaranteed as a reference position (delta between 9088 and 9089).

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error computed on the basis of odometric information, using last detected BG whose integrity is already guaranteed as a reference position (delta between 9088 and 9089).

1d14. VBR continues to navigate the Digital Map.

1d15. Steps from 1d9 to 1d13 are repeated for next VBGs detected.

1d15. VBR will store maximum the information for eight VBGs.

1d16. When this buffer is full and another VBG is detected, only the information of the last eight VBG are stored.

1d17. VBR continues to navigate the Digital Map.

1d18. Use case terminates.

Alternate Scenario 1e

In this scenario the VBR is in FN mode and it is previously configured to virtualize all the Eurobalises in the Digital Map. VBR detects VBG1 and confirms its integrity with packet 44/10. Then, it continues to navigate the Digital Map never confirming the integrity of next VBGs. VBR will store information for the last eight VBGs in Pending Status.

1e1. VBR is in FN mode.

1e2. Satellite data are available and augmentation corrections are sent.

1e3. VBR detects a VBG with NID_BG=9088.

1e4. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of NID_BG=9088.

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG2

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=9088

1e5. The GAD verifies and confirms the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise.

1e6. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Confirmed

b. NID_VALBG = 9088.

1e7. The packet 44/10 with positive check result is received within the GNSS integrity confirmation timeout.

1e8. VBR considers as confirmed the integrity for the VBG with NID_BG=9088.

1e9. Then, VBR detects a VBG with NID_BG=9089.

1e10. The packet 44/10 isn’t received within the GNSS integrity confirmation timeout.

1e11. VBR can continue to navigate the Digital Map.

1e12. While GNSS confirmation timeout does not expire, VBR detects next VBGs (NIDs_VBG= 9345, 9045, 9145, 9245, 9047, 9149, 9049).

1e13. When the buffer contains 8 VBGs in pending status

1e15. VBR will store the information for eight VBGs in Pending Status (PVT validity, NID_BG, BG_LOCSPACE, ROLLBACK_NID_BG, SWITCH_ID, SWICH_INT, GNSS_INT).

1e16. When this buffer is full and another VBG (NID_BG=9052) is detected, it is inserted in the buffer.

1e17. The first Pending VBG (NID_BG=9089) exits the buffer and associated integrity failures shall be conservatively assumed.

1e18. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) with:

a. NID_LRBG = 9089

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error computed on the basis of odometric information, using last detected BG whose integrity is already guaranteed as a reference position (delta between 9088 and 9089).

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error computed on the basis of odometric information, using last detected BG whose integrity is already guaranteed as a reference position (delta between 9088 and 9089).

1e19. VBR continues to navigate the Digital Map.

1e20. Use case terminates.

Alternate Scenario 1f

In this scenario the VBR is in FN mode and it is previously configured to virtualize all the Eurobalises in the Digital Map. Previously a packet 44/11 with GNNSS timeout parameter sets on "*Never Expires*" was sent. VBR detects VBG1 and confirms its integrity with packet 44/10. Then, it continues to navigate the Digital Map never confirming the integrity of next VBGs. VBR will store information for the last eight VBGs in Pending Status.

1f1. VBR is in FN mode and, previously, a packet 44/11 with GNNSS timeout parameter sets on "*Never Expires*" was sent.

1f2. Satellite data are available and augmentation corrections are sent.

1f3. VBR detects a VBG with NID_BG=9088.

1f4. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of NID_BG=9088.

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG2

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=9088

1f5. The GAD verifies and confirms the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise.

1f6. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Confirmed

b. NID_VALBG = 9088.

1f7. VBR considers as confirmed the integrity for the VBG with NID_BG=9088.

1f8. Then, VBR detects a VBG with NID_BG=9089.

1f9. The packet 44/10 isn't received.

1f10. VBR can continue to navigate the Digital Map.

1f11. VBR detects next VBGs (NIDs_VBG= 9345, 9045, 9145, 9245, 9047, 9149, 9049).

1f12. When the buffer contains 8 VBGs in pending status

1f13. VBR will store the information for eight VBGs in Pending Status (PVT validity, NID_BG, BG_LOCSPACE, ROLLBACK_NID_BG, SWITCH_ID, SWICH_INT, GNSS_INT).

1f14. When this buffer is full and another VBG (NID_BG=9052) is detected, it is inserted in the buffer.

1f15. The first Pending VBG (NID_BG=9089) exits the buffer and associated integrity failures shall be conservatively assumed.

1f16. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) with:

a. NID_LRBG = 9089

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error computed on the basis of odometric information, using last detected BG whose integrity is already guaranteed as a reference position (delta between 9088 and 9089).

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error computed on the basis of odometric information, using last detected BG whose integrity is already guaranteed as a reference position (delta between 9088 and 9089).

1e17. VBR continues to navigate the Digital Map.

1e18. Use case terminates.

Alternate Scenario 1g

In this scenario the VBR is in SB mode and it is initialized by the ON-BOARD KERNEL (reception of the packet 205) with a Position Report containing a previous Eurobalise. When VBR detects a VBG and its integrity is not confirmed, the rollback procedure is applied to the BG contained in the PR.

1g1. VBR receives from ON-BOARD KERNEL the packet 205 (Valid Position Report) with the known valid position of the train and it is valid relating to the expiration mechanisms based on time and space.

1g2. The GNSS data (Navigation) are available to compute a safe PVT.

1g3. The VBR is able to determine a safe and unique train position information.

1g4. Operational mode of the VBR changes from SB to FN.

1g5. VBR receives from TV the packet 44/6 (Switch Point Status).

1g6.VBR remains in FN mode and detects VBG1 (NID_BG=9048).

1g7. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of 9088.

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG1

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=9048

1g8. The packet 44/10 isn't received within the GNSS integrity confirmation timeout.

1g9. VBR considers the GNSS position integrity failed for the VBG 9048.

1g10. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to the BG contained in the Position Report.

1g11. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = 9048

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error computed on the basis of odometric information, using last detected BG whose integrity is already guaranteed as a reference position (delta between 9048 and 9046).

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error computed on the basis of odometric information, using last detected BG whose integrity is already guaranteed as a reference position (delta between 9048 and 9046).

1g12. Use case terminates.

Alternate Scenario 1b9a

In this scenario the VBR is in TD mode and it is initialized by the TV (reception of the packet 44/5) with a Position Report containing a successive VBG1 (NID_BG=9270). When VBR detects VBG1 and its integrity is confirmed the PVT becomes invalid. Hence, the successive VBGs are confirmed on the basis of the odometric information.

1b9a1. The Augmentation Data expired and the PVT becomes invalid.

1b9a2. The GAD sends to VBR the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Integrity Confirmed

b. NID_VALBG = VBG1.

1b9a3. The packet 44/10 is received within the GNSS integrity confirmation timeout.

1b9a4. VBR considers the GNSS position integrity confirmed for the VBG1 with a packet 247.

1b9a5. VBR continues to move and VBG2 (NID_BG=9170) is detected.

1b9a6. The integrity of VBG1 is automatically confirmed with a packet 247 because no PVT is available.

1b9a7. Use case terminates.

Alternate Scenario 1h

In this scenario the VBR is in TD mode and it is initialized by the TV (reception of the packet 44/5) with a Position Report containing a successive VBG0 (NID_BG=16111). When VBR detects VBG1 (NID_BG=16113) and its integrity is not confirmed, the rollback procedure can be applied and VBR continues to navigate the Digital Map.

1h1. VBR receives from TV the packet 44/5 (Valid Position Report) with the known valid position of the train (with respect the VBG1=16111) and it is valid relating to the expiration mechanisms based on time and space.

1h2. The GNSS data (Navigation) are available to compute a safe PVT.

1h3. The VBR is able to determine a safe and unique train position information.

1h4. Operational mode of the VBR changes from TD to FN.

1h5.VBR remains in FN mode.

1h6. VBR detects the virtual balise group VBG1(NID_BG=16113).

1h7. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of VBG1

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG1

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=VBG1

1h8. The GAD verifies and doesn’t confirm the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise (VBG1).

1h9. The packet 44/10 isn’t received within the GNSS integrity confirmation timeout.

1h10. VBR considers the GNSS position integrity failed for the VBG1.

1h11. VBR can do the rollback with respect the VBG contained in the previous packet 44/5

1h12. VBR continues to navigate the Digital Map.

1h13. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1a: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1a1a: REQ_8.1.2.5, REQ_8.1.2.1, REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1a1a10a: REQ_8.1.2.1, REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1b: REQ_8.1.1.1.

Alternate Scenario 3a: REQ_8.1.1.1.

Alternate Scenario 1a2a: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 3b: REQ_8.1.1.1.

Alternate Scenario 1c: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1d: REQ_8.1.2.1, REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1e: REQ_8.1.2.1, REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1f: REQ_8.1.2.1, REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1g: REQ_8.1.1.1

Alternate Scenario 1b9a: REQ_8.1.1.1

Alternate Scenario 1h: REQ_8.1.1.1

Test: VBR_GPIAR_001

Target: Main Scenario

Description: In this scenario the VBG1 previously detected by VBR has been successfully performed (Virtual Balises whose integrity is confirmed both by the TV and the GAD). The VBR detects the VBG2 and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a positive check result from GAD and without overpassing any switch point after the VBG1 detection, the VBR considers the VBG2 integrity confirmed.

No additional information is needed from TV.

Test: VBR_GPIAR_002

Target: Alternate Scenario 1a

Description: In this scenario VBR detects the VBG1 whose integrity is automatically confirmed by TV and the GAD. So, when the GNSS position integrity fails on the VBG2, the VBR can use the VBG1 as safe reference position to perform a GNSS Position Rollback action.

Test: VBR_GPIAR_003

Target: Alternate Scenario 1a1a

Description: VBR doesn't receive for the VBG1 the GNSS Position Integrity result from GAD.

When the GNSS position integrity fails for VBG1 the VBR can use the EBG1 as safe reference position to perform a GNSS Position Rollback action.

Test: VBR_GPIAR_004

Target: Alternate Scenario 1a1a10a

Description: The Eurobalise EB1 detected by the integrated BTM during initialization phase (SoM procedure) is considered as valid. When the GNSS Position Integrity fails on the VBG2, the GNSS position Rollback is performed using as safe reference position the Eurobalise EB1 because the previous VBG1 hasn't integrity confirmed from TV.

Test: VBR_GPIAR_005

Target: Alternate Scenario 1b

Description: In this scenario the VBR is in TD mode and it is initialized by the TV (reception of the packet 44/5) with a Position Report containing a successive VBG1 (NID_BG=9270). When VBR detects VBG1 and its integrity is not confirmed, the rollback procedure cannot be applied and detection of an unlinked BG that provides a text information is simulated.

Test: VBR_GPIAR_006

Target: Alternate Scenario 3a

Description: In this scenario VBG2 cannot be validated from GAD and the VBR considers failed the GNSS position integrity check.

The VBR can continue to navigate the Digital Map as far as it can rollback to a previous safe reference position (VBG1) and as a consequence VBR sends to EVC the NID_LRBG of the last “Validated BG” and the parameters related to the enlargement of the Confidence Interval.

Test: VBR_GPIAR_007

Target: Alternate Scenario 1a2a

Description: In this scenario VBR detects the VBG1 whose integrity is automatically confirmed by TV and the GAD. So when the GNSS position integrity fails on the VBG2, the VBR can use the VBG1 as safe reference position to perform a GNSS Position Rollback action.

Test: VBR_GPIAR_008

Target: Alternate Scenario 3b

Description: In this scenario VBG2 cannot be validated from GAD and the VBR considers failed the GNSS position integrity check.

The VBR can continue to navigate the Digital Map as far as it can rollback to a previous safe reference position (VBG1) and as a consequence VBR sends to EVC the NID_LRBG of the last “Validated BG” and the parameters related to the enlargement of the Confidence Interval.

Test: VBR_GPIAR_009

Target: Alternate Scenario 1c

Description: In this scenario the VBR is in SB mode and it is initialized by the ON-BOARD KERNEL (reception of the packet 205). VBR detects VBG1 and confirms its integrity. Then, it stops to send packets 44/105

Test: VBR_GPIAR_010

Target: Alternate Scenario 1d

Description: In this scenario the VBR is in FN mode. VBR detects VBG1 and confirms its integrity. Then, it continues to navigate the Digital Map never confirming the integrity of next VBGs. VBR will store information only for the last eight VBGs.

Test: VBR_GPIAR_011

Target: Alternate Scenario 1e

Description: In this scenario the VBR is in FN mode and it is previously configured to virtualize all the Eurobalises in the Digital Map. VBR detects VBG1 and confirms its integrity with packet 44/10. Then, it continues to navigate the Digital Map never confirming the integrity of next VBGs. VBR will store information for the last eight VBGs in Pending Status

Test: VBR_GPIAR_012

Target: Alternate Scenario 1f

Description: In this scenario the VBR is in FN mode and it is previously configured to virtualize all the Eurobalises in the Digital Map. Previously a packet 44/11 with GNNSS timeout parameter sets on "*Never Expires*" was sent. VBR detects VBG1 and confirms its integrity with packet 44/10. Then, it continues to navigate the Digital Map never confirming the integrity of next VBGs. VBR will store information for the last eight VBGs in Pending Status

Test: VBR_GPIAR_013

Target: Alternate Scenario 1g

Description: In this scenario the VBR is in SB mode and it is initialized by the ON-BOARD KERNEL (reception of the packet 205) with a Position Report containing a previous Eurobalise. When VBR detects a VBG and its integrity is not confirmed, the rollback procedure is applied to the BG contained in the PR.

Test: VBR_GPIAR_014

Target: Alternate Scenario 1b9a

Description: In this scenario the VBR is in TD mode and it is initialized by the TV (reception of the packet 44/5) with a Position Report containing a successive VBG1 (NID_BG=9270). When VBR detects VBG1 and its integrity is confirmed the PVT becomes invalid. Hence, the successive VBGs are confirmed on the basis of the odometric information.

Test: VBR_GPIAR_015

Target: Alternate Scenario 1h

Description: In this scenario the VBR is in TD mode and it is initialized by the TV (reception of the packet 44/5) with a Position Report containing a successive VBG0 (NID_BG=16111). When VBR detects VBG1 (NID_BG=16113) and its integrity is not confirmed, the rollback procedure can be applied and VBR continues to navigate the Digital Map.

6.3.3.13 Digital Map Navigation Integrity

The Digital Map navigation integrity is the capability of the VBR to determine a safe and unique train position information on the Digital Map.

After a switch point with known position is overpassed, the VBR sends to TV the Digital Map Navigation Integrity (packet 44/104) to verify the correctness and freshness of point position information. The TV performs a integrity check and sends to VBR the Digital Map Navigation Integrity Result containing the position integrity check result.

In case of positive check result, the integrity of the switch point for Digital Map Navigation Integrity is confirmed from TV.

VBR exits from Full Navigation mode In case of Digital Map Navigation integrity is declared failed.

The VBR is not capable to determine safe and unique train position information if the most advanced train position (most retracted in case of reverse movement) has overpassed at least a facing-point having unknown or out of control status.

Trigger

VBR virtual antenna crosses over a switch point with status known

OR

VBR virtual antenna crosses over a switch point with status unknown or out of control.

OR

VBR receives from TV a packet 44/9 with Q_PRINTEGRITYCHECK = “Integrity Not Confirmed data not updated”

Precondition

FN.

Postcondition

FN, TD or SB.

Main Scenario

VBR is not able to determine a safe and unique train position in the VBR Digital Map for the current position (including the confidence interval) since the most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point having unknown status.

1. VBR detects that the most advanced vehicle position has overpassed a facing point having unknown or out of control status.

2. GNSS data information is available.

3. Operational mode switches from FN to TD mode.

4. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PKT_STATUS_BTM) with Q_VBR_OB_OPMODE = TD.

5. Use case terminates.

Alternate Scenario 1a

The Eurobalise EB1 detected by the integrated BTM during initialization phase (SoM procedure) is considered as valid. During the mission VBR ignores the received confirmation (packet 44/9 from TV) in case it is referred to an unexpected switch point. So, the Virtual Balise detected after a switch-point for which VBR doesn't have correctness and freshness confirmation, are considered balise integrity not confirmed as for the Digital Map Navigation Integrity.

1a1. A switch-point (M_PTID=A) has been overpassed by train.

1a2. VBR sends to TV the packet 44/104 (Digital Map Navigation Integrity) with:

• M_PTSTATUSID=last value received in the packet 44/6 (Switch Point Status).

• M_PTID=A

1a3. VBR doesn't receive any packet 44/9 (Digital Map Navigation Integrity Result) from TV.

1a4. VBR detects the virtual balise group VBG1.

1a5. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) associated to the VBG1.

1a6.The packet 44/10 with positive check result is received within the GNSS integrity confirmation timeout.

1a7. VBR considers (for the VBG1) balise integrity confirmed as for the GNSS position integrity confirmed but not confirmed as for the Digital Map navigation.

1a8. Another switch-point (M_PTID=B) has been overpassed by train.

1a9. VBR sends to TV the packet 44/104 (Digital Map Navigation Integrity) with:

• M_PTSTATUSID= last value received in the packet 44/6 (Switch Point Status).

• M_PTID= B

1a10. VBR receives from TV the packet 44/9 associated to the previous switch point M_PTID= A:

• Q_PRINTEGRITYCHECK= Position Integrity Confirmed

• M_PTSTATUSID= last value received in the packet 44/104 (Digital Map Navigation Integrity).

• M_PTID= A

This information is ignored by VBR because it is not associated to a switch point whose position correctness and freshness confirmation is pending.

1a11. VBR detects the virtual balise group VBG2.

1a12. VBR considers the GNSS position integrity failed for the VBG2.

1a13. VBR can continue to navigate the Digital Map as far as it can rollback to a previous safe reference position (EB1 detected by the integrated BTM during SoM procedure).

1a14. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to EBG1 with:

a. NID_LRBG = EBG1

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=EBG1

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=EBG1.

1a15. Use case terminates.

Alternate Scenario 1b

In this scenario VBR overpasses a switch point and sends to TV its identifier to allow trackside to perform Digital Map navigation integrity check. VBR receives from Trackside Verification (TV) module information on failed check on correctness and freshness of switch point position information used to navigate the Digital Map. VBR declares Digital Map Navigation Integrity failed and exits from FN mode.

1b1. GNSS data information isn’t available.

1b2. A switch-point (M_PTID= A) has been overpassed by train.

1b3. VBR sends to TV the packet 44/104 (Digital Map Navigation Integrity) with:

• M_PTSTATUSID=last value received in the packet 44/6 (Switch Point Status).

• M_PTID=A

1b4. VBR receives from TV the packet 44/9 associated to the previous switch point M_PTID= A:

• Q_PRINTEGRITYCHECK= Integrity Not Confirmed data not updated

• M_PTSTATUSID= last value received in the packet 44/104 (Digital Map Navigation Integrity).

• M_PTID= A

1b5. Digital Map Navigation Integrity fails and operational mode switches from FN to SB mode.

1b6. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SB

1b7. Use case terminates.

Alternate Scenario 1c

In this scenario VBR receives from ON-BOARD KERNEL the packet 214 (Order to VBR) in order to delete or to reset the stored information related to the current mission.

1c1. VBR is in FN mode in Nominal Conditions.

1c2. VBR receives the packet 44/6 (Switch Point Status) containing the next switch point positions (M_PTID= A, M_PTID= B, M_PTID= C).

1c3. A switch-point (M_PTID= A) has been overpassed by train.

1c4. VBR receives from ON-BOARD KERNEL the packet 214 (Order to VBR) with:

• NID_VBRORDER= Reset Switch Points status information.

In order to reset the stored information related to the current mission.

1c5. A switch-point (M_PTID= B) has been overpassed by train.

1c6. VBR detects that the most advanced vehicle position has overpassed a facing point having unknown status.

1c7. Digital Map Navigation Integrity fails and operational mode switches from FN to TD mode.

1c8. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = TD.

1c9. Use case terminates.

Alternate Scenario 1c4a

In this scenario the VBR receives a packet 44/6 containing void information (N_ITER=0) and it deletes all corresponding information currently applicable. For this reason when the most advanced vehicle position (most retracted in case of reverse movement) overpasses a facing point, the Digital Map Navigation integrity fails because its status is unknown.

1c4a1. VBR receives from TV a packet 44/6 with:

• N_ITER=0

1c4a2. The switch-point (previous M_PTID= B) has been overpassed by train.

1c4a3. VBR detects that the most advanced vehicle position has overpassed a facing point having unknown status.

1c4a4. Digital Map Navigation integrity fails and operational mode switches from FN to TD mode.

1c4a5. Use case terminates.

Alternate Scenario 2a

VBR is not able to determine a safe and unique train position in the VBR Digital Map for the current position (including the confidence interval) since the most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point having unknown status. In this scenario VBR is in FN mode and the differential corrections are expired.

2a1. GNSS data information isn't available.

2a2. Operational mode switches from FN to SB mode.

2a3. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = SB.

2a4. Use case terminates.

Alternate Scenario 1c4b

In this scenario the VBR receives a packet 44/6 containing first a list of switch points, and then void information (N_ITER=0) and it deletes all corresponding information currently applicable. For this reason when the most advanced vehicle position (most retracted in case of reverse movement) overpasses a facing point, the Digital Map Navigation integrity fails because its status is unknown.

1c4b1. VBR receives from TV a packet 44/6 with:

• PTSTATUS_ID= 0

• N_ITER=9

1c4b2. VBR receives from TV another packet 44/6 with:

• PTSTATUS_ID= 1

• N_ITER=0

1c4b3. The switch-point (previous M_PTID=B) has been overpassed by train.

1c4b4. VBR detects that the most advanced vehicle position has overpassed a facing point having unknown status.

1c4b5. Digital Map Navigation integrity fails and operational mode switches from FN to TD mode.

1c4b6. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3.

Alternate Scenario 1a: REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 1b: REQ_8.1.2.3, REQ_8.1.1.1.

Alternate Scenario 1c: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3.

Alternate Scenario 1c4a: REQ_8.1.1.1

Alternate Scenario 2a: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3.

Alternate Scenario 1c4b: REQ_8.1.2.3, REQ_8.1.1.

Test: VBR_DMNI_001

Target: Main Scenario

Description: VBR is not able to determine a safe and unique train position in the VBR Digital Map for the current position (including the confidence interval) since the most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point having unknown status.

Test: VBR_DMNI_002

Target: Alternate Scenario 1a

Description: The Eurobalise EB1 detected by the integrated BTM during initialization phase (SoM procedure) is considered as valid. During the mission VBR ignores the received confirmation (packet 44/9 from TV) in case it is referred to an unexpected switch point. So, the Virtual Balise detected after a switch-point for which VBR doesn't have correctness and freshness confirmation, are considered balise integrity not confirmed as for the Digital Map Navigation Integrity.

Test: VBR_DMNI_003

Target: Alternate Scenario 1b

Description: In this scenario VBR overpasses a switch point and sends to TV its identifier to allow trackside to perform Digital Map navigation integrity check. VBR receives from Trackside Verification (TV) module information on failed check on correctness and freshness of switch point position information used to navigate the Digital Map. VBR declares Digital Map Navigation Integrity failed and exits from FN mode.

Test: VBR_DMNI_004

Target: Alternate Scenario 1c

Description: In this scenario VBR receives from ON-BOARD KERNEL the packet 214 (Order to VBR) in order to delete or to reset the stored information related to the current mission.

Test: VBR_DMNI_005

Target: Alternate Scenario 1c4a

Description: In this scenario the VBR receives a packet 44/6 containing void information (N_ITER=0) and it deletes all corresponding information currently applicable. For this reason when the most advanced vehicle position (most retracted in case of reverse movement) overpasses a facing point, the Digital Map Navigation integrity fails because its status is unknown.

Test: VBR_DMNI_006

Target: Alternate Scenario 2a

Description: VBR is not able to determine a safe and unique train position in the VBR Digital Map for the current position (including the confidence interval) since the most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point having unknown status. In this scenario VBR is in FN mode and the differential corrections are expired.

Test: VBR_DMNI_007

Target: Alternate Scenario 1c4b

Description: In this scenario the VBR receives a packet 44/6 containing first a list of switch points, and then void information (N_ITER=0) and it deletes all corresponding information currently applicable. For this reason, when the most advanced vehicle position (most retracted in case of reverse movement) overpasses a facing point, the Digital Map Navigation integrity fails because its status is unknown.

6.3.3.14

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6.3.3.15 PVT

The VBR periodically calculates the augmented PVT information on the basis of:

• GNSS Observation Data

• Navigation Data from GAD

• Augmentation and Integrity Data from GAD

The VBR uses, for the augmented PVT calculation, the differential corrections related to the generic satellite k only if the Packet 44/3 has “VALID” corrections values for that satellite K.

Trigger

VBR receives from GAD an update of the packet 44/3.

Precondition

VBR is in FN mode.

Postcondition

VBR is in FN mode.

Main Scenario

1. VBR receives from GAD the packet 44/3 with differential corrections that are "VALID" for the minimum number of satellites needful to calculate PVT.

2. VBR uses the received Differential Corrections to calculate PVT (with a minimum refresh rate of 1 Hz).

3. VBR receives from GAD an update of the packet 44/3 with "SPECIAL" differential corrections for the satellite K.

4. VBR doesn’t use the satellite K for the PVT calculation.

5. VBR is no more able to calculate PVT with satellite K.

6. VBR stores as valid the Navigation Data related to the satellite K.

7. VBR receives from GAD an update of the packet 44/3 with "VALID" differential corrections for the satellite K.

8. VBR uses the received Differential Corrections related to satellite K (together with the stored Navigation Data related to satellite K) in order to restart the PVT computation.

9. VBR invalidates the differential corrections related to the satellite K at the time T = Reference_Time + T_MAX_EXP_AG_TIME (due to time-based expiration mechanism).

10. VBR doesn’t use the satellite K for the PVT calculation.

11. VBR is no more able to calculate PVT.

12. Use case terminates.

Alternate Scenario 3a

If the VBR receives Differential Corrections having “HARD_INVALID” values for a satellite K, it shall consider the Differential Corrections for the satellite K as “INVALID” and it shall not use satellite K for the computation of the PVT.

3a1. VBR receives from GAD an update of the packet 44/3 with "HARD_INVALID" differential corrections for the satellite K.

3a2. Continue at Main Scenario, step 4.

Alternate Scenario 3b

If the VBR receives Differential Corrections having “SOFT_INVALID” values for a satellite K, it shall consider the Differential Corrections for the satellite K as “INVALID” and it shall not use satellite K for the computation of the PVT.

3b1. VBR receives from GAD an update of the packet 44/3 with "SOFT_INVALID" differential corrections for the satellite K.

3b2. Continue at Main Scenario, step 4.

Alternate Scenario 3c

If the VBR receives a packet 44/3 with T_GPS_PRC = 4294967295, it shall consider all the Differential Corrections as “INVALID” and it shall not use the related satellites for the computation of the PVT.

3c1. VBR receives from GAD an update of the packet 44/3 with T_GPS_PRC = 4294967295.

3c2. VBR doesn’t use the satellites related to the packet 44/3 for the PVT calculation.

3c3. VBR is no more able to calculate PVT.

3c4. VBR stores as valid the Navigation Data of the satellites related to the packet 44/3.

3c5. VBR receives from GAD an update of the packet 44/3 with "VALID" differential corrections for the satellites related to the previous packet 44/3.

3c6. VBR uses the received Differential Corrections (together with the stored Navigation Data) in order to restart the PVT computation.

3c7. Use case terminates.

Alternate Scenario 3d

If the VBR receives a packet 44/3 with N_ITER=0 it shall not use the related satellites for the computation of the PVT.

3d1. VBR receives from GAD an update of the packet 44/3 with N_ITER=0.

3d2. VBR deletes all corresponding information currently applicable (about the stored and valid differential corrections).

3d3. VBR is no more able to calculate PVT when the previous valid packet 44/3 expires.

3d4. VBR stores as valid the Navigation Data of the satellites related to the packet 44/3.

3d5. Use case terminates.

Alternate Scenario 3e

If the VBR receives a packet 44/8 with N_ITER=0 it shall not use the related satellites for the computation of the PVT.

3e1. VBR receives from GAD an update of the packet 44/8 with N_ITER=0.

3e2. VBR deletes all corresponding information currently applicable (about the stored and valid navigation data).

3e3. VBR is no more able to calculate PVT.

3e4. VBR stores as valid the Navigation Data of the satellites related to the packet 44/3.

3e5. Use case terminates.

Alternate Scenario 3a1a

If the VBR receives Differential Corrections having “HARD_INVALID” values for a satellite K, it shall not perform any freshness check on these corrections, since they are not valid, so it shall not use satellite K for the computation of the PVT.

3a1a1. VBR receives from GAD an update of the packet 44/3 with "HARD_INVALID" differential corrections for the satellite K. These corrections are already time-elapsed.

3a1a2. Continue at Main Scenario, step 4.

Alternate Scenario 3f

VBR is in FN mode and the calculated PVT is valid since it received correct navigation and correction data. When VBR does not receive corrections for a long time (some minutes) the PVT is invalidated. But, Navigation Data validity endures for hours so, when new corrections are received, they are accepted and PVT becomes valid again.

3f1. VBR is in FN mode and PVT is valid.

3f2. VBR invalidates the differential corrections at the time T = Reference_Time + T_MAX_EXP_AG_TIME (due to time-based expiration mechanism).

3f3. VBR is no more able to calculate PVT.

3f4. VBR stores as valid the Navigation Data.

3f5. After some minutes, VBR receives from GAD an update of the packet 44/3 with "VALID" differential corrections.

3f6. VBR uses the received Differential Corrections (together with the stored Navigation Data related to satellite K) in order to restart the PVT computation.

3f7. VBR invalidates the differential corrections at the time T = Reference_Time + T_MAX_EXP_AG_TIME (due to time-based expiration mechanism).

3f8. VBR is no more able to calculate PVT.

3f9. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.2.3, REQ_8.1.2.2, REQ_8.1.1.1, REQ_8.1.2.1.

Alternate Scenario 3a: REQ_8.1.2.1, REQ_8.1.2.3.

Alternate Scenario 3b: REQ_8.1.2.1, REQ_8.1.2.3.

Alternate Scenario 3c: REQ_8.1.2.1, REQ_8.1.2.3.

Alternate Scenario 3d: REQ_8.1.2.1, REQ_8.1.2.3, REQ_8.1.1.1.

Alternate Scenario 3e: REQ_8.1.2.1, REQ_8.1.2.3, REQ_8.1.1.1.

Alternate Scenario 3a1a: REQ_8.1.2.1, REQ_8.1.2.3, REQ_8.1.1.1.

Alternate Scenario 3f: REQ_8.1.2.3.

Test: VBR_PVT_001

Target: Main Scenario

Description: The VBR periodically calculates the PVT information on the basis of:

• GNSS Observation Data

• Navigation data from GAD

• Augmentation and integrity data from GAD

The VBR uses, for the PVT calculation, the differential corrections related to the generic satellite k only if the Packet 44/3 has “VALID” corrections values for that satellite k.

If the differential corrections for the generic satellite k are "Special", these corrections are not used for the PVT calculation by VBR.

Test: VBR_PVT_002

Target: Alternate Scenario 3a

Description: If the VBR receives Differential Corrections having “HARD_INVALID” values for a satellite K, it shall consider the Differential Corrections for the satellite K as “INVALID” and it shall not use satellite K for the computation of the PVT.

Test: VBR_PVT_003

Target: Alternate Scenario 3b

Description: If the VBR receives Differential Corrections having “SOFT_INVALID” values for a satellite K, it shall consider the Differential Corrections for the satellite K as “INVALID” and it shall not use satellite K for the computation of the PVT.

Test: VBR_PVT_004

Target: Alternate Scenario 3c

Description: If the VBR receives a packet 44/3 with T_GPS_PRC = 4294967295, it shall consider all the Differential Corrections as “INVALID” and it shall not use the related satellites for the computation of the PVT.

Test: VBR_PVT_005

Target: Alternate Scenario 3d

Description: If the VBR receives a packet 44/3 with N_ITER=0 it shall not use the related satellites for the computation of the PVT.

Test: VBR_PVT_006

Target: Alternate Scenario 3e

Description: If the VBR receives a packet 44/8 with N_ITER=0 it shall not use the related satellites for the computation of the PVT.

Test: VBR_PVT_007

Target: Alternate Scenario 3a1a

Description: If the VBR receives Differential Corrections having “HARD_INVALID” values for a satellite K, it shall not perform any freshness check on these corrections, since they are not valid, so it shall not use satellite K for the computation of the PVT.

Test: VBR_PVT_008

Target: Alternate Scenario 3f

Description: VBR is in FN mode and the calculated PVT is valid since it received correct navigation and correction data. When VBR does not receive corrections for a long time (some minutes) the PVT is invalidated. But, Navigation Data validity endures for hours so, when new corrections are received, they are accepted and PVT becomes valid again.

6.3.3.16 Augmentation data expiration mechanism

The VBR, when receives from GAD the GNSS Differential Corrections Packet (Packet 44/3), uses an expiration mechanism based on time and space in order to invalidate the data received after the expected time or space is expired.

This expiration mechanism uses the configuration parameters received from the GAD in the GNSS Parameters (Packet 44/11) or the local default configuration values in case no Packet 44/11 has been received.

This expiration mechanism shall be applied to all the packets 44/3 "valid" received by VBR.

The expiration mechanism used by VBR in SB\TD mode during position initialization, has been verified in the test category “Position Initialization from GAD".

Trigger

VBR considers that augmentation data are not valid anymore due to expiration mechanism based on:

• T_MAX_EXP_AG_TIME provided in the Packet 44/11

OR

• T_MAX_EXP_AG_TIME default configuration value

OR

• D_MAX_EXP_AG_SPACE provided in the Packet 44/11

OR

• D_MAX_EXP_AG_SPACE default configuration value.

Precondition

VBR is in FN mode.

Postcondition

VBR is in FN mode or TD.

Main Scenario

VBR considers that augmentation data are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME provided in the Packet 44/11 sent together with the Packet 44/3.

1. VBR receives the Packet 44/3 containing the differential corrections (tagged with Reference_Time) related to the satellites 5, 13, 14, 15, 17, 20, 23, 24, 30and the Packet 44/11.

2. VBR receives a Packet 44/3 containing the update of the differential corrections related to the satellites 1, 3 at the time T < Reference_Time + T_MAX_EXP_AG_TIME.

3. VBR invalidates the differential corrections related to the satellite 5 at the time T = Reference_Time + T_MAX_EXP_AG_TIME (due to expiration mechanism based on the T_MAX_EXP_AG_TIME of the Packet 44/11).

Alternate Scenario 1a

The VBR considers that augmentation data are not valid anymore due to expiration

mechanism based on T_MAX_EXP_AG_TIME default configuration value.

1a1.VBR receives the Packet 44/3 containing the differential corrections (tagged with Reference_Time) related to the satellites 5, 13, 14, 15, 17, 20, 23, 24, 30.

1a2. VBR receives a Packet 44/3 containing the update of the differential corrections related to the satellites 13, 14, 15, 17, 20, 23, 24, 30at the time T < Reference_Time + T_MAX_EXP_AG_TIME.

1a3. VBR invalidates the differential corrections related to the satellite 5 at the time T = Reference_Time + T_MAX_EXP_AG_TIME (due to expiration mechanism based on the T_MAX_EXP_AG_TIME default configuration value).

1a4. Use case terminates.

Alternate Scenario 1b

VBR is in FN mode.

VBR considers that augmentation data are not valid anymore due to expiration mechanism

based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11 sent together with the Packet 44/3 and D_ESTODO_BG is known (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

• CTODL_CURR = current value of CTODL.

1b1. VBR receives the Packet 44/3 containing the differential corrections (related to1b1. VBR receives the Packet 44/3 containing the differential corrections (related to

Reference_Location) for 9 satellites (5, 13, 14, 15, 17, 20, 23, 24, 30) and the Packet 44/11.

1b2. When (|CTODL_CURR - D_ESTODO_BG|) < D_MAX_EXP_AG_SPACE, VBR receives a Packet 44/3 containing the update of the differential corrections for satellites 13, 14, 15, 17, 20, 23, 24, 30..

1b3. When (|CTODL_CURR - D_ESTODO_BG|) > D_MAX_EXP_AG_SPACE, VBR invalidates the differential corrections related to the satellite 5 (due to expiration mechanism based on the D_MAX_EXP_AG_SPACE of the Packet 44/11).

1b4. Use case terminates.

Alternate Scenario 1c

VBR is in FN mode.

VBR considers that augmentation data are not valid anymore due to expiration mechanism

based on D_MAX_EXP_AG_SPACE default configuration value and D_ESTODO_BG is known (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

CTODL_CURR = current value of CTODL.

1c1. VBR receives the Packet 44/3 containing the differential corrections (related to

Reference_Location) for the satellites 5, 13, 14, 15, 17, 20, 23, 24, 30.

1c2. When (|CTODL_CURR - D_ESTODO_BG|) < D_MAX_EXP_AG_SPACE, VBR receives a Packet 44/3 containing the update of the differential corrections for the satellites 13, 14, 15, 17, 20, 23, 24, 30.

1c3. When (|CTODL_CURR - D_ESTODO_BG|) > D_MAX_EXP_AG_SPACE, VBR invalidates the differential corrections related to the satellite 5 (due to expiration mechanism based on the D_MAX_EXP_AG_SPACE default configuration value).

1c4. Use case terminates.

Alternate Scenario 1d

VBR is in FN mode.

VBR considers that augmentation data are not valid anymore due to expiration mechanism

based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11 sent together with the Packet

44/3 and D_ESTODO_BG is unknown (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

- CTODL_CURR = current value of CTODL
- CTODL_REF = CTODL (space) in which PDU 7 that transports packet 44/3 has been received
- D_LRBG_MAX = maximum distance from the LRBG used by GAD for the Differential corrections calculation.

1d1. VBR receives the Packet 44/3 containing the differential corrections (related to Reference_Location) for the satellites 1, 2, 3 and the Packet 44/11.

1d2. When (|CTODL_CURR-CTODL_REF|+D_LRBG_MAX) < D_MAX_EXP_AG_SPACE, VBR receives a Packet 44/3 containing the update of the differential corrections for the satellites 1, 3.

1d3. When (|CTODL_CURR-CTODL_REF|+D_LRBG_MAX) > D_MAX_EXP_AG_SPACE, VBR invalidates the differential corrections related to the satellite 2 (due to expiration mechanism based on the D_MAX_EXP_AG_SPACE of the Packet 44/11).

1d4. Use case terminates.

Alternate Scenario 1e

VBR is in FN mode.

VBR considers that augmentation data are not valid anymore due to expiration mechanism

based on D_MAX_EXP_AG_SPACE default configuration value and D_ESTODO_BG is unknown (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

• CTODL_CURR = current value of CTODL

• CTODL_REF = CTODL (space) in which PDU 7 that transports packet 44/3 has been received

• D_LRBG_MAX = maximum distance from the LRBG used by GAD for the Differential corrections calculation.

1e1. VBR receives the Packet 44/3 containing the differential corrections (related to

Reference_Location) for the satellites 1, 2, 3.

1e2. When (|CTODL_CURR-CTODL_REF|+D_LRBG_MAX) < D_MAX_EXP_AG_SPACE, VBR receives a Packet 44/3 containing the update of the differential corrections for the satellites 1, 3.

1e3. When (|CTODL_CURR-CTODL_REF|+D_LRBG_MAX) > D_MAX_EXP_AG_SPACE, VBR invalidates the differential corrections related to the satellite 2 (due to expiration mechanism based on the D_MAX_EXP_AG_SPACE default configuration value).

1e4. Use case terminates.

Alternate Scenario 1f

VBR is in FN mode.

VBR considers that augmentation data received in the previous mode (TD) are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME provided in the Packet 44/11.

1f1. VBR receives in TD mode the Packet 44/3 containing the differential corrections (tagged with Reference_Time) related to the satellites 5, 13, 14, 15, 17, 20, 23, 24, 30.

1f2. VBR is in FN mode and invalidates the differential corrections related to all the satellites at the time T = Reference_Time + T_MAX_EXP_AG_TIME (due to expiration mechanism based on the T_MAX_EXP_AG_TIME of the Packet 44/11).

1f3. Use case terminates.

Alternate Scenario 1g

VBR is in FN mode.

VBR considers that augmentation data received in the previous mode (TD) are not valid anymore due to expiration mechanism based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11.

In this case the condition to be verified will be based on:

• CTODL_CURR = current value of CTODL

• CTODL_REF = 0

• D_LRBG_MAX = maximum distance from the LRBG used by GAD for the Differential corrections calculation.

1g1. VBR receives in TD mode the Packet 44/3 containing the differential correction (related to Reference_Location) for the satellites 5, 13, 14, 15, 17, 20, 23, 24, 30.

1g2. When (|CTODL_CURR-CTODL_REF|+D_LRBG_MAX) > D_MAX_EXP_AG_SPACE, VBR invalidates the differential corrections related to all the satellites (due to expiration mechanism based on the D_MAX_EXP_AG_SPACE of the Packet 44/11).

1g3. Use case terminates.

Alternate Scenario 1b2a

VBR is in FN mode.

VBR switches to TD mode and considers that augmentation data are not valid anymore due to expiration mechanism based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11 sent together with the Packet 44/3 and D_ESTODO_BG is known (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

• CTODL_CURR = current value of CTODL.

1b2a1. When (|CTODL_CURR - D_ESTODO_BG|) < D_MAX_EXP_AG_SPACE, VBR receives a Packet 44/3 containing the update of the differential corrections for satellites 13, 14, 15, 17, 20, 23, 24, 30.

1b2a2. VBR overpasses a facing point with status unknown and switches to TD.

1b2a3. When (|CTODL_CURR - D_ESTODO_BG|) > D_MAX_EXP_AG_SPACE, VBR invalidates the differential corrections related to the satellite 5 (due to expiration mechanism based on the D_MAX_EXP_AG_SPACE of the Packet 44/11).

1b2a4. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1.

Alternate Scenario 1a: REQ_8.1.1.1.

Alternate Scenario 1b: REQ_8.1.1.1.

Alternate Scenario 1c: REQ_8.1.1.1.

Alternate Scenario 1d: REQ_8.1.1.1.

Alternate Scenario 1e: REQ_8.1.1.1.

Alternate Scenario 1f: REQ_8.1.1.1.

Alternate Scenario 1g: REQ_8.1.1.1.

Alternate Scenario 1b2a: REQ_8.1.1.1.

Test: VBR_ADEM_001

Target: Main Scenario

Description: VBR considers that augmentation data are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME provided in the Packet 44/11 sent together with the Packet 44/3.

Test: VBR_ADEM_002

Target: Alternate Scenario 1a

Description: The VBR considers that augmentation data are not valid anymore due to expiration

mechanism based on T_MAX_EXP_AG_TIME default configuration value.

Test: VBR_ADEM_003

Target: Alternate Scenario 1b

Description: VBR is in FN mode.

VBR considers that augmentation data are not valid anymore due to expiration mechanism

based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11 sent together with the Packet 44/3 and D_ESTODO_BG is known (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

• CTODL_CURR = current value of CTODL.

Test: VBR_ADEM_004

Target: Alternate Scenario 1c

Description: VBR is in FN mode.

VBR considers that augmentation data are not valid anymore due to expiration mechanism

based on D_MAX_EXP_AG_SPACE default configuration value and D_ESTODO_BG is known (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

CTODL_CURR = current value of CTODL.

Test: VBR_ADEM_005

Target: Alternate Scenario 1d

Description: VBR is in FN mode.

VBR considers that augmentation data are not valid anymore due to expiration mechanism based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11 sent together with the Packet

44/3 and D_ESTODO_BG is unknown (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

• CTODL_CURR = current value of CTODL

• CTODL_REF = CTODL (space) in which PDU 7 that transports packet 44/3 has been received

• D_LRBG_MAX = maximum distance from the LRBG used by GAD for the Differential corrections calculation.

Test: VBR_ADEM_006

Target: Alternate Scenario 1e

Description: VBR is in FN mode.

VBR considers that augmentation data are not valid anymore due to expiration mechanism

based on D_MAX_EXP_AG_SPACE default configuration value and D_ESTODO_BG is unknown (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

• CTODL_CURR = current value of CTODL

• CTODL_REF = CTODL (space) in which PDU 7 that transports packet 44/3 has been received

• D_LRBG_MAX = maximum distance from the LRBG used by GAD for the Differential corrections calculation.

Test: VBR_ADEM_007

Target: Alternate Scenario 1f

Description: VBR is in FN mode.

VBR considers that augmentation data received in the previous mode (TD) are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME provided in the Packet 44/11.

Test: VBR_ADEM_008

Target: Alternate Scenario 1g

Description: VBR is in FN mode.

VBR considers that augmentation data received in the previous mode (TD) are not valid anymore due to expiration mechanism based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11.

In this case the condition to be verified will be based on:

• CTODL_CURR = current value of CTODL

• CTODL_REF = 0

• D_LRBG_MAX = maximum distance from the LRBG used by GAD for the Differential corrections calculation.

Test: VBR_ADEM_009

Target: Alternate Scenario 1b2a

Description: VBR is in FN mode.

VBR switches to TD mode and considers that augmentation data are not valid anymore due to expiration mechanism based on D_MAX_EXP_AG_SPACE provided in the Packet 44/11 sent together with the Packet 44/3 and D_ESTODO_BG is known (value contained in PDU 7 that transports packet 44/3).

In this case the condition to be verified will be based on:

• CTODL_CURR = current value of CTODL.

6.3.3.17 Virtual Balise Detection

When the VBR determines a "VBR virtual antenna" position that may be associated with specific Digital Map locations at which a virtual balise has been assigned, the VBR provides the associated Virtual Balise message to the on-board signalling core.

The VBR calculates and provide to the on-board signalling core a dynamic Virtual Balise location reference error bound.

The VBR reports to the ON-BOARD KERNEL the correct sequence of the Virtual Balises based on the detected train orientation of the vehicle (e.g., Nominal, Reverse relative to the linear reference system in the track).

In this test category the VB detection is verified both for train moving forward and for train moving backward.

Trigger

VBR determines a "VBR virtual antenna" that may be associated with specific Digital Map locations at which a virtual balise has been assigned.

Precondition

VBR is in FN mode.

Postcondition

VBR is in FN, SB, TD or SF mode.

Main Scenario

1. VBR is in FN mode and, in SC mode, has been previously configured to:

• receive CTODL from ON-BOARD KERNEL

• provide only Virtual Balises to ON-BOARD KERNEL, So, the filtering of Eurobalises is active in FN mode.

2. VBR checks that all the following conditions are fulfilled:

• consistency of the Digital Map and interface protocol version with RBC/TV

AND

• unique position determination (including the confidence interval) on the track is guaranteed

AND

• for a sufficient number of satellites, valid GNSS Observation Data are available and, for these satellites, VBR has received valid GNSS Navigation Data (packet 44/8) and GNSS Differential Corrections (packet 44/3) that are still valid.

3. VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the virtual balise VB1 (first balise of the first VBG1 "Virtual Balise Group 1") has been assigned and sends to the ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram) with:

• locSpace computed according to ON-BOARD KERNEL CTODL

• locSpaceMin\locSpaceMax computed according to ON-BOARD KERNEL CTODL and to the delta, between the dynamic virtual balise position accuracy and the Q_LOCACC stored in the Digital Map.

• locTime computed according to ON-BOARD KERNEL CTODL

• Q_VIRT_BAL_TLG = Virtual Balise

• the correct telegram related to VB1 from Digital Map.

4. VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location, more advanced than the location of the previous VB1, relating to the Digital Map orientation, at which the virtual balise VB2 (first balise of the second VBG2 "Virtual Balise Group 2) has been assigned and sends to the ON-BOARD KERNEL the PDU Number 2 (PacketBalise Telegram) with:

• locSpace computed according to ON-BOARD KERNEL CTODL

• locSpaceMin\locSpaceMax computed according to ON-BOARD KERNEL CTODL and to the delta, between the dynamic virtual balise position accuracy and the Q_LOCACC stored in the Digital Map.

• locTime computed according to ON-BOARD KERNEL CTODL

• Q_VIRT_BAL_TLG = Virtual Balise

• the correct telegram related to VB2 from Digital Map.

5. Use case terminates.

Alternate Scenario 1b

In SC mode, VBR has been previously configured to provide Virtualized Real Balise to ON-BOARD KERNEL. So, the Eurobalises associated to Balise Groups marked with specific flags in the VBR Digital Map are detected by the VBR, vice versa VBR filters the other Balise Groups.

1b1. VBR is in FN mode and, in SC mode, has been previously configured to:

• receive CTODL from ON-BOARD KERNEL

• provide Virtualized Real Balise to ON-BOARD KERNEL.

1b2. VBR checks that all the following conditions are fulfilled:

• consistency of the Digital Map and interface protocol version with RBC/TV

AND

• unique position determination (including the confidence interval) on the track is guaranteed

AND

• for a sufficient number of satellites, valid GNSS Observation Data are available and, for these satellites, VBR has received valid GNSS Navigation Data (packet 44/8) and GNSS Differential Corrections (packet 44/3) that are still valid.

1b3. VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the Virtualized Real Balise VRB1 has been assigned and sends to the ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram) with:

• locSpace computed according to ON-BOARD KERNEL CTODL

• locSpaceMin\locSpaceMax computed according to ON-BOARD KERNEL CTODL and to the delta, between the dynamic virtualized real balise position accuracy and the Q_LOCACC stored in the Digital Map.

• locTime computed according to ON-BOARD KERNEL CTODL

• Q_VIRT_BAL_TLG = Virtualized EuroBalise

• the correct telegram related to VRB1 from Digital Map.

1b4. VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location, more advanced than the location of the previous VB1 (first balise of the first VBG1 "Virtual Balise Group 1"), relating to the Digital Map orientation, at which the virtual balise VB2 (first balise of the second VBG2 "Virtual Balise Group 2") has been assigned and sends to the ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram) with:

• locSpace computed according to ON-BOARD KERNEL CTODL

• locSpaceMin\locSpaceMax computed according to ON-BOARD KERNEL CTODL and to the delta, between the dynamic virtual balise position accuracy and the Q_LOCACC stored in the Digital Map.

• locTime computed according to ON-BOARD KERNEL CTODL

• Q_VIRT_BAL_TLG = Virtual Balise

• the correct telegram related to VB2 from Digital Map.

1b5. Use case terminates.

Alternate Scenario 2a

VBR disables the virtual balise detection function in SB mode.

2a1. VBR checks that the unique position determination (including the confidence interval) on the track is no more guaranteed and GNSS data information isn’t available.

2a2. VBR switches to SB mode.

2a3. VBR reaches a railway position associated to the virtual balise VB1 and doesn't send to the ON-BOARD KERNEL any PDU Number 2.

2a4. Use case terminates.

Alternate Scenario 2b

VBR disables the virtual balise detection function in TD mode.

2b1. VBR checks that the unique position determination (including the confidence interval) on the track is no more guaranteed.

2b2. VBR switches to TD mode.

2b3. VBR reaches a railway position associated to the virtual balise VB1 and doesn't send to the ON-BOARD KERNEL any PDU Number 2.

2b4. Use case terminates.

Alternate Scenario 2c

VBR detects the virtual balises using the CTODL provided by ON-BOARD KERNEL.

2c1. VBR checks that are not available GNSS Observation Data for a sufficient number of satellites.

2c2. VBR determines, using the ON-BOARD KERNEL CTODL to navigate on the Digital Map, a train position associated with a specific Digital Map location at which the virtual balise VB1(first balise of the first VBG1 "Virtual Balise Group 1") has been assigned and sends to the ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram) with:

• locSpace computed according to ON-BOARD KERNEL CTODL

• locSpaceMin\locSpaceMax computed according to ON-BOARD KERNEL CTODL and to the delta, between the dynamic virtual balise position accuracy and the Q_LOCACC stored in the Digital Map.

• locTime computed according to ON-BOARD KERNEL CTODL

• Q_VIRT_BAL_TLG = Virtual Balise

• the correct telegram related to VB1 from Digital Map.

2c3. Use case terminates.

Alternate Scenario 3a

In SC mode, VBR has been previously configured to provide only Virtual Balises to ON-BOARD KERNEL, so it doesn't provide Virtualized Real Balise to ON-BOARD KERNEL.

3a1. VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the Virtualized Real Balise VRB1 has been assigned and it doesn't send to ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram Real) related to VRB1.

3a2. Use case terminates.

Alternate Scenario 4a

VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the VB (N_PIG=1, first balise of the second VBG2 "Virtual Balise Group 2") has been assigned relating to the Digital Map orientation. When an EOM/SoM action is performed, VBR must guarantee that all Balises of the same BG shall be delivered with coherent LocSpace fields. More in detail a same VB can be re-detected only when the train is moving in different direction. The following test case is applicable for any VB.

4a1. VBR sends to the ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram) with:

• NID_C= X

• NID_BG= A

• locSpace computed according to ON-BOARD KERNEL CTODL.

• N_PIG = 1

• the correct telegram related to VB, N_PIG=1 from Digital Map.

4a2. The internal Virtual Balise Detection Status related to VBG2 is so valorized:

BG_status=OPEN

BG_npig_open=1

BG_npig_to_close=0.

4a3. The train is in standstill condition between the N_PIG=1 and N_PIG=0 of the VBG2.

4a4. An EOM Request is performed.

4a5. After the SoM procedure the train is in standstill condition (generic P1 point) and VBR is still in FN mode.

4a6. The train accelerates from P1 to P0 moving backward in NORTH -> SOUTH direction (without changing its orientation). VBR determines, using the ON-BOARD KERNEL CTODL to navigate on the Digital Map, a train position associated with a specific Digital Map location at which the virtual balise VB (N_PIG = 1) has been assigned.

4a7. The VB (N_PIG=1, NID_BG=A) is re-detected because the train is running in the different direction of the previous VB N_PIG=1 detected before of the EOM. VBR sends to the ON-BOARD KERNEL the associated PDU Number 2 (Packet Balise Telegram) with coherent LocSpace fields.

4a8. The train is in standstill condition.

4a9. The train accelerates from P0 to P1 moving forward in SOUTH -> NORTH direction (without changing its orientation). VBR determines, using the ON-BOARD KERNEL CTODL to navigate on the Digital Map, a train position associated with a specific Digital Map location at which the virtual balise VB (N_PIG = 1) has been assigned.

4a10. The VB (N_PIG=1, NID_BG=A) is re-detected because the train is running in the different direction of the previous VB N_PIG=1. VBR sends to the ON-BOARD KERNEL the associated PDU Number 2 (Packet Balise Telegram) with coherent LocSpace fields.

4a11. The internal Virtual Balise Detection Status related to VBG2 is so valorized:

BG_status=OPEN

BG_npig_open=1

BG_npig_to_close=0.

4a12. The train continues to move in forward direction and VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the virtual balise VB (N_PIG = 0) has been assigned.

4a13. The VB (N_PIG=0, NID_BG=A) is detected. VBR sends to the ON-BOARD KERNEL the associated PDU Number 2 (Packet Balise Telegram) with coherent LocSpace fields.

4a14. The internal Virtual Balise Detection Status related to VBG2 is so valorized:

BG_status= CLOSED.

4a15. Use case terminates.

Alternate Scenario 4a5a

In case of EOM/SoM VBR must guarantee that all Balises of the same BG shall be delivered with coherent LocSpace fields. In detail VBR does not close a BG until all of its balises are detected (or at least its "last" balise is detected, depending on the N_PIG of the balise used to open the BG).

4a5a1. VBR is in FN mode and the train accelerates from P0 towards P1 in SOUTH -> NORTH direction (distance traveled = about 10 meters).

4a5a2. The train is in standstill condition.

4a5a3. The train moves in NORTH -> SOUTH direction (without changing its orientation).

4a5a4. VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the virtual balise VB (N_PIG=0, NID_BG=A) has been assigned and sends to the ON-BOARD KERNEL the Packet Balise Telegram with a coherent locspace.

4a5a5. The internal Virtual Balise Detection Status related to VBG2 is so valorized:

BG_status=CLOSED.

4a5a6. The train continues to move in backward direction and VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the virtual balise VB (N_PIG=1, NID_BG=A) has been assigned.

4a5a7. The VB (N_PIG=1, NID_BG=A) is detected. VBR sends to the ON-BOARD KERNEL the associated PDU Number 2 (Packet Balise Telegram) with coherent LocSpace fields.

4a5a8. The internal Virtual Balise Detection Status related to VBG2 is so valorized:

BG_status=OPEN

BG_npig_open=1

BG_npig_to_close=0.

4a5a9. Use case terminates.

Alternate Scenario 4a6a

VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the VB (N_PIG=0, second balise of the second VBG2 "Virtual Balise Group 2") has been assigned relating to the Digital Map orientation. When an EOM/SoM action is performed, VBR must guarantee that all Virtual Balises of the same BG shall be delivered with coherent LocSpace fields. The following test case is applicable for any VB.

4a6a1. The train accelerates in SOUTH -> NORTH direction. VBR determines, using the ON-BOARD KERNEL CTODL to navigate on the Digital Map, a train position associated with a specific Digital Map location at which the virtual balise VB (N_PIG = 0, NID_BG=A) has been assigned.

4a6a2. The VB (N_PIG=0, NID_BG=A) is detected. VBR sends to the ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram) with coherent LocSpace fields.

4a6a3. The internal Virtual Balise Detection Status related to VBG2 is so valorized:

BG_status=CLOSED.

4a6a4. The train is in standstill condition in a generic P0 point.

4a6a5. The train accelerates from P0 to P1 moving backward in NORTH -> SOUTH direction (without changing its orientation). VBR determines, using the ON-BOARD KERNEL CTODL to navigate on the Digital Map, a train position associated with a specific Digital Map location at which the virtual balise VB (N_PIG=0, NID_BG=A) has been assigned.

4a6a6. The VB (N_PIG=0, NID_BG=A) is re-detected because the train is running in the different direction of the previous VB (N_PIG=0, NID_BG=A). VBR sends to the ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram) with coherent LocSpace fields.

4a6a7. The internal Virtual Balise Detection Status related to VBG2 is so valorized:

BG_status=OPEN

BG_npig_open=0

BG_npig_to_close=1.

4a6a8. The train continues to move in backward direction and VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the virtual balise VB (N_PIG=1, NID_BG=A) has been assigned.

4a6a9. The VB (N_PIG=1, NID_BG=A) is detected. VBR sends to the ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram) with coherent LocSpace fields.

4a6a10. The internal Virtual Balise Detection Status related to VBG2 is so valorized:

BG_status=CLOSED.

4a6a11. Use case terminates.

Alternate Scenario 4b

VBR is not able to associate a unique path in the track database for the current position. The aim of this test is to verify the proper reset of the input data at the module Virtual Balise Detection.

4b1. VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the virtual balise VBG has been assigned.

4b2. VBR detects that the most advanced vehicle position has overpassed a facing point having unknown status.

4b3. VBR considers the position integrity failed then the operational mode of VBR changes from FN to TD.

4b4. VBR (function VBD Reset) Re-initialization data structures in order to delete all data related to previous Virtual Balise Detections.

4b5. Use case terminates.

Alternate Scenario 4c

VBR doesn't perform any Virtual Balise Detection if the train is at standstill condition also when the VBR Virtual Antenna is over (or very close to) a Virtual Balise.

4c1. The train moves from P0 towards P1 in SOUTH -> NORTH direction.

4c2. The train speed is very low but different from zero value (standstill condition).

4c3. VBR is in FN mode and it determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the virtual balise VB1 has been assigned.

4c4. VBR sends to the ON-BOARD KERNEL the PDU Number 2 (Packet Balise Telegram) related to Virtual Balise VB1 (N_PIG=1).

4c5. The train decelerates till reaching the position P1 associated with a specific Digital Map location at which the virtual balise VB2 (N_PIG=0) has been assigned.

4c6. The train is at standstill condition (point P1) with the VBR Virtual Antenna over (or very close to) a Virtual Balise VB2 (N_PIG=0), but the Virtual balise Detection is inhibited.

4c7. The PKT_BALISE_TEL related at VB2 is sent to ON-BOARD KERNEL only when the current train speed is different from zero value.

4c8. Use case terminates.

Alternate Scenario 4d

The resulting stored Train Orientation after reception and management of packet 44/5 from TV isn't change also when the PVT constrained solution becomes invalid during train mission. In this case a wrong balise detection is avoid.

4d1. Train decelerates till the point P0 the Augmented PVT is refreshed regularly.

4d2. Train reaches the standstill condition. The point P0 is about 60 meters far from VBG1.

4d3. Train accelerates from P0 moving backward in NORTH -> SOUTH direction (without changing its orientation).

4d4. Train decelerates till the point P1 at standstill condition. The point P1 is about 20 meters far from VBG1.

4d5. The VBR considers that augmentation data are not valid anymore due to expiration mechanism based on T_MAX_EXP_AG_TIME default configuration value.

4d6. The PVT constrained solution becomes more and more invalid.

4d7. The CTODL orientation isn't recomputed during the mission.

4d8. The train starts from P1 moving in SOUTH -> NORTH direction.

4d9. VBR doesn't detect again the VBG1.

4d10. Use case terminates.

Alternate Scenario *a

The VBR permanently ceases to provide virtual balises to ON-BOARD KERNEL if a safety-critical failure is detected (SF mode).

*a1. VBR detects a safety-critical failure and switches to SF mode.

*a2. VBR reaches a railway position associated to the virtual balise VB1 and doesn't send to the ON-BOARD KERNEL any PDU Number 2.

*a3. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.2.6, REQ_8.1.1.1, REQ_8.1.2.7, REQ_8.1.2.8, REQ_8.1.2.3, REQ_8.1.1.3, REQ_8.1.1.5, REQ_8.1.3.5, REQ_8.1.2.2.

Alternate Scenario 1b: REQ_8.1.2.6, REQ_8.1.1.1.

Alternate Scenario 2a: REQ_8.1.2.6, REQ_8.1.1.1, REQ_8.1.1.3.

Alternate Scenario 2b: REQ_8.1.2.6, REQ_8.1.2.3, REQ_8.1.1.1, REQ_8.1.1.3.

Alternate Scenario 2c: REQ_8.1.2.6, REQ_8.1.2.3, REQ_8.1.2.7.

Alternate Scenario 3a: REQ_8.1.2.6, REQ_8.1.1.1, REQ_8.1.2.3.

Alternate Scenario 4a: REQ_8.1.2.6, REQ_8.1.2.3, REQ_8.1.2.8, REQ_8.1.2.2.

Alternate Scenario 4a5a: REQ_8.1.2.6, REQ_8.1.2.3, REQ_8.1.2.8, REQ_8.1.2.2.

Alternate Scenario 4a6a: REQ_8.1.2.6, REQ_8.1.2.3, REQ_8.1.2.8.

Alternate Scenario 4b: REQ_8.1.2.6, REQ_8.1.2.3.

Alternate Scenario 4c: REQ_8.1.2.6, REQ_8.1.2.2, REQ_8.1.2.3, REQ_8.1.2.7, REQ_8.1.2.2.

Alternate Scenario 4d: REQ_8.1.2.6, REQ_8.1.2.2, REQ_8.1.2.8.

Alternate Scenario *a: REQ_8.1.2.11, REQ_8.1.1.1.

Test: VBR_VBD_001

Target: Main Scenario

Description: VBR has been configured in SC mode to receive CTODL from OBSC and provide only Virtual Balises. VBR is in FN mode, it determines a train position associated with a specific VBR Digital Map location at which the virtual balise VB1 (balise of the first VBG1 "Virtual Balise Group 1") has been assigned. VBR supervises the integrated BTM function (in order to allow filtering of specific Eurobalises) and it sends to the ON-BOARD KERNEL the Packet Balise Telegram related to the first virtual balise.

In this test, VBR picks up another telegram on a first virtual balise "VB2" of the second VBG2 "Virtual Balise Group 2 and it sends to the ON-BOARD KERNEL the related Packet Balise Telegram. The correct sequence of the Virtual Balise is based on the detected train orientation of the vehicle relative to the linear reference system in the track.

Test: VBR_VBD_002

Target: Alternate Scenario 1b

In SC mode, VBR has been previously configured to provide Virtualized Real Balise to ON-BOARD KERNEL. So, the Eurobalises associated to Balise Groups marked with specific flags in the VBR Digital Map are detected by the VBR, vice versa VBR filters the other Balise Groups.

Test: VBR_VBD_003

Target: Alternate Scenario 2a

Description: VBR disables the virtual balise detection function in SB mode.

Test: VBR_VBD_004

Target: Alternate Scenario 2b

Description: VBR disables the virtual balise detection function in TD mode.

Test: VBR_VBD_005

Target: Alternate Scenario 2c

Description: VBR detects the virtual balises using the CTODL provided by ON-BOARD KERNEL.

Test: VBR_VBD_006

Target: Alternate Scenario 3a

Description: In SC mode, VBR has been previously configured to provide only Virtual Balises to ON-BOARD KERNEL, so it doesn't provide Virtualized Real Balise to ON-BOARD KERNEL.

Test: VBR_VBD_007

Target: Alternate Scenario 4a

Description: VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the VB (N_PIG=1, first balise of the second VBG2 "Virtual Balise Group 2") has been assigned relating to the Digital Map orientation. When an EoM/SoM action is performed, VBR must guarantee that all Balises of the same BG shall be delivered with coherent LocSpace fields. More in detail a same VB can be re-detected only when the train is moving in different direction. The following test case is applicable for any VB.

Test: VBR_VBD_008

Target: Alternate Scenario 4a5a

Description: In case of EoM/SoM VBR must guarantee that all Balises of the same BG shall be delivered with coherent LocSpace fields. In detail VBR does not close a BG until all of its balises are detected (or at least its "last" balise is detected, depending on the N_PIG of the balise used to open the BG).

Test: VBR_VBD_009

Target: Alternate Scenario 4a6a

Description: VBR determines a “VBR virtual antenna” position associated with a specific Digital Map location at which the VB (N_PIG=0, second balise of the second VBG2 "Virtual Balise Group 2") has been assigned relating to the Digital Map orientation. When an EoM/SoM action is performed, VBR must guarantee that all Virtual Balises of the same BG shall be delivered with coherent LocSpace fields. The following test case is applicable for any VB.

Test: VBR_VBD_010

Target: Alternate Scenario 4b

Description: VBR is not able to associate a unique path in the track database for the current position. The aim of this test is to verify the proper reset of the input data at the module Virtual Balise Detection.

Test: VBR_VBD_011

Target: Alternate Scenario 4c

Description: VBR doesn't perform any Virtual Balise Detection if the train is at standstill condition also when the VBR Virtual Antenna is over (or very close to) a Virtual Balise.

Test: VBR_VBD_012

Target: Alternate Scenario 4d

Description: The resulting stored Train Orientation after reception and management of packet 44/5 from TV isn't change also when the PVT constrained solution becomes invalid during train mission. In this case a wrong balise detection is avoid.

Test: VBR_VBD_013

Target: Alternate Scenario *a

Description: The VBR permanently ceases to provide virtual balises to ON-BOARD KERNEL if a safety-critical failure is detected (SF mode).

6.3.3.18 TV Message Check

VBR shall not consider packets received from TV if any of the following consistency criteria is not fulfilled:

• the whole packet shall be complete

• the variables shall not have invalid values (spare/out of range values).

Trigger

Packet 44/X received from TV.

Precondition

VBR is in SB, TD or FN mode.

Postcondition

VBR is in SB, TD or FN mode.

Main Scenario

1. VBR receives from TV an incomplete packet 44/X.

2. VBR rejects the packet 44/X and the packet is not stored on board.

3. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with WARNING.

Alternate Scenario 1a

1a1. VBR receives from TV a packet 44/X containing variables with spare values.

1a2. Continue at Main Scenario, step 2.

Alternate Scenario 1b

Operational mode of the VBR is SC and it receives Valid Position Report. It stores this information and switches to FN after the IF and DB versions are checked successfully.

1b1. VBR is in SC mode.

1b2. VBR receives packet 44/5 (Valid Position Report) and accepts it.

1b3. VBR receives packet 44/1 and switches to SB.

1b4. VBR is in SB and timeout for 44/5 is not expired anymore.

1b5. VBR switches to FN mode.

1b6. Use case terminates

Alternate Scenario 1c

Operational mode of the VBR changes from Stand-by (SB) to Full Navigation (FN) with a direct transition when VBR is capable to determine safe and unique train position information on the Digital Map. In this scenario VBR receives the position train initialization from ON-BOARD KERNEL.

1c1. VBR is in SB mode and it sending to GAD the packet 44/101 (Reference Position) and the packet 44/100 (Digital Map and Interface Protocol Compatibility Check Result) and the packet 44/103 (Position Report Validation Request).

1c2. VBR receives from ON-BOARD KERNEL the Valid Position Report (packet 205) with the known valid position of the train.

1c3. The train orientation autonomously estimated by the VBR is confirmed.

1c4. VBR is able to compute a safe and unique train position information on the Digital Map (1D).

1c5. Operational mode of the VBR changes from SB to FN.

1c6. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = FN.

1c7. VBR receives packet 44/6.

1c8. VBR stops to send packet 44/100 and packet 44/103, it continues to send packet 44/101.

1c9. Use case terminates.

Alternate Scenario 1d

VBR can switch from TD mode to FN mode always coming from previous SB mode (SB ->TD ->FN), both at the system initialization and after Digital Map and Interface Protocol Version check. In this scenario VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

1d1. VBR unsuccessfully checks the consistency of the track Digital Map.

1d2. VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

1d3. The train orientation autonomously estimated by the VBR is confirmed.

1d4. The VBR is able to compute a safe and unique train position (1D).

1d5. Operational mode of the VBR changes from TD to FN.

1d6. VBR stops to send the packet 44/103 (Position Report Validation Request).

1d7. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with Q_VBR_OB_OPMODE = FN.

1d8. Use case terminates.

Alternate Scenario 1d7a

VBR can switch from TD mode to FN mode always coming from previous SB mode (SB ->TD ->FN), both at the system initialization and after Digital Map and Interface Protocol Version check. In this scenario VBR receives from TV the Valid Position Report when it is in FN mode and it is rejected.

1d7a1While in FN mode, VBR receives packet 44/5 and it rejects it.

1d7a2. Use case terminates.

Alternate Scenario 1b2a

VBR receives a packet 44/6 when it is in SC and it rejects it.

1b2a1. VBR receives from ON-BOARD KERNEL the packet 44/6 containing the list of switch points status, and it rejects it.

1b2a2.VBR receives navigation data and corrections and switches to TD.

1b2a3. VBR receives packet 44/5 and switches to FN.

1b2a4. When VBR overpasses a facing point included in the list of the previous 44/6, it exits from FN.

1b2a5. Use case terminates.

Alternate Scenario 1c2a

Operational mode of the VBR changes from Stand-by (SB) to Full Navigation (FN) with a direct transition when VBR is capable to determine safe and unique train position information on the Digital Map. In this scenario VBR receives the swicth point status list when in SB.

1c2a1. While in SB, VBR receives packet 44/6 and accepts it.

1c2a2. VBR receives from ON-BOARD KERNEL the Valid Position Report (packet 205) with the known valid position of the train.

1c2a3. The train orientation autonomously estimated by the VBR is confirmed.

1c2a4. VBR is able to compute a safe and unique train position information on the Digital Map (1D).

1c2a5. Operational mode of the VBR changes from SB to FN.

1c2a6. The switch in FN leaves unchanged the switch point status information.

1c2a7. When VBR overpasses a facing point included in the list of the previous 44/6, it continues to navigate Digital Map.

1c2a8. Use case terminates.

Alternate Scenario 1e

Operational mode of the VBR is TD and it receives the switch point status list.

1d1. While in TD, VBR receives packet 44/6 and accepts it.

1d2. VBR receives from TV packet 44/5 with the known valid position of the train.

1d3. The train orientation autonomously estimated by the VBR is confirmed.

1d4. VBR is able to compute a safe and unique train position information on the Digital Map (1D).

1d5. Operational mode of the VBR changes from TD to FN.

1d6. When VBR overpasses a facing point included in the list of the previous 44/6, it continues to navigate Digital Map.

1d7. Use case terminates.

Alternate Scenario 1b2b

VBR receives a packet 44/9 and 44/10 when it is in SC and it rejects them.

1b2b1. VBR receives the packet 44/9 (confirming the integrity of switch point 14) and 44/10 (confirming the integrity of NID_BG=9270).

1b2b2.VBR receives navigation data and corrections and switches to TD.

1b2b3. VBR receives packet 44/5 and switches to FN.

1b2b4. When VBR detects VBG with NID_BG=9270, it does not consider its integrity confirmed, but it sends packet 209 after the GNSS integrity confirmation timeout.

1b2b5. When VBR overpasses the facing point 14, it does not consider its integrity confirmed, and continues to send packet 44/104.

1b2b6. Use case terminates.

Alternate Scenario 1c2b

Operational mode of the VBR changes to Full Navigation (FN) when VBR is capable to determine safe and unique train position information on the Digital Map. In this scenario VBR receives packets 44/9 and 44/10 when in SB.

1c2b1. While in SB, VBR receives the packet 44/9 (confirming the integrity of switch point 14) and 44/10 (confirming the integrity of NID_BG=9270).

1c2b2. VBR receives navigation and augmentation data and the Valid Position Report.

1c2b3. VBR switches to TD

1c2b4. The train orientation autonomously estimated by the VBR is confirmed.

1c2b5. VBR is able to compute a safe and unique train position information on the Digital Map (1D).

1c2b6. Operational mode of the VBR changes from TB to FN.

1c2b7. When VBR detects VBG with NID_BG=9270, it does not consider its integrity confirmed, but it sends packet 209 after the GNSS integrity confirmation timeout.

1c2b8. When VBR overpasses the facing point 14, it does not consider its integrity confirmed, and continues to send packet 44/104.

1c2b9. Use case terminates.

Alternate Scenario 1f

Operational mode of the VBR is TD and it receives packets 44/9 and 44/10.

1e1. While in TD, VBR receives the packet 44/9 (confirming the integrity of switch point 14) and 44/10 (confirming the integrity of NID_BG=9270).

1e2. VBR receives from TV packet 44/5 with the known valid position of the train.

1e3. The train orientation autonomously estimated by the VBR is confirmed.

1e4. VBR is able to compute a safe and unique train position information on the Digital Map (1D).

1e5. Operational mode of the VBR changes from TD to FN.

1e6. When VBR detects VBG with NID_BG=9270, it does not consider its integrity confirmed, but it sends packet 209 after the GNSS integrity confirmation timeout.

1e7. When VBR overpasses the facing point 14, it does not consider its integrity confirmed, and continues to send packet 44/104.

1e8. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1.

Alternate Scenario 1a: REQ_8.1.1.1.

Alternate Scenario 1b: REQ_8.1.1.1.

Alternate Scenario 1c: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3

Alternate Scenario 1d: REQ_8.1.1.1, REQ_8.1.2.3,

Alternate Scenario 1d7a: REQ_8.1.1.1, REQ_8.1.2.3,

Alternate Scenario 1b2a: REQ_8.1.1.3, REQ_8.1.1.1, REQ_8.1.2.3,

Alternate Scenario 1c2a: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3,

Alternate Scenario 1e: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3

Alternate Scenario 1b2b: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3

Alternate Scenario 1c2b: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3.

Alternate Scenario 1f: REQ_8.1.1.1, REQ_8.1.1.3, REQ_8.1.2.3

Test: VBR_TMC_001

Target: Main Scenario

Description: VBR shall not consider packets received from TV if any of the following consistency criteria is not fulfilled:

• the whole packet shall be complete

• the variables shall not have invalid values (spare/out of range values). In this test VBR rejects the packet 44/1 received by TV because incomplete.

Test: VBR_TMC_002

Target: Alternate Scenario 1a

Description: In this test VBR rejects the packet 44/6 received by TV because containing variables with spare values.

Test: VBR_TMC_003

Target: Alternate Scenario 1b

Description: Operational mode of the VBR is SC and it receives Valid Position Report. It stores this information and switches to FN after the IF and DB versions are checked successfully.

Test: VBR_TMC_004

Target: Alternate Scenario 1c

Description: Operational mode of the VBR changes from Stand-by (SB) to Full Navigation (FN) with a direct transition when VBR is capable to determine safe and unique train position information on the Digital Map. In this scenario VBR receives the position train initialization from ON-BOARD KERNEL.

Test: VBR_TMC_005

Target: Alternate Scenario 1d

Description: VBR can switch from TD mode to FN mode always coming from previous SB mode (SB ->TD ->FN), both at the system initialization and after Digital Map and Interface Protocol Version check. In this scenario VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

Test: VBR_TMC_006

Target: Alternate Scenario 1d7a

Description: VBR can switch from TD mode to FN mode always coming from previous SB mode (SB ->TD ->FN), both at the system initialization and after Digital Map and Interface Protocol Version check. In this scenario VBR receives from TV the Valid Position Report when it is in FN mode and it is rejected.

Test: VBR_TMC_007

Target: Alternate Scenario 1b2a

Description: VBR receives from ON-BOARD KERNEL the packet 44/6 containing the list of switch points status, and it rejects it.

Test: VBR_TMC_008

Target: Alternate Scenario 1c2a

Description: Operational mode of the VBR changes from Stand-by (SB) to Full Navigation (FN) with a direct transition when VBR is capable to determine safe and unique train position information on the Digital Map. In this scenario VBR receives the swith point status list when in SB.

Test: VBR_TMC_009

Target: Alternate Scenario 1e

Description: Operational mode of the VBR is TD and it receives the switch point status list.

Test: VBR_TMC_010

Target: Alternate Scenario 1b2b

Description: VBR receives a packet 44/9 and 44/10 when it is in SC and it rejects them.

Test: VBR_TMC_011

Target: Alternate Scenario 1c2b

Description: Operational mode of the VBR changes to Full Navigation (FN) with a direct transition when VBR is capable to determine safe and unique train position information on the Digital Map. In this scenario VBR receives packets 44/9 and 44/10 when in SB.

Test: VBR_TMC_012

Target: Alternate Scenario 1f

Description: Operational mode of the VBR is TD and it receives packets 44/9 and 44/10.

6.3.3.19 GAD Message Check

VBR shall not consider packets received from GAD if any of the following consistency criteria is not fulfilled:

• the whole packet shall be complete

• the variables shall not have invalid values (spare/out of range values).

Trigger

Packet 44/X received from GAD.

Precondition

VBR is in SB, TD or FN mode.

Postcondition

VBR is in SB, TD or FN mode.

Main Scenario

1. VBR receives from GAD an incomplete packet 44/X.

2. VBR rejects the packet 44/X and the packet is not stored on board.

3. VBR sends to ON-BOARD KERNEL the PDU Number 1 (PACKET_STATUS_BTM) with WARNING.

4. Use case terminates.

Alternate Scenario 1a

1a1. VBR receives from GAD a packet 44/X containing variables with spare values.

1a2. Continue at Main Scenario, step 2.

Alternate Scenario 1b

VBR is in SC mode and receives packet 44/11. When a new packet 44/11 is received, VBR accepts it and updates its parameters with the last info received.

1b1. VBR is in SC mode.

1b2. VBR receives from GAD a packet 44/11 with T_MAX_EXP_AG_TIME=40s.

1b3. VBR receives from TV the packet 44/1 (Digital Map and Interface Protocol Version Packet).

1b4. VBR successfully checks the VBR DB version and the Interface protocol version and switches to SB.

1b5. VBR receives from GAD packet 44/8 and 44/3 and switches to TD.

1b6. The transition in TD leaves unchanged the configuration parameters received in SB, and the GNSS Navigation data and Differential Corrections.

1b7. The corrections availability times out because of the expiration mechanisms based on time (after 40s).

1b8. VBR switches to SB.

1b8. VBR receives from TV a wrong packet 44/1 and switches to SC.

1b9. While VBR is in SC, a new packet 44/11 (with T_MAX_EXP_AG_TIME=60s) is received.

1b10. VBR receives from TV the correct packet 44/1 and switches to SB.

1b11. The transition in SB leaves unchanged the configuration parameters received in SC.

1b12. VBR receives from GAD packet 44/3 and switches to TD (since both the transition in SC than SB leaves unchanged the GNSS Navigation Data).

1b13. The corrections availability times out because of the expiration mechanisms based on time (after 60s).

1b14. VBR switches to SB.

1b15. Use case terminates

Alternate Scenario 1c

VBR is in SB mode and receives packet 44/11. When a new packet 44/11 is received, VBR accepts it and updates its parameters with the last info received.

1c1. VBR is in SB mode.

1c2. VBR receives from GAD a packet 44/11 with T_MAX_EXP_AG_TIME=40s.

1c3. VBR receives from GAD packet 44/8 and 44/3 and switches to TD.

1c4. The corrections availability times out because of the expiration mechanisms based on time (after 40s).

1c5. VBR switches to SB.

1c6. While VBR is in SB, a new packet 44/11 (with T_MAX_EXP_AG_TIME=60s) is received.

1c7. VBR receives from GAD packet 44/3 and switches to TD.

1c8. The corrections availability times out because of the expiration mechanisms based on time (after 60s).

1c9. VBR switches to SB.

1c10. VBR receives new valid augmentation data and switches to TD.

1c11. After 40 seconds a new packet 44/1 is received with wrong IFPROTOCOL Version.

1c12. VBR switches from TD to SC.

1c13. When a correct packet 44/1 is received VBR switches to SB.

1c14. Valid Augmentation data are received and VBR switches to TD.

1c15. The correction availability times out in 30 s (since the switch to SC resetting the configuration parameters).

1c16. VBR switches to SB.

1c17. Use case terminates

Alternate Scenario 1d

VBR is in TD mode and receives packet 44/11. When a new packet 44/11 is received, VBR accepts it and updates its parameters with the last info received.

1d1. VBR is in TD mode.

1d2. VBR receives from GAD a packet 44/11 with T_MAX_EXP_AG_TIME=40s.

1d4. The corrections availability times out because of the expiration mechanisms based on time (after 40s).

1d5. VBR switches to SB.

1d6. VBR receives a packet 44/3 and switches to TD.

1d7. The switch in TD mode leaves unchanged the GNSS Differential Corrections.

1d8. While VBR is in TD, a new packet 44/11 (with T_MAX_EXP_AG_TIME=60s) is received.

1d9. The corrections availability times out because of the expiration mechanisms based on time (after 60s).

1d10. VBR switches to SB.

1d11. Use case terminates

Alternate Scenario 1e

VBR is in FN mode and receives packet 44/11. When a new packet 44/11 is received, VBR accepts it and updates its parameters with the last info received.

1e1. VBR is in FN mode.

1e2. VBR receives from GAD a packet 44/11 with T_MAX_EXP_AG_TIME=40s.

1e4. The corrections availability times out because of the expiration mechanisms based on time (after 40s).

1e5. VBR is not able anymore to compute a valid PVT.

1e6. VBR receives a packet 44/3 and the PVT is valid again.

1e7. While VBR is in FN, a new packet 44/11 (with T_MAX_EXP_AG_TIME=60s) is received.

1e8. The corrections availability times out because of the expiration mechanisms based on time (after 60s).

1e9. VBR is not able anymore to compute a valid PVT.

1e10. Use case terminates

Alternate Scenario 1b2a

VBR is in SC mode, receives a packet 44/3 and rejects it.

1b2a1. VBR is in SC mode.

1b2a2. VBR receives from GAD navigation and corrections data.

1b2a3VBR receives a correct packet 44/1 and switches to SB.

1b2a4. VBR remains in SB.

1b2a5. Use case terminates

Alternate Scenario 1f

VBR is in SC mode and receives packets 44/8 and 44/3. When new packets 44/8 and 44/3 are received, VBR accepts them and updates its parameters with the last info received.

1f1. VBR is in SC mode.

1f2. VBR receives from GAD GNSS navigation and augmentation data.

1f3. VBR receives from TV the packet 44/1 (Digital Map and Interface Protocol Version Packet).

1f4. VBR successfully checks the VBR DB version and the Interface protocol version and switches to SB.

1f5. VBR switches to TD.

1f6. The corrections availability times out because of the expiration mechanisms based on time (after 40s).

1f7. VBR switches to SB.

1f8. VBR receives from TV a wrong packet 44/1 and switches to SB.

1f9. While VBR is in SC, new packets 44/3 and 44/8 are received containing invalid data on satellites 2, 5, 6, 7, 9 and 13.

1f10. VBR receives from TV the correct packet 44/1 and switches to SB.

1f11. VBR receives from GAD packet 44/3.

1f12. VBR cannot evolve to TD mode.

1f13. Use case terminates

Alternate Scenario 1g

VBR is in SB mode and receives packets 44/8 and 44/3. When new packets 44/8 and 44/3 are received, VBR accepts them and updates its parameters with the last info received.

1g1. VBR is in SB mode.

1g2. VBR receives from GAD GNSS navigation and augmentation data.

1g3. VBR switches to TD.

1g4. The corrections availability times out because of the expiration mechanisms based on time (after 30s).

1g5. VBR switches to SB.

1g6. While VBR is in SB, new packets 44/8 are received containing invalid data on satellites 2, 5, 6, 7, 9 and 13.

1g7. VBR receives from GAD packet 44/3.

1g8. VBR cannot evolve to TD mode.

1g9. Use case terminates

Alternate Scenario 1h

VBR is in TD mode and receives new packet 44/8 and 44/3, VBR accepts it and updates its parameters with the last info received.

1h1. VBR is in TD mode.

1h2. VBR receives from GAD a packet 44/8.

1h3. While VBR is in TD, new packets 44/3 and 44/8 are received containing invalid data on satellites 2, 5, 6, 7, 9 and 13.

1h4. VBR switches to SB.

1h5. Use case terminates.

Alternate Scenario 1h2a

VBR is in FN mode and receives new packets 44/8 and 44/3 are received, VBR accepts it and updates its parameters with the last info received.

1h2a1. VBR receives from ON BOARD KERNEL a packet 205.

1h2a2. VBR switches to FN.

1h2a3. While VBR is in FN, new packets 44/3 and 44/8 are received containing invalid data on satellites 2, 5, 6, 7, 9 and 13.

1h2a4. VBR continues to navigate the Digital Map but the computed PVT is not valid anymore.

1h2a5. Use case terminates.

Alternate Scenario 1e2a

In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity confirmed.The VBR detects the VBG2 (NID_BG = 9168) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a positive check result from GAD and with the confirmation of the integrity of the switch point after the VBG1 detection, the VBR considers the VBG2 integrity confirmed.

No additional information is needed from TV.

1e2a1. VBR is in FN mode.

1e2a2. A switch-point (M_PTID=41) has been overpassed by train.

1e2a3. VBR sends to TV the packet 44/104 (Digital Map Navigation Integrity) with:

• M_PTSTATUSID=last value received in the packet 44/6 (Switch Point Status).

• M_PTID=41

1e2a4. VBR receives from TV the packet 44/9 associated to the previous switch point M_PTID=41:

• Q_PRINTEGRITYCHECK= Position Integrity Confirmed.

• M_PTSTATUSID= last value received in the packet 44/104 (Digital Map Navigation Integrity).

• M_PTID=41.

1e2a5.VBR detects the virtual balise group VBG2.

1e2a6. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of VBG2

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG2

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=VBG2

1e2a7. The GAD verifies and confirms the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise (VBG2).

1e2a8. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Confirmed

b. NID_VALBG = VBG2.

1e2a9. The packet 44/10 with positive check result is received within the GNSS integrity confirmation timeout.

1e2a10. VBR considers as confirmed the integrity for the VBG2.

1e2a11. VBR considers the VBG2 with integrity confirmed both by TV and GAD trackside modules and it sends to ON-BOARD KERNEL the packet 247 "Validated BG Info" with:

• NID_VALBG=VBG2.

1e2a12. Use case terminates.

Alternate Scenario 1i

VBR is in SB mode and receives packets 44/8, 44/3 and 44/6. When VBR switches to SC, all these data (44/3 and 44/6) are deleted.

1i1. VBR is in SB mode.

1i2. VBR receives from GAD GNSS navigation and augmentation data.

1i3. VBR switches to TD.

1i4. VBR receives from TV the switch point status list (44/6).

1i5. VBR receives from TV the packet 44/1 (Digital Map and Interface Protocol Version Packet).

1i6. VBR unsuccessfully checks the VBR the Interface protocol version and switches to SC.

1i7. VBR receives from TV the correct packet 44/1.

1i8. VBR switches to SB.

1i9. PVT is invalid.

1i10. VBR receives from TV the Valid Position Report (packet 44/5) with the known valid position of the train.

1i11. VBR switches to FN.

1i12. When VBR overpasses a switch point, it exits from FN.

1i13. Use case terminates

Alternate Scenario 1b2a

VBR is in SC mode and receives Cab status, Active BTM Antenna and when switches to SB it receives the packets 44/11, 44/8, 44/3 and 44/6. When VBR switches to SC, all these data (44/3 and 44/6) are deleted, while the other remains unchanged.

1b2a1. VBR in SC receives information about Cab status and Active BTM Antenna.

1b2a2. VBR receives packet 44/1 with correct IF protocol version and DB version and switches to SB.

1b2a3. VBR receives configuration parameters through packet 44/11 and set T_MAX_EXP_AG_TIME=40 s.

1b2a4. VBR receives GNSS Navigation data.

1b2a5. VBR receives the list of switch point status.

1b2a6. VBR receives GNSS Differential Corrections and switches to TD.

1b2a7. The Position Report is correctly received and VBR switches to FN.

1b2a8. While in FN, the PVT is valid, since the GNSS data and Differential corrections are unchanged.

1b2a9. When GNSS Differential corrections expires for time expiration mechanisms, the PVT becomes invalid.

1b2a10. VBR received another packet 44/3 from GAD in order to validate the PVT.

1b2a11. A packet 44/1 with incorrect IF protocol version is received and VBR switches to SC.

1b2a12. A correct packet 44/1 is received and VBR switches to SB.

1b2a13. Position Report has to be received again because of the data deleted in SC mode.

1b2a14. VBR switches to FN.

1b2a15. PVT is invalid because the previous switch to SC deleted the GNSS Differential Corrections.

1b2a16. VBR overpasses a switch point with unknown status (because of the previous switch to SC that deleted the switch point status list).

1b2a17. VBR switches from FN to SB.

1b2a18. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1.

Alternate Scenario 1a: REQ_8.1.1.1

Alternate Scenario 1b: REQ_8.1.1.1.

Alternate Scenario 1c: REQ_8.1.1.1.

Alternate Scenario 1d: REQ_8.1.1.1.

Alternate Scenario 1e: REQ_8.1.1.1

Alternate Scenario 1b2a: REQ_8.1.1.1

Alternate Scenario 1f: REQ_8.1.1.1

Alternate Scenario 1g: REQ_8.1.1.1

Alternate Scenario 1h: REQ_8.1.1.1

Alternate Scenario 1h2a: REQ_8.1.1.1

Alternate Scenario 1e2a: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3

Alternate Scenario 1i: REQ_8.1.1.3, REQ_8.1.1.1

Alternate Scenario 1b2a: REQ_8.1.1.3, REQ_8.1.1.1

Test: VBR_GMC_001

Target: Main Scenario

Description: VBR shall not consider packets received from GAD if any of the following consistency criteria is not fulfilled:

• the whole packet shall be complete

• the variables shall not have invalid values (spare/out of range values). In this test VBR rejects the packet 44/11 received by GAD because incomplete.

Test: VBR_GMC_002

Target: Alternate Scenario 1a

Description: In this test VBR rejects the packet 44/11 received by GAD because containing variables with spare values.

Test: VBR_GMC_003

Target: Alternate Scenario 1b

Description: VBR is in SC mode and receives packet 44/11. When a new packet 44/11 is received, VBR accepts it and updates its parameters with the last info received.

Test: VBR_GMC_004

Target: Alternate Scenario 1c

Description: VBR is in SB mode and receives packet 44/11. When a new packet 44/11 is received, VBR accepts it and updates its parameters with the last info received.

Test: VBR_GMC_005

Target: Alternate Scenario 1d

Description: VBR is in TD mode and receives packet 44/11. When a new packet 44/11 is received, VBR accepts it and updates its parameters with the last info received.

Test: VBR_GMC_006

Target: Alternate Scenario 1e

Description: VBR is in FN mode and receives packet 44/11. When a new packet 44/11 is received, VBR accepts it and updates its parameters with the last info received.

Test: VBR_GMC_007

Target: Alternate Scenario 1b2a

Description: VBR is in SC mode, receives a packet 44/3 and rejects it.

Test: VBR_GMC_008

Target: Alternate Scenario 1f

Description: VBR is in SC mode and receives packets 44/8. When new packets 44/8 are received, VBR accepts them and updates its parameters with the last info received.

Test: VBR_GMC_009

Target: Alternate Scenario 1g

Description: VBR is in SB mode and receives packets 44/8 and 44/3. When new packets 44/8 and 44/3 are received, VBR accepts them and updates its parameters with the last info received.

Test: VBR_GMC_010

Target: Alternate Scenario 1h

Description: VBR is in TD mode and receives new packets 44/8 and 44/3 are received, VBR accepts it and updates its parameters with the last info received.

Test: VBR_GMC_011

Target: Alternate Scenario 1h2a

Description: VBR is in FN mode and receives new packets 44/8 and 44/3 are received, VBR accepts it and updates its parameters with the last info received.

Test: VBR_GMC_012

Target: Alternate Scenario 1e2a

Description: In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity confirmed. The VBR detects the VBG2 (NID_BG = 9168) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a positive check result from GAD and with the confirmation of the integrity of the switch point after the VBG1 detection, the VBR considers the VBG2 integrity confirmed.

No additional information is needed from TV.

Test: VBR_GMC_013

Target: Alternate Scenario 1i

Description: VBR is in SB mode and receives packets 44/8, 44/3 and 44/6. When VBR switches to SC, all these data (44/3 and 44/6) are deleted.

Test: VBR_GMC_014

Target: Alternate Scenario 1b2a

Description: VBR is in SC mode and receives Cab status, Active BTM Antenna and when switches to SB it receives the packets 44/11, 44/8, 44/3 and 44/6. When VBR switches to SC, all these data (44/3 and 44/6) are deleted, while the other remains unchanged.

6.3.3.20 Train Orientation Management

When VBR receives the packet 44/5 (Valid Position Report) from TV or the packet 205 (Valid Position Report) from ON-BOARD KERNEL it performs the train orientation check between the VBR Train Orientation internally calculated (using the cab status information provided by the ERTMS/ETCS on-board kernel) and the Train Orientation in relation to the direction of the LRBG received in the packet 44/5 or the packet 205. If the resulting stored Train Orientation after reception and management of packet 44/5 from TV or packet 205 from ON-BOARD KERNEL is “Unknown”, VBR mode cannot evolve to FN.

Trigger

VBR receives from TV the packet 44/5

OR

VBR receives from ON-BOARD KERNEL the packet 205.

Precondition

VBR is in SB, TD mode.

Postcondition

VBR is in SB, TD, FN mode.

Main Scenario

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation to obtain the final Train Orientation.

1. VBR receives message 239 with:

M_TICAB_STATUS= CAB A active

2. VBR is in TD mode and continues to send to TV the packet 44/103 with: NID_LRBG=Known.

3. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Nominal
bgOrient=Nominal

CabStatus=A

4. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Nominal.

5. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

6. The final PR interpretation is Nominal

7. This result is compared with the VBR train orientation that is Nominal.

8. VBR evaluates that the output of the combination is Nominal

9. VBR mode switches to FN mode

10. Use case terminates

Alternate Scenario 3a

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

3a1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Reverse
bgOrient=Reverse

CabStatus=A

3a2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Nominal.

3a3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

3a4. The final PR interpretation is Nominal

3a5. The result of the final PR interpretation is compared with the VBR train orientation that is Reverse.

3a6. VBR evaluates that the output of the combination is Unknown

3a7. VBR mode cannot evolve to FN mode

3a8. Use case terminates

Alternate Scenario 7a

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation.

6b1. The result of the final PR interpretation is compared with the VBR train orientation that is Unknown.

6b2. VBR evaluates that the output of the combination is Nominal

6b3. VBR mode switches to FN mode

6b4. Use case terminates

Alternate Scenario 1a

The train Orientation with respect to LRBG is given by:

- Message 239 (CAB B active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation to obtain the final Train Orientation.

1a1. VBR receives message 239 with:

M_TICAB_STATUS= CAB B active

1a2. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Nominal
bgOrient=Nominal

CabStatus=B

1a3. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Reverse.

1a4. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

1a5. The final PR interpretation is Reverse

1a6. This result is compared with the VBR train orientation that is Nominal.

1a7. VBR evaluates that the output of the combination is Unknown

1a8. VBR mode cannot switch to FN mode

1a9. Use case terminates

Alternate Scenario 1a2a

The train Orientation with respect to LRBG is given by:

- Message 239 (CAB B active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

1a2a1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Reverse
bgOrient=Reverse

CabStatus=B

1a2a2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Reverse.

1a2a3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

1a2a4. The final PR interpretation is Reverse

1a2a5. The result of the final PR interpretation is compared with the VBR train orientation that is Reverse.

1a2a6. VBR evaluates that the output of the combination is Reverse

1a2a7. VBR mode switches to FN mode

1a2a8. Use case terminates

Alternate Scenario 1a2b

The train Orientation with respect to LRBG is given by:

- Message 239 (CAB B active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation.

1a2b1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Nominal
bgOrient=Nominal

CabStatus=B

1a2b2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Reverse.

1a2b3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Reverse).

1a2b4. The final PR interpretation is Reverse

1a2b5. The result of the final PR interpretation is compared with the VBR train orientation that is Unknown.

1a2b6. VBR evaluates that the output of the combination is Reverse

1a2b7. VBR mode switches to FN mode

1a2b8. Use case terminates

Alternate Scenario 1b

The train Orientation with respect to LRBG is given by:

- Message 239 (No cab active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation to obtain the final Train Orientation.

1b1. VBR receives message 239 with:

M_TICAB_STATUS= No cab active

1b2. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Nominal
bgOrient=Nominal

CabStatus=No cab active

1b3. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) cannot be calculated and VBR cannot switch to FN.

1b4. Use case terminates.

Alternate Scenario 1b2a

The train Orientation with respect to LRBG is given by:

- Message 239 (No cab active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

1b2a1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Reverse
bgOrient=Reverse

CabStatus=No cab active

1b2a2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) cannot be calculated and VBR cannot switch to FN.

1b2a3. Use case terminates

Alternate Scenario 1b2b

The train Orientation with respect to LRBG is given by:

- Message 239 (No cab active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation.

1b2b1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Nominal
bgOrient=Nominal

CabStatus=No cab active

1b2b2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Unknown.

1b2b3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

2b2b4. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) cannot be calculated and VBR cannot switch to FN.

1b2b4. Use case terminates

Alternate Scenario 3b

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

3b1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Nominal
bgOrient=Reverse

CabStatus=A

3b2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Reverse.

3b3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

3b4. The final PR interpretation is Reverse

3b5. The result of the final PR interpretation is compared with the VBR train orientation that is Reverse.

3b6. VBR evaluates that the output of the combination is Reverse

3b7. VBR switches to FN mode

3b8. Use case terminates

Alternate Scenario 1a2c

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

1a2c1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Nominal
bgOrient=Reverse

CabStatus=B

1a2c2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Nominal.

1a2c3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

1a2c4. The final PR interpretation is Nominal

1a2c5. The result of the final PR interpretation is compared with the VBR train orientation that is Reverse.

1a2c6. VBR evaluates that the output of the combination is Unknown

1a2c7. VBR cannot evolve to FN mode

1a2c8. Use case terminates

Alternate Scenario 3c

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

3c1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Reverse
bgOrient=Nominal

CabStatus=A

3c2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Reverse.

3c3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

3c4. The final PR interpretation is Reverse

3c5. The result of the final PR interpretation is compared with the VBR train orientation that is Nominal.

3c6. VBR evaluates that the output of the combination is Unknown

3c7. VBR cannot evolve to FN mode

3c8. Use case terminates

Alternate Scenario 1a2d

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

1a2d1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Reverse
bgOrient=Nominal

CabStatus=B

1a2d2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Nominal.

1a2d3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

1a2d4. The final PR interpretation is Nominal

1a2d5. The result of the final PR interpretation is compared with the VBR train orientation that is Nominal.

1a2d6. VBR evaluates that the output of the combination is Nominal

1a2d7. VBR switches to FN mode

1a2d8. Use case terminates

Alternate Scenario 3d

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Nominal) to obtain the final Train Orientation.

3d1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Unknown
bgOrient=Nominal

CabStatus=A

3d2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Unknown.

3d3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

3d4. The final PR interpretation is Unknown

3d5. The result of the final PR interpretation is compared with the VBR train orientation that is Nominal.

3d6. VBR evaluates that the output of the combination is Nominal

3d7. VBR switches to FN mode

3d8. Use case terminates

Alternate Scenario 3d5a

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation.

3d5a1. The result of the final PR interpretation is compared with the VBR train orientation that is Unknown.

3d5a2. VBR evaluates that the output of the combination is Unknown

3d5a3. VBR cannot evolve to FN mode

3d5a4. Use case terminates

Alternate Scenario 1a2d

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Nominal) to obtain the final Train Orientation.

1a2d1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Unknown
bgOrient=Nominal

CabStatus=B

1a2d2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Unknown.

1a2d3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

1a2d4. The final PR interpretation is Unknown

1a2d5. The result of the final PR interpretation is compared with the VBR train orientation that is Nominal.

1a2d6. VBR evaluates that the output of the combination is Nominal

1a2d7. VBR switches to FN mode

1a2d8. Use case terminates

Alternate Scenario 1a2e

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation.

1a2e1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Unknown
bgOrient=Nominal

CabStatus=B

1a2e2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Unknown.

1a2e3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

1a2e4. The final PR interpretation is Unknown

1a2e5. The result of the final PR interpretation is compared with the VBR train orientation that is Unknown.

1a2e6. VBR evaluates that the output of the combination is Unknown

1a2e7. VBR cannot evolve to FN mode

1a2e8. Use case terminates

Alternate Scenario 3e

The train Orientation with respect to LRBG is given by:

- Message 239

- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

3e1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Unknown
bgOrient=Reverse

CabStatus=A

3e2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Unknown.

3e3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

3e4. The final PR interpretation is Unknown

3e5. The result of the final PR interpretation is compared with the VBR train orientation that is Reverse.

3e6. VBR evaluates that the output of the combination is Reverse

3e7. VBR switches to FN mode

3e8. Use case terminates

Alternate Scenario 1a2f

The train Orientation with respect to LRBG is given by:

- Message 239
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation.

1a2f1. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Unknown
bgOrient=Reverse

CabStatus=B

1a2f2. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Unknown.

1a2f3. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

1a2f4. The final PR interpretation is Unknown

1a2f5. The result of the final PR interpretation is compared with the VBR train orientation that is Reverse.

1a2f6. VBR evaluates that the output of the combination is Reverse

1a2f7. VBR switches to FN mode

1a2f8. Use case terminates

Alternate Scenario 1b2c

The train Orientation with respect to LRBG is given by:

- Message 239 (No cab active)
- Packet 205 from ON-BOARD KERNEL after the detection of an Eurobalise

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

1b2c1. VBR overpasses an Eurobalise (NID_BG=9062).

1b2c2 VBR receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Reverse
bgOrient=Reverse

CabStatus=No cab active

1b2c3. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) cannot be calculated and VBR cannot switch to FN.

1b2c4. Use case terminates

Alternate Scenario 1c

The train Orientation with respect to LRBG is given by:

- Message 239 (in this scenario received in SB mode)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation to obtain the final Train Orientation.

1c1. VBR is in SB and receives message 239 with:

M_TICAB_STATUS=01 (CAB A active)

1c2. VBR receives GNSS navigation and differential corrections data and switches to TD mode.

1c3. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Nominal
bgOrient=Reverse

CabStatus=A

1c4. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Reverse.

1c5. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

1c6. The final PR interpretation is Reverse.

1c7. This result is compared with the VBR train orientation that is Reverse.

1c8. VBR evaluates that the output of the combination is Nominal

1c9. VBR mode switches to FN mode

1c10. Use case terminates

Alternate Scenario 1d

The train Orientation with respect to LRBG is given by:

- Message 239 (in this scenario received in TD mode)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation to obtain the final Train Orientation.

1d1. VBR is in TD mode and receives message 239 with:

M_TICAB_STATUS=01 (CAB A active)

1d2. VBR receives from TV the packet 44/5 or it receives from ON-BOARD-KERNEL the packet 205 and the train Orientation is computed as follows:

trOrient= Q_DIRLRBG*(sign(bgOrient))*CabStatus.

In this scenario:

Q_DIRLRBG=Nominal
bgOrient=Reverse

CabStatus=A

1d3. The resulting Train Orientation on the Digital Map (PR*Cab status*BGOrient) is Reverse.

1d4. The Train Orientation on the Digital Map is then projected on the DB track by comparing it with the BG orientation with respect to the path (Left-to-Right/Nominal).

1d5. The final PR interpretation is Reverse.

1d6. This result is compared with the VBR train orientation that is Reverse.

1d7. VBR evaluates that the output of the combination is Nominal

1d8. VBR mode switches to FN mode

1d9. Use case terminates

Requirements:

Main Scenario: REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 3a: REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 7a: REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1a: REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1a2a: REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1a2b: REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1b: REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1b2a: REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1b2b: REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 3b: REQ_8.1.2.8, REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1a2c: REQ_8.1.1.1, REQ_8.1.2.8, REQ_8.1.2.2.

Alternate Scenario 3c: REQ_8.1.1.1, REQ_8.1.2.8, REQ_8.1.2.2.

Alternate Scenario 1a2d: REQ_8.1.2.8, REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 3d: REQ_8.1.2.8, REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 3d5a: REQ_8.1.1.1, REQ_8.1.2.8, REQ_8.1.2.2.

Alternate Scenario 1a2d: REQ_8.1.2.8, REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1a2e: REQ_8.1.1.1, REQ_8.1.2.8, REQ_8.1.2.2.

Alternate Scenario 3e: REQ_8.1.2.8, REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1a2f: REQ_8.1.2.8, REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1b2c: REQ_8.1.2.8, REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1c: REQ_8.1.2.8, REQ_8.1.1.1, REQ_8.1.2.2.

Alternate Scenario 1d: REQ_8.1.2.8, REQ_8.1.1.1, REQ_8.1.2.2.

Test: VBR_TOM_001

Target: Main Scenario

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab A active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (Q_DIRLRBG=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Nominal) to obtain the final Train Orientation.

Test: VBR_TOM_002

Target: Alternate Scenario 3a

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab A active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation

Test: VBR_TOM_003

Target: Alternate Scenario 7a

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab A active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation

Test: VBR_TOM_004

Target: Alternate Scenario 1a

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab B active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Nominal) to obtain the final Train Orientation.

Test: VBR_TOM_005

Target: Alternate Scenario 1a2a

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab B active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

Test: VBR_TOM_006

Target: Alternate Scenario 1a2b

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab B active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation.

Test: VBR_TOM_007

Target: Alternate Scenario 1b

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (No Cab Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Nominal) to obtain the final Train Orientation.

Test: VBR_TOM_008

Target: Alternate Scenario 1b2a

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (No Cab Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

Test: VBR_TOM_009

Target: Alternate Scenario 1b2b

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (No Cab Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation.

Test: VBR_TOM_010

Target: Alternate Scenario 3b

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab A Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Reverse)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

Test: VBR_TOM_011

Target: Alternate Scenario 1a2c

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab B Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation

Test: VBR_TOM_012

Target: Alternate Scenario 3c

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab A Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Reverse)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Nominal) to obtain the final Train Orientation

Test: VBR_TOM_013

Target: Alternate Scenario 1a2d

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab B Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Nominal)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Nominal) to obtain the final Train Orientation

Test: VBR_TOM_014

Target: Alternate Scenario 3d

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab A Active)

- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Unknown)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Nominal) to obtain the final Train Orientation

Test: VBR_TOM_015

Target: Alternate Scenario 3d5a

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab A Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Unknown)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation

Test: VBR_TOM_016

Target: Alternate Scenario 1a2d

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab B Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Unknown)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Nominal) to obtain the final Train Orientation

Test: VBR_TOM_017

Target: Alternate Scenario 1a2e

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab B Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Unknown)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Unknown) to obtain the final Train Orientation

Test: VBR_TOM_018

Target: Alternate Scenario 3e

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab A active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Unknown)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation

Test: VBR_TOM_019

Target: Alternate Scenario 1a2f

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (Cab B Active)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL (PR_Orientation=Unnown)

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation

Test: VBR_TOM_020

Target: Alternate Scenario 1b2c

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (No cab active)
- Packet 205 from ON-BOARD KERNEL after the detection of an Eurobalise

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

Test: VBR_TOM_021

Target: Alternate Scenario 1c

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (in this scenario received in SB mode)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

Test: VBR_TOM_022

Target: Alternate Scenario 1d

Description:

The train Orientation with respect to LRBG is given by:

- Message 239 (in this scenario received in TD mode)
- Packet 44/5 from TV OR packet 205 from ON-BOARD KERNEL

The projected Train Orientation on the Digital Map is then compared with the VBR Train Orientation (that is Reverse) to obtain the final Train Orientation.

6.3.3.21 VBG Integrity

When the VBR receives, from Trackside Verification (TV) module, confirmation on correctness and freshness of point position information used to navigate the Digital Map up to a switch point, it shall consider balise integrity confirmed as for the Digital Map navigation for all encountered Virtual Balise Groups, with the eventual exception of Virtual Balise Groups that follow a facing-point located after the given switch point. A VBG can be considered integer if the integrity on the Digital Map AND if the GNSS Position Integrity are confirmed.

Trigger

VBR virtual antenna crosses over a switch point with status known AND New VB Detection

OR

VBR virtual antenna crosses over a switch point with status unknown or out of control AND New VB Detection

OR

VBR receives from TV a packet 44/9 with Q_PRINTEGRITYCHECK = "Integrity Not Confirmed data not updated" AND New VB Detection

Precondition

FN.

Postcondition

FN, TD or SB.

Main Scenario

In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity confirmed. The VBR detects the VBG2 (NID_BG = 9168) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a positive check result from GAD and with the confirmation of the integrity of the switch point after the VBG1 detection, the VBR considers the VBG2 integrity confirmed.

No additional information is needed from TV.

1. A switch-point (M_PTID=41) has been overpassed by train.

2. VBR sends to TV the packet 44/104 (Digital Map Navigation Integrity) with:

• M_PTSTATUSID=last value received in the packet 44/6 (Switch Point Status).

• M_PTID=41

3. VBR receives from TV the packet 44/9 associated to the previous switch point M_PTID=41:

• Q_PRINTEGRITYCHECK= Position Integrity Confirmed.

• M_PTSTATUSID= last value received in the packet 44/104 (Digital Map Navigation Integrity).

• M_PTID=41.

4.VBR detects the virtual balise group VBG2.

5. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of VBG2

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG2

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=VBG2

6. The GAD verifies and confirms the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise (VBG2).

7. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Confirmed

b. NID_VALBG = VBG2.

8. The packet 44/10 with positive check result is received within the GNSS integrity confirmation timeout.

9. VBR considers as confirmed the integrity for the VBG2.

10. VBR considers the VBG2 with integrity confirmed both by TV and GAD trackside modules and it sends to ON-BOARD KERNEL the packet 247 "Validated BG Info" with:

• NID_VALBG=VBG2.

11. Use case terminates.

Alternate Scenario 7a

In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity confirmed. The VBR detects the VBG2 (NID_BG = 9168) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On the expiration of the check result from GAD and with the confirmation of the integrity of the switch point after the VBG1 detection, the VBR considers the VBG2 integrity failed. So, the VBR can use the VBG1 as safe reference position to perform a GNSS Position Rollback action.

7a1. The packet 44/10 isn’t received within the GNSS integrity confirmation timeout.

7a2. VBR considers the GNSS position integrity failed for the VBG2.

7a3. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to the previous safe reference position (VBG1).

7a4. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = VBG2

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG2

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG2.

7a5. Use case terminates.

Alternate Scenario 7b

In this scenario the VBG1 (NID_BG= 9089) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity confirmed.The VBR detects the VBG2 (NID_BG = 9365) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a negative check result from GAD and with the confirmation of the integrity of the switch point after the VBG1 detection, the VBR considers the VBG2 integrity confirmed.

No additional information is needed from TV.

7b1. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Not Confirmed

b. NID_VALBG = VBG2.

7b2. The packet 44/10 with negative check result is received within the GNSS integrity confirmation timeout.

7b3. VBR considers the GNSS position integrity failed for the VBG2.

7b4. VBR stops to send packet 44/105.

7b5. VBR can continue to navigate the Digital Map and it computes the train position information (including the confidence interval) with respect to the previous safe reference position (VBG1).

7b6. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = VBG2

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG2

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG2.

7b7. Use case terminates.

Alternate Scenario 3a

In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point without receiving answer about its integrity status.The VBR detects the VBG2 (NID_BG = 9168) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a positive check result from GAD and without the confirmation of the integrity of the switch point after the VBG1 detection, the VBR can’t consider the VBG2 integrity confirmed.

3a1. VBR doesn’t receive from TV the packet 44/9 associated to the previous switch point, so it continues to send packet 44/104.

3a2.VBR detects the virtual balise group VBG2.

3a3. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of VBG2

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG2

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=VBG2

3a4. The GAD verifies and confirms the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise (VBG2).

3a5. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Confirmed

b. NID_VALBG = VBG2.

3a6. The packet 44/10 with positive check result is received within the GNSS integrity confirmation timeout.

3a7. VBR continues to navigate on the Digital Map but can’t consider as confirmed the integrity for the VBG2, because the Digital Map Navigation Integrity is not confirmed.

3a8. Use case terminates.

Alternate Scenario 3a5a

In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point without receiving answer about its integrity status. The VBR detects the VBG2 (NID_BG = 9168) and it doesn’t receive information about its integrity. So, the VBR can’t consider the VBG2 integrity confirmed, but it can continue to navigate the Digital Map.

3a5a1. VBR doesn’t receive from GAD the packet 44/10 (GNSS Position Integrity Result).

3a5a2. VBR sends to EVC the packet 209 after the GNSS integrity confirmation timeout (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = VBG2

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG2

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG2.

3a5a3. VBR continues to navigate on the Digital Map and it continues to send packet 44/104.

3a5a4. Use case terminates.

Alternate Scenario 3a5b

In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point without receiving answer about its integrity status.The VBR detects the VBG2 (NID_BG = 9168) and it receives negative result about its integrity. So, the VBR can’t consider the VBG2 integrity confirmed, but it can continue to navigate the Digital Map.

3a5b1. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Not Confirmed

b. NID_VALBG = VBG2.

3a5b2. The packet 44/10 with negative check result is received within the GNSS integrity confirmation timeout.

3a5b3. VBR sends to EVC the packet 209 (Confidence Interval Enlargement) related to VBG2 with:

a. NID_LRBG = VBG2

b. L_ADDDOUBTOVER= Quantity to be added to over-reading error related to the NID_LRBG=VBG2

c. L_ADDDOUBTUNDER= Quantity to be added to under-reading error related to the NID_LRBG=VBG2.

3a5b4. VBR continues to navigate on the Digital Map and continues to send packet 44/104.

3a5b5. Use case terminates.

Alternate Scenario 3b

In this scenario the detection of VBG1 (NID_BG= 9070) has been successfully performed and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity not confirmed. Hence, VBR exits from Full Navigation mode.

3b1. VBR receives from TV the packet 44/9 associated to the previous switch point M_PTID=41:

• Q_PRINTEGRITYCHECK= Position Integrity Not Confirmed.

• M_PTSTATUSID= last value received in the packet 44/104 (Digital Map Navigation Integrity).

• M_PTID=41.

3b2.VBR exits from FN.

3b3. Use case terminates.

Alternate Scenario 3c

In this scenario the detection of VBG1 (NID_BG= 9070) has been successfully performed and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point and the Digital Map Navigation Integrity Result contains wrong id of the used switch list. Hence, when VBR detects the VBG2 (NID_BG=9168), it can't consider its integrity confirmed.

3c1. VBR receives from TV the packet 44/9 associated to the previous switch point M_PTID=41:

• Q_PRINTEGRITYCHECK= Position Integrity Not Confirmed.

• M_PTSTATUSID≠last value received in the packet 44/104 (Digital Map Navigation Integrity).

• M_PTID=41.

3c2. VBR detects the virtual balise group VBG2.

3c3. VBR sends to GAD the packet 44/105 (GNSS Position Integrity) with:

a. T_GPS_BAL_PRC = T_GPS_PRC of the last packet 44/3 considered as valid and used for the detection of VBG2

b. T_GPS_BAL_PVT = GPS time of the PVT used for the detection of VBG2

c. M_USED_PRN = indicating satellites used on board to calculate PVT (the satellite K is one of the used satellites).

d. NID_VALBG=VBG2

3c4. The GAD verifies and confirms the correctness and freshness of augmentation and integrity data used to provide the Virtual Balise (VBG2).

3c5. VBR receives from GAD the packet 44/10 (GNSS Position Integrity Result) with:

a. Q_PRINTEGRITYCHECK = Position Integrity Confirmed

b. NID_VALBG = VBG2.

3c6. The packet 44/10 with positive check result is received within the GNSS integrity confirmation timeout.

3c7. VBR continues to navigate on the Digital Map but can't consider as confirmed the integrity for the VBG2, because the Digital Map Navigation Integrity is not confirmed.

3c8. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3.

Alternate Scenario 7a: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3.

Alternate Scenario 7b: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3.

Alternate Scenario 3a: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3.

Alternate Scenario 3a5a: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3.

Alternate Scenario 3a5b: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3.

Alternate Scenario 3b: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3.

Alternate Scenario 3c: REQ_8.1.1.1, REQ_8.1.2.3, REQ_8.1.1.3.

Test: VBR_VBGI_001

Target: Main Scenario

Description: In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity confirmed.The VBR detects the VBG2 (NID_BG = 9168) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a positive check result from GAD and with the confirmation of the integrity of the switch point after the VBG1 detection, the VBR considers the VBG2 integrity confirmed.

Test: VBR_VBGI_002

Target: Alternate Scenario 7a

Description: In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity confirmed.The VBR detects the VBG2 (NID_BG = 9168) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On the expiration of the check result from GAD and with the confirmation of the integrity of the switch point after the VBG1 detection, the VBR considers the VBG2 integrity failed. So, the VBR can use the VBG1 as safe reference position to perform a GNSS Position Rollback action.

Test: VBR_VBGI_003

Target: Alternate Scenario 7b

Description: In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity confirmed.The VBR detects the VBG2 (NID_BG = 9168) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a negative check result from GAD and with the confirmation of the integrity of the switch point after the VBG1 detection, the VBR considers the VBG2 integrity confirmed.

No additional information is needed from TV.

Test: VBR_VBGI_004

Target: Alternate Scenario 3a

Description: In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point without receiving answer about its integrity status.The VBR detects the VBG2 (NID_BG = 9168) and provides to GAD the identifier of the used augmentation data (if available) in order to require the GNSS position integrity check. On receiving of a positive check result from GAD and without the confirmation of the integrity of the switch point after the VBG1 detection, the VBR can't consider the VBG2 integrity confirmed.

Test: VBR_VBGI_005

Target: Alternate Scenario 3a5a

Description: In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point without receiving answer about its integrity status.The VBR detects the VBG2 (NID_BG = 9168) and it doesn't receive information about its integrity. So, the VBR can't consider the VBG2 integrity confirmed, but it can continues to navigate the Digital Map.

Test: VBR_VBGI_006

Target: Alternate Scenario 3a5b

Description: In this scenario the VBG1 (NID_BG= 9070) has been successfully detected and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point without receiving answer about its integrity status. The VBR detects the VBG2 (NID_BG = 9168) and it receives negative result about its integrity. So, the VBR can't consider the VBG2 integrity confirmed, but it can continue to navigate the Digital Map.

Test: VBR_VBGI_007

Target: Alternate Scenario 3b

Description: In this scenario the detection of VBG1 (NID_BG= 9070) has been successfully performed and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point with Integrity not confirmed. Hence, VBR exits from Full Navigation mode.

Test: VBR_VBGI_008

Target: Alternate Scenario 3c

Description: In this scenario the detection of VBG1 (NID_BG= 9070) has been successfully performed and its integrity is confirmed both by the TV and the GAD. The most advanced vehicle position (most retracted in case of reverse movement) has overpassed a facing point and the Digital Map Navigation Integrity Result contains wrong id of the used switch list. Hence, when VBR detects the VBG2 (NID_BG=9168), it can't consider its integrity confirmed.

6.3.3.22 Eurobalise Filtering

The VBR can emulate the functions of the integrated BTM also for installed Eurobalises, implementing a virtualization of real balises.

After a virtualization order from EVC, based on the REQ_8.1.1.1 requirement, the virtualization command "wins" over any value of the virtual cover flag, such as:

• the integrated BTM disabled (hence, no Eurobalise is received);

• all BGs of the Digital Map are managed as virtual, regardless of the Virtual Cover flag.

In summary, when:

• Virtualization of EuroBalises = Yes

It will always be:

• Flag EuroBalises Digital Map = NR

• BTM Status = NR

• Output to EVC = Virtualized BG (in FN) or nothing (in all other Modes)

Trigger

The VBR is configured by ON-BOARD KERNEL to turn on/off the virtualization of Eurobalises

AND

VBR virtual antenna crosses over an Eurobalise

Precondition

SC, SB, TD, FN.

Postcondition

SC, SB, TD, FN.

Main Scenario

In this scenario the VBR is in SC mode and the ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). The BTM System is correctly configured. The sending of Eurobalise is expected, since in SC mode the Virtual Cover of the Eurobalise can never be activated, as the content of the Digital Map is not still available.

1. VBR is in SC mode and BTM System has been correctly configured

2. The ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER).

3. VBR crosses over an Eurobalise

4. A packet Balise Telegram Real is sent with:

• Q_MODULATION = FSK

• Q_VIRT_BAL_TLG = EuroBalise

5. Use case terminates.

Alternate Scenario 1a

In this scenario the VBR is in SC mode and the BTM system is KO.

1a1. VBR is in SC mode

1a2. BTM System is KO

1a3. VBR crosses over an Eurobalise

1a4. No packet Balise Telegram Real is sent.

1a5. Use case terminates.

Alternate Scenario 2a

In this scenario the VBR is in SC mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured.

2a1. The BTM has been correctly configured.

2a2. The ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER)

2a3. VBR crosses over an Eurobalise

2a4. A packet Balise Telegram Real is sent with:

• Q_MODULATION = FSK

• Q_VIRT_BAL_TLG = EuroBalise

2a5. Use case terminates.

Alternate Scenario 1b

In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is activated.

1b1. VBR is in SB mode.

1b2. The ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER.

1b3. VBR crosses over an Eurobalise

1b4. No packet Balise Telegram Real is sent.

1b5. Use case terminates.

Alternate Scenario 1b2a

In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL_NOT_VIRT (Real balise not virtualizable)

1b2a1. The ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER).

1b2a2. The BTM System is correctly configured.

1b2a3. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL_NOT_VIRT (Real balise not virtualizable)

1b2a4. VBR crosses over an Eurobalise

1b2a5. A packet Balise Telegram Real is sent with:

• Q_MODULATION = FSK

• Q_VIRT_BAL_TLG = EuroBalise

1b2a6. Use case terminates.

Alternate Scenario 1b2a3a

In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _VIRT (Real balise virtualizable in every mode)

1b2a3a1. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _VIRT (Real balise virtualizable in every mode)

1b2a3a2. VBR crosses over an Eurobalise

1b2a3a3. No packet Balise Telegram Real is sent.

1b2a3a4. The Eurobalise is always detected by the BTM, and this is tracked by its specific data logger

1b2a3a5. Use case terminates.

Alternate Scenario 1b2a3b

In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode)

1b2a3b1. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode)

1b2a3b2. VBR crosses over an Eurobalise

1b2a3b3. No packet Balise Telegram Real is sent.

1b2a3b4. Use case terminates.

Alternate Scenario 1b2a2a

In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode)

1b2a2a1The BTM System is KO.

1b2a2a2. VBR crosses over an Eurobalise

1b2a2a3. No packet Balise Telegram Real is sent.

1b2a2a4. Use case terminates.

Alternate Scenario 1c

In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is activated.

1c1. VBR is in TD mode.

1c2. The ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER.

1c3. VBR crosses over an Eurobalise

1c4. No packet Balise Telegram Real is sent.

1c5. Use case terminates.

Alternate Scenario 1c2a

In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL_NOT_VIRT (Real balise not virtualizable)

1c2a1. The ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER).

1c2a2. The BTM System is correctly configured.

1c2a3. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL_NOT_VIRT (Real balise not virtualizable)

1c2a4. VBR crosses over an Eurobalise

1c2a5. A packet Balise Telegram Real is sent.

1c2a6. Use case terminates.

Alternate Scenario 1c2a3a

In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _VIRT (Real balise virtualizable in every mode)

1c2a3a1. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _VIRT (Real balise virtualizable in every mode)

1c2a3a2. VBR crosses over an Eurobalise

1c2a3a3. No packet Balise Telegram Real is sent.

1c2a3a4. A packet 205 is sent to initialize VBR with respect to the Eurobalise.

1c2a3a5. VBR cannot switch to FN because the virtual cover for this Eurobalise is activates.

1c2a3a6. Use case terminates.

Alternate Scenario 1c2a3b

In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode)

1c2a3b1. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode)

1c2a3b2. VBR crosses over an Eurobalise

1c2a3b3. No packet Balise Telegram Real is sent.

1c2a3b4. Use case terminates.

Alternate Scenario 1c2a2a

In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode)

1c2a2a1The BTM System is KO.

1c2a2a2. VBR crosses over an Eurobalise

1c2a2a3. No packet Balise Telegram Real is sent.

1c2a2a4. Use case terminates.

Alternate Scenario 1d

In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is activated.

1d1. VBR is in FN mode.

1d2. The ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER.

1d3. VBR crosses over an Eurobalise

1d4. No packet Balise Telegram Real is sent, but a packet balise telegram is sent to VBR (the EBV is sent as a VBG).

1d5. Use case terminates.

Alternate Scenario 1d2a

In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL_NOT_VIRT (Real balise not virtualizable)

1d2a1. The ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER).

1d2a2. The BTM System is correctly configured.

1d2a3. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL_NOT_VIRT (Real balise not virtualizable)

1d2a4. VBR crosses over an Eurobalise

1d2a5. A packet Balise Telegram Real is sent.

1d2a6. Use case terminates.

Alternate Scenario 1d2a3a

In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _VIRT (Real balise virtualizable in every mode)

1d2a3a1. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _VIRT (Real balise virtualizable in every mode)

1d2a3a2. VBR crosses over an Eurobalise

1d2a3a3. No packet Balise Telegram Real is sent, but a packet balise telegram is sent from VBR (the EBG is sent as a VBG).

1d2a3a4. Use case terminates.

Alternate Scenario 1d2a3b

In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode)

1c2a3b1. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode)

1c2a3b2. VBR crosses over an Eurobalise

1c2a3b3. No packet Balise Telegram Real is sent, but a packet balise telegram is sent from VBR (the EBG is sent as a VBG).

1c2a3b4. Use case terminates.

Alternate Scenario 1d2a2a

In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode)

1d2a2a1The BTM System is KO.

1d2a2a2. VBR crosses over an Eurobalise

1d2a2a3. No packet Balise Telegram Real nor packet balise telegram is sent.

1d2a2a4. Use case terminates.

Alternate Scenario 1e

In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization and to provide the CTODL (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is activated.

1d1. VBR is in FN mode.

1d2. The ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization and to provide CTODL (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER.

1d3. VBR crosses over an Eurobalise

1d4. No packet Balise Telegram Real is sent, but a packet balise telegram is sent from VBR (the EBG is sent as a VBG).

1d5. Use case terminates.

Alternate Scenario 1f

In this scenario the VBR does not receive satellite data and it receives a telegram of an Eurobalise that is not contained in the Digital Map Track DB. Then, it is initialized with respect to this EBG through a packet 205. VBR does not switch to FN.

1f1. VBR is in SB and GNSS data are not available.

1f2. VBR continues to navigate the DM and a packet balise telegram of an Eurobalise that is not contained in the DM (NID_BG=980) is sent.

1f3. VBR receives from ON-BOARD Kernel packet 205 that initializes VBR from the Eurobalise with NID_BG=980.

1f4. VBR does not switch to FN and it remains in SB.

1f5. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1

Alternate Scenario 1a: REQ_8.1.1.1

Alternate Scenario 2a: REQ_8.1.1.1

Alternate Scenario 1b: REQ_8.1.1.1

Alternate Scenario 1b2a: REQ_8.1.1.1

Alternate Scenario 1b2a3a: REQ_8.1.1.1

Alternate Scenario 1b2a3b: REQ_8.1.1.1

Alternate Scenario 1b2a2a: REQ_8.1.1.1

Alternate Scenario 1c: REQ_8.1.1.1

Alternate Scenario 1c2a: REQ_8.1.1.1

Alternate Scenario 1c2a3a: REQ_8.1.1.1

Alternate Scenario 1c2a3b: REQ_8.1.1.1

Alternate Scenario 1c2a2a: REQ_8.1.1.1

Alternate Scenario 1d: REQ_8.1.1.1

Alternate Scenario 1d2a: REQ_8.1.1.1

Alternate Scenario 1d2a3a: REQ_8.1.1.1

Alternate Scenario 1d2a3b: REQ_8.1.1.1

Alternate Scenario 1d2a2a: REQ_8.1.1.1

Alternate Scenario 1e: REQ_8.1.1.1

Alternate Scenario 1f: REQ_8.1.1.1

Test: VBR_EBFIL_001

Target: Main Scenario

Description: In this scenario the VBR is in SC mode and the ON-BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). The BTM System is correctly configured. The sending of Eurobalise is expected, since in SC mode the Virtual Cover of the Eurobalise can never be activated, as the content of the Digital Map is not still available.

Test: VBR_EBFIL_002

Target: Alternate Scenario 1a

Description: In this scenario the VBR is in SC mode and the BTM system is KO.

Test: VBR_EBFIL_003

Target: Alternate Scenario 2a

Description: In this scenario the VBR is in SC mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured.

Test: VBR_EBFIL_004

Target: Alternate Scenario 1b

Description: In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is activated.

Test: VBR_EBFIL_005

Target: Alternate Scenario 1b2a

Description: In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL_NOT_VIRT (Real balise not virtualizable).

Test: VBR_EBFIL_006

Target: Alternate Scenario 1b2a3a

Description: In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _VIRT (Real balise virtualizable in every mode).

Test: VBR_EBFIL_007

Target: Alternate Scenario 1b2a3b

Description: In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode).

Test: VBR_EBFIL_008

Target: Alternate Scenario 1b2a2a

Description: In this scenario the VBR is in SB mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode).

Test: VBR_EBFIL_009

Target: Alternate Scenario 1c

Description: In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is activated.

Test: VBR_EBFIL_010

Target: Alternate Scenario 1c2a

Description: In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL_NOT_VIRT (Real balise not virtualizable).

Test: VBR_EBFIL_011

Target: Alternate Scenario 1c2a3a

Description: In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _VIRT (Real balise virtualizable in every mode).

Test: VBR_EBFIL_012

Target: Alternate Scenario 1c2a3b

Description: In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode).

Test: VBR_EBFIL_013

Target: Alternate Scenario 1c2a2a

Description: In this scenario the VBR is in TD mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode).

Test: VBR_EBFIL_014

Target: Alternate Scenario 1d

Description: In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is activated.

Test: VBR_EBFIL_015

Target: Alternate Scenario 1d2a

Description: In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL_NOT_VIRT (Real balise not virtualizable)

Test: VBR_EBFIL_016

Target: Alternate Scenario 1d2a3a

Description: In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _VIRT (Real balise virtualizable in every mode).

Test: VBR_EBFIL_017

Target: Alternate Scenario 1d2a3b

Description: In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode).

Test: VBR_EBFIL_018

Target: Alternate Scenario 1d2a2a

Description: In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn off the EuroBalise Virtualization (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is disables and the BTM System is correctly configured. The flag of the Eurobalise on the Digital Map is set to Q_TBAL_REAL _FN_VIRT (Real balise virtualizable only in FN mode).

Test: VBR_EBFIL_019

Target: Alternate Scenario 1e

Description: In this scenario the VBR is in FN mode and the ON -BOARD KERNEL sends the PDU PKT_BTM_ORDER to turn on the EuroBalise Virtualization and to provide the CTODL (through the M_VBR_OB_ORDERS present in the PDU PKT_BTM_ORDER). Hence, the filtering of Eurobalise is activated.

Test: VBR_EBFIL_020

Target: Alternate Scenario 1f

Description: In this scenario the VBR does not receive satellitar data and it receives a telegram of an Eurobalise that is not contained in the Digital Map Track DB. Then, it is initialized with respect to this EBG through a packet 205. VBR does not switch to FN.

6.3.3.23 GNSS Test Antenna

A specific GNSS Antennas Test in VBR system is implemented in order to check the GNSS Reception Chains and their correct functioning. So when the absolute value of the difference between the number of satellites tracked by the two receivers (with CNR greater than the minimum allowed) is above the configuration threshold continuously for a space greater than configuration value or for a configuration number of virtual consecutive balise groups, the LDS must report a warning in PKT_STATUS_BTM regarding the reception chain.

The warning is sent also when the mean of the CNR values related to Local Tracked Satellites (both by Section A and/or by Section B) is under a given configuration threshold and the travelled space or the number of detected VBGs are over a given configuration threshold.

In case of malfunction on GNSS Antenna A and/or Antenna B is no longer exist, OBU-LDS sends to OBSC the PKT_STATUS_BTM about the new correct internal state.

Trigger

VBR detects a problem in the chain Satellite Antenna -> RF Cables equally on Section A and/or on Section B.

Precondition

VBR is in FN mode.

Post-condition

VBr is in FN mode.

Main Scenario

In this scenario is verified the proper detection of malfunction on GNSS reception chain A. The check is performed monitoring the mean of CNRs related to local tracked satellites on chain A and the warning is notified counting the number of different VBG.

1. VBR is in FN mode with a valid PVT solution.

2. The GNSS reception chain A has problem of correct reception satellite signals.

3. The mean of CNRs on Local Tracked Satellites (chain A) is under a given configuration threshold. The internal state of GNSS Antennas Test is in PRE_WARN_SING_SEC_SAT mode (chain A).

4. VBR continues the mission and then it detects a number of different VBG over a given configuration threshold (2).

5. The warning on single GNSS reception chain A is detected and VBR sends to ON-BOARD Kernel the PKT_BTM_STATUS with M_VBR_OB_WARNINGS= VBR has detected GNSS antenna A malfunction

6. In this case ATP (Automatic Train Protection) can apply its own VBR Redundancy Policies and it can discard the VBR Device which is in trouble.

7. Use case terminates.

Alternate Scenario 2a

In this scenario is verified the proper detection of malfunction on GNSS reception chain B. The check is performed monitoring the mean of CNRs related to local tracked satellites on chain B during the travelled space on single section in over a configuration thereshold (maxSpaceRec=1120 m).

2a1. The GNSS reception chain B has problem of correct reception satellite signals.

2a2. The mean of CNRs on Local Tracked Satellites (chain B) is under a given configuration threshold. The internal state of GNSS Antennas Test is in PRE_WARN_SING_SEC_SAT mode (chain B).

2a3. VBR continues the mission and the travelled space is over a given configuration threshold (checking space on single section B).

2a4. The warning on single GNSS reception chain B is detected and VBR sends to ON-BOARD Kernel the PKT_BTM_STATUS with M_VBR_OB_WARNINGS= VBR has detected GNSS antenna B malfunction

2a5. Use case terminates.

Alternate Scenario 2a2a

In this scenario is verified the proper detection of malfunction on GNSS reception chain B. The check is performed monitoring the number of tracked satellites by section A and section B (Common Tracked Satellites).

2a2a1. The GNSS reception chain B has problem of correct reception satellite signals.

2a2a2. The difference between number of tracked satellites by section A and section B is over a given configuration threshold (nSatMaxDiff=4). The internal state of GNSS Antennas Test is in PRE_WARN_COMM_SAT mode (chain B).

2a2a3. VBR continues the mission and the travelled space is over a given configuration threshold (configuration used: maxSpaceDiff=1220m, maxSpaceRec=infinite, NVBG=8). The internal state of GNSS Antenna Test is in WARNING_COMM_SAT.

2a2a4. Monitoring the Common Tracked Satellite the warning on single GNSS reception chain B is detected and VBR sends to On Board Kernel the PKT_BTM_STATUS with M_VBR_OB_WARNINGS= VBR has detected GNSS antenna B malfunction

2a2a5. VBR sends to ON-BOARD Kernel the PKT_BTM_STATUS with M_VBR_OB_WARNINGS= VBR has not detected any GNSS antenna A/B malfunction or the malfunction no longer exists

2a2a6. Use case terminates.

Alternate Scenario 7a

In this scenario is verified the proper information (PKT_BTM_STATUS) provided from VBR to On Board Kernel in case of malfunction on GNSS Antenna A no longer exist.

7a1. The malfunction on GNSS Antenna A no longer exist.

7a2. The mean of CNRs on Local Tracked Satellites (chain A) is over a given configuration threshold.

7a3. VBR sends to ON-BOARD Kernel the PKT_BTM_STATUS with M_VBR_OB_WARNINGS= VBR has not detected any GNSS antenna A/B malfunction or the malfunction no longer exists

7a4. Use case terminates

Alternate Scenario 2a6a

In this scenario is verified the proper information (in the PKT_BTM_STATUS) provided from VBR to ON-BOARD Kernel in case of malfunction on GNSS Antenna B no longer exist.

2a6a1. The malfunction on GNSS Antenna B no longer exist.

2a6a2. VBR sends to On Board Kernel the PKT_BTM_STATUS with M_VBR_OB_WARNINGS = VBR has not detected any GNSS antenna A/B malfunction or the malfunction no longer exists

2a6a3. Use case terminates

Alternate Scenario 3a

In this scenario is verified the proper detection of malfunction on GNSS reception chain A and/or reception chain B. The check is performed monitoring the common tracked satellites between GNSS reception chain A and B.

3a1. The GNSS reception chain A has lowest number of local tracked satellites.

3a2. The difference between number of tracked satellites by section A and by section B is over a given threshold (nSatMaxDiff=1).

The internal state of GNSS Antennas Test is in PRE_WARN_COMM_SAT mode.

3a3. VBR continues the mission and then it detects a number of different VBG over a given configuration threshold (2).

3a4. The warning state (WARNING_COMM_SAT) is detected and VBR sends to ON-BOARD Kernel the PKT_BTM_STATUS with M_VBR_OB_WARNINGS= VBR has detected GNSS antenna A malfunction

3a5. Use case terminates.

Alternate Scenario 3a6a

Monitoring the common tracked satellite between both section A and B in this test is verified the proper information (in the PKT_BTM_STATUS) provided from VBR to ON-BOARD Kernel I in case of malfunction on GNSS Antenna A no longer exist.

3a6a1. The malfunction on GNSS Antenna A no longer exist.

3a6a2. The difference between number of tracked satellites by section A and by section B is under a given configuration threshold.

3a6a3. VBR sends to ON-BOARD Kernel the PKT_BTM_STATUS with M_VBR_OB_WARNINGS= VBR has not detected any GNSS antenna A/B malfunction or the malfunction no longer exists

3a6a4. Use case terminates

Alternate Scenario 4a

In Pre-Warning state the counting on the check threshold (configuration value, NVBG=2) not included the same VBG already detected.

4a1. VBR continues the mission moving in forward train direction and then a virtual balise group VBG1 is detected (1° detection).

4a2. Train decelerates till reaching the point P1 at standstill then the train moving in backward and the previous VBG1 is re-detected (2° detection).

4a3. The train moves in forward direction and the VBG1 is re-detected (3° detection), but the PKT_STATUS_BTM (Warning on chain A) is not sent to ON-BOARD Kernel.

4a4. Then the number counted on the VBGs detected over a given configuration threshold shall be make on closed status of different VBGs.

4a5. GNSS Antennas Test doesn't change the internal state of in WARN_SING_SEC_SAT mode (chain A).

4a6. Use case terminates.

Alternate Scenario 2b

In this scenario is verified the proper detection of malfunction on GNSS reception chain A. The check is performed monitoring the number of tracked satellites by section A and section B (Common Tracked Satellites).

2b1. The GNSS reception chain A has problem of correct reception satellite signals.

2b2. The difference between number of tracked satellites by section A and section B is over a given configuration threshold (nSatMaxDiff=4). The internal state of GNSS Antennas Test is in PRE_WARN_COMM_SAT mode (chain A).

2b3. VBR continues the mission and first an Eurobalise is detected from BTM and, then, a VBG is detected from VBR.

2b4. While the travelled space is no over the given configuration threshold (maxSpaceDiff=3000m) and the number of different VBG detected is under the given configuration threshold (2), the internal state of GNSS Antennas Test remains in PRE_WARN_COMM_SAT mode

2b5. Use case terminates.

Requirements:

Main Scenario: REQ_8.1.1.1

Alternate Scenario 2a: REQ_8.1.1.1

Alternate Scenario 2a2a: REQ_8.1.1.1

Alternate Scenario 7a: REQ_8.1.1.1

Alternate Scenario 2a6a: REQ_8.1.1.1

Alternate Scenario 3a: REQ_8.1.1.1

Alternate Scenario 3a6a: REQ_8.1.1.1

Alternate Scenario 4a: REQ_8.1.1.1

Alternate Scenario 2b: REQ_8.1.1.1

Test: VBR_GNSSAT_001

Target: Main Scenario

Description: VBR is in FN mode and continuosly monitors the mean of CNRs a related to local tracked satellites on chain A. Due to malfunction on GNSS reception chain A, the mean value of CNRs become under a configuration threshold. So when a number of different VBG over a given configuration value is detected, VBR sends to ON-BOARD Kernel the PKT_STATUS_BTM (warning of malfunction on chain A).

Test: VBR_GNSSAT_002

Target: Alternate Scenario 2a

Description: VBR is in FN mode and continuosly monitors the mean of CNRs a related to local tracked satellites on chain B. Due to malfunction on GNSS reception chain B, the mean value of CNRs become under a configuration threshold. So when the travelled space by train (on single section B) is over a given configuration threshold, VBR sends to ON-BOARD Kernel the PKT_STATUS_BTM (warning of malfunction on chain B).

Test: VBR_GNSSAT_003

Target: Alternate Scenario 7a

Description: VBR is in FN mode and continuosly monitors the mean of CNRs a related to local tracked satellites on chain A. The mean value of CNRs become over a configuration threshold because a malfunction on GNSS reception chain A is no longer exists. VBR sends to OBSC the PKT_STATUS_BTM (malfunction on chain A no longer exist).

Test: VBR_GNSSAT_004

Target: Alternate Scenario 2a6a

Description: VBR is in FN mode and continuosly monitors the mean of CNRs a related to local tracked satellites on chain B. The mean value of CNRs become over a configuration threshold because a malfunction on GNSS reception chain B is no longer exists. VBR sends to ON-BOARD Kernel the PKT_STATUS_BTM (malfunction on chain B no longer exist).

Test: VBR_GNSSAT_005

Target: Alternate Scenario 3a

Description: VBR is in FN mode and continuosly monitors number of common tracked satellites between GNSS reception chain A and B. The number of tracked satellite by section A and by section B is over a given configuration threshold due to malfunction on GNSS reception A. So when a number of different VBG over a given configuration value is detected, VBR sends to ON-BOARD Kernel the PKT_STATUS_BTM (warning of malfunction on chain A).

Test: VBR_GNSSAT_006

Target: Alternate Scenario 3a6a

Description: VBR is in FN mode and a previous warning of malfunction on chain A has been sent to ON-BOARD Kernel. Monitoring the common tracked satellite between both section A and B in this test is verified the proper notification (in the PKT_BTM_STATUS) provided from VBR to ON-BOARD Kernel in case of malfunction on GNSS Antenna A no longer exist.

Test: VBR_GNSSAT_007

Target: Alternate Scenario 2a2a

Description: VBR is in FN mode and continuosly monitors number of common tracked satellites between GNSS reception chain A and B. The number of tracked satellite by section A and by section B is over a given configuration threshold due to malfunction on GNSS reception B. So when the space travelled is over a given configuration value (maxSpaceDiff=1220 m), VBR sends to ON-BOARD Kernel the PKT_STATUS_BTM (warning of malfunction on chain B).

In this test is also verified the proper notification provided to ON-BOARD Kernel in case of malfunction on GNSS B no longer exist.

Test: VBR_GNSSAT_008

Target: Alternate Scenario 4a

Description: During VBR is in FN mode, the GNSS Reception Chain fails (No signal satellite is available from Antenna A). So, the "BG 1" is detected more time in backward and in forward train traveling direction.

The PKT_STATUS_BTM is not sent (warning Antenna A =65536) to ON-BOARD Kernel because the counting on the check threshold (configuration value) not incluted the same VBG already detected.

About the SATR ANTENNAS TEST, the compute of the number of the Detected VBGs over a given configuration Threshold shall be make on closed status of different VBGs

Test: VBR_GNSSAT_009

Target: Alternate Scenario 2b

Descritpion: In this scenario is verified the proper detection of malfunction on GNSS reception chain A. The check is performed monitoring the number of tracked satellites by section A and section B (Common Tracked Satellites).

6.4 Integration Phase

In this section, the tests to be performed in the field and in the laboratory to validate the integration between the Ground Sub-System and the VBTS will be reported.

In particular, the following are indicated:

- the functional tests of the Signalling System

- the SDT-SSB integration test cases

- the RBC-IXL integration test cases.

6.4.1 Test Environment

The definition of the tests in this document is intended for execution on two test environments:

- Integrated Laboratory Environment (LAB)

- SITE

For each test procedure, the required execution environment (LAB and/or SITE) is defined.

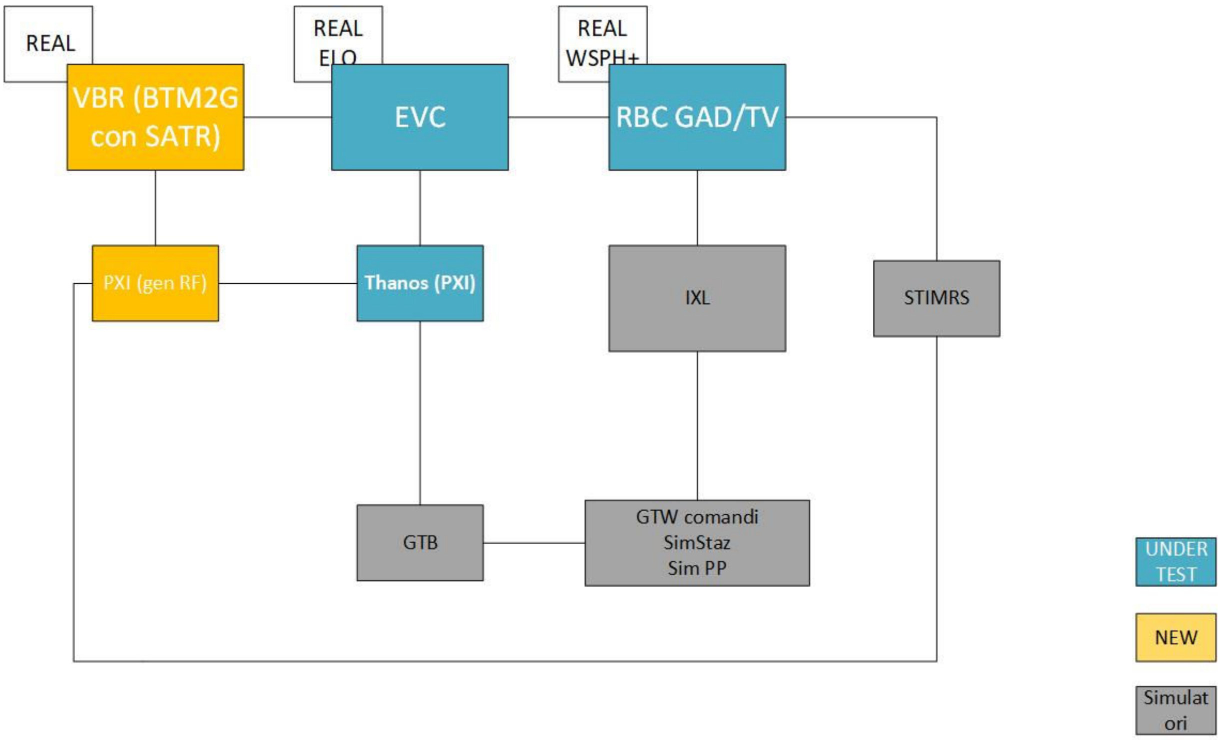


Figure 6-13: Test execution environment

6.4.2 Test Description

This section describes the process of defining functional tests and defines the structure and identification of the tests specified in this document, together with the criteria for analyzing the results.

6.4.2.1 Test Identification

6.4.2.1.1 Name of Test Procedures

In order to identify each test procedure, the name of each single procedure follows this rule:

<Activity>_< Main_functionality >_< Test_Procedure_ID >

Where:

- **Activity:**
  - Identify the activity:
    - Virtual Balise Transmission System: ***VBTS***
- **Main functionality:**
  - Identify the core functionality of the scenario:
    - Start of Mission: ***SOM***
    - End of Mission: ***EOM***
    - Unconditional Emergency Message: ***UEM***
    - Conditional Emergency Message: ***CEM***
    - Temporary Speed Restriction: ***TSR***
    - Bushing temperature sensing: ***RTB***
    - Movement Authority: ***MA***
    - Service posts: ***PdS***
    - Shortening MA Cooperatives: ***COSMA***
    - Safe connection (RBC-SSB): ***COM***
    - LNTC →L2 Transition: ***LNTC-L2***
    - L2 →LNTC Transition: ***L2-LNTC***
    - Shunting: ***SH***
    - Track description: ***TD***
    - 2-train test: ***2Trains***
- **Test_Procedure_ID:**
  - Unique identifier needed to distinguish each procedure from all the others.

6.4.2.1.2 Name of the Test Cases

In order to identify each test case, the name of each individual test follows this rule:

<Activity>_<Interface>_< Test_Case_ID >

Where:

- **Activity:**
  - Identify the activity:
    - Virtual Balise Transmission System: ***VBTS***
- **Interface:**
  - Identify the interface affected by the test:
    - ***SDT-SSB***
- **Test_Case_ID:**

- Unique identifier needed to distinguish each test case from all others.

6.4.2.3 Test Versioning Strategy

Each test present in this specification (Test Procedures and Test Cases) is characterized by the "Version" attribute which defines the test revision.

This information is essential to define the test modifications that have an impact on the execution and on the analysis of the results of the same.

The “Version” attribute is defined ***MM.mm***, where:

- ***MM***: *Test Major version* - Increased for changes impacting test execution
- ***mm***: *Test minor version* - Incremented for changes without impacting test execution

“*Test major version”* changes, the “*Test minor version*” is reset.

6.4.2.3.1 Versioning of the Test Procedures

The changes may affect the various fields that characterize the Test Procedure.

Below are the changes applicable to each field (defined in section 6.4.2.5.1) with the relative impact on versioning.

- **Test Procedure Name**
  - Edit acronym for < Main_Functionality >→ *minor version (mm)*
- **Test Procedure Description**
  - Editing the description of the test→ *minor version (mm)*
- **Test Procedure Summary**
  - Modify attribute enhancement " Function "→ *minor version (mm)*
  - Modify the " Execution " attribute enhancement→ *Major version (MM)*
  - Change enhancement of attribute “ Scenario's Type ”→ *minor version (mm)*
  - Modify attribute enhancement " Mandatory for interface "→ *minor version (mm)*
- **Pre-Condition Test Procedures**
  - Adding a Pre-condition→ *Major version (MM)*
  - Deleting a Pre-condition→ *minor version (mm)*
  - Functional modification. Pre-condition→ *Major version (MM)*
    (e.g., Train in operating mode or position different from what was previously defined)
- **Test Cases**
  - Addition of one or more Test Cases→ *Major version (MM)*
  - Deleting one or more Test Cases→ *Major version (MM)*
  - Changing the ordering of Test Cases→ *Major version (MM)*
  - Increasing the Major version of a Test Case→ *Major version (MM)*
  - Increasing the minor version of a Test Case→ *minor version (mm)*
- **Post-Condition Test Procedures**
  - Adding a Post-condition→ *minor version (mm)*
  - Deleting a Post-condition→ *minor version (mm)*
  - Edit Post-condition→ *minor version (mm)*
    (e.g., Train in operating mode or position different from what was previously defined)

Syntactic-grammatical modifications (grammar, morphological and punctuation revision), text styles and layout have no impact on the versioning.

6.4.2.3.2 Versioning of Test Cases

The changes may affect the various fields that characterize the Test Case.

Below are the applicable changes for each field (defined in section 6.4.2.5.2) with the relative impact on versioning.

- **Test Case Name**
  - Edit acronym for < Activity >→ *minor version (mm)*
  - Change acronym for < Interface >→ *minor version (mm)*
- **Test Case Descriptions**
  - Editing the description of the test→ *minor version (mm)*
- **Test Case Summary**
  - Change enhancement of one or more attributes→ *minor version (mm)*
- **Test Case Pre-Condition**
  - Adding a Pre-condition→ *Major version (MM)*
  - Deleting a Pre-condition→ *minor version (mm)*
  - Functional modification. Pre-condition→ *Major version (MM)*
    (e.g., Train in operating mode or position different from what was previously defined)
- **Test Steps**
  - Adding a Step→ *Major version (MM)*
  - Deleting a Step→ *Major version (MM)*
  - Changing the ordering of the Steps→ *Major version (MM)*
  - Functional modification of a Step with impact on test execution→ *Major version (MM)*
    (e.g., Addition of a check on the DMI and/or HMI, to be performed during the execution of the test)
  - Modification of a Step without impact on the execution of the test →minor version (mm)
    (e.g., Modification of a check on a variable, type Q_FRONT in pkt 65, to be checked in the logs after running the test)
- **Test Case Post-Condition**
  - Adding a Post-condition→ *minor version (mm)*
  - Deleting a Post-condition→ *minor version (mm)*
  - Edit Post-condition→ *minor version (mm)*
    (e.g., Train in operating mode or position different from what was previously defined)

Syntactic-grammatical changes (grammar, morphological and punctuation), text styles and layout changes have no impact on the versioning.

6.4.2.4 Definition of Test Procedures

The test procedures have been defined as an ordered combination of different test cases in order to define the railway scenarios and test a single functionality under different conditions.

The body of the scenario is the sequence of test cases and associated steps, where the post condition of one test case is the precondition of the next test case.

6.4.2.4.1 Scenario type

The procedures are characterized by the type of scenario, as follows:

- **Nominal**: scenario of normal operation during railway operation.
- **Not Nominal**: scenario of non-normal progress during railway operation.
- **Degraded**: scenario due to a deteriorated situation.

6.4.2.5 Test structure

6.4.2.5.1 Test Procedure Structure

A test procedure is defined as follows:

<Test Procedure Name> Provides a unique test identifier as described in section 6.4.2.1.1
<Test Procedure Description > Identify a brief description of the test objective
<Test Procedure Summary > It provides information about the scenario and the conditions required for its execution, as below: • ***Function:*** Main features affected by the scenario (e.g., SOM, EOM, MA …) • ***Execution:*** Test Environment required for execution (e.g., LAB and/or SITE) • ***Scenario's type:*** Provides the type of scenario as described in section 6.4.2.4.1 (e.g., Nominal, Not Nominal or Degraded) • ***Mandatory for interface:*** Defines whether a test procedure is mandatory to validate the reference interface ("SDT-SSB"). The mandatory test procedures represent the minimum set of procedures to be performed to guarantee the execution of all the integration test cases and therefore the validation of the relative interface • ***version:*** Provides test review, management of which is described in section 6.4.2.3.1
<Notes> Free field for any additional information (e.g., logistic or geographical requirements)
<Test Procedure Pre-Condition > System condition required before running test
<Test Scenario> Scenario body, as follows: • ***Test case name and description:*** Provides a unique identifier of the test case (as defined in section 6.4.2.1.2) and a short description

• ***Test step:*** Contains the description of the actions and verifications required for the execution of the test as defined in section 6.4.2.6.2
<Test Procedure Post- Condition > State of the system after running the test.

6.4.2.5.2 Test Case structure

A test case is defined as follows:

<Test Case Name> Provides a unique test identifier as described in section 6.4.2.1.2
<Test Case Descriptions > Identify a brief description of the test objective
<Test Case Summary > It provides information about the witness about the conditions required for its execution, as follows: • ***Function:*** Main features affected by the scenario (e.g., SOM, EOM, MA …) • ***version:*** Provides test review, handling of which is described in section 6.4.2.3.2
<Notes> Free field for any additional information (e.g., logistic or geographical requirements)
<Test Case Pre-Condition > System condition required before running test
<Test Steps> It contains the description of the actions and verifications required for the execution of the test as defined in section 6.4.2.6.2
<Test Case Post- Condition > State of the system after running the test.

6.4.2.6 Test Case Details

6.4.2.6.1 Test Cases

The Test case is a set of conditions or variables through which the test will determine if the System meets the requirements and works correctly.

Each test case is associated with a Test Step and a related covered requirement.

6.4.2.6.2 Test Steps

The Test Step specifies the sequence of actions required for test execution, detailing how to execute the associated test case through instructions to the tester.

Steps can be of three different types:

- **Step: ACTION**
  Step that defines an action that the operator must perform to stimulate the system in order to determine its defined state or condition.
- **Step: EVENT**
  Step that defines an action that the tester must perform via simulator or an event that must be waited for in order to determine a defined state or condition of the system. This step is not necessarily covered by a requirement, but it is a fundamental step to define the status to be verified in the subsequent steps.
- **Step: CHECK**
  Step which defines a check to be performed in order to ensure that the system works correctly in accordance with the reference requirements. Typically, this verification could be related to messages exchanged between the subsystems and/or to the status of the subsystems shown through their interfaces with the operators (HMI, DMI).

Each step provides more details about the requirements covered, as below:

- **Requirements:**
  Reference requirement identifier

Please note that the requirements covered come from the WP5 deliverable as stated in §6 In such deliverable the requirments are defined in related and dedicated section (e.g. §8.1.1.1) so that in this Section the covered requirements have the following naming convention:

REQ_{D5.1 Section number}.

Furthermore, at the end of the execution, each step is defined:

- **Execution ("EXE"):** Step required during test execution (eg Actions to be performed, Events to be created or Checks to be performed on HMi or DMI)
- **Reporting ("REP"):** Step of interest only during Log analysis (eg Check to be performed on the relationships or messages exchanged between subsystems)

An example is the following:

step	Description	Expected Results
1 EXE	**ACTION** ***Requirements*** *[Id_Requirement]*	*[Operation that the system operator must perform]* *[operator does A]*
2 EXE	**EVENT** ***Requirements*** *[Id_Requirement]*	*{Event that the tester must wait for]* *[Wait for B to happen]*
3 EXE / REP	**CHECK** ***Requirements*** *[Id_Requirement]*	*[Check to perform]* *[verifies that C is true]*

6.4.3 Procedures Test

This section provides all the test procedures defined in this document, broken down by their main functionality.

Each test procedure, as described in Section 6.4.2.5.1, is defined as a sequence of test cases.

6.4.3.1 SOM

6.4.3.1.1 VBTS_SOM_001

SoM from invalid or unknown position for a train, upstream of a physical BG, with non-approximate position			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM SR MA	SITE LAB	Nominal	00.00

Notes	

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- Train number and relative position unknown to SSR
- SSB initiates SOM procedure after transition to SB from NP mode
- VBR in Start-Up Configuration (SC) mode (No Power before SOM)
- Between the min SFE and the downstream signal consecutively a physical BG (on which the SSB will locate) and a VBG configured in the Digital Map
- At least the first SBR downstream of the train front is verified as "FS Proved"
- In the SBR immediately after the train there is at least one VBG configured in the Digital Map
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection

4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_007 - SOM Position Report management with invalid or unknown Q_STATUS**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=0 (Invalid) or 2 (Unknown) and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=0/2) with Pkt0
2 EXE	CHECK	RBC receives the SoM Position Report [Msg 157] with Q_STATUS=0 or 2, and considers the train position invalid or unknown and the train icon is not displayed on the RBC QL
3 REP	CHECK	RBC sends Train Accepted message [Msg 41] to SSB, with ACK request [M_ACK=1] RBC -> SSB: Msg41 (M_ACK=1)
4 REP	CHECK	The SSB sends the ACK message [Msg 146] to the [Msg 41] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_002 - Check compatibility of Interface Protocol and Digital Map versions for a VBR in SC, resulting in transition of VBR to SB**	
step	**Description**	**Expected Result**

1 REP	CHECK __________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.3.6	The VBR, having verified the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received from the TV, switches to Stand-By (SB) mode
4 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.1.1 REQ_8.1.2.3	The VBR informs the VT of the compatibility of the Interface Protocol versions and the Digital Map signatures through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") and includes: - the "Reference Position" package [Pkt 44/ 101] with NID_LRBG="unknown"; - the “Position Validation Check Result” package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB (VBR) -> RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITER=0)
5 REP	CHECK __________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_010 - Position initialization and transition to TD for a VBR with invalid or unknown position**	
step	**Description**	**Expected Result**

1 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The SSB sends a Position Report [Msg 136] with Pkt 0 which also includes the packets sent by the VBR: - the packet “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44/100], sent to the TV, with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="1") - the packet “Reference Position” [Pkt 44/101], sent to TV, with NID_LRBG=“unknown”; - the “Position Report Validation Request” packet [Pkt 44/103], sent to the GAD, which contains an empty list (N_ITER=0) of possible positions where the VBR assumes it could be located SSB (VBR) -> RBC (GAD/TV): MSG136 with PKT0, PKT44/100 (NID_VBRPACKET = 100, Q_IFPROTOVERCHKRES = 1 and Q_DBvalidate = 1), PKT44/101 (NID_VBRPACKET = 101, NID_LRBG = 16777215) and PKT44/103 (NID_VBRPACKET = 103, 103, 103, 103, N_iter = 0)
2 REP	CHECK ___________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
3 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
4 REP	CHECK ___________ Requirements REQ_8.1.1.1	GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
5 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
6 REP	CHECK ___________ Requirements REQ_8.1.1.1	The VBR calculates the unsafe approximate position and supplies the GAD with the NID_LRBG of the closest balise identified in the Digital Map through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Reference Position" [Pkt 44/101] with NID_LRBG=”known” and includes: - the “Digital Map and Interface Protocol Compatibility Check Result” package [Pkt 44/100] - the “Position Report Validation Request” package [Pkt 44/103] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0, Pkt44/101 (NID_VBRPACKET=101, NID_LRBG), Pkt44/100 (NID_VBRPACKET=100) and Pkt44/103 (NID_VBRPACKET=103)
7 REP	CHECK ___________ Requirements REQ_8.1.1.1	GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the necessary information for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)

8 REP	CHECK Requirements REQ_8.1.1.1	The VBR calculates the safe position using the navigation data (44/8) and the differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
9 REP	CHECK Requirements REQ_8.1.1.1 REQ_8.1.3.3	The VBR provides the TV with a list of estimated positions on the Digital Map and the related confidence intervals through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0] and the "Position Report Validation Request" packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/103 (NID_VBRPACKET=103, N_ITER>0, NID_LRBG(K), Q_DIRLRBG(K)) and Pkt44/101 (NID_VBRPACKET=101, NID_LRBG)
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_016 - SR authorization for SSB with non-Approximate position**	
step	**Description**	**Expected Result**

1 REP	EVENT	RBC considers the train position NOT "Approximate" since it has not received the relevant train number from SSR.
2 EXE	CHECK	The RBC TO is notified that the conditions for considering the train position "Approximate" are not satisfied.
3 REP	CHECK	RBC sends to the SSB a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72] containing the text message “Position not validated” and without ACK request [M_ACK=0] RBC -> SSB: Msg24 with Pkt72 (M_LEVELTEXTDISPLAY=3, Q_TEXTCONFIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0)
4 EXE	ACTION	The PdC recognizes the text message "Position not validated", displayed on the DMI
5 EXE	ACTION	The PdC selects Start on the DMI
6 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
7 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg 2], with finite distance (D_SR=0) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
9 EXE	ACTION	The SR mode is proposed to the PdC which recognizes it by pressing on the DMI for about 3 seconds (delay type button)
10 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_017 - First assignment of the MA with an OS-FS profile for a train in SR which locates on a physical BG, with consequent transition of the VBR to FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in the first activation window (carrying out the Override procedure if the train is in SR with a travelable distance equal to zero)

2 EXE	CHECK	The advancing train detects a physical BG and sends a PR [Msg 136] in SR (with M_MODE=2) and includes: - the "Position Report Validation Request" packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)
3 EXE	CHECK	The train icon is displayed on the RBC QL which locates the SSB against the received LRBG and verifies that the SSB is located within the first activation window with the min safe front end: - there is no turnout between the min safe front end and the downstream signal - there is no LX start location facing away from the signal
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
5 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
6 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window (up to the joint downstream signal) and FS on subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER= 0 if there are no switches). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET =6, N_ITERS>=0)
7 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
8 EXE	CHECK	The MA is displayed on the RBC QL
9 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
10 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it

11 EXE	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
12 EXE	CHECK	If the SSB is in the OS activation window (100 m from the downstream signal), the text message “EXTENDED MA IN FS” is displayed on the DMI for 30 seconds
TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)
TC	**VBTS_SDT-SSB_033 - OS-FS transition for a train with VBR in FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
2 EXE	ACTION	The PdC moves the train forward into the next SBR by passing the junction downstream of the signal with the mSFE

3 EXE	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- SSB in FS
- VBR in Full Navigation (FN) mode

6.4.3.1.2 VBTS_SOM_002

SoM from invalid or unknown position for a train, upstream of a virtual BG, with approximate position online			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM SR MA	SITE LAB	Not nominal	00.00

Notes	This scenario foresees the failure to detect the VBG downstream of the train (VBR in TD) and the consequent localization on a physical BG: a possible application is with SOM in front of a line signal MGNT817 with localization on the physical PI MGNT-10267-R -01.

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains (P_MAXTRAIN) that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- Line train upstream of a line SBR
- Train number and relative position known to SSR
- SSB initiates SOM procedure after transition to SB from NP mode
- VBR in Start-Up Configuration (SC) mode (No Power before SOM)
- Immediately downstream of the train front and in line with the signal, there is a VBG configured in the Digital Map
- In the line SBR downstream of the train there is at least one physical BG (on which the train will be located) followed by a VBG (e.g., the one in line with the signal)
- At least the first two SBRs downstream of the train front are verified as "FS Proved"
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible

TC	VBTS_SDT-SSB_001 - Activation of a Communication Session	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection

4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_007 - SOM Position Report management with invalid or unknown Q_STATUS**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=0 (Invalid) or 2 (Unknown) and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=0/2) with Pkt0
2 EXE	CHECK	RBC receives the SoM Position Report [Msg 157] with Q_STATUS=0 or 2, and considers the train position invalid or unknown and the train icon is not displayed on the RBC QL
3 REP	CHECK	RBC sends Train Accepted message [Msg 41] to SSB, with ACK request [M_ACK=1] RBC -> SSB: Msg41 (M_ACK=1)
4 REP	CHECK	The SSB sends the ACK message [Msg 146] to the [Msg 41] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_002 - Check compatibility of Interface Protocol and Digital Map versions for a VBR in SC, resulting in transition of VBR to SB**	

step	Description	Expected Result
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and "VBR DataBase Version" (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6	The VBR, having verified the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received from the TV, switches to Stand-By (SB) mode
4 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1 REQ_8.1.2.3	The VBR informs the VT of the compatibility of the Interface Protocol versions and the Digital Map signatures through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") and includes: - the "Reference Position" package [Pkt 44/101] with NID_LRBG="unknown"; - the "Position Validation Check Result" package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB (VBR) -> RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITER=0)
5 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_010 - Position initialization and transition to TD for a VBR with invalid or unknown position**	
step	**Description**	**Expected Result**

1 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The SSB sends a Position Report [Msg 136] with Pkt 0 which also includes the packets sent by the VBR: - the packet “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44/100], sent to the TV, with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="1") - the packet “Reference Position” [Pkt 44/101], sent to TV, with NID_LRBG=“unknown”; - the “Position Report Validation Request” packet [Pkt 44/103], sent to the GAD, which contains an empty list (N_ITER=0) of possible positions where the VBR assumes it could be located SSB (VBR) -> RBC (GAD/TV): MSG136 with PKT0, PKT44/100 (NID_VBRPACKET = 100, Q_IFPROTOVERCHKRES = 1 and Q_DBvalidate = 1), PKT44/101 (NID_VBRPACKET = 101, NID_LRBG = 16777215) and PKT44/103 (NID_VBRPACKET = 103, 103, 103, 103, N_iter = 0)
2 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
3 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
4 REP	CHECK __________ Requirements REQ_8.1.1.1	GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
5 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
6 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR calculates the unsafe approximate position and supplies the GAD with the NID_LRBG of the closest balise identified in the Digital Map through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Reference Position" [Pkt 44/101] with NID_LRBG=”known” and includes: - the “Digital Map and Interface Protocol Compatibility Check Result” package [Pkt 44/100] - the “Position Report Validation Request” package [Pkt 44/103] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0, Pkt44/101 (NID_VBRPACKET=101, NID_LRBG), Pkt44/100 (NID_VBRPACKET=100) and Pkt44/103 (NID_VBRPACKET=103)

7 REP	CHECK __________ Requirements REQ_8.1.1.1	GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the necessary information for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
8 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR calculates the safe position using the navigation data (44/8) and the differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
9 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.3	The VBR provides the TV with a list of estimated positions on the Digital Map and the related confidence intervals through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0] and the "Position Report Validation Request" packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/103 (NID_VBRPACKET=103, N_ITER>0, NID_LRBG(K), Q_DIRLRBG(K)) and Pkt44/101 (NID_VBRPACKET=101, NID_LRBG)
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Ac-knowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL

TC	VBTS_SDT-SSB_014 - SR authorization for SSB with “Approximate” position online	
step	**Description**	**Expected Result**
1 REP	EVENT	RBC considers the train position "Approximate" on the CdB detected busy and congruent with the position received from SSR, having verified that the train number previously received from the SSB (NID_OPERATIONAL in Train running number [Pkt5]) and the train number received from SSR are congruent .
2 EXE	ACTION	The PdC selects Start on the DMI
3 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
4 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg2], with infinite distance (D_SR=32767) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=32767)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]

TC	VBTS_SDT-SSB_035 - Failure to detect a VBG for an SSB in SR with approximate position and with VBR in TD	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) with LRBG “unknown” SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (NID_LRBG=16777215, M_MODE=2) and Pkt44/103 (NID_VBRPACKET= 103)
2 EXE	ACTION	The PdC moves the train forward
3 EXE	EVENT	The train passes with the "VBR virtual antenna" the position where a VBG is foreseen in the Digital Map but the VBR does not detect the VBG being in TD mode
4 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) with LRBG “unknown” SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (NID_LRBG=16777215, M_MODE=2) and Pkt44/103 (NID_VBRPACKET= 103)

TC	VBTS_SDT-SSB_018 - First assignment of the MA with an OS-FS profile for a train in SR whose position previously considered approximated by RBC becomes known for the detection of a physical BG with consequent transition of the VBR to FN	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward
2 EXE	CHECK	The train detects a physical BG and sends a PR [Msg 136] in SR (with M_MODE=2) and includes: - the "Position Report Validation Request" packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)
3 EXE	CHECK	The train icon is displayed on the RBC QL which locates the SSB against the received LRBG and verifies that the SSB is located within the first activation window with the min safe front end: - there is no turnout between the min safe front end and the downstream signal - there is no LX start location facing away from the signal
4 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
5 REP	CHECK ___________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
6 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends to the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window (up to the joint downstream of the signal) and FS on the subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<=L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The MA is displayed on the RBC QL

9 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
10 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
11 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
12 EXE	CHECK	If the SSB is in the OS activation window (100 m from the downstream signal), the text message "EXTENDED MA IN FS" is displayed on the DMI for 30 seconds
TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)
TC	**VBTS_SDT-SSB_033 - OS-FS transition for a train with VBR in FN**	

step	Description	Expected Result
1 REP	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
2 EXE	ACTION	The PdC moves the train forward into the next SBR by passing the junction downstream of the signal with the mSFE
3 EXE	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- SSB in FS with a VBG validated as LRBG
- VBR in Full Navigation (FN) mode

6.4.3.1.3 VBTS_SOM_003

SoM from invalid or unknown position for a train on the station with approximate position in the presence of VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS SOM SR MA	SITE LAB	Nominal	00.00

Notes	

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- Train on a parking CdB (with relative CdB occupied)
- Train number and its position known to SSR
- SSB initiates SOM procedure after transition to SB from NP mode
- VBR in Start-Up Configuration (SC) mode (No Power before SOM)
- The SBR (Departure Route) after the signal in front of the train is considered "FS Proved"
- Only one departure itinerary downstream of the parking CdB is considered "intact"
- Between the min SFE and the downstream signal there is at least one physical BG, different from the one in line with the signal (the train will locate on the physical BG immediately downstream of the FE)
- The SBR downstream of the train includes at least one switch
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155

5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_007 - SOM Position Report management with invalid or unknown Q_STATUS**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=0 (Invalid) or 2 (Unknown) and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=0/2) with Pkt0
2 EXE	CHECK	RBC receives the SoM Position Report [Msg 157] with Q_STATUS=0 or 2, and considers the train position invalid or unknown and the train icon is not displayed on the RBC QL
3 REP	CHECK	RBC sends Train Accepted message [Msg 41] to SSB, with ACK request [M_ACK=1] RBC -> SSB: Msg41 (M_ACK=1)
4 REP	CHECK	The SSB sends the ACK message [Msg 146] to the [Msg 41] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_002 - Check compatibility of Interface Protocol and Digital Map versions for a VBR in SC, resulting in transition of VBR to SB**	
step	**Description**	**Expected Result**

1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6	The VBR, having verified the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received from the TV, switches to Stand-By (SB) mode
4 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1 REQ_8.1.2.3	The VBR informs the VT of the compatibility of the Interface Protocol versions and the Digital Map signatures through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") and includes: - the "Reference Position" package [Pkt 44/101] with NID_LRBG="unknown"; - the “Position Validation Check Result” package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB (VBR) -> RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITER=0)
5 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_010 - Position initialization and transition to TD for a VBR with invalid or unknown position**	
step	**Description**	**Expected Result**

1 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The SSB sends a Position Report [Msg 136] with Pkt 0 which also includes the packets sent by the VBR: - the packet "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44/100], sent to the TV, with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") - the packet "Reference Position" [Pkt 44/101], sent to TV, with NID_LRBG="unknown"; - the "Position Report Validation Request" packet [Pkt 44/103], sent to the GAD, which contains an empty list (N_ITER=0) of possible positions where the VBR assumes it could be located SSB (VBR) -> RBC (GAD/TV): MSG136 with PKT0, PKT44/100 (NID_VBRPACKET = 100, Q_IFPROTOVERCHKRES = 1 and Q_DBvalidate = 1), PKT44/101 (NID_VBRPACKET = 101, NID_LRBG = 16777215) and PKT44/103 (NID_VBRPACKET = 103, 103, 103, 103, N_iter = 0)
2 REP	CHECK ___________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
3 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
4 REP	CHECK ___________ Requirements REQ_8.1.1.1	GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
5 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
6 REP	CHECK ___________ Requirements REQ_8.1.1.1	The VBR calculates the unsafe approximate position and supplies the GAD with the NID_LRBG of the closest balise identified in the Digital Map through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Reference Position" [Pkt 44/101] with NID_LRBG="known" and includes: - the "Digital Map and Interface Protocol Compatibility Check Result" package [Pkt 44/100] - the "Position Report Validation Request" package [Pkt 44/103] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0, Pkt44/101 (NID_VBRPACKET=101, NID_LRBG), Pkt44/100 (NID_VBRPACKET=100) and Pkt44/103 (NID_VBRPACKET=103)

7 REP	CHECK __________ Requirements REQ_8.1.1.1	GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the necessary information for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
8 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR calculates the safe position using the navigation data (44/8) and the differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
9 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.3	The VBR provides the TV with a list of estimated positions on the Digital Map and the related confidence intervals through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0] and the "Position Report Validation Request" packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/103 (NID_VBRPACKET=103, N_ITER>0, NID_LRBG(K), Q_DIRLRBG(K)) and Pkt44/101 (NID_VBRPACKET=101, NID_LRBG)
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL

TC	VBTS_SDT-SSB_015 - SR authorization for SSB with "Approximate" position on station	
step	**Description**	**Expected Result**
1 REP	EVENT	RBC considers the train position "Approximate" on the CdB detected as occupied and congruent with the position received from SSR, having verified that the train number previously received from the SSB (NID_OPERATIONAL in Train running number [Pkt 5]) and the train number received from SSR are congruent.
2 EXE	ACTION	The PdC selects Start on the DMI
3 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
4 REP	CHECK	RBC sends to the SSB a SR Authorization [Msg 2] message, with infinite distance (D_SR=32767) and ACK request [M_ACK=1] and including the List of Balises in SR Authority packet [Pkt 63] with the list of PIs present on the CdB where the position of the train has been approximated and on the downstream SBR (excluding the signal PI, if present, which protects the SBR following the departure itinerary on which the SR Authorization has been assigned and also including any NID_BG associated with SCMT deceleration PI) RBC -> SSB: Msg2 (M_ACK=1 and D_SR=32767) with Pkt63
5 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
6 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_019 - First assignment of the MA with an OS-FS profile for a train in SR whose position previously considered approximated by RBC becomes known on the station for the detection of a physical BG with consequent transition of the VBR to FN**	
step	**Description**	**Expected Result**
1 REP	ACTION	The PdC moves the train forward
2 EXE	CHECK	The train detects a physical BG included in the List of Balises packet in SR Authority [Pkt 63] received and sends a PR [Msg 136] in SR (with M_MODE=2) and includes: - the “Position Report Validation Request” packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)

3 EXE	CHECK	The train icon is displayed on the RBC QL which locates the SSB against the received LRBG and verifies that the SSB is located within the first activation window with the min safe front end: - there is no turnout between the min safe front end and the downstream signal - there is no LX start location facing away from the signal
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
5 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
6 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends to the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered “FS Proved”, and includes the Switch Point Status packet [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION), Pkt44/6 (NID_VBRPACKET =6, N_ITER>0, Q_PTSTATUS(k)=1/2) [e Pkt51]
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The MA is displayed on the RBC QL
9 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
10 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
11 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
12 EXE	CHECK	Text message “EXTENDED MA IN FS” is displayed on the SSB DMI for 30 seconds when the SSB enters the OS activation window (100m from downstream signal)

13 EXE	ACTION	The PdC advances the train into the next SBR
14 EXE	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- Train in FS on the departure itinerary of a DP
- VBR in Full Navigation (FN) mode

6.4.3.1.4 VBTS_SOM_004

SoM from invalid or unknown position for a train with non-approximate position in the presence of VBR with incompatible Interface Protocol version

FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM SR MA	LAB	Degraded	00.00

Notes	This scenario foresees the detection of only physical BGs in SR and OS and requires the presence of two consecutive VBGs in the downstream SBR which must be purely virtual (any physical virtualized buoys must be covered); a possible application is with SOM on cdb 812" in legal parity direction (e.g., train in front of signal VTTN814 with localization on PI VTTN-16058-R/C-814). In case of failure of the compatibility check of the Interface Protocol and/or Digital Map versions between VBR and RBC, the VBR remains in SC and therefore the SSB continues its mission without being able to detect VBG.

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- Train number and relative position unknown to SSR
- Immediately downstream of the train and in the same SBR there are consecutively a physical BG (on which the SSB will be located) and two VBGs configured in the Digital Map
- SSB initiates SOM procedure after transition to SB from NP mode
- VBR in Start-Up Configuration (SC) mode (No Power before SOM)
- At least the first SBR downstream of the train front is verified as "FS Proved"
- Communication between TV and GAD on Channel 0 is active
- The versions of the Interface Protocol and Digital Maps used by GAD and RBC are compatible
- The Interface Protocol versions used by VBR and RBC are not compatible

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection

4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_007 - SOM Position Report management with invalid or unknown Q_STATUS**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=0 (Invalid) or 2 (Unknown) and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=0/2) with Pkt0
2 EXE	CHECK	RBC receives the SoM Position Report [Msg 157] with Q_STATUS=0 or 2, and considers the train position invalid or unknown and the train icon is not displayed on the RBC QL
3 REP	CHECK	RBC sends Train Accepted message [Msg 41] to SSB, with ACK request [M_ACK=1] RBC -> SSB: Msg41 (M_ACK=1)
4 REP	CHECK	The SSB sends the ACK message [Msg 146] to the [Msg 41] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_004 - Management of a VBR with incompatible Interface Protocol version**	

step	Description	Expected Result
1 REP	CHECK __________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR detects the incompatibility of the supported Interface Protocol version with the one received and informs the TV through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="0") SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=0)
4 EXE	CHECK	The text message “Track DB check failed” is displayed on the DMI of the SSB
5 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.3.61	RBC considers the train without an active VBR and consequently the connection channel with the GAD associated with the train is not opened
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146

5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - "Reference Position" [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - "Position Report Validation Request" [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL

TC	**VBTS_SDT-SSB_016 - SR authorization for SSB with non-Approximate position**	
step	**Description**	**Expected Result**
1 REP	EVENT	RBC considers the train position NOT "Approximate" since it has not received the relevant train number from SSR.
2 EXE	CHECK	The RBC TO is notified that the conditions for considering the train position "Ap-proximate" are not satisfied.
3 REP	CHECK	RBC sends to the SSB a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72] containing the text message "Position not validated" and without ACK request [M_ACK=0] RBC -> SSB: Msg24 with Pkt72 (M_LEVELTEXTDISPLAY=3, Q_TEXTCON-FIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0)
4 EXE	ACTION	The PdC recognizes the text message "Position not validated", displayed on the DMI
5 EXE	ACTION	The PdC selects Start on the DMI
6 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
7 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg 2], with finite distance (D_SR=0) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
9 EXE	ACTION	The SR mode is proposed to the PdC which recognizes it by pressing on the DMI for about 3 seconds (delay type button)

10 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_020 - First assignment of the MA with an OS-FS profile for a train in SR which locates on a physical BG, in the presence of VBR in SC mode and considered not active by RBC**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PoC performs the "Override" procedure and moves the train forward
2 EXE	CHECK	The train detects a physical BG and sends a PR [Msg136] in SR (with M_MODE=2) and includes the packet "Digital Map Interface Protocol Check" [Pkt 44/100] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/100 (NID_VBRPACKET=100)
3 EXE	CHECK	The train icon is displayed on the RBC QL which locates the SSB against the received LRBG and verifies that the SSB is located within the first activation window with the min safe front end: - there is no turnout between the min safe front end and the downstream signal - there is no LX start location facing away from the signal
4 REP	CHECK	RBC sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered " FS Proved" and includes the Linking package [Pkt 5] with all the BGs included in the MA (including the VBGs) RBC -> SSB: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt80 (D_MAMODE >=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)

8 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
9 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1) and Pkt44/100 (NID_VBRPACKET=100)
TC	**VBTS_SDT-SSB_040 - Failure to detect a VBG in appointment for a train with VBR considered not active by RBC**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS/OS (with M_MODE=0/1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0/1) and Pkt44/100 (NID_VBRPACKET=100)
2 EXE	ACTION __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The PdC moves the train forward
3 EXE	EVENT __________ Requirements REQ_8.1.1.3	The train passes with the "VBR virtual antenna" the position where an appointment VBG is expected but the VBR does not detect the VBG being in SC mode
4 REP	CHECK __________ Requirements REQ_8.1.1.3	SSB sends a PR [Msg 136] in FS/OS (with M_MODE=0/1) and “Error reporting” [Pkt 4] with M_ERROR=0 (Balise group: linking consistency error) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0/1), Pkt4 (M_ERROR=0) and Pkt44/100 (NID_VBRPACKET=100)
5 EXE	CHECK	An alarm is sent to the RBC operator informing him of the receipt of the Error Reporting [Pkt 4] packet from the SSB (Balise group: linking consistency error)
TC	**VBTS_SDT-SSB_041 - Failure to detect a second consecutive VBG in appointment for a train with non-active VBR**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS/OS (with M_MODE=0/1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0/1) and Pkt44/100 (NID_VBRPACKET=100)
2 EXE	ACTION __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The PdC moves the train forward

3 EXE	EVENT ___________ Requirements REQ_8.1.1.3	The train passes with the "VBR virtual antenna" the position where an appointment VBG is expected but the VBR does not detect the VBG being in SC mode
4 EXE	CHECK	The SSB, having lost the last two PIs in the appointment, applies the Service Brake until the train is stopped
5 REP	CHECK ___________ Requirements REQ_8.1.1.3	The SSB sends a PR [Msg 136] in FS/OS (with M_MODE=0/1) and “Error reporting” [Pkt 4] with M_ERROR=7 (Double linking error) SSB -> RBC: Msg136 with Pkt0 (M_MODE = 0/1), Pkt4 (M_ERROR=7) and Pkt44/100 (NID_VBRPACKET=100)
6 EXE	CHECK	An alarm is sent to the RBC operator informing it of the receipt of the Error Reporting [Pkt 4] packet from the SSB (Double linking error)
7 EXE	CHECK	The PdC confirms that when the train is stopped, the SSB issues the service brake and that the track conditions relating to the MA are no longer displayed on the DMI and the permitted speed is 0 km/h
8 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC with "Reason for MA request sending" valued as "Track description deleted" (Q_MARQSTREASON=10) SSB -> RBC: Msg132 (Q_MARQSTREASON=10) with Pkt0
9 REP	CHECK	RBC re-sends to SSB the MA, currently assigned to the train or an extended MA if possible, with ack request RBC -> SSB: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5
10 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
11 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the MA received

Post condition

- SSB in OS with assigned MA covering in FS at least the SBR immediately downstream of the train
- RBC considers the train without an active VBR (non-compatibility of Interface Protocol and/or Digital Map versions between VBR and RBC)
- VBR is in Start-Up Configuration (SC) mode

6.4.3.1.5 VBTS_SOM_005

SoM from invalid or unknown position for a train with non-approximate position in the presence of VBR with incompatible Digital Maps version			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM SR MA	LAB	Degraded	00.00

Notes	This scenario foresees the detection of only physical BGs in SR and OS and requires the presence of two consecutive VBGs in the downstream SBR which must be purely virtual (any physical virtualized buoys must be covered); a possible application is with SOM on cdb 812" in legal parity direction (e.g., train in front of signal VTTN814 with localization on PI VTTN-16058-R/C-814). In case of failure of the compatibility check of the Interface Protocol and/or Digital Map versions between VBR and RBC, the VBR remains in SC and therefore SSB continues its mission without being able to detect VBG.

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- Train number and relative position not known to SSR
- Immediately downstream of the train and in the same SBR there are consecutively a physical BG (on which the SSB will be located) and two VBGs configured in the Digital Map
- SSB initiates SOM procedure after transition to SB from NP mode
- VBR in Start-Up Configuration (SC) mode (No Power before SOM)
- At least the first SBR downstream of the train front is verified as "FS Proved"
- Communication between TV and GAD on Channel 0 is active
- The versions of the Interface Protocol and Digital Maps used by GAD and RBC are compatible
- VBR and RBC have compatible Interface protocol versions but the Digital Maps versions do not match

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection

4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_007 - SOM Position Report management with invalid or unknown Q_STATUS**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=0 (Invalid) or 2 (Unknown) and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=0/2) with Pkt0
2 EXE	CHECK	RBC receives the SoM Position Report [Msg 157] with Q_STATUS=0 or 2, and considers the train position invalid or unknown and the train icon is not displayed on the RBC QL
3 REP	CHECK	RBC sends Train Accepted message [Msg 41] to SSB, with ACK request [M_ACK=1] RBC -> SSB: Msg41 (M_ACK=1)
4 REP	CHECK	The SSB sends the ACK message [Msg 146] to the [Msg 41] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_005 - Management of a VBR with incompatible Ditigal Maps version**	

step	Description	Expected Result
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR detects the incompatibility of the Digital Map version supported with the one received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="0") SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1, Q_DBVALIDATE =0)
4 EXE	CHECK	The text message “Track DB check failed” is displayed on the DMI of the SSB
5 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train without an active VBR and consequently the connection channel with the GAD associated with the train is not opened

TC	VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146

5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - "Reference Position" [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - "Position Report Validation Request" [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL

TC	VBTS_SDT-SSB_016 - SR authorization for SSB with non-Approximate position	
step	**Description**	**Expected Result**
1 REP	EVENT	RBC considers the train position NOT "Approximate" since it has not received the relevant train number from SSR.
2 EXE	CHECK	The RBC TO is notified that the conditions for considering the train position "Ap-proximate" are not satisfied.
3 REP	CHECK	RBC sends to the SSB a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72] containing the text message "Position not validated" and without ACK request [M_ACK=0] RBC -> SSB: Msg24 with Pkt72 (M_LEVELTEXTDISPLAY=3, Q_TEXTCON-FIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0)
4 EXE	ACTION	The PdC recognizes the text message "Position not validated", displayed on the DMI
5 EXE	ACTION	The PdC selects Start on the DMI
6 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
7 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg 2], with finite distance (D_SR=0) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
9 EXE	ACTION	The SR mode is proposed to the PdC which recognizes it by pressing on the DMI for about 3 seconds (delay type button)

10 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_020 - First assignment of the MA with an OS-FS profile for a train in SR which locates on a physical BG, in the presence of VBR in SC mode and considered not active by RBC**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PoC performs the "Override" procedure and moves the train forward
2 EXE	CHECK	The train detects a physical BG and sends a PR [Msg136] in SR (with M_MODE=2) and includes the packet "Digital Map Interface Protocol Check" [Pkt 44/100] SSB -> RBC: Msg136 with Pkt0 (M_MODE= 2) and Pkt44/100 (NID_VBRPACKET=100)
3 EXE	CHECK	The train icon is displayed on the RBC QL which locates the SSB against the received LRBG and verifies that the SSB is located within the first activation window with the min safe front end: - there is no turnout between the min safe front end and the downstream signal - there is no LX start location facing away from the signal
4 REP	CHECK	RBC sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered " FS Proved" and includes the Linking package [Pkt 5] with all the BGs included in the MA (including the VBGs) RBC -> SSB: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt80 (D_MAMODE >=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)

8 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
9 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1) and Pkt44/100 (NID_VBRPACKET=100)
TC	**VBTS_SDT-SSB_040 - Failure to detect a VBG in appointment for a train with VBR considered not active by RBC**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS/OS (with M_MODE=0/1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0/1) and Pkt44/100 (NID_VBRPACKET=100)
2 EXE	ACTION __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The PdC moves the train forward
3 EXE	EVENT __________ Requirements REQ_8.1.1.3	The train passes with the "VBR virtual antenna" the position where an appointment VBG is expected but the VBR does not detect the VBG being in SC mode
4 REP	CHECK __________ Requirements REQ_8.1.1.3	SSB sends a PR [Msg 136] in FS/OS (with M_MODE=0/1) and “Error reporting” [Pkt 4] with M_ERROR=0 (Balise group: linking consistency error) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0/1), Pkt4 (M_ERROR=0) and Pkt44/100 (NID_VBRPACKET=100)
5 EXE	CHECK	An alarm is sent to the RBC operator informing him of the receipt of the Error Reporting [Pkt 4] packet from the SSB (Balise group: linking consistency error)
TC	**VBTS_SDT-SSB_041 - Failure to detect a second consecutive VBG in appointment for a train with non-active VBR**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS/OS (with M_MODE=0/1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0/1) and Pkt44/100 (NID_VBRPACKET=100)
2 EXE	ACTION __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The PdC moves the train forward

3 EXE	EVENT __________ Requirements REQ_8.1.1.3	The train passes with the "VBR virtual antenna" the position where an appointment VBG is expected but the VBR does not detect the VBG being in SC mode
4 EXE	CHECK	The SSB, having lost the last two PIs in the appointment, applies the Service Brake until the train is stopped
5 REP	CHECK __________ Requirements REQ_8.1.1.3	The SSB sends a PR [Msg 136] in FS/OS (with M_MODE=0/1) and “Error reporting” [Pkt 4] with M_ERROR=7 (Double linking error) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0/1), Pkt4 (M_ERROR=7) and Pkt44/100 (NID_VBRPACKET=100)
6 EXE	CHECK	An alarm is sent to the RBC operator informing it of the receipt of the Error Reporting [Pkt 4] packet from the SSB (Double linking error)
7 EXE	CHECK	The PdC confirms that when the train is stopped, the SSB issues the service brake and that the track conditions relating to the MA are no longer displayed on the DMI and the permitted speed is 0 km/h
8 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC with "Reason for MA request sending" valued as "Track description deleted" (Q_MARQSTREASON=10) SSB -> RBC: Msg132 (Q_MARQSTREASON=10) with Pkt0
9 REP	CHECK	RBC re-sends to SSB the MA, currently assigned to the train or an extended MA if possible, with ack request RBC -> SSB: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5
10 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
11 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the MA received

Post condition

- SSB in OS with assigned MA covering in FS at least the SBR immediately downstream of the train
- RBC considers the train without an active VBR (non-compatibility of Interface Protocol and/or Digital Map versions between VBR and RBC)
- VBR is in Start-Up Configuration (SC) mode

6.4.3.1.6 VBTS_SOM_006

Nominal SoM for a train in line with VBR in full navigation and with virtual LRBG located upstream of the max safe front end of the train			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SUM	SITE LAB	Nominal	00.00

Notes	

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- Virtual LRBG is positioned upstream of the max safe front end of the train
- There are no turnouts taken at the tip of the train orientation between LRBG (upstream of the train) and the max safe front end
- Train in the first activation window of a line SBR (downstream of an EOM)
- At least the first SBR downstream of the train front is verified as "FS Proved"
- Immediately downstream of the train, and in its own SBR, there is at least one VBG configured in the Digital Map
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155

5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_006 - SOM Position Report management with Q_STATUS Valid and with LRBG placed upstream of the max safe front end of the train**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB located and the train icon is displayed on RBC's QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**
1 REP	CHECK Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

3 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the "Position Report Validation Request" [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)

6 REP	CHECK __________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data "acceptable" and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - "Reference Position" [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - "Position Report Validation Request" [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_021 - First assignment of the MA with an OS-FS profile for a train running in SB, with VBR in FN and with LRBG positioned upstream of the train front**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC selects Start on the DMI
2 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132

3 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends to the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET =6, N_ITERS>=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL
6 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
7 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
8 EXE	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
9 EXE	CHECK	If the SSB is in the OS activation window (100 m from the downstream signal), the text message "EXTENDED MA IN FS" is displayed on the DMI for 30 seconds

TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)

3 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK ___________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)

Post condition

- Train in OS, downstream of a validated VBG, with assigned MA covering in FS at least the SBR immediately downstream of the train
- VBR in Full Navigation (FN) mode

6.4.3.1.7 VBTS_SOM_007

Nominal SoM for a stationary train with VBR in Full Navigation and with virtual LRBG located upstream of the train's max safe front end			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS SOM MA	SITE LAB	Nominal	00.00

Notes	This scenario requires the presence of a virtual BG (which the train will detect before performing EOM) and only physical BGs between the mSFE and the departure signal: a possible application is with SOM on the MGNT302 parking cdb in illegal direction (e.g., train immediately downstream of the virtual PI MGNT-10321-R/C-43 and with only physical BGs downstream until signal MGNT23).

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- Virtual LRBG is positioned upstream of the max safe front end of the train
- There are no turnouts taken at the tip of the train orientation between LRBG (upstream of the train) and the max safe front end
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- Train in the first activation window on the station (downstream of an EOM)
- At least the first downstream SBR (departure itinerary) of the SSB front is verified as "FS Proved"
- The T_MISSION timer is not active
- Between the min SFE and the downstream signal there are only physical BGs, including the one on axis to the signal
- The SBR downstream of the train includes at least one switch
- In the SBR immediately downstream of the train and upstream of the switch there is at least one VBG configured in the Digital Map
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB

3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_006 - SOM Position Report management with Q_STATUS Valid and with LRBG placed upstream of the max safe front end of the train**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB located and the train icon is displayed on RBC's QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**

1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the “Position Report Validation Request” [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)

4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
6 REP	CHECK ___________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_022 - First assignment of the MA with an OS-FS profile for a train stationed in SB, with VBR system and with LRBG positioned upstream of the train front**	
step	**Description**	**Expected Result**

1 EXE	ACTION	The PdC selects Start on the DMI
2 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
3 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends to the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered "FS Proved" and includes the Switch Point Status packet [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET =6, N_ITER>0, Q_PTSTATUS(k)=1/2)
4 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	If the VBR is in TD mode, having received the valid position from the SSB and the 44/6 packet, it manages to calculate the safe and unique position and then goes into Full Navigation (FN) state
6 EXE	CHECK	The MA is displayed on the RBC QL
7 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
8 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
9 EXE	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
10 EXE	CHECK	Text message "EXTENDED MA IN FS" is displayed on the SSB DMI for 30 seconds when the SSB enters the OS activation window (100m from downstream signal)
11 EXE	CHECK	In line with the National Values previously received (V_NVONSIGHT=6) the maximum speed allowed in the OS operating mode is 30 km/h
12 EXE	ACTION	The PdC advances the train into the next SBR

13 EXE	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)
Post condition · Train in FS on the departure itinerary with a VBG validated as LRBG · VBR in Full Navigation (FN) mode		

6.4.3.1.8 VBTS_SOM_008

Nominal SOM for a train with VBR in FN located on the station with T_MISSION active and with virtual LRBG placed upstream of the max safe front end of the train			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS SOM MA	SITE LAB	Nominal	00.00

Notes	Scenario with an SSB performing a new SOM Valid after RBC has activated the T_MISSION (300 s), associated with the stationing CDB, following the assignment of the MA in FS (at least until the start signal) and the localization of the SSB in FS on the same CdB. This scenario requires the presence of a virtual BG (which the train will pick up before performing EOM) which allows the train, once picked up, to locate itself entirely on the parking cdb: a possible application is the TRCT302 cdb (e.g., train immediately downstream of the Virtual PI TRCT-11307-R-44 in legal peer direction).

Pre Condition

- SSB in FS with MA assigned up to the PoS protection signal
- LRBG is positioned upstream of the max safe front end of the train
- Station SBR, downstream of the protection signal, presents the formation of the itinerary as the only condition for not being considered "FS Proved"
- The CdB downstream of the starting signal is in the "Free" state
- The parking CDB of the arrival itinerary downstream of the train has at least one VBG configured in the Digital Map at least the length of the train from the joint
- At least one switch is included in the arrival and departure itineraries downstream of the train front
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_023 - T_MISSION activation for an SSB in FS and VBR in FN which locates on station following an extension of the MA up to the starting signal**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The signalman forms the station route(s) to allow the train to arrive at the staging area
3 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132

4 REP	CHECK __________ Requirements REQ_8.1.3.3	Once the MA extension conditions have been verified on the SBR of the station downstream of the train front considered "FS proved", RBC sends the SSB a Movement Authority message [Msg 3] with request for ACK (M_ACK = 1), which covers the SBR of downstream station with "Full Supervision" profile and includes the Switch Point Status package [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k)=1/2)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
7 EXE	CHECK	The MA, which includes the arrival itinerary, is displayed on the RBC QL
8 EXE	ACTION	The PdC makes the train move forward until it locates entirely on the station
9 EXE	CHECK	RBC fully locates the train in FS mode on the parking CdB and activates the associated T_MISSION timer

TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)

4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)
TC	**VBTS_SDT-SSB_043 - Nominal EoM procedure for an SSB with assigned MA, in the presence of a VBR system**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC, with the train stopped, carries out the EoM procedure
2 REP	CHECK	SSB sends End of Mission message [Msg150] to RBC SSB -> RBC: Msg150
3 REP	CHECK	RBC starts the de-registration of the SSB by sending a General Message [Msg24] which contains the Packet Session Management [Pkt42] with the Q_RBC variable equal to zero (0) and with the RBC identifier and telephone number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
4 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
5 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
6 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
7 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
8 REP	CHECK	RBC releases the association between the SSB NID_ENGINE and the signal
TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)

2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_006 - SOM Position Report management with Q_STATUS Valid and with LRBG placed upstream of the max safe front end of the train**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB located and the train icon is displayed on RBC's QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**

1 REP	CHECK __________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the “Position Report Validation Request” [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK __________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)

4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
6 REP	CHECK __________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_024 - First assignment of the MA in FS for a train on the station with VBR in FN and with T_MISSION active and LRBG positioned upstream of the train front**	
step	**Description**	**Expected Result**

1 EXE	ACTION	The DCO forms the departure itinerary downstream of the train
2 EXE	ACTION	The PdC selects Start on the DMI
3 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
4 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an FS profile on the first activation window and on the subsequent SBRs considered " FS Proved" and includes the Switch Point Status packet [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k)=1/2)
5 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 EXE	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- Train in FS on the station with MA that covers at least the departure itinerary
- VBR is in Full Navigation (FN) mode

6.4.3.1.9 VBTS_SOM_009

Loss of Safe Connection between RBC and an SSB in FS with VBR in FN and subsequent rated SOM			
FUNCTION	**Execution**	**Scenario's Type**	**version**
MA SOM COM	LAB	Degraded	00.00

Notes	For an SSB making a new Valid SOM after a connection drop while in FS, RBC maintains the association between the SSB's NID_ENGINE and the signal immediately downstream of the SSB. Following the EoM procedure carried out during an interruption of the safe connection, the SSB tries three times (every 15 seconds) to send msg150 (UNISIG SUBSET 026-Rev. 3.6.2, par 5.5.4.1.1) and , not having received a reply, must terminate the session by sending msg156 (UNISIG SUBSET 026-Rev. 3.6.2, par 5.5.4.1.1.1); following the three sendings of msg156 (UNISIG SUBSET 026-Rev. 3.6.2, par 3.5.5.3.1) without response, the SSB considers the session terminated (UNISIG SUBSET 026-Rev. 3.6.2, par 3.5.5.3 .2). Consequently, for the test scenario, before executing the SOM procedure immediately after the EOM, it is necessary to wait at least 120 seconds for the previous session to be considered terminated.

Pre Condition

- Communication session between RBC and SSB successfully established
- Train in FS with assigned MA which also covers the subsequent SBRs
- Train located by RBC in the first activation window
- Virtual LRBG is positioned upstream of the max safe front end of the train
- There are no turnouts taken at the tip of the train orientation between LRBG (upstream of the train) and the max safe front end
- The NID_ENGINE associated with the signal immediately downstream of the train front corresponds to the NID_ENGINE of the SSB
- All CdBs between the one occupied by the min safe front end of the train and the signal immediately downstream of the train front end are found to be free
- At least the first SBR downstream of the SSB front is verified as "FS Proved"
- Train stationary immediately upstream of a VBG configured in the Digital Map
- RBC-GAD communication channel open and uniquely assigned to the train number
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_025 - Loss of Safe Connection between RBC and an SSB in FS with VBR in FN and subsequent new connection request in SB**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	EVENT	Loss of the RBC-SSB radio link
3 EXE	CHECK	RBC detects the failure of the Safe Connection with the SSB and activates the T_RESTORE (300 seconds)

4 EXE	CHECK	The T_NVCONTACT expires (7 seconds) and the SSB, with the train stopped, reduces the current MA on the train front
5 EXE	ACTION	The PdC carries out the EoM procedure
6 EXE	ACTION	The PdC starts a new SOM
7 EXE	EVENT	The Safe Connection with the SSB is re-established within the T_RESTORE
8 REP	CHECK	RBC associates the Safe Connection with the still active "Communication Session" and deactivates the T_RESTORE timer
9 REP	CHECK ___________ Requirements REQ_8.1.3.8	The communication channel between RBC-GAD associated with the specific train is considered still active
10 REP	CHECK	RBC releases the association between the NID_ENGINE of the SSB and the signal, for all signals except the one immediately downstream of the SSB
11 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
12 REP	CHECK	RBC sends RBC/RIU System Version [Msg 32] message to SSB with ACK request [M_ACK=1] RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
13 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
14 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the message Session Established [Msg 159], considers the Communication Session active SSB -> RBC: Msg159
15 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57, Pkt58 and Pkt3
16 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_006 - SOM Position Report management with Q_STATUS Valid and with LRBG placed upstream of the max safe front end of the train**	
step	**Description**	**Expected Result**

1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB located and the train icon is displayed on RBC's QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and "VBR DataBase Version" (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the "Position Report Validation Request" [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	
step	**Description**	**Expected Result**

1 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
6 REP	CHECK __________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode

TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146

5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - "Reference Position" [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - "Position Report Validation Request" [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_027 - First assignment of the MA with a profile of FS on the first activation window and on the subsequent SBRs following loss of Safe Connection for a train with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC selects Start on the DMI
2 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
3 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an FS profile on the first activation window and on the subsequent SBRs considered " FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL
6 EXE	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**

1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)
Post condition · Train in FS with a VBG validated as LRBG · VBR in Full Navigation (FN) mode		

6.4.3.1.10 VBTS_SOM_010

Loss of Safe Connection between RBC and an SSB in OS with VBR in FN and subsequent rated SOM			
FUNCTION	**Execution**	**Scenario's Type**	**version**
MA SOM COM	LAB	Degraded	00.00

Notes	Following the EoM procedure carried out during an interruption of the safe connection, the SSB tries three times (every 15 seconds) to send msg150 (UNISIG SUBSET 026-Rev. 3.6.2, par 5.5.4.1.1) and , not having received a reply, must terminate the session by sending msg156 (UNISIG SUBSET 026-Rev. 3.6.2, par 5.5.4.1.1.1); following the three sendings of msg156 (UNISIG SUBSET 026-Rev. 3.6.2, par 3.5.5.3.1) without response, the SSB considers the session terminated (UNISIG SUBSET 026-Rev. 3.6.2, par 3.5.5.3 .2). Consequently, for the test scenario, before executing the SOM procedure immediately after the EOM, it is necessary to wait at least 120 seconds for the previous session to be considered terminated.

Pre Condition

- Communication session between RBC and SSB successfully established
- SSB in OS with MA assigned in FS covering at least next SBR
- Train located by RBC in the first activation window
- Virtual LRBG is positioned upstream of the max safe front end of the train
- There are no turnouts taken at the tip of the train orientation between LRBG (upstream of the train) and the max safe front end
- All CdBs between the one occupied by the min safe front end of the train and the signal immediately downstream of the train front end are found to be free
- At least the first SBR downstream of the SSB front is verified as "FS Proved"
- Train stationary immediately upstream of a VBG configured in the Digital Map
- RBC-GAD communication channel open and uniquely assigned to the train number
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_026 - Loss of Safe Connection between RBC and an SSB in OS with VBR in FN and subsequent new connection request in SB**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
2 EXE	EVENT	Loss of the RBC-SSB radio link
3 EXE	CHECK	RBC detects the failure of the Safe Connection with the SSB and activates the T_RESTORE (300 seconds)
4 EXE	CHECK	The T_NVCONTACT expires (7 seconds) and the SSB, with the train stopped, reduces the current MA on the train front
5 EXE	ACTION	The PdC carries out the EoM procedure

6 EXE	ACTION	The PdC starts a new SOM
7 EXE	EVENT	The Safe Connection with the SSB is re-established within the T_RESTORE
8 REP	CHECK	RBC associates the Safe Connection with the still active "Communication Session" and deactivates the T_RESTORE timer
9 REP	CHECK ___________ Requirements REQ_8.1.3.8	The communication channel between RBC-GAD associated with the specific train is considered still active
10 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
11 REP	CHECK	RBC sends RBC/RIU System Version [Msg 32] message to SSB with ACK request [M_ACK=1] RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
12 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
13 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the message Session Established [Msg 159], considers the Communication Session active SSB -> RBC: Msg159
14 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57, Pkt58 and Pkt3
15 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_006 - SOM Position Report management with Q_STATUS Valid and with LRBG placed upstream of the max safe front end of the train**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB located and the train icon is displayed on RBC's QL

TC	VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the “Position Report Validation Request” [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train

TC	VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

3 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
6 REP	CHECK __________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode

TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL

TC	VBTS_SDT-SSB_028 - First assignment of the MA with an OS-FS profile following loss of Safe Connection for a train with VBR in FN	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC selects Start on the DMI
2 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
3 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends to the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and in FS on the subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL
6 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
7 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
8 EXE	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)

TC	VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)	
step	**Description**	**Expected Result**
1 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".

2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)

Post condition

- SSB in OS with MA assigned in FS covering at least next SBR
- Downstream train of a validated VBG
- VBR in Full Navigation (FN) mode

6.4.3.1.11 VBTS_SOM_011

SOM valid, in the presence of VBR system, for a train with ambiguous position due to the presence of a facing point between LRBG and max safe front end			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM SR MA	SITE LAB	Not nominal	00.00

Notes	In this scenario, the VBR is in SB mode following the EOM procedure performed in the previous mission with the train stationary after passing the facing point and checking the Digital Map Integrity.

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- LRBG is positioned upstream of the max safe front end of the train
- There is a facing point (Digital Map integrity already verified) between LRBG and the max safe front end of the train
- Immediately downstream of the train and in its own SBR, there are consecutively a VBG and a physical BG
- At least the first SBR downstream of the train front is verified as "FS Proved"
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible
- Communication between TV and GAD on Channel 0 is active
- VBR in Stand-By (SB) mode (Full Navigation in previous mission)

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155

5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_008 - SOM Position Report management with Q_STATUS Valid for a train, equipped with VBR system, with ambiguous position**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB not located due to the presence of a facing point between the LRBG and the max safe front end of the train: the train icon is not displayed on the RBC QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

3 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the "Position Report Validation Request" [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK __________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)

6 REP	CHECK __________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_016 - SR authorization for SSB with non-Approximate position**	
step	**Description**	**Expected Result**
1 REP	EVENT	RBC considers the train position NOT "Approximate" since it has not received the relevant train number from SSR.
2 EXE	CHECK	The RBC TO is notified that the conditions for considering the train position "Approximate" are not satisfied.

3 REP	CHECK	RBC sends to the SSB a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72] containing the text message "Position not validated" and without ACK request [M_ACK=0] RBC -> SSB: Msg24 with Pkt72 (M_LEVELTEXTDISPLAY=3, Q_TEXTCONFIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0)
4 EXE	ACTION	The PdC recognizes the text message "Position not validated", displayed on the DMI
5 EXE	ACTION	The PdC selects Start on the DMI
6 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
7 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg 2], with finite distance (D_SR=0) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
9 EXE	ACTION	The SR mode is proposed to the PdC which recognizes it by pressing on the DMI for about 3 seconds (delay type button)
10 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - "Reference Position" [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - "Position Report Validation Request" [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_036 - Failure to detect a VBG for an SSB in SR with non-approximate position and with VBR in TD**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PoC performs the "Override" procedure and moves the train forward
2 REP	CHECK	The train sends a PR [Msg 136] in SR (with M_MODE=2) which includes the packet "Position Validation Check Result" [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)

3 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
4 REP	CHECK ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The VBR, being in Track Discrimination mode, does not detect the virtual BG

TC	**VBTS_SDT-SSB_017 - First assignment of the MA with an OS-FS profile for a train in SR which locates on a physical BG, with consequent transition of the VBR to FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in the first activation window (carrying out the Override procedure if the train is in SR with a travelable distance equal to zero)
2 EXE	CHECK	The advancing train detects a physical BG and sends a PR [Msg 136] in SR (with M_MODE=2) and includes: - the "Position Report Validation Request" packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)
3 EXE	CHECK	The train icon is displayed on the RBC QL which locates the SSB against the received LRBG and verifies that the SSB is located within the first activation window with the min safe front end: - there is no turnout between the min safe front end and the downstream signal - there is no LX start location facing away from the signal
4 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
5 REP	CHECK ___________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)

6 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window (up to the joint downstream signal) and FS on subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER= 0 if there are no switches). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MA-MODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET =6, N_ITERS>=0)
7 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
8 EXE	CHECK	The MA is displayed on the RBC QL
9 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
10 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
11 EXE	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
12 EXE	CHECK	If the SSB is in the OS activation window (100 m from the downstream signal), the text message “EXTENDED MA IN FS” is displayed on the DMI for 30 seconds

TC	**VBTS_SDT-SSB_033 - OS-FS transition for a train with VBR in FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
2 EXE	ACTION	The PdC moves the train forward into the next SBR by passing the junction down-stream of the signal with the mSFE
3 EXE	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- Train in FS
- VBR in Full Navigation (FN) mode

6.4.3.1.12 VBTS_SOM_012

SOM not valid for a train with VBR without GPS coverage			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM SR MA	LAB	Degraded	00.00

Notes	This scenario envisages the detection of only physical BGs in SR and OS: a possible application is with SOM in front of a protection signal (e.g., train in front of signal MGNT01 with localization on PI MGNT-16049-R/C-01).

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- Train number and relative position not known to SSR
- Between the min SFE and the downstream signal there are only physical BGs, including the one on axis to the signal (the SSB will locate on the physical BG immediately downstream of the FE)
- In the SBR immediately after the train there is at least one VBG configured in the Digital Map
- At least the first SBR downstream of the train front is verified as "FS Proved"
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible
- GPS coverage not present for the VBR
- VBR in Start-Up Configuration (SC) mode

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155

5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

TC	**VBTS_SDT-SSB_007 - SOM Position Report management with invalid or unknown Q_STATUS**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=0 (Invalid) or 2 (Unknown) and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=0/2) with Pkt0
2 EXE	CHECK	RBC receives the SOM Position Report [Msg 157] with Q_STATUS=0 or 2, and considers the train position invalid or unknown and the train icon is not displayed on the RBC QL
3 REP	CHECK	RBC sends Train Accepted message [Msg 41] to SSB, with ACK request [M_ACK=1] RBC -> SSB: Msg41 (M_ACK=1)
4 REP	CHECK	The SSB sends the ACK message [Msg 146] to the [Msg 41] SSB -> RBC: Msg146

TC	**VBTS_SDT-SSB_002 - Check compatibility of Interface Protocol and Digital Map versions for a VBR in SC, resulting in transition of VBR to SB**	
step	**Description**	**Expected Result**

1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6	The VBR, having verified the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received from the TV, switches to Stand-By (SB) mode
4 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1 REQ_8.1.2.3	The VBR informs the VT of the compatibility of the Interface Protocol versions and the Digital Map signatures through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") and includes: - the "Reference Position" package [Pkt 44/101] with NID_LRBG="unknown"; - the “Position Validation Check Result” package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB (VBR) -> RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITER=0)
5 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_012 - Location initialization failure for a VBR with invalid or unknown location due to no GPS coverage**	
step	**Description**	**Expected Result**

1 REP	CHECK ________ Requirements REQ_8.1.1.1	The SSB sends a Position Report [Msg 136] with Pkt 0 which also includes the packets sent by VBR: - the Reference Position packet [Pkt 44/101], sent to the TV, with NID_LRBG= “unknown”; - the Position Report Validation Request [Pkt 44/103] packet, sent to the GAD, which contains an empty list (N_ITER=0) of possible positions where the VBR assumes it could be located - the "Digital Map and Interface Protocol Compatibility" packet Check Result” [Pkt 44/100], sent to TV, with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="1") SSB (VBR) - > RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITERS=0)
2 REP	CHECK ________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
3 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
4 REP	CHECK ________ Requirements REQ_8.1.1.1	GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) ->SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
5 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
6 REP	CHECK ________ Requirements REQ_8.1.1.1	The VBR, due to lack of GPS coverage, cannot calculate the unsafe approximate position and therefore remains in Stand-By (SB) mode
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)

2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_016 - SR authorization for SSB with non-Approximate position**	
step	**Description**	**Expected Result**
1 REP	EVENT	RBC considers the train position NOT "Approximate" since it has not received the relevant train number from SSR.
2 EXE	CHECK	The RBC TO is notified that the conditions for considering the train position "Approximate" are not satisfied.
3 REP	CHECK	RBC sends to the SSB a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72] containing the text message “Position not validated” and without ACK request [M_ACK=0] RBC -> SSB: Msg24 with Pkt72 (M_LEVELTEXTDISPLAY=3, Q_TEXTCONFIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0)
4 EXE	ACTION	The PdC recognizes the text message "Position not validated", displayed on the DMI
5 EXE	ACTION	The PdC selects Start on the DMI
6 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132

7 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg 2], with finite distance (D_SR=0) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
9 EXE	ACTION	The SR mode is proposed to the PdC which recognizes it by pressing on the DMI for about 3 seconds (delay type button)
10 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - "Reference Position" [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - "Position Report Validation Request" [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_030 - First assignment of the MA with an OS-FS profile for a train in SR which locates on a physical BG with consequent transition of the VBR from SB to FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PoC performs the "Override" procedure and moves the train forward
2 EXE	CHECK	The train receives a physical PI and sends a PR [Msg 136] in SR (with M_MODE=2) and includes: - the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1"); - the "Reference Position" package [Pkt 44/101] with NID_LRBG="unknown"; - the "Position Validation Check Result" package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB -> RBC: msg136 with pkt0 (m_mode = 2), pkt44/100 (nid_vbrpacket = 100, q_ifprotoverchkres = 1 and q_dbvalidate = 1), pkt44/101 (nid_vbrpacket = 101, nid_lrbg = 16777215) and pkt44/103 _VBRPACKET = 103, N_ITER=0)
3 EXE	CHECK	The train icon is displayed on the RBC QL which locates the SSB against the received LRBG and verifies that the SSB is located within the first activation window with the min safe front end: - there is no turnout between the min safe front end and the downstream signal - there is no LX start location facing away from the signal
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state

5 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
6 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
7 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered " FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITERS>=0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
9 EXE	CHECK	The MA is displayed on the RBC QL
10 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
11 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
12 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
13 EXE	CHECK	Text message “EXTENDED MA IN FS” is displayed on the SSB DMI for 30 seconds when the SSB enters the OS activation window (100m from downstream signal)
14 EXE	ACTION	The PdC advances the train into the next SBR

15 EXE	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_039 - Detection of a VBG for a train with VBR in Full Navigation (FN) without GPS coverage for the VBR**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] which includes: - the pkt0 with the NID_LRBG of the detected VBG - the "GNSS Position Integrity" packet [Pkt 44/105], in case the VBR has a PVT whose integrity not yet checked SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)

Post condition

- Train in FS with a VBG as LRBG
- GPS coverage not present for the VBR
- VBR in Full Navigation (FN) mode

6.4.3.1.13 VBTS_SOM_013

SOM for an unlocated train with VBR in TD following the Digital Map integrity failure during the previous mission			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM SR MA	SITE LAB	Not nominal	00.00

Notes	This scenario is executable following the failure of the Digital Map integrity due to the passing of a switch in SR following the Override procedure (which causes the cancellation of the information contained in the Switch Point Status [pkt 44/6]). A possible application for this scenario is with a train on cdb VTTN164 immediately downstream of facing point PNT19.

Pre Condition

- SSB in SR after the Override procedure
- LRBG is positioned upstream of the max safe front end of the train
- There is a facing point between LRBG and the max safe front end of the train
- The train passed the facing point in SR
- Immediately downstream of the train there is a VBG and a physical BG
- At least the first SBR downstream of the train front is verified as "FS Proved"
- VBR in Track Discrimination (TD) mode due to Digital Map Integrity Failure

TC	**VBTS_SDT-SSB_044 - Nominal EoM procedure for an SSB in SR, in the presence of a VBR system**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC, with the train stopped, carries out the EoM procedure
2 REP	CHECK	SSB sends End of Mission message [Msg150] to RBC SSB -> RBC: Msg150
3 REP	CHECK	RBC starts the de-registration of the SSB by sending a General Message [Msg24] which contains the Packet Session Management [Pkt42] with the Q_RBC variable equal to zero (0) and with the RBC identifier and telephone number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
4 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
5 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
6 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended

7 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
8 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR, no longer receiving the differential corrections [pkt 44/3] for at least 30 seconds (timer T_MAX_EXP_AG_TIME=30 s expired), is no longer able to calculate the safe 3D GNSS position and goes into Stand By (SB) mode
TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)

9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_008 - SOM Position Report management with Q_STATUS Valid for a train, equipped with VBR system, with ambiguous position**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB not located due to the presence of a facing point between the LRBG and the max safe front end of the train: the train icon is not displayed on the RBC QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the “Position Report Validation Request” [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK __________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	

step	Description	Expected Result
1 REP	CHECK ___________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
6 REP	CHECK ___________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)

4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_016 - SR authorization for SSB with non-Approximate position**	
step	**Description**	**Expected Result**
1 REP	EVENT	RBC considers the train position NOT "Approximate" since it has not received the relevant train number from SSR.
2 EXE	CHECK	The RBC TO is notified that the conditions for considering the train position "Ap-proximate" are not satisfied.
3 REP	CHECK	RBC sends to the SSB a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72] containing the text message “Position not validated” and without ACK request [M_ACK=0] RBC -> SSB: Msg24 with Pkt72 (M_LEVELTEXTDISPLAY=3, Q_TEXTCON-FIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0)
4 EXE	ACTION	The PdC recognizes the text message "Position not validated", displayed on the DMI
5 EXE	ACTION	The PdC selects Start on the DMI
6 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
7 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg 2], with finite distance (D_SR=0) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
9 EXE	ACTION	The SR mode is proposed to the PdC which recognizes it by pressing on the DMI for about 3 seconds (delay type button)

10 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - "Reference Position" [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - "Position Report Validation Request" [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_036 - Failure to detect a VBG for an SSB in SR with non-approximate position and with VBR in TD**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PoC performs the "Override" procedure and moves the train forward
2 REP	CHECK	The train sends a PR [Msg 136] in SR (with M_MODE=2) which includes the packet "Position Validation Check Result" [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)
3 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
4 REP	CHECK __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The VBR, being in Track Discrimination mode, does not detect the virtual BG
TC	**VBTS_SDT-SSB_017 - First assignment of the MA with an OS-FS profile for a train in SR which locates on a physical BG, with consequent transition of the VBR to FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in the first activation window (carrying out the Override procedure if the train is in SR with a travelable distance equal to zero)
2 EXE	CHECK	The advancing train detects a physical BG and sends a PR [Msg 136] in SR (with M_MODE=2) and includes: - the "Position Report Validation Request" packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)

3 EXE	CHECK	The train icon is displayed on the RBC QL which locates the SSB against the received LRBG and verifies that the SSB is located within the first activation window with the min safe front end: - there is no turnout between the min safe front end and the downstream signal - there is no LX start location facing away from the signal
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
5 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
6 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window (up to the joint downstream signal) and FS on subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER= 0 if there are no switches). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET =6, N_ITERS>=0)
7 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
8 EXE	CHECK	The MA is displayed on the RBC QL
9 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
10 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
11 EXE	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
12 EXE	CHECK	If the SSB is in the OS activation window (100 m from the downstream signal), the text message “EXTENDED MA IN FS” is displayed on the DMI for 30 seconds

Post condition
· Train in OS with MA in FS covering at least the SBR downstream of the train · VBR in Full Navigation (FN) mode

6.4.3.1.14 VBTS_SOM_014

SOM not valid for a train with VBR in Full Navigation and with virtual LRBG located downstream of the min safe front end of the train			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM SR MA	LAB	Not nominal	00.00
Notes			

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains (P_MAXTRAIN) that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- Before EOM, the train has detected virtual LRBG in both directions (EOM performed after detecting back-ward LRBG)
- Virtual LRBG is positioned downstream of the train front and on the same SBR where the train is located
- There are no switches between the min safe front end of the train and the LRBG
- Train in the first activation window of a line SBR (downstream of an EOM)
- At least the first SBR (line or station) downstream of the SSB front is verified as "FS Proved"
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible
- Communication between TV and GAD on Channel 0 is active
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection re-quest (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_EN-GINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155

5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_009 - SOM Position Report management with invalid Q_STATUS due to the detection of a VBG in both directions**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB, having picked up the virtual LRBG more than once (due to a backward movement of the train), does not consider the reference position of the VBG to be valid for the SOM and sends the SOM Position Report [Msg 157] message to RBC with Q_STATUS= 0 (Invalid) with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=0) with Pkt0
2 EXE	CHECK __________ Requirements REQ_8.1.1.1	RBC receives the SOM Position Report [Msg 157] with Q_STATUS=0, and considers the train position invalid or unknown and the train icon is not displayed on the RBC QL
3 REP	CHECK	RBC sends Train Accepted message [Msg 41] to SSB, with ACK request [M_ACK=1] RBC -> SSB: Msg41 (M_ACK=1)
4 REP	CHECK	The SSB sends the ACK message [Msg 146] to the [Msg 41] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**

1 REP	CHECK __________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with “VBTS Inter-face Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the “Position Report Validation Request” [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALI-DATE=1) [and Pkt 44/103]
4 REP	CHECK __________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)

4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
6 REP	CHECK __________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_016 - SR authorization for SSB with non-Approximate position**	
step	**Description**	**Expected Result**

1 REP	EVENT	RBC considers the train position NOT "Approximate" since it has not received the relevant train number from SSR.
2 EXE	CHECK	The RBC TO is notified that the conditions for considering the train position "Approximate" are not satisfied.
3 REP	CHECK	RBC sends to the SSB a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72] containing the text message “Position not validated” and without ACK request [M_ACK=0] RBC -> SSB: Msg24 with Pkt72 (M_LEVELTEXTDISPLAY=3, Q_TEXTCONFIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0)
4 EXE	ACTION	The PdC recognizes the text message "Position not validated", displayed on the DMI
5 EXE	ACTION	The PdC selects Start on the DMI
6 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
7 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg 2], with finite distance (D_SR=0) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
9 EXE	ACTION	The SR mode is proposed to the PdC which recognizes it by pressing on the DMI for about 3 seconds (delay type button)
10 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_029 - First assignment of the MA with an OS-FS profile for a train, with VBR in FN, which locates on a VBG following the Override procedure**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PoC performs the "Override" procedure and moves the train forward
2 REP	CHECK	The train sends a PR [Msg 136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)

3 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
5 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
6 EXE	CHECK	The train icon is displayed on the RBC QL which locates the SSB against the received LRBG and verifies that the SSB is located within the first activation window with the min safe front end: - there is no turnout between the min safe front end and the downstream signal - there is no LX start location facing away from the signal
7 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
8 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered " FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITERS>=0)
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 EXE	CHECK	The MA is displayed on the RBC QL

11 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
12 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
13 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
14 EXE	CHECK	Text message “EXTENDED MA IN FS” is displayed on the SSB DMI for 30 seconds when the SSB enters the OS activation window (100m from downstream signal)
15 EXE	CHECK	In line with the National Values previously received (V_NVONSIGHT=6) the maximum speed allowed in the OS operating mode is 30 km/h
16 EXE	ACTION	The PdC advances the train into the next SBR
17 EXE	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- Train in FS
- LRBG is positioned upstream of the train front
- VBR in Full Navigation (FN) mode

6.4.3.1.15 VBTS_SOM_015

SOM from invalid or unknown position for a train with approximate position on line that picks up two physical PIs with single balise			
FUNCTION	**Execution**	**Scenario's Type**	**version**
Pkt1 SOM SR MA	LAB	Degraded	00.00

Notes	

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- SSB initiates SOM procedure after transition to SB from NP mode
- Line train upstream of a line SBR
- Train number and its position known to SSR
- Immediately downstream of the train, and in its own SBR, there are two consecutive single balise physical PIs
- Train in the first activation window
- At least the first SBR downstream of the train front is verified as "FS Proved"
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible
- VBR in Start-Up Configuration (SC) mode (No Power before SOM)

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155

5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_007 - SOM Position Report management with invalid or unknown Q_STATUS**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=0 (Invalid) or 2 (Unknown) and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=0/2) with Pkt0
2 EXE	CHECK	RBC receives the SOM Position Report [Msg 157] with Q_STATUS=0 or 2, and considers the train position invalid or unknown and the train icon is not displayed on the RBC QL
3 REP	CHECK	RBC sends Train Accepted message [Msg 41] to SSB, with ACK request [M_ACK=1] RBC -> SSB: Msg41 (M_ACK=1)
4 REP	CHECK	The SSB sends the ACK message [Msg 146] to the [Msg 41] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_002 - Check compatibility of Interface Protocol and Digital Map versions for a VBR in SC, resulting in transition of VBR to SB**	
step	**Description**	**Expected Result**

1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6	The VBR, having verified the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received from the TV, switches to Stand-By (SB) mode
4 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1 REQ_8.1.2.3	The VBR informs the VT of the compatibility of the Interface Protocol versions and the Digital Map signatures through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") and includes: - the "Reference Position" package [Pkt 44/101] with NID_LRBG="unknown"; - the “Position Validation Check Result” package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB (VBR) -> RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITER=0)
5 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_010 - Position initialization and transition to TD for a VBR with invalid or unknown position**	
step	**Description**	**Expected Result**

1 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The SSB sends a Position Report [Msg 136] with Pkt 0 which also includes the packets sent by the VBR: - the packet "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44/100], sent to the TV, with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") - the packet "Reference Position" [Pkt 44/101], sent to TV, with NID_LRBG="unknown"; - the "Position Report Validation Request" packet [Pkt 44/103], sent to the GAD, which contains an empty list (N_ITER=0) of possible positions where the VBR assumes it could be located SSB (VBR) -> RBC (GAD/TV): MSG136 with PKT0, PKT44/100 (NID_VBRPACKET = 100, Q_IFPROTOVERCHKRES = 1 and Q_DBvalidate = 1), PKT44/101 (NID_VBRPACKET = 101, NID_LRBG = 16777215) and PKT44/103 (NID_VBRPACKET = 103, 103, 103, 103, N_iter = 0)
2 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
3 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
4 REP	CHECK __________ Requirements REQ_8.1.1.1	GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) ->SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
5 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
6 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR calculates the unsafe approximate position and supplies the GAD with the NID_LRBG of the closest balise identified in the Digital Map through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Reference Position" [Pkt 44/101] with NID_LRBG="known" and includes: - the "Digital Map and Interface Protocol Compatibility Check Result" package [Pkt 44/100] - the "Position Report Validation Request" package [Pkt 44/103] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0, Pkt44/101 (NID_VBRPACKET=101, NID_LRBG), Pkt44/100 (NID_VBRPACKET=100) and Pkt44/103 (NID_VBRPACKET=103)
7 REP	CHECK __________ Requirements REQ_8.1.1.1	GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the necessary information for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)

8 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR calculates the safe position using the navigation data (44/8) and the differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
9 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.3	The VBR provides the TV with a list of estimated positions on the Digital Map and the related confidence intervals through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0] and the "Position Report Validation Request" packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/103 (NID_VBRPACKET=103, N_ITER>0, NID_LRBG(K), Q_DIRLRBG(K)) and Pkt44/101 (NID_VBRPACKET=101, NID_LRBG)
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_014 - SR authorization for SSB with “Approximate” position online**	
step	**Description**	**Expected Result**

1 REP	EVENT	RBC considers the train position "Approximate" on the CdB detected busy and congruent with the position received from SSR, having verified that the train number previously received from the SSB (NID_OPERATIONAL in Train running number [Pkt5]) and the train number received from SSR are congruent .
2 EXE	ACTION	The PdC selects Start on the DMI
3 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
4 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg2], with infinite distance (D_SR=32767) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=32767)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_042 - Localization of a train in SR, in the presence of a VBR system, which picks up two physical PIs with single balise**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) and includes the package “Position Validation Check Result” [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET =103)
2 EXE	ACTION	The PdC moves the train forward
3 EXE	EVENT	The SSB detects a single balise of a physical PI (NID_LRBG = "A")
4 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) with the Position Report based on two Balise Groups [Pkt1] packet referring to a single balise of the LRBG and with PRVLRBG "unknown" SSB -> RBC: Msg136 with Pkt1 (NID_LRBG=“A”, NID_PRVLRBG =“unknown”, Q_DIRLRBG=2, Q_DLRBG=2, Q_DIRTRAIN=2, V_TRAIN>0, M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)
5 EXE	EVENT	The SSB detects a new single balise of a physical PI (NID_LRBG = "B")

6 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) with the Position Report based on two Balise Groups [Pkt1] packet referring to a single balise of the LRBG and with PRVLRBG "known" SSB -> RBC: Msg136 with Pkt1 (NID_LRBG="B", NID_PRVLRBG ="A", Q_DIRLRBG=1, Q_DLRBG=1, Q_DIRTRAIN=1, V_TRAIN>0, M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)
7 EXE	CHECK	RBC considers the PR valid and the SSB located and the train icon is displayed on RBC's QL
8 REP	CHECK Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
9 REP	CHECK Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG="B ", NID_PRVLRBG="A", D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
10 REP	CHECK	RBC obtains the direction of travel of the train from its configuration of the line (checking the position of the PIs to which the NID_LRBG and NID_PRVLRBG variables refer) and sends the "Assignment of coordinate system" message to the SSB with ACK request (M_ACK=1) [Train orientation according to LRBG] RBC -> SSB: Msg45 (M_ACK=1; Q_ORIENTATION=1) [Train orientation opposite to LRBG] RBC -> SSB: Msg45 (M_ACK=1; Q_ORIENTATION=0)
11 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
12 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) with the [Pkt0] [Train orientation according to LRBG] SSB -> RBC: Msg136 with Pkt0 (NID_LRBG="B", Q_DIRLRBG=1, Q_DLRBG=1, Q_DIRTRAIN=1, V_TRAIN>0, M_MODE=2) [Train orientation opposite to LRBG] SSB -> RBC: Msg136 with Pkt0 (NID_LRBG="B", Q_DIRLRBG=0, Q_DLRBG=0, Q_DIRTRAIN=0, V_TRAIN>0, M_MODE=2)
TC	**VBTS_SDT-SSB_031 - First assignment of the MA with an OS-FS profile for a train in SR located by RBC and consequent transition of the VBR to FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=2)

2 REP	Check ________ REQ_8.1.3.3	RBC sends to the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window (up to the joint downstream of the signal) and FS on the subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, and Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<=L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
3 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
4 EXE	CHECK	The MA is displayed on the RBC QL
5 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
6 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
7 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
8 EXE	CHECK	If the SSB is in the OS activation window (100 m from the downstream signal), the text message “EXTENDED MA IN FS” is displayed on the DMI for 30 seconds
9 EXE	ACTION	The PdC advances the train into the next SBR
10 EXE	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- Train in FS
- VBR in Full Navigation (FN) mode

6.4.3.1.16 VBTS_SOM_076

SOM from position valid for a train, equipped with VBR system, having unacceptable train data			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM	LAB	Not nominal	00.00

Notes	When RBC receives the "Validated Train Data", it must verify their acceptability, and if these are not, being unable to send any authorization to the train, it must order its disconnection. RBC also evaluates trani data compatibility against the SBR specification.

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- SSB initiates SOM procedure after transition to SB from NP mode
- LRBG is positioned upstream of the max safe front end of the train
- There are no turnouts taken at the tip of the train orientation between LRBG (upstream of the train) and the max safe front end
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)

6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_006 - SOM Position Report management with Q_STATUS Valid and with LRBG placed upstream of the max safe front end of the train**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB located and the train icon is displayed on RBC's QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**
1 REP	CHECK Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

3 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and “VBR Data Base Version Validation Result” (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the “Position Report Validation Request” [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train

TC	**VBTS_SDT-SSB_141 - Management of unacceptable Validated Train Data on the SBR where the SSB is located**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters unacceptable or incompatible train data with the SBR where the train is located
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg129] with the packet Position Report [Pkt0] and Validated train data [Pkt11] SSB -> RBC: Msg129 with Pkt0 and Pkt11
3 REP	CHECK	If RBC considers the train data "not compatible" with the SBR where the train is located but "acceptable" among the line parameters, it sends the SSB the message Acknowledgment of Train Data [Msg8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	The SSB sends the ACK message [Msg146] related to Msg8 SSB -> RBC: Msg146
5 REP	CHECK	RBC sends to the SSB a General Message [Msg24] with ACK request (M_ACK = 1), with a Packet for sending plain text messages [Pkt72] with the driver's confirmation request (Q_TEXTCONFIRM=1) and Q_TEXTREPORT= 1 containing the message with the information of the incompatible parameter RBC -> SSB: Msg24 with Pkt72 (Q_TEXTCLASS=1, Q_TEXTDISPLAY=1, D_TEXTDISPLAY=32767, M_MODETEXTDISPLAY =15, M_LEVELTEXTDISPLAY=5, L_TEXTDISPLAY=32767, T_TEXTDISPLAY=1023, M_MODETEXTDISPL AY =15, M_LEVELTEXTDISPLAY=5, Q_TEXTCONFIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=1, NID_TEXMESSAGE)
6 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

7 EXE	ACTION	The PdC recognizes the text message displayed on the DMI with the information of the incompatible parameter
8 REP	CHECK	The SSB sends the RBC the message Text Message Acknowledged by Driver [Msg158] SSB -> RBC: Msg158 (NID_TEXMESSAGE) with Pkt0
9 REP	CHECK	RBC sends the SSB to the SSB an order to release the Communication Session, by sending a General Message [Msg24] containing the [Pkt42] without ACK request, which includes Q_RBC = 0, the identity of RBC, the telephone number RBC and activate timer T_WAITTERM RBC -> SSB: Msg24 with Pkt42 (Q_DIR=2, Q_RBC=0, Q_SLEEPSESSION=1)
10 REP	CHECK	SSB sends RBC message Termination of the Communication Session [Msg156] SSB -> RBC: Msg156
11 REP	CHECK	RBC stops sending the vitality message and deactivates the timer T_WAITTERM and sends the train the SSB message the message Acknowledgment of Termination of a Communication Session [Msg39] and considers the communication session terminated RBC -> SSB: Msg39
12 EXE	CHECK	The message for validated train data "INACCEPTABLE" is notified on the RBC TO
13 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
Post condition · Communication session between RBC and SSB terminated · The communication channel between RBC and GAD assigned to the train is closed · VBR in Full Navigation (FN) mode		

6.4.3.2 PdS

6.4.3.2.1 VBTS_PdS_016

Nominal gear in a PM with verification of the integrity of the Digital Map for an SSB in FS and VBR in FN with management of the Danger Point and Overlap			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	SITE LAB	Nominal	00.00

Notes	

Pre Condition

- SSB in FS, located on the SBR immediately upstream of the warning signal of a PoS (PM)
- SSB with MA assigned until warning signal
- The line SBR downstream of the train front presents the input signal in the closed state, as the only missing condition to be considered "FS Proved"
- Arrival and departure itineraries downstream of the train front not formed
- The starting signal of the DP includes both Danger Point and Overlap (eg the point to be protected is included in the exit zone)
- There is at least one facing point in the arrival and departure itinerary
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_046 - Extension of the MA in FS, for an SSB with VBR in FN, up to the protection signal of the PO in front of the train with Danger Point**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The signalman cancels the closure of the warning signal of the PO in front of the train
2 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=1/0)
3 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC activates the MA extension process given that the MA extension conditions in FS are verified on the SBR immediately upstream of the DP and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with "On Sight" / "Full Supervision" profile and the SBR immediately upstream of the DP with "Full Supervision" profile and includes: - the Level 2 package /3 Movement Authority [Pkt15] which indicates the presence of a Danger Point associated with the MA, having distance D_DP from the EoA - the Switch Point Status packet [Pkt 44/6], sent from the TV to the VBR, which contains an empty list (N_ITER =0) of switches included in MA RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION, Q_DANGERPOINT=1, D_DP>0, V_RELEASEDP=126, Q_OVERLAP=0), Pkt27, Pkt21 , Pkt5, Pkt44/6 (NID_VBRPACKET=6, N_ITER=0) [and Pkt80]

4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
6 EXE	CHECK	The updated MA is displayed on the RBC QL
7 EXE	ACTION	The PdC moves the train forward into the next SBR and approaches the guard signal (train as close as possible to the guard signal)
8 EXE	CHECK	The PdC confirms that the correct release speed (associated with the Danger Point) is displayed on the DMI in the "Area for speed information"
9 EXE	CHECK	RBC receives from the SSB a PR [Msg136] in FS (with M_MODE=0) such as to locate it with the edge near the SSB protection signal -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_047 - Extension of the MA in FS up to the starting signal of the running track with Danger Point and Overlap for an SSB in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO activates the station itinerary on the running track downstream of the train front by selecting the DP entry signal as the origin point and the DP departure signal as the final point
2 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
3 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC activates the MA extension process given that the MA extension conditions are verified in FS on the station SBR relating to the arrival itinerary of the PoS and sends to the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front and the subsequent SBR relating to the arrival itinerary of the DP with the "Full Supervision" profile and includes: - the Level 2/3 Movement package Authority [Pkt15] which indicates the presence of a Danger Point associated with the MA, placed in correspondence with the point to be protected, having D_DP distance from the EoA and release speed calculated on board, and an Overlap associated with the MA, having D_OL distance from the EoA (i.e. equal to the exit zone) and with timer T_OL which assumes the value foreseen by the configuration of the station system to be activated when the initiation joint of the parking CdB is passed (D_STARTOL from EoA) - the Switch Point Status packet [Pkt 44/ 6], sent from the VT to the VBR, which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION, Q_DANGERPOINT=1, D_DP>0, V_RELEASEDP=126, Q_OVERLAP=1, T_OL>0, D_STARTOL>0, V_RELEASEOL=126, D_OL>0), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k)=1/2)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
6 EXE	CHECK	The updated MA is displayed on the RBC QL
TC	**VBTS_SDT-SSB_063 - Digital Map integrity check for an SSB with VBR in FN that has passed a facing point**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC makes the train move forward until it passes the facing point with the VBR Virtual Antenna
2 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
3 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
TC	**VBTS_SDT-SSB_059 - Expiration of the Overlap availability time-out for an SSB in FS, in the presence of a VBR system, stopped on the parking CDB**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train on the parking CdB
2 REP	EVENT	The SSB activates the timer T_OL (validity time of the overlap) having exceeded the D_STARTOL indicated in the previously received Pkt15 (start joint of the parking CdB)
3 REP	CHECK	The SSB sends a PR [Msg136] in FS (with M_MODE=0) to the RBC locating with the edge on the stationing CDB -> RBC: Msg136 with Pkt0 (M_MODE=0)
4 EXE	ACTION	The PdC moves the train forward approaching the departure signal and stops the train on the stationing CDB (train as close as possible to the departure signal and totally localized on the stationing CDB)
5 EXE	EVENT	When the train is stopped, the SSB resets the time-out T_OL, even if it has not previously expired and considers the overlap as not available

6 EXE	CHECK	Due to unavailability of the overlap, the Supervised Location (SL) is updated and is defined by the Danger Point (therefore placed at a distance from the EoA of D_DP) and the DP confirms that the "speed profile" on the DMI in the "Area for planning information" is updated with release speed associated with the Danger Point
7 REP	CHECK	The SSB sends a PR [Msg136] in FS (with M_MODE=0) to RBC locating with the edge near the start signal SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_048 - Extension of the MA in FS beyond the starting signal of the PO for a SBB in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO activates the departure itinerary by selecting the origin point corresponding to the departure signal and the final point of the station SBR
2 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
3 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC activates the MA extension process given that the MA extension conditions in FS are verified and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front , which covers the SBR occupied by the train front, the subsequent SBR relating to the departure itinerary of the DP, and any downstream SBR considered "FS proved", with a "Full Supervision" profile and includes the Switch Point Status package [Pkt 44/ 6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k)=1/2)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
6 EXE	CHECK	The updated MA is displayed on the RBC QL
7 EXE	ACTION	The PoC drives the train past the PoS starting signal
8 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_063 - Digital Map integrity check for an SSB with VBR in FN that has passed a facing point**	
step	**Description**	**Expected Result**

1 EXE	ACTION	The PdC makes the train move forward until it passes the facing point with the VBR Virtual Antenna
2 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with "Point status identifier" (M_PTSTATUSID) and "Point Identifier" (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
3 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")

Post condition

- SSB in FS, located downstream of the starting signal of a PO and downstream of a facing point
- VBR in Full Navigation (FN) mode

6.4.3.2.2 VBTS_PdS_017

Extension of the MA for an SSB in FS on a station SBR and subsequent failure of the integrity of the Digital Map following the passing of a facing point downstream of the Override procedure			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	SITE LAB	Not nominal	00.00

Notes	

Pre Condition

- SSB in FS, located in the line SBR immediately upstream of the protection signal of a PoS (PM)
- SSB with MA assigned up to protection signal with Danger Point
- Arrival and departure itineraries downstream of the train not formed
- The station SBR immediately downstream of the train includes at least one facing point
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_045 - Extension of the MA in FS up to the starting signal with Danger Point and possible Overlap for an SSB in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The DCO activates the station itinerary downstream of the train front by selecting the DP entry signal as the origin point and the DP departure signal as the final point
3 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
4 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC activates the MA extension process given that the MA extension conditions are verified in FS on the station SBR relating to the arrival itinerary of the PoS and sends to the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front and the subsequent SBR relating to the arrival itinerary of the DP with "Full Supervision" profile and includes the Switch Point Status package [Pkt 44 /6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION, Q_DANGERPOINT=1, D_DP>0, V_RELEASEDP=126, Q_OVERLAP=0/1), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTA-TUS(k)=1/2)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

6 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
7 EXE	CHECK	The updated MA is displayed on the RBC QL
8 EXE	ACTION	The PoC drives the train past the PoS protection signal
9 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_065 - Failure of the integrity of the Digital Map, for an SSB with VBR in FN, due to passing an unknown facing point following the Override procedure and consequent transition of the VBR to TD**	
step	**Description**	**Expected Result**
1 EXE	ACTION	If not already stopped, the PdC stops the train immediately upstream of the facing point and carries out the Override procedure
2 EXE	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
3 EXE	ACTION	The PdC moves the train beyond the facing point
4 REP	CHECK	The VBR, detecting that the MaxSafeAntenna (corresponding to the position of the VBR Virtual Antenna increased by the confidence interval, default 30m) of the train has passed a facing-point with position unknown to the SSB, considers the Digital Map Navigation Integrity failed and switches to Track Discrimination (TD)
5 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) and includes the package “Position Report Validation Request” [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET =103)
6 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
7 REP	CHECK	The VBR, not being able to uniquely determine a single path of the Digital Map, discards the "Position Report Validation Request" [pkt 44/5] received from the TV and remains in TD mode

Post condition

- SSB in SR, located beyond the protection signal of a PO and downstream of a facing point
- VBR in Track Discrimination (TD) mode due to Digital Map Integrity Failure

6.4.3.2.3 VBTS_PdS_018

Failure of the integrity of the Digital Map following the passing of a facing point for a train that has passed, following an Override procedure, a protection signal located at Via Impedita			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	LAB	Not nominal	00.00

Notes	

Pre Condition

- SSB in FS, located in the line SBR immediately upstream of the protection signal of a PoS (PM)
- SSB with MA assigned up to protection signal with Danger Point
- Arrival and departure itineraries downstream of the train not formed
- The station SBR immediately downstream of the train includes at least one facing point
- Immediately downstream of the facing point there is a VBG configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_066 - Failure of the integrity of the Digital Map due to passing a facing-point not included in the MA and consequent transition of the VBR to TD with failure to detect a VBG**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The PoC moves the train towards its EoA and approaches the guard signal stopping the train less than D_NVOVTRP (200 m) from the signal
3 EXE	ACTION	The HP carries out the Override procedure
4 EXE	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
5 EXE	ACTION	The PdC advances the train into the next station SBR and beyond the facing-point
6 REP	CHECK	The VBR, detecting that the MaxSafeAntenna (corresponding to the position of the VBR Virtual Antenna increased by the confidence interval, default 30m) of the train has passed a facing-point with position unknown to the SSB, considers the Digital Map Navigation Integrity failed and switches to Track Discrimination (TD)
7 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".

8 REP	CHECK ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The VBR, being in Track Discrimination mode, does not detect the virtual BG
9 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) and includes the package “Position Report Validation Request” [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET =103)
10 REP	CHECK ___________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
11 REP	CHECK	The VBR, not being able to uniquely determine a single path of the Digital Map, discards the "Position Report Validation Request" [pkt 44/5] received from the TV and remains in TD mode
Post condition · SSB in SR, located beyond the protection signal of a PoS and downstream of an undetected VBG · VBR in Track Discrimination (TD) mode due to Digital Map Integrity Failure		

6.4.3.2.4 VBTS_PdS_019

Failure of the integrity of the Digital Map for an SSB in TR that has passed a facing-point and subsequent re-evaluation of the MA for an SSB in SR due to Override command			
FUNCTION	**Execution**	**Scenario's Type**	**version**
DP EMU MA	SITE LAB	Nominal	00.00

Notes	The execution of the test requires that the train is moving at high speed in such a way that, after the activation of the single train emergency, it passes the facing point and the down-stream VBG during emergency braking. Therefore, this scenario requires that downstream of the facing point there is a VBG at a distance such as to allow the train to pass it during emergency braking: a possible applica-tion is with the train on the odd track in the legal direction, located on cdb VTTN113 a up-stream of the PNT21 and the VBG VTTN-10367-R-43; or, by train on the even track in the legal direction, located on the cdb VTTN164 upstream of the PNT19 and the VBG VTTN-10364-R-812.

Pre Condition

- Train in FS with assigned MA which also covers subsequent SBRs (at least one station SBR including a facing-point)
- At least the first SBR beyond the facing point is considered "FS Proved"
- Immediately downstream of the facing point there is a virtual BG
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_068 - Failure of the Digital Map integrity and failure to detect a VBG for an SSB in TR, for an emergency activation command to the single train, which passed a facing point during emergency braking**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train towards the facing point
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 EXE	ACTION	The RBC Operator through the RBC TO carries out an "Emergency activation of single train" command
4 REP	CHECK	RBC sends Unconditional Emergency Stop message [Msg16] to train RBC -> SSB: Msg16 (NID_EM=0)
5 EXE	CHECK	The PdC confirms that the DMI shows the message "Unconditional emergency" and the "brake intervention symbol"
6 EXE	CHECK	The emergency condition for the train is displayed on the operator interface

7 EXE	CHECK	The Train receives the [Msg16], switches to TRIP and sends a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)
8 REP	CHECK	The train sends the ACK message to the unconditional emergency [Msg147] with Q_EMERGENCYSTOP = 2 SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=2) with Pkt0 (M_MODE=7)
9 REP	CHECK	RBC receives [Msg147] with Q_EMERGENCYSTOP = 2 and stops sending [Msg16]
10 EXE	EVENT	During emergency braking, the train passes the facing point with the MaxSFE
11 REP	CHECK	The VBR, detecting that the MaxSafeAntenna (corresponding to the position of the VBR Virtual Antenna increased by the confidence interval, default 30m) of the train has passed a facing-point with position unknown to the SSB, considers the Digital Map Navigation Integrity failed and switches to Track Discrimination (TD)
12 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	When braking, the train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
13 REP	CHECK __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The VBR, being in Track Discrimination mode, does not detect the virtual BG
14 EXE	ACTION	The PdC, with the train stopped, recognizes the Trip on the DMI
15 EXE	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8) and Pkt44/103 (NID_VBRPACKET=103)
16 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK re-quest RBC -> SSB: Msg6 (M_ACK=1)
17 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_049 - Assignment of the MA with OS-FS profile and consequent transition of VBR to FN for an SSB in SR following the Override procedure and VBR in TD**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PoC performs the "Override" procedure and moves the train forward in the first activation window

2 EXE	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)
3 REP	CHECK	RBC verifies that the SSB is located within the first activation window with the min safe front end and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE >=0, M_MAMODE=0, L_MA-MODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB and the 44/6 packet, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
6 EXE	CHECK	The MA is displayed on the RBC QL
7 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
8 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
9 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)

Post condition

- Train in OS with MA assigned in FS on downstream SBRs
- VBR in Full Navigation (FN) mode

6.4.3.2.5 VBTS_PdS_020

Running through the yield track of a PM for an SSB in FS and VBR in FN with Danger Point and Overlap management			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	SITE LAB	Nominal	00.00

Notes	

Pre Condition

- SSB in FS, located on the SBR immediately upstream of the warning signal of a PoS (PM with precedence)
- SSB with MA assigned until warning signal
- The line SBR downstream of the train front presents the input signal in the closed state, as the only missing condition to be considered "FS Proved"
- Arrival and departure itineraries downstream of the train front not formed
- The starting signal of the PO on the yield track includes both Danger Point and Overlap (eg the point to be protected is included in the exit zone)
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_046 - Extension of the MA in FS, for an SSB with VBR in FN, up to the protection signal of the PO in front of the train with Danger Point**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The signalman cancels the closure of the warning signal of the PO in front of the train
2 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=1/0)
3 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC activates the MA extension process given that the MA extension conditions in FS are verified on the SBR immediately upstream of the DP and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with "On Sight" / "Full Supervision" profile and the SBR immediately upstream of the DP with "Full Supervision" profile and includes: - the Level 2 package /3 Movement Authority [Pkt15] which indicates the presence of a Danger Point associated with the MA, having distance D_DP from the EoA - the Switch Point Status packet [Pkt 44/6], sent from the TV to the VBR, which contains an empty list (N_ITER =0) of switches included in MA RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION, Q_DANGERPOINT=1, D_DP>0, V_RELEASEDP=126, Q_OVERLAP=0), Pkt27, Pkt21 , Pkt5, Pkt44/6 (NID_VBRPACKET=6, N_ITER=0) [and Pkt80]
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
6 EXE	CHECK	The updated MA is displayed on the RBC QL
7 EXE	ACTION	The PdC moves the train forward into the next SBR and approaches the guard signal (train as close as possible to the guard signal)
8 EXE	CHECK	The PdC confirms that the correct release speed (associated with the Danger Point) is displayed on the DMI in the "Area for speed information"
9 EXE	CHECK	RBC receives from the SSB a PR [Msg136] in FS (with M_MODE=0) such as to locate it with the edge near the SSB protection signal -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_050 - Extension of the MA in FS up to the starting signal of a yield track with Danger Point and Overlap for an SSB in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO activates the diverted station itinerary downstream of the train front by selecting the DP entry signal as the origin point and a DP track priority departure signal as the final point
2 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
3 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC activates the MA extension process given that the MA extension conditions in FS are verified on the station SBR relating to the arrival itinerary on a priority track of the PdS and sends the SSB a Movement Authority message [Msg3] with request to ACK (M_ACK = 1) and with "Full Supervision" profile and includes: - the International Static Speed Profile package [Pkt27] which includes the variations of the static speed profiles (V_STATIC) included in the extended MA (in particular on the deviation) with Q_FRONT=0 indicating that the speed must be applied along the entire length of the train - the Level 2/3 Movement Authority packet [Pkt15] which indicates the presence of a Danger Point associated with the MA, placed in correspondence with the point to be protected, having distance D_DP from EoA and release speed calculated on board, and an Overlap associated with the MA, having distance D_OL from EoA and with timer T_OL which assumes the value envisaged by the configuration of the station system to be activated when the start joint of the CdB is exceeded (D_STARTOL from EoA) - the Switch Point Status packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION, Q_DANGERPOINT=1, D_DP>0, V_RELEASEDP=126, Q_OVERLAP=1, T_OL>0, D_STARTOL>0, D_OL>0, V_RELEASEOL=126), Pkt27 (V_STATIC, Q_FRONT=0), Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k)=1/2)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
6 EXE	CHECK	The updated MA is displayed on the RBC QL
TC	**VBTS_SDT-SSB_064 - Digital Map integrity check for an SSB in FS with VBR in FN that has passed a facing point on a detour route**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC makes the train move forward until it passes the facing point with the VBR Virtual Antenna
2 REP	CHECK Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
3 REP	CHECK Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
4 EXE	ACTION	The PdC moves the train on the detour
5 EXE	CHECK	Consistent with the previously received Pkt27 (Q_FRONT=0) the speed profile on the detour is applied for the entire length of the train, i.e. until the train completely tails the detour
TC	**VBTS_SDT-SSB_059 - Expiration of the Overlap availability time-out for an SSB in FS, in the presence of a VBR system, stopped on the parking CDB**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train on the parking CdB
2 REP	EVENT	The SSB activates the timer T_OL (validity time of the overlap) having exceeded the D_STARTOL indicated in the previously received Pkt15 (start joint of the parking CdB)
3 REP	CHECK	The SSB sends a PR [Msg136] in FS (with M_MODE=0) to the RBC locating with the edge on the stationing CDB -> RBC: Msg136 with Pkt0 (M_MODE=0)
4 EXE	ACTION	The PdC moves the train forward approaching the departure signal and stops the train on the stationing CDB (train as close as possible to the departure signal and totally localized on the stationing CDB)

5 EXE	EVENT	When the train is stopped, the SSB resets the time-out T_OL, even if it has not previously expired and considers the overlap as not available
6 EXE	CHECK	Due to unavailability of the overlap, the Supervised Location (SL) is updated and is defined by the Danger Point (therefore placed at a distance from the EoA of D_DP) and the DP confirms that the "speed profile" on the DMI in the "Area for planning information" is updated with release speed associated with the Danger Point
7 REP	CHECK	The SSB sends a PR [Msg136] in FS (with M_MODE=0) to RBC locating with the edge near the start signal SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_048 - Extension of the MA in FS beyond the starting signal of the PO for a SBB in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO activates the departure itinerary by selecting the origin point corresponding to the departure signal and the final point of the station SBR
2 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
3 REP	CHECK ——————— Requirements REQ_8.1.3.3	RBC activates the MA extension process given that the MA extension conditions in FS are verified and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front , which covers the SBR occupied by the train front, the subsequent SBR relating to the departure itinerary of the DP, and any downstream SBR considered "FS proved", with a "Full Supervision" profile and includes the Switch Point Status package [Pkt 44/ 6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k)=1/2)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
6 EXE	CHECK	The updated MA is displayed on the RBC QL
7 EXE	ACTION	The PoC drives the train past the PoS starting signal
8 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_064 - Digital Map integrity check for an SSB in FS with VBR in FN that has passed a facing point on a detour route**	

step	Description	Expected Result
1 EXE	ACTION	The PdC makes the train move forward until it passes the facing point with the VBR Virtual Antenna
2 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with "Point status identifier" (M_PTSTATUSID) and "Point Identifier" (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
3 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
4 EXE	ACTION	The PdC moves the train on the detour
5 EXE	CHECK	Consistent with the previously received Pkt27 (Q_FRONT=0) the speed profile on the detour is applied for the entire length of the train, i.e. until the train completely tails the detour

Post condition

- SSB in FS, located downstream of the starting signal of a PO and downstream of a facing point
- VBR in Full Navigation (FN) mode

6.4.3.2.6 VBTS_PdS_021

Integrity failure of the Digital Map during travel in SR in a PoS with variation of the maximum speed due to the detection of an NV type PI and subsequent TR due to the receipt of the "Stop if in Staff Responsible" packet			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS	SITE LAB	Not nominal	00.00

Notes	The execution of this scenario requires the following sequence of PIs: SR/A, NV, R (VBG), SR/A (any intermediate PIs do not affect the execution of the test). (eg legal peer on the Novara-RHO section with start of tests on the stationing of MGNT301).

Pre Condition

- Train stopped in FS on a parking CdB (less than D_NVOVTR=200 m from the starting signal immediately downstream)
- The two departure signals downstream of the train front are at obstruction
- Downstream of the train there are at least one SR/A, NV type PI, a VBG and a SR/A type PI
- In the SBR immediately downstream of the train, and upstream of the NV type PI, there is a facing point
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_060 - Management of the Override procedure, for an SSB in FS with VBR in FN which picks up an SR/A type PI**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PoC performs the "Override" procedure and moves the train forward
2 EXE	CHECK	The Override symbol is displayed on the DMI
3 EXE	CHECK	The train sends a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
4 EXE	CHECK	The SSB, within 60 s (T_NVOVTRP), while advancing, detects an SR/A type PI which includes the "Stop if in SR" Packet (Pkt137) PI -> SSB: Pkt3 (V_NVSTFF=6), Pkt46 (M_LEVELTR=3) , Pkt137 (Q_SRSTOP=0) and Pkt255
5 EXE	CHECK	In line with the previously received National values (V_NVSTFF=6) the maximum speed allowed in the SR operating mode is 30 km/h
6 REP	CHECK	After receiving an SR/A type PI, the Override procedure ends and the train sends a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
7 EXE	CHECK	The PdC confirms that the train is in SR and the Override symbol is no longer displayed on the DMI

TC	VBTS_SDT-SSB_069 - Failure of the Digital Map Integrity for an SSB in SR that passes a facing-point with unknown position and consequent transition of the VBR in TD	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
2 EXE	ACTION	The PdC moves the train beyond the facing point
3 REP	CHECK	The VBR, detecting that the MaxSafeAntenna (corresponding to the position of the VBR Virtual Antenna increased by the confidence interval, default 30m) of the train has passed a facing-point with position unknown to the SSB, considers the Digital Map Navigation Integrity failed and switches to Track Discrimination (TD)

TC	VBTS_SDT-SSB_061 - Speed reduction allowed for an SSB in SR with VBR in TD which detects a PI of type NV and consequent transition of the VBR to FN	
step	**Description**	**Expected Result**
1 EXE	CHECK	The SSB, advancing, detects a PI of type NV PI -> SSB: Pkt3 (V_NVSTFF=2), Pkt72 (M_MODETEXTDISPLAY=2, Q_TEXTCONFIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0) , Pkt145 and Pkt255
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
3 EXE	CHECK	The PdC recognizes the text message "speed reduction to 10 km/h" displayed on the DMI
4 EXE	CHECK	In line with the previously received National values (V_NVSTFF=2) the maximum speed allowed in the SR operating mode is 10 km/h
5 REP	CHECK	The train sends a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)

TC	VBTS_SDT-SSB_021 - First assignment of the MA with an OS-FS profile for a train running in SB, with VBR in FN and with LRBG positioned upstream of the train front	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC selects Start on the DMI
2 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132

3 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends to the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered “FS Proved” and includes the “Switch Point Status” packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET =6, N_ITERS>=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL
6 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
7 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
8 EXE	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
9 EXE	CHECK	If the SSB is in the OS activation window (100 m from the downstream signal), the text message “EXTENDED MA IN FS” is displayed on the DMI for 30 seconds

TC	**VBTS_SDT-SSB_062 - Transition to TR for an SSB in SR with VBR in FN which detects a PI containing the "Stop if in Staff Responsible" package**	
step	**Description**	**Expected Result**
1 EXE	CHECK	The SSB, advancing, detects a PI of type SR/A which includes the Packet "Stop if in SR" (Pkt137) PI -> SSB: Pkt3 (V_NVSTFF=6), Pkt46 (M_LEVELTR=3), Pkt137 (Q_SRSTOP=0) and Pkt255
2 EXE	CHECK	The Train switches to TRIP and sends a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)
3 EXE	ACTION	The PdC, with the train stopped, recognizes the Trip on the DMI
4 EXE	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)

5 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK request RBC -> SSB: Msg6 (M_ACK=1)
6 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
Post condition · SSB in PT · VBR in Full Navigation (FN) mode		

6.4.3.2.7 VBTS_PdS_080

Management of the MA, for an SSB in FS with VBR in FN, on station SBR considered "OS Proved" following a rescue procedure			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	LAB	Degraded	00.00
Notes			
Pre Condition · SSB in FS with MA assigned up to the protection signal of a PoS (PM) · SSB located upstream of OS activation window (more than 100m from downstream signal defined as EoA) · RBC considers the arrival and departure itineraries immediately after the train as "not proven". · The blocks of the arrival and departure itineraries are active · A cdb of the arrival itinerary, different from the overlay one, is busy · A cdb of the starting itinerary, different from the covering one, is busy · VBR in Full Navigation (FN) mode			

TC	**VBTS_SDT-SSB_146 - Extension of the MA in OS , for an SSB in FS with VBR in FN, up to the departure signal of a station SBR considered "OS Proved" following the rescue procedure on an unduly occupied CDB**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO selects the "CDB" command (red CDB icon) and requests the Tx on the busy CDB with the corresponding PO (point of origin) of the arrival itinerary which includes it
2 EXE	CHECK	RBC considers the station SBR, downstream of the train front, "OS Proved"
3 EXE	ACTION	The PdC brings the train into the OS activation window (minSFE at 100m from the downstream signal defined as EoA)

4 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
5 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=1)
6 REP	CHECK	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are verified and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned at upstream of the train front, which covers the SBR occupied by the train front and the following SBR with an "On Sight" profile and includes: - the Mode Profile package in OS [Pkt80] which extends from the LRBG (or from the Cdb joint on which the train is positioned, in the case of LRBG on the Cdb preceding that of the train) and includes the entire first activation window and the entire subsequent SBR RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<=L_ENDSECTION) and Pkt44/6
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
9 EXE	CHECK	The MA is displayed on the RBC QL
TC	**VBTS_SDT-SSB_147 - Extension of the MA in OS, for an SSB in OS with VBR in FN, on the departure itinerary following the rescue procedure on an unduly occupied cdb**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO selects the "CDB" command (red CDB icon) and requests the Tx on the busy CDB with the corresponding PO (point of origin) of the departure itinerary which includes it
2 EXE	CHECK	RBC considers the station SBR, downstream of the train front, "OS Proved"
3 EXE	ACTION	The PdC advances the train into the next SBR and takes it into the OS activation window (minSFE at 100m from the downstream signal defined as EoA)
4 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
5 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=1)

6 REP	CHECK	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are verified and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned at upstream of the train front, which covers the SBR occupied by the train front and the following SBR with an "On Sight" profile and includes: - the Mode Profile package in OS [Pkt80] which extends from the LRBG (or from the Cdb joint on which the train is positioned, in the case of LRBG on the Cdb preceding that of the train) and includes the entire first activation window and the entire subsequent SBR RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<=L_ENDSECTION) and Pkt44/6
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
9 EXE	CHECK	The MA is displayed on the RBC QL
10 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN OS” with T_TEXTDISPLAY=30 seconds and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY=>0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
11 EXE	CHECK	SSB displays the message “MA IN OS EXTENSION” on the DMI for 30 seconds
12 EXE	ACTION	The PdC moves the train past the start signal

Post condition

- SSB in OS on the departure itinerary
- VBR in Full Navigation (FN) mode

6.4.3.2.8 VBTS_PdS_081

Management of the MA, for an SSB in FS with VBR in FN, on station SBR considered "OS Proved" following the rescue procedure on the cdb immediately downstream of the starting signal			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	LAB	Degraded	00.00

Notes	

Pre Condition

- Train located upstream of the protection signal of a PoS
- SSB in FS with MA given until the starting signal with Overlap
- The starting signal is at "Via Impedita" (start itinerary not formed)
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_148 - Reduction of the MA in FS on the protection signal of a DP following the undue occupation of the CDB immediately downstream of the starting signal**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	There is an undue occupation of the cdb immediately after the starting signal
3 EXE	CHECK	RBC considers the station SBR relating to the arrival itinerary "not Proven"
4 REP	CHECK	RBC verifies that the conditions exist for sending a reduced MA for the SSB, with a new EoA the protection signal of a DP downstream of the train front, and sends the SSB a Movement Authority message [Msg3] with request for ACK (M_ACK = 1), referred to the LRBG positioned upstream of the train front, and includes: - the Level 2/3 Movement Authority packet [Pkt15] which indicates the presence of a Danger Point associated with the MA, having distance D_DP from EoA and speed release calculated on board RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION, Q_DANGERPOINT=1, D_DP>0, V_RELEASEDP=126, Q_OVERLAP=0), Pkt27, Pkt21, Pkt5 and Pkt44/6
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the reduction in the MA received
7 EXE	CHECK	The updated MA is displayed on the RBC QL

8 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_149 - Extension of the MA in OS without Overlap, for an SSB in FS with VBR in FN, up to the departure signal of a station SBR considered "OS Proved" following the rescue procedure on the CDB immediately after the departure**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO selects the "CDB" command (red CDB icon) and requests the Tx on the busy CDB with the corresponding PO (point of origin) of the arrival itinerary which includes it
2 EXE	CHECK	RBC considers the station SBR, downstream of the train front, "OS Proved"
3 EXE	ACTION	The PdC brings the train into the OS activation window (minSFE at 100m from the downstream signal defined as EoA)
4 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
5 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
6 REP	CHECK	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are verified and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned at upstream of the train front, which covers the SBR occupied by the train front with a "Full supervision" profile and the subsequent SBR with an "On Sight" profile and includes: - the Level 2/3 Movement Authority package [Pkt15] which indicates the presence of a Danger Point associated with the MA, placed in correspondence with the point to be protected, having D_DP distance from the EoA and release speed calculated on board and without Overlap - the Mode Profile package in OS [Pkt80] which extends from the signal in front of the train and includes entire next SBR RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION, Q_DANGERPOINT=1, D_DP>0, V_RELEASEDP=126, Q_OVERLAP=0), Pkt27, Pkt21, Pkt5 , Pkt80 (D_MAMODE>0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
9 EXE	CHECK	The MA is displayed on the RBC QL
TC	**VBTS_SDT-SSB_150 - Extension of the MA in OS on the starting itinerary following the rescue procedure on the CDB immediately after the starting signal**	

step	Description	Expected Result
1 EXE	ACTION	The DCO activates the departure itinerary by selecting the origin point corresponding to the departure signal and the final point of the station SBR
2 EXE	ACTION	The DCO selects the "CDB" command (red CDB icon) and requests the Tx on the busy CDB with the corresponding PO (point of origin) of the departure itinerary which includes it
3 EXE	CHECK	RBC considers the station SBR relative to the departure itinerary as “OS Proved”.
4 EXE	ACTION	The PdC brings the train into the OS activation window (minSFE at 100m from the downstream signal defined as EoA)
5 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
6 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=1)
7 REP	CHECK	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are verified and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned at upstream of the train front, which covers the SBR occupied by the train front and the subsequent SBR with an "On Sight" profile and includes: - the Level 2/3 Movement Authority package [Pkt15] which indicates the presence of a danger point associated with the MA , placed in correspondence with the point to be protected, having D_DP distance from the EoA and release speed calculated on board - the Mode Profile packet in OS [Pkt80] which extends from the LRBG (or from the Cdb joint on which the train is positioned, in the case of LRBG on the Cdb preceding that of the train) and includes the entire first activation window and the entire subsequent SBR RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION, Q_DANGERPOINT= 1, D_DP>0, V_RELEASEDP=126), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<=L_ENDSECTION) and Pkt44/6
8 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
9 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
10 EXE	CHECK	The MA is displayed on the RBC QL

11 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN OS” with T_TEXTDISPLAY=30 seconds and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY=>0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
12 EXE	CHECK	SSB displays the message “MA IN OS EXTENSION” on the DMI for 30 seconds
13 EXE	ACTION	The PdC moves the train past the start signal
14 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)

Post condition

- SSB in OS on the departure itinerary
- VBR in Full Navigation (FN) mode

6.4.3.3 MA

6.4.3.3.1 VBTS_MA_022

Reduction and extension of the MA in FS for an SSB in FS in the presence of the VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	SITE LAB	Not nominal	00.00

Notes	

Pre Condition

- Train in FS with MA assigned covering at least the two subsequent line SBRs
- Immediately downstream of the train, and in its own SBR, there is at least one VBG configured in the Digital Map
- In the SBR immediately after the train there is at least one VBG configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK ___________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)

TC	VBTS_SDT-SSB_054 - MA reduction for an SSB in FS with VBR in FN	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO commands the closure of the input signal of the SBR immediately down-stream of the train front
2 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC checks that there are conditions for sending a reduced MA for the SSB, with new EoA the initial signal of the first SBR considered degraded and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with a "Full Supervision" profile and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15, Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
3 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
4 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the reduction in the MA received
5 EXE	CHECK	The updated MA is displayed on the RBC QL
6 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

TC	VBTS_SDT-SSB_051 - Extension of the MA in FS for an SSB in FS with VBR in FN following the opening of a signal	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO undoes the input signal latch of the first degraded SBR
2 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
3 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC verifies that the MA extension conditions are met on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the edge train, which covers the SBR occupied by the train front and the subsequent SBRs with the "Full Supervision" profile and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15, Pkt27, Pkt21, Pkt5 (Q_NEWCOUNTRY=0/1, Q_LINKREACTION=2, Q_LOCACC=5) and Pkt44/6 (NID_VBRPACKET=6, N_ITER >=0)

4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
6 EXE	CHECK	The MA is displayed on the RBC QL
7 EXE	ACTION	The PdC advances the train into the next SBR
8 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)

Post condition

- FS train downstream of a validated VBG
- VBR in Full Navigation (FN) mode

6.4.3.3.2 VBTS_MA_023

MA extension and reduction in FS for an SSB in OS in presence of VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	LAB	Not nominal	00.00

Notes	

Pre Condition

- SSB in OS with MA assigned up to the signal ahead of the train (MA covering only the SBR where the train is located)
- Train located upstream of OS activation window (more than 100m from downstream signal)
- Immediately downstream of the train, and upstream of the OS activation window (more than 100m from the downstream signal), there is at least one VBG configured in the Digital Map
- At least the first SBR downstream of the SSB front is considered "FS Proved"
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)

4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)
TC	**VBTS_SDT-SSB_053 - Automatic MA extension in FS for an SSB in OS mode with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC brings the SSB into the OS activation window (100m from the signal defined as EoA) and stops the train
2 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
3 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=1)
4 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with an "On Sight" profile and the subsequent SBRs with a "Full Supervision" profile and includes the "Switch Point Status" package [Pkt 44 /6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MA-MODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
8 EXE	CHECK	The text message “FS MA EXTENSION” is displayed on the SSB DMI for 30 sec-onds
TC	**VBTS_SDT-SSB_056 - MA reduction, for an SSB in OS with VBR in FN, after the closure of the first signal immediately in front of the train**	

step	Description	Expected Result
1 EXE	ACTION	The DCO commands the closure of the input signal of the SBR immediately in front of the train front
2 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC checks that there are conditions for sending a reduced MA for the SSB, with new EoA the signal immediately in front of the train, which is the initial signal of the first SBR considered degraded, and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with an "On Sight" profile and includes: - the Mode Profile package in OS [Pkt80] which is extends from the LRBG (or from the CdB joint on which the train is positioned, in the case of LRBG on the CdB preceding that of the train) and includes the entire first activation window - the "Switch Point Status" package [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<=L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
3 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
4 EXE	CHECK	The updated MA is displayed on the RBC QL
5 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
TC	**VBTS_SDT-SSB_057 - Extension of the MA in FS, for an SSB in OS with VBR in FN, located in the OS activation window downstream of the signal opening**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO commands the opening of the input signal of the SBR immediately in front of the train front
2 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) for train located in OS activation window SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
3 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=1)

4 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with OS profile and at least the following SBR with FS profile, and includes the "Switch Point Status" package [Pkt 44/6], sent from VT to VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION) , Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
8 EXE	CHECK	The text message “FS MA EXTENSION” is displayed on the SSB DMI for 30 seconds
9 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
10 EXE	ACTION	The PdC advances the train into the next SBR
11 EXE	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- SSB in FS
- VBR in Full Navigation (FN) mode

6.4.3.3.3 VBTS_MA_024

GNSS Position Integrity failure and consequent rollback to a VBG, for an SSB in FS with VBR in FN picking up a VBG using an out-of-date PVT			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT COM	LAB	Degraded	00.00

Notes	The scenario has to be performed in the laboratory as it requires a degradation of the CUSUM which can be simulated through a specific StimRS script. The test scenario foresees that during the RBC-SSB connection failure and within the T_NVCONTACT (7 seconds), an anomaly occurs on the CUSUM value and that the train detects a VBG without updated differential corrections.

Pre Condition

- Communication session between RBC and SSB successfully established
- Train in FS with assigned MA covering the following SBRs
- The SSB has a validated VBG as LRBG
- Immediately downstream of the train, and in its own SBR, there is at least one VBG configured in the Digital Map
- The VBR has received the correct and updated differential corrections from the GAD
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_072 - Failure to send the differential corrections related to a CUSUM anomaly due to a temporary drop in the Safe Connection between SSB-RBCs**	
step	**Description**	**Expected Result**
1 EXE	EVENT	Temporary loss of the RBC-SSB radio connection
2 EXE	CHECK	RBC detects the failure of the Safe Connection with the SSB and activates the T_RESTORE (300 seconds) displaying the degradation on the QL
3 EXE	EVENT ________ Requirements REQ_8.1.1.1	Within the T_NVCONTACT (7 seconds) an anomaly occurs on the CUSUM value; therefore, the GAD considers the last differential corrections sent to the VBR no longer valid but RBC, due to the failure of the Safe Connection, cannot send the GNSS Differential Corrections packet [pkt 44/3]
4 REP	CHECK	The VBR continues to calculate the PVT using the last differential corrections re-ceived from the GAD (prior to the CUSUM anomaly)
TC	**VBTS_SDT-SSB_071 - GNSS position integrity failure, and consequent GNSS Position Rollback, for a VBR capturing a VBG using an outdated PVT**	
step	**Description**	**Expected Result**

1 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	Within the T_NVCONTACT (7 seconds), the advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna"
2 EXE	CHECK	The T_NVCONTACT expires and the SSB in line with the previously received National Values (M_NVCONTACT=1) applies the service braking, and with the train stationary, reduces the current MA on the train front
3 EXE	EVENT	The Safe Connection with the SSB is re-established, within the T_RESTORE, during one of the attempts (every 15 seconds) to restore by the SSB
4 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] with the GPS time received from the GAD (T_GPS_BAL_PRC) and the GPS time in which the virtual balise was captured (T_GPS_BAL_PVT) SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG , T_GPS_BAL_PRC, T_GPS_BAL_PVT)
5 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies that the T_GPS_BAL_PVT is greater than the GPS time in which the anomaly occurred on the CUSUM and therefore considers the GNSS Position integrity failed and sends: - the "GNSS Position Integrity Result" package [Pkt 44/10] by valorising "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=1) and the identifier of the VBG for which validation was requested (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=1, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
6 REP	CHECK ___________ Requirements REQ_8.1.1.1	The VBR updates its position by performing the GNSS Position Rollback, calculating a widening of the train edges (L_DOUBTUNDER and L_DOUBTOVER) using the PVLRBG as a reference and sends a Position Report to RBC [Msg 136] with [Pkt 0] SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0)
7 REP	CHECK	RBC receives a Position Report and sends the MA (in FS) to the SSB, with ack request, currently assigned to the train RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt44/6
8 REP	CHECK	SSB sends ACK message [Msg146] to RBC SSB -> RBC: Msg146
9 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3] containing the differential corrections calculated following the anomaly on the CUSUM and resumes the cyclical sending (T_CORR_PERIOD=10s) of the information required for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)

10 REP	CHECK	The VBR calculates the PVT using the latest available differential corrections
11 REP	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_075 - Recalibration of the confidence interval for an SSB with VBR in FN picking up a VBG**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The PoC moves the train forward until it passes the position where a VBG is fore-seen in the Digital Map with the "VBR virtual antenna"
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0], with the recalibrated confidence interval (L_DOUBTUNDER and L_DOUBTOVER), and the "GNSS Position Integrity" [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, L_DOUBTUNDER, L_DOUBTOVER, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with the packet "GNSS Position Integrity Result" [Pkt 44/10] valuing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the identifier of the validated VBG (NID_VALBG) RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)

Post condition

- SSB in FS
- Train immediately downstream of a validated VBG with recalibrated confidence interval
- The VBR calculated an updated PVT based on the updated differential corrections sent by the GAD
- VBR in Full Navigation (FN) mode

6.4.3.3.4 VBTS_MA_025

GNSS Position Integrity failure and consequent rollback to a physical BG, for an SSB in FS with VBR in FN picking up a VBG using an out-of-date PVT			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT COM	LAB	Degraded	00.00

Notes	The scenario has to be performed in the laboratory as it requires a degradation of the CUSUM which can be simulated through a specific StimRS script. The test scenario foresees that during the RBC-SSB connection failure and within the T_NVCONTACT (7 seconds), an anomaly occurs on the CUSUM value and that the train detects a VBG without updated differential corrections.

Pre Condition

- Communication session between RBC and SSB successfully established
- Train in FS with assigned MA covering the following SBRs
- SSB has a physical BG as its LRBG
- Immediately downstream of the train, and in its own SBR, there is at least one VBG configured in the Digital Map
- The VBR has received the correct and updated differential corrections from the GAD
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_072 - Failure to send the differential corrections related to a CUSUM anomaly due to a temporary drop in the Safe Connection between SSB-RBCs**	
step	**Description**	**Expected Result**
1 EXE	EVENT	Temporary loss of the RBC-SSB radio connection
2 EXE	CHECK	RBC detects the failure of the Safe Connection with the SSB and activates the T_RESTORE (300 seconds) displaying the degradation on the QL
3 EXE	EVENT ——— Requirements REQ_8.1.1.1	Within the T_NVCONTACT (7 seconds) an anomaly occurs on the CUSUM value; therefore, the GAD considers the last differential corrections sent to the VBR no longer valid but RBC, due to the failure of the Safe Connection, cannot send the GNSS Differential Corrections packet [pkt 44/3]
4 REP	CHECK	The VBR continues to calculate the PVT using the last differential corrections received from the GAD (prior to the CUSUM anomaly)
TC	**VBTS_SDT-SSB_071 - GNSS position integrity failure, and consequent GNSS Position Rollback, for a VBR capturing a VBG using an outdated PVT**	
step	**Description**	**Expected Result**

1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	Within the T_NVCONTACT (7 seconds), the advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna"
2 EXE	CHECK	The T_NVCONTACT expires and the SSB in line with the previously received National Values (M_NVCONTACT=1) applies the service braking, and with the train stationary, reduces the current MA on the train front
3 EXE	EVENT	The Safe Connection with the SSB is re-established, within the T_RESTORE, during one of the attempts (every 15 seconds) to restore by the SSB
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] with the GPS time received from the GAD (T_GPS_BAL_PRC) and the GPS time in which the virtual balise was captured (T_GPS_BAL_PVT) SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG , T_GPS_BAL_PRC, T_GPS_BAL_PVT)
5 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies that the T_GPS_BAL_PVT is greater than the GPS time in which the anomaly occurred on the CUSUM and therefore considers the GNSS Position integrity failed and sends: - the "GNSS Position Integrity Result" package [Pkt 44/10] by valorising "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=1) and the identifier of the VBG for which validation was requested (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=1, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
6 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR updates its position by performing the GNSS Position Rollback, calculating a widening of the train edges (L_DOUBTUNDER and L_DOUBTOVER) using the PVLRBG as a reference and sends a Position Report to RBC [Msg 136] with [Pkt 0] SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0)
7 REP	CHECK	RBC receives a Position Report and sends the MA (in FS) to the SSB, with ack request, currently assigned to the train RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt44/6
8 REP	CHECK	SSB sends ACK message [Msg146] to RBC SSB -> RBC: Msg146
9 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3] containing the differential corrections calculated following the anomaly on the CUSUM and resumes the cyclical sending (T_CORR_PERIOD=10s) of the information required for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)

10 REP	CHECK	The VBR calculates the PVT using the latest available differential corrections
11 REP	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_075 - Recalibration of the confidence interval for an SSB with VBR in FN picking up a VBG**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The PoC moves the train forward until it passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna"
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0], with the recalibrated confidence interval (L_DOUBTUNDER and L_DOUBTOVER), and the "GNSS Position Integrity" [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, L_DOUBTUNDER, L_DOUBTOVER, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with the packet "GNSS Position Integrity Result" [Pkt 44/10] valuing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the identifier of the validated VBG (NID_VALBG) RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)

Post condition

- SSB in FS
- Train immediately downstream of a validated VBG with recalibrated confidence interval
- The VBR calculated an updated PVT based on the updated differential corrections sent by the GAD
- VBR in Full Navigation (FN) mode

6.4.3.3.5 VBTS_MA_026

Updated navigation data and differential fixes for an SSB in OS with VBR in FN			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	LAB	Not nominal	00.00

Notes	The scenario has to be performed in the laboratory as it requires a variation of the Navigation Data which can be simulated using a specific StimRS script.

Pre Condition

- SSB in OS with MA assigned in FS on subsequent SBRs
- Immediately downstream of the train, and in its own SBR, there is at least one VBG configured in the Digital Map (different from the one aligned to the signal)
- The GAD has already sent to the VBR at least one 44/3 packet containing the differential corrections
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_073 - Update of navigation data and differential corrections for a VBR in FN due to the availability of new data relating to a satellite currently visible from the VBR**	
step	**Description**	**Expected Result**
1 EXE	EVENT	RBC detects the availability of navigation data relating to a new satellite
2 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD detects that navigation data is available for a new satellite and then sends the VBR a General Message [Msg 24], requesting ACK (M_ACK=1), with a GNSS Navigation Data [Pkt 44/8] packet RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
3 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	GAD activates the calculation of the differential corrections calculated on the up-dated navigation data and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" package [Pkt 44/3] which contains the information necessary for the calculation of the PVT RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)

TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**

1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)

Post condition

- Train in OS with MA assigned in FS on subsequent SBRs
- The VBR has received an update of navigation data and differential corrections from the GAD
- VBR in Full Navigation (FN) mode

6.4.3.3.6 VBTS_MA_027

Failure to validate a VBG for a VBR in FN that no longer receives the differential corrections due to the SD of one or more RS			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	LAB	Degraded	00.00

Notes	

Pre Condition

- SSB in FS with assigned MA covering at least subsequent SBRs
- The GAD is cyclically sending the differential corrections to the VBR
- Communication between the GAD and at least two Reference Stations (RS) is successfully established
- Immediately downstream of the train, and in its own SBR, there are at least two VBGs configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_074 - Interruption of the cyclic sending of the differential corrections to a VBR due to the shutdown of one or more RS**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD cyclically (T_CORR_PERIOD=10s) sends to the VBR a General Message [Msg 24] with the packet "GNSS Differential Correction" [Pkt 44/3] RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET =3)
2 EXE	EVENT __________ Requirements REQ_8.1.3.2	The shutdown of one or more RS occurs in such a way that the RS currently available are less than 2
3 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD, detecting that the number of RS available is less than 2, interrupts the cyclical sending of the differential corrections [pkt 44/3]
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR, no longer receiving the differential corrections for a period of time greater than T_MAX_EXP_AG_TIME (30 s), considers the satellite information in its possession obsolete and switches to odometric navigation

TC	**VBTS_SDT-SSB_038 - Detection of two VBGs for a train with VBR in Full Navigation (FN) which does not receive the differential corrections**	
step	**Description**	**Expected Result**

1 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where the first VBG is expected with the "VBR virtual antenna".
2 REP	CHECK ___________ Requirements REQ_8.1.1.1	The VBR, not having yet confirmed the integrity of the last calculated PVT, sends RBC a Position Report [Msg136] which includes the "GNSS Position Integrity" packet [Pkt 44/105] and the pkt0 with the NID_LRBG of the VBG SSB - > RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where the second VBG is expected with the "VBR virtual antenna".
5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The VBR, not having received the differential corrections from the GAD, does not request the validation of the VBG and therefore the SSB sends the RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the VBG without carrying out the recalibration of the confidence interval (L_DOUBTUNDER and L_DOUBTOVER) SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0/1)

Post condition

- SSB in FS with a VBG like LRBG
- The VBR navigates the Digital Map with odometry only due to the lack of updated differential corrections
- VBR in Full Navigation (FN) mode

6.4.3.3.7 VBTS_MA_028

Failure to validate a VBG for a VBR in FN without GPS coverage and subsequent recalibration of the odometric error following capture of a physical BG			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	LAB	Degraded	00.00

Notes	

Pre Condition

- SSB in FS with MA assigned until a dial tone
- The SSB has a validated VBG as LRBG
- All the conditions to consider the SBR downstream of the EoA as "FS Proved" are verified with the exception of the signal status (resulting at obstruction following signal closure)
- In the SBR immediately downstream of the EoA there are consecutively a VBG, configured in the Digital Map, and a physical BG
- GPS coverage not present for VBR (timer T_MAX_EXP_AG_TIME=30 s expired)
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_051 - Extension of the MA in FS for an SSB in FS with VBR in FN following the opening of a signal**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO undoes the input signal latch of the first degraded SBR
2 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
3 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC checks that the MA extension conditions are met on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the edge train, which covers the SBR occupied by the train front and the subsequent SBRs with the "Full Supervision" profile and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15, Pkt27, Pkt21, Pkt5 (Q_NEWCOUNTRY=0/1, Q_LINKREACTION=2, Q_LOCACC=5) and Pkt44/6 (NID_VBRPACKET=6, N_ITER >=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received

6 EXE	CHECK	The MA is displayed on the RBC QL
7 EXE	ACTION	The PdC advances the train into the next SBR
8 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_039 - Detection of a VBG for a train with VBR in Full Navigation (FN) without GPS coverage for the VBR**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] which includes: - the pkt0 with the NID_LRBG of the detected VBG - the "GNSS Position Integrity" packet [Pkt 44/105], in case the VBR has a PVT whose integrity not yet checked SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
TC	**VBTS_SDT-SSB_076 - Recalibration of the confidence interval for an SSB with VBR in FN picking up a physical BG**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward
2 REP	CHECK	SSB detects a physical BG and sends RBC a PR [Msg136] in FS/OS (with M_MODE=0/1) with the confidence interval recalibrated SSB -> RBC: Msg136 with Pkt0 (L_DOUBTUNDER, L_DOUBTOVER, M_MODE=0 /1)
Post condition · SSB in FS · Train immediately downstream of a physical BG with recalibrated confidence interval · GPS coverage not present for the VBR · VBR in Full Navigation (FN) mode		

6.4.3.3.8 VBTS_MA_029

Failure of the GNSS Position Integrity and consequent rollback following the detection of the virtual LRBG during a backward movement for an SSB in PT with VBR in FN and subsequent re-evaluation of the MA with an OS-FS profile for the train in position shifted			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	SITE LAB	Not nominal	00.00

Notes	

Pre Condition

- Train in PT located by RBC in the first activation window
- LRBG is a validated VBG positioned upstream of the train front (less than 20 m, D_NVPOTRP) and on the same SBR where the train is located
- At least the first SBR downstream of the SSB front is verified as "FS Proved"
- No active Emergency for the train
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_077 - GNSS Position Rollback for a VBR in FN which, during the backward movement of an SSB in PT, has detected a VBG in both travel directions**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC a PR [Msg 136] valid in PT (with M_MODE=8), from standstill (V_TRAIN = 0) which includes the [Pkt 0] referred to the LRBG which is upstream of the train front SSB -> RBC: Msg136 with Pkt0 (D_LRBG<20m, Q_DIRLRBG = Q_DLRBG, V_TRAIN = 0, M_MODE = 8)
2 EXE	ACTION __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The PdC moves the train backwards in PT until it passes the LRBG with the "VBR virtual antenna".
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR, detecting that the VBG (LRBG) has been captured more than once, does not request the validation of the VBG from the GAD but considers the GNSS position integrity failed and performs the GNSS Position Rollback procedure and updates its position by calculating an enlargement of the fronts of the train (L_DOUBTUNDER and L_DOUBTOVER) using the LRBG as reference and send to RBC a Position Report [Msg 136] with [Pkt 0] SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, Q_DIRLRBG<>Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN >0, M_MODE=8)
4 EXE	CHECK	In line with the previously received National Values (D_NVPOTRP=20) the SSB allows to cover the maximum withdrawal distance in PT operating mode of 20m

5 EXE	ACTION	The PdC stops the train after 20m of backward movement
6 REP	CHECK	The SSB sends RBC a PR [Msg136] valid in PT (M_MODE = 8) which includes the [Pkt0] referring to the VBG which is downstream of the train front SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, Q_DIRLRBG<>Q_DLRBG , V_TRAIN = 0, M_MODE = 8)
TC	**VBTS_SDT-SSB_078 - Re-evaluation of the MA, in the presence of a VBR system, for an SSB in PT with virtual LRBG positioned downstream of the front train with subsequent failure of the GNSS Position Integrity following the detection of the LRBG during a forward movement**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC selects Start on the DMI
2 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (Q_DIRLRBG<>Q_DLRBG, M_MODE=8)
3 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends to the SSB a MA with Shifted Location Reference [Msg33] message with ACK request (M_ACK = 1) and D_REF correctly calculated as the distance between LRBG and the new Shifted reference location, with an OS-FS profile and includes the packet “Switch Point Status” [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg33 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 (D_LINK=D_REF, NID_BG= NID_LRBG), Pkt80 (D_MA-MODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET= 6, N_ITERS>=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL
6 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window and 32767 if LRBG in downstream SBR) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
7 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
8 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) in position Shifted SSB -> RBC: Msg136 with Pkt0 (Q_DIRLRBG<>Q_DLRBG, M_MODE=1)
9 EXE	CHECK	If LRBG is in downstream SBR, text message “EXTENDED MA IN FS” is displayed on SSB DMI for 30 seconds

10 EXE	ACTION	The PdC moves the train forward
11 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where the LRBG is foreseen with the "VBR virtual antenna".
12 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR, detecting that the VBG (LRBG) has been captured more than once, does not request the validation of the VBG from the GAD but considers the GNSS position integrity failed and performs the GNSS Position Rollback procedure and updates its position by calculating an enlargement of the fronts of the train (L_DOUBTUNDER and L_DOUBTOVER) using the LRBG as reference and send to RBC a Position Report [Msg 136] with [Pkt 0] SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, Q_DIRLRBG<>Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN >0, M_MODE=8)
13 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC receives the PR which notifies the passage on the LRBG and then sends the SSB a Movement Authority message [Msg3] with request for ACK (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS- profile FS and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) - > SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>= 0)
14 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

Post condition

- Train in OS with assigned MA covering the SBR occupied by the train front with "On Sight" profile and the subsequent SBRs with "Full Supervision" profile
- LRBG is a VBG positioned upstream of the train front and on the same SBR where the train is located
- VBR in Full Navigation (FN) mode
- The VBR performed the GNSS Position Rollback procedure following the detection of a VBG (LRBG) in both directions of travel

6.4.3.3.9 VBTS_MA_030

MA reduction in FS for an SSB in FS with VBR in FN and subsequent extension with OS-FS profile on the degraded SBR for "Off/Fault" signal			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	LAB	Degraded	00.00

Notes	

Pre Condition

- SSB in FS with assigned MA covering at least downstream line SBR
- Train travels at low speeds or is stationary
- SSB located upstream of OS activation window (more than 100m from downstream signal)
- VBR is in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_058 - MA reduction, for an SSB in FS and VBR in FN, up to the initial signal of a degraded SBR for "Off/Fault" signal**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The status of the line signal that protects the SBR downstream of the train front changes to "Off/Fault" and consequently RBC considers the SBR "OS-FS Proved"
2 REP	CHECK Requirements REQ_8.1.3.3	RBC checks that there are conditions for sending a reduced MA for the SSB with new EoA the initial signal of the SBR considered degraded and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the 'LRBG positioned upstream of the train front, which covers the SBR occupied by the train front and any subsequent SBRs up to the initial signal of the SBR considered degraded, with "Full Supervision" profile RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt44/6
3 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
4 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the reduction in the MA received
5 EXE	CHECK	The updated MA is displayed on the RBC QL
6 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_052 - Automatic extension of the MA in OS-FS on the SBR downstream of the train front for an SSB in FS mode with VBR in FN**	
step	**Description**	**Expected Result**

1 EXE	ACTION	The PdC brings the train into the OS activation window (100m from the downstream signal defined as EoA)
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
4 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are verified and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with "Full supervision" profile and the following SBR with OS profile in the OS_AFTER_SGN_WIN window (between the signal and the joint immediately downstream) and FS on the remaining part RBC -> SSB: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>0, M_MAMODE=0, L_MAMODE<L_ENDSECTION, L_ACKMAMODE=100) and Pkt44/6
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
8 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
9 EXE	ACTION	The HP advances the SSB past the off/fault signal, past the OS_AFTER_SGN_WIN window by passing the joint immediately downstream of the signal
10 EXE	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- SSB in FS
- VBR is in Full Navigation (FN) mode

6.4.3.3.10 VBTS_MA_031

Nominal running on even track in left direction (legal) in presence of VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	SITE LAB	Nominal	00.00

Notes	Applicable scenario on the first L2 SBR in the following cases: · SSB with MA OS-FS downstream of a valid SOM. · SSB with MA OS-FS downstream of new localization on a PI inside the SBR. · SSB with MA in FS after a level transition.

Pre Condition

- SSB in OS or FS, with MA covering subsequent SBRs in FS (MAs of maximum length)
- Train located on the first SBR of ERTMS L2 area
- All SBRs downstream of the train front (line and station itineraries in the correct layout) are considered "FS Proved"
- Train on the even track at the right end of the line with left orientation (legal)
- Along the line there are VBGs configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_081 - Nominal gear along the entire line in correct layout in the presence of VBR system**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in the following SBRs
2 REP	CHECK	The train cyclically sends (as defined in the previously received Pkt58) a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)

5 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
6 REP	CHECK ___________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)
7 REP	CHECK	The SSB, in approaching its EoA (as defined in the previously received Pkt57), sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
8 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC checks that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1) with FS profile on the subsequent SBRs (MA of maximum length) and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER)
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
11 EXE	CHECK	The MA is displayed on the RBC QL
12 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
13 EXE	ACTION	The PdC moves the train in the station until it passes a facing point with the MaxSFE
14 REP	CHECK ___________ Requirements REQ_8.1.1.1	VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)

15 REP	CHECK ___________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
16 EXE	ACTION	The PdC makes the train continue along the entire line in the correct route following the indications on the DMI (with the EoA progressively updated with relative extensions of the MA)
17 EXE	CHECK	The train is stationary near its EoA coinciding with the line exit signal
18 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN=0)

Post condition

- Train in FS
- Train stationary near its EoA coinciding with the line exit signal
- Train on the equal track at the left end of the line with left orientation
- VBR in Full Navigation (FN) mode

6.4.3.3.11 VBTS_MA_032

Nominal running on odd track in right direction (legal) with VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	SITE LAB	Nominal	00.00

Notes	Applicable scenario on the first L2 SBR in the following cases: · SSB with MA OS-FS downstream of a valid SOM. · SSB with MA OS-FS downstream of new localization on a PI inside the SBR. · SSB with MA in FS after a level transition.

Pre Condition

- SSB in OS or FS, with MA covering subsequent SBRs in FS (MAs of maximum length)
- Train located on the first SBR of ERTMS L2 area
- All SBRs downstream of the train front (line and station itineraries in the correct layout) are considered "FS Proved"
- Train on the odd track at the extreme left of the line with right orientation
- Along the line there are VBGs configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_081 - Nominal gear along the entire line in correct layout in the presence of VBR system**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in the following SBRs
2 REP	CHECK	The train cyclically sends (as defined in the previously received Pkt58) a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)

5 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
6 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)
7 REP	CHECK	The SSB, in approaching its EoA (as defined in the previously received Pkt57), sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
8 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC checks that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1) with FS profile on the subsequent SBRs (MA of maximum length) and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER)
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
11 EXE	CHECK	The MA is displayed on the RBC QL
12 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
13 EXE	ACTION	The PdC moves the train in the station until it passes a facing point with the MaxSFE
14 REP	CHECK __________ Requirements REQ_8.1.1.1	VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)

15 REP	CHECK ___________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
16 EXE	ACTION	The PdC makes the train continue along the entire line in the correct route following the indications on the DMI (with the EoA progressively updated with relative extensions of the MA)
17 EXE	CHECK	The train is stationary near its EoA coinciding with the line exit signal
18 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN=0)

Post condition

- Train in FS
- Train stationary near its EoA coinciding with the line exit signal
- Train on the odd track at the far right of the line with right orientation
- VBR in Full Navigation (FN) mode

6.4.3.3.12 VBTS_MA_033

Nominal running on even track in right direction (illegal) in the presence of VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	SITE LAB	Not nominal	00.00

Notes	Applicable scenario on the first L2 SBR in the following cases: · SSB with MA OS-FS downstream of a valid SOM. · SSB with MA OS-FS downstream of new localization on a PI inside the SBR. · SSB with MA in FS after a level transition.

Pre Condition

- SSB in OS or FS, with MA covering subsequent SBRs in FS (MAs of maximum length)
- Train located on the first SBR of ERTMS L2 area
- All SBRs downstream of the train front (line and station itineraries in the correct layout) are considered "FS Proved"
- Train on the equal track at the left end of the line with right orientation
- Along the line there are VBGs configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_081 - Nominal gear along the entire line in correct layout in the presence of VBR system**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in the following SBRs
2 REP	CHECK	The train cyclically sends (as defined in the previously received Pkt58) a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
4 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)

5 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
6 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)
7 REP	CHECK	The SSB, in approaching its EoA (as defined in the previously received Pkt57), sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
8 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC checks that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1) with FS profile on the subsequent SBRs (MA of maximum length) and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER)
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
11 EXE	CHECK	The MA is displayed on the RBC QL
12 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
13 EXE	ACTION	The PdC moves the train in the station until it passes a facing point with the MaxSFE
14 REP	CHECK __________ Requirements REQ_8.1.1.1	VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)

15 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
16 EXE	ACTION	The PdC makes the train continue along the entire line in the correct route following the indications on the DMI (with the EoA progressively updated with relative extensions of the MA)
17 EXE	CHECK	The train is stationary near its EoA coinciding with the line exit signal
18 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN=0)

Post condition

- Train in FS
- Train stationary near its EoA coinciding with the line exit signal
- Train on the even track at the right end of the line with right orientation
- VBR in Full Navigation (FN) mode

6.4.3.3.13 VBTS_MA_034

<table>
<tr><th colspan="4">Nominal running on the odd track in the left direction (illegal) in the presence of the VBR system</th></tr>
<tr><td>FUNCTION</td><td>Execution</td><td>Scenario's Type</td><td>version</td></tr>
<tr><td>BUT</td><td>SITE LAB</td><td>Not nominal</td><td>00.00</td></tr>
<tr><td>Notes</td><td colspan="3">Applicable scenario on the first L2 SBR in the following cases:
· SSB with MA OS-FS downstream of a valid SOM.
· SSB with MA OS-FS downstream of new localization on a PI inside the SBR.
· SSB with MA in FS after a level transition.</td></tr>
<tr><td colspan="4">Pre Condition
· SSB in OS or FS, with MA covering subsequent SBRs in FS (MAs of maximum length)
· Train located on the first SBR of ERTMS L2 area
· All SBRs downstream of the train front (line and station itineraries in the correct layout) are considered "FS Proved"
· Train on the odd track at the far right of the line with left orientation
· Along the line there are VBGs configured in the Digital Map
· VBR in Full Navigation (FN) mode</td></tr>
<tr><td>TC</td><td colspan="3">VBTS_SDT-SSB_081 - Nominal gear along the entire line in correct layout in the presence of VBR system</td></tr>
<tr><td>step</td><td>Description</td><td colspan="2">Expected Result</td></tr>
<tr><td>1
EXE</td><td>ACTION</td><td colspan="2">The PdC moves the train forward in the following SBRs</td></tr>
<tr><td>2
REP</td><td>CHECK</td><td colspan="2">The train cyclically sends (as defined in the previously received Pkt58) a PR [Msg136] in FS (with M_MODE=0)

SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)</td></tr>
<tr><td>3
EXE</td><td>EVENT
____
Requirements

REQ_8.1.2.3
REQ_8.1.1.1</td><td colspan="2">The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".</td></tr>
<tr><td>4
REP</td><td>CHECK
____
Requirements

REQ_8.1.1.1
REQ_8.1.2.3</td><td colspan="2">The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105]

SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)</td></tr>
</table>

5 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
6 REP	CHECK ___________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)
7 REP	CHECK	The SSB, in approaching its EoA (as defined in the previously received Pkt57), sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
8 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC checks that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1) with FS profile on the subsequent SBRs (MA of maximum length) and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER)
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
11 EXE	CHECK	The MA is displayed on the RBC QL
12 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
13 EXE	ACTION	The PdC moves the train in the station until it passes a facing point with the MaxSFE
14 REP	CHECK ___________ Requirements REQ_8.1.1.1	VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)

15 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
16 EXE	ACTION	The PdC makes the train continue along the entire line in the correct route following the indications on the DMI (with the EoA progressively updated with relative extensions of the MA)
17 EXE	CHECK	The train is stationary near its EoA coinciding with the line exit signal
18 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN=0)
Post condition · Train in FS · Train stationary near its EoA coinciding with the line exit signal · Train on the odd track at the extreme left of the line with left orientation · VBR in Full Navigation (FN) mode		

6.4.3.3.14 VBTS_MA_035

Nominal gear in left direction with transition from odd (illegal) to even (legal) track with VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	SITE LAB	Not nominal	00.00

Notes	

Pre Condition

- Train on the odd track at the extreme right of the line with left orientation (illegal), on the first line SBR of the block
- The first DP downstream of the train front is a PC or PM which has a deviated route (such as to allow for track changes)
- SSB in FS with MA assigned up to the entry signal of the deviated itinerary
- All the conditions for considering the SBR of the station in divert "FS Proved" are verified with the exception of the formation of the itinerary and the consequent movement of the switches
- No bottom station route of the diversion is formed
- Downstream of the DP, the block of the adjacent track has an orientation in line with that of the train
- In the line SBRs downstream of the DP there is at least one VBG configured in the Digital Map
- All line SBRs downstream of the DP are considered "FS Proved"
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_082 - Operation of an SSB in FS and VBR in FN with track change downstream of an extension of the MA**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The DCO forms the station itinerary in deviation (and any further itinerary, in the case of PM, to allow the train to travel the deviation and change track)
3 EXE	CHECK	RBC considers the SBR of the diverted station (and any other SBR, of the same DP, downstream) "FS Proved"
4 EXE	ACTION	The PdC moves the train towards the PdS
5 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)

6 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC verifies that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1) which covers the SBR occupied by the front of the train and the subsequent SBRs with FS profile and includes the International Static Speed Profile package [Pkt27] and the Switch Point Status package [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27 (V_STATIC, Q_FRONT=0), Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k) =1/2)
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
9 EXE	CHECK	The MA is displayed on the RBC QL
10 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
11 EXE	ACTION	The PdC moves the train in the station until it passes the facing point with the MaxSFE
12 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
13 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
14 EXE	ACTION	The PdC moves the train on the detour
15 EXE	CHECK	Consistent with the previously received Pkt27 (Q_FRONT=0) the speed profile on the detour is applied for the entire length of the train, i.e. until the train completely tails the detour
16 EXE	ACTION	The PdC carries the train to its EoA on the new track

17 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
18 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
19 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
20 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)
21 EXE	CHECK	The train is stopped near its EoA in FS
22 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN=0)

Post condition

- Train in FS
- Train stationary near its EoA (Protection signal of the PoS or LL)
- Train on even track with left orientation (legal)
- VBR in Full Navigation (FN) mode

6.4.3.3.15 VBTS_MA_036

Nominal gear in left direction with change from even (legal) to odd (illegal) track with VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	SITE LAB	Not nominal	00.00
Notes			

Pre Condition

- Train on the even track at the right end of the line with left orientation (legal), on the first line SBR of the block
- The first DP downstream of the train front is a PC or PM which has a deviated route (such as to allow for track changes)
- SSB in FS with MA assigned up to the entry signal of the deviated itinerary
- All the conditions for considering the SBR as a deviation of the "FS Proved" DP are verified with the exception of the formation of the itinerary and the consequent movement of the switches
- No station itinerary downstream of the deviation is formed - Downstream of the DP, the block of the adjacent track has the same orientation as that of the train
- In the line SBRs downstream of the DP there is at least one VBG configured in the Digital Map
- All line SBRs downstream of the DP are considered "FS Proved"
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_082 - Operation of an SSB in FS and VBR in FN with track change downstream of an extension of the MA**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The DCO forms the station itinerary in deviation (and any further itinerary, in the case of PM, to allow the train to travel the deviation and change track)
3 EXE	CHECK	RBC considers the SBR of the diverted station (and any other SBR, of the same DP, downstream) "FS Proved"
4 EXE	ACTION	The PdC moves the train towards the PdS
5 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)

6 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC verifies that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1) which covers the SBR occupied by the front of the train and the subsequent SBRs with FS profile and includes the International Static Speed Profile package [Pkt27] and the Switch Point Status package [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27 (V_STATIC, Q_FRONT=0), Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k) =1/2)
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
9 EXE	CHECK	The MA is displayed on the RBC QL
10 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
11 EXE	ACTION	The PdC moves the train in the station until it passes the facing point with the MaxSFE
12 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
13 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
14 EXE	ACTION	The PdC moves the train on the detour
15 EXE	CHECK	Consistent with the previously received Pkt27 (Q_FRONT=0) the speed profile on the detour is applied for the entire length of the train, i.e. until the train completely tails the detour
16 EXE	ACTION	The PdC carries the train to its EoA on the new track

17 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
18 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
19 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
20 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)
21 EXE	CHECK	The train is stopped near its EoA in FS
22 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN=0)

Post condition

- Train in FS
- Train stationary near its EoA (Protection signal of the PoS or LL)
- Train on odd track with left orientation (illegal)
- VBR in Full Navigation (FN) mode

6.4.3.3.16 VBTS_MA_037

Nominal right hand direction with transition from odd (legal) to even (illegal) track with VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	SITE LAB	Not nominal	00.00

Notes	

Pre Condition

- Train on the odd track at the extreme left of the line with right (legal) orientation, on the first line SBR of the block
- The first DP downstream of the train front is a PC or PM which has a deviated route (such as to allow for track changes)
- SSB in FS with MA assigned up to the entry signal of the deviated itinerary
- All the conditions for considering the SBR as a deviation of the "FS Proved" DP are verified except for the formation of the itinerary and the consequent movement of the switches
- No bottom station route of the diversion is formed
- Downstream of the DP, the block of the adjacent track has an orientation in line with that of the train
- In the line SBRs downstream of the DP there is at least one VBG configured in the Digital Map
- All line SBRs downstream of the DP are considered "FS Proved"
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_082 - Operation of an SSB in FS and VBR in FN with track change downstream of an extension of the MA**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The DCO forms the station itinerary in deviation (and any further itinerary, in the case of PM, to allow the train to travel the deviation and change track)
3 EXE	CHECK	RBC considers the SBR of the diverted station (and any other SBR, of the same DP, downstream) "FS Proved"
4 EXE	ACTION	The PdC moves the train towards the PdS
5 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)

6 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC verifies that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1) which covers the SBR occupied by the front of the train and the subsequent SBRs with FS profile and includes the International Static Speed Profile package [Pkt27] and the Switch Point Status package [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27 (V_STATIC, Q_FRONT=0), Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k) =1/2)
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
9 EXE	CHECK	The MA is displayed on the RBC QL
10 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
11 EXE	ACTION	The PdC moves the train in the station until it passes the facing point with the MaxSFE
12 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
13 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
14 EXE	ACTION	The PdC moves the train on the detour
15 EXE	CHECK	Consistent with the previously received Pkt27 (Q_FRONT=0) the speed profile on the detour is applied for the entire length of the train, i.e. until the train completely tails the detour
16 EXE	ACTION	The PdC carries the train to its EoA on the new track

17 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
18 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
19 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
20 REP	CHECK ___________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)
21 EXE	CHECK	The train is stopped near its EoA in FS
22 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN=0)

Post condition

- Train in FS
- Train stationary near its EoA (Protection signal of the PoS or LL)
- Train on even track with right orientation (Illegal)
- VBR in Full Navigation (FN) mode

6.4.3.3.17 VBTS_MA_038

Nominal right hand direction with transition from even (illegal) to odd (legal) track with VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS MA	SITE LAB	Not nominal	00.00

Notes	

Pre Condition

- Train on the even leftmost track of the line with right (illegal) orientation, on the first line SBR of the block
- The first DP downstream of the train front is a PC or PM which has a deviated route (such as to allow for track changes)
- SSB in FS with MA assigned up to the entry signal of the deviated itinerary
- All the conditions for considering the SBR as a deviation of the "FS Proved" DP are verified with the exception of the formation of the itinerary and the consequent movement of the switches
- No bottom station route of the diversion is formed
- Downstream of the DP, the block of the adjacent track has an orientation in line with that of the train
- In the line SBRs downstream of the DP there is at least one VBG configured in the Digital Map
- All line SBRs downstream of the DP are considered "FS Proved"
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_082 - Operation of an SSB in FS and VBR in FN with track change downstream of an extension of the MA**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The DCO forms the station itinerary in deviation (and any further itinerary, in the case of PM, to allow the train to travel the deviation and change track)
3 EXE	CHECK	RBC considers the SBR of the diverted station (and any other SBR, of the same DP, downstream) "FS Proved"
4 EXE	ACTION	The PdC moves the train towards the PdS
5 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)

6 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC verifies that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1) which covers the SBR occupied by the front of the train and the subsequent SBRs with FS profile and includes the International Static Speed Profile package [Pkt27] and the Switch Point Status package [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27 (V_STATIC, Q_FRONT=0), Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k) =1/2)
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
9 EXE	CHECK	The MA is displayed on the RBC QL
10 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
11 EXE	ACTION	The PdC moves the train in the station until it passes the facing point with the MaxSFE
12 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
13 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
14 EXE	ACTION	The PdC moves the train on the detour
15 EXE	CHECK	Consistent with the previously received Pkt27 (Q_FRONT=0) the speed profile on the detour is applied for the entire length of the train, i.e. until the train completely tails the detour
16 EXE	ACTION	The PdC carries the train to its EoA on the new track

17 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
18 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
19 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
20 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)
21 EXE	CHECK	The train is stopped near its EoA in FS
22 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN=0)

Post condition

- Train in FS
- Train stationary near its EoA (Protection signal of the PoS or LL)
- Train on odd track with right orientation (legal)
- VBR in Full Navigation (FN) mode

6.4.3.3.18 VBTS_MA_077

MA reduction in FS and subsequent extensions in OS on degraded SBR for cdb detected busy, for an SSB in FS and with VBR in FN			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT	LAB	Degraded	00.00

Notes	

Pre Condition

- SSB in FS with assigned MA covering at least the next two SBRs
- Train travels at low speeds or is stationary
- The third SBR downstream of the train (the one immediately downstream of the EoA) is considered OS proved (it has a busy CdB)
- The three SBRs downstream of the train are line SBRs
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_142 - MA reduction, for an SSB in FS and VBR in FN, up to the initial signal of the degraded SBR (previously "FS Proved")**	
step	**Description**	**Expected Result**
1 EXE	EVENT	There is an illegal occupation of a CdB of the second SBR downstream of the train front
2 EXE	CHECK	RBC considers the second SBR downstream of the SSB front as "OS Proved"
3 REP	CHECK	RBC checks that there are conditions for sending a reduced MA for the SSB with new EoA the initial signal of the SBR considered degraded and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the 'LRBG positioned upstream of the train front, which covers the SBR occupied by the train front and the subsequent SBRs up to the initial signal of the SBR considered degraded, with "Full Supervision" profile RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the reduction in the MA received
6 EXE	CHECK	The updated MA is displayed on the RBC QL
7 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_055 - Automatic extension of the MA in OS on the SBR downstream of the train front for an SSB in FS mode with VBR in FN**	

step	Description	Expected Result
1 EXE	ACTION	The PdC brings the train into the OS activation window (minSFE at 100m from the downstream signal defined as EoA)
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
4 REP	CHECK	RBC verifying that the SSB is located in the OS activation window and that the MA extension conditions are verified, sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with the "Full supervision" profile and the subsequent SBR with the "On Sight" profile and includes: - the Mode Profile package in OS [Pkt80] which extends from the signal in front of the train and includes the entire following SBR RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5. Pkt80 (D_MAMODE>0, M_MAMODE=0, L_MAMODE<L_ENDSECTION, L_ACKMAMODE=100) and Pkt44/6
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
8 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
9 EXE	ACTION	The PdC moves the train to the next SBR (considered OS proved for busy CdB)
TC	**VBTS_SDT-SSB_143 - Automatic extension of the MA in OS on the SBR downstream of the train front for an SSB in OS mode with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC brings the train into the OS activation window (minSFE at 100m from the downstream signal defined as EoA)
2 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
3 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=1)

4 REP	CHECK	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are verified and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front and the following SBR with an "On Sight" profile and includes: - the Mode Profile package in OS [Pkt80] which extends from the LRBG (if on the same CdB as the train) and includes the entire first activation window and the entire subsequent SBR RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<=L_ENDSECTION) and 44/6
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN OS” with T_TEXTDISPLAY=30 seconds and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY=>0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
8 EXE	CHECK	SSB displays the message “MA IN OS EXTENSION” on the DMI for 30 seconds

Post condition

- Train in OS, with assigned MA covering the SBR occupied by the train front and the following SBR with an “On Sight” profile
- VBR in Full Navigation (FN) mode

6.4.3.4 CEM

6.4.3.4.1 VBTS_CEM_039

Management of an Ignored Conditional Emergency for the management of the shadow CdB for an SSB in FS with VBR in FN and subsequent verification of the integrity of the Digital Map			
FUNCTION	**Execution**	**Scenario's Type**	**version**
EMC	LAB	Nominal	00.00

Notes	SDT must manage the "Shadow CdB" function only for the path CdBs that act as immobilisation of a turnout, at which convergence can occur. This scenario requires that a VBG is present upstream of the immobilization CDB (which includes a facing-point): a possible application is with a train on the odd track in the legal direction, located downstream of the validated VBG VTTN-10383-R-23 (on the cdb VTTN153).

Pre Condition

- Train in FS in slow movement on the CdB immediately upstream of the immobilization one (which includes a facing point)
- The SSB has a validated VBG as LRBG
- The CdB of immobilization is included in the MA
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_083 - Management of an ignored Conditional Emergency for an SSB in FS, with VBR in FN, following the occupation by the train of the immobilization CdB immediately downstream of the train front**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward on the immobilization CDB
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) such as to locate the train upstream of the CdB joint detected busy SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 REP	CHECK	RBC verifies that the min safe front end of the train has not yet passed the immobilization CdB joint detected busy and sends a Conditional Emergency Stop message [Msg15] to the SSB RBC -> SSB: Msg15 (NID_EM=x, D_EMERGENCYSTOP>0)
4 REP	CHECK	The SSB receives the [Msg15] and sends the Acknowledgment of Emergency Stop message [Msg147] with the variable Q_EMERGENCYSTOP=3 (MEC ignored) SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=3) with Pkt0 (M_MODE=0)
5 EXE	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) such as to locate the train on the immobilization CdB previously detected busy SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

TC	VBTS_SDT-SSB_063 - Digital Map integrity check for an SSB with VBR in FN that has passed a facing point	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC makes the train move forward until it passes the facing point with the VBR Virtual Antenna
2 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
3 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
Post condition · FS train downstream of a facing point · VBR in Full Navigation (FN) mode		

6.4.3.4.2 VBTS_CEM_040

Management of an Accepted Conditional Emergency for the management of the shadow CdB for an SSB in FS with VBR in FN, transition of the VBR in TD following the passing of a facing-point downstream of the Override procedure and subsequent passage in FN following the assignment of the MA			
FUNCTION	**Execution**	**Scenario's Type**	**version**
EMU EMC	LAB	Degraded	00.00

Notes	SDT must manage the "Shadow CdB" function only for the path CdBs that act as immobilisation of a turnout, at which convergence can occur. Scenario executable on the immobilization CDB VTTN114 and VBG VTTN-10367 immediately downstream of the PNT21.

Pre Condition

- Train in FS located on the CdB immediately upstream of the immobilization one (which includes a facing-point)
- Between the minSFE of the train and the signal immediately downstream there is only one switch (facing-point)
- The station SBR immediately downstream of the train presents the formation of the itinerary as the only condition for not being considered "FS Proved"
- The CdB of immobilization is included in the MA
- Immediately downstream of the facing point there is a VBG configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_084 - Management of an Accepted Conditional Emergency for a SSB in FS, with VBR in FN, in the case of undue occupation of the immobilization CdB downstream of the train front**	
step	**Description**	**Expected Result**
1 EXE	EVENT	Unlawful occupation of the immobilization CdB immediately downstream of the CdB occupied by the train.
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) such as to locate the train upstream of the CdB joint detected busy SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 REP	CHECK	RBC verifies that the train has not yet located on the CdB detected as occupied (it has not passed the joint upstream of this CdB with its edge) and sends a Conditional Emergency Stop message [Msg15] to the SSB RBC -> SSB: Msg15 (NID_EM = x, D_EMERGENCYSTOP>0)
4 REP	CHECK	The SSB receives the [Msg15] and sends the Acknowledgment of Emergency Stop message [Msg147] with the variable Q_EMERGENCYSTOP=0/1 (MEC Accepted). SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=0/1) with Pkt0 (M_MODE=0)
5 REP	CHECK	RBC, after receiving the [Msg147] with Q_EMERGENCYSTOP=0/1, send an Unconditional Emergency Stop message [Msg16] to the SSB RBC -> SSB: Msg16 (NID_EM=0)

6 EXE	CHECK	The PdC confirms that the DMI shows the message "Unconditional emergency" and the "brake intervention symbol"
7 EXE	CHECK	The emergency condition for the train is displayed on the operator interface
8 EXE	CHECK	The Train receives the [Msg16], switches to TRIP and sends a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)
9 REP	CHECK	The train sends the ACK message to the unconditional emergency [Msg147] with Q_EMERGENCYSTOP = 2 SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=2)
10 EXE	ACTION	The PdC, with the train stopped, recognizes the Trip on the DMI
11 EXE	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
12 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK request RBC -> SSB: Msg6 (M_ACK=1)
13 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
14 REP	CHECK	RBC sends the Revocation of Emergency Stop [Msg18] with ACK request (M_ACK=1) and with the appropriate NID_EM related to the sent Msg15 RBC -> SSB: Msg18 (M_ACK=1, NID_EM=x)
15 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
16 REP	CHECK	RBC sends the Revocation of Emergency Stop [Msg18] with ACK request (M_ACK=1) and with the appropriate NID_EM related to the sent Msg16 RBC -> SSB: Msg18 (M_ACK=1, NID_EM=0)
17 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
18 EXE	CHECK	The emergency condition is no longer displayed on the operator interface
19 REP	CHECK	RBC receives a PR [Msg136] in PT (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
TC	**VBTS_SDT-SSB_065 - Failure of the integrity of the Digital Map, for an SSB with VBR in FN, due to passing an unknown facing point following the Override procedure and consequent transition of the VBR to TD**	

step	Description	Expected Result
1 EXE	ACTION	If not already stopped, the PdC stops the train immediately upstream of the facing point and carries out the Override procedure
2 EXE	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
3 EXE	ACTION	The PdC moves the train beyond the facing point
4 REP	CHECK	The VBR, detecting that the MaxSafeAntenna (corresponding to the position of the VBR Virtual Antenna increased by the confidence interval, default 30m) of the train has passed a facing-point with position unknown to the SSB, considers the Digital Map Navigation Integrity failed and switches to Track Discrimination (TD)
5 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) and includes the package “Position Report Validation Request” [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET =103)
6 REP	CHECK ___________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
7 REP	CHECK	The VBR, not being able to uniquely determine a single path of the Digital Map, discards the "Position Report Validation Request" [pkt 44/5] received from the TV and remains in TD mode
TC	**VBTS_SDT-SSB_037 - Failure to detect a VBG for an SSB located in SR but with VBR in TD**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in SR
2 REP	CHECK	The train sends a PR [Msg 136] in SR (with M_MODE=2) and includes the packet “Position Validation Check Result” [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)
3 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".

4 REP	CHECK __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The VBR, being in Track Discrimination mode, does not detect the virtual BG
TC	**VBTS_SDT-SSB_152 - Assignment of the MA with OS-FS profile for an SSB in SR with VBR in TD, and subsequent transition of the VBR to FN following the reception of the "Valid Position Report packet"**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in the first activation window (if not already present)
2 EXE	ACTION	The DCO forms the departure itinerary downstream of the train
3 REP	CHECK __________ Requirements REQ_8.1.3.3 REQ_8.1.3.3	RBC verifies that the SSB is located within the first activation window with the min safe front end and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (including the facing point present between LRBG and minSFE) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL
6 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
7 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
8 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) and includes the package “Position Validation Check Result” [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=1) and Pkt44/103 (NID_VBRPACKET =103)

9 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
10 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from RBC and considering its position unique in the Digital Map (following receipt of pkt 44/6), is able to calculate the safe and unique position and therefore passes into Full Navigation (FN) status
11 EXE	CHECK	If the train is in the OS activation window (100 m from downstream signal), the text message "EXTENSION OF MA IN FS" is displayed on the SSB DMI for 30 seconds
TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)

Post condition · Train in OS with assigned MA covering in FS at least the SBR immediately downstream of the train · Downstream train of a validated VBG · VBR in Full Navigation (FN) mode

6.4.3.4.3 VBTS_CEM_041

Management of a Conditional Emergency Ignored for shadow signal for a train with SSB in OS and VBR in FN without GPS coverage			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT CEM	LAB	Degraded	00.00

Notes	SDT must manage the "Shadow Signal" function for the CB immediately downstream of the Signal (first CB of the SBR).

Pre Condition

- SSB in OS with MA assigned up to the signal ahead of the train (MA covering only the SBR where the train is located)
- Train located upstream of OS activation window (more than 100m from downstream signal)
- LRBG positioned upstream of the train front
- Immediately downstream of the train, and on the SBR itself, there is only one VBG (in line with the signal)
- GPS coverage not present for VBR (timer T_MAX_EXP_AG_TIME=30 s expired)
- At least the first SBR downstream of the SSB front is considered "FS Proved"
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_053 - Automatic MA extension in FS for an SSB in OS mode with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC brings the SSB into the OS activation window (100m from the signal defined as EoA) and stops the train
2 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
3 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=1)
4 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are verified on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with an "On Sight" profile and the subsequent SBRs with a "Full Supervision" profile and includes the "Switch Point Status" package [Pkt 44 /6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MA-MODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER)

5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
8 EXE	CHECK	The text message “FS MA EXTENSION” is displayed on the SSB DMI for 30 seconds
TC	**VBTS_SDT-SSB_039 - Detection of a VBG for a train with VBR in Full Navigation (FN) without GPS coverage for the VBR**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] which includes: - the pkt0 with the NID_LRBG of the detected VBG - the "GNSS Position Integrity" packet [Pkt 44/105], in case the VBR has a PVT whose integrity not yet checked SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
TC	**VBTS_SDT-SSB_085 - Management of a Conditional Emergency ignored due to shadow signal for an SSB in OS, in the presence of the VBR system, following the occupation by the train of the first cdb of the downstream SBR**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train slowly onto the next CdB, passing the signal ahead of it
2 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) such as to locate the train upstream of the CdB joint detected busy SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
3 REP	CHECK	RBC verifies that the min safe front end of the train has not yet passed the Stop Location and sends a Conditional Emergency Stop message [Msg15] to the SSB RBC -> SSB: Msg15 (NID_EM=x, D_EMERGENCYSTOP>=0)

4 REP	CHECK	The SSB receives the [Msg15] and sends the Acknowledgment of Emergency Stop message [Msg147] with the variable Q_EMERGENCYSTOP=3 (MEC ignored). SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=3) with Pkt0 (M_MODE=1)
5 EXE	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) such as to locate the train on the CdB previously detected busy SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- Train in FS with assigned MA which also covers the subsequent SBRs
- GPS coverage not present for the VBR
- VBR in Full Navigation (FN) mode

6.4.3.4.4 VBTS_CEM_042

Management of a Conditional Emergency Accepted for an SSB in FS and VBR in FN for the management of the shadow signal			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT CEM	LAB	Degraded	00.00

Notes	SDT must manage the "Shadow Signal" function for the CB immediately downstream of the Signal (first CB of the SBR).

Pre Condition

- SSB in FS with assigned MA covering at least the next SBR
- Slow moving train
- Train located on the last CdB of the SBR
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_086 - Management of an Accepted Conditional Emergency for an SSB in FS and VBR in FN for the management of the shadow signal following the undue occupation of the first CdB of the SBR immediately downstream of the front train**	
step	**Description**	**Expected Result**
1 EXE	EVENT	Unlawful occupation of the CdB immediately downstream of the CdB occupied by the train.
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) such as to locate the train upstream of the CdB joint detected busy SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 REP	CHECK	RBC verifies that the min safe front end of the train has not yet passed the Stop Location and sends a Conditional Emergency Stop message [Msg15] to the SSB RBC -> SSB: Msg15 (NID_EM=x, D_EMERGENCYSTOP>0)
4 REP	CHECK	The SSB receives the [Msg15] and sends the Acknowledgment of Emergency Stop message [Msg147] with the variable Q_EMERGENCYSTOP=0/1 (MEC Accepted). SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=0/1) with Pkt0 (M_MODE=0)
5 EXE	CHECK	The PdC confirms that the SSB considers the Stop Location sent in the Conditional Emergency Stop message [D_EMERGENCYSTOP in Msg15], 20m upstream of the signal downstream of the train front, as the new SvL and that it has updated the braking curve bringing the train to stop
6 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) at stationary train SSB -> RBC: Msg136 with Pkt0 (V_TRAIN=0, M_MODE=0)

7 REP	CHECK	RBC sends the Revocation of Emergency Stop [Msg18] with ACK request (M_ACK=1) and with appropriate Nid_EM related to the sent Msg15 RBC -> SSB: Msg18 (M_ACK=1, NID_EM=x)
8 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
9 REP	CHECK	RBC receives the ack message [Msg146] and then sends the SSB a Movement Authority message [Msg3] requesting ACK (M_ACK = 1), with EoA at the stop location RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt44/6
10 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
11 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- Train in FS with MA up to the signal immediately after the front of the train
- RBC has detected an illegal occupation of the CdB immediately downstream of the train front (first CdB of the downstream SBR)
- No active Emergency for the train
- VBR in Full Navigation (FN) mode

6.4.3.4.5 VBTS_CEM_043

Management of a Conditional Accepted Emergency for SSB in OS and VBR in FN for the management of the shadow signal with virtual LRBG positioned downstream of the train front and on its own SBR			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT CEM	LAB	Degraded	00.00

Notes	SDT must manage the "Shadow Signal" function for the CB immediately downstream of the Signal (first CB of the SBR).

Pre Condition

- Train in PT located by RBC on the last CdB of the SBR (in the first activation window)
- LRBG is a validated VBG positioned downstream of the train front and at least 20 meters upstream of the signal in front of the train (corresponding to the Stop Location)
- At least the first SBR downstream of the train front is considered "FS Proved"
- No active Emergency for the train
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_079 - Revaluation of the MA with OS-FS profile, for an SSB in PT and VBR in FN, with virtual LRBG positioned downstream of the train front**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC selects Start on the DMI
2 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (Q_DIRLRBG<>Q_DLRBG, M_MODE=8)
3 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends to the SSB a MA with Shifted Location Reference [Msg33] message with ACK request (M_ACK = 1) and D_REF correctly calculated as the distance between LRBG and the new Shifted reference location, with an OS profile on the first activation window and FS on subsequent SBRs considered "FS Proved" and includes: - the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg33 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 (D_LINK=D_REF, NID_BG= NID_LRBG), Pkt80 (D_MA-MODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL

6 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window and 32767 if LRBG in downstream SBR) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
7 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
8 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) in position Shifted SSB -> RBC: Msg136 with Pkt0 (Q_DIRLRBG<>Q_DLRBG, M_MODE=1)
9 EXE	CHECK	If LRBG is in downstream SBR, text message "EXTENDED MA IN FS" is displayed on SSB DMI for 30 seconds
TC	**VBTS_SDT-SSB_087 - Management of a Conditional Accepted Emergency, for an SSB in OS and VBR in FN, for the management of the shadow signal with virtual LRBG positioned downstream of the front of the train and at least 20m upstream of the signal in front of the train**	
step	**Description**	**Expected Result**
1 EXE	EVENT	Unlawful occupation of the CdB immediately downstream of the CdB occupied by the train
2 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) such as to locate the train upstream of the CdB joint detected busy SSB -> RBC: Msg136 with Pkt0 (Q_DIRLRBG<>Q_DLRBG, M_MODE=1)
3 REP	CHECK	RBC verifies that the min safe front end of the train has not yet passed the Stop Location and sends a Conditional Emergency Stop message [Msg15] to the SSB with variable D_REF equal to 0 and D_EMERGENCYSTOP equal to the absolute distance between the LRBG and the point positioned at 20 meters upstream of the signal in front of the train (stop location). RBC -> SSB: Msg15 (NID_EM=x, D_REF=0, D_EMERGENCYSTOP>0)
4 REP	CHECK	The SSB receives the [Msg15] and sends the Acknowledgment of Emergency Stop message [Msg147] with the variable Q_EMERGENCYSTOP=0/1 (MEC Accepted). SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=0/1) with Pkt0 (M_MODE=1)
5 EXE	CHECK	The DP confirms that the SSB considers the Stop Location sent in the Conditional Emergency Stop message [D_EMERGENCYSTOP in Msg15], 20m upstream of the signal downstream of the train front, as the new SvL
6 REP	CHECK	RBC sends the Revocation of Emergency Stop [Msg18] with ACK request (M_ACK=1) and with appropriate Nid_EM related to the sent Msg15 RBC -> SSB: Msg18 (M_ACK=1, NID_EM=x)
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

8 REP	CHECK	RBC receives the ack message [Msg146] and then sends to the SSB a MA with Shifted Location Reference [Msg33] message with ACK request (M_ACK = 1), with EoA at the stop location and with Mode Profile packets [Pkt80] and Switch Point Status [Pkt44/6] RBC -> SSB: Msg33 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<=L_ENDSECTION) and Pkt44/ 6
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (Q_DIRLRBG<>Q_DLRBG, M_MODE=1)

Post condition

- Train in OS with MA up to the signal immediately after the front of the train
- LRBG is a validated VBG positioned downstream of the train front
- RBC has detected an illegal occupation of the CdB immediately downstream of the train front (first CdB of the downstream SBR)
- No active Emergency for the train
- VBR in Full Navigation (FN) mode

6.4.3.5 UEM

6.4.3.5.1 VBTS_UEM_044

Management of an unconditional Emergency for a single train in FS, in the presence of the VBR system, and subsequent re-evaluation of the MA for an SSB in SR following the Override procedure			
FUNCTION	**Execution**	**Scenario's Type**	**version**
EMU BUT	SITE LAB	Not nominal	00.00

Notes	The scenario foresees that the train picks up a VBG in TR during the emergency braking due to the activation of an unconditional emergency for single train activated by the operator; it is therefore necessary for the train to be moving immediately upstream of the VBG when the limp is activated.

Pre Condition

- Train in FS located in the first activation window with assigned MA which also covers the subsequent SBRs
- Immediately downstream of the train, and in its own SBR, there is a VBG configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_088 - Management of an unconditional Emergency by command from RBC operator for an SSB in FS with VBR in FN which, during emergency braking, picks up a VBG**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The RBC Operator through the RBC TO carries out an "Emergency activation of single train" command
3 REP	CHECK	RBC sends Unconditional Emergency Stop message [Msg16] to train RBC -> SSB: Msg16 (NID_EM=0)
4 EXE	CHECK	The PdC confirms that the DMI shows the message "Unconditional emergency" and the "brake intervention symbol"
5 EXE	CHECK	The emergency condition for the train is displayed on the operator interface
6 EXE	CHECK	The Train receives the [Msg16], switches to TRIP and sends a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)
7 REP	CHECK	The train sends the ACK message to the unconditional emergency [Msg147] with Q_EMERGENCYSTOP = 2. SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=2) with Pkt0 (M_MODE=7)
8 REP	CHECK	RBC receives [Msg147] with Q_EMERGENCYSTOP = 2 and stops sending [Msg16]

9 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The train during emergency braking passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna"
10 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=7) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
11 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
12 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=7)
13 EXE	ACTION	The PdC, with the train stopped, recognizes the Trip on the DMI
14 EXE	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
15 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK request RBC -> SSB: Msg6 (M_ACK=1)
16 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
17 REP	CHECK	RBC releases the association between the SSB NID_ENGINE and the signal
TC	**VBTS_SDT-SSB_080 - Transition to SR after Override and Reevaluation command of the MA with OS-FS profile for an SSB initially in PT and VBR in FN, after an emergency activated by the operator and not revoked**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in PT (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)

2 EXE	ACTION	The PdC performs Override
3 EXE	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
4 EXE	CHECK	RBC considers the distress no longer active for the SSB and the distress condition for the train is no longer displayed on the operator interface
5 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC verifies that the SSB is located within the first activation window with the min safe front end and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE >=0, M_MAMODE=0, L_MA-MODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
6 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
7 EXE	CHECK	The MA is displayed on the RBC QL
8 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
9 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
10 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
11 EXE	ACTION	The PdC moves the train to the next SBR
12 EXE	CHECK	Text message “EXTENDED MA IN FS” is displayed on the SSB DMI for 30 seconds when the SSB enters the OS activation window (100m from downstream signal)
13 EXE	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- Train in FS
- VBR in Full Navigation (FN) mode

6.4.3.5.2 VBTS_UEM_045

Detection of the virtual LRBG during a backward movement for a Train in PT with VBR in FN following an unconditional emergency activated by the RBC Operator			
FUNCTION	**Execution**	**Scenario's Type**	**version**
EMU	LAB	Not nominal	00.00

Notes	The maximum distance that can be covered with a backward movement for a train in PT is defined by the national value D_NVPOTRP (20m); therefore, the HP must stop the train within 20m after having received the VBG.

Pre Condition

- Train in FS
- Immediately downstream of the train, and in its own SBR, there is at least one VBG configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)

TC	VBTS_SDT-SSB_089 - Management of an unconditional Emergency for SSB in FS with VBR in FN for emergency activation command to the single train sent by the RBC operator	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The RBC Operator through the RBC TO carries out an "Emergency activation of single train" command
3 REP	CHECK	RBC sends Unconditional Emergency Stop message [Msg16] to train RBC -> SSB: Msg16 (NID_EM=0)
4 EXE	CHECK	The PdC confirms that the DMI shows the message "Unconditional emergency" and the "brake intervention symbol"
5 EXE	CHECK	The emergency condition for the train is displayed on the operator interface
6 EXE	CHECK	The Train receives the [Msg16], switches to TRIP and sends a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)
7 REP	CHECK	The train sends the ACK message to the unconditional emergency [Msg147] with Q_EMERGENCYSTOP = 2. SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=2) with Pkt0 (M_MODE=7)
8 REP	CHECK	RBC receives [Msg147] with Q_EMERGENCYSTOP = 2 and stops sending [Msg16]
9 EXE	ACTION	The PdC, with the train stopped, recognizes the Trip on the DMI
10 EXE	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
11 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK request RBC -> SSB: Msg6 (M_ACK=1)
12 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
13 REP	CHECK	RBC releases the association between the SSB NID_ENGINE and the signal

TC	VBTS_SDT-SSB_090 - Revocation of the emergency to the single train, in the presence of the VBR system, previously activated by the RBC operator	
step	**Description**	**Expected Result**

1 REP	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
2 EXE	ACTION	The RBC Operator through the RBC TO carries out a command to "Revoke the emergency for the single train"
3 REP	CHECK	RBC sends Revocation of Emergency Stop [Msg18] with ACK request (M_ACK=1) RBC -> SSB: Msg18 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The emergency condition is no longer displayed on the operator interface
6 REP	CHECK	RBC receives a PR [Msg136] in PT (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
TC	**VBTS_SDT-SSB_077 - GNSS Position Rollback for a VBR in FN which, during the backward movement of an SSB in PT, has detected a VBG in both travel directions**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC a PR [Msg 136] valid in PT (with M_MODE=8), from standstill (V_TRAIN = 0) which includes the [Pkt 0] referred to the LRBG which is upstream of the train front SSB -> RBC: Msg136 with Pkt0 (D_LRBG<20m, Q_DIRLRBG = Q_DLRBG, V_TRAIN = 0, M_MODE = 8)
2 EXE	ACTION __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The PdC moves the train backwards in PT until it passes the LRBG with the "VBR virtual antenna".
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR, detecting that the VBG (LRBG) has been captured more than once, does not request the validation of the VBG from the GAD but considers the GNSS position integrity failed and performs the GNSS Position Rollback procedure and updates its position by calculating an enlargement of the fronts of the train (L_DOUBTUNDER and L_DOUBTOVER) using the LRBG as reference and send to RBC a Position Report [Msg 136] with [Pkt 0] SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, Q_DIRLRBG<>Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN >0, M_MODE=8)
4 EXE	CHECK	In line with the previously received National Values (D_NVPOTRP=20) the SSB allows to cover the maximum withdrawal distance in PT operating mode of 20m
5 EXE	ACTION	The PdC stops the train after 20m of backward movement

6 REP	CHECK	The SSB sends RBC a PR [Msg136] valid in PT (M_MODE = 8) which includes the [Pkt0] referring to the VBG which is downstream of the train front SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, Q_DIRLRBG<>Q_DLRBG, V_TRAIN = 0, M_MODE = 8)

Post condition

- SSB stopped in PT
- LRBG is a validated VBG positioned downstream of the train front within a distance of 20m (D_NVPOTRP)
- No active Emergency for the train
- VBR in Full Navigation (FN) mode

6.4.3.5.3 VBTS_UEM_046

Digital Map Integrity failure for an SSB in PT, following an all-train emergency, which passes a facing-point during a backward movement			
FUNCTION	**Execution**	**Scenario's Type**	**version**
EMU DP	LAB	Not nominal	00.00

Notes	The test scenario requires that the train stops in TR, following the emergency to all trains, within 20m from the validated facing-point in order to allow it to go upstream of the switch according to D_NVPOTRP.

Pre Condition

- SSB in OS in a station SBR
- Slow moving train
- The front of the train passed a trailing point by a maximum of 20 metres
- Immediately downstream of the train, and on its own SBR, there is a facing point
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_091 - Management of an unconditional Emergency for an SSB in OS and VBR in FN for activation command of an emergency to all trains sent by the RBC operator**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
2 EXE	ACTION	The RBC Operator through the RBC TO sends an "Emergency activation to all trains" command
3 REP	CHECK	RBC sends an Unconditional Emergency Stop message [Msg16] to all connected trains RBC -> SSB: Msg16 (NID_EM=0)
4 EXE	CHECK	The HP of the connected train confirms that the DMI shows the message "uncon-ditional emergency" and the "brake intervention symbol"
5 EXE	CHECK	The emergency condition for the train is displayed on the operator interface
6 EXE	CHECK	The Train receives the [Msg16], switches to TRIP and sends a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)
7 REP	CHECK	The train sends the ACK message to the unconditional emergency [Msg147] with Q_EMERGENCYSTOP = 2. SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=2) with Pkt0 (M_MODE=7)
8 REP	CHECK	RBC receives [Msg147] with Q_EMERGENCYSTOP = 2 and stops sending [Msg16]

9 EXE	ACTION	The PdC, with the train stopped, recognizes the Trip on the DMI
10 EXE	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
11 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK request RBC -> SSB: Msg6 (M_ACK=1)
12 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_092 - Revocation of the emergency to all trains, previously activated by the RBC operator**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
2 EXE	ACTION	The RBC Operator through the RBC TO carries out a "Revoke all trains emergency" command
3 REP	CHECK	RBC sends Revocation of Emergency Stop [Msg18] with ACK request (M_ACK=1) RBC -> SSB: Msg18 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The emergency condition is no longer displayed on the operator interface
6 REP	CHECK	RBC receives a PR [Msg136] in PT (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
TC	**VBTS_SDT-SSB_067 - Digital Map integrity failure, for an SSB in PT with VBR in FN, which passes a point during a backward movement**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC a PR [Msg 136] valid in PT (with M_MODE=8), from standstill (V_TRAIN = 0) which includes the [Pkt 0] referred to the LRBG which is upstream of the train front SSB -> RBC: Msg136 with Pkt0 (Q_DIRLRBG = Q_DLRBG, V_TRAIN = 0, M_MODE = 8)
2 EXE	ACTION	The PdC moves the train in PT backwards until it goes upstream of the facing-point

3 REP	CHECK	The VBR, detecting that the minSafeAntenna (corresponding to the position of the VBR Virtual Antenna) of the train has passed a facing point with unknown position, considers the Digital Map Navigation Integrity failed and switches to Track Discrimination (TD) mode
Post condition · Train in PT upstream of a trailing point following a backward movement · No active Emergency for the train · VBR in Track Discrimination (TD) mode due to Digital Map Integrity Failure		

6.4.3.5.4 VBTS_UEM_078

Management of an unconditional emergency for an SSB in FS due to the occupation of a CDB of the SBR on which the train is located			
FUNCTION	**Execution**	**Scenario's Type**	**version**
EMU	LAB	Degraded	00.00
Notes			
Pre Condition · SSB in FS located on an SBR including at least three CDBs · Downstream of the train front, and in its own SBR, there are at least two free detected CDBs · VBR in Full Navigation (FN) mode			

TC	**VBTS_SDT-SSB_144 - Management of an unconditional emergency for an SSB in FS with VBR in FN, following the illegal occupation of a CDB downstream of the train front and included in its own SBR**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	EVENT	There is an unlawful occupation of a cdb other than the one immediately downstream of the train but included in its own SBR
3 REP	CHECK	RBC sends Unconditional Emergency Stop message [Msg16] to train RBC -> SSB: Msg16 (NID_EM=0)
4 EXE	CHECK	The PdC confirms that the DMI shows the message "Unconditional emergency" and the "brake intervention symbol"

5 EXE	CHECK	The emergency condition for the train is displayed on the operator interface
6 EXE	CHECK	The Train receives the [Msg16], switches to TRIP and sends a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)
7 REP	CHECK	The train sends the ACK message to the unconditional emergency [Msg147] with Q_EMERGENCYSTOP = 2. SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=2) with Pkt0 (M_MODE=7)
8 REP	CHECK	RBC receives [Msg147] with Q_EMERGENCYSTOP = 2 and stops sending [Msg16]
9 EXE	ACTION	The PdC, with the train stopped, recognizes the Trip on the DMI
10 EXE	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
11 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK request RBC -> SSB: Msg6 (M_ACK=1)
12 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
13 REP	CHECK	RBC releases the association between the SSB NID_ENGINE and the signal
14 REP	CHECK	RBC sends Revocation of Emergency Stop [Msg18] with ACK request (M_ACK=1) RBC -> SSB: Msg18 (M_ACK=1)
15 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
16 EXE	CHECK	The emergency condition is no longer displayed on the operator interface
17 REP	CHECK	RBC receives a PR [Msg136] in PT (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)

Post condition

- SSB in PT
- No active emergency for the train
- VBR in Full Navigation (FN) mode

6.4.3.6 EOM

6.4.3.6.1 VBTS_EOM_047

Nominal EoM procedure for an SSB in FS with VBR in FN			
FUNCTION	**Execution**	**Scenario's Type**	**version**
EOM extension	SITE LAB	Nominal	00.00

Notes	

Pre Condition

- SSB in FS
- The communication channel between RBC and GAD assigned to the train is open
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_043 - Nominal EoM procedure for an SSB with assigned MA, in the presence of a VBR system**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC, with the train stopped, carries out the EoM procedure
2 REP	CHECK	SSB sends End of Mission message [Msg150] to RBC SSB -> RBC: Msg150
3 REP	CHECK	RBC starts the de-registration of the SSB by sending a General Message [Msg24] which contains the Packet Session Management [Pkt42] with the Q_RBC variable equal to zero (0) and with the RBC identifier and telephone number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
4 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
5 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
6 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
7 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
8 REP	CHECK	RBC releases the association between the SSB NID_ENGINE and the signal

Post condition
· Communication session between RBC and SSB terminated · The communication channel between RBC and GAD assigned to the train is closed · VBR in Full Navigation (FN) mode

6.4.3.6.2 VBTS_EOM_048

Nominal EoM procedure for an SSB in OS with VBR in FN			
FUNCTION	**Execution**	**Scenario's Type**	**version**
EOM extension	LAB	Nominal	00.00

Notes	

Pre Condition

- SSB in OS
- The communication channel between RBC and GAD assigned to the train is open
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_043 - Nominal EoM procedure for an SSB with assigned MA, in the presence of a VBR system**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC, with the train stopped, carries out the EoM procedure
2 REP	CHECK	SSB sends End of Mission message [Msg150] to RBC SSB -> RBC: Msg150
3 REP	CHECK	RBC starts the de-registration of the SSB by sending a General Message [Msg24] which contains the Packet Session Management [Pkt42] with the Q_RBC variable equal to zero (0) and with the RBC identifier and telephone number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
4 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
5 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
6 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
7 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
8 REP	CHECK	RBC releases the association between the SSB NID_ENGINE and the signal

Post condition
· Communication session between RBC and SSB terminated · The communication channel between RBC and GAD assigned to the train is closed · VBR in Full Navigation (FN) mode

6.4.3.6.3 VBTS_EOM_049

Nominal EoM procedure for an SSB in SR in the presence of a VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
EOM extension	LAB	Nominal	00.00

Notes	

Pre Condition

- SSB in unlocated SR
- The communication channel between RBC and GAD assigned to the train is open
- VBR in Track Discrimination (TD) mode

TC	**VBTS_SDT-SSB_044 - Nominal EoM procedure for an SSB in SR, in the presence of a VBR system**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC, with the train stopped, carries out the EoM procedure
2 REP	CHECK	SSB sends End of Mission message [Msg150] to RBC SSB -> RBC: Msg150
3 REP	CHECK	RBC starts the de-registration of the SSB by sending a General Message [Msg24] which contains the Packet Session Management [Pkt42] with the Q_RBC variable equal to zero (0) and with the RBC identifier and telephone number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
4 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
5 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
6 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
7 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO

8 REP	CHECK ___________ Requirements REQ_8.1.1.1	The VBR, no longer receiving the differential corrections [pkt 44/3] for at least 30 seconds (timer T_MAX_EXP_AG_TIME=30 s expired), is no longer able to calculate the safe 3D GNSS position and goes into Stand By (SB) mode

Post condition

- Communication session between RBC and SSB terminated
- The communication channel between RBC and GAD assigned to the train is closed
- VBR in Track Discrimination (TD) mode

6.4.3.7 COM

6.4.3.7.1 VBTS_COM_050

Failure of GNSS position integrity following non-validation of a VBG due to radio degradation in RBC-SSB communication and consequent GNSS position rollback			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT COM	SITE LAB	Degraded	00.00

Notes	

Pre Condition

- Train in FS with assigned MA covering the following SBRs
- Immediately downstream of the train, and in its own SBR, there are at least two consecutive VBGs configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)

TC	VBTS_SDT-SSB_070 - GNSS position rollback for an SSB in FS with VBR in FN due to failure to validate a VBG due to a temporary RBC-SSB connection drop	
step	**Description**	**Expected Result**
1 EXE	ACTION __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	As the train moves forward, it passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) - (RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 EXE	EVENT	Temporary loss of the RBC-SSB radio link
4 EXE	CHECK	The T_NVCONTACT expires (7 seconds) and the SSB, in line with the previously received National Values (M_NVCONTACT=1), applies the service braking, and with the train stationary, reduces the current MA on the train front.
5 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR, not receiving a response from RBC within 30 s (T_MAX_EXP_IC_TIME), considers the GNSS position integrity failed
6 EXE	EVENT	The Safe Connection with the SSB is re-established, within the T_RESTORE, during one of the 3 attempts (120 seconds) to restore by the SSB
7 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR updates its position by calculating a widening of the train edges (L_DOUBTUNDER and L_DOUBTOVER) using the PVLRBG as a reference and sends a Position Report to RBC [Msg 136] with [Pkt 0] SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0/1)
Post condition · FS train downstream of a non-validated VBG · The fronts of the train were widened following the failure of GNSS position integrity · VBR in Full Navigation (FN) mode		

6.4.3.7.2 VBTS_COM_051

Safe connection management between RBC and SSB in presence of VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT COM	SITE LAB	Degraded	00.00

Notes		
Pre Condition · Communication session between RBC and SSB successfully established · SSB in FS with MA assigned up to the signal in front of the train (MA covering only the SBR where the train is located) · SBR downstream of the SSB front is considered "OS Proved" · Train located upstream of OS activation window (more than 100m from downstream signal) · VBR in Full Navigation (FN) mode		
TC	**VBTS_SDT-SSB_093 - Restore of the Safe Connection before the expiry of the T_RESTORE with train in FS and VBR in FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends a PR [Msg136] in FS (with M_MODE=0) to the RBC SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	EVENT	Loss of the RBC-SSB radio link
3 EXE	CHECK	RBC detects the failure of the Safe Connection with the SSB and activates the T_RESTORE (300 seconds) displaying the degradation on the QL
4 REP	CHECK	RBC does not send any messages to the SSB
5 EXE	CHECK	The T_NVCONTACT expires (7 seconds) and the SSB, in line with the previously received National Values (M_NVCONTACT=1), applies the service braking, and with the train stationary, reduces the current MA on the train front.
6 REP	CHECK __________ Requirements REQ_8.1.1.1	The T_MAX_EXP_AG_TIME (30 seconds) expires and the VBR considers the last differential corrections received no longer valid and switches to navigation based on odometric data
7 EXE	EVENT	The Safe Connection with the SSB is re-established, within the T_RESTORE, during one of the attempts (every 15 seconds) to restore by the SSB
8 REP	CHECK	The SSB sends a PR [Msg136] in FS (with M_MODE=0) to the RBC SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
9 REP	CHECK	RBC receives a Position Report and sends the MA (in FS) to the SSB, with ack request, currently assigned to the train RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
10 REP	CHECK	SSB sends ACK message [Msg146] to RBC SSB -> RBC: Msg146

11 REP	CHECK ________ Requirements REQ_8.1.1.1 REQ_8.1.1.4	RBC sends to the VBR the General Messages [Msg 24] with the “GNSS Differential Correction” packets [Pkt 44/3] calculated during the RBC-SSB connection failure, and restores the cyclical sending (T_CORR_PERIOD=10s) of the information necessary to PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
12 REP	CHECK	RBC resumes sending messages to the SSB continuing to manage the train normally in FS
TC	**VBTS_SDT-SSB_055 - Automatic extension of the MA in OS on the SBR downstream of the train front for an SSB in FS mode with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC brings the train into the OS activation window (minSFE at 100m from the downstream signal defined as EoA)
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
4 REP	CHECK	RBC verifying that the SSB is located in the OS activation window and that the MA extension conditions are verified, sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with the "Full supervision" profile and the subsequent SBR with the "On Sight" profile and includes: - the Mode Profile package in OS [Pkt80] which extends from the signal in front of the train and includes the entire following SBR RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5. Pkt80 (D_MAMODE>0, M_MAMODE=0, L_MAMODE<L_ENDSECTION, L_ACKMAMODE=100) and Pkt44/6
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The MA is displayed on the RBC QL
7 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
8 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
9 EXE	ACTION	The PdC moves the train to the next SBR (considered OS proved for busy CdB)
TC	**VBTS_SDT-SSB_094 - Restore of the Safe Connection before the expiration of the T_RESTORE with train in OS and VBR in FN**	

step	Description	Expected Result
1 REP	CHECK	SSB sends PR [Msg136] in OS (with M_MODE=1) to RBC SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
2 EXE	EVENT	Loss of the RBC-SSB radio link
3 EXE	CHECK	RBC detects the failure of the Safe Connection with the SSB and activates the T_RESTORE (300 seconds) displaying the degradation on the QL
4 REP	CHECK	RBC does not send any messages to the SSB
5 EXE	CHECK	The T_NVCONTACT expires (7 seconds) and the SSB in line with the previously received National Values (M_NVCONTACT=1) applies the service braking, and with the train stationary, reduces the current MA on the train front
6 REP	CHECK ___________ Requirements REQ_8.1.1.1	The T_MAX_EXP_AG_TIME (30 seconds) expires and the VBR considers the last differential corrections received no longer valid and switches to navigation based on odometric data
7 EXE	EVENT	The Safe Connection with the SSB is re-established, within the T_RESTORE, during one of the attempts (every 15 seconds) to restore by the SSB
8 REP	CHECK	SSB sends PR [Msg136] in OS (with M_MODE=1) to RBC SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
9 REP	CHECK	RBC receives a Position Report and sends the MA (in OS) to the SSB, with ack request, currently assigned to the train RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (M_MAMODE=0) and Pkt44/6
10 REP	CHECK	SSB sends ACK message [Msg146] to RBC SSB -> RBC: Msg146
11 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.1.4	RBC sends to the VBR the General Messages [Msg 24] with the “GNSS Differential Correction” packets [Pkt 44/3] calculated during the RBC-SSB connection failure, and restores the cyclical sending (T_CORR_PERIOD=10s) of the information necessary to PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
12 REP	CHECK	RBC resumes sending messages to the SSB continuing to manage the train normally in OS
TC	**VBTS_SDT-SSB_095 - Nominal management of Safe Connection loss after its correct and complete activation, for an SSB equipped with VBR system**	
step	**Description**	**Expected Result**
1 EXE	EVENT	Loss of the RBC-SSB radio link

2 EXE	CHECK	RBC detects the failure of the Safe Connection with the SSB and activates the T_RESTORE (300 seconds) but continues to consider the communication session active
3 EXE	CHECK	On the RBC QL the connection with the SSB is displayed as KO
4 EXE	EVENT	The T_RESTORE expires and the safe connection has not yet been restored
5 REP	CHECK	RBC considers the communication with the SSB in the "LOST" state, stores the information relating to the SSB (position, train data and any alarms) and activates the T_STORETRAIN
6 REP	CHECK	T_STORETRAIN expires and RBC releases the train/channel association, considers the Safe Connection with SSB terminated, closes the RBC-GAD communication channel assigned to the train and cancels the train
7 EXE	CHECK	The train is no longer displayed on RBC's QL

Post condition

- Communication session between RBC and SSB terminated
- The communication channel between RBC and GAD assigned to the train is closed
- VBR in Full Navigation (FN) mode

6.4.3.7.3 VBTS_COM_052

GNSS Position Integrity failure and consequent rollback for an SSB that, during a temporary connection drop, picks up a VBG and subsequent recalibration of the confidence interval on a VBG			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT COM	SITE LAB	Degraded	00.00

Notes	

Pre Condition

- Communication session between RBC and SSB successfully established
- SSB in FS with assigned MA covering subsequent SBRs
- Immediately downstream of the train, and in its own SBR, there are two VBGs configured consecutively in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_096 - Detection of a VBG for an SSB in SR that performs Override during an RBC-SSB connection drop and subsequent restoration of the connection within the T_RESTORE**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends a PR [Msg136] in FS (with M_MODE=0) to the RBC SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	EVENT	Loss of the RBC-SSB radio link
3 EXE	CHECK	RBC detects the failure of the Safe Connection with the SSB and activates the T_RESTORE (300 seconds) displaying the degradation on the QL
4 REP	CHECK	RBC does not send any messages to the SSB
5 EXE	CHECK	The T_NVCONTACT expires (7 seconds) and the SSB, in line with the previously received National Values (M_NVCONTACT=1), applies the service braking, and with the train stationary, reduces the current MA on the train front.
6 REP	CHECK ___________ Requirements REQ_8.1.1.1	The T_MAX_EXP_AG_TIME (30 seconds) expires and the VBR considers the last differential corrections received no longer valid and switches to navigation based on odometric data
7 EXE	ACTION	The PdC performs the Override procedure and confirms that the SSB transits in SR mode

8 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes with the "VBR virtual antenna" the position where a VBG is foreseen in the Digital Map but, since the Safe connection is not active, the VBR does not require the validation of the VBG
9 EXE	EVENT	The Safe Connection with the SSB is re-established, within the T_RESTORE, during one of the attempts (every 15 seconds) to restore by the SSB
10 EXE	CHECK	The SSB sends to RBC a Position Report [Msg136] in SR (with M_MODE=2) with the NID_LRBG of the VBG not validated and with a widening of the confidence interval (L_DOUBTUNDER and L_DOUBTOVER) SSB -> RBC: Msg136 with Pkt0 (NID_LRBG , L_DOUBTOVER, L_DOUBTUNDER, M_MODE=2)
11 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC verifies that the SSB is located within the first activation window with the min safe front end and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE >=0, M_MAMODE=0, L_MA-MODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
12 REP	CHECK	SSB sends ACK message [Msg146] to RBC SSB -> RBC: Msg146
13 EXE	CHECK	The MA is displayed on the RBC QL
14 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
15 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
16 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
17 EXE	CHECK	If the train is in the OS activation window (100 m from downstream signal), the text message “EXTENSION OF MA IN FS” is displayed on the SSB DMI for 30 seconds

18 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.1.4	RBC sends to the VBR the General Messages [Msg 24] with the “GNSS Differential Correction” packets [Pkt 44/3] calculated during the RBC-SSB connection failure, and restores the cyclical sending (T_CORR_PERIOD=10s) of the information necessary to PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
TC	**VBTS_SDT-SSB_075 - Recalibration of the confidence interval for an SSB with VBR in FN picking up a VBG**	
step	**Description**	**Expected Result**
1 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The PoC moves the train forward until it passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna"
2 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0], with the recalibrated confidence interval (L_DOUBTUNDER and L_DOUBTOVER), and the "GNSS Position Integrity” [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, L_DOUBTUNDER, L_DOUBTOVER, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with the packet "GNSS Position Integrity Result" [Pkt 44/10] valuing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the identifier of the validated VBG (NID_VALBG) RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG)
4 REP	CHECK ___________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, M_MODE=0/1)

Post condition

- SSB in OS with MA assigned in FS on downstream SBRs
- Train immediately downstream of a validated VBG with recalibrated confidence interval
- VBR in Full Navigation (FN) mode

6.4.3.7.4 VBTS_COM_053

Procedure for disconnecting a train with VBR in SF mode			
FUNCTION	**Execution**	**Scenario's Type**	**version**
COM	LAB	Degraded	00.00
Notes			

Pre Condition

- Communication session between RBC and SSB established
- VBR in Full Navigation (FN) mode

TC	VBTS_SDT-SSB_097 - Disconnection procedure of a train with VBR presenting itself in SF mode	
step	**Description**	**Expected Result**
1 EXE	EVENT ___________ Requirements	The VBR detects a fault that has an impact on safety (eg loss of the CTODL) with consequent passage to SF of the VBR and the SSB
2 EXE	CHECK	RBC receives a PR [Msg136] in SF (with M_MODE=9) SSB -> RBC: Msg136 with Pkt0 (M_MODE=9)
3 REP	CHECK	RBC starts the de-registration of the SSB activating the timer T_WAITTERM (10s) and sending a General Message [Msg24] which contains the Packet Session Management [Pkt42] with the variable Q_RBC equal to zero (0) and with the identifier that the number RBC Phone Number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
4 EXE	CHECK	RBC not having received the Termination of a Communication Session [Msg156] message within the timer T_WAITTERM (10 s) considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and cancels the SSB from the list of connected trains and shown on the TO of RBC

Post condition

- Communication session between RBC and SSB terminated
- VBR in System Failure (SF) mode

6.4.3.7.5 VBTS_COM_079

Procedure for disconnecting a train in SF mode, in the presence of the VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
COM	LAB	Degraded	00.00
Notes			

Pre Condition
- Communication session between RBC and SSB established

TC	**VBTS_SDT-SSB_145 - Disconnection procedure for a train presenting itself in SF mode, in the presence of the VBR system**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB detects a fault that has an impact on safety
2 EXE	CHECK	RBC receives a PR [Msg136] in SF (with M_MODE=9) SSB -> RBC: Msg136 with Pkt0 (M_MODE=9)
3 REP	CHECK	Having detected a fault condition, the SSB closes the communication channel with the VBR which, consequently, passes into System Failure (SF) mode
4 REP	CHECK	RBC starts the de-registration of the SSB activating the timer T_WAITTERM (10s) and sending a General Message [Msg24] which contains the Packet Session Management [Pkt42] with the variable Q_RBC equal to zero (0) and with the identifier that the number RBC Phone Number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
5 EXE	CHECK	RBC not having received the Termination of a Communication Session [Msg156] message within the timer T_WAITTERM (10 s) considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and cancels the SSB from the list of connected trains and shown on the TO of RBC

Post condition
- Communication session between RBC and SSB terminated
- VBR in System Failure (SF) mode

6.4.3.8 LNTC-L2

6.4.3.8.1 VBTS_LNTC-L2_054

Nominal input management in L2 for an SSB equipped with VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PJ MA	SITE LAB	Nominal	00.00

Notes	Scenario valid in case the area upstream of the entry border is an ERTMS level 2 area. This scenario requires the presence of a VBG between the first fixed PI in area L2 (eg of type R or R/C) and the boundary PI of type S/L2.

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains (P_MAXTRAIN) that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- SSB in National System upstream of the connection PI (eg type C or Cs or R/C)
- Between the first PI useful for the assignment of the MA (eg of type R) and the boundary PI S/L2 there is at least one VBG configured in the Digital Map
- The orientation of the train agrees with the direction of the entry point in the level 2 ERTMS area
- At least the first SBR downstream of the entry boundary is "FS Proved"
- The SBR downstream of the border includes at least one VBG configured in the Digital Map
- VBR in Start-Up Configuration (SC) mode
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible

TC	**VBTS_SDT-SSB_098 - Activation of a Communication Session for SSB coming from a non-ERTMS area which detects a C/Cs type PI**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train towards area L2
2 EXE	CHECK	SSB, moving towards the ERTMS area, detects a connection PI (eg type C or Cs or R/C)
3 EXE	EVENT	The SSB sends the RBC a Safe Connection request with the data received from the connection PI (Pkt 42): - the telephone number of the RBC - the ID of the RBC
4 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
5 EXE	CHECK	The SSB informs the PdC of the established Safe Connection

6 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
7 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1) RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
8 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
9 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the message Session Established [Msg 159], considers the Communication Session active SSB -> RBC: Msg159
10 REP	CHECK	SSB sends Packet Train running number [Pkt 5] in [Msg 136] SSB -> RBC: Msg136 with Pkt0 (M_MODE=13) and Pkt5 (NID_OPERATIONAL)
11 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
12 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_151 - Compatibility check of Interface Protocol and Digital Map versions for a train, with VBR in SC, coming from a non-ERTMS area, with consequent transition of VBR to SB and subsequently to FN**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6	The VBR, having verified the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received from the TV, switches to Stand-By (SB) mode

4 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.1.1 REQ_8.1.2.3	The VBR informs the VT of the compatibility of the Interface Protocol versions and the Digital Map signatures through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") and includes: - the "Reference Position" package [Pkt 44/101] with NID_LRBG="unknown"; - the "Position Validation Check Result" package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB (VBR) -> RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALI-DATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITER=0)
5 REP	CHECK __________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
6 EXE	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
TC	**VBTS_SDT-SSB_099 - Management of GNSS Parameters and GNSS Navigation Data for a train coming from a non-ERTMS area and consequent transition of VBR to FN**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
TC	**VBTS_SDT-SSB_100 - Nominal management of Validated Train Data for an SSB coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg129] with the packets Position Report [Pkt0] with M_MODE=13 (National System) and Validated train data [Pkt11] SSB -> RBC: Msg129 with Pkt0 (M_MODE=13) and Pkt11
2 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the Acknowledgment of Train Data [Msg8] message requesting (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
3 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
4 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_101 - Input MA assignment for an SSB, with VBR in FN, coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 EXE	CHECK	SSB, moving towards the ERTMS area, detects a fixed PI in area L2 (eg of type R) PI -> SSB: Pkt46 (M_LEVELTR=3, N_ITER=1, M_LEVELTR(k)=1) and Pkt255
2 REP	CHECK	The SSB, being in a level contained in the priority list of the previously received packet 46, remains in SN mode and sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the fixed PI in area L2 SSB -> RBC: Msg136 with Pkt0 (M_MODE=13)
3 REP	CHECK	RBC activates the input MA assignment process and sends the SSB a General Message [Msg24] which includes the Level Transition Order packet [Pkt41] to announce the level transition to L2 to a train in SN and the National Values packet [Pkt3] with ACK request (M_ACK=1) RBC -> SSB: Msg24 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR=200) and Pkt3
4 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146

5 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends to the SSB, entering area L2, the entry MA with ACK request [M_ACK=1] referred to the LRBG positioned upstream of the train front and includes the Level Transition Order packet [Pkt41] to announce the level transition to the L2 and the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR=200), Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 (Q_NEWCOUNTRY=0/1, Q_LINKREACTION=2, Q_LOCACC=5), Pkt3 [and Pkt51] and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
6 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
7 EXE	CHECK	The entry MA assigned to the train is displayed on the RBC QL
TC	**VBTS_SDT-SSB_104 - Updating of an input MA previously recognized by an SSB, with VBR in FN, which picks up a VBG**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The SSB, moving towards the ERTMS area, passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna"
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] (M_MODE = 13) and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=13) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the new LRBG SSB -> RBC: Msg136 with Pkt0 (M_MODE=13)

5 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC must update the SSB input MA by sending Msg3 with ACK request [M_ACK=1] referring to the new LRBG and includes the Level Transition Order packet [Pkt41] to announce the level transition to L2 and the "Switch Point Status" packet [Pkt 44/6], sent from VT to VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK= 1) with Pkt41 (M_LEVELTR=3, L_ACK-LEVELTR=200), Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt3 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
6 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_109 - Entry in L2 for an SSB, equipped with VBR system, coming from a non-ERTMS area with detection of an S/L2 type PI**	
step	**Description**	**Expected Result**
1 EXE	CHECK	SSB, moving towards the ERTMS area, and shortly before the border signal detects an S/L2 type PI PI -> SSB: Pkt3, Pkt46 (M_LEVELTR=3, N_ITER=1, M_LEVELTR(k)=1), Pkt145 and Pkt255
2 EXE	CHECK	The SSB makes the transition to L2 and sends a Position Report [Msg136 - Pkt0] with M_MODE=0 (Full Supervision) referring to the new LRBG Note: the transition to L2 could anticipate the detection of the border PI and is performed in compliance with Pkt41 previously recognized by SSB SSB -> RBC: Msg136 with Pkt0 (M_LEVEL=3 and M_MODE=0)
3 EXE	CHECK	The PoC confirms that the DMI in the "Areas for level information" shows the symbol relating to "Level 2"
4 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC must update the MA to the SSB by sending a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers at least the first SBR considered FS proved RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
5 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
6 REP	CHECK	RBC sends to the SSB the National Values packet [Pkt3], contained in a General Message [Msg24] with acknowledgment request [M_ACK=1] RBC -> SSB: Msg24 (M_ACK=1) with Pkt3
7 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**

1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)

Post condition

- Train in FS in area L2 downstream of a validated VBG
- VBR is in Full Navigation (FN) mode

6.4.3.8.2 VBTS_LNTC-L2_055

L2 entry management in the absence of GPS coverage for an SSB equipped with VBR system			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PJ MA	SITE LAB	Degraded	00.00

Notes	Scenario valid in case the area upstream of the entry border is an ERTMS level 2 area.

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains (P_MAXTRAIN) that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- SSB in National System upstream of the connection PI (eg type C or Cs or R/C)
- The orientation of the train agrees with the direction of the entry point in the level 2 ERTMS area
- At least the first SBR downstream of the entry boundary is "FS Proved"
- The SBR downstream of the border includes at least one VBG configured in the Digital Map
- GPS coverage not present for VBR (timer T_MAX_EXP_AG_TIME=30 s expired)
- VBR in Start-Up Configuration (SC) mode
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible

TC	VBTS_SDT-SSB_098 - Activation of a Communication Session for SSB coming from a non-ERTMS area which detects a C/Cs type PI	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train towards area L2
2 EXE	CHECK	SSB, moving towards the ERTMS area, detects a connection PI (eg type C or Cs or R/C)
3 EXE	EVENT	The SSB sends the RBC a Safe Connection request with the data received from the connection PI (Pkt 42): - the telephone number of the RBC - the ID of the RBC
4 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
5 EXE	CHECK	The SSB informs the PdC of the established Safe Connection

6 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
7 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1) RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
8 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
9 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the message Session Established [Msg 159], considers the Communication Session active SSB -> RBC: Msg159
10 REP	CHECK	SSB sends Packet Train running number [Pkt 5] in [Msg 136] SSB -> RBC: Msg136 with Pkt0 (M_MODE=13) and Pkt5 (NID_OPERATIONAL)
11 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
12 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_151 - Compatibility check of Interface Protocol and Digital Map versions for a train, with VBR in SC, coming from a non-ERTMS area, with consequent transition of VBR to SB and subsequently to FN**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.3.6	The VBR, having verified the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received from the TV, switches to Stand-By (SB) mode

4 REP	CHECK ――――― Requirements REQ_8.1.3.6 REQ_8.1.1.1 REQ_8.1.2.3	The VBR informs the VT of the compatibility of the Interface Protocol versions and the Digital Map signatures through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") and includes: - the "Reference Position" package [Pkt 44/101] with NID_LRBG="unknown"; - the "Position Validation Check Result" package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB (VBR) -> RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITER=0)
5 REP	CHECK ――――― Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
6 EXE	CHECK ――――― Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
TC	**VBTS_SDT-SSB_099 - Management of GNSS Parameters and GNSS Navigation Data for a train coming from a non-ERTMS area and consequent transition of VBR to FN**	
step	**Description**	**Expected Result**
1 REP	CHECK ――――― Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ――――― Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

5 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
TC	**VBTS_SDT-SSB_100 - Nominal management of Validated Train Data for an SSB coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg129] with the packets Position Report [Pkt0] with M_MODE=13 (National System) and Validated train data [Pkt11] SSB -> RBC: Msg129 with Pkt0 (M_MODE=13) and Pkt11
2 REP	CHECK	RBC considers the train data "acceptable" and sends the SSB the Acknowledgment of Train Data [Msg8] message requesting (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
3 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
4 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_101 - Input MA assignment for an SSB, with VBR in FN, coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 EXE	CHECK	SSB, moving towards the ERTMS area, detects a fixed PI in area L2 (eg of type R) PI -> SSB: Pkt46 (M_LEVELTR=3, N_ITER=1, M_LEVELTR(k)=1) and Pkt255
2 REP	CHECK	The SSB, being in a level contained in the priority list of the previously received packet 46, remains in SN mode and sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the fixed PI in area L2 SSB -> RBC: Msg136 with Pkt0 (M_MODE=13)
3 REP	CHECK	RBC activates the input MA assignment process and sends the SSB a General Message [Msg24] which includes the Level Transition Order packet [Pkt41] to announce the level transition to L2 to a train in SN and the National Values packet [Pkt3] with ACK request (M_ACK=1) RBC -> SSB: Msg24 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR=200) and Pkt3

4 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
5 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends to the SSB, entering area L2, the entry MA with ACK request [M_ACK=1] referred to the LRBG positioned upstream of the train front and includes the Level Transition Order packet [Pkt41] to announce the level transition to the L2 and the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR=200), Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 (Q_NEWCOUNTRY=0/1, Q_LINKREACTION=2, Q_LOCACC=5), Pkt3 [and Pkt51] and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
6 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
7 EXE	CHECK	The entry MA assigned to the train is displayed on the RBC QL
TC	**VBTS_SDT-SSB_103 - Updating of an input MA previously recognized by an SSB, with VBR in FN, coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 EXE	CHECK	SSB, moving towards the ERTMS area, detects a new PI (different from the transition one)
2 REP	CHECK	The SSB sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the new LRBG SSB -> RBC: Msg136 with Pkt0 (M_MODE=13)
3 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC must update the SSB input MA by sending Msg3 with ACK request [M_ACK=1] referring to the new LRBG and includes the Level Transition Order packet [Pkt41] to announce the level transition to L2 and the "Switch Point Status" packet [Pkt 44/6], sent from VT to VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK= 1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR=200), Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt3 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
4 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_109 - Entry in L2 for an SSB, equipped with VBR system, coming from a non-ERTMS area with detection of an S/L2 type PI**	
step	**Description**	**Expected Result**

1 EXE	CHECK	SSB, moving towards the ERTMS area, and shortly before the border signal detects an S/L2 type PI PI -> SSB: Pkt3, Pkt46 (M_LEVELTR=3, N_ITER=1, M_LEVELTR(k)=1), Pkt145 and Pkt255
2 EXE	CHECK	The SSB makes the transition to L2 and sends a Position Report [Msg136 - Pkt0] with M_MODE=0 (Full Supervision) referring to the new LRBG Note: the transition to L2 could anticipate the detection of the border PI and is performed in compliance with Pkt41 previously recognized by SSB SSB -> RBC: Msg136 with Pkt0 (M_LEVEL=3 and M_MODE=0)
3 EXE	CHECK	The PoC confirms that the DMI in the "Areas for level information" shows the symbol relating to "Level 2"
4 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC must update the MA to the SSB by sending a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers at least the first SBR considered FS proved RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
5 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
6 REP	CHECK	RBC sends to the SSB the National Values packet [Pkt3], contained in a General Message [Msg24] with acknowledgment request [M_ACK=1] RBC -> SSB: Msg24 (M_ACK=1) with Pkt3
7 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146

TC	**VBTS_SDT-SSB_039 - Detection of a VBG for a train with VBR in Full Navigation (FN) without GPS coverage for the VBR**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] which includes: - the pkt0 with the NID_LRBG of the detected VBG - the "GNSS Position Integrity" packet [Pkt 44/105], in case the VBR has a PVT whose integrity not yet checked SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)

Post condition
· Train in FS in area L2 downstream of a non-validated VBG · GPS coverage not present for the VBR · VBR is in Full Navigation (FN) mode

6.4.3.8.3 VBTS_LNTC-L2_056

Postponed assignment of the entry MA, for a train equipped with the VBR system coming from a non-ERTMS area, due to the closure of the border signal			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PJ MA	SITE LAB	Not nominal	00.00
Notes			

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains (P_MAXTRAIN) that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- SSB in National System upstream of the connection PI (eg type C or Cs or R/C)
- Between the connection PI and the border PI S/L2 there are at least one VBG configured in the Digital Map and a physical BG
- The orientation of the train agrees with the direction of the entry point in the level 2 ERTMS area
- The SBR downstream of the border signal presents the input signal in the closed state, as the only missing condition to be considered "FS Proved"
- VBR in Start-Up Configuration (SC) mode
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible

TC	VBTS_SDT-SSB_098 - Activation of a Communication Session for SSB coming from a non-ERTMS area which detects a C/Cs type PI	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train towards area L2
2 EXE	CHECK	SSB, moving towards the ERTMS area, detects a connection PI (eg type C or Cs or R/C)
3 EXE	EVENT	The SSB sends the RBC a Safe Connection request with the data received from the connection PI (Pkt 42): - the telephone number of the RBC - the ID of the RBC
4 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
5 EXE	CHECK	The SSB informs the PdC of the established Safe Connection

6 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
7 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1) RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
8 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
9 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the message Session Established [Msg 159], considers the Communication Session active SSB -> RBC: Msg159
10 REP	CHECK	SSB sends Packet Train running number [Pkt 5] in [Msg 136] SSB -> RBC: Msg136 with Pkt0 (M_MODE=13) and Pkt5 (NID_OPERATIONAL)
11 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
12 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_151 - Compatibility check of Interface Protocol and Digital Map versions for a train, with VBR in SC, coming from a non-ERTMS area, with consequent transition of VBR to SB and subsequently to FN**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6	The VBR, having verified the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received from the TV, switches to Stand-By (SB) mode

4 REP	CHECK _________ Requirements REQ_8.1.3.6 REQ_8.1.1.1 REQ_8.1.2.3	The VBR informs the VT of the compatibility of the Interface Protocol versions and the Digital Map signatures through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") and includes: - the "Reference Position" package [Pkt 44/101] with NID_LRBG="unknown"; - the “Position Validation Check Result” package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB (VBR) -> RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITER=0)
5 REP	CHECK _________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
6 EXE	CHECK _________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
TC	**VBTS_SDT-SSB_099 - Management of GNSS Parameters and GNSS Navigation Data for a train coming from a non-ERTMS area and consequent transition of VBR to FN**	
step	**Description**	**Expected Result**
1 REP	CHECK _________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK _________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

5 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
TC	**VBTS_SDT-SSB_100 - Nominal management of Validated Train Data for an SSB coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg129] with the packets Position Report [Pkt0] with M_MODE=13 (National System) and Validated train data [Pkt11] SSB -> RBC: Msg129 with Pkt0 (M_MODE=13) and Pkt11
2 REP	CHECK	RBC considers the train data "acceptable" and sends the SSB the Acknowledgment of Train Data [Msg8] message requesting (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
3 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
4 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_108 - Validation of a VBG for an SSB with VBR in FN coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] (M_MODE = 13) and the "GNSS Position Integrity" packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG, M_MODE=13) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)

3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the new LRBG SSB -> RBC: Msg136 with Pkt0 (M_MODE=13)
5 EXE	CHECK	RBC does not assign the entry MA since the first SBR downstream of the entry boundary is not "FS Proved"

TC	VBTS_SDT-SSB_102 - Postponed assignment of the entry MA for a train with VBR in FN coming from a non-ERTMS area due to a temporary closure of the entry boundary signal	
step	**Description**	**Expected Result**
1 EXE	CHECK	SSB, moving towards the ERTMS area, detects a physical PI compatible with the assignment of the input MA (eg fixed in L2 area of type R)
2 REP	CHECK	The SSB sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the compatible physical handset upon entry into area L2 SSB -> RBC: Msg136 with Pkt0 (M_MODE=13)
3 EXE	CHECK	RBC does not assign the entry MA since the first SBR downstream of the entry boundary is not "FS Proved"
4 EXE	ACTION	The DCO commands the opening of the input signal of the degraded SBR by signal in the closed state
5 EXE	CHECK	The entry signal passes at Via Libera and RBC considers the SBR downstream of the boundary signal as "FS Proved".
6 REP	CHECK	The SSB sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to a PI compatible with the activation of the MA assignment process SSB -> RBC: Msg136 with Pkt0 (M_MODE=13)
7 REP	CHECK	RBC activates the input MA assignment process and sends the SSB a General Message [Msg24] which includes the Level Transition Order packet [Pkt41] to announce the level transition to L2 to a train in SN and the National Values packet [Pkt3] with ACK request (M_ACK=1) RBC -> SSB: Msg24 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR=200) and Pkt3
8 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146

9 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC checks that the conditions for assigning the input MA are satisfied and sends the input MA to the SSB with ACK request [M_ACK=1] referring to the LRBG positioned upstream of the train front, which includes: - the Level Transition Order packet [Pkt41] to announce the level transition to L2 - the National Values package [Pkt3] - the Switch Status Point package [Pkt44/6] RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR=200), Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt3 and Pkt44/6
10 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_109 - Entry in L2 for an SSB, equipped with VBR system, coming from a non-ERTMS area with detection of an S/L2 type PI**	
step	**Description**	**Expected Result**
1 EXE	CHECK	SSB, moving towards the ERTMS area, and shortly before the border signal detects an S/L2 type PI PI -> SSB: Pkt3, Pkt46 (M_LEVELTR=3, N_ITER=1, M_LEVELTR(k)=1), Pkt145 and Pkt255
2 EXE	CHECK	The SSB makes the transition to L2 and sends a Position Report [Msg136 - Pkt0] with M_MODE=0 (Full Supervision) referring to the new LRBG Note: the transition to L2 could anticipate the detection of the border PI and is performed in compliance with Pkt41 previously recognized by SSB SSB -> RBC: Msg136 with Pkt0 (M_LEVEL=3 and M_MODE=0)
3 EXE	CHECK	The PoC confirms that the DMI in the "Areas for level information" shows the symbol relating to "Level 2"
4 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC must update the MA to the SSB by sending a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers at least the first SBR considered FS proved RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
5 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
6 REP	CHECK	RBC sends to the SSB the National Values packet [Pkt3], contained in a General Message [Msg24] with acknowledgment request [M_ACK=1] RBC -> SSB: Msg24 (M_ACK=1) with Pkt3
7 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
Post condition · Train in FS in area L2 · VBR is in Full Navigation (FN) mode		

6.4.3.8.4 VBTS_LNTC-L2_057

Management of two TSRs, one of which stopped, downstream of an extension of the incoming MA for an SSB, equipped with a VBR system, coming from a non-ERTMS area			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PJ TSR MA	LAB	Not nominal	00.00

Notes	Scenario valid in case the area upstream of the entry border is an ERTMS level 2 area.

Pre Condition

- Communication session between RBC and SSB not established
- The maximum number of trains (P_MAXTRAIN) that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- There are no other trains registered with the same NID_ENGINE variable value of the SSB under test
- The SSB has an acceptable NID_ENGINE and cryptographic keys matching those of the RBC to be called
- SSB in National System upstream of the connection PI (eg type C or Cs or R/C)
- The orientation of the train agrees with the direction of the entry point in the level 2 ERTMS area
- At least the first SBR downstream of the entry boundary is "FS Proved"
- The second SBR downstream of the boundary signal has the input signal in the closed state as the only missing condition to be considered "FS Proved"
- 2 TSRs (one of which is stopped) are active downstream of the signal in the closed state
- VBR in Start-Up Configuration (SC) mode
- Communication between TV and GAD on Channel 0 is active
- The Interface Protocol and Digital Maps versions used by RBC, GAD and VBR are compatible

TC	**VBTS_SDT-SSB_098 - Activation of a Communication Session for SSB coming from a non-ERTMS area which detects a C/Cs type PI**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train towards area L2
2 EXE	CHECK	SSB, moving towards the ERTMS area, detects a connection PI (eg type C or Cs or R/C)
3 EXE	EVENT	The SSB sends the RBC a Safe Connection request with the data received from the connection PI (Pkt 42): - the telephone number of the RBC - the ID of the RBC
4 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
5 EXE	CHECK	The SSB informs the PdC of the established Safe Connection

6 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
7 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1) RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
8 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
9 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the message Session Established [Msg 159], considers the Communication Session active SSB -> RBC: Msg159
10 REP	CHECK	SSB sends Packet Train running number [Pkt 5] in [Msg 136] SSB -> RBC: Msg136 with Pkt0 (M_MODE=13) and Pkt5 (NID_OPERATIONAL)
11 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
12 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_151 - Compatibility check of Interface Protocol and Digital Map versions for a train, with VBR in SC, coming from a non-ERTMS area, with consequent transition of VBR to SB and subsequently to FN**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.3.6	The VBR, having verified the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received from the TV, switches to Stand-By (SB) mode

4 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1 REQ_8.1.2.3	The VBR informs the VT of the compatibility of the Interface Protocol versions and the Digital Map signatures through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" packet [Pkt 44/100] with “VBTS Interface Version Check Result” (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") and includes: - the "Reference Position" package [Pkt 44/101] with NID_LRBG="unknown"; - the “Position Validation Check Result” package [Pkt 44/103] which contains an empty list (N_ITER=0); SSB (VBR) -> RBC (GAD/TV): Msg136 with Pkt0, Pkt44/100 (NID_VBRPACKET=100, Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1), Pkt44/101 (NID_VBRPACKET=101, NID_LRBG=16777215) and Pkt44/103 (NID_VBRPACKET=103, N_ITER=0)
5 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
6 EXE	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
TC	**VBTS_SDT-SSB_099 - Management of GNSS Parameters and GNSS Navigation Data for a train coming from a non-ERTMS area and consequent transition of VBR to FN**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
TC	**VBTS_SDT-SSB_100 - Nominal management of Validated Train Data for an SSB coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg129] with the packets Position Report [Pkt0] with M_MODE=13 (National System) and Validated train data [Pkt11] SSB -> RBC: Msg129 with Pkt0 (M_MODE=13) and Pkt11
2 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the Acknowledgment of Train Data [Msg8] message requesting (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
3 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
4 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_101 - Input MA assignment for an SSB, with VBR in FN, coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 EXE	CHECK	SSB, moving towards the ERTMS area, detects a fixed PI in area L2 (eg of type R) PI -> SSB: Pkt46 (M_LEVELTR=3, N_ITER=1, M_LEVELTR(k)=1) and Pkt255
2 REP	CHECK	The SSB, being in a level contained in the priority list of the previously received packet 46, remains in SN mode and sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the fixed PI in area L2 SSB -> RBC: Msg136 with Pkt0 (M_MODE=13)
3 REP	CHECK	RBC activates the input MA assignment process and sends the SSB a General Message [Msg24] which includes the Level Transition Order packet [Pkt41] to announce the level transition to L2 to a train in SN and the National Values packet [Pkt3] with ACK request (M_ACK=1) RBC -> SSB: Msg24 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR=200) and Pkt3
4 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146

5 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends to the SSB, entering area L2, the entry MA with ACK request [M_ACK=1] referred to the LRBG positioned upstream of the train front and includes the Level Transition Order packet [Pkt41] to announce the level transition to the L2 and the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR=200), Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 (Q_NEWCOUNTRY=0/1, Q_LINKREACTION=2, Q_LOCACC=5), Pkt3 [and Pkt51] and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
6 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
7 EXE	CHECK	The entry MA assigned to the train is displayed on the RBC QL
TC	**VBTS_SDT-SSB_105 - Assignment of two TSRs in the extension of an input MA previously recognized by an SSB, with VBR in FN, coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO commands the opening of the input signal of the degraded SBR by signal in the closed state
2 REP	CHECK ___________ Requirements REQ_8.1.3.3	Since the conditions for the extension of the input MA to the downstream SBRs considered "FS Proved" have been verified, RBC updates the input MA to the SSB by sending a Msg3 with ACK request [M_ACK=1] referring to the LRBG, which also covers subsequent SBRs and includes: - the Level Transition Order packet [Pkt41] to announce the level transition to L2 - the National Values packet [Pkt3] - the “Switch Point Status” packet [Pkt 44/6], sent from the VT to VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACKLEVELTR= 200), Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt3 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
3 REP	CHECK	RBC sends the SSB a General Message [Msg24] which includes 2 Temporary Speed Restriction packets [Pkt65] and the Packet for Sending Plan Text Messages [Pkt72] containing the text message "SLOWDOWN WITH STOP", with display until the beginning of the RBC -> SSB deceleration: Msg24 (M_ACK=1) with Pkt65 (V_TSR>0), Pkt65 (V_TSR>0) and Pkt72 (D_TEXTDISPLAY=0, L_TEXTDISPLAY>0, Q_TEXTCONFIRM=2, Q_CONFTEXTDISPLAY=1, Q_TEXTREPORT=0)
4 REP	CHECK	The SSB sends the ACK message [Msg146] related to Msg3 SSB -> RBC: Msg146
5 REP	CHECK	The SSB sends the ACK message [Msg146] related to Msg24 SSB -> RBC: Msg146

6 EXE	CHECK	The entry MA assigned to the train is displayed on the RBC QL with the new EoA
TC	**VBTS_SDT-SSB_106 - Revocation of a programmed TSR previously recognized by an SSB, with VBR in FN, coming from a non-ERTMS area**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The RBC operator revokes, through the RBC TO, the scheduled TSR assigned to the SSB
2 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC must update the MA input to the SSB by sending Msg3 with ACK request [M_ACK=1], and includes: - the Level Transition Order packet [Pkt41] to announce the level transition to L2 - the National Values packet [Pkt3] - the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt41 (M_LEVELTR=3, L_ACK-LEVELTR=200), Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt3 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
3 REP	CHECK	RBC sends to the SSB a General Message [Msg24] which includes a "Temporary Speed Restriction" packet [Pkt65], a Temporary Speed Restriction Revocation packet [Pkt66] and the "Packet for Sending Plain Text Messages" packet [Pkt72] containing the message of text "DELOWER WITH STOP", with display up to the start of the slowdown RBC -> SSB: Msg24 (M_ACK=1) with Pkt65 (V_TSR>0), Pkt66 (NID_TSR=k) and Pkt72 (D_TEXTDISPLAY=0, L_TEXTDISPLAY> 0, Q_TEXTCONFIRM=2, Q_CONFTEXTDISPLAY=1, Q_TEXTREPORT=0)
4 REP	CHECK	The SSB sends the ACK message [Msg146] related to Msg3 SSB -> RBC: Msg146
5 REP	CHECK	The SSB sends the ACK message [Msg146] related to Msg24 SSB -> RBC: Msg146
6 EXE	CHECK	RBC considers the revoked TSR as Not Active, deleting it from the list of managed ones
TC	**VBTS_SDT-SSB_110 - Entry in L2 for an SSB, with VBR in FN, coming from a non-ERTMS area, which was previously assigned a TSR with stop**	
step	**Description**	**Expected Result**
1 EXE	CHECK	SSB, moving towards the ERTMS area, and shortly before the border signal detects an S/L2 type PI PI -> SSB: Pkt3, Pkt46 (M_LEVELTR=3, N_ITER=1, M_LEVELTR(k)=1), Pkt145 and Pkt255

2 EXE	CHECK	The SSB makes the transition to L2 and sends a Position Report [Msg136 - Pkt0] with M_MODE=0 (Full Supervision) referring to the new LRBG Note: the transition to L2 is made in compliance with the Pkt41 previously recognized by the SSB SSB -> RBC: Msg136 with Pkt0 (M_LEVEL=3 and M_MODE=0)
3 EXE	CHECK	The PoC confirms that the DMI in the "Areas for level information" shows the symbol relating to "Level 2"
4 EXE	ACTION	The PdC recognizes the text message "SLOWDOWN WITH STOP" and moves the train forward
5 REP	CHECK	RBC must update the MA to the SSB by sending a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers at least the first SBR considered FS proved RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
6 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
7 REP	CHECK	RBC sends to the SSB a General Message [Msg24] with acknowledgment request [M_ACK=1], which includes the Temporary Speed Restriction packet [Pkt65] and the Packet for Sending Plan Text Messages [Pkt72] containing the text message "SLOWDOWN WITH STOP", with display until the start of slowdown RBC -> SSB: Msg24 (M_ACK=1) with Pkt65 (NID_TSR, V_TSR>0) and Pkt72 (D_TEXTDISPLAY=0, L_TEXTDISPLAY>0, Q_TEXTCONFIRM=2, Q_CONFTEXTDISPLAY=1, Q_TEXTREPORT=0)
8 REP	CHECK	The SSB sends the ACK message [Msg146] related to Msg24 SSB -> RBC: Msg146
9 REP	CHECK	RBC sends to the SSB the National Values packet [Pkt3], contained in a General Message [Msg24] with acknowledgment request [M_ACK=1] RBC -> SSB: Msg24 (M_ACK=1) with Pkt3
10 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
11 EXE	CHECK	The PdC moves the train in the SBR covered by the TSR by updating the maximum speed that can be reached on the DMI

Post condition

- FS train in an area covered by a TSR with a stop
- VBR is in Full Navigation (FN) mode

6.4.3.8.5 VBTS_LNTC-L2_058

Cancellation of the entry procedure for an emergency activation command to a single train for an SSB, with VBR in FN, coming from a non-ERTMS area with subsequent disconnection following entry into area L2 in SN mode			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PJ EMU MA	LAB	Not nominal	00.00

Notes	The D_ENTRYWINDOW parameter must be configured upstream of each input signal and must be equal to the lower of the following two values: · (Maximum train speed) x [processing time of the message (0.5s) + maximum re-transmission delay of the message on GSM-R (2.5s)]; · Distance between the border signal and the first turnout upstream of the border signal itself.

Pre Condition

- Train in National System moves towards ERTMS area with assigned entry MA
- The SSB is located outside the D_ENTRYWINDOW window before the input signal
- VBR is in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_107 - Cancellation of the entry procedure for the activation command of an emergency to the single train sent by the RBC operator**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The RBC Operator through the RBC TO carries out an "Emergency activation for single train" command for the SSB entering the ERTMS Area
2 REP	CHECK	RBC cancels the SSB entry procedure, located outside the D_ENTRYWINDOW window, and sends the message General Message [Msg24] with Level Transition Order [Pkt41] packet to order the immediate transition to NTC Level RBC -> SSB: Msg24 with Pkt41 (M_LEVELTR=1, L_ACKLEVELTR=200)
3 EXE	CHECK	The entry MA is no longer displayed on the RBC QL

TC	**VBTS_SDT-SSB_111 - Procedure for disconnecting an SSB in SN and VBR in FN entering Area L2**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) SSB -> RBC: Msg136 with Pkt0 (M_MODE=13)
2 EXE	CHECK	SSB, moving towards the ERTMS area, and shortly before the border signal detects an S/L2 type PI PI -> SSB: Pkt3, Pkt46 (M_LEVELTR=3, N_ITER=1, M_LEVELTR(k)=1), Pkt145 and Pkt255

3 REP	CHECK	The SSB, following the cancellation of the entry procedure previously received, does not make the transition to L2 and sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the new LRBG Note: the transition to L2 is not carried out in compliance with Pkt41 previously recognized by the SSB SSB -> RBC: Msg136 with Pkt0 (M_LEVEL=1 and M_MODE=13)
4 REP	CHECK	RBC sends a "Communication Session" termination order [Msg24] with [Pkt42] to the SSB that has entered ERTMS area L2 in SN mode RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
5 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
6 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
7 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
8 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO

Post condition

- Communication session between RBC and SSB terminated
- VBR is in Full Navigation (FN) mode

6.4.3.9 L2-LNTC

6.4.3.9.1 VBTS_L2-LNTC_059

Nominal output management towards a non-ERTMS area of an SSB in FS and VBR in FN			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PJ MA	SITE LAB	Nominal	00.00
Notes			

Pre Condition

- Train in FS with MA on the signal upstream of the last SBR in L2
- The SBR upstream of the output signal presents the input signal in the closed state, as the only missing condition to be considered "FS Proved"
- The aspect of the exit sign is arranged at Via Libera
- VBR is in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_112 - Assignment of output MA with V_EMA different from zero and Danger point absent, for an SSB in FS with VBR in FN and output signal placed at Via Libera**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO commands the opening of the input signal of the SBR upstream of the output signal
2 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
3 REP	CHECK	RBC verifies that the conditions for sending an output MA for the SSB exist, since the SBR upstream of the output signal has become "FS Proved", and sends a General Message [Msg24] with request for ack (M_ACK=1) including Level Transition Order packet [Pkt41] to announce NTC RBC -> SSB level transition: Msg24 (M_ACK=1) with Pkt41 (M_LEVELTR=1, L_ACKLEVELTR=200)
4 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
5 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC, after at least 5 seconds (T_ACKTRLNTC) from receiving the ack to the level transition announcement, must send the output MA with ACK request [M_ACK=1] referred to the LRBG positioned upstream of the train front, with profile of “Full Supervision” which includes the Level Transition Order packet [Pkt41] to announce the NTC level transition and the “Switch Point Status” packet [Pkt 44/6], sent from TV to VBR, which contains an empty list (N_ITER =0) of switches included in the MA RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt41 (M_LEVELTR=1, L_ACKLEVELTR=200), Pkt15 (L_ENDSECTION, Q_DANGERPOINT=0, V_EMA>0), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER=0)

6 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
7 EXE	CHECK	The PdC confirms that on the DMI in the "Area for planning information" the "speed profile" is updated with the correct speed corresponding to the LoA
8 EXE	CHECK	The updated MA is displayed on the QL until the exit signal with the correct V_EMA value
TC	**VBTS_SDT-SSB_113 - Exit from area L2 for a train with VBR in FN which detects a W type PI and subsequently S/LT, with exit signal placed at Via Libera**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train towards the exit signal
2 EXE	CHECK	SSB, moving towards the non-ERTMS area, detects a W-type PI -> SSB: Pkt41 (M_LEVELTR=1), Pkt145 and Pkt255
3 EXE	ACTION	The HP recognizes the next transition to the NTC level (200m behind the Exit signal, in line with L_ACKLEVELTR=200m received in pkt 41)
4 EXE	CHECK	SSB, moving towards the non-ERTMS area and just before the output signal, detects an S/LT type PI -> SSB: Pkt41 (M_LEVELTR=1), Pkt145 and Pkt255
5 REP	CHECK	The SSB makes the transition to the traditional signaling system and sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the new LRBG SSB -> RBC: Msg136 with Pkt0 (M_LEVEL=1 and M_MODE=13)
6 EXE	CHECK	The PoC confirms that the DMI in the "Areas for level information" shows the symbol relating to "STM" or "SCMT" and in the "Areas for mode information" the symbol relating to the "National System" mode
7 EXE	ACTION	The PdC moves the train leaving the area L2 completely
8 REP	CHECK	The SSB sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) which locates the min safe rear end of the SSB downstream of the S/LT transition PI SSB -> RBC: Msg136 with Pkt0 (M_LEVEL=1 and M_MODE=13)
9 REP	CHECK	RBC has received a PR from the SSB, located with the min safe rear end downstream of the S/LT transition PI, so it sends a communication session termination order [Msg24] with [Pkt42] to the SSB which is leaving the ERTMS area L2 RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
10 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156

11 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
12 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
13 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO

Post condition

- National System train in non-ERTMS area
- VBR is in Full Navigation (FN) mode

6.4.3.9.2 VBTS_L2-LNTC_060

Nominal output management towards a non-ERTMS area of an SSB in FS with SSB in FN without GPS coverage			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PJ MA	SITE LAB	Not nominal	00.00

Notes	

Pre Condition

- Train in FS with MA extending up to the signal upstream of the last SBR in L2
- Immediately downstream of the train, and on its own SBR, there is a VBG configured in the Digital Map
- The SBR upstream of the output signal presents the input signal in the closed state, as the only missing condition to be considered "FS Proved"
- The aspect of the exit sign is arranged at Via Libera
- GPS coverage not present for VBR (timer T_MAX_EXP_AG_TIME=30 s expired)
- VBR is in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_039 - Detection of a VBG for a train with VBR in Full Navigation (FN) without GPS coverage for the VBR**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] which includes: - the pkt0 with the NID_LRBG of the detected VBG - the "GNSS Position Integrity" packet [Pkt 44/105], in case the VBR has a PVT whose integrity not yet checked SSB -> RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0/1) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
TC	**VBTS_SDT-SSB_112 - Assignment of output MA with V_EMA different from zero and Danger point absent, for an SSB in FS with VBR in FN and output signal placed at Via Libera**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO commands the opening of the input signal of the SBR upstream of the output signal

2 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
3 REP	CHECK	RBC verifies that the conditions for sending an output MA for the SSB exist, since the SBR upstream of the output signal has become "FS Proved", and sends a General Message [Msg24] with request for ack (M_ACK=1) including Level Transition Order packet [Pkt41] to announce NTC RBC -> SSB level transition: Msg24 (M_ACK=1) with Pkt41 (M_LEVELTR=1, L_ACKLEVELTR=200)
4 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
5 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC, after at least 5 seconds (T_ACKTRLNTC) from receiving the ack to the level transition announcement, must send the output MA with ACK request [M_ACK=1] referred to the LRBG positioned upstream of the train front, with profile of "Full Supervision" which includes the Level Transition Order packet [Pkt41] to announce the NTC level transition and the "Switch Point Status" packet [Pkt 44/6], sent from TV to VBR, which contains an empty list (N_ITER =0) of switches included in the MA RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt41 (M_LEVELTR=1, L_ACKLEVELTR=200), Pkt15 (L_ENDSECTION, Q_DANGERPOINT=0, V_EMA>0), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER=0)
6 REP	CHECK	SSB sends ACK message [Msg146] SSB -> RBC: Msg146
7 EXE	CHECK	The PdC confirms that on the DMI in the "Area for planning information" the "speed profile" is updated with the correct speed corresponding to the LoA
8 EXE	CHECK	The updated MA is displayed on the QL until the exit signal with the correct V_EMA value

TC	**VBTS_SDT-SSB_113 - Exit from area L2 for a train with VBR in FN which detects a W type PI and subsequently S/LT, with exit signal placed at Via Libera**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train towards the exit signal
2 EXE	CHECK	SSB, moving towards the non-ERTMS area, detects a W-type PI -> SSB: Pkt41 (M_LEVELTR=1), Pkt145 and Pkt255
3 EXE	ACTION	The HP recognizes the next transition to the NTC level (200m behind the Exit signal, in line with L_ACKLEVELTR=200m received in pkt 41)
4 EXE	CHECK	SSB, moving towards the non-ERTMS area and just before the output signal, detects an S/LT type PI -> SSB: Pkt41 (M_LEVELTR=1), Pkt145 and Pkt255

5 REP	CHECK	The SSB makes the transition to the traditional signaling system and sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) referring to the new LRBG SSB -> RBC: Msg136 with Pkt0 (M_LEVEL=1 and M_MODE=13)
6 EXE	CHECK	The PoC confirms that the DMI in the "Areas for level information" shows the symbol relating to "STM" or "SCMT" and in the "Areas for mode information" the symbol relating to the "National System" mode
7 EXE	ACTION	The PdC moves the train leaving the area L2 completely
8 REP	CHECK	The SSB sends a Position Report [Msg136 - Pkt0] with M_MODE=13 (National System) which locates the min safe rear end of the SSB downstream of the S/LT transition PI SSB -> RBC: Msg136 with Pkt0 (M_LEVEL=1 and M_MODE=13)
9 REP	CHECK	RBC has received a PR from the SSB, located with the min safe rear end downstream of the S/LT transition PI, so it sends a communication session termination order [Msg24] with [Pkt42] to the SSB which is leaving the ERTMS area L2 RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
10 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
11 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
12 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
13 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO

Post condition

- National System train in non-ERTMS area
- GPS coverage not present for the VBR
- VBR is in Full Navigation (FN) mode

6.4.3.10 SH

6.4.3.10.1 VBTS_SH_061

Management of a Shunting request for an SSB with unknown or approximate position and VBR in TD, with subsequent valid SOM and VBR transition to FN following the acquisition of a new physical PI in Shunting mode			
FUNCTION	**Execution**	**Scenario's Type**	**version**
MA SH SOM COM	SITE LAB	Nominal	00.00

Notes	The Temporary Shunting Areas (TSA) are predefined off-line areas, and can be configured for those service points in which the "Shunting Zones", the routings and the manual maneuvers of the switches (MD) are foreseen in which it is possible perform maneuvering movements. In order for the maneuvering area to be activated, it is necessary that there are no blockages in place for the arrival itinerary (train totally located on the parking CdB) and that all the switches included in the maneuvering area are in the position such to isolate the area itself (in the event that a diverted itinerary is formed, the DCO, after the train has passed through the station, carries out the command to change the position of the relative switches to "normal"). This scenario requires the presence of at least one physical BG between the mSFE and the departure signal, where the train will locate, and one VBG in the SBR immediately downstream of the train.

Pre Condition

- Train stopped in SR with unknown or approximate position
- Train located entirely on the station for which a maneuvering area with relative associated TSA is configured
- The station SBR, relating to the departure itinerary, presents the formation of the itinerary as the only condition for not being considered "FS Proved"
- Between the min SFE and the downstream signal there is at least one physical BG in addition to the one on axis with the signal
- In the SBR immediately after the train there is at least one VBG configured in the Digital Map
- The SBR downstream of the train includes at least one facing point
- Train data compatible with the SBR on which the train is and the one immediately downstream
- The maneuvering area, which includes the CdB occupied by the train, and the relative associated TSA are active
- VBR in Track Discrimination (TD) mode

TC	**VBTS_SDT-SSB_114 - Management of a Shunting Request for SSB with VBR in TD and unknown or approximate position**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The RBC operator issues a train-TSA association command
2 REP	CHECK	RBC associates the train with the active TSA
3 EXE	ACTION	With the train stopped, the PdC presses the "Shunting Request" button on the DMI for about 3 seconds (delay type button)

4 REP	CHECK	SSB sends Request for Shunting message to RBC [Msg130] SSB -> RBC: Msg130
5 REP	CHECK	RBC sends the SSB the message SH Authorized [Msg28] with ack request RBC -> SSB: Msg28 (M_ACK=1)
6 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
7 EXE	CHECK	The PdC confirms that the SSB goes into Shunting mode
TC	**VBTS_SDT-SSB_116 - EoM procedure for an SSB that has received a Shunting mode authorization, in the presence of a VBR system**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB, entered SH, sends an End of Mission message [Msg 150] to the RBC with M_MODE=3 SSB -> RBC: Msg150 with Pkt0 (M_MODE=3)
2 REP	CHECK	RBC initiates the de-registration of the SSB by sending a General Message [Msg 24] containing the Packet Session Management [Pkt 42] with the Q_RBC variable equal to zero (0) and with the RBC identifier and telephone number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
3 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg 156] to the RBC SSB -> RBC: Msg156
4 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg 39] RBC -> SSB: Msg39
5 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with the RBC has ended and the SSB is in Shunting mode
6 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
7 REP	CHECK ___________ Requirements REQ_8.1.1.1	If the VBR is in Track Discrimination (TD) mode, no longer receiving the differential corrections [pkt 44/3] for at least 30 seconds (timer T_MAX_EXP_AG_TIME=30 s expired), it is no longer able to calculate the safe 3D GNSS position and switches to Stand By mode (SB)
TC	**VBTS_SDT-SSB_117 - Shunting movement for a train with VBR in SB which picks up a physical BG and subsequent "Exit Shunting" request**	
step	**Description**	**Expected Result**

1 EXE	ACTION	The PdC moves the train forward in Shunting mode
2 EXE	EVENT	SSB, advancing, detects a new physical PI (which becomes the new LRBG)
3 REP	CHECK ___________ Requirements REQ_8.1.1.1 REQ_8.1.1.3	The VBR, having received the valid position from the SSB, is able to calculate the safe and unique position and therefore passes into the Full Navigation (FN) state
4 EXE	ACTION	The Pdc stops the train, carries out the "Exit Shunting" command by pressing on the DMI for about 3 seconds (delay type button) and confirms that the SSB switches to SB mode

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2

8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_121 - Deregistration of a train, equipped with VBR system, which during the SOM phase sends a Position report in SB**	
step	**Description**	**Expected Result**
1 REP	CHECK	SSB switches to SB and sends PR [Msg136] to SB (with M_MODE=6) SSB -> RBC: Msg136 with Pkt0 (M_MODE=6)
2 REP	CHECK	RBC not receiving Msg157 must start the unregistration procedure and send the SSB an order to release the "Communication Session" [Msg24] with [Pkt42] RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
3 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
4 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
5 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
6 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB

3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_006 - SOM Position Report management with Q_STATUS Valid and with LRBG placed upstream of the max safe front end of the train**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB located and the train icon is displayed on RBC's QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**

1 REP	CHECK __________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and "VBR DataBase Version" (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the "Position Report Validation Request" [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK __________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)

4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK __________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
6 REP	CHECK __________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL
TC	**VBTS_SDT-SSB_032 - First assignment of the MA with OS-FS profile for a stationed train with VBR system following the deactivation of the maneuvering area and the subsequent formation of the departure itinerary**	
step	**Description**	**Expected Result**

1 EXE	ACTION	The signalman deactivates the maneuvering area (associated with a known TSA in the RBC configuration) which includes the CdB occupied by the train
2 EXE	CHECK	The deactivated Maneuvering Area is canceled from the RBC QL
3 EXE	ACTION	The DCO forms the departure itinerary downstream of the train
4 EXE	ACTION	The PdC selects Start on the DMI
5 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
6 REP	CHECK ___________ Requirements REQ_8.1.3.3	RBC sends the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and in FS on the subsequent SBRs considered “FS Proved” and includes the Switch Point Status packet [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k)=1/2)
7 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
8 EXE	CHECK	The MA is displayed on the RBC QL
9 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
10 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
11 EXE	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
12 EXE	CHECK	Text message “EXTENDED MA IN FS” is displayed on the SSB DMI for 30 seconds when the SSB enters the OS activation window (100m from downstream signal)
13 EXE	CHECK	In line with the National Values previously received (V_NVONSIGHT=6) the maximum speed allowed in the OS operating mode is 30 km/h
14 EXE	ACTION	The PdC advances the train into the next SBR

15 EXE	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_034 - Validation of a VBG detected by a VBR in Full Navigation (FN)**	
step	**Description**	**Expected Result**
1 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.1	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The VBR requests the validation of the VBG from the GAD through a Train Position Report [Msg 136] which the SSB sends to the RBC including the [Pkt 0] and the “GNSS Position Integrity” packet [Pkt 44/105] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0 (NID_LRBG) and Pkt44/105 (NID_VBRPACKET=105, NID_VALBG)
3 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.2	The GAD verifies the validity of the detected VBG and sends a General Message [Msg 24] with: - the "GNSS Position Integrity Result" package [Pkt 44/10] enhancing "Result of the Position Integrity" (Q_PRINTEGRITYCHECK=0) and the validated VBG identifier (NID_VALBG) - the "GNSS Differential Correction" package [Pkt 44/3] containing the differential corrections calculated with respect to the updated position of the VBR RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/10 (NID_VBRPACKET=10, Q_PRINTEGRITYCHECK=0, NID_VALBG) and Pkt44/3 (NID_VBRPACKET=3)
4 REP	CHECK __________ Requirements REQ_8.1.1.1	The SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the validated VBG SSB -> RBC: Msg136 with Pkt0 (NID_LRBG)
Post condition · Train in FS on the departure itinerary with a VBG validated as LRBG · No maneuvering area (associated with a known TSA in the RBC configuration) is active · VBR in Full Navigation (FN) mode		

6.4.3.10.2 VBTS_SH_062

Management of a Shunting request for SSB in FS with VBR in FN located inside an active TSA and subsequent failure of the Digital Map integrity due to overcoming a facing-point during the Shunting movement			
FUNCTION	**Execution**	**Scenario's Type**	**version**
MA SH SOM SR COM	SITE LAB	Not nominal	00.00

Notes	The Temporary Shunting Areas (TSA) are predefined off-line areas, and can be configured for those service points in which the "Shunting Zones", the routings and the manual maneuvers of the switches (MD) are foreseen in which it is possible perform maneuvering movements. In order for the maneuvering area to be activated, it is necessary that there are no blockages in place for the arrival itinerary (train totally located on the parking CdB) and that all the switches included in the maneuvering area are in the position such to isolate the area itself (in the event that a diverted itinerary is formed, the DCO, after the train has passed through the station, carries out the command to change the position of the relative switches to "normal"). This scenario requires the presence of a VBG immediately downstream of a facing point: a possible application is with a train on station VTTN302 in the legal odd direction.

Pre Condition

- Train located entirely on a station for which a maneuvering area with relative associated TSA is configured
- SSB in FS with MA assigned until the starting signal
- The maneuvering area, which includes the CdB occupied by the train, and the relative associated TSA are active
- The bottom station SBR of the train includes at least one facing point
- Immediately downstream of the facing point there is a VBG configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_115 - Management of a Shunting request for SSB located within the active TSA associated with a maneuvering area**	
step	**Description**	**Expected Result**
1 EXE	ACTION	With the train stopped, the PdC presses the "Shunting Request" button on the DMI for about 3 seconds (delay type button)
2 REP	CHECK	SSB sends Request for Shunting message to RBC [Msg130] SSB -> RBC: Msg130
3 REP	CHECK	RBC sends the SSB the message SH Authorized [Msg28] with ack request RBC -> SSB: Msg28 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The PdC confirms that the SSB goes into Shunting mode

TC	VBTS_SDT-SSB_116 - EoM procedure for an SSB that has received a Shunting mode authorization, in the presence of a VBR system	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB, entered SH, sends an End of Mission message [Msg 150] to the RBC with M_MODE=3 SSB -> RBC: Msg150 with Pkt0 (M_MODE=3)
2 REP	CHECK	RBC initiates the de-registration of the SSB by sending a General Message [Msg 24] containing the Packet Session Management [Pkt 42] with the Q_RBC variable equal to zero (0) and with the RBC identifier and telephone number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
3 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg 156] to the RBC SSB -> RBC: Msg156
4 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg 39] RBC -> SSB: Msg39
5 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with the RBC has ended and the SSB is in Shunting mode
6 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
7 REP	CHECK ___________ Requirements REQ_8.1.1.1	If the VBR is in Track Discrimination (TD) mode, no longer receiving the differential corrections [pkt 44/3] for at least 30 seconds (timer T_MAX_EXP_AG_TIME=30 s expired), it is no longer able to calculate the safe 3D GNSS position and switches to Stand By mode (SB)

TC	VBTS_SDT-SSB_118 - Digital Map integrity failure for a train with VBR in FN that passes a facing-point during the movement in Shunting, and subsequent request for "Exit Shunting"	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train, in shunting mode, into the downstream SBR and beyond the facing point
2 REP	CHECK	The VBR, detecting that the MaxSafeAntenna (corresponding to the position of the VBR Virtual Antenna increased by the confidence interval, default 30m) of the train has passed a facing-point with position unknown to the SSB and that the last differential corrections [pkt 44/3] received are expired (timer T_MAX_EXP_AG_TIME=30 s), it considers the Digital Map Navigation Integrity failed and switches to Stand By (SB) mode
3 EXE	ACTION	The PdC stops the train, carries out the "Exit Shunting" command by pressing on the DMI for about 3 seconds (delay type button) and confirms that the SSB switches to SB mode

TC	VBTS_SDT-SSB_001 - Activation of a Communication Session	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_121 - Deregistration of a train, equipped with VBR system, which during the SOM phase sends a Position report in SB**	
step	**Description**	**Expected Result**

1 REP	CHECK	SSB switches to SB and sends PR [Msg136] to SB (with M_MODE=6) SSB -> RBC: Msg136 with Pkt0 (M_MODE=6)
2 REP	CHECK	RBC not receiving Msg157 must start the unregistration procedure and send the SSB an order to release the "Communication Session" [Msg24] with [Pkt42] RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
3 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
4 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
5 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
6 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO

TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146

7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_008 - SOM Position Report management with Q_STATUS Valid for a train, equipped with VBR system, with ambiguous position**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB not located due to the presence of a facing point between the LRBG and the max safe front end of the train: the train icon is not displayed on the RBC QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**
1 REP	CHECK Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and "VBR DataBase Version" (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

3 REP	CHECK __________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the "Position Report Validation Request" [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK __________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_010 - Position initialization and transition to TD for a VBR with invalid or unknown position**	
step	**Description**	**Expected Result**
1 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.2.3	The SSB sends a Position Report [Msg 136] with Pkt 0 which also includes the packets sent by the VBR: - the packet "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44/100], sent to the TV, with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") - the packet "Reference Position" [Pkt 44/101], sent to TV, with NID_LRBG="unknown"; - the "Position Report Validation Request" packet [Pkt 44/103], sent to the GAD, which contains an empty list (N_ITER=0) of possible positions where the VBR assumes it could be located SSB (VBR) -> RBC (GAD/TV): MSG136 with PKT0, PKT44/100 (NID_VBRPACKET = 100, Q_IFPROTOVERCHKRES = 1 and Q_DBvalidate = 1), PKT44/101 (NID_VBRPACKET = 101, NID_LRBG = 16777215) and PKT44/103 (NID_VBRPACKET = 103, 103, 103, 103, N_iter = 0)
2 REP	CHECK __________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
3 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

4 REP	CHECK __________ Requirements REQ_8.1.1.1	GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
5 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
6 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR calculates the unsafe approximate position and supplies the GAD with the NID_LRBG of the closest balise identified in the Digital Map through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Reference Position" [Pkt 44/101] with NID_LRBG="known" and includes: - the "Digital Map and Interface Protocol Compatibility Check Result" package [Pkt 44/100] - the "Position Report Validation Request" package [Pkt 44/103] SSB (VBR) -> RBC (GAD): Msg136 with Pkt0, Pkt44/101 (NID_VBRPACKET=101, NID_LRBG), Pkt44/100 (NID_VBRPACKET=100) and Pkt44/103 (NID_VBRPACKET=103)
7 REP	CHECK __________ Requirements REQ_8.1.1.1	GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the necessary information for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)
8 REP	CHECK __________ Requirements REQ_8.1.1.1	The VBR calculates the safe position using the navigation data (44/8) and the differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
9 REP	CHECK __________ Requirements REQ_8.1.1.1 REQ_8.1.3.3	The VBR provides the TV with a list of estimated positions on the Digital Map and the related confidence intervals through a Train Position Report [Msg 136] that the SSB sends to the RBC including the [Pkt 0] and the "Position Report Validation Request" packet [Pkt 44/103] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/103 (NID_VBRPACKET=103, N_ITER>0, NID_LRBG(K), Q_DIRLRBG(K)) and Pkt44/101 (NID_VBRPACKET=101, NID_LRBG)
TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11

3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL

TC	**VBTS_SDT-SSB_016 - SR authorization for SSB with non-Approximate position**	
step	**Description**	**Expected Result**
1 REP	EVENT	RBC considers the train position NOT "Approximate" since it has not received the relevant train number from SSR.
2 EXE	CHECK	The RBC TO is notified that the conditions for considering the train position "Approximate" are not satisfied.
3 REP	CHECK	RBC sends to the SSB a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72] containing the text message “Position not validated” and without ACK request [M_ACK=0] RBC -> SSB: Msg24 with Pkt72 (M_LEVELTEXTDISPLAY=3, Q_TEXTCONFIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0)
4 EXE	ACTION	The PdC recognizes the text message "Position not validated", displayed on the DMI
5 EXE	ACTION	The PdC selects Start on the DMI
6 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
7 REP	CHECK	RBC sends to the SSB a message SR Authorization [Msg 2], with finite distance (D_SR=0) and ACK request [M_ACK=1] RBC -> SSB: Msg2 (M_ACK=1 and D_SR=0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146

9 EXE	ACTION	The SR mode is proposed to the PdC which recognizes it by pressing on the DMI for about 3 seconds (delay type button)
10 EXE	CHECK	The SSB switches to SR and sends a PR [Msg 136] in SR (with M_MODE=2) [Msg 136 can also include the following packets: - "Digital Map and Interface Protocol Compatibility Check Result" [Pkt 44/100] if the SSB has not yet received any Pkt 44/3 or Pkt44/6; - "Reference Position" [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - "Position Report Validation Request" [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) [Pkt44/100, Pkt44/101 and Pkt44/103]
TC	**VBTS_SDT-SSB_036 - Failure to detect a VBG for an SSB in SR with non-approximate position and with VBR in TD**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PoC performs the "Override" procedure and moves the train forward
2 REP	CHECK	The train sends a PR [Msg 136] in SR (with M_MODE=2) which includes the packet "Position Validation Check Result" [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)
3 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
4 REP	CHECK __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The VBR, being in Track Discrimination mode, does not detect the virtual BG

Post condition

- Train in SR downstream of an undetected VBG
- The maneuvering area, which includes the CdB occupied by the train, and the relative associated TSA are active
- VBR in Track Discrimination (TD) mode

6.4.3.10.3 VBTS_SH_063

Management of a Shunting request for an SSB in FS with VBR in FN located within an active TSA with subsequent valid SOM following the detection of a VBG during Shunting movement			
FUNCTION	**Execution**	**Scenario's Type**	**version**
MA SH SOM COM	SITE LAB	Nominal	00.00

Notes	The Temporary Shunting Areas (TSA) are predefined off-line areas, and can be configured for those service points in which the "Shunting Zones", the routings and the manual maneuvers of the switches (MD) are foreseen in which it is possible perform maneuvering movements. In order for the maneuvering area to be activated, it is necessary that there are no blockages in place for the arrival itinerary (train totally located on the parking CdB) and that all the switches included in the maneuvering area are in the position such to isolate the area itself (in the event that a diverted itinerary is formed, the DCO, after the train has passed through the station, carries out the command to change the position of the relative switches to "normal").

Pre Condition

- Train located entirely on a station for which a maneuvering area with relative associated TSA is configured
- SSB in FS with MA assigned until the starting signal
- The maneuvering area, which includes the CdB occupied by the train, and the relative associated TSA are active
- Between the min SFE and the downstream signal there is a single VBG configured in the Digital Map
- The T_MISSION timer is not active
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_115 - Management of a Shunting request for SSB located within the active TSA associated with a maneuvering area**	
step	**Description**	**Expected Result**
1 EXE	ACTION	With the train stopped, the PdC presses the "Shunting Request" button on the DMI for about 3 seconds (delay type button)
2 REP	CHECK	SSB sends Request for Shunting message to RBC [Msg130] SSB -> RBC: Msg130
3 REP	CHECK	RBC sends the SSB the message SH Authorized [Msg28] with ack request RBC -> SSB: Msg28 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The PdC confirms that the SSB goes into Shunting mode

TC	VBTS_SDT-SSB_116 - EoM procedure for an SSB that has received a Shunting mode authorization, in the presence of a VBR system	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB, entered SH, sends an End of Mission message [Msg 150] to the RBC with M_MODE=3 SSB -> RBC: Msg150 with Pkt0 (M_MODE=3)
2 REP	CHECK	RBC initiates the de-registration of the SSB by sending a General Message [Msg 24] containing the Packet Session Management [Pkt 42] with the Q_RBC variable equal to zero (0) and with the RBC identifier and telephone number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
3 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg 156] to the RBC SSB -> RBC: Msg156
4 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg 39] RBC -> SSB: Msg39
5 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with the RBC has ended and the SSB is in Shunting mode
6 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
7 REP	CHECK ___________ Requirements REQ_8.1.1.1	If the VBR is in Track Discrimination (TD) mode, no longer receiving the differential corrections [pkt 44/3] for at least 30 seconds (timer T_MAX_EXP_AG_TIME=30 s expired), it is no longer able to calculate the safe 3D GNSS position and switches to Stand By mode (SB)

TC	VBTS_SDT-SSB_119 - Detection of a VBG for an SSB in SH with VBR in FN, and subsequent "Exit Shunting" request	
step	**Description**	**Expected Result**
1 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
2 REP	CHECK ___________ Requirements REQ_8.1.1.1	The SSB, not being connected to the RBC, cannot request the validation of the VBG which, therefore, will become the new LRBG but will not be useful for the recalibration of the odometric error

3 EXE	ACTION	The PdC stops the train, carries out the "Exit Shunting" command by pressing on the DMI for about 3 seconds (delay type button) and confirms that the SSB switches to SB mode
TC	**VBTS_SDT-SSB_001 - Activation of a Communication Session**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_121 - Deregistration of a train, equipped with VBR system, which during the SOM phase sends a Position report in SB**	

step	Description	Expected Result
1 REP	CHECK	SSB switches to SB and sends PR [Msg136] to SB (with M_MODE=6) SSB -> RBC: Msg136 with Pkt0 (M_MODE=6)
2 REP	CHECK	RBC not receiving Msg157 must start the unregistration procedure and send the SSB an order to release the "Communication Session" [Msg24] with [Pkt42] RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
3 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg156] to the RBC SSB -> RBC: Msg156
4 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg39] RBC -> SSB: Msg39
5 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with RBC has ended
6 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO

TC	VBTS_SDT-SSB_001 - Activation of a Communication Session	
step	**Description**	**Expected Result**
1 EXE	EVENT	The SSB, with acceptable NID_ENGINE, sends the RBC a Safe Connection request (level 2) with: - the telephone number of the RBC - ID of the RBC Entered by the PdC at the beginning of the first mission or received from a PI of connection (Pkt 42)
2 REP	CHECK	RBC receives the safe connection request, verifies that the value of the NID_ENGINE variable is acceptable and that the maximum number of trains has not been registered, and sends the safe connection confirmation to the SSB
3 EXE	CHECK	The SSB informs the PdC of the established Safe Connection
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg 155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg 32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)

6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg 146] to [Msg 32] SSB -> RBC: Msg146
7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the Session Established message [Msg 159] which includes the Onboard supported system versions [Pkt 2] packet and considers the Communication Session active SSB -> RBC: Msg159 with Pkt2
8 REP	CHECK	RBC sends a General Message [Msg 24] with request for ACK (M_ACK=1) which includes the packets Movement Authority Request Parameters [Pkt 57], Position Report Parameters [Pkt 58] and National Values [Pkt 3] with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
TC	**VBTS_SDT-SSB_006 - SOM Position Report management with Q_STATUS Valid and with LRBG placed upstream of the max safe front end of the train**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB sends to RBC the message SOM Position Report [Msg 157] with Q_STATUS=1 and with Position Report [Pkt 0] SSB -> RBC: Msg157 (Q_STATUS=1) with Pkt0 (NID_LRBG, D_LRBG, Q_DIRLRBG=Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER)
2 EXE	CHECK	RBC considers the SOM PR valid and the SSB located and the train icon is displayed on RBC's QL
TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

3 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the "Position Report Validation Request" [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)

6 REP	CHECK __________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode

TC	**VBTS_SDT-SSB_013 - Nominal Management of Validated Train Data**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC enters the train data and the train number (if not already entered before connection)
2 REP	CHECK	The SSB sends the RBC the message Validated Train Data [Msg 129] with the Position Report packet [Pkt 0 or Pkt 1] and Validated train data [Pkt 11] SSB -> RBC: Msg129 with Pkt0/1 and Pkt11
3 REP	CHECK	RBC considers the train data “acceptable” and sends the SSB the message Acknowledgment of Train Data [Msg 8] with request for (M_ACK = 1) RBC -> SSB: Msg8 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message [Msg 146] SSB -> RBC: Msg146
5 REP	CHECK	If not previously sent in Msg 157, the SSB sends Packet Train running number [Pkt 5] in [Msg 136] [Msg 136 may also include the following packets: - “Digital Map and Interface Protocol Compatibility Check Result” [Pkt 44 /100] if the SSB has not yet received any Pkt 44/3 or Pkt 44/6; - “Reference Position” [Pkt 44/101] if the VBR has transitioned to SB and has not yet received a valid LRBG from EVC; - “Position Report Validation Request” [Pkt 44/103] if VBR is in SB or TD.] SSB -> RBC: Msg136 with Pkt0/1 and Pkt5 (NID_OPERATIONAL) [Pkt44/100, Pkt44/101 and Pkt44/103]
6 EXE	CHECK	The train data and the NID_OPERATIONAL are displayed on the RBC QL

TC	**VBTS_SDT-SSB_032 - First assignment of the MA with OS-FS profile for a stationed train with VBR system following the deactivation of the maneuvering area and the subsequent formation of the departure itinerary**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The signalman deactivates the maneuvering area (associated with a known TSA in the RBC configuration) which includes the CdB occupied by the train
2 EXE	CHECK	The deactivated Maneuvering Area is canceled from the RBC QL
3 EXE	ACTION	The DCO forms the departure itinerary downstream of the train

4 EXE	ACTION	The PdC selects Start on the DMI
5 REP	CHECK	The SSB sends a MA Request [Msg 132] message to RBC SSB -> RBC: Msg132
6 REP	CHECK Requirements REQ_8.1.3.3	RBC sends the SSB a Movement Authority message [Msg 3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and in FS on the subsequent SBRs considered “FS Proved” and includes the Switch Point Status packet [Pkt 44/6] which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k)=1/2)
7 REP	CHECK	SSB sends ACK message to RBC [Msg 146] SSB -> RBC: Msg146
8 EXE	CHECK	The MA is displayed on the RBC QL
9 REP	CHECK	RBC sends a General Message [Msg 24] with a packet Packet for sending plain text messages [Pkt 72], containing the text message "EXTENSION OF MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
10 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
11 EXE	CHECK	RBC receives a PR [Msg 136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
12 EXE	CHECK	Text message “EXTENDED MA IN FS” is displayed on the SSB DMI for 30 seconds when the SSB enters the OS activation window (100m from downstream signal)
13 EXE	CHECK	In line with the National Values previously received (V_NVONSIGHT=6) the maximum speed allowed in the OS operating mode is 30 km/h
14 EXE	ACTION	The PdC advances the train into the next SBR
15 EXE	CHECK	RBC receives a PR [Msg 136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- Train in FS on the departure itinerary
- No maneuvering area (associated with a known TSA in the RBC configuration) is active
- VBR is in Full Navigation (FN) mode

6.4.3.10.4 VBTS_SH_064

Reconnection in TR for a train in SH mode, equipped with VBR system, which detects a PI containing the "Danger for Shunting Information" packet			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SH PoS	LAB	Not nominal	00.00

Notes	In order for the maneuvering area to be activated, it is necessary that there are no blockages in place for the arrival itinerary (train totally located on the parking CdB) and that all the switches included in the maneuvering area are in the position such to isolate the area itself (in the event that a diverted itinerary is formed, the DCO, after the train has passed through the station, carries out the command to change the position of the relative switches to "nor-mal").

Pre Condition

- Train located entirely on a parking CDB
- SSB stopped in FS with MA assigned until the starting signal of the DP
- A Maneuvering Area and its associated TSA, which include the CdB occupied by the train, are active
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_115 - Management of a Shunting request for SSB located within the active TSA associated with a maneuvering area**	
step	**Description**	**Expected Result**
1 EXE	ACTION	With the train stopped, the PdC presses the "Shunting Request" button on the DMI for about 3 seconds (delay type button)
2 REP	CHECK	SSB sends Request for Shunting message to RBC [Msg130] SSB -> RBC: Msg130
3 REP	CHECK	RBC sends the SSB the message SH Authorized [Msg28] with ack request RBC -> SSB: Msg28 (M_ACK=1)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The PdC confirms that the SSB goes into Shunting mode

TC	**VBTS_SDT-SSB_116 - EoM procedure for an SSB that has received a Shunting mode authorization, in the presence of a VBR system**	
step	**Description**	**Expected Result**
1 REP	CHECK	The SSB, entered SH, sends an End of Mission message [Msg 150] to the RBC with M_MODE=3 SSB -> RBC: Msg150 with Pkt0 (M_MODE=3)

2 REP	CHECK	RBC initiates the de-registration of the SSB by sending a General Message [Msg 24] containing the Packet Session Management [Pkt 42] with the Q_RBC variable equal to zero (0) and with the RBC identifier and telephone number RBC -> SSB: Msg24 with Pkt42 (Q_RBC=0)
3 REP	CHECK	The SSB sends a message "Termination of a Communication Session" [Msg 156] to the RBC SSB -> RBC: Msg156
4 REP	CHECK	RBC receives [Msg156] and sends Acknowledgment of Termination of a Communication Session [Msg 39] RBC -> SSB: Msg39
5 EXE	CHECK	The PdC confirms that the DMI informs that the communication session with the RBC has ended and the SSB is in Shunting mode
6 EXE	CHECK	RBC considers the communication session with the train terminated, releases the Safe Connection, closes the RBC-GAD communication channel assigned to the train and therefore deletes the SSB from the database and removes it from the list of connected trains shown on the TO
7 REP	CHECK ___________ Requirements REQ_8.1.1.1	If the VBR is in Track Discrimination (TD) mode, no longer receiving the differential corrections [pkt 44/3] for at least 30 seconds (timer T_MAX_EXP_AG_TIME=30 s expired), it is no longer able to calculate the safe 3D GNSS position and switches to Stand By mode (SB)
TC	**VBTS_SDT-SSB_120 - Detection of a type M handset for an SSB, in the presence of the VBR system, which advances in Shunting mode**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in Shunting mode
2 EXE	EVENT	SSB, advancing, detects an M-type PI, placed in correspondence with the maneuver limit stake, which includes the "Danger for Shunting Information" (Pkt132) Packet PI -> SSB: Pkt132 (Q_ASPECT=0) and Pkt255
3 EXE	CHECK	The PdC confirms that the SSB has transited in TR by activating the braking and initiating the connection with RBC
4 REP	CHECK	The SSB sends the RBC the message Initiation of Communication Session [Msg155] SSB -> RBC: Msg155
5 REP	CHECK	RBC sends the RBC/RIU System Version [Msg32] message to the SSB with ACK request [M_ACK=1] and M_VERSION = 33 (Version 2.1). RBC -> SSB: Msg32 (M_ACK=1, M_VERSION=33)
6 REP	CHECK	SSB sends RBC Acknowledgment message [Msg146] to [Msg32] SSB -> RBC: Msg146

7 REP	CHECK	The SSB, having verified compatibility with the ground subsystem, sends the RBC the message Session Established [Msg159], considers the Communication Session active SSB -> RBC: Msg159
8 REP	CHECK	RBC sends a General Message [Msg24] with ACK request (M_ACK=1) which includes the Movement Authority Request Parameters [Pkt57], Position Report Parameters [Pkt58] and National Values [Pkt3] packets with D_VALIDNV (now) RBC -> SSB: Msg24 with Pkt57 (T_MAR=12, T_TIMEOUTRQST=1023, T_CYCRQST=8), Pkt58 (T_CYCLOC=8, D_CYCLOC=32767, M_LOC=1) and Pkt3 (D_VALIDNV=32767)
9 REP	CHECK	SSB sends ACK message [Msg146] to RBC SSB -> RBC: Msg146
10 REP	CHECK	The Train sends a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)
11 EXE	ACTION	The PdC, with the train stopped, recognizes the Trip on the DMI
12 EXE	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
13 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK request RBC -> SSB: Msg6 (M_ACK=1)
14 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

TC	**VBTS_SDT-SSB_003 - Check compatibility of Interface Protocol and Digital Map versions between VBR and GAD**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.6	The TV sends a General Message to the VBR [Msg 24] which includes the Digital Map and Interface Protocol Version packet [Pkt 44/1] with ACK request (M_ACK=1), valuing "Interface Protocol Version" (M_IFPROTOVER=01.02) and “VBR DataBase Version” (M_DBVERSION) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/1 (NID_VBRPACKET=1, M_IFPROTOVER=01.02, M_DBVERSION)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146

3 REP	CHECK ___________ Requirements REQ_8.1.3.6 REQ_8.1.1.1	The VBR verifies the compatibility of the supported Interface Protocol versions and of the Digital Map signatures with those received and informs the VT through a Train Position Report [Msg 136] that the SSB sends to RBC including the [Pkt 0] and the "Digital Map Interface Protocol Check" [Pkt 44/100] with "VBTS Interface Version Check Result" (Q_IFPROTOVERCHKRES="1") and "VBR Data Base Version Validation Result" (Q_DBVALIDATE="1") [If VBR is in SB or TD, the SSB also includes the "Position Report Validation Request" [Pkt 44/103] inside the Position Report] SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/100 (NID_VBRPACKET=100 , Q_IFPROTOVERCHKRES=1 and Q_DBVALIDATE=1) [and Pkt 44/103]
4 REP	CHECK ___________ Requirements REQ_8.1.3.6	RBC considers the train with active VBR and opens a communication channel with the GAD uniquely assigned to the train
TC	**VBTS_SDT-SSB_011 - Management of GNSS Parameters and GNSS Navigation Data for a train that has sent a valid PR**	
step	**Description**	**Expected Result**
1 REP	CHECK ___________ Requirements REQ_8.1.3.2	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1) which includes the GNSS Parameters packet [Pkt 44/11] RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/11 (NID_VBRPACKET=11, T_MAX_EXP_AG_TIME=30, D_MAX_EXP_AG_SPACE=42, G_SIGMA_IONO_TIME=2, G_SIGMA_IONO_SPACE=2.5, G_SIGMA_TROPO_TIME=0, G_SIGMA_TROPO_SPACE=0, G_SIGMA_EPH_TIME=0, G_SIGMA_EPH_SPACE=0, T_MAX_EXP_IC_TIME=30)
2 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
3 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD sends to the VBR a General Message [Msg 24] with ACK request (M_ACK=1), and with a GNSS Navigation Data packet [Pkt 44/8], for each of the currently visible satellites RBC (GAD) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/8 (NID_VBRPACKET=8)
4 REP	CHECK	SSB sends ACK message [Msg 146] to RBC SSB -> RBC: Msg146
5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The GAD activates the calculation of the differential corrections associated with the train position and sends the VBR a General Message [Msg 24] with the "GNSS Differential Correction" packet [Pkt 44/3], starting a cyclical sending (T_CORR_PERIOD=10s) of the information needed for PVT calculation RBC (GAD) -> SSB (VBR): Msg24 with Pkt44/3 (NID_VBRPACKET=3)

6 REP	CHECK __________ Requirements REQ_8.1.1.1	If the VBR is in Stand-By (SB) mode, it calculates the safe position using the navigation data (44/8) and differential corrections (44/3) provided by the GAD and then switches to Track Discrimination (TD) mode
Post condition · SSB in PT · The PdC cannot enter the train data (EOM must be performed to proceed) · VBR in Full Navigation (FN) mode		

6.4.3.11 TD

6.4.3.11.1 VBTS_TD_065

Management of the MA for an SSB in FS with VBR in FN due to the presence of a punctual NSA activated by the operator			
FUNCTION	**Execution**	**Scenario's Type**	**version**
TD MA	LAB	Degraded	00.00
Notes			

Pre Condition

- SSB in FS with assigned MA covering the immediately downstream SBR
- The second SBR downstream of the train (the one immediately downstream of the EoA) is considered OS Proved (it has a busy CdB)
- The third SBR downstream of the train is considered FS Proved
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_122 - Failure to extend the MA in OS for an SSB in FS with VBR in FN due to the presence of an active NSA**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The RBC operator sets up and activates a punctual Non stopping area inside the degraded SBR due to CdB being busy
2 EXE	CHECK	RBC illuminates the activated NSA symbol on the QL
3 EXE	ACTION	The PoC brings the SSB into the OS activation window (100m from the down-stream signal considered EOA)
4 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
5 REP	CHECK	RBC verifies that the SSB is located in the OS activation window and that the MA extension conditions are not verified, since the immediately downstream SBR, considered "OS Proved", includes an active NSA
6 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_123 - Extension of the MA in FS for an SSB in FS with VBR in FN, containing a punctual NSA activated by the operator and subsequently revoked**	
step	**Description**	**Expected Result**
1 EXE	EVENT	The occupied CdB of the SBR downstream of the train becomes free and RBC considers FS proved the SBR previously considered degraded

2 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)
3 REP	CHECK ________ Requirements REQ_8.1.3.3	RBC checks that the MA extension conditions are met on the downstream SBRs considered "FS proved" and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the edge train, which covers the subsequent SBR with the "Full Supervision" profile, and includes: - the Track Condition package [Pkt68] to manage the Non stopping area punctually activated by the operator - the "Switch Point Status" package [Pkt 44/6], sent from VT to VBR, which contains the status of the switches included in the MA assigned to the train (N_ITER=0 if there are no switches) RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION) , Pkt27, Pkt21, Pkt5, Pkt68 (M_TRACKCOND=0) and Pkt44/6 (NID_VBRPACKET=6, N_ITER>=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
6 EXE	CHECK	The MA is displayed on the RBC QL
7 EXE	ACTION	The PdC brings the SSB to the punctual NSA activated by the operator
8 EXE	CHECK	The PoC confirms that the DMI in the "Areas for orders and announcement of track conditions" shows the icons relating to "Non Stopping area" (grey symbol) and "Non Stopping area announcement" (yellow symbol) in correct sequence
9 EXE	ACTION	The PdC advances the SSB onto the next SBR, passing the "Non Stopping Area" activated by the operator
10 EXE	ACTION	The RBC operator revokes the previously activated Punctual Non stopping area
11 EXE	CHECK	RBC cancels the previously activated NSA and its symbol is no longer displayed on the QL
12 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)

Post condition

- SSB in FS
- NSA revoked by operator
- VBR in Full Navigation (FN) mode

6.4.3.12 RTB

6.4.3.12.1 VBTS_RTB_066

RTB alarm management for one SSB, with VBR in FN, with FS-TR-PT-SR mode transition			
FUNCTION	**Execution**	**Scenario's Type**	**version**
RTB EMU MA	LAB	Not nominal	00.00

Notes	If the train has already received the General Message [Msg24] with the packet Packet for sending plain text messages [Pkt72] this is not canceled with the transition in TR-PT-SR mode.

Pre Condition

- SSB in FS with MA assigned having EoA on warning signal of a PoS
- Moving train, located upstream of the RTB sensor
- The SBR beyond the EoA presents the input signal in the closed state, as the only missing condition to be considered "FS Proved"
- All the conditions for considering the SBR of the station downstream of the "FS Proved" protection signal are verified with the exception of the formation of the (arrival) itinerary
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_124 - Extension of the MA up to the protection signal of the DP immediately downstream and subsequent association of the Boccole Calde Alarm detected by RTB for a train in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	EVENT	The SSB bypasses the RTB sensor which detects the alarm state
3 EXE	CHECK	Having detected an RTB alarm, the starting signal concerned, connected to RTB, cannot set the go-ahead and the RTB alarm is signaled on the QLv with the initials "RTB" flashing white
4 EXE	ACTION	The signalman cancels the entry signal closure of the first SBR in front of the EoA assigned to the train
5 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132

6 REP	CHECK ___________ Requirements REQ_8.1.3.3	Since the MA extension conditions have been verified on the SBRs downstream of the SSB considered "FS proved", RBC sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the front train, which covers the SBR occupied by the train front and the subsequent SBRs with a "Full Supervision" profile and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains an empty list (N_ITER =0) of switches included in the MA RBC -> SSB: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER=0)
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
9 EXE	CHECK	The updated MA is displayed on the RBC QL
10 EXE	CHECK	RBC having located the SSB with the min safe front end in the "RTB alarm activation" window (in the distance between the RTB device, according to its direction, and the protection signal of the DP immediately downstream) associates the received RTB alarm from IL to SSB, then RBC displays the RTB-SSB alarm association on the QL of the TO
11 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “STOP FOR RTB ALARM” RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY=32767, M_MODETEXTDISPLAY=15, M_LEVELTEXTDISPLAY =5, L_TEXTDISPLAY=32767, T_TEXTDISPLAY=1023, M_MODETEXTDISPLAY=15, M_LEVELTEXTDISPLAY=5, Q_TEXTCONFIRM=1, Q_CONFTEXTDISPLAY=0, Q_TEXTREPORT=0)
12 EXE	CHECK	The HP displays but does not recognize the text message "STOP DUE TO RTB ALARM"

TC	**VBTS_SDT-SSB_125 - RTB alarm management previously associated for an SSB in PT with VBR in FN which transits in SR after Override command with subsequent re-evaluation of the MA**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The RBC Operator through the RBC TO carries out an "Emergency activation of single train" command
2 REP	CHECK	RBC sends Unconditional Emergency Stop message [Msg16] to train RBC -> SSB: Msg16 (NID_EM=0)
3 EXE	CHECK	The PdC confirms that the DMI shows the message "Unconditional emergency" and the "brake intervention symbol"
4 EXE	CHECK	The emergency condition for the train is displayed on the operator interface
5 EXE	CHECK	RBC receives a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)

6 REP	CHECK	The SSB sends the unconditional emergency ACK message [Msg147] with Q_EMERGENCYSTOP = 2. SSB -> RBC: Msg147 (Q_EMERGENCYSTOP=2) with Pkt0 (M_MODE=7)
7 EXE	CHECK	The PdC with the train stopped, but cannot recognize the Trip on the DMI because the message relating to the RTB is displayed
8 EXE	ACTION	The HP recognizes the text message "STOP DUE TO RTB ALARM"
9 EXE	ACTION	The PdC recognizes the Trip on the DMI
10 EXE	CHECK	RBC receives a PR [Msg136] in PT (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
11 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK request RBC -> SSB: Msg6 (M_ACK=1)
12 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
13 EXE	ACTION	The PdC performs Override
14 EXE	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
15 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC verifies that the SSB is located within the first activation window with the min safe front end and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered "FS Proved" and includes the "Switch Point Status" packet [Pkt 44/6], sent from the VT to the VBR, which contains a list empty (N_ITER=0) of switches included in the MA RBC -> SSB: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (D_MAMODE>=0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/6 (NID_VBRPACKET=6, N_ITER=0)
16 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
17 EXE	CHECK	The MA is displayed on the RBC QL
18 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the start of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)

19 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
20 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
21 EXE	CHECK	RBC continues to display the RTB-SSB alarm association on the QL of the TO

Post condition

- Train in OS with MA OS-FS having Eoa on the protection signal of the DP
- "RTB alarm" active and associated with the train
- VBR in Full Navigation (FN) mode

6.4.3.13 TSR

6.4.3.13.1 VBTS_TSR_067

Extension of the MA, for a SSB in FS and VBR in FN, with 2 partially overlapping slowdowns with stop, with application of the Service Brake due to non-recognition by the PdC, and subsequent revocation of the more restrictive TSR			
FUNCTION	**Execution**	**Scenario's Type**	**version**
TSR MA	LAB	Not nominal	00.00

Notes	

Pre Condition

- SSB in FS with MA assigned until a dial tone (in closed state)
- The SBR downstream of the EoA presents the input signal in the closed state, as the only missing condition to be considered "FS Proved"
- No TSR assigned to the train
- No active TSR in front of the EoA
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_126 - Extension of the MA in FS with 2 decelerations with stop, partially overlapping, for an SSB in FS with VBR in FN, with application of the Service Brake due to failure to recognize by the PdC**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The RBC operator sets and activates 2 partially overlapping programmed TSRs with different maximum speeds as follows: - TSR1: slowdown with stop with starting point in the first SBR in front of the EoA assigned to the train - TSR2: slowdown with stop with starting point in the second SBR in front of the EoA assigned to the train
3 EXE	CHECK	RBC illuminates the activated TSR symbol on the QL
4 EXE	ACTION	The signalman cancels the entry signal closure of the first SBR in front of the EoA assigned to the train
5 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132

6 REP	CHECK	Since the MA extension conditions have been verified on the SBRs downstream of the SSB considered "FS proved", RBC verifies that the MA to be sent to the train intersects the TSRs previously activated by the RBC operator, and sends a General Message [Msg24] with two Temporary Speed Restriction [Pkt65] and a Packet for Sending Plan Text Messages [Pkt72] containing the text message “SLOWDOWN WITH STOP”, with display up to the beginning of the slowdown closest to the SSB (TSR1) RBC -> SSB: Msg24 (M_ACK=1) with Pkt65 (NID_TSR, D_TSR, Q_FRONT=0, V_TSR>0) and Pkt65 (NID_TSR, Q_FRONT=0, V_TSR>0), Pkt72 (D_TEXTDISPLAY=0, L_TEXTDISPLAY=D_TSR, Q_TEXTCONFIRM=2, Q_CONFTEXTDISPLAY= 1, Q_TEXTREPORT=0)
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
8 REP	CHECK	RBC sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the subsequent SBRs with the "Full Supervision" profile and includes the "Switch Point Status” [Pkt44/6] RBC -> SSB: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 EXE	CHECK	An alarm for two TSRs with stop is displayed on the RBC TO
11 EXE	CHECK	The text message "SLOWDOWN WITH STOP" is proposed to the PdC which does not recognize it
12 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
13 EXE	CHECK	The MA is displayed on the RBC QL
14 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
15 EXE	ACTION	The PdC moves the train towards the TSRs (without recognizing them on the DMI)
16 EXE	CHECK	When the start of the first deceleration is reached, the SSB applies the Service Brake until the train stops
17 REP	CHECK	The SSB sends a PR [Msg136] in FS (with M_MODE=0) to the RBC when the train is stopped SSB -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN=0)
18 EXE	CHECK	The text message "RALLENTAMENTO CON FERMATA" is recognized by the PdC (as per UNISIG Q_TEXTCONFIRM=2: Confirmation required: command application of the service brake when display end condition is fulfilled, unless the text has already been acknowledged by the driver)

19 EXE	CHECK	The PdC confirms that the service braking is released
20 EXE	ACTION	The PdC restarts the train by advancing in the area covered by the 2 TSRs (area where the two TSRs overlap)
21 EXE	CHECK	The train moves on the slowed sections gradually updating the maximum speed that can be reached on the DMI.
TC	**VBTS_SDT-SSB_130 - Revocation of the more restrictive TSR assigned to SSB with VBR in FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	While the train is traveling in the area covered by the delays, the RBC operator revokes, through the RBC TO, the most restrictive TSR among those assigned to the SSB
3 EXE	CHECK	RBC considers the revoked TSR as Not Active, deleting it from the list of managed ones
4 REP	CHECK	RBC revokes the TSR, sending to the SSB a General Message [Msg24] with packet "Temporary speed restriction Revocation" [Pkt66] containing the NID_TSR associated with the revoked slowdown RBC -> SSB: Msg24 (M_ACK=1) with Pkt66 (NID_TSR=k)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The SSB proceeds in FS on the slowed section updating the target speed on the DMI
7 EXE	ACTION	The PdC moves the train beyond the area covered by the delays
8 EXE	CHECK	The SSB proceeds in FS until it completely tails the area covered by the slowdown (for Q_FRONT=0 in the received pkt65) and updates the target speed on the DMI as the maximum speed allowed by the line

Post condition

- SSB in FS
- No delays assigned to the train
- VBR in Full Navigation (FN) mode

6.4.3.13.2 VBTS_TSR_068

TSR management in a MA Shifted with 2 slowdowns activated by the operator, one of which with a stop starting upstream of the LRBG and one downstream of the LRBG which includes a facing-point			
FUNCTION	**Execution**	**Scenario's Type**	**version**
PoS TSR MA	LAB	Not nominal	00.00

Notes	

Pre Condition

- Train in PT or SB located by RBC in the SBR immediately upstream of a DP (PM)
- LRBG is positioned downstream of the train front and on the same SBR where the train is located
- At least the first SBR downstream of the SSB front is verified as "FS Proved" (arrival itinerary formed)
- The station SBR immediately downstream of the train includes at least one facing point
- No Emergency active for the train
- No active TSR in front of the train front
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_129 - Management of TSRs in a MA Shifted in the assignment of the MA which covers a slowdown with a stop starting upstream of the LRBG and one downstream of the LRBG which covers a facing-point**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The RBC operator sets and activates two partially overlapping programmed TSRs at different maximum speeds as follows: - TSR1: a slowdown, with a stop, which starts upstream of the LRBG and downstream of the front train and ends in the downstream SBR - TSR2: a slowdown starting downstream of the LRBG and including the facing point
2 EXE	CHECK	RBC illuminates the activated TSR symbol on the QL
3 EXE	ACTION	The PdC selects Start on the DMI
4 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
5 REP	CHECK	RBC verifies that the MA to be sent to the train intersects the TSRs, then assigns to the SSB the TSR previously activated by the RBC operator with start of the slowdown downstream of the LRBG, sending a General Message [Msg24] with a Temporary Speed Restriction [Pkt65] RBC -> SSB: Msg24 (M_ACK=1) with Pkt65 (NID_TSR, V_TSR>0)
6 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

7 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC sends the SSB a MA with Shifted Location Reference [Msg33] message with ACK request (M_ACK = 1) and D_REF correctly calculated as the distance between LRBG and the new Shifted Location, referred to the LRBG positioned downstream of the train front, with an OS-FS profile and includes: - the Temporary Speed Restriction [Pkt65] packet relating to the TSR activated upstream of the LRBG and with D_TSR valued as the distance between the reference location and the starting point of the temporary speed reduction and a Packet packet for sending plain text messages [Pkt72], containing the “SLOWDOWN WITH STOP” text message to be displayed until the slowdown begins (L_TEXTDISPLAY) - the “Switch Point Status” packet [Pkt 44/6], sent from TV to VBR , which contains the status of the switches included in the MA assigned to the train RBC (TV) -> SSB (VBR): Msg33 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 (D_LINK=D_REF, NID_BG=NID_LRBG) , Pkt65 (NID_TSR, D_TSR<D_REF), Pkt72 (D_TEXTDISPLAY=0, L_TEXTDISPLAY>0, Q_TEXTCONFIRM=2, Q_CONFTEXTDISPLAY=1, Q_TEXTREPORT=0), Pkt80 (D_MAMODE>0, M_MAMODE=0, L_MAMODE<L_ENDSECTION) and Pkt44/ 6 (NID_VBRPACKET=6, N_ITER>0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
9 EXE	CHECK	The MA is displayed on the RBC QL
10 REP	CHECK	RBC sends a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message “EXTENSION OF MA IN FS” with T_TEXTDISPLAY=30 RBC -> SSB: Msg24 with Pkt72 (D_TEXTDISPLAY>= 0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
11 EXE	ACTION	The OS mode is proposed to the PdC which recognizes it
12 EXE	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1, Q_DIRLRBG<>Q_DLRBG)
13 EXE	ACTION	The PdC recognizes the text message "SLOWDOWN WITH STOP" and moves the train forward
14 EXE	CHECK	The SSB advances in the slow section, detects the LRBG and sends a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1, Q_DIRLRBG=Q_DLRBG)
15 REP	CHECK __________ Requirements REQ_8.1.3.3	RBC receives the PR which notifies the passage on the LRBG and then sends to the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referring to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on subsequent SBRs considered “FS Proved” RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 (M_MAMODE=0) and Pkt44/6 (NID_VBRPACKET=6, N_ITER)
16 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

TC	VBTS_SDT-SSB_133 - Digital Map integrity check for an SSB with VBR in FN that passes a facing point included in a TSR	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=1)
2 EXE	ACTION	The PdC makes the train move forward in the next SBR moving on the slowing sections updating the maximum speed that can be reached on the DMI (area in which the two TSRs overlap)
3 EXE	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
4 EXE	CHECK	The advancing train passes the facing point with the VBR Virtual Antenna
5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)
6 REP	CHECK ___________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
7 EXE	ACTION	The PdC moves the train beyond the facing point and in the slowed section, updating the maximum speed allowed on the DMI

Post condition

- SSB in FS downstream of a facing point
- Train moving on a slow stretch
- VBR in Full Navigation (FN) mode

6.4.3.13.3 VBTS_TSR_069

Management of a programmed TSR with the extension and reduction of the MA assigned to an SSB, with VBR in FN, and subsequent revocation of the previously assigned slowdown			
FUNCTION	**Execution**	**Scenario's Type**	**version**
TSR MA	LAB	Not nominal	00.00

Notes	

Pre Condition

- SSB in FS with MA assigned until a dial tone (in closed state)
- The first two SBRs beyond EoA have the input signal in the closed state, as the only missing condition to be considered "FS Proved"
- No TSR assigned to the train
- No active TSR in front of the EoA
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_127 - MA extension in FS with an operator configured TSR for an SSB in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The RBC operator sets up and activates a scheduled TSR (at speeds < 30 km/h) which starts in the first SBR beyond the train's assigned EoA and covers, at least partially, the second SBR beyond the train's assigned EoA
3 EXE	CHECK	RBC illuminates the activated TSR symbol on the QL
4 EXE	ACTION	The signalman cancels the entry signal closure of the first SBR in front of the EoA assigned to the train
5 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
6 REP	CHECK	Since the MA extension conditions on the SBRs downstream of the SSB considered "FS proved" have been verified, RBC verifies that the MA to be sent to the train intersects the TSR, then assigns the TSR to the SSB up to the new EoA, sending a General Message [Msg24] with a Temporary Speed Restriction [Pkt65] RBC -> SSB: Msg24 (M_ACK=1) with Pkt65 (NID_TSR, V_TSR>0)
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

8 REP	CHECK	RBC sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the subsequent SBR with "Full Supervision" profile RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
11 EXE	CHECK	The MA is displayed on the RBC QL
12 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_128 - Extension of the MA in FS with consequent extension of the previously recognized TSR for an SSB in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The signalman cancels the entry signal closure of the first SBR in front of the EoA assigned to the train
3 REP	CHECK	SSB sends MA Request [Msg132] message to RBC SSB -> RBC: Msg132
4 REP	CHECK	Since the MA extension conditions have been verified on the SBRs downstream of the SSB considered "FS proved", RBC verifies that the length of the TSR previously sent to the SSB is modified (extended) in the MA that must be sent to the train, therefore it updates the TSR, sending a General Message [Msg24] with a Temporary Speed Restriction [Pkt65] RBC -> SSB: Msg24 (M_ACK=1) with Pkt65 (NID_TSR, V_TSR>0)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 REP	CHECK	RBC sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the subsequent SBR with "Full Supervision" profile RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
7 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146

8 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
9 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
TC	**VBTS_SDT-SSB_131 - Reduction of MA in FS with consequent reduction of TSR previously recognized by an SSB in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The DCO commands the closure of the input signal of the second SBR included in the MA assigned to the SSB (in which there is the end of the TSR previously recognized by the train)
3 REP	CHECK	RBC checks that there are conditions for sending a reduced MA for the SSB, and then sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front with new EoA the initial signal of the first SBR considered degraded RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the reduction in the MA received
6 EXE	CHECK	The updated MA is displayed on the RBC QL
7 REP	CHECK	RBC verifies that in the MA sent to the train the length of the TSR previously sent to the SSB has been modified (reduced), then updates the TSR by sending a General Message [Msg24] with a Temporary Speed Restriction packet [Pkt65] RBC -> SSB: Msg24 (M_ACK=1) with Pkt65 (NID_TSR, V_TSR>0)
8 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
9 EXE	CHECK	The SSB advances in FS showing, on the DMI, the target speed as the maximum speed allowed by the line up to the last part of the MA where there is a slowdown
TC	**VBTS_SDT-SSB_132 - Revocation of TSR previously recognized by SSB requested by RBC operator**	
step	**Description**	**Expected Result**

1 EXE	CHECK	RBC receives a PR [Msg136] in FS/OS (with M_MODE=0/1) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0/1)
2 EXE	ACTION	The RBC operator revokes, through the RBC TO, the TSR assigned to the SSB (or in the case of several TSRs, the more restrictive one)
3 EXE	CHECK	RBC considers the revoked TSR as Not Active, deleting it from the list of managed ones
4 REP	CHECK	RBC revokes the TSR, sending to the SSB a General Message [Msg24] with packet "Temporary speed restriction Revocation" [Pkt66] containing the NID_TSR associated with the revoked slowdown RBC -> SSB: Msg24 (M_ACK=1) with Pkt66 (NID_TSR=k)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	ACTION	The PdC moves the train forward in the area previously covered by the slowdown
7 EXE	CHECK	The SSB proceeds by updating the target speed on the DMI

Post condition

- SSB in FS
- VBR in Full Navigation (FN) mode

6.4.3.13.4 VBTS_TSR_070

Management of an associated TSR, for SSB in FS with VBR in FN, downstream of the activation of an out of service that affects the track adjacent to the one where the front train is located			
FUNCTION	**Execution**	**Scenario's Type**	**version**
TSR	LAB	Not nominal	00.00

Notes	

Pre Condition

- Train in FS within the stretch of line not affected by an out of service
- Adjacent track not affected by an out of service
- There are no blockages in progress affecting the block (point of origin) adjacent to the one where the train is located
- No block section occupied on the track adjacent to the one where the train front is located
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_134 - Management of an associated TSR (at 150 km/h) for an SSB, equipped with a VBR system, following the activation of an out of service on the adjacent track**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO of the DP with block oriented for departures, activates an out of service on the track adjacent to the one where the front train is located using the "Request fs" command
2 EXE	CHECK	RBC displays the symbol relating to the fs on the QL
3 EXE	CHECK	RBC immediately activates an associated TSR (150 km/h) on the track where the train front is located (adjacent to the stretch of line affected by the out of service) and illuminates the symbol corresponding to the associated TSR on the QL
4 REP	CHECK	RBC sends a General Message [Msg24] with a Temporary Speed Restriction [Pkt65] packet with ACK request (M_ACK=1), with slowdown speed relative to the associated TSRs equal to 150 Km/h RBC -> SSB: Msg24 (M_ACK = 1) with Pkt65 (NID_TSR, V_TSR=30)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The train moves on the slowed sections gradually updating the maximum speed that can be reached on the DMI
TC	**VBTS_SDT-SSB_135 - Revocation of an associated TSR previously assigned to the SSB, equipped with the VBR system, following the deactivation of an out of service on the adjacent track**	
step	**Description**	**Expected Result**

1 EXE	ACTION	The DCO of the DP with oriented block for departures deactivates the out of service using the "Annullamento fs" command
2 EXE	CHECK	RBC deactivates the associated TSR (150 km/h) on the track adjacent to the stretch of line previously affected by the out of service and deactivates the symbol corresponding to the associated TSR on the QL
3 EXE	CHECK	RBC detects that the ASSOCIATE TSR previously assigned to the SSB has been deactivated
4 REP	CHECK	RBC revokes the TSR, sending to the SSB a General Message [Msg24] with packet "Temporary speed restriction Revocation" [Pkt66] containing the NID_TSR associated with the revoked slowdown RBC -> SSB: Msg24 (M_ACK=1) with Pkt66 (NID_TSR=k)
5 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
6 EXE	CHECK	The SSB proceeds by updating the target speed on the DMI

Post condition

- Train in FS
- No active outages affect the stretch of line where the train is located and the adjacent track
- VBR in Full Navigation (FN) mode

6.4.3.14 COSMA

6.4.3.14.1 VBTS_COSMA_071

Agreed revocation of the MA, on the protection signal of the DP, accepted by the train with consequent release of the itinerary PO and subsequent failure of the integrity of the Digital Map following the passing of a facing-point after the Override procedure			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT PoS COSMA	SITE LAB	Not nominal	00.00

Notes	COSMA, on ERTMS ITALIA lines, is a blockage release optimization procedure in place for a route destroyed through a DIT command. Through the "PO Release Consent Request", RBC receives the indication to check with the SSB the possibility of stopping the SSB before the IT protection signal is destroyed and previously included in the assigned MA.

Pre Condition

- SSB in FS with assigned MA which also covers subsequent SBRs (includes an arrival itinerary)
- Slow moving train away from station SBR guard signal (relative to arrival route)
- The arrival itinerary includes at least one facing point
- Immediately downstream of the facing point there is a VBG configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_136 - Agreed revocation of the MA, on the PoS protection signal, accepted by the train following the Itinerary Destruction command (DIT) given by the DCO operator**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO issues the "Destroy Itinerary" (DIT) command of the arrival itinerary in progress, located downstream of the train front, and included in the MA assigned to it
2 EXE	CHECK	IXL turns Red the protection signal of the PO protecting the arrival itinerary for which the destroy command has been applied
3 REP	CHECK Requirements REQ_8.1.3.3	RBC checks that there are conditions for sending a reduced MA for the SSB, and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with "Full Supervision" profile up to the protection signal of the DP which protects the arrival itinerary, for which the "Destruction Itinerary" (DIT) command has been applied and includes the "Switch Point Status" package [Pkt 44 /6], sent from VT to VBR, which contains an empty list (N_ITER=0) of switches included in the MA RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL until the protection signal of the PoS protecting the arrival itinerary, for which the "Destruction Itinerary" (DIT) command has been applied

6 REP	CHECK	RBC sends the Request to Shorten MA [Msg9] message, referring to the LRBG positioned upstream of the train front, and activates the T_COSMA (the length of the MA indicated in this message must be one meter less than that indicated in the shortened MA [Msg3], previously sent to the train) RBC -> SSB: Msg9 with Pkt15 (L_ENDSECTION, T_ EMA=1023, Q_SECTION-TIMER=0, Q_ENDTIMER=0)
7 REP	CHECK	The train accepts the reduced MA reported in [Msg9] by sending the RBC [Msg137] (Request to Shorten MA is Granted) SSB -> RBC: Msg137
8 REP	CHECK	RBC deactivates the T_COSMA timer and sends the SSB a Movement Authority message [Msg3] with ACK request [M_ACK=1], selecting as EoA the protection signal of the PoS which protects the arrival itinerary for which the Request message was sent to Shorten MA [Msg9] RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
11 EXE	CHECK	IXL releases the blocking of the PO relating to the DIT command and on the HMI the appearance of the shield relating to the origin point of the arrival itinerary is displayed in "Medium grey"
TC	**VBTS_SDT-SSB_066 - Failure of the integrity of the Digital Map due to passing a facing-point not included in the MA and consequent transition of the VBR to TD with failure to detect a VBG**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 EXE	ACTION	The PoC moves the train towards its EoA and approaches the guard signal stopping the train less than D_NVOVTRP (200 m) from the signal
3 EXE	ACTION	The HP carries out the Override procedure
4 EXE	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
5 EXE	ACTION	The PdC advances the train into the next station SBR and beyond the facing-point
6 REP	CHECK	The VBR, detecting that the MaxSafeAntenna (corresponding to the position of the VBR Virtual Antenna increased by the confidence interval, default 30m) of the train has passed a facing-point with position unknown to the SSB, considers the Digital Map Navigation Integrity failed and switches to Track Discrimination (TD)

7 EXE	EVENT __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
8 REP	CHECK __________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The VBR, being in Track Discrimination mode, does not detect the virtual BG
9 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) and includes the package “Position Report Validation Request” [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET =103)
10 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
11 REP	CHECK	The VBR, not being able to uniquely determine a single path of the Digital Map, discards the "Position Report Validation Request" [pkt 44/5] received from the TV and remains in TD mode

Post condition

- SSB in SR, located beyond the protection signal of a PO and downstream of a facing point
- Train downstream of an undetected VBG
- VBR in Track Discrimination (TD) mode due to Digital Map Integrity Failure

6.4.3.14.3 VBTS_COSMA_072

Agreed revocation of the MA, on the protection signal of the DP, refused by the train with consequent failure to release the itinerary PO and passage in TR of the SSB due to exceeding the EoA			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT PoS COSMA	SITE LAB	Not nominal	00.00

Notes	COSMA, on ERTMS ITALIA lines, is a blockage release optimization procedure in place for a route destroyed through a DIT command. Through the "PO Release Consent Request", RBC receives the indication to check with the SSB the possibility of stopping the SSB before the IT protection signal is destroyed and previously included in the assigned MA.

Pre Condition

- SSB in FS with assigned MA which also covers subsequent SBRs (includes an arrival itinerary)
- Train moving near the DP protection signal
- The arrival itinerary includes at least one facing point
- Immediately downstream of the facing point there is a VBG configured in the Digital Map
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_137 - Agreed revocation of the MA, on the protection signal of the DP, rejected by the train following the Itinerary Destruction command (DIT) given by the DCO operator and consequent transition to TR of the SSB for exceeding EoA**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO issues the "Destroy Itinerary" (DIT) command of the arrival itinerary in progress, located downstream of the train front, and included in the MA assigned to it
2 EXE	CHECK	IXL turns Red the protection signal of the PO protecting the arrival itinerary for which the destroy command has been applied
3 REP	CHECK Requirements REQ_8.1.3.3	RBC checks that there are conditions for sending a reduced MA for the SSB, and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with "Full Supervision" profile up to the protection signal of the DP which protects the arrival itinerary for which the "Destruction Itinerary" (DIT) command has been applied and includes the "Switch Point Status" package [Pkt 44/ 6], sent from VT to VBR, which contains an empty list (N_ITER=0) of switches included in the MA RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21 , Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL until the protection signal of the PoS protecting the arrival itinerary, for which the "Destruction Itinerary" (DIT) command has been applied

6 REP	CHECK	RBC sends the Request to Shorten MA [Msg9] message, referring to the LRBG positioned upstream of the train front, and activates the T_COSMA (the length of the MA indicated in this message must be one meter less than that indicated in the shortened MA [Msg3], previously sent to the train). RBC -> SSB: Msg9 with Pkt15 (L_ENDSECTION, T_ EMA=1023, Q_SECTION-TIMER=0, Q_ENDTIMER=0)
7 REP	CHECK	The train rejects the shortened MA reported in [Msg9] by sending the RBC [Msg138] (Request to Shorten MA is Rejected) SSB -> RBC: Msg138
8 REP	CHECK	RBC deactivates the T_COSMA timer and sends the SSB a Movement Authority message [Msg3] with ACK request [M_ACK=1], selecting as EoA the protection signal of the PoS which protects the arrival itinerary for which the Request message was sent to Shorten MA [Msg9] RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
9 EXE	CHECK	PO blocking remains active
10 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
11 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
12 EXE	EVENT	The SSB unduly exceeds the EoA (protection signal of the PoS) with the minSFE
13 EXE	CHECK	The SSB detects that MinSFE is over EoA and switches to TRIP, sending a PR [Msg136] in TR (with M_MODE=7) SSB -> RBC: Msg136 with Pkt0 (M_MODE=7)
14 EXE	ACTION	The PdC stops the train and recognizes the train trip on the DMI
15 EXE	CHECK	RBC receives PR in PT mode [Msg136] (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)
16 REP	CHECK	RBC sends message Recognition of the exit from TR mode [Msg6] with ACK request RBC -> SSB: Msg6 (M_ACK=1)
17 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
18 REP	CHECK	RBC receives a PR [Msg136] in PT (with M_MODE=8) SSB -> RBC: Msg136 with Pkt0 (M_MODE=8)

TC	VBTS_SDT-SSB_065 - Failure of the integrity of the Digital Map, for an SSB with VBR in FN, due to passing an unknown facing point following the Override procedure and consequent transition of the VBR to TD	
step	**Description**	**Expected Result**
1 EXE	ACTION	If not already stopped, the PdC stops the train immediately upstream of the facing point and carries out the Override procedure
2 EXE	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) SSB -> RBC: Msg136 with Pkt0 (M_MODE=2)
3 EXE	ACTION	The PdC moves the train beyond the facing point
4 REP	CHECK	The VBR, detecting that the MaxSafeAntenna (corresponding to the position of the VBR Virtual Antenna increased by the confidence interval, default 30m) of the train has passed a facing-point with position unknown to the SSB, considers the Digital Map Navigation Integrity failed and switches to Track Discrimination (TD)
5 REP	CHECK	RBC receives a PR [Msg136] in SR (with M_MODE=2) and includes the package "Position Report Validation Request" [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET =103)
6 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The VT, having received the "Position Report Validation Request" packet and considering the localized SSB, sends to the VBR a General Message [Msg 24] which includes the "Valid Position Report packet" [Pkt 44/5] with ACK request (M_ACK=1), setting the variables according to the last valid PR received RBC (TV) -> SSB (VBR): Msg24 (M_ACK=1) with Pkt44/5 (NID_VBRPACKET=5, Q_DIR=2, NID_LRBG, NID_PRVLRBG= 16777215, D_LRBG, Q_DIRLRBG, Q_DLRBG, L_DOUBTOVER, L_DOUBTUNDER, V_TRAIN and Q_DIRTRAIN)
7 REP	CHECK	The VBR, not being able to uniquely determine a single path of the Digital Map, discards the "Position Report Validation Request" [pkt 44/5] received from the TV and remains in TD mode

TC	VBTS_SDT-SSB_037 - Failure to detect a VBG for an SSB located in SR but with VBR in TD	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC moves the train forward in SR
2 REP	CHECK	The train sends a PR [Msg 136] in SR (with M_MODE=2) and includes the packet "Position Validation Check Result" [Pkt 44/103] SSB -> RBC: Msg136 with Pkt0 (M_MODE=2) and Pkt44/103 (NID_VBRPACKET=103)

3 EXE	EVENT ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The advancing train passes the position where a VBG is foreseen in the Digital Map with the "VBR virtual antenna".
4 REP	CHECK ___________ Requirements REQ_8.1.2.3 REQ_8.1.1.3	The VBR, being in Track Discrimination mode, does not detect the virtual BG

Post condition

- SSB in SR, located beyond the protection signal of a PO and downstream of a facing point
- Train downstream of an undetected VBG
- VBR in Track Discrimination (TD) mode due to Digital Map Integrity Failure

6.4.3.14.4 VBTS_COSMA_073

Agreed revocation of the MA, on the protection signal of a DP (PM), accepted by the train and subsequent extension of the MA on the itinerary of precedence			
FUNCTION	**Execution**	**Scenario's Type**	**version**
BUT PoS COSMA	LAB	Not nominal	00.00

Notes	COSMA, on ERTMS ITALIA lines, is a blockage release optimization procedure in place for a route destroyed through a DIT command. Through the "PO Release Consent Request", RBC receives the indication to check with the SSB the possibility of stopping the SSB before the IT protection signal is destroyed and previously included in the assigned MA.

Pre Condition

- SSB in FS with assigned MA which also covers subsequent SBRs (includes an arrival itinerary)
- Slow moving train away from station SBR guard signal (relative to arrival route)
- The arrival itinerary includes at least one facing point
- Immediately downstream of the facing point there is a VBG configured in the Digital Map
- The starting signal of the PO on the yield track includes both Danger Point and Overlap (eg the point to be protected is included in the exit zone)
- VBR in Full Navigation (FN) mode

TC	**VBTS_SDT-SSB_136 - Agreed revocation of the MA, on the PoS protection signal, accepted by the train following the Itinerary Destruction command (DIT) given by the DCO operator**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO issues the "Destroy Itinerary" (DIT) command of the arrival itinerary in progress, located downstream of the train front, and included in the MA assigned to it
2 EXE	CHECK	IXL turns Red the protection signal of the PO protecting the arrival itinerary for which the destroy command has been applied
3 REP	CHECK Requirements REQ_8.1.3.3	RBC checks that there are conditions for sending a reduced MA for the SSB, and sends the SSB a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with "Full Supervision" profile up to the protection signal of the DP which protects the arrival itinerary, for which the "Destruction Itinerary" (DIT) command has been applied and includes the "Switch Point Status" package [Pkt 44 /6], sent from VT to VBR, which contains an empty list (N_ITER=0) of switches included in the MA RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER=0)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The MA is displayed on the RBC QL until the protection signal of the PoS protecting the arrival itinerary, for which the "Destruction Itinerary" (DIT) command has been applied

6 REP	CHECK	RBC sends the Request to Shorten MA [Msg9] message, referring to the LRBG positioned upstream of the train front, and activates the T_COSMA (the length of the MA indicated in this message must be one meter less than that indicated in the shortened MA [Msg3], previously sent to the train) RBC -> SSB: Msg9 with Pkt15 (L_ENDSECTION, T_ EMA=1023, Q_SECTION-TIMER=0, Q_ENDTIMER=0)
7 REP	CHECK	The train accepts the reduced MA reported in [Msg9] by sending the RBC [Msg137] (Request to Shorten MA is Granted) SSB -> RBC: Msg137
8 REP	CHECK	RBC deactivates the T_COSMA timer and sends the SSB a Movement Authority message [Msg3] with ACK request [M_ACK=1], selecting as EoA the protection signal of the PoS which protects the arrival itinerary for which the Request message was sent to Shorten MA [Msg9] RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt44/6
9 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
10 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) SSB -> RBC: Msg136 with Pkt0 (M_MODE=0)
11 EXE	CHECK	IXL releases the blocking of the PO relating to the DIT command and on the HMI the appearance of the shield relating to the origin point of the arrival itinerary is displayed in "Medium grey"

TC	**VBTS_SDT-SSB_050 - Extension of the MA in FS up to the starting signal of a yield track with Danger Point and Overlap for an SSB in FS with VBR in FN**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The DCO activates the diverted station itinerary downstream of the train front by selecting the DP entry signal as the origin point and a DP track priority departure signal as the final point
2 REP	CHECK	The SSB sends a MA Request [Msg132] message to RBC SSB -> RBC: Msg132 with Pkt0 (M_MODE=0)

3 REP	CHECK ________ Requirements REQ_8.1.3.3	RBC activates the MA extension process given that the MA extension conditions in FS are verified on the station SBR relating to the arrival itinerary on a priority track of the PdS and sends the SSB a Movement Authority message [Msg3] with request to ACK (M_ACK = 1) and with "Full Supervision" profile and includes: - the International Static Speed Profile package [Pkt27] which includes the variations of the static speed profiles (V_STATIC) included in the extended MA (in particular on the deviation) with Q_FRONT=0 indicating that the speed must be applied along the entire length of the train - the Level 2/3 Movement Authority packet [Pkt15] which indicates the presence of a Danger Point associated with the MA, placed in correspondence with the point to be protected, having distance D_DP from EoA and release speed calculated on board, and an Overlap associated with the MA, having distance D_OL from EoA and with timer T_OL which assumes the value envisaged by the configuration of the station system to be activated when the start joint of the CdB is exceeded (D_STARTOL from EoA) - the Switch Point Status packet [Pkt 44/6], sent from the VT to the VBR, which contains the status of the switches (Q_PTSTATUS) included in the MA assigned to the train (N_ITER>0). RBC (TV) -> SSB (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION, Q_DANGERPOINT=1, D_DP>0, V_RELEASEDP=126, Q_OVERLAP=1, T_OL>0, D_STARTOL>0, D_OL>0, V_RELEASEOL=126), Pkt27 (V_STATIC, Q_FRONT=0), Pkt21, Pkt5 and Pkt44/6 (NID_VBRPACKET=6, N_ITER>0, Q_PTSTATUS(k)=1/2)
4 REP	CHECK	SSB sends ACK message to RBC [Msg146] SSB -> RBC: Msg146
5 EXE	CHECK	The DP confirms that on the DMI the "Area for planning information" has been updated in line with the extension of the MA received
6 EXE	CHECK	The updated MA is displayed on the RBC QL

TC	**VBTS_SDT-SSB_064 - Digital Map integrity check for an SSB in FS with VBR in FN that has passed a facing point on a detour route**	
step	**Description**	**Expected Result**
1 EXE	ACTION	The PdC makes the train move forward until it passes the facing point with the VBR Virtual Antenna
2 REP	CHECK ________ Requirements REQ_8.1.1.1	The VBR verifies that the train has passed a facing point and requests the VT to verify the integrity of the Digital Map through a Position Report [Msg 136] which the SSB sends to RBC including the [Pkt 0] and the Digital Map Navigation Integrity packet [Pkt 44/104] with “Point status identifier” (M_PTSTATUSID) and “Point Identifier” (M_PTID) SSB (VBR) -> RBC (TV): Msg136 with Pkt0 and Pkt44/104 (NID_VBRPACKET=104, M_PTSTATUSID and M_PTID)

3 REP	CHECK __________ Requirements REQ_8.1.1.4 REQ_8.1.3.3	The TV sends to the VBR a General Message [Msg 24], without ACK request (M_ACK=0), which includes the packet "Digital Map Navigation Integrity Result" [Pkt 44/9] with positive outcome of the integrity check (Q_PRINTEGRITYCHECK = "00") performed on the switch just passed (M_PTSTATUSID and M_PTID) RBC (TV) -> SSB (VBR): Msg24 (M_ACK=0) with Pkt44/9 (NID_VBRPACKET=9, M_PTSTATUSID, M_PTID, Q_PRINTEGRITYCHECK = "00")
4 EXE	ACTION	The PdC moves the train on the detour
5 EXE	CHECK	Consistent with the previously received Pkt27 (Q_FRONT=0) the speed profile on the detour is applied for the entire length of the train, i.e. until the train completely tails the detour

Post condition

- SSB in FS with assigned MA covering a detoured itinerary
- VBR in Full Navigation (FN) mode

6.4.3.15 2TRAINS

6.4.3.15.1 VBTS_2Trains_074

Reduction of the MA for a first train downstream of the connection of a second train, equipped with a VBR system, on an SBR included in the assigned MA and subsequent pursuit along the line of the two trains			
FUNCTION	**Execution**	**Scenario's Type**	**version**
SOM 2MA trains	LAB	Not nominal	00.00

Notes	To carry out the test, the hare train (Train2) must be equipped with a VBR system, while the follower train (Train1) is a pure ERTMS SSB.

Pre Condition

- Train1 in OS with MA assigned in OS on the SBR line immediately downstream of the train front
- Train1 stopped or moving slowly
- The SBR downstream of the train front1 has a busy CdB (no unconnected SSB is located there)
- The first SBR downstream of the train front1 is considered "OS Proved" while the subsequent SBRs are "FS Proved"
- Downstream of Treno1 there are at least 3 line SBRs
- Train2 in NP on CdB busy with VBR in No Power mode (NP)
- The maximum number of trains that RBC can accept has not been reached
- The maximum number of trains that TV can accept has not been reached
- The Interface Protocol and Digital Maps versions used by RBC, GAD and the VBR of Treno2 are compatible
- Immediately downstream of Train2, and on its own SBR, there is a physical BG (on which the train will be located)

TC	**VBTS_SDT-SSB_138 - Reduction of the MA in OS for the connection of a new train, equipped with a VBR system, located on a SBR included in the assigned MA and subsequent extension downstream of the advancement of the hare train**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives from Train1 a PR [Msg136] in OS (with M_MODE=1) SSB1 -> RBC: Msg136 with Pkt0 (M_MODE=1)
2 EXE	EVENT	Train2 connects to RBC and locates, moving in SR, with consequent transition of VBR to FN (following reception of 44/8 packets and differential corrections [44/3] and detection of a physical BG)
3 REP	CHECK	RBC, considering Train2 located on an SBR included in the MA assigned to Train1, verifies that the conditions exist for sending a reduced MA, with a new EoA the signal immediately ahead (which corresponds to the initial signal of the SBR occupied by Train2) and sends to Train1 a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, which covers the SBR occupied by the train front with "On Sight" profile RBC -> SSB:SSB1: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt80 (D_MAMODE>=0; L_MAMODE<= L_ENDSECTION)
4 REP	CHECK	Train1 sends ACK message to RBC [Msg146] SSB1 -> RBC: Msg146

5 REP	CHECK	RBC sends to Train2 a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the first activation window and FS on the subsequent SBRs considered " FS Proved" and includes Switch Point Status [44/6] RBC (TV) -> SSB2 (VBR): Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5, Pkt80 and Pkt44/6 packet
6 REP	CHECK	Train2 sends ACK message to RBC [Msg146] SSB2 -> RBC: Msg146
7 REP	CHECK	RBC sends to Train2 a General Message [Msg24] with a packet Packet for sending plain text messages [Pkt72], containing the text message "EXTENSION OF THE MA IN FS" with T_TEXTDISPLAY=30 and D_TEXTDISPLAY equal to the distance between the LRBG and the 'beginning of OS activation window (0 m if LRBG inside OS activation window) RBC -> SSB2: Msg24 with Pkt72 (D_TEXTDISPLAY>=0, T_TEXTDISPLAY=30, Q_TEXTCONFIRM=0)
8 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) from Train2] SSB2 -> RBC: Msg136 with Pkt0 (M_MODE=1)
9 EXE	ACTION	The PoC moves Train2 (hare) forward on the following line SBR in compliance with its MA, freeing the line SBR immediately downstream of Train1 (following)
10 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train2 SSB2 -> RBC: Msg136 with Pkt0 (M_MODE=0)
11 REP	CHECK	Train1 sends MA Request message [Msg132] to RBC SSB1 -> RBC: Msg132
12 REP	CHECK	RBC sends to Train1 (follower) a Movement Authority message [Msg3] with ACK request (M_ACK = 1), referred to the LRBG positioned upstream of the train front, with an OS profile on the OS activation window and FS on the SBRs subsequent considered "FS Proved", up to the signal upstream of the SBR where Train2 is located (hare) RBC -> SSB1: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5 and Pkt80
13 REP	CHECK	Train1 sends ACK message to RBC [Msg146] SSB1 -> RBC: Msg146
14 REP	CHECK	RBC receives a PR [Msg136] in OS (with M_MODE=1) from Train1 SSB1 -> RBC: Msg136 with Pkt0 (M_MODE=1)
15 EXE	ACTION	The PoC advances Train1 into the next SBR
16 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train1 SSB1 -> RBC: Msg136 with Pkt0 (M_MODE=0)

TC	VBTS_SDT-SSB_139 - Tracking along the line of two FS trains, one of which equipped with the VBR system	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train2 SSB2 -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train1 SSB1 -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 EXE	ACTION	The PdC moves Train2 (hare) forward on the following SBR in compliance with its MA, freeing the SBR immediately downstream of Train1 (following)
4 REP	CHECK	Train1 (follower) sends MA Request message [Msg132] to RBC1 SSB1 -> RBC: Msg132
5 REP	CHECK	RBC sends to Train1 (follower) a Movement Authority message [Msg3] with request for ACK (M_ACK = 1), referred to the LRBG positioned upstream of the train front, having EoA on the signal upstream of the SBR where Train2 is located (hare), with "Full Supervision" profile RBC -> SSB1: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5
6 REP	CHECK	Train1 sends ACK message to RBC [Msg146] SSB1 -> RBC: Msg146
7 EXE	ACTION	Train1 chases Train2 along the line
8 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train1 SSB1 -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN>0)
9 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train2 SSB2 -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN>0)

Post condition

- Train2 (hare) in FS with MA assigned in FS on the following SBRs
- Train2 (hare) with VBR in Full Navigation (FN) mode
- Train1 (follower) in FS with MA assigned in FS up to the signal upstream of the SBR where Train2 is located

6.4.3.15.2 VBTS_2Trains_075

Line tracking between two FS trains, one of which is equipped with a VBR system that loses GPS coverage while running			
FUNCTION	**Execution**	**Scenario's Type**	**version**
2MA trains	LAB	Degraded	00.00

Notes	To carry out the test, the hare train must be equipped with a VBR system; moreover, the scenario requires that the SBR downstream of Treno2 includes only VBG: a possible application is with Treno2 (hare) located on CdB 823 on the odd track in the legal direction and Treno1 (pursuer) on cdb 825.

Pre Condition

- Train1 (follower) in FS with MA assigned in FS up to the signal upstream of the SBR where Train2 is located
- Train2 (hare) in FS with MA assigned in FS on the following SBRs
- Train2 (hare) with VBR in Full Navigation (FN) mode
- GPS coverage present for the VBR of Treno2
- Downstream of Treno2 there are at least 3 line SBRs considered "FS Proved"
- The SBR downstream of Train2 only includes VBGs configured in the Digital Map (including the one on axis to the signal)

TC	**VBTS_SDT-SSB_139 - Tracking along the line of two FS trains, one of which equipped with the VBR system**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train2 SSB2 -> RBC: Msg136 with Pkt0 (M_MODE=0)
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train1 SSB1 -> RBC: Msg136 with Pkt0 (M_MODE=0)
3 EXE	ACTION	The PdC moves Train2 (hare) forward on the following SBR in compliance with its MA, freeing the SBR immediately downstream of Train1 (following)
4 REP	CHECK	Train1 (follower) sends MA Request message [Msg132] to RBC1 SSB1 -> RBC: Msg132
5 REP	CHECK	RBC sends to Train1 (follower) a Movement Authority message [Msg3] with request for ACK (M_ACK = 1), referred to the LRBG positioned upstream of the train front, having EoA on the signal upstream of the SBR where Train2 is located (hare), with "Full Supervision" profile RBC -> SSB1: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5
6 REP	CHECK	Train1 sends ACK message to RBC [Msg146] SSB1 -> RBC: Msg146

7 EXE	ACTION	Train1 chases Train2 along the line
8 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train1 SSB1 -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN>0)
9 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train2 SSB2 -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN>0)

TC	**VBTS_SDT-SSB_140 - Loss of GPS coverage for the VBR of a hare train with consequent failure to calibrate the odometric fronts following the detection of VBGs**	
step	**Description**	**Expected Result**
1 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train1 SSB1 -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN>0)
2 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train2 SSB2 -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN>0)
3 EXE	EVENT	The VBR of train2 (hare) loses GPS coverage and switches to odometric naviga-tion when the timer T_MAX_EXP_AG_TIME (30 seconds) expires
4 EXE	ACTION	The PdC, after the timer T_MAX_EXP_AG_TIME has expired, moves Train2 for-ward until it passes with the "VBR virtual antenna" the position where a VBG is foreseen in the Digital Map
5 REP	CHECK ___________ Requirements REQ_8.1.1.1	The VBR, not having GPS coverage, does not require the validation of the VBG and therefore the SSB sends to RBC a Position Report [Msg136] with pkt0 and the NID_LRBG of the VBG without performing the recalibration of the confidence interval (L_DOUBTUNDER and L_DOUBTOVER) SSB - > RBC: Msg136 with Pkt0 (NID_LRBG, L_DOUBTOVER, L_DOUBTUNDER, M_MODE=0)
6 EXE	EVENT	The SSB2 advancing detects other VBGs configured in the Digital Map for which it will not carry out the recalibration of the confidence interval
7 EXE	ACTION	The PdC makes Train2 (hare) advance in compliance with its MA, until it frees the SBR immediately downstream of Train1 (pursuer)
8 REP	CHECK	Train1 (follower) sends MA Request message [Msg132] to RBC SSB1 -> RBC: Msg132
9 REP	CHECK	RBC sends to Train1 (follower) a Movement Authority message [Msg3] with re-quest for ACK (M_ACK = 1), referred to the LRBG positioned upstream of the train front, having EoA on the signal upstream of the SBR where Train2 is located (hare), with "Full Supervision" profile RBC -> SSB1: Msg3 (M_ACK=1) with Pkt15 (L_ENDSECTION), Pkt27, Pkt21, Pkt5
10 REP	CHECK	Train1 sends ACK message to RBC [Msg146] SSB1 -> RBC: Msg146

11 EXE	ACTION	Train1 chases Train2 along the line
12 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train1 SSB1 -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN>0)
13 REP	CHECK	RBC receives a PR [Msg136] in FS (with M_MODE=0) from Train2 SSB2 -> RBC: Msg136 with Pkt0 (M_MODE=0, V_TRAIN>0)

Post condition

- Train2 (hare) in FS with MA assigned in FS on the following SBRs
- Train2 (hare) with VBR in Full Navigation (FN) mode
- GPS coverage not present for the VBR of Train2 (timer T_MAX_EXP_AG_TIME=30 s expired)
- Train1 (follower) in FS with MA assigned in FS up to the signal upstream of the SBR where Train2 is located

7 AZD's Demonstrator Test Scenarios

This section describes the proposed test scenarios for AZD's demonstrator.

The development of AZD's demonstrator started in the previous X2Rail-2 project, where the testing was also addressed. Therefore, the tests described here are the more mature version reflecting previous experience and current knowledge.

The AZD's test bench intended for laboratory tests was described in [20]. We can remind here that the laboratory tests are based on sorted and categorised real environment railway data collected during the campaign on the *Havlickuv Brod – Zdarec u Skutce* line. To complement laboratory tests, on-site tests on the *Kopidlno – Dolni Bousov* line will be performed too.

7.1 Demonstrator configuration for tests

This section summarises the configuration (parameters assignment) of the demonstrator (its internal algorithms) used jointly for laboratory and on-site testing.

This configuration should be understood as the initial version, certainly some of the parameters will be adjusted after the results of laboratory tests.

- GNSS systems: GPS and Galileo only, in particular GPS L1 C/A, GPS L5, Galileo E1-B/C, Galileo E5a, navigation messages: GPS LNAV, Galileo FNAV; observables and nav. data from other systems are discarded
- Criteria for signal quality selection: all standard health indicators, minimal C/No: 32 dB-Hz, minimal satellite elevation: 5 deg
- SBAS system: emulated: zero corrections, no alerts, fixed error model for code measurements: final ionosphere-free combination of L1/L5 observables has assigned sigma of 3.0 m, K factor: corresponds to THR=2.4e-6
- Tropospheric model: Simple Black model
- A priori reception information:
    - Dynamic processing window length (estimated from the coasted confidence interval in the previous step)
    - Behaviour in case of shadowing according to the a priori information: sigma of the corresponding signal inflated by 3x
- GNSS position estimator resilience: 1 failure in observables
- GNSS and speed sensor fusion: fixed length of processing window with a depth of 11 samples
- Speed sensor inaccuracy: ±2% of the nominal speed value

7.2 Laboratory tests

7.2.1 Goal of laboratory tests

The laboratory tests play a significant role in AZD's demonstrator development. Briefly, we can summarise the goal of the tests as follows:

- Verification of implemented algorithms in the demonstrator, i.e. all functions work as expected
- Adjustment of internal algorithm parameters in the frame of demonstrator; since the developing algorithm can be tested with identical input data (completely forming the external environment) the algorithm coefficients/parameters can be adjusted to get optimal performance
- Performance estimation of demonstrator; since a huge volume of input laboratory data was prepared (representing complete test train runs) the logged output data can be statistically

processed and performance parameters estimated. The laboratory tests are mainly focused on the availability and accuracy (the size of the confidence interval) of the safe train position.

- The laboratory tests also deeply address the algorithm behaviour under various GNSS local feared events, i.e. the correctness of implemented countermeasures; for that reason, significant effort was dedicated to the identification of epochs in the input data, where interesting local feared events occurred (so-called deep interest interval in the later text)

It is also worth mentioning the scope of AZD's laboratory tests. Despite the fact that the AZD's demonstrator is implementing a virtual balise reader, the laboratory tests address only the safe train position estimate, thus, the function of virtual balise detection is not in the scope of the laboratory tests. The reason for that is the status of the input data, where no balises were defined in the map (track axis for laboratory tests, i.e. the track map for Havlickuv Brod – Zdarec u Skutce has no prepared layer with virtual balises). The function of virtual balise detection will be tested in the frame of on-site tests (field tests) in the line Kopidlno – Dolni Bousov, where a complete track map is prepared.

7.2.2 List of laboratory test scenarios

This section enumerates test scenarios for laboratory tests in the form of a table, see Table 7-1. Each test scenario represents one train run usually between the two final stations on the mentioned railway line. The IDs for test scenarios are therefore identical to the IDs of selected test runs.

The laboratory test bed is adopted to run all these test scenarios sequentially in a common batch and thus significantly simplify the laboratory testing.

Table 7-1 also summarises the duration of particular test runs. In total, the prepared test scenarios represent over 67 hours of train runs.

No.	Test scenario ID/ Test run ID	GPST start [s]	GPST end [s]	Duration [min]
1	200727_4Q01	1279883613	1279888800	86
2	200727_4Q02	1279910885	1279915800	82
3	200727_4Q03	1279915801	1279918860	51
4	200728_4Q04	1279936600	1279938970	40
5	200728_4Q05	1279979630	1279983720	68
6	200728_4Q06	1279984370	1279988950	76
7	200729_4Q07	1280023300	1280030300	117
8	200729_4Q08	1280030301	1280033800	58
9	200729_4Q09	1280033801	1280037500	62
10	200729_4Q10	1280037560	1280042260	78
11	200729_4Q11	1280072960	1280077050	68
12	200729_4Q12	1280077120	1280081200	68
13	200729_4Q13	1280081201	1280084220	50
14	200730_4Q18	1280151100	1280157000	98
15	200730_4Q19	1280157001	1280160300	55
16	200730_4Q20	1280160301	1280164180	65
17	200730_4Q21	1280164181	1280167800	60
18	200730_4Q22	1280167801	1280171355	59
19	200731_4Q23	1280201700	1280203400	28

20	200731_4Q24	1280231137	1280235267	69
21	200731_4Q25	1280236150	1280240790	77
22	200910_5Q01	1283781080	1283785000	65
23	200910_5Q02	1283785820	1283790720	82
24	200911_5Q03	1283839230	1283843880	78
25	200911_5Q04	1283875155	1283879300	69
26	200921_5Q05	1284731422	1284735600	70
27	200921_5Q06	1284736180	1284741060	81
28	200922_5Q07	1284789830	1284794150	72
29	200922_5Q08	1284825288	1284829220	66
30	200929_5Q09	1285412940	1285418490	93
31	200929_5Q10	1285440480	1285444430	66
32	201005_5Q11	1285931380	1285936880	92
33	201005_5Q12	1285958884	1285962880	67
34	201006_5Q13	1286027350	1286031500	69
35	201006_5Q14	1286032248	1286036720	75
36	201007_5Q15	1286085740	1286090400	78
37	201007_5Q16	1286120970	1286124990	67
38	201007_5Q17	1286125826	1286129150	55
39	201007_5Q18	1286129455	1286132355	48
40	201008_5Q19	1286168744	1286171770	50
41	201008_5Q20	1286171950	1286174825	48
42	201008_5Q21	1286194120	1286197240	52
43	201008_5Q22	1286198085	1286200590	42
44	201008_5Q23	1286201375	1286204865	58
45	201008_5Q24	1286205002	1286207688	45
46	201008_5Q25	1286208500	1286211688	53
47	201008_5Q26	1286212022	1286214955	49
48	201008_5Q27	1286215860	1286219077	54
49	201009_5Q28	1286279220	1286283183	66
50	201009_5Q29	1286284266	1286288824	76
51	201011_5Q30	1286460535	1286463777	54
52	201011_5Q31	1286475144	1286478370	54
53	201011_5Q32	1286478371	1286481700	56
54	201011_5Q33	1286481701	1286485307	60
55	201012_5Q34	1286545788	1286549666	65
56	201012_5Q35	1286550511	1286556770	104
57	201013_5Q36	1286596933	1286600133	53
58	201013_5Q37	1286600380	1286603420	51
59	201013_5Q38	1286604110	1286608501	73
60	201013_5Q39	1286639477	1286643377	65

61	201013_5Q40	1286644167	1286647509	56
62	201013_5Q41	1286647822	1286650788	49

Table 7-1: List of test scenarios (test runs) for laboratory tests

7.2.3 Execution of laboratory tests

This section provides a formal description of the execution of laboratory test scenarios. The description provided here is common for all of them.

Assumptions:

- The laboratory test bench (as described in [20]) is prepared; this covers the preparation of processed GNSS and sensor data for particular train runs, track database (containing track axis and a priori reception information), estimated position references (ground truth)

Preconditions:

- The internal demonstrator algorithms are configured according to Sec. 7.1.
- The complete input dataset for a particular test scenario is selected (in particular, data with observables, ephemerides and sensor data, track data matching the route for a given scenario)
- Start and stop epochs are pre-set (if differ from the default option which is the maximum span for the scenario input dataset)

Test steps:

- The compiled demonstrator's algorithms (i.e. SW implementation of the demonstrator) are executed on a standard PC platform taking the scenario input dataset and optionally the start and stop epochs as command line arguments
- Based on the evaluation of the result, the same scenario input dataset can be used with the modified configuration of the demonstrator's internal algorithms

Expected result:

- Logged outputs (in the form of text files) of PPSR, PEST, and PPOS functional blocks, see Sec. 7.2.4

7.2.4 Output assessment of laboratory tests

The section summarizes the output values of internal functional blocks which will be logged during the execution of laboratory test scenarios. In addition, the approach, how the output values will be processed (which statistics will be estimated), is provided too.

The section is structured according to the demonstrator's function blocks which are the subject of laboratory tests. All addressed functions, namely PPSR, PEST, and PPOS, are sub-functions of ESTP (Estimate Safe Train Position). The ESTP is the main functional block responsible for the provision of the safe train position.

7.2.4.1 PPSR

The functional block PPSR (processing in the pseudo-range domain) is responsible for the selection of GNSS observables (GNSS measurements) allowed to be used for the GNSS position estimate (the position estimate is performed in the PEST functional block). The observables are selected based on quality indicators and other criteria.

7.2.4.1.1 Values to be logged

- Number of received satellite observables per different frequency bands (L1/E1 only, L5/E5a only, L1/E1+L5/E5a)
- Number of satellite observables after the selection in PPSR per different frequency band
- Satellite positions and (approximate) vehicle position for PDOP parameter computation

7.2.4.1.2 Statistics to be evaluated

- availability of instants with a sufficient number of observables (regardless of signal quality)
- availability of instants with a sufficient number of observables (respecting signal quality)
- continuity of instants with a sufficient number of observables (regardless of signal quality)
- continuity of instants with a sufficient number of observables (respecting signal quality)
- Position DOP (PDOP) of the constellation (regardless of signal quality)
- Position DOP (PDOP) of the constellation (respecting signal quality)

The term “regardless of/respecting signal quality” indicates whether the particular statistic is evaluated before or after applying the PPSR criteria, which determines which observables (ionosphere-free measurements) are allowed to be used in PEST.

The availability statistics are computed as a number of instants satisfying the minimal number of observables for position estimate divided by all instants.

The continuity statistics are provided as a histogram, where lengths of gaps with unsatisfied conditions are evaluated, including zero-length gaps (i.e. including the situations where the conditions with a minimal number of observables are met).

In such a continuity histogram, the first bin height (for zero-length gap) represents the number of instants with the satisfied minimal number of observables immediately followed by the instant where the minimal number of observables is satisfied too. Therefore, this first bin well represents the “continuity” term in a common understanding as a probably of uninterruptible service given that the service is available at the beginning.

7.2.4.2 PEST

The functional block PEST (GNSS position estimator) takes ionosphere-free measurements, track axis data and provides the GNSS position estimate including its confidence interval.

7.2.4.2.1 Values to be logged

- estimated GNSS position consisting of:
    - centre of a confidence interval, expressed both as 1D and 3D position, a 3D position is in the Cartesian (x, y, z) and Geodetic (lat, long, height) form
    - length of a confidence interval

7.2.4.2.2 Statistics to be evaluated

- instantaneous GNSS position error, i.e. a distance between the centre of a confidence interval and position reference (ground truth)
- accuracy of GNSS position estimate: location of position reference (ground truth) inside the estimated confidence interval:
    - histogram of position reference inside the normalized confidence interval [-0.5; 0.5]
    - percentage of position reference (ground truth) outside/inside of the confidence interval
- precision of GNSS position estimate, i.e. length of GNSS confidence interval:
    - ordinary/cumulative histogram of confidence interval length (pdf/CDF)
- availability of GNSS position estimate

- continuity of GNSS position
    - o histogram of interval lengths without the GNSS positions (including the zero-length intervals)

7.2.4.3 PPOS

The functional block PPOS (processing in the position domain) fuses the GNSS position estimate and independent speed sensor information to the final fused position estimate.

7.2.4.3.1 Values to be logged

- estimated fused position consisting of:
    - o centre of confidence interval, both as 1D and 3D position, a 3D position is in the Cartesian (x, y, z) and Geodetic (lat, long, height) form
    - o length of confidence interval
- instantaneous speed estimate (from the independent speed sensor) including its confidence interval

7.2.4.3.2 Statistics to be evaluated

- instantaneous fused position error, i.e. a distance between the centre of a confidence interval and position reference (ground truth)
- accuracy of fused position estimate: location of position reference (ground truth) inside the estimated confidence interval:
    - o histogram of position reference inside the normalized confidence interval [-0.5; 0.5]
    - o percentage of position reference (ground truth) outside/inside of the confidence interval
- precision of fused position estimate, i.e. length of fused confidence interval:
    - o ordinary/cumulative histogram of confidence interval length (pdf/CDF)
- availability of fused position estimate
- continuity of fused position
    - o histogram of interval lengths without the fused positions (including the zero length intervals)

7.2.5 Techniques for the deep interest interval selection

Each test scenario for a laboratory test has assigned a complete data set needed for the test. The data set consists of obvious components such as GNSS, speed sensor, and map data but also data necessary for the test evaluation as position reference (ground truth). The data set usually covers the entire length of the line, i.e. the line between end stations Havlickuv Borod and Zdarec u Skutce.

For effective analysis of the developed algorithms, especially the proposed countermeasures against GNSS local feared events, the data from the measured campaign were processed with the aim to find intervals with interesting degradation of GNSS signals (as a consequence of local fired events, as are multipath, RF interference, signal attenuation/shadowing). The test outputs, generated on these intervals, will be analysed in detail to confirm the correct behaviour of proposed algorithms / countermeasures under various extreme conditions.

This section (Sec. 7.2.5) provides a methodology for how such intervals were selected and describes the techniques which were used for the selection. The next section, Sec. 7.2.6, provides a description of such selected intervals, including their unique identifications (IDs of test scenarios with starting and stopping times of the intervals).

7.2.5.1 Techniques for RF interference detection

7.2.5.1.1 Utilization of build-in receiver capability

Technique Code: XCAB = XAIM

The technique is based on the built-in capability of Septentrio receivers to identify such events. The receiver provides parameters about RF interference in the RFStatus SBF block. This block contains RF interference information directly provided by the built-in algorithm, along with information about the RF bands where the interference was detected and/or mitigated by the receiver. The data in the RFStatus block are analysed for each epoch in the appropriate frequency bands (GPS L1/ L5). If RF interference is detected, the data are marked according to the respective frequency bands, L1 or L5.

The occurrence of RF interference was investigated in all time epochs of all train runs in the recorded data. In this way, all the places, where the RF interference indication occurred, were searched. GPX files were generated for these locations to allow examination on the map.

The following conclusions emerged from this analysis:

- All cases of RF interference were detected in the L1 band, with no occurrence in the L5 band.
- RF interference events were mainly detected close to two locations, the first is near the Hlinsko station, and the second near Zdirec nad Doubravou station, see Figure 7-1.

Due to the nature of the method, it is impossible to separate internal interferences coming from the vehicle and RF interferences from external sources along the track. However, due to the consistent detection of RF interferences in certain locations only, it can be assumed that the RF interference generated internally (by onboard train equipment) is negligible.

Figure 7-1: Illustration of detected RF interference events on the map close to Hlinsko and Zdirec nad Doubravou stations for selected train runs.

7.2.5.2 Techniques based on GNSS measurements (GNSS observables)

The section presents techniques mainly utilizing GNSS observables (code measurements – pseudoranges, phase measurements, Doppler measurements, and signal quality indicators). The main distinctive feature (compared to the other group of techniques) is the analysis done on individual satellite signals per different frequency bands. This offers detailed information on the one hand but sometimes overloads the evaluation due to the number of parameters in one epoch on the other hand.

7.2.5.2.1 Code measurement (pseudorange) difference between L1 and L5

Technique Code: XCAB = XAR2

The technique calculates the difference between the code measurements (pseudoranges) of the same satellite but measured in different frequency bands. The result of this technique is two types of data files, one for GPS L1/L5 signals and one for Galileo E1/E5a signals:

Parameter file #1: $P_x - P_y = P_{GPS,L1} - P_{GPS,L5}$
Parameter file #2: $P_x - P_y = P_{GAL,E1} - P_{GAL,E5a}$

The analysis of the XAR2 technique is performed on the basis of parameter differences over time. Differences were chosen as a method that ensures the detection of rapid changes in the course of the parameters, which indicates the possible occurrence of an unfavourable phenomenon in a relevant epoch.

The test statistic for evaluation assumes the setting of the threshold value at the 4 sigma level. If the threshold value is exceeded, it is assumed that an adverse event has occurred. An example of statistical evaluation is presented in Figure 7-2. The phenomenon significance is determined from the size of the exceedance above the threshold. The significance of the phenomenon is marked with integer numbers from 0 to 5, where 0 means the smallest effect of the phenomenon, while 5 means the most significant effect of the phenomenon.

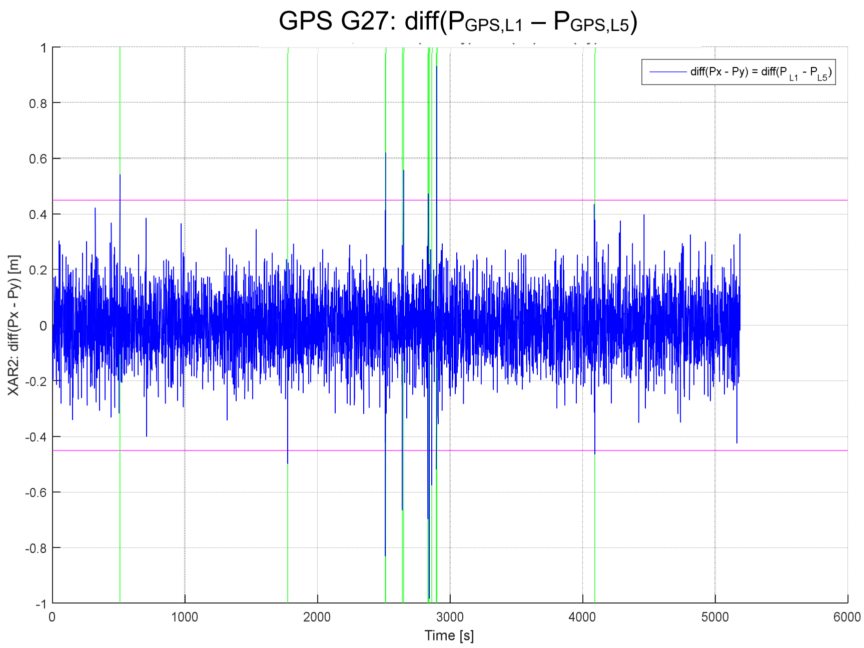


Figure 7-2: Example of evaluation of the XAR2 technique for the GPS G27 satellite. Blue line shows the calculated parameter differences over time. Magenta lines represent the threshold setting levels. Green lines show time instants in which the detection occurred (threshold exceeded).

7.2.5.2.2 Deviation of code measurements (pseudoranges) over the time

Technique Code: XCAB = XARD

The aim of this technique is to identify time instants when the GNSS signal might be disturbed. The technique performs analysis of pseudoranges in the time domain. If the GNSS signal is not disturbed, pseudorange time evolution can be basically modelled with two components. The first one is a slow trend caused by the relative motion of the satellite and the receiver. The second one is faster and can be modelled as a correlated noise, the noise level of which should be within certain bounds under normal conditions.

The technique uses pseudoranges in the time domain for the calculation of their first-order differences that correspond to the radial speed. The estimate of the radial speed of the j-th satellite relative to the receiver at the time instant t_i is calculated using the first-order backward difference as

$$\Delta^1 P_{x,j}(t_i) = \frac{P_{x,j}(t_i) - P_{x,j}(t_{i-1})}{t_i - t_{i-1}},$$

where $t_{i-1} < t_i$ are two consecutive time instants within the sampling period at which the pseudoranges $P_{x,j}$ of the j-th satellite were obtained in the corresponding frequency band $x = GPS\ L1/\ \mathrm{GPS\ L5}/\ \mathrm{Galileo\ E1}/$

Galileo E5a. Note that due to backward differences, the speed estimate $\Delta^1 P_{x,j}(t_i)$ cannot be computed for the first time instant. In general, the time difference can be greater due to measurement outages caused by satellite signal shadowing and then the speed estimate is less accurate. In order to avoid such an inappropriate estimate, the radial speed is not estimated if pseudoranges for a given satellite are unavailable in both consecutive samples. The analysis is not performed in such cases.

The result of the speed estimate computation is four output data files with calculated parameters $\Delta^1 P_{x,j}(t_i)$ separately for GPS L1, GPS L5, Galileo E1 and Galileo E5a signals.

Similarly to the pseudoranges, the radial speed consists of two components. The first much higher component has a slow trend due to the relative motion between the satellite and the receiver. The second component is much smaller, but it changes significantly faster as a result of the train movement. Any sudden changes in radial speed can indicate a potential disturbing factor. The only expected jump in the measured pseudorange that is not considered as a disturbance is the reset of the internal receiver clock to keep it close to the GNSS time. However, this can be easily recognized and removed from the analysis because they happen at all pseudoranges at the same time and have the same magnitude.

Sudden changes in the radial speed cannot be evaluated directly, because both its components are inseparably merged. In addition, its first component given by the relative motion of the satellite-receiver has a more significant influence. Therefore, for the Type A analysis, the geometric distance is used to calculate the Delta Double Difference of the j-th SV as follows

$$\Delta_{Ddiff,x,j}(t_i) = \Delta^2 P_{x,j}(t_i) - \Delta^2 GeomDist_j(t_i),$$

where the estimate of the radial acceleration of the j-th SV relative to the receiver at the time instant t_i is computed using the second-order backward difference as

$$\Delta^2 P_{x,j}(t_i) = \frac{\Delta^1 P_{x,j}(t_i) - \Delta^1 P_{x,j}(t_{i-1})}{t_i - t_{i-1}},$$

$\Delta^2 GeomDist_j(t_i)$ is the second-order backward difference of geometric distance of the j-th SV at the time instant t_i

$$\Delta^2 GeomDist_j(t_i) = \frac{\Delta^1 GeomDist_j(t_i) - \Delta^1 GeomDist_j(t_{i-1})}{t_i - t_{i-1}},$$

$\Delta^1 GeomDist_j(t_i)$ is the first-order backward differences of geometric distance of the j-th SV at the time instant t_i

$$\Delta^1 GeomDist_j(t_i) = \frac{GeomDist_j(t_i) - GeomDist_j(t_{i-1})}{t_i - t_{i-1}}.$$

$GeomDist_j(t_i)$ is the geometric distance of the j-th SV at the time instant t_i computed from the reference position (see Sec. 7.2.5.3.4). Note that the second-order backward differences cannot be calculated for the first pair of time instants.

The use of geometric distance in the Delta Double Difference calculation significantly reduces the influence of both fast and slow components of change in radial speed. In Delta Double Difference Δ_{Ddiff}, a component corresponding to noise remains present along with a component corresponding to sudden changes in radial speed. The quantity Δ_{Ddiff} is therefore very suitable for statistical evaluation to find sudden changes in the radial speed of the j-th SV. An example of statistical evaluation is illustrated in Figure 7-3. The test statistic for evaluation assumes the setting of the threshold value at the $3.65\ \sigma$ level. Exceeding the threshold value indicates a potential disturbing factor.

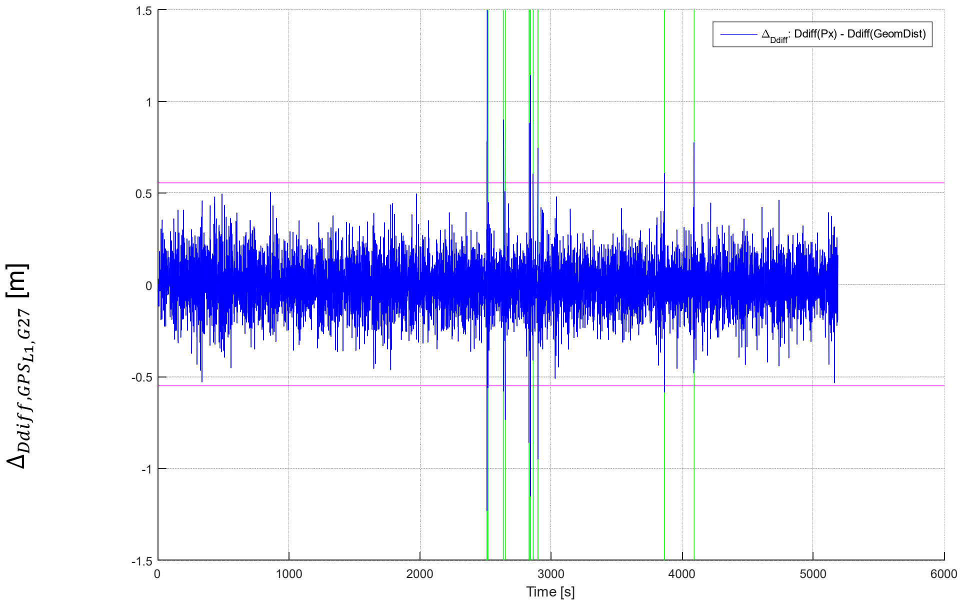


Figure 7-3: Type A analysis of the XARD technique. Example of statistical evaluation for the G27 satellite in GPS L1 band. Blue line shows the Delta Double Difference over time. Magenta lines represent the threshold setting levels. Green lines show time instants in which the detection occurred (the threshold was exceeded).

A second type of radial speed evaluation, called Type B analysis, uses the difference between the radial speed and the first-order backward difference of geometric distance:

$$\Delta_{Sdiff,x,j}(t_i) = \Delta^1 P_{x,j}(t_i) - \Delta^1 GeomDist_j(t_i).$$

The disadvantage of the quantity Δ_{Sdiff} is, in addition to noise, a certain course of the curve, as shown in Figure 7-4 with the blue line. Therefore, Type B analysis uses the moving average filter of Δ_{Sdiff} shown in Figure 7-4 by the red line to calculate the Delta Single Difference as follows

$$\Delta_{Sdiff,MA,x,j}(t_i) = \Delta_{Sdiff,x,j}(t_i) - \Delta_{Sdiff,MovingAverage}(t_i).$$

Delta Single Difference effectively removes the course of the curve. In type B analysis, the remaining component consisting of noise and adverse occasional phenomena is then statistically evaluated, see Figure 7-5. The threshold value for the detection of adverse phenomena was experimentally determined at the level of $3.57\ \sigma$.

The significance of disturbing factors in both types of analysis is determined by the size of the exceedance above the threshold. It is distinguished by integer numbers from 0 to 5, where 0 means a negligible effect, while 5 means the strongest effect of the disturbing factor. See an example of Type B Analysis in Figure 7-6.

GPS L1, G27: Δ_{Sdiff} and its Moving Average

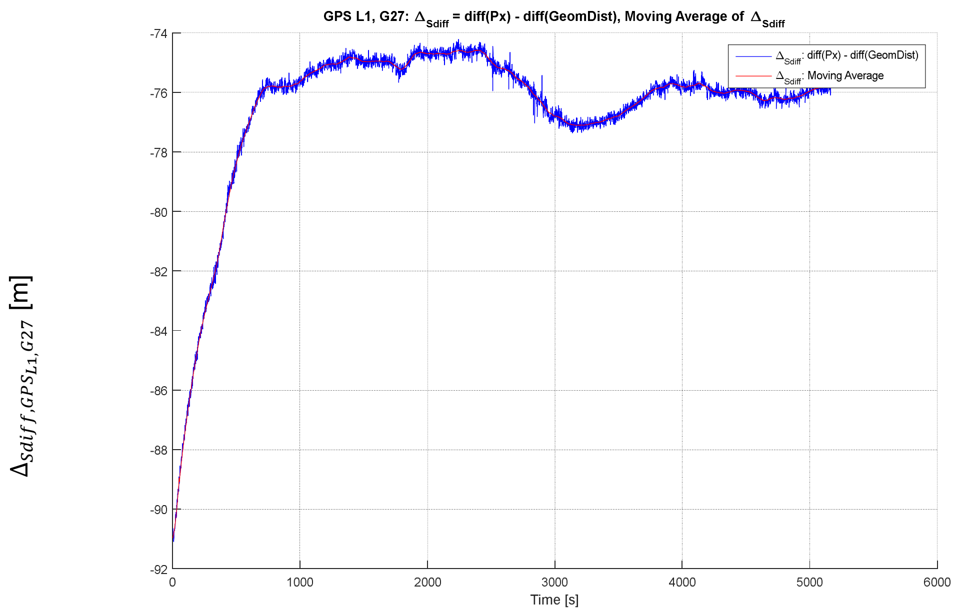


Figure 7-4: The first-order backward differences between pseudorange and geometric distance (blue line). Moving average filter is represented with the red line.

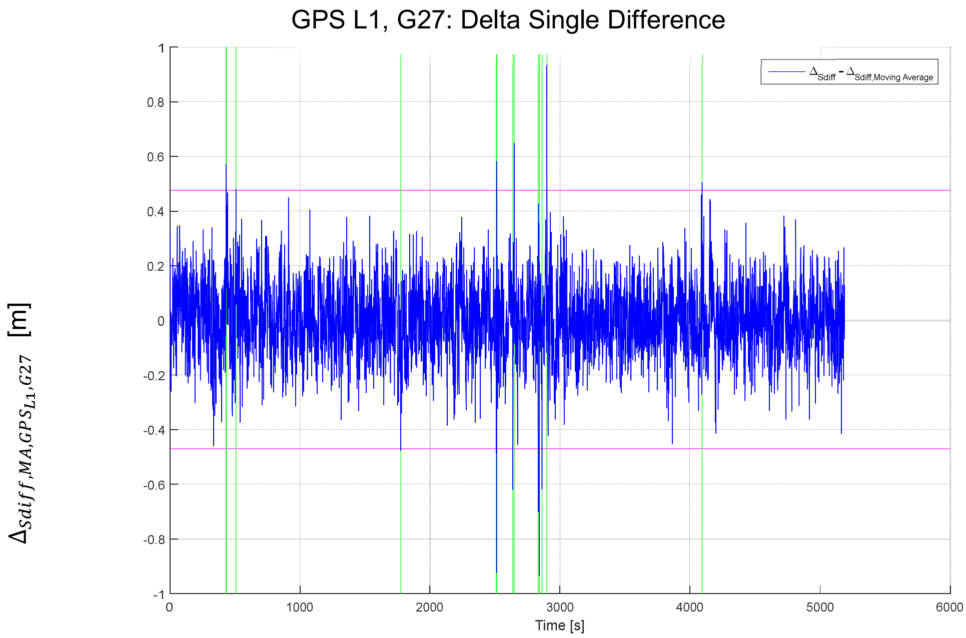


Figure 7-5: Type B analysis of the XARD technique. Example of statistical evaluation for the G27 satellite in GPS L1 band. Blue line shows the Delta Single Difference over time. Magenta lines represent the threshold setting levels. Green lines show time instants in which the detection occurred (the threshold was exceeded).

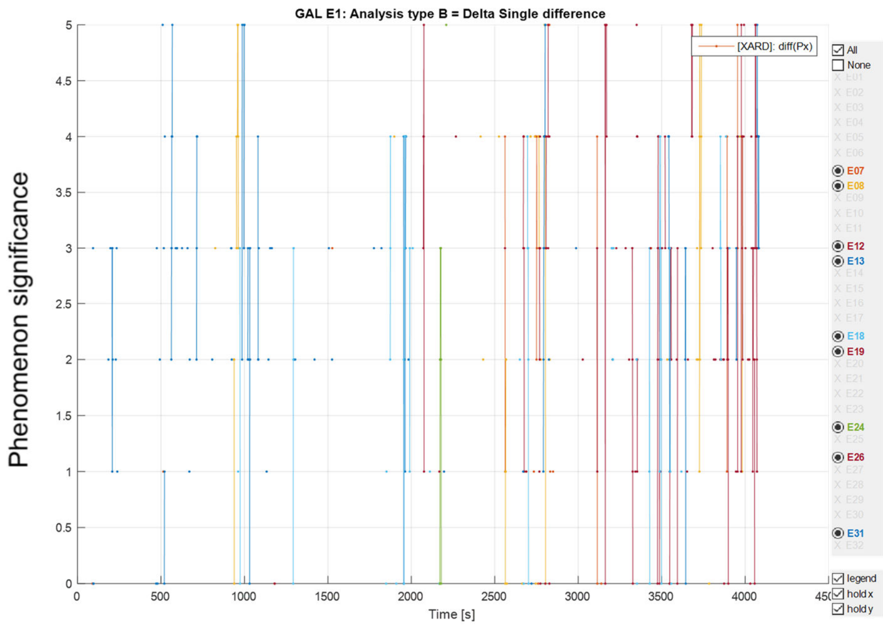


Figure 7-6: Type B analysis in the XARD technique for Galileo E1 band. Significance level of the phenomenon: 0=very low, 1=low, 2=middle, 3=high, 4=very high, 5=extreme, NaN= no phenomenon.

7.2.5.2.3 Code Minus Carrier

Technique Code: XCAB = XARC

The aim of the Code Minus Carrier (CMC) technique is to identify the epochs where GNSS measurements are subject to multipath error. CMC is computed by subtracting the carrier phase measurements from the corresponding pseudoranges to remove the effect of non-dispersive systematic errors such as receiver and satellite clock errors, orbital errors and tropospheric delays. The CMC for the j-th satellite at the time instant t_i is calculated as

$$CMC_{x,j}(t_i) = P_{x,j}(t_i) - L_{x,j}(t_i),$$

where x is the relevant frequency band $\{GPS\ L1, \mathrm{GPS\ L5}, \mathrm{Galileo\ E1}, \mathrm{Galileo\ E5a}\}$. $P_{x,j}(t_i)$ and $L_{x,j}(t_i)$ are the corresponding pseudorange and carrier phase measurements.

Another metric used in the XARC technique calculates the first-order difference of CMC as follows

$$\Delta^1 CMC_{x,j}(t_i) = \frac{CMC_{x,j}(t_i) - CMC_{x,j}(t_{i-1})}{t_i - t_{i-1}}.$$

The effect of the ionosphere can be eliminated by a linear combination of code and carrier phase measurements on two frequencies:

$$CMC_{x,y,iono,j}(t_i) = CMC_{x,j}(t_i) - 2\frac{f_y^2}{f_x^2 - f_y^2}(\mathrm{L}_{x,j} - \mathrm{L}_{y,j}),$$

where $x = L1, y = L5$ for GPS and $x = E1, y = E5a$ for Galileo, $f_{L1} = f_{E1} = 1575.42\ \mathrm{MHz}$, $f_{L5} = f_{E5a} = 1176.45\ \mathrm{MHz}$. The metric $CMC_{x,y,iono,j}(t_i)$ removes the double ionospheric error (due to ionospheric code delay and phase advance).

The first-order differences of $CMC_{x,y,iono,j}(t_i)$ is given by

$$\Delta^1 CMC_{x,y,iono,j}(t_i) = \frac{CMC_{x,y,iono,j}(t_i) - CMC_{x,y,iono,j}(t_{i-1})}{t_i - t_{i-1}}.$$

The CMC technique covers all four metrics described above. It is worth mentioning that all these metrics are corrected after the data gap (after a cycle slip or phase measurement discontinuity). The correction is applied in that way, the first value of the metrics after the data gap is set to zero. The correction is essentially a rough estimate of carrier ambiguity.

The first two metrics CMC_x and $\Delta^1 CMC_x$ are important especially for such satellites where only measurements in the GPS L1/ Galileo E1 band are available. The remaining two metrics $CMC_{x,y,iono}$ and $\Delta^1 CMC_{x,y,iono}$ are not available for such single frequency satellites.

The data for each metric for a given GNSS system and the corresponding frequency band are stored in a separate output file. The data are arranged in columns, where the first column contains GPS time and the other columns contain data for individual SV. Each line corresponds to one measurement epoch with GPS time. A total of 16 output parameters files are created (4 CMC metrics for each of 4 frequency bands).

The result of the analyses performed on CMC metrics is the creation of another six types of data output files. In the first analysis of Type A, an evaluation of the $\Delta^1 CMC_x$ is performed. The second Type B analysis statistically evaluates the quantity $\Delta^1 CMC_{x,y,iono}$.

In addition to code multipath, CMC_x also includes carrier phase ambiguities, ionospheric error, code and carrier noise, and carrier phase multipath. Considering that the integer ambiguity is constant during cycle slip-free periods and ionosphere changes are slow, then their effects can be removed using Simple Moving Average (SMA) filter. The SMA filter should be sufficiently short to avoid biases due to the geometry changing. In statistical analysis of Type C, the pseudorange multipath error can be extracted by a CMC-based monitoring metric as

$$m_{x,j}^{CMC}(t_i) = CMC_{x,j}(t_i) - \frac{1}{n} \sum_{k=i-n+1}^{i} CMC_{x,j}(t_k),$$

where the second term of the expression specifies the mean value of the CMC metric at the time instant t_i calculated by SMA as an unweighted average of the previous n data.

In Type D analysis, the first-order backward difference of the $m_{x,j}^{CMC}$ is evaluated. The Type E analysis process SMA of the $CMC_{x,y,iono,j}(t_i)$. Finally, the Type F analysis evaluates the first-order backward difference of SMA of the $CMC_{x,y,iono,j}(t_i)$.

The test statistic for evaluation assumes a threshold setting of 4 sigma. When the threshold value is exceeded, the occurrence of an adverse event is assumed. The phenomenon significance is evaluated with whole numbers from 0 to 5. 0 means the smallest influence of the phenomenon, 5 means the most significant influence of the phenomenon.

Note that for one train run, a large number of total 40 output files (16 parameter files + 24 analysis files) are generated by the CMC technique.

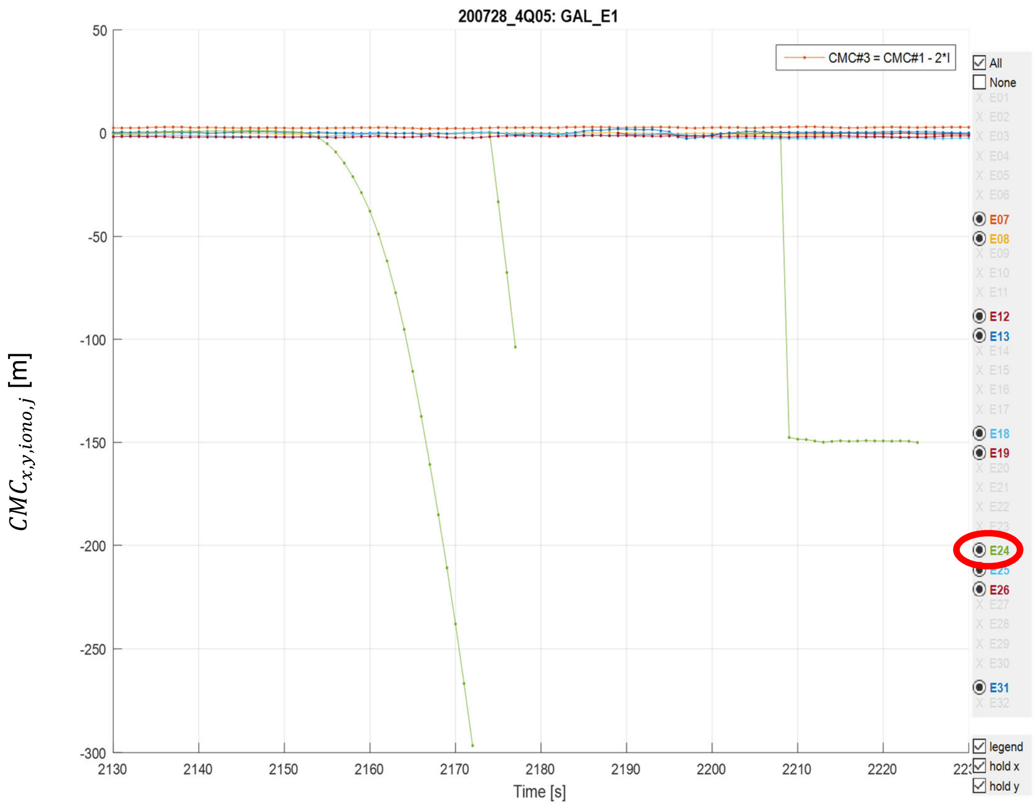


Figure 7-7: Metric $CMC_{x,y,iono,j}(t_i)$ identifies SIS failure of E24 in measurement 200728_4Q05 between 2154 - 2224 s.

7.2.5.2.4 Utilization of build-in receiver capability

Technique Code: XCAB = XRMS

Similarly to RF interference detection, the Septentrio receiver has a built-in algorithm which can be utilized for epoch detection with multipath signal reception, In particular, the receiver offers MPCorrection corrections which were applied on the unprocessed raw pseudoranges to suppress the multipath error on them. Therefore, such a correction can be well utilized as a multipath indicator.

Data processing involves obtaining and analysis of the MPCorrection parameter from the Septentrio receiver. Figure 7-8 shows the probability density function of the MPCorrection parameters consolidated from all GPS and Galileo satellites in individual frequency bands. Statistics can also be expressed separately for individual GNSS satellites or collectively for all GPS+Galileo satellites in a given frequency band.

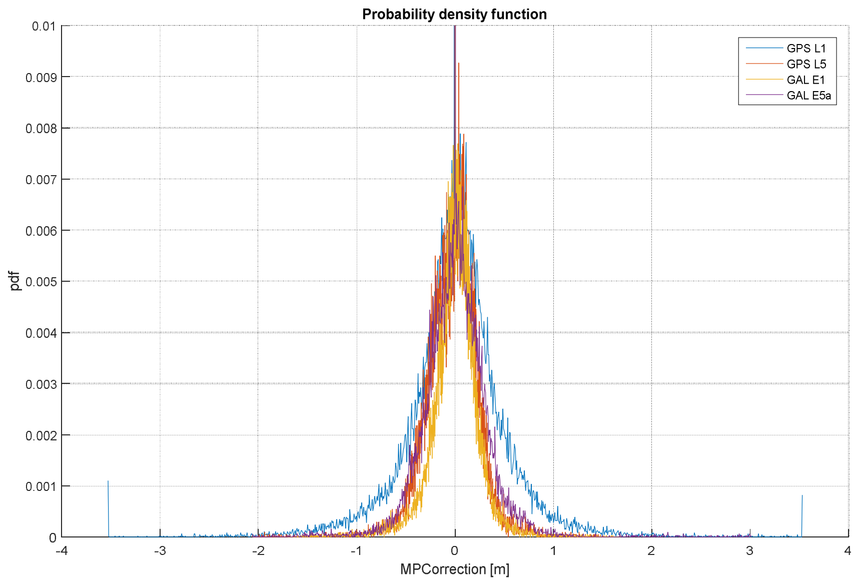


Figure 7-8: MPCorrection statistics for selected train ride.

7.2.5.2.5 Joint evaluation of technique outputs

The outlined techniques in the previous sections provide an indication of feared events from various perspectives. For the selection of deep interest interval (range of epochs with an interesting demonstration of feared events on which the demonstrator behaviour should be studied), the conformity of different techniques has to be detected. The approach which was finally selected utilizes a graphical representation of different technique outputs in the common chart and the manual (a trained expert involved) selection of epochs. The selections are performed separately per particular satellites and frequency bands.

An example of the described joint evaluation is shown in Figure 7-9. The explanation of particular epochs follows below the graph.

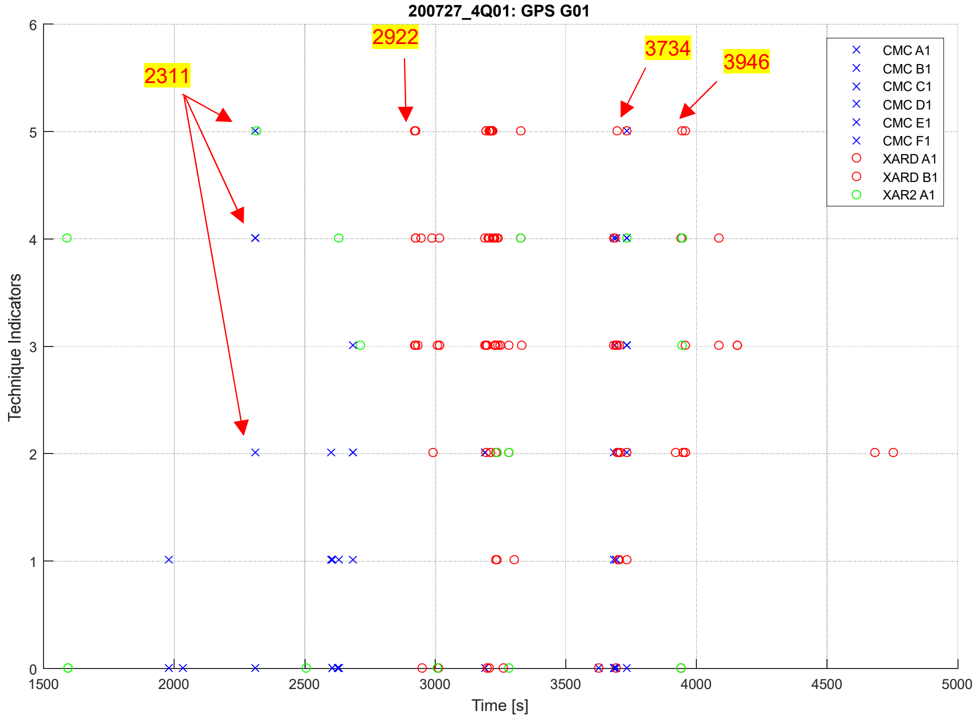


Figure 7-9: Example of common evaluation of indicators for GPS G01 in the L1 band depending on time. Meaning of the phenomenon indicator on the y-axis is as follows: 0=very low, 1=low, 2=middle, 3=high, 4=very high, 5=extrem, NaN=no phenomenon. Note that CMC A1 mean Analysis type A of CMC in GPS L1 band, XARD A1 means Analysis Type A (Delta Double Difference) in GPS L1, XAR2 A1 means Analysis of pseudorange difference GPS L1 – L5.

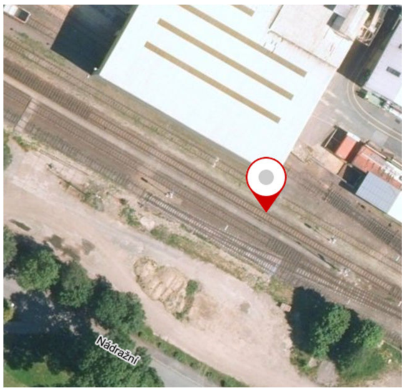
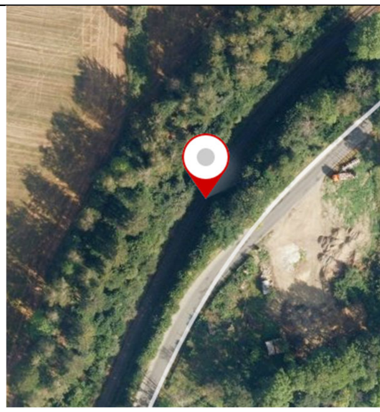
Time [s] = 2311	Time [s] = 2922
L1 signal reflection from a nearby building	Signal failure when passing through trees
	

Figure 7-10: Common evaluation of indicators for GPS G01 in the L1 band. Significant failures are shown on the map.

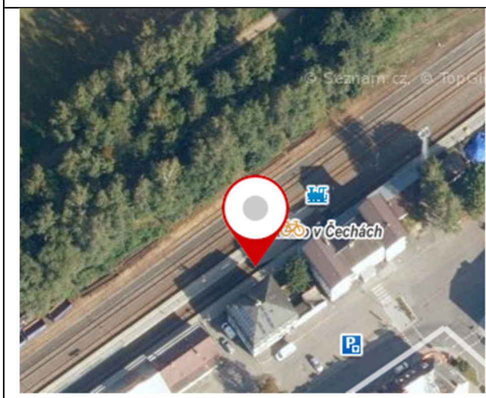
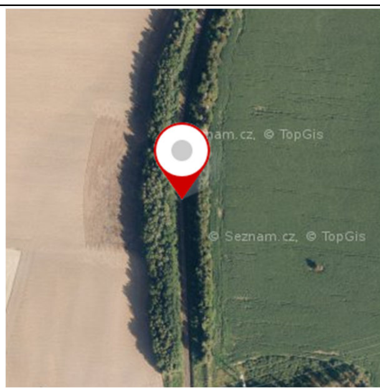
Time [s] = 3734	Time [s] = 3946
Signal passage through trees	Signal passage through trees
	

Figure 7-11: Common evaluation of indicators for GPS G01 in the L1 band. Significant failures are shown on the map.

7.2.5.3 Techniques based on estimated position

This section presents techniques based on the analysis in the position domain, i.e. estimated positions (estimated with the given algorithm configuration) together with corresponding parameters (e.g. DOP) are evaluated with respect to the position reference (ground truth) or even simply to the track axis.

7.2.5.3.1 Estimate of PVT_1 position

Technique Code: XCAB = XPP1

This is not a technique for feared event detection but rather the auxiliary value used in the techniques described later.

The so-called PVT_1 estimate is a position computed from GNSS code measurements. The dual frequency measurements (ionosphere-free combination) of L1 and L5 bands are used and the estimate itself utilizes the weighted least squares. This estimate doesn't utilize any proposed countermeasures (unlike the algorithms in the demonstrator). This is also valid for the track axis (which is not used too).

The result of PVT_1 is a file with positions estimated (in Cartesian coordinates) complemented with the information regarding the utilized systems (GPS only, Galileo only, combination of GPS and Galileo).

7.2.5.3.2 Quality parameters for PVT_1 estimate

Technique Code: XCAB = XADS.
Similarly, as the PVT_1 estimate, this is not a technique for feared event detection but provides complementary information to help with the exclusion of PVT_1 values due to the bad geometry of satellites in particular epochs.

The output includes DOP parameters and the number of satellites used in PVT_1. PVT_1 values are excluded according to the DOP values which have been extremely exceeded above a specified threshold.

7.2.5.3.3 WSSE -- Weighted Sum of Squared Errors

Technique Code: XCAB = XAPS.

This technique utilizes the Weighted Sum of Squared Errors (WSSE) value, computed during the PVT estimate, as an indicator for epochs where GNSS SIS was unfavourably affected.

The determination of WSSE assumes that measurements from n_{SV} satellites are available at a given epoch. The WSSE can be calculated according to the following formula

$$WSSE = \hat{e}^T W \hat{e}$$

where $\hat{e}$ is the vector of pseudorange residuals

$$\hat{e} = \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_{n_{SV}} \end{bmatrix},$$

W^{-1} is the covariance matrix associated with the measurement errors

$$W^{-1} = \begin{bmatrix} \sigma_{e_1} & 0 & \dots & 0 \\ 0 & \sigma_{e_2} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & \sigma_{e_{n_{SV}}} \end{bmatrix},$$

and σ_{e_i} is the standard deviation of the residual for satellite i.

A small WSSE value indicates a close fit of the model to the measurements, while a high WSSE indicates some discrepancy between the measurements and the estimated model. During the WSSE evaluation process, the calculated WSSE value is directly compared to a predefined threshold. If the WSSE is less than a given threshold, no failure is assumed. If WSSE exceeds a given threshold, there is most likely an inconsistency or a significant error in the pseudoranges.

Test statistic supposes that the probability of exceeding the WSSE above a threshold T_{WSSE} under the null hypothesis H_0 (no fault) is not greater that the acceptable probability of false alarm P_{FA}

$$P(WSSE > T_{WSSE} | H_0) \leq P_{FA}.$$

The detection threshold T_{WSSE} is derived from the assumption that WSSE has a central Chi-square distribution with $(n_{SV} - m)$ degrees of freedom under the null hypothesis H_0

$$T_{WSSE} = \chi^2_{cdf,inv}(1 - P_{FA}, n_{SV} - m),$$

where m is the number of unknowns of PVT estimate, $\chi^2_{cdf,inv}(P, k)$ is the inverse of Chi-square cdf with k degrees of freedom at value of P.

7.2.5.3.4 Reference position (ground truth)

Technique Code: XCAB = XPRC

Similarly to PVT_1, this is not a technique for feared event detection, but rather the auxiliary value used in the techniques described later.

For laboratory tests of AZD's demonstrator, the position reference (ground truth) is prepared using GNSS phase measurements and the data from permanent reference stations. The reference is computed in post-processing mode for all test runs selected for laboratory tests (i.e. for all laboratory test scenarios).

The previous experience has shown that such position reference has better properties than the reference (ground truth) based on sensor data totally independent of GNSS (absolute position markers + odometry sensors).

The only drawback of this approach is the limited availability in GNSS-challenging environments (partially or fully covered sky with obstacles). In such situations, the position reference has to be complemented using the GNSS autonomous solution or even with the combination of odometry sensor(s). It is also worth mentioning that the reference position is fitted to the track axis therefore effectively minimising any transverse (lateral) errors.

7.2.5.3.5 Difference of PVT estimation from reference position

Technique Code: XCAB = XAPE

This technique calculates the deviation of PVT_1 estimate from GNSS reference positions both in 3D space and in the horizontal plane. The output file contains data arranged in three columns: GPS time, Deviation of PVT_1 estimate from the reference position in 3D, Deviation of PVT_1 projection from the reference position in the horizontal plane. Each line of the record corresponds to one epoch.

The technique utilizes the fact that the significant GNSS signal degradation (not only due to the local feared events) is apparent as a deviation between PVT_1 and the position reference (ground truth).

The application of this technique goes in a few steps. A simplified description follows. First, the significant deviation between PVT_1 and the position reference preselects these epochs for further analysis. Then, indicators as DOP and WSSE are applied to explain, if possible, the reason for the deviation. The deviation due to the inadequate satellite geometry (high DOP value) is out of interest since the deviation is not a consequence of signal degradation. On the other hand, a high value of WSSE can support the suspicion of failure(s) in the measurement(s), as a consequence of signal degradation due to the local feared events.

The disadvantage of this technique is the fact that can be detected only those degraded signals (due to the local feared events) which are used in the PVT_1 estimate. Even worse, it has to be also considered, not all signal degradations are directly demonstrated in the position domain. Therefore, in such situations, the signal degradations are not visible with this technique.

7.2.5.3.6 Transverse deviation of PVT estimation from track axis map

Technique Code: XCAB = XAPT

Another technique utilizes the transverse distance of the PVT_1 estimate to the track axis. The technique is robust in that sense that no position reference for a particular train run is needed and thus any possible failure in the position reference does not impact the technique. Only the track axis as a result of the geodetic survey is used.

The track axis map represents the set of track points derived with very high accuracy. The advantage is that the error of the track axis map is much lower than in the case of the reference position from postprocessing. Another advantage of the track axis map is its independence from GNSS.

However, the longitudinal position error is not known, of course, in this approach. Assuming that the statistical behaviour of the error in the longitudinal direction is similar to the statistical behaviour of the error in the transverse direction, it is possible to use the transverse error instead of the longitudinal error, if the goal is to estimate the statistical values only.

7.2.6 Identified deep interest intervals

The section enumerates intervals, which were identified as interesting for the detailed analysis of implemented algorithm behaviour. The intervals were identified using the previously described techniques (some combination of them). These intervals are subsets of complete test run intervals.

Each identified interval consists of the table with the reference to the corresponding test run. The interval itself is defined with its start and end in GPS System Time and epoch numbers (valid for the given test run). The table also provides different parameters of applied techniques which support the decision of the interval selection. Where appropriate, the situation on a map and graphical visualization of the parameters from applied techniques are provided too.

7.2.6.1 Signal reflection of a lower elevation satellite from a building near the track

Failure: Reflection of SIS from the wall of a nearby building.

Location: Cerea building near the Chotebor station.

Test run	**GPST [s]**	**Epoch [s]**	**SV**	**SV used in PVT**	**SV elevation [deg]**	**NSV**	**GDOP**	**Err3D [m]**	**Err2D [m]**	**WSSE**
200727_4Q01	1279885231 1279885232	1619 1620	G18	Y	7	9	1.9 2.4	38.8 39.4	23.5 18.2	47.2 40.0
200729_4Q12	1280079392 1280079393	2273 2274	G26	Y	9	11	2.4	34.9 33.2	10.8 10.7	99.8 93.8
200729_4Q09	1280035487 1280035488	1687 1688	G06	N	13	- - -	- - -	- - -	- - -	- - -

Table 7-2: Specification of intervals related to the signal reflection from the Cerea building

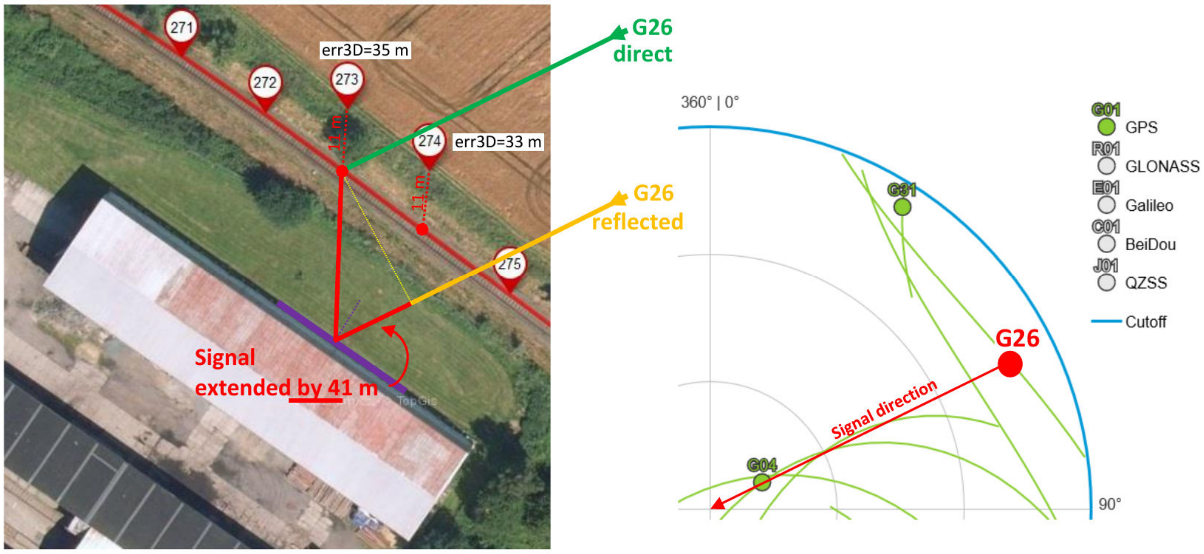


Figure 7-12: The figure on the left schematically shows the reflection of the G26 signal for train run 200729_4Q12 at epoch 2273 s. The numbered points are calculated PVT solutions in individual consecutive epochs. The red points placed on the track are the true train positions (reference points). PVT solution points no. 273 and 274 correspond to epochs 2273 s and 2274 s, respectively. The right image shows the direction of propagation of the G26 signal in sky visibility graph.

Compared to the direct signal, the reflected signal has an extended path of approx. 41 m. This value was determined by the deviation compensation calculation method. The same value can be measured on the map. The following figure shows the same level of failure in the XAR2 technique. This type of signal reflection caused a higher error in PVT, up to 35 m.

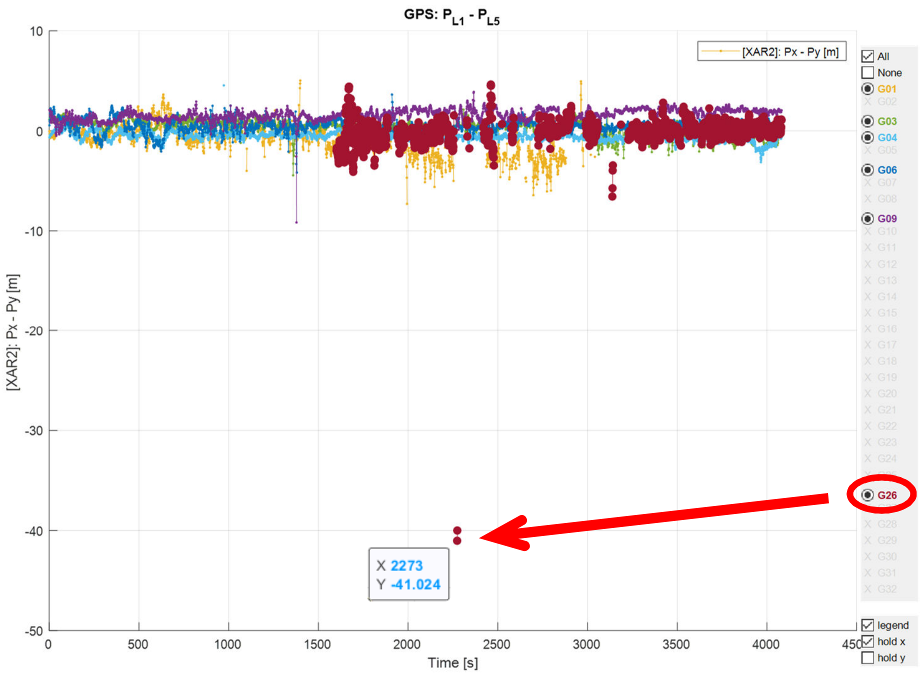


Figure 7-13: Visible jump in the XAR2 technique for the G26 satellite for train ride 200729_4Q12 at epochs 2273 – 2274 s.

Measurement: 200730_4Q18

Failure: Reflection of SIS from the wall of a nearby building during a train run.

Location: Hlinsko Kouty.

Test run	**GPST [s]**	**Epoch [s]**	**SV**	**SV used in PVT**	**SV elevation [deg]**
200730_4Q18	1280156800:1280156802	5701:5703	E27	N	3

Table 7-3: Specification of interval related to the signal reflection from the building near Hlinsko Kouty, train run 200730_4Q18

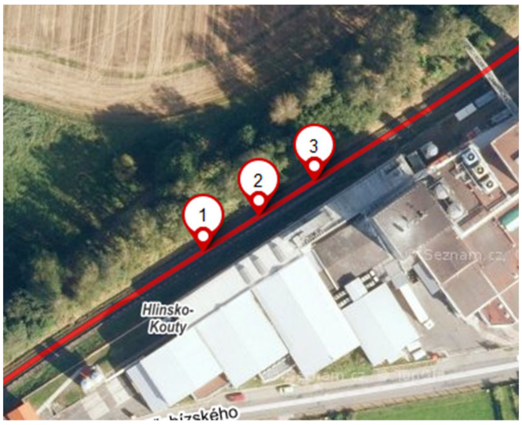


Figure 7-14: Situation on the map, train run 200730_4Q18

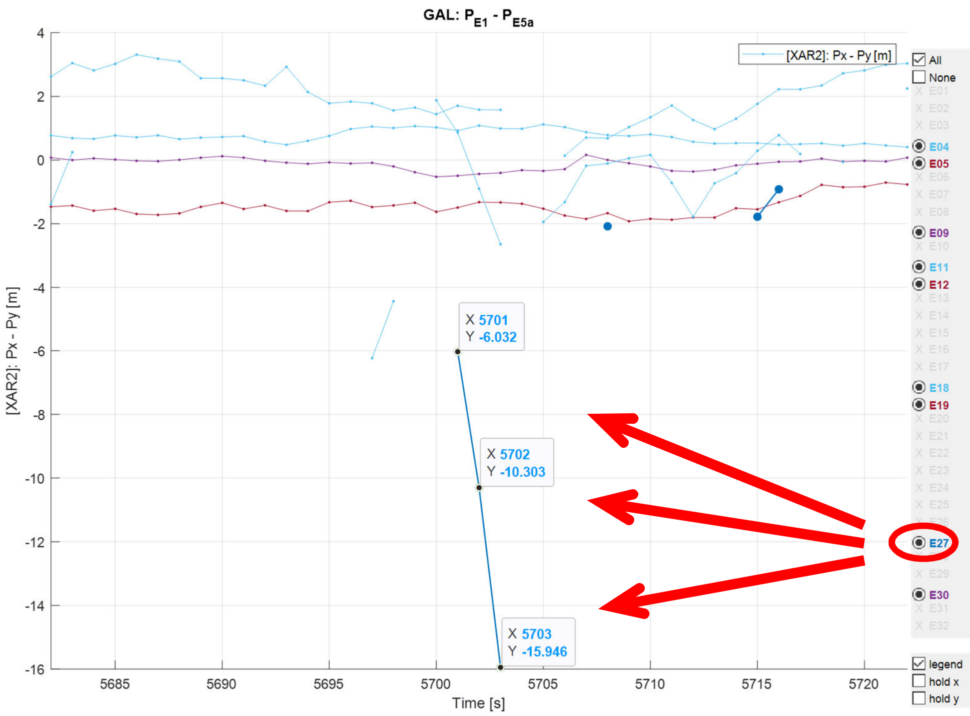


Figure 7-15: Visualization of XAR2 parameter, detected failure for satellite E27, train run 200730_4Q18

7.2.6.2 Signal reflection of a higher elevation satellite from the building near the track

Failure: SIS reflection of a higher elevation satellite (200729_4Q12) from the south wall of a building close to the track.

Location: Near the railway station Zdirec nad Doubravou.

Test run	GPST [s]	Epoch [s]	SV	SV used in PVT	SV elevation [deg]	NSV	GDOP	Err3D [m]	Err2D [m]	WSSE
200729_4Q12	1280080081	2962	E15	Y	6	9	3.8	12.3	12.2	4.7
	1280080083 1280080084 1280080085	2964 2965 2966	E13	Y	43	9 9 11	3.6 3.6 2.9	48.2 42.0 26.6	44.6 38.7 16.2	67.4 51.2 67.6
200729_4Q11	1280075044 1280075045	2085 2086	G09	Y	24	11	2.6	7.1 7.7	4.6 5.1	27.8 36.8
200730_4Q18	1280156024: 1280156053	4925:4954	E18	N	18	- - -	- - -	- - -	- - -	- - -
	1280156026: 1280156030	4927:4931	E27	N	3.7	- - -	- - -	- - -	- - -	- - -
	1280156063	4964	E05 G08	Y Y	18.5 8.4	7	3.7	28	3	5
	1280156064	4965	G08	Y	8.4	6	4.7	27	2	4
	1280156066	4967	G04	Y	19.4	6	4.9	23	2	3
	1280156067: 1280156069	4968:4970	E05 G04	Y Y	18.5 19.4	7-8	3.7	31-37	22-26	28-37
	1280156073	4974	G04	N	19.4	- - -	- - -	- - -	- - -	- - -
	1280156074: 1280156079	4975:4980	G04	Y	19.4	8-9	2.7-4	7-16	4-13	9-43

Table 7-4: Specification of intervals related to the reflection from the south wall of a building close to Zdirec nad Doubravou station

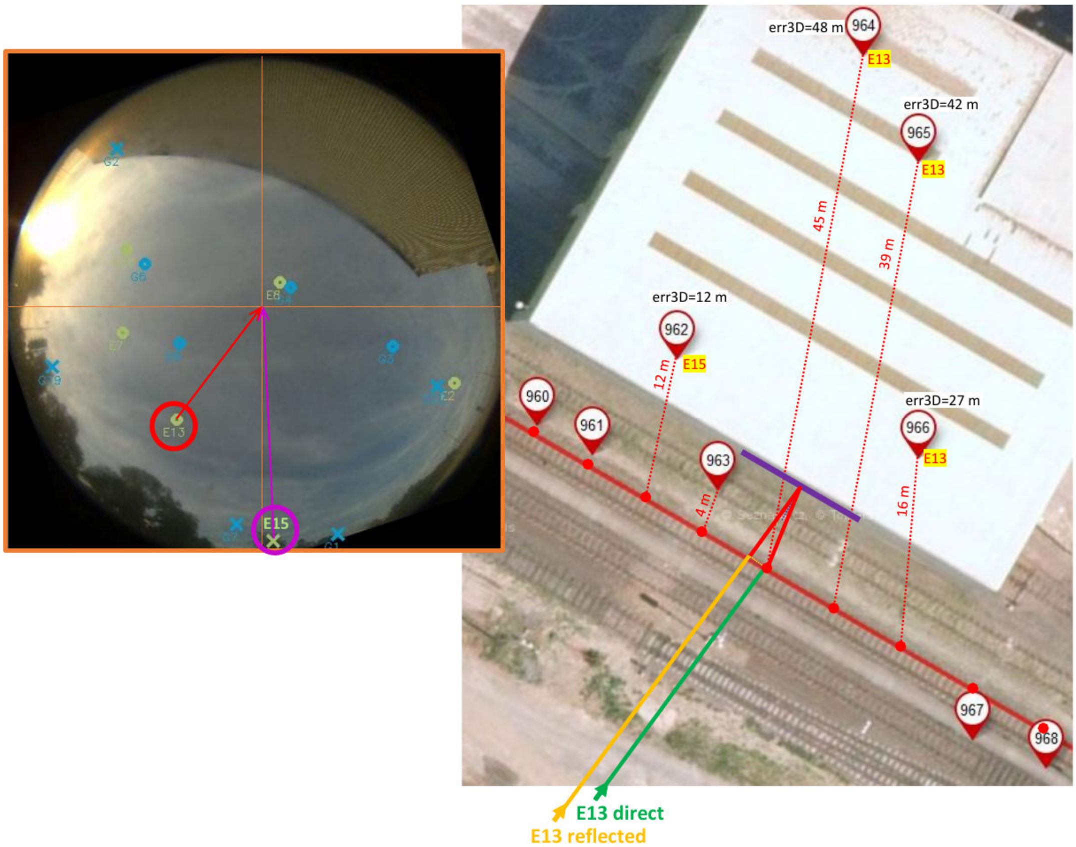


Figure 7-16: The image on the right shows epochs of the PVT solution for the train run 200729_4Q12 from 2960 to 2968 s, which are labeled as 960 to 968. Significant errors in position are evident in the affected epochs. The reflection of the E13 signal is schematically shown for the epoch with the highest PVT error. The left image is a sky visibility chart showing the propagation directions of the E13 and the E15 signals. In the epoch 2962 s, the signal of the lower elevation satellite E15 was reflected, while E13 was not applied in the PVT calculation.

7.2.6.3 Signal failure in a station during standstill

Measurement: 200729_4Q12

Failure: SIS failure during train standstill in Zdirec nad Doubravou.

Location: Railway station Zdirec nad Doubravou.

Test run	GPST [s]	Epoch [s]	SV	SV used in PVT	SV elevation [deg]
200729_4Q12	1280080047:1280080068	2928:2949	E15	N	6
200730_4Q18	1280156024:1280156053	4925:4954	E18	N	8
	1280156026:1280156030	4927:4931	E27	N	3.7

Table 7-5: Specification of intervals with signal failure during standstill

Signal failures of the E15 satellite occurred while standing at the Zdirec nad Doubravou station. It is a satellite with a low elevation, so these reflections come from buildings near the track (railway station, hall building) and interference when the signal passes through the trees near the station. Signal failures were detected with the XAR2 technique as shown in Figure 7-17; see the evident deviation for the E15 satellite at the epochs 2928 – 2949 s (yellow line). The E15 satellite was not used in the PVT calculation, therefore the determination of the PVT estimate was not affected.

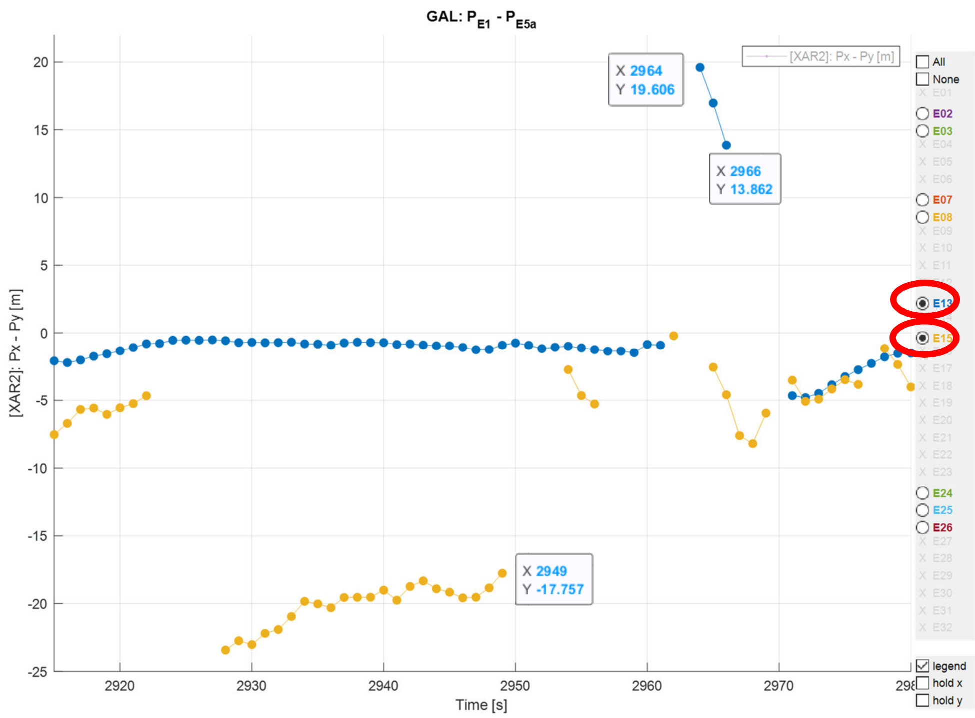


Figure 7-17: XAR2 technique illustrates a visible deviation in the curve for the E15 satellite of 200729_4Q12 run at the epochs 2928 – 2949 s (yellow line). Blue line shows the values for the E13 satellite with an evident jump at the epochs 2964 – 2966 s, which corresponds to the failure described in Sec. 7.2.6.2

7.2.6.4 Strong signal failure in Zdirec nad Doubravou station

Measurement: 200728_4Q05

Failure: Strong SIS failure of low elevation E24 satellite when stopping and departing from Zdirec nad Doubravou station, mainly caused by the reflection from the northwest wall of the building near the track. The size of the failure also affects signal reception and processing in the receiver. This type of failure results in significant position estimation error.

Location: Railway station Zdirec nad Doubravou

Test run	GPST [s]	Epoch [s]	SV	SV used in PVT	SV elevation [deg]	NSV	GDOP	Err3D [m]	Err2D [m]	WSSE
200728_4Q05	1279981753	2124	E24	N	5.3	- - -	- - -	- - -	- - -	- - -
	1279981763 1279981776: 1279981784	2134, 2147: 2155	E24	Y	5.3	9	1.9	91 to 94	64 to 65	298 to 329
	1279981785 1279981787 1279981790	2156, 2158, 2161	E24	Y	5.3	8	2.3	91 97 113	68 72 84	312 365 500
	1279981796 1279981799	2167, 2170	E24	Y	5.3	9	1.9	179 222	127 158	1161 1760
	1279981830: 1279981834	2201: 2205	E24	Y	5.3	10	1.7	190 to 191	151	1803 to 1841

Table 7-6: Specification of intervals related to the E24 signal failure in Zdirec nad Doubravou; train run 200728_4Q05

The satellite E24 is not used for PVT in all epochs. However, the E24 signal failure is apparent in all identified epochs in the range 2124 – 2208 s. Based on the XAR2 technique, the maximum magnitude of the failure is in epoch 2177 s.

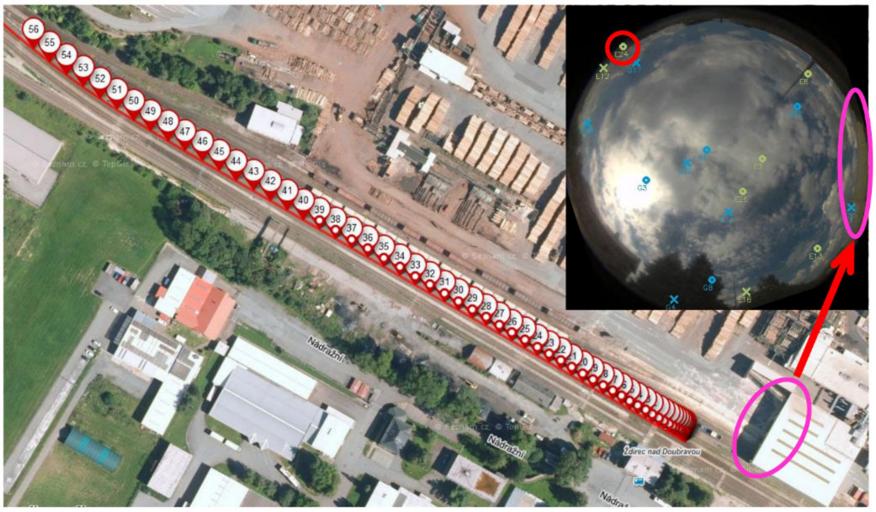


Figure 7-18: Situation on the map for E24 signal failure in Zdirec nad Doubravou; the relevant sky-plot indicates the building wall which causes the reflection and also the position of the satellite which signal is reflected.

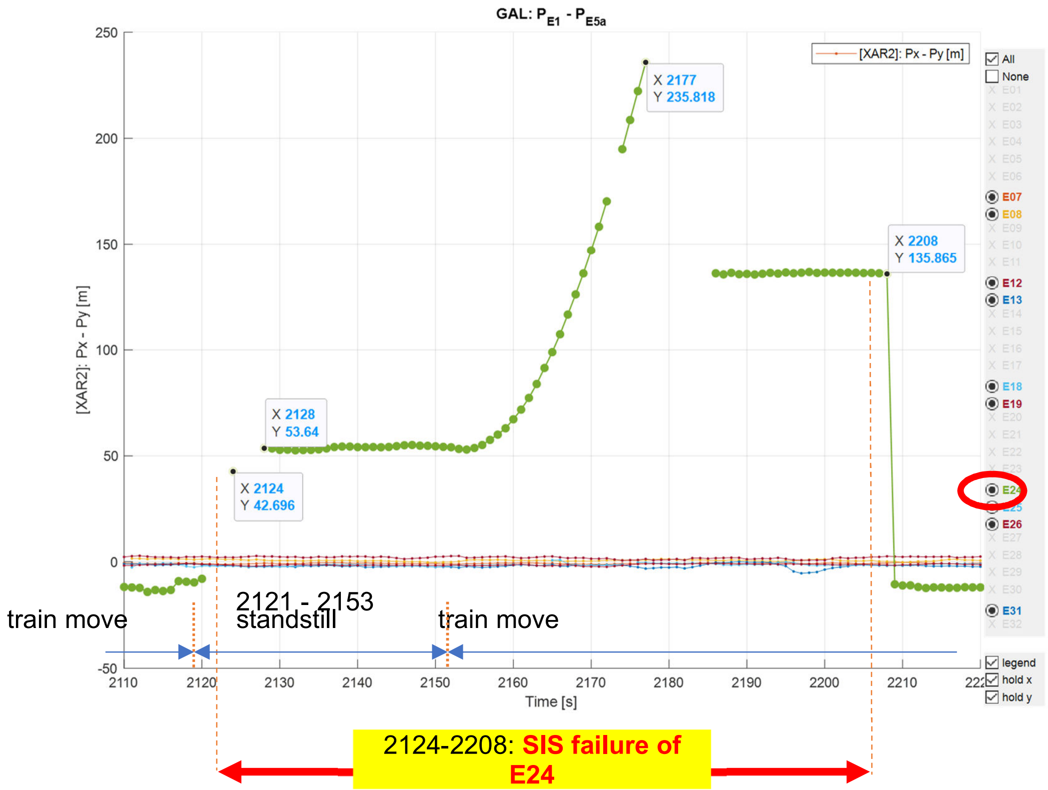


Figure 7-19: Visualization of XAR2 parameters for E24 signal failure in Zdirec nad Doubravou

7.2.6.5 Signal reflection from the station building in Havlickuv Brod during standstill

Failure: SIS reflection of low elevation satellite from the station building during standstill and after departure.

Location: Havlickuv Brod railway station.

Test run/ Speed	GPST [s]	Epoch [s]	SV	SV used in PVT	SV elevation [deg]	NSV	GDOP	Err3D [m]	Err2D [m]	WSSE
200727_4Q01 0 km/h	1279883641 1279883648 1279883653 1279883656 1279883659 1279883667:1279883668 1279883679 1279883686:1279883687 1279883693:1279883694 1279883696 1279883699 1279883701:1279883703	29 36 41 44 47 55:56 67 74:75 81:82 84 87 89:91	E26	Y	7	9	3.1	25.1 to 45.4	20.5 to 38.4	85 to 265

	1279883706:1279883709 1279883712:1279883716 1279883720:1279883721	94:97 100:104 108:109								
	1279883726:1279883727	114:115	E26	Y	7	9	3.1	15 to 18	14 to 16	48 to 61
	1279883766	154	E26	Y	7	9	3.1	12	12	39
200727_4Q01 17 km/h	1279883920:1279883921	308:309	E26	Y	7	9	3.0	25 to 26	23	86 to 98
200728_4Q05 0 km/h	1279983708 1279983713:1279983720	4079 4084:4091	E13	N	26	- - -	- - -	- - -	- - -	- - -
200729_4Q09 0 km/h	1280036752:1280037293	2952:3493	G06	N	5.5	- - -	- - -	- - -	- - -	- - -
200729_4Q12 0 km/h	1280077168:1280077704	49:585	E07	N	29 to 32	- - -	- - -	- - -	- - -	- - -
200730_4Q18 0 km/h	1280152157:1280152163	1058:1064	E12	N	14	- - -	- - -	- - -	- - -	- - -
	1280152164 1280152168	1065 1069	E12	Y	14	8	5.7	35 32	13 12	15 11
	1280152169:1280152299	1070:1200	E12	N Y	14	- - - 9	- - - 4.2	- - - 8-12	- - - 1-8	- - - 22-31
	1280152234:1280152266 1280152267:1280152279 1280152280:1280152306	1135:1167 1168:1180 1181:1207	G10	Y Y Y	12	7-8 7-8 8	4.4 4.6 4.5	20-31 31-34 16-30	6-11 12-16 7-13	2-5 3-4 1-3
	1280152885:1280152896 1280152897:1280152933 1280152934	1786:1797 1798:1834 1835	E19	Y Y Y	13	10 9 10	2.3 2.4 2.3	21-26 23-28 20	12-16 11-14 12	19-38 3-9 39
	1280153114:1280153132 1280153133:1280153140 1280153141:1280153153	2015:2033 2034:2041 2042:2054	G10	Y Y Y	7.0 6.9 6.8	8-9 8 8	3.6-4 4 4	19-31 33-35 > 30	9-11 11-12 30-33	5-18 8-10 7-9
	1280153154:1280153179 1280153180:1280153198	2055:2080 2081:2099	G10	Y Y	6.7 6.5	8 8	4 4	33-42 42-48	10-14 13-17	8-18 14-19
	1280153205 1280153218	2106 2119	G10	Y Y	6.5 6.4	8 8	4 4	45 46	15 16	20 18
	1280153712:1280153765	2613:2666	E12	N	6.5	- - -	- - -	- - -	- - -	- - -

Table 7-7: Specification of intervals related to the signal reflection from the building in Havlickuv Brod station

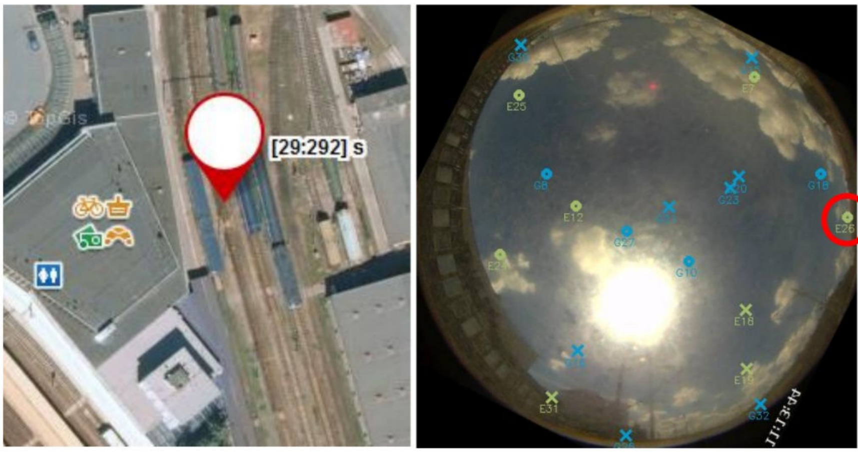


Figure 7-20: Position of the train on the map, train run 200727_4Q01 (left); the corresponding sky plot with the highlighted E26 satellite which signal is reflected from the opposite building (right)

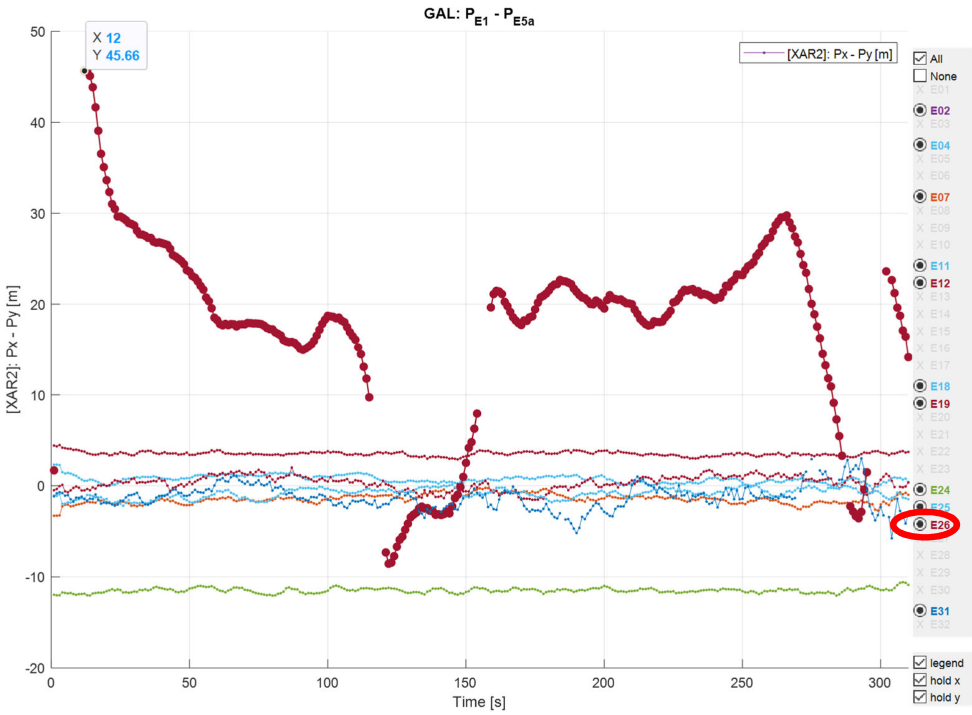


Figure 7-21: Visualization of XAR2 parameters with problematic satellite signal E26; train run 200727_4Q01

7.2.6.6 Signal failure due to passing through trees

Failure: SIS failure due to passing through trees.

Location: Various places on the track where there are trees nearby.

Test run	GPST [s]	Epoch [s]	SV	SV used in PVT	SV elevation [deg]	NSV	GDOP	Err3D [m]	Err2D [m]	WSSE
200728_4Q05	1279979860	231	G27	Y	10.6	9	3.1	24	4.7	54
200729_4Q11	1280076529	3570	G01	Y	27.8	9	2.9	18	9	7
200729_4Q12	1280078497	1378	G09	Y	49.6	13	1.8	3.4	3.3	36
	1280077972	853	E24	N	7.9	- - -	- - -	- - -	- - -	- - -
	1280077973: 1280077975	854:856	E02 E24	N N	5.3 7.9	- - -	- - -	- - -	- - -	- - -
	1280077982 1280077983	863 864	E24 E25	N N	7.9 15.7	- - -	- - -	- - -	- - -	- - -
	1280077989: 1280077991	870:872	E24	N	7.9	- - -	- - -	- - -	- - -	- - -
	1280078136: 1280078138	1017:1019	E24	N	7.7	- - -	- - -	- - -	- - -	- - -
	1280078449: 1280078450	1330:1331	E15	N	16.0	- - -	- - -	- - -	- - -	- - -
	1280078474: 1280078477	1355:1358	E25	N	17.1	- - -	- - -	- - -	- - -	- - -
	1280078523: 1280078525	1404:1406	E15	N	15.5	- - -	- - -	- - -	- - -	- - -
	1280079053: 1280079055	1934:1936	E24	N	6.1	- - -	- - -	- - -	- - -	- - -
	1280079478	2359	E02	N	13.0	- - -	- - -	- - -	- - -	- - -
	1280079755: 1280079759	2636:2640	E13	N	44.8	- - -	- - -	- - -	- - -	- - -
	1280079768	2649	E25	N	20.0	- - -	- - -	- - -	- - -	- - -
	1280080215: 1280080220	3096:3101	E02	N	16.9	- - -	- - -	- - -	- - -	- - -
	1280080290: 1280080292	3171:3173	E25	N	20.8	- - -	- - -	- - -	- - -	- - -
	1280080331: 1280080332	3212:3213	E02	N	17.4	- - -	- - -	- - -	- - -	- - -
200730_4Q18	1280154488	3389	E05	Y	9.7	7	4.0	31	5	4
	1280155347: 1280155349	4248:4250	E05	N	14.4	- - -	- - -	- - -	- - -	- - -
	1280155745: 1280155749	4646:4650	G32	N	28.1	- - -	- - -	- - -	- - -	- - -
	1280156292: 1280156295	5193:5196	E18 E27	N	10 3.5	- - -	- - -	- - -	- - -	- - -

Table 7-8: Specification of intervals related to failures due to signal passing through the vegetation (trees)

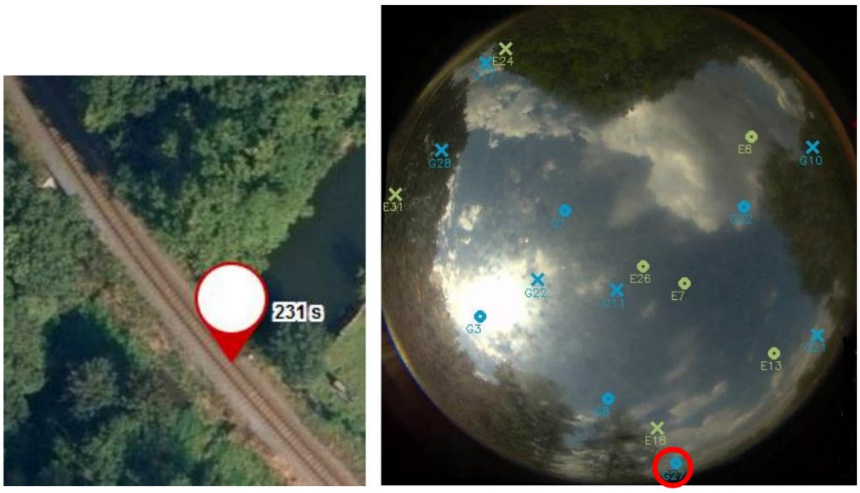


Figure 7-22: Situation on the map and relevant sky plot; train run 200728_4Q05

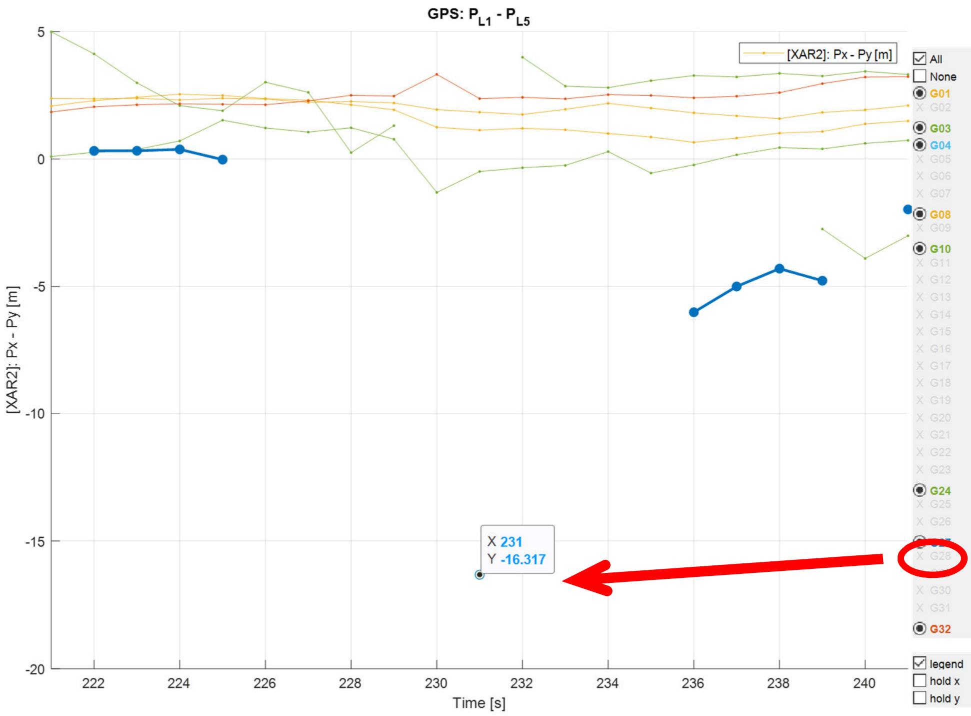


Figure 7-23: Visualization of XARP2 parameters; train run 200728_4Q05

7.2.6.7 Signal reflection from the metal structure of a railway bridge

Failure: SIS reflection from the railway bridge.

Location: Metal structure of railway bridge near the Havlickuv Brod station.

Test run	GPST [s]	Epoch [s]	SV	SV used in PVT	SV elevation [deg]	NSV	GDOP	Err3D [m]	Err2D [m]	WSSE
200727_4Q01	1279884011 1279884012 1279884013 1279884014 1279884015	399 400 401 402 403	G10	Y	68.2	6 7 7 7 7	10	21 17 16 9 6	15 12 12 7 5	0.1 to 0.3
200728_4Q05	1279983609 1279983610 1279983612 1279983613	3980 3981 3983 3984	G08 E08	Y	9.5 11.4	7 6 6 7	4.5 6.1 4.6 2.9	6.6 7.4 7.5 8.3	4.6 7.2 6.0 7.7	2.1 2.9 0.9 2.7
200729_4Q11	1280076937 1280076939 1280076940 1280076941	3978 3980 3981 3982	G09	Y	38.0	10	2.5	9.1 9.0 8.1 7.2	3.1 2.7 1.5 1.6	11.1 11.0 8.5 7.0
200730_4Q20	1280160921 1280160922 1280160923	621 622 623	G01	N	41.5	- - -	- - -	- - -	- - -	- - -
	1280160925 1280160926	625 626	G01	Y	41.5	8 7	3.0 6.3	10.6 4.1	10.0 4.1	11.9 5.6

Table 7-9: Specification of intervals related to failures due to bridge structure near the Havlickuv Brod station

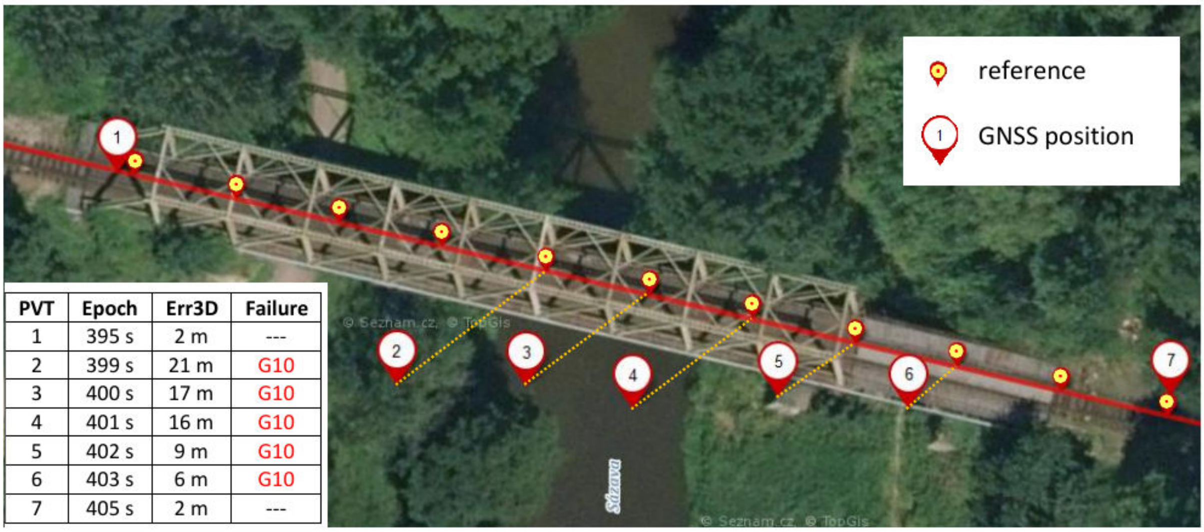


Figure 7-24: Situation on the map with highlighted errors in the position domain (estimated position PVT_1 versus position reference); train run 200727_4Q01

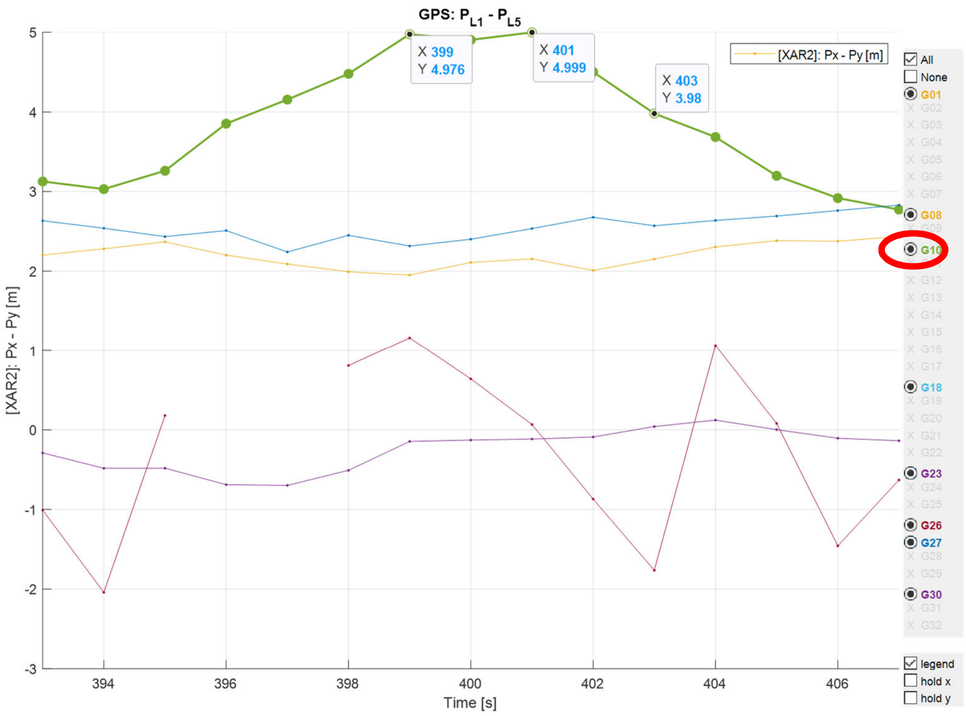


Figure 7-25: Visualization of XAR2 parameters, there is apparent slight degradation for G10 satellite signal; train run 200727_4Q01

7.2.6.8 Signal failure after passing under the bridge

Measurement: 200729_4Q12

Failure: Signal failure of the Galileo E07 satellite after passing under the road bridge.

Location: Wooded arch close to Havlickuv Brod station.

Test run	**GPST [s]**	**Epoch [s]**	**SV**	**SV used in PVT**	**SV elevation [deg]**	**NSV**	**GDOP**	**Err3D [m]**	**Err2D [m]**	**WSSE**
200729_4Q12	1280077987	868	E07	Y	33	7	5.6	18.8	9.4	6.3

Table 7-10: Specification of interval relevant to the signal failure in wooded arch close to Havlickuv Brod station; train run 200729_4Q12

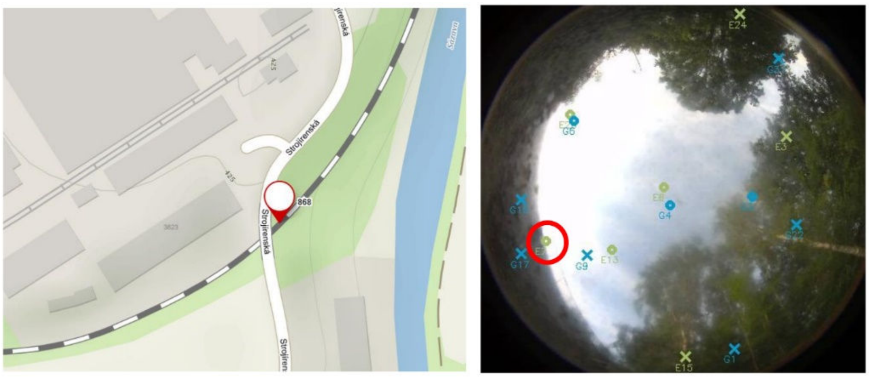


Figure 7-26: Situation on the map and relevant sky plot; train run 200729_4Q12On

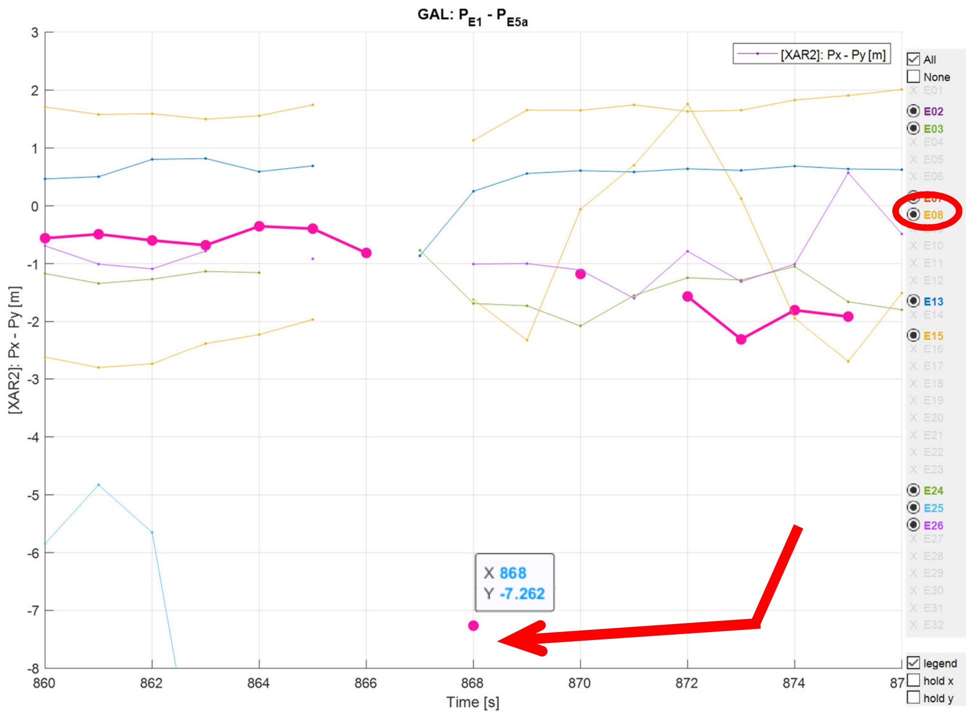


Figure 7-27: E07 signal failure (highlighted pink) in XAR2 technique at epoch 868 s. The passage under the bridge was during the epochs 866 - 867 s.

7.2.6.9 Signal failure due to trees in station

Measurement: 200729_4Q09

Failure: SIS failure of the G32 satellite after departure from the Sobinov station.

Location: Sobinov railway station.

Test run	GPST [s]	Epoch [s]	SV	SV used in PVT	SV elevation [deg]	NSV	GDOP	Err3D [m]	Err2D [m]	WSSE
200729_4Q09	1280035163	1363	G32	Y	16.6	7	3.7	68.0	25.2	155.4
	1280035166	1366	G32	Y	16.6	10	2.4	26.3	22.8	262.4

Table 7-11: Specification of interval (epochs) related to failures after departure from the Sobinov station; train run 200729_4Q09

Figure 7-28: Situation on the map and relevant sky plot; train run 200729_4Q09

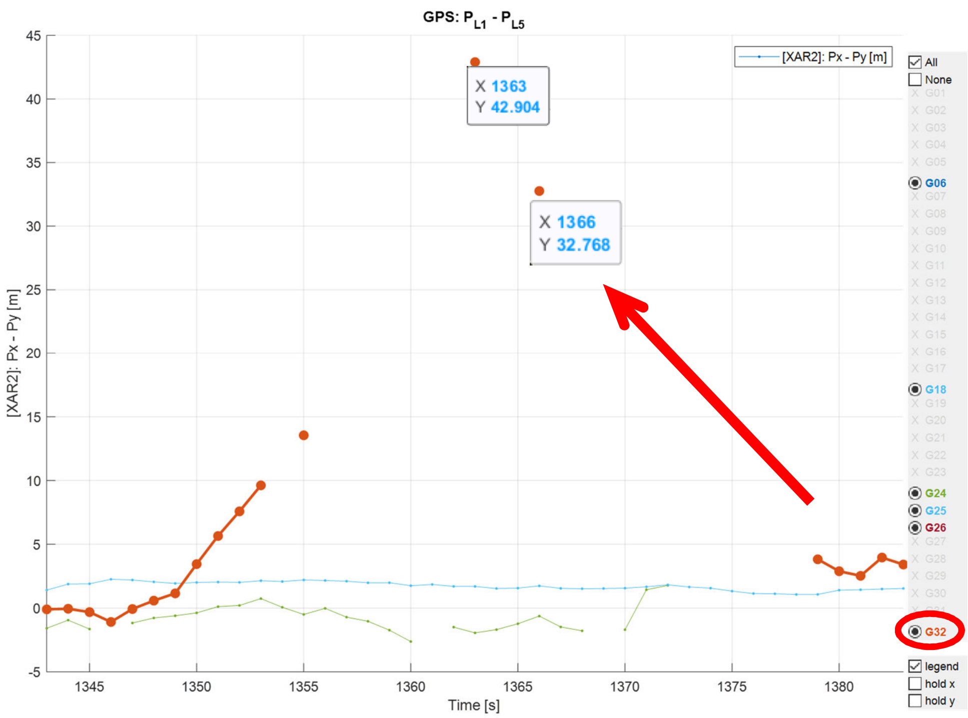


Figure 7-29: XAR2 technique for train run 200729_4Q09, failures of G32 satellite.

Measurement: 200730_4Q20

Failure: SIS failure of G01 and G09 satellites after departure from the Vitanov station.

Location: Vitanov station.

Speed [km/h]	**GPST [s]**	**Epoch [s]**	**SV**	**SV used in PVT**	**SV elevation [deg]**	**NSV**	**GDOP**	**Err3D [m]**	**Err2D [m]**	**WSSE**
0	1280163831:1280163834 1280163836: 1280163837 1280163839:1280163845	3531:3534 3536:3537 3539:3545	G01	N	19.3	- - -	- - -	- - -	- - -	- - -
	1280163835:1280163842	3535:3542	G09	N	43.3	- - -	- - -	- - -	- - -	- - -
3	1280163847	3547	G09	Y	43.3	6	7.6	225	93	46
12	1280163856	3556	G09 G01	Y N	43.3 19.1	6	7.6	42	13	0.2
13	1280163857	3557	G09 G01	Y Y	43.4 19.1	7	3.8	6	5	10
14	1280163858	3558	G09 G01	Y Y	43.4 19.1	7	3.8	5	5	6

Table 7-12: Specification of intervals (epochs) related to failures after departure from the Vitanov station; train run 200730_4Q20.

Figure 7-30: Situation on the map

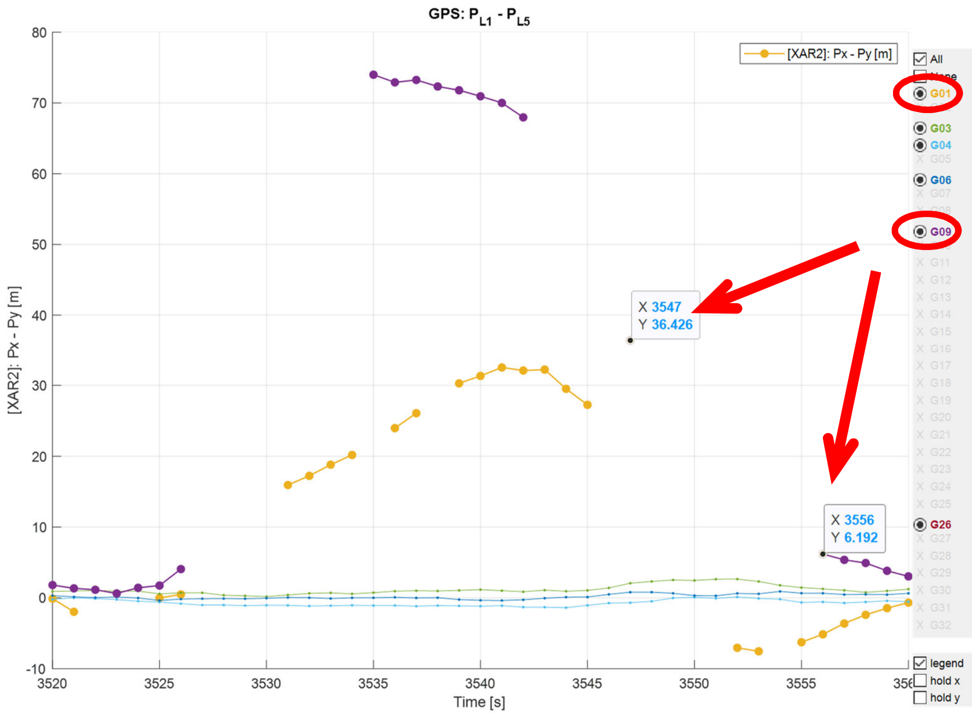


Figure 7-31: XAR2 technique for train run 200730_4Q20, failures of G01 and G09 satellites.

Measurement: 200730_4Q18

Failure: SIS failure of the E27 satellite when the train stopped at the Vitanov station.

Location: Vitanov station.

Test run	GPST [s]	Epoch [s]	SV	SV used in PVT	SV elevation [deg]	NSV	GDOP	Err3D [m]	Err2D [m]	WSSE
200730_4Q18 0 km/h	1280156660: 1280156667	5561:5568	E27	N	3.1	- - -	- - -	- - -	- - -	- - -

Table 7-13: Specification of interval related to failures after the stop at the Vitanov station; train run 200730_4Q18.

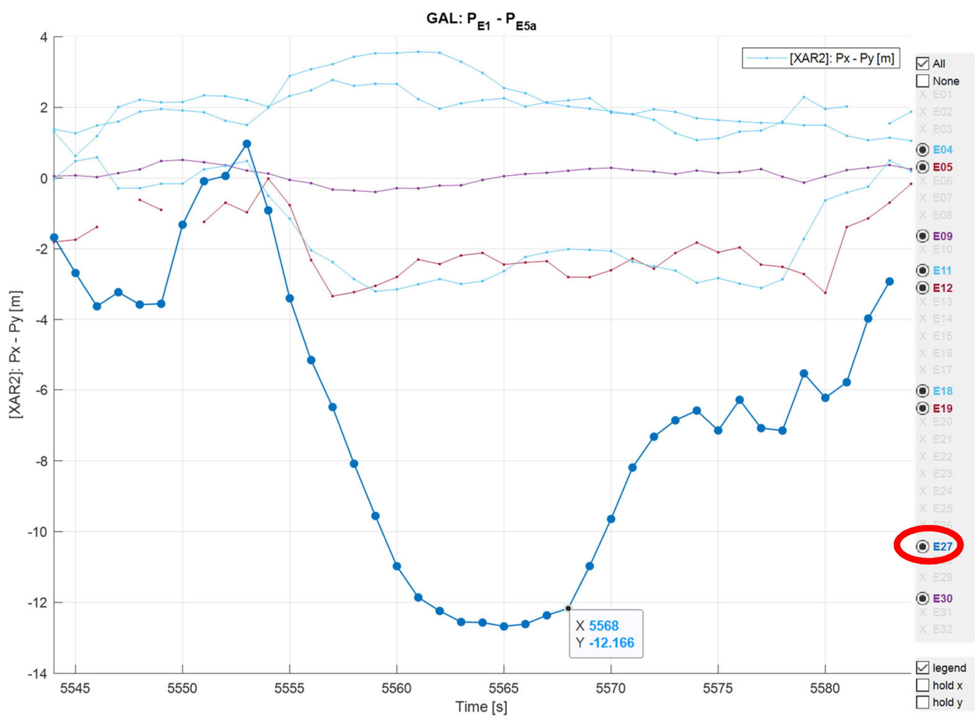


Figure 7-32: XAR2 technique for train run 200730_4Q18, failures of E27 satellite.

7.3 On-site tests

7.3.1 Goal of on-site tests

The on-site tests (field tests) complement the laboratory testing of AZD's demonstrator. The roles of these tests can be summarised as follows:

- Verification of implemented algorithms in the demonstrator: This means, all tested functions work as expected. It is worth mentioning that the more extensive set of functions is tested, including the virtual balise detection function (which is not addressed in the laboratory tests).
- Algorithm testing according to prescribed speed profiles: This is allowed due to the utilization of a dedicated test vehicle on a test line (contrary to the laboratory tests where the train in regular commercial operation was used and thus without any possibility to control its mission).
- Testing of real-time behaviour of the implemented algorithms: The most comprehensive set of implemented functions is executed on a contemporary computation platform in the natural railway environment. This allows demonstrator assessment from the computation burden and time constraint perspectives.

Due to the nature of on-site tests (utilization of a dedicated test vehicle), the cumulative duration of all proposed scenarios for on-site tests cannot reach the value for laboratory tests (where the data from a train in commercial operation were collecting for a long period).

Due to the need to test the detection of virtual balises, the track data for the test line is prepared including the layer with the positions of virtual balises.

7.3.2 Description of test line Kopidlno – Dolni Bousov

The Kopidlno – Dolni Bousov line is territorially part of the Bakov nad Jizerou – Kopidlno line, which is situated 60 km northeast of Prague, in the Czech Republic. Originally, the entire line Bakov nad Jizerou – Kopidlno (marked as Line No. 063) was completely owned by the national infrastructure manager (Sprava zeleznic, s.o.). The line section between the Dolni Bouzov station and the Kamensko signal box (close to the Kopidlno station) was purchased by AZD in 2016.

The line is now without any commercial operation and therefore suitable for on-site testing.

The Kopidlno - Dolní Bousov line is a regional line passing the rural landscape, whereas the entire wider area along the line is relatively flat. The line goes through small towns, villages, and agricultural fields. Occasionally, the line goes along small forests on one side of the track (close to stations Ledkov, Liban, Domousice and Ritonice) or the line is lined by trees and bushes. The vegetation around the line is rather sparse (there are no line sections where the sky is completely covered by vegetation). The line is without tunnels and other man-made constructions significantly restricting the sky visibility.

There are over 40 level crossings on the line. Most of them are without any warning device (only marked with cross signs). From the test scenarios perspective, these level crossings impose speed restrictions for the test train.

The Kopidlno – Dolni Bousov line technical parameters are summarised below:

- Line length: approximately 24 [km]
- Maximal gradient: less than 15 [‰]
- Height difference: approximately 60 [m]
- Cumulative elevation: approximately 110 [m]
- Gauge: 1435 [mm]
- Maximal velocity: 60 [km/h]
- Electrification system: not electrified
- Number of track: 1
- Specialties: long sections without restricted sky view
- Environment: rural, occasional trees or small forests
- Reference points: 46 locations identified for future installation of ETCS balise groups

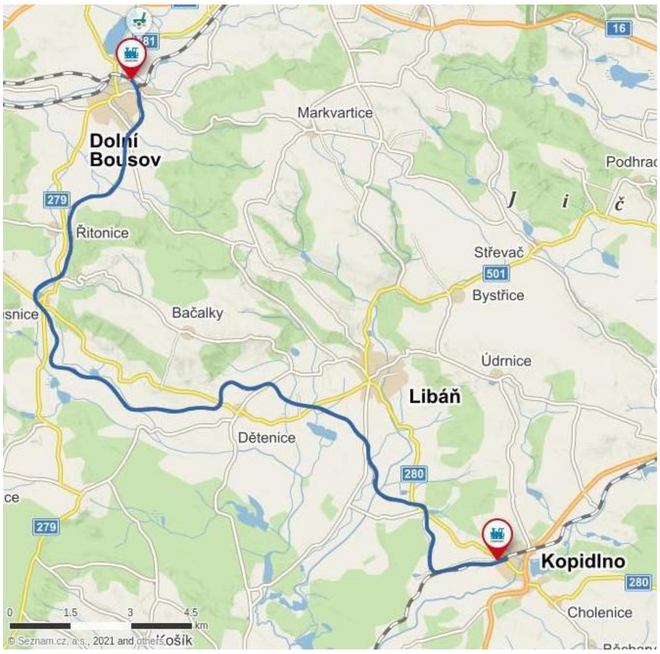


Figure 7-33: Map of Kopidlno – Dolní Bousov line (source: www.mapy.cz)

7.3.3 Description of test vehicle MUV 69

The complete HW set of demonstrator will be installed on MUV 69 class vehicle, which is a light diesel maintenance vehicle.

Selected technical parameters are listed below:

- Length: 6757 mm
- Width: 2680 mm
- Height: 2650 mm
- Weight: 7480 kg
- Load capacity: 8000 kg
- Wheelbase: 1435 mm
- Wheel diameter: 700 mm
- Number of seats in the cabin: 6
- Engine: TATRA T-912-3 four-stroke diesel in-line 6-cylinder with direct fuel injection, air-cooled
- Maximal permitted speed: 40 [km/h]
- Design speed: 60 [km/h]

Figure 7-34: Maintenance railway vehicle MUV 69 in Detenice station

7.3.4 List of on-site test scenarios

For the on-site test, the 5 different scenarios entitled with capital letters A to E are defined. There can be distinguished two types of scenarios:

- Testing on the entire test line emulating normal train move – test scenario A
- Testing of different virtual balise passages (differs in the surrounding environment) – test scenarios B to E

The list of all scenarios are summarized in Table 7-14.

The approach for on-site test scenarios is different to laboratory ones. Only Scenario A represent an ordinary train move on most part of Kopidlno – Dolni Bousov line. The other scenarios, B –E, are focused on testing of virtual balise detection function under different dynamic conditions. Due to this reason, Scenario A and Scenarios B – E, are evaluated differently.

The scenarios are organised in that way, that void train move (a train move not belonging to any scenarios) is minimised, see Figure 7-35.

Scenario's ID	Scenario description
A	Ordinary train move over the entire line Kopidlno – Dolni Bousov
B	Virtual balise detection test with speed 40 km/h
C	Virtual balise detection test with speed 10 km/h
D	Virtual balise detection test with acceleration and deceleration
E	Virtual balise detection test under a standstill

Table 7-14: List of test scenarios for on-site tests

7.3.5 Specification of on-site test scenarios

7.3.5.1 Test scenario A

Scenario A represents a normal train run. The test vehicle will pass entire the line Kopidlno – Dolni Bousov, respecting the line speed limits.

The set of logged values obtained in the frame of scenario A are identical to those ones from laboratory testing. Therefore, scenario A can be understood as equivalent to any of laboratory test scenarios but performed on the different line.

Description of the test scenario process:

- The test scenario starts close to the Kamensko signal box (near the Kopidlno station), and ends close to the Dolni Bousov station. The vehicle speed respects the line speed limits (i.e. the speed is close to the allowed maximum) including temporal speed restriction.
- The subset of implemented functions of the demonstrator, in particular PPSR, PEST, and PPOS, are executed on the HW in real time.
- The identified values, see Sec. 7.3.7, are logged for the later assessment of the test.

7.3.5.2 Test scenario B

Scenario B deals with the passage of the test vehicle over a virtual balise at the maximum allowed speed (for the given line section and the vehicle).

The purpose of this test scenario is (together with others from the group B – E) to evaluate demonstrator performance under different dynamic conditions.

Description of the test scenario process:

- The test scenario starts in the position approximately 200 [m] ahead of the virtual balise and ends 200 [m] behind it. The vehicle speed, when passing the balise, is constant and is 40 [km/h] (which is the maximal allowed speed for the given line segment and test vehicle).
- All implemented functions of the demonstrator, in particular PPSR, PEST, PPOS, PCOS, and VBD, are executed on the HW in real time.
- The identified values, see Sec. 7.3.8, are logged for later assessment of the test.

7.3.5.3 Test scenario C

Scenario C deals with the passage of the test vehicle over a virtual balise at slow speed.

The purpose of this test scenario is (together with others from the group B – E) to evaluate demonstrator performance under different dynamic conditions.

Description of the test scenario process:

- The test scenario starts in the position approximately 200 [m] ahead of the virtual balise and ends 200 [m] behind it. The vehicle speed, when passing the balise, is constant and is 10 [km/h].
- All implemented functions of the demonstrator, in particular PPSR, PEST, PPOS, PCOS, and VBD, are executed on the HW in real time.
- The identified values, see Sec. 7.3.8, are logged for later assessment of the test.

7.3.5.4 Test scenario D

Scenario D deals with the passage of the test vehicle over a virtual balise with increasing speed (acceleration) or decreasing speed (deceleration). This scenario thus has two variants which are tested separately.

The purpose of this test scenario is (together with others from the group B – E) to evaluate demonstrator performance under different dynamic conditions.

Description of the test scenario process:

- The test scenario starts in the position approximately 200 [m] ahead of the virtual balise and ends 100 [m] behind it. The speed is increased from 10 [km/h] to 40 [km/h] in case of acceleration, and decreased from 40 [km/h] to 10 [km/h] in case of deceleration.
- All implemented functions of the demonstrator, in particular PPSR, PEST, PPOS, PCOS, and VBD, are executed on the HW in real time.
- The identified values, see Sec. 7.3.8, are logged for later assessment of the test.

7.3.5.5 Test scenario E

Scenario E addresses the test vehicle at a standstill at the exact location of a virtual balise.

The purpose of this test scenario is (together with others from the group B – E) to evaluate demonstrator performance under different dynamic conditions.

- The test vehicle is at a standstill at the exact location of the virtual balise for 5 minutes.
- All implemented functions of the demonstrator, in particular PPSR, PEST, PPOS, PCOS, and VBD, are executed on the HW in real time.
- The identified values, see Sec. 7.3.8, are logged for later assessment of the test.

7.3.5.6 Succession of on-site test scenarios

The succession of test scenarios (i.e. the order in which the scenarios will be performed) is visualized in Figure 7-35. The succession was proposed in a way to minimise the test train move not belonging in any of the scenarios.

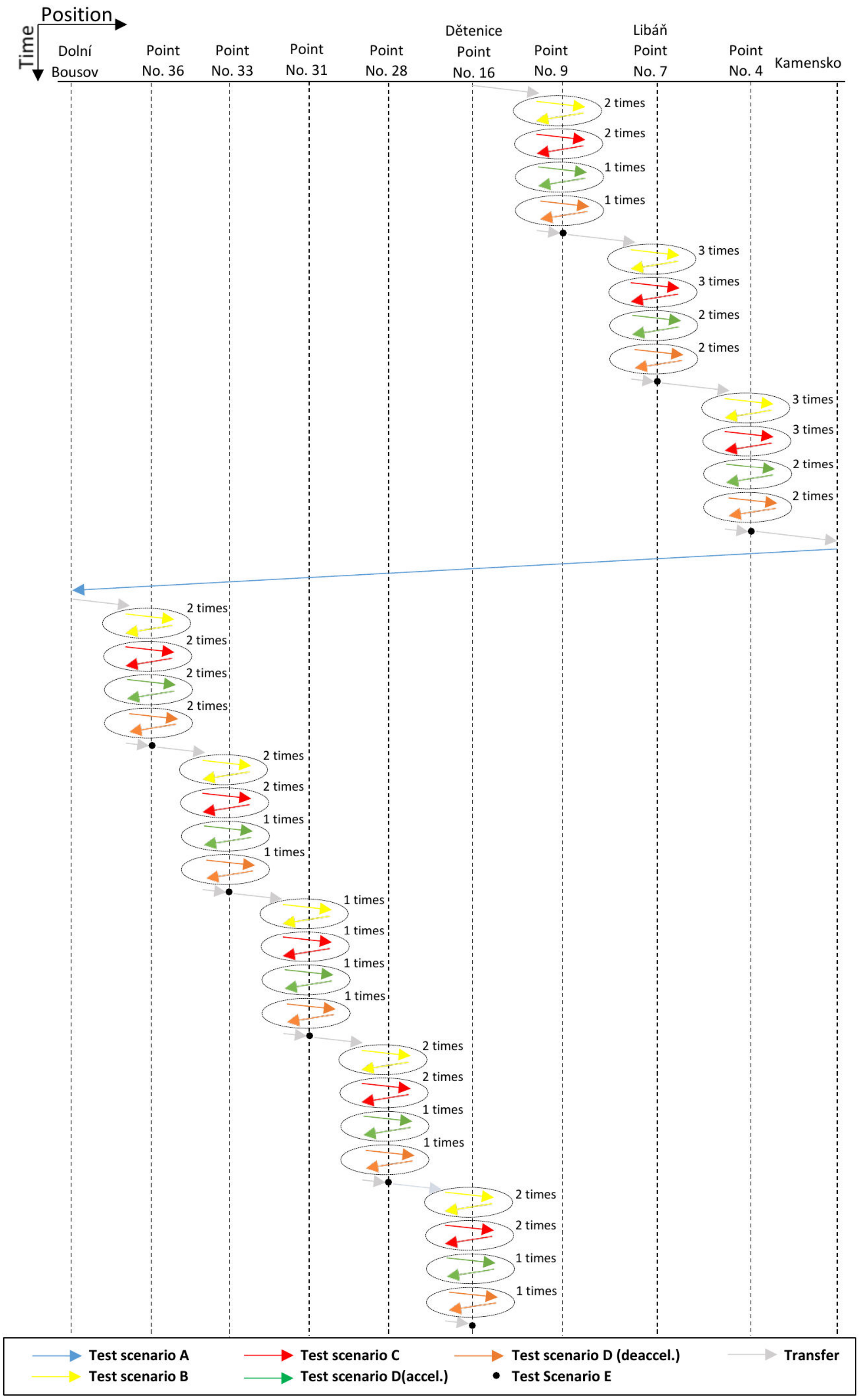


Figure 7-35: The succession of scenarios for on-site tests

7.3.6 Specification of virtual balise positions

The section provides the description of selected positions on the track, where virtual balises are “installed” for the purpose of on-site tests.

The eight positions are selected in total from the set of 46 possibilities. These 46 possible positions are intended for the future installation of ETCS balises (balise groups). The positions are already well marked in the field (using colour paint on the sleepers) and also the database with the exact geodetics locations exists. Both are helpful since optical markers (reflectors) will be installed on sleepers to allow independent assessment of the virtual balise detection in the frame of tests.

The key criterion for the selection of eight positions for virtual balises is a diversity of the surrounding environment, i.e. mainly the variation of obstacles which shadow, block or reflect GNSS signal.

The selected positions have the following identifiers (No): 4, 7, 9, 16, 28, 31, 33, and 40. Their location in the frame of Kopidlno – Dolni Bousov line is shown in Figure 7-44. The list of selected locations with the relation to the particular on-site test scenarios is provided in Table 7-15.

Note also, that the test scenario A does not utilize knowledge of any selected eight virtual balise positions. The role of scenario A is different compared to scenarios B – E. While scenario A emulates ordinary train movement (the movement of railway vehicle is restricted just by the accrual line speed profile), scenarios B – E are designed to assess the virtual balise detection under the different train dynamic conditions (constant speed, acceleration/deceleration, standstill) and different surrounding environment (diversity of selected virtual balise locations).

7.3.6.1 VB location No. 4 – near the Ledkov village

Figure 7-36: VB location No. 4 on an orthophoto map

Sky visibility:

- Long shading by trees from the west side of the track, greater shading in the direction of Dolni Bousov (north direction)

Use within test scenarios:

- B: 3x direction Dolni Bousov, 3x direction Kopidlno
- C: 3x direction Dolni Bousov, 3x direction Kopidlno
- D acceleration: 2x direction Dolni Bousov, 2x direction Kopidlno
- D deceleration: 2x direction Dolni Bousov, 2x direction Kopidlno
- E: 5 minutes

Specific information:

- It is desirable to compare the test scenario results for the Kopidlno direction with the test scenario results for the Dolni Bousov direction.

7.3.6.2 VB location No. 7 – next to the Liban station

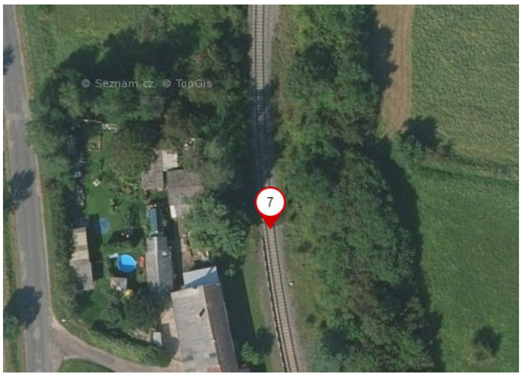


Figure 7-37: VB location No. 7 on an orthophoto map

Sky visibility:

- Long shading by trees and buildings from the west side of the track, long shading by trees from west side of track

Use within test scenarios:

- B: 3x direction Dolni Bousov, 3x direction Kopidlno
- C: 3x direction Dolni Bousov, 3x direction Kopidlno
- D acceleration: 2x direction Dolni Bousov, 2x direction Kopidlno
- D deceleration: 2x direction Dolni Bousov, 2x direction Kopidlno
- E: 5 minutes

7.3.6.3 VB location No. 9 – south of the Liban airport

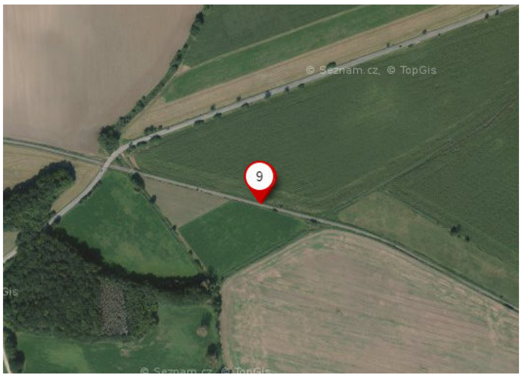


Figure 7-38: VB location No. 9 on an orthophoto map

Sky visibility:

- Perfect sky visibility (open sky)

Use within test scenarios:

- B: 2x direction Dolni Bousov, 2x direction Kopidlno

- C: 2x direction Dolni Bousov, 2x direction Kopidlno
- D acceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- D deceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- E: 5 minutes

7.3.6.4 VB location No. 16 – inside the Detenice station

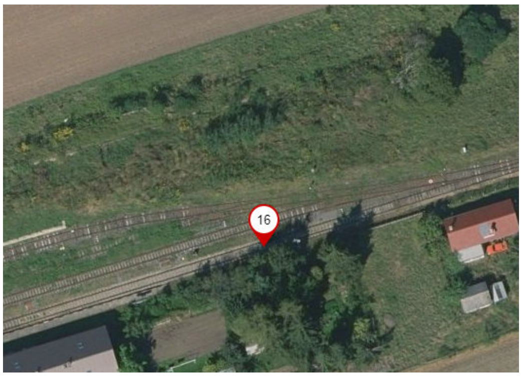


Figure 7-39: VB location No. 16 on an orthophoto map

Sky visibility:

- Partial shading by trees and buildings from the south side of the tracks

Use within test scenarios:

- B: 2x direction Dolni Bousov, 2x direction Kopidlno
- C: 2x direction Dolni Bousov, 2x direction Kopidlno
- D acceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- D deceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- E: 5 minutes

7.3.6.5 VB location No. 28 – arch section between the Osenice and Detenice villages

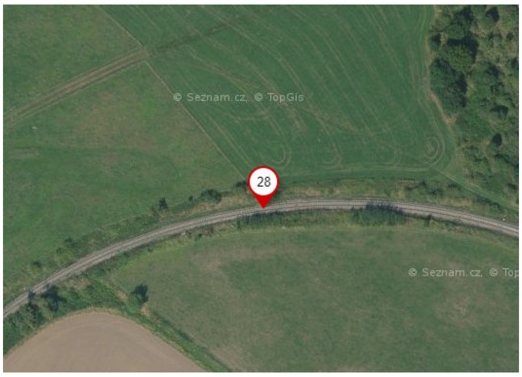


Figure 7-40: VB location No. 28 on an orthophoto map

Sky visibility:

- Occasional shading by trees and bushes

Use within test scenarios:

- B: 2x direction Dolni Bousov, 2x direction Kopidlno
- C: 2x direction Dolni Bousov, 2x direction Kopidlno
- D acceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- D deceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- E: 5 minutes

7.3.6.6 VB location No. 31 – southwest of the Osenice village

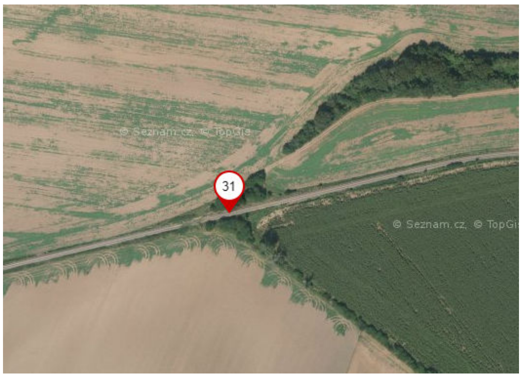


Figure 7-41: VB location No. 31 on an orthophoto map

Sky visibility:
- Almost ideal sky visibility

Use within test scenarios:
- B: 1x direction Dolni Bousov, 1x direction Kopidlno
- C: 1x direction Dolni Bousov, 1x direction Kopidlno
- D acceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- D deceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- E: 5 minutes

7.3.6.7 VB location No. 33 – near the Rokytnany pond

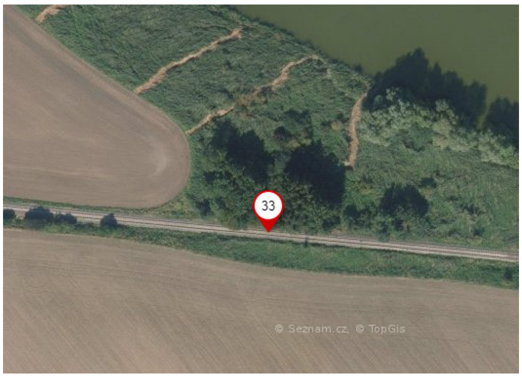


Figure 7-42: VB location No. 33 on an orthophoto map

Sky visibility:
- Short shading by trees from the north side of the track

Use within test scenarios:

- B: 2x direction Dolni Bousov, 2x direction Kopidlno
- C: 2x direction Dolni Bousov, 2x direction Kopidlno
- D acceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- D deceleration: 1x direction Dolni Bousov, 1x direction Kopidlno
- E: 5 minutes

7.3.6.8 VB location No. 36 – in the Domousice village

Figure 7-43: VB location No. 36 on an orthophoto map

Sky visibility:

- Sky is shading by trees from both sides of the track

Use within test scenarios:

- B: 2x direction Dolni Bousov, 2x direction Kopidlno
- C: 2x direction Dolni Bousov, 2x direction Kopidlno
- D acceleration: 2x direction Dolni Bousov, 2x direction Kopidlno
- D deceleration: 2x direction Dolni Bousov, 2x direction Kopidlno
- E: 7 minutes

7.3.6.9 Relations to the scenarios

Table 7-15 provides the summary of positions selected for Virtual Balieses and their relation to the particular scenarios. The positions on the map are provided in Figure 7-44.

Note, the table utilizes the following notation: “dir. DB and “dir. K” means “direction Dolni Bousov” and “direction Kopidlno”, respectively.

VB No.	Scenario B	Scenario C	Scenario D		Scenario E
			Acc.	Dec.	
4	A	dir. DB: 3x dir. K: 3x	dir. DB: 2x dir. K: 2x	dir. DB: 2x dir. K: 2x	5 min
7	dir. DB: 3x dir. K: 3x	dir. DB: 3x dir. K: 3x	dir. DB: 2x dir. K: 2x	dir. DB: 2x dir. K: 2x	5 min
9	dir. DB: 2x dir. K: 2x	dir. DB: 2x dir. K: 2x	dir. DB: 1x dir. K: 1x	dir. DB: 1x dir. K: 1x	5 min
16	dir. DB: 2x dir. K: 2x	dir. DB: 2x dir. K: 2x	dir. DB: 1x dir. K: 1x	dir. DB: 1x dir. K: 1x	5 min
28	dir. DB: 2x dir. K: 2x	dir. DB: 2x dir. K: 2x	dir. DB: 1x dir. K: 1x	dir. DB: 1x dir. K: 1x	5 min
31	dir. DB: 1x dir. K: 1x	dir. DB: 1x dir. K: 1x	dir. DB: 1x dir. K: 1x	dir. DB: 1x dir. K: 1x	5 min
33	dir. DB: 2x dir. K: 2x	dir. DB: 2x dir. K: 2x	dir. DB: 1x dir. K: 1x	dir. DB: 1x dir. K: 1x	5 min
36	dir. DB: 2x dir. K: 2x	dir. DB: 2x dir. K: 2x	dir. DB: 2x dir. K: 2x	dir. DB: 2x dir. K: 2x	7 min

Table 7-15: Relation between virtual balise (VB) positions and on-site scenarios B – E.

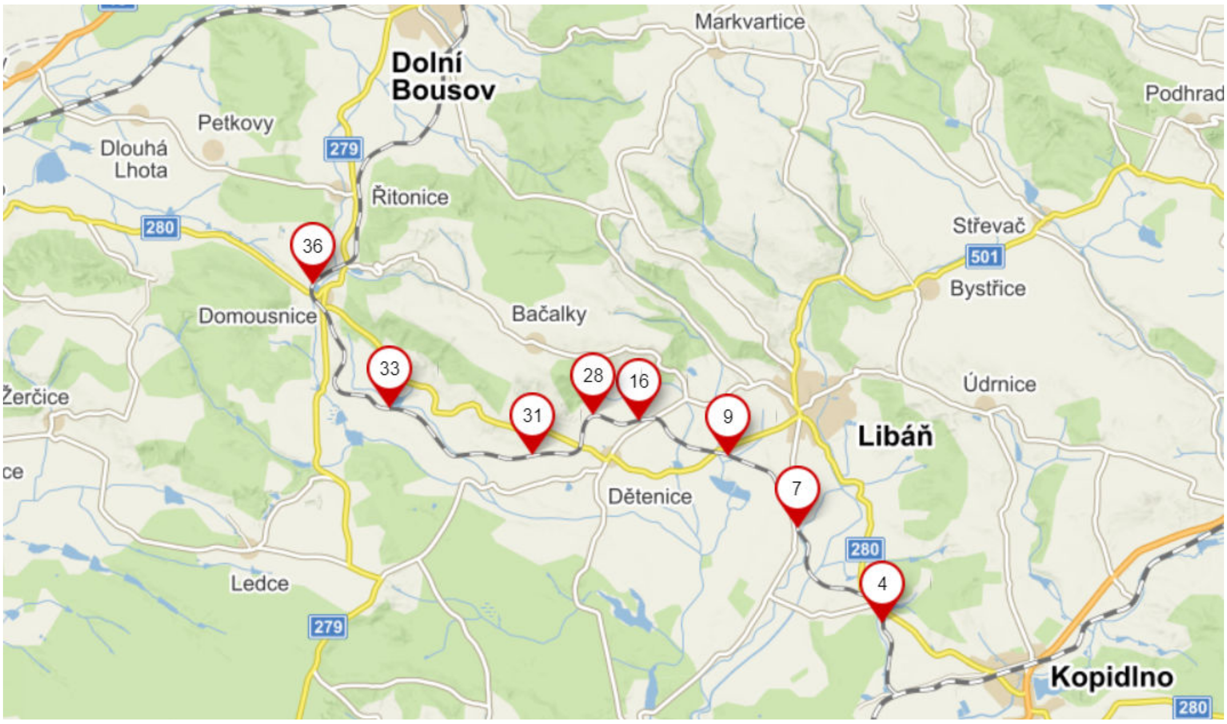


Figure 7-44: Virtual Balise positions on a map

7.3.7 Output assessment for on-site tests: Scenario A

The logged values and estimated statistics for the evaluation of scenario A are identical to the laboratory tests. Therefore, no additional information is presented in this section and only the reference to the laboratory test assessment is provided, see Sec. 7.2.2.

7.3.8 Output assessment for on-site tests: Scenarios B – E

The assessment of scenarios B – E differs from scenario A (and laboratory tests). The reason is that the objective of these scenarios is the evaluation of the virtual balise detection which is not part of any laboratory tests or even on-sites test under scenario A.

Similarly to Sec. 7.2.2, the section summarises the values which will be logged during the execution of on-site tests together with the statistics to be estimated.

The section structure is identical to Sec. 7.2.2. The values and statistics are presented in the structure of particular internal functions, for which they are relevant. Apart from the functions already introduced in Sec. 7.2.2 (PPSR, PEST, and PPOS), two new functions are introduced here (PCOS and VBD).

7.3.8.1 PPSR

The same values and statistics will be logged and processed as for laboratory tests, see Sec. 7.2.4.1.

Note that the assessment of the PPSR inputs and outputs provides essential information regarding current GNSS conditions and thus it is worth to be logged and processed too.

7.3.8.2 PEST

The output values of PEST function are not logged or even processed for on-site tests.

7.3.8.3 PPOS

The same values and statistics will be also logged and processed as for laboratory tests, see Sec. 7.2.4.3.

The output of this function represents the position estimate being used in the next functions, PCOS and VBD. These functions are only tested in scenarios B – E and it is worth assessing their input too.

7.3.8.4 PCOS + VBD

The functional block PCOS (position coasting) takes the best safe position estimate (the fused position provided by PPOS) and translates this position to the current time. The translation includes also the adaptation of the corresponding confidence interval. Thus, the function solves the issue with the fact that the best safe position estimate is provided with some delay (meaning that this position estimate is valid for the past time instant).

The functional block VBD (virtual balise detection) simply compare the current position (as provided by PCOS) with the stored positions of virtual balises. If there is a match the virtual balise detection event is announced and logged.

7.3.8.4.1 Values to be logged

- Detection time of the virtual balise with the corresponding confidence interval; this is the detection time provided by the tested demonstrator
- Time instant when the vehicle passes the location with the virtual balise according to the information from the installed optical sensor

7.3.8.4.2 Statistics to be evaluated

- accuracy of virtual balise detection: location of virtual balise true position (according to the optical sensor) inside the balise confidence interval
    - histogram of balise true position inside the normalized confidence interval [-0.5; 0.5]
    - percentage of balise true position outside/inside of the confidence interval
- precision of virtual balise detection, i.e. length of virtual balise confidence interval:
    - ordinary/cumulative histogram of confidence interval (pdf/CDF)
- availability of virtual balise, i.e. number of successfully detected balises divided by all balises

8 MerMec Demonstrator Test Specifications and Scenarios

The demonstrator develops by MERMEC for X2Rail 5 WP6 implements a Virtual Balise solution as a result of what was done during the X2Rail-2 project and the activities carry out in X2Rail-5 project. It is fed with real data from real acquisitions. The entire demonstrator will be tested in the laboratory, the receiver will be installed also on the vehicle even when the test runs are performed. The receiver outputs are collected during real trips. The activities in the laboratory will be used to evaluate the deviation from an independent and very precise Ground Truth.

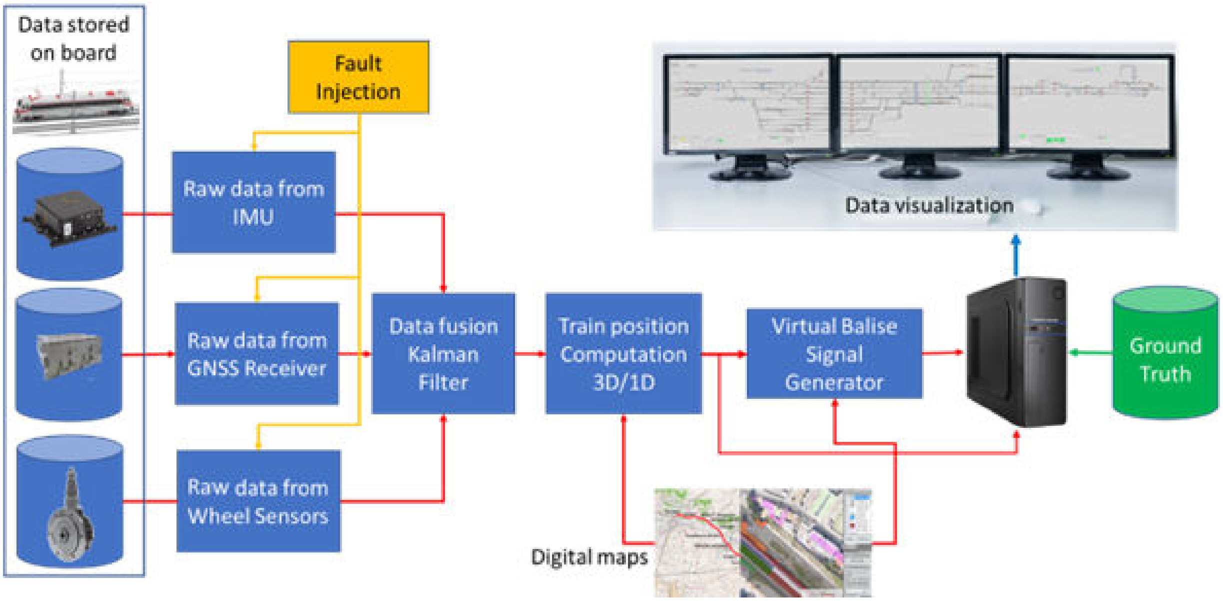


Figure 8-1: MERMEC Test architecture

All The Test activities are aligned with the architecture indicated in the Figure 8-1

The foreseen activities are those of the definition of the Use Cases and consequent definition of the Test Cases.

At least one test activities will then be produced for each Test Case and for every test activity will be a Test Report.

8.1 Use Case

We intend to evaluate the following Use Cases:

journey from station A to station B.

8.1.1 Use Case 01

Use Case Group	*Positioning*
Use Case	Train Positioning activities during travel from Station A up to Station B
UC ID	UC_POS_01
Main actor	Driver
Other actors	GNSS RECEIVER

	IMU WHEEL SENSORS
Main goal	Collect all the data during the trip
Assumptions	No Augmentation system is present. All the data collected are synchronized
Precondition	No failures from wayside are foreseen
Flow of events	1. Driver starts up the train. 2. All the On board equipment perform the initialization phase a. All the systems work correctly goes to point 3 b. At least two of the input are in failure goes to point 8 3. Driver performs the Start of Mission. 4. Driver moves the train from station A. 5. All the data produce by the GNSS Receiver are collected. 6. All the data produced by the IMU are collected. 7. All the data produced by the Wheel sensors are collected. 8. Driver stops the train in the station C between Station A and Station B 9. Driver moves the train from Station C. 10. All the data produce by the GNSS Receiver are collected. 11. All the data produced by the IMU are collected. 12. All the data produced by the Wheel sensors are collected. 13. Driver stops the train in the station B *14.* End of Use Case
Postcondition	the train is stopped in the station and the logs are downloaded from all the systems involved.

8.1.2 Use Case 02

Use Case Group	*Positioning*
Use Case	Train Positioning Laboratory activities
UC ID	UC_POS_02
Main actor	Laboratory operator
Other actors	GNSS RECEIVER IMU WHEEL SENSORS *DATA FUSION* *TRAIN POSITIONING COMPUTATION (**TPC**)* *VIRTUAL BALISE GENERATOR* *DIGITAL MAPS*
Main goal	Evaluate the deviation of the train position respect to the Ground Truth
Assumptions	No Augmentation system is present.
Precondition	No failures from wayside are foreseen
Flow of events	*1.* Operator download in the laboratory environment the system logs. *2.* Operator download the Ground Truth in the laboratory environment. 3. Operator chooses the type of perturbation he/she wants to introduce. 4. Operator provide the Dynamic Route information. 5. The Operator start the simulation. 6. The DATA FUSION Algorithm receive in input the data from GNSS Receiver IMU and Wheel Sensor

	7. TPC Algorithm use the Digital Map and Dynamic Route 8. TPC inside the laboratory environment provide train Position. 9. Laboratory Environment collect all the train position points 10. Laboratory Environment provide the Virtual Balise position. 11. End of Use Case
Postcondition	All the data are stored in the laboratory repository.

8.2 Test Case

The Test Cases are linked to the Use Cases. Follow the Test Cases.

8.2.1 Test Case POS 01 01

Test Case Group	*Positioning*
Test Case	Train Positioning activities during travel from Station A up to Station B Linked to UC_POS_01
TC ID	TC_POS_01_01
Main actor	Driver
Other actors	GNSS RECEIVER IMU WHEEL SENSORS
Main goal	Obtain all the data during the trip
Assumptions	No Augmentation system is present. All the data collected are synchronised
Precondition	No failures in the data collection are foreseen
Flow of events	1. Driver starts up the train. 2. Check if the data are starting to be collected. 3. Driver stops the train in the station B 4. Check that the data are collected. *5.* End of Use Case
Postcondition	the train is stopped in the station and all the check about the data acquisition is done.

Depending on the availability of the line, various test cases will be performed with different speeds in order to have better availability of the data to be processed.

8.2.2 Test Case POS 02 01

Test Case Group	*Positioning*
Test Case	Train Positioning Laboratory activities Nominal conditions Linked to UC_POS_02
TC ID	TC_POS_02_01
Main actor	Laboratory operator
Other actors	GNSS RECEIVER IMU WHEEL SENSORS *TRAIN POSITIONING COMPUTATION (**TPC**)* *DIGITAL MAPS & DYNAMIC ROUTE* *GROUND TRUTH*

Main goal	Check the deviation of the train position respect to the Ground Truth
Assumptions	No Augmentation system is present.
Precondition	No failures from wayside are foreseen
Flow of events	*1.* Operator check and download in the laboratory environment the system logs. *2.* Operator check and download the Ground Truth in the laboratory environment. 3. Operator doesn't introduce any type of perturbation. 4. Operator Check and download the Dynamic Route information. 5. The Operator start the simulation. 6. The TPC Algorithm elaborates its input. 7. Operator check the train Position provide to the laboratory environment. 8. Operator check the differences between the TPC output and the Ground Truth and evaluate the deviation 9. Operator evaluate the Virtual Balise position respect to the real one present in the ground truth. 10. End of Use Case
Postcondition	The result of the test is stored in the laboratory repository.

8.2.3 Test Case POS 02 02

Test Case Group	*Positioning*
Test Case	Train Positioning Laboratory activities Introduction of IMU perturbation Linked to UC_POS_02
TC ID	TC_POS_02_02
Main actor	Laboratory operator
Other actors	GNSS RECEIVER IMU WHEEL SENSORS *TRAIN POSITIONING COMPUTATION (**TPC**)* *DIGITAL MAPS & DYNAMIC ROUTE* *GROUND TRUTH*
Main goal	Check the deviation of the train position respect to the Ground Truth
Assumptions	No Augmentation system is present.
Precondition	No failures from wayside are foreseen
Flow of events	*1.* Operator check and download in the laboratory environment the system logs. *2.* Operator check and download the Ground Truth in the laboratory environment. 3. Operator introduces perturbation in the IMU data (white noise). 4. Operator Check and download the Dynamic Route information. 5. The Operator start the simulation. 6. The TPC Algorithm elaborates its inputs. 7. Operator check the train Position provide to the laboratory environment.

	8. Operator check the differences between the TPC output and the Ground Truth and evaluate the deviation 9. Operator evaluate the Virtual Balise position respect to the real one present in the ground truth. 10. End of Use Case
Postcondition	The result of the test is stored in the laboratory repository.

8.2.4 Test Case POS 02 03

Test Case Group	*Positioning*
Test Case	Train Positioning Laboratory activities Introduction of Wheel Sensor perturbation Linked to UC_POS_02
TC ID	TC_POS_02_03
Main actor	Laboratory operator
Other actors	GNSS RECEIVER IMU WHEEL SENSORS *TRAIN POSITIONING COMPUTATION (**TPC**)* *DIGITAL MAPS & DYNAMIC ROUTE* *GROUND TRUTH*
Main goal	Check the deviation of the train position respect to the Ground Truth
Assumptions	No Augmentation system is present.
Precondition	No failures from wayside are foreseen
Flow of events	*1.* Operator check and download in the laboratory environment the system logs. *2.* Operator check and download the Ground Truth in the laboratory environment. 3. Operator introduces perturbation in the Wheel Sensor data (white noise). 4. Operator Check and download the Dynamic Route information. 5. The Operator start the simulation. 6. The TPC Algorithm elaborates its inputs. 7. Operator check the train Position provide to the laboratory environment. 8. Operator check the differences between the TPC output and the Ground Truth and evaluate the deviation 9. Operator evaluate the Virtual Balise position respect to the real one present in the ground truth. 10. End of Use Case
Postcondition	The result of the test is stored in the laboratory repository.

8.2.5 Test Case POS 02 04

Test Case Group	*Positioning*
Test Case	Train Positioning Laboratory activities Introduction of GNSS data perturbation Linked to UC_POS_02

TC ID	TC_POS_02_04
Main actor	Laboratory operator
Other actors	GNSS RECEIVER IMU WHEEL SENSORS *TRAIN POSITIONING COMPUTATION (**TPC**)* *DIGITAL MAPS & DYNAMIC ROUTE* *GROUND TRUTH*
Main goal	Check the deviation of the train position respect to the Ground Truth
Assumptions	No Augmentation system is present.
Precondition	No failures from wayside are foreseen
Flow of events	*1.* Operator check and download in the laboratory environment the system logs. *2.* Operator check and download the Ground Truth in the laboratory environment. 3. Operator introduces perturbation in the GNSS receiver data (white noise in the channel). 4. Operator Check and download the Dynamic Route information. 5. The Operator start the simulation. 6. The TPC Algorithm elaborates its inputs. 7. Operator check the train Position provide to the laboratory environment. 8. Operator check the differences between the TPC output and the Ground Truth and evaluate the deviation. 9. Operator evaluate the Virtual Balise position respect to the real one present in the ground truth. 10. End of Use Case
Postcondition	The result of the test is stored in the laboratory repository.

8.2.6 Test Case POS 02 05

Test Case Group	*Positioning*
Test Case	Train Positioning Laboratory activities Introduction of GNSS data perturbation Linked to UC_POS_02
TC ID	TC_POS_02_05
Main actor	Laboratory operator
Other actors	GNSS RECEIVER IMU WHEEL SENSORS *TRAIN POSITIONING COMPUTATION (**TPC**)* *DIGITAL MAPS & DYNAMIC ROUTE* *GROUND TRUTH*
Main goal	Check the deviation of the train position respect to the Ground Truth
Assumptions	No Augmentation system is present.
Precondition	No failures from wayside are foreseen
Flow of events	*1.* Operator check and download in the laboratory environment the system logs.

	2. Operator check and download the Ground Truth in the laboratory environment. 3. Operator introduces perturbation in the GNSS receiver data (temporary lack of signals). 4. Operator Check and download the Dynamic Route information. 5. The Operator start the simulation. 6. The TPC Algorithm elaborates its inputs. 7. Operator check the train Position provide to the laboratory environment. 8. Operator check the differences between the TPC output and the Ground Truth and evaluate the deviation. 9. Operator evaluate the Virtual Balise position respect to the real one present in the ground truth. 10. End of Use Case
Postcondition	The result of the test is stored in the laboratory repository.

8.2.7 Test Case POS 02 06

Test Case Group	*Positioning*
Test Case	Train Positioning Laboratory activities Introduction of GNSS data perturbation signal loss Linked to UC_POS_02
TC ID	TC_POS_02_06
Main actor	Laboratory operator
Other actors	GNSS RECEIVER IMU WHEEL SENSORS *TRAIN POSITIONING COMPUTATION (**TPC**)* *DIGITAL MAPS & DYNAMIC ROUTE* *GROUND TRUTH*
Main goal	Check the deviation of the train position respect to the Ground Truth
Assumptions	No Augmentation system is present.
Precondition	No failures from wayside are foreseen
Flow of events	*11.* Operator check and download in the laboratory environment the system logs. *12.* Operator check and download the Ground Truth in the laboratory environment. 13. Operator introduces perturbation in the GNSS receiver data (signal completely loss). 14. Operator Check and download the Dynamic Route information. 15. The Operator start the simulation. 16. The TPC Algorithm elaborates its inputs. 17. Operator check the train Position provide to the laboratory environment. 18. Operator check the differences between the TPC output and the Ground Truth and evaluate the deviation.

	19. Operator evaluate the Virtual Balise position respect to the real one present in the ground truth. 20. End of Use Case
Postcondition	The result of the test is stored in the laboratory repository.

9 References

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10 Appendix A: Ownership of Results

The following table lists the ownership of contributions for this deliverable.

Ownership of results			
Company	**Percent-age(*)**	**Short Description of share/ of delivered input**	**Concrete Result (where applicable)**
AZD	30%	Description of his own test specification	§7
HSTS	40%	Description of his own test specification and preparation of the deliverable	§6
MERMEC	30%	Description of his own test specification	§7

Table 10-1: Ownership of contributions

The percentage is estimate simply by considering the number of main technical sections filled