

# OCORA

Open CCS On-board Reference Architecture

## Functional Vehicle Adapter Test Plan (level 2 of the V-Cycle)

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## References

Reader's note: please be aware that the numbers in square brackets, e.g. [1], as per the list of referenced documents below, is used throughout this document to indicate the references to external documents. Wherever a reference to a TSI-CCS SUBSET is used, the SUBSET is referenced directly (e.g. SUBSET-026). OCORA always reference to the latest available official version of the SUBSET, unless indicated differently.

- [1] OCORA-BWS01-010 – Release Notes
- [2] OCORA-BWS01-020 – Glossary
- [3] OCORA-BWS01-030 – Question and Answers
- [4] OCORA-BWS01-040 – Feedback Form
- [5] OCORA-BWS02-030 – Technical Slide Deck
- [6] OCORA-BWS03-010 – Introduction to OCORA
- [7] OCORA-BWS03-020 – Guiding Principles
- [8] OCORA-BWS04-010 – Problem Statements
- [9] OCORA-BWS08-020 – Tooling
- [10] OCORA-BWS08-010 – Methodology
- [11] OCORA-TWS01-011 – System Requirements
- [12] OCORA-TWS01-030 – System Architecture
- [13] OCORA-TWS04-010 – Functional Vehicle Adapter – Introduction
- [14] OCORA-TWS04-011 – Functional Vehicle Adapter – Requirements
- [15] OCORA-TWS04-012 – Functional Vehicle Adapter – Standard Communication Interface Specification
- [16] OCORA-TWS04-013 – Functional Vehicle Adapter – Design Guideline
- [17] OCORA-TWS06-020 – (Cyber-) Security – Guideline
- [18] OCORA-TWS07-010 – Modular Safety – Strategy
- [19] OCORA-TWS07-020 – RAMS\_Evolution-management
- [20] OCORA-TWS09-010 – Testing – Strategy
- [21] OCORA-TWS09-110 – Testing – Functional Vehicle Adapter Integration Plan
- [22] OCORA-TWS09-020 – Testing strategy requirements
- [23] OCORA-TWS09-050 – Cybersecurity testing strategy

# 1 Introduction

## Functional Vehicle Adapter

The Functional Vehicle Adapter (FVA) is a software function deployed on the OCORA computing platform, on a separate computing unit or on the OCORA Gateway. Its job is to provide an OCORA unified and standardized interface towards the CCS applications for vehicle functions and vehicle information needed by the OCORA on-board applications and services.

Although the TSI-CCS SUBSET-034, -119, -139 and -143 are defining the interface to the vehicle (TCMS system), vehicles from different suppliers and especially from different generations have still different interfaces implemented. This adapter allows to map, on a functional level, the commands sent, and the information received from a specific TCMS into the OCORA standard. This includes that the FVA can likewise be used to integrate vehicles through wired connections. The FVA can be seen as a configurable software function that can be adapted through parametrization, to be easily customized to the vehicle.

## Functional Vehicle Adapter (FVA) and Train Adapter (TA)

The FVA SW, in the OCORA Gateway [12], is hosted in the Train Adapter (TA) module that is a physical HW that contains also the I/O interfaces (wired I/O interface) necessary for the communication to other devices.

The system architecture document [11] describes a 'Train Adapter' that is used to integrate the CCS on-board system into a vehicle.

Only the functional vehicle adapter (FVA) is considered in this document. The interfaces of the functional vehicle adapter are [5] : CI-TCMS, CI-WIOC, SCI-FVA,SCI-MDCM and SCI-VL.

The principal scope of the FVA is to provide the main conversion logic between vehicle (TCMS) and CCS on-board.

This document is published as part of the OCORA Release R3, together with the documents listed in the Release Notes [1] . Before reading this document, it is recommended to read the Release Notes [1]. The reader should also be aware of the Glossary [2] and the Question and Answers [3]

For further understanding of the context and the motivation of OCORA the Introduction to OCORA [6] and the Problem Statements [8] are available.

A FVA test plan will be provided by each FVA supplier.

The aim of this document is to provide a template of FVA test plan document to ensure an harmonization of that OCORA will get all the requested information from any supplier at this project stage.

OCORA will provide to the supplier the list of requirements that need to be checked by a test at this test level.

In the test report, the link between the requirement and the test will be detailed, for traceability.

## 1.1 Purpose of the document

The purpose of this document is to describe how the SW product "Functional Vehicle Adapter" (FVA), as standard module of the OCORA architecture, shall be tested.

For the scope of this document the same consideration related to the testing is valid for any type of appropriate HW hosting the FVA SW. The Test Plan will consider all the physical and software interfaces of the FVA as well as the tests to be performed on those: despite the functioning of the physical interface towards the vehicle are not part of this test verification, the capability of the FVA SW to properly address the interface is instead to be verified.

This document aims to be a requirement reference for the FVA SW suppliers for

- All SW components that are part of the FVA solution and are tested together
- FVA SW tests in the TA HW hosting the solution (OCORA standard or eventually alternative)

## 1.2 Applicability of the document

The document is currently considered informative but may become a standard at a later stage for OCORA compliant on-board CCS solutions. Subsequent releases of this document will be developed based on a modular and iterative approach, evolving within the progress of the OCORA collaboration.

## 1.3 Context of the document

This document is part of OCORA Testing Strategy [20]. The current scope is to address, for each main building block of the OCORA architecture, a separated Integration and Test plan where integration and testing, either in factory or on site, are managed as depicted on the sketch below.

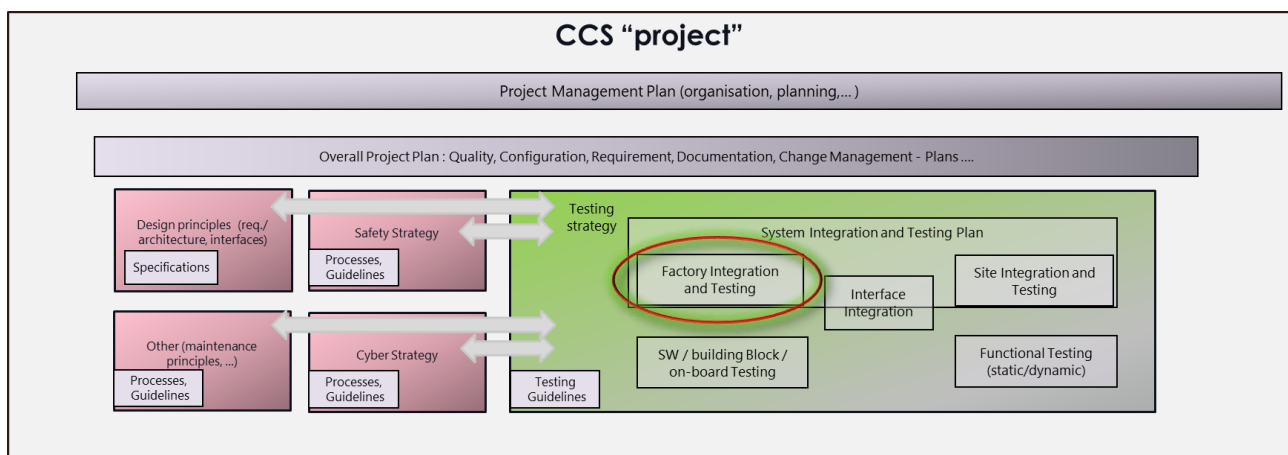


Figure 1: Sketch CCS Project

## 2 System definition

The following picture shows the context of the FVA SW when included in the OCORA Gateway.

The I/O wired resources are included in an HW solution here named TA (Train Adapter).

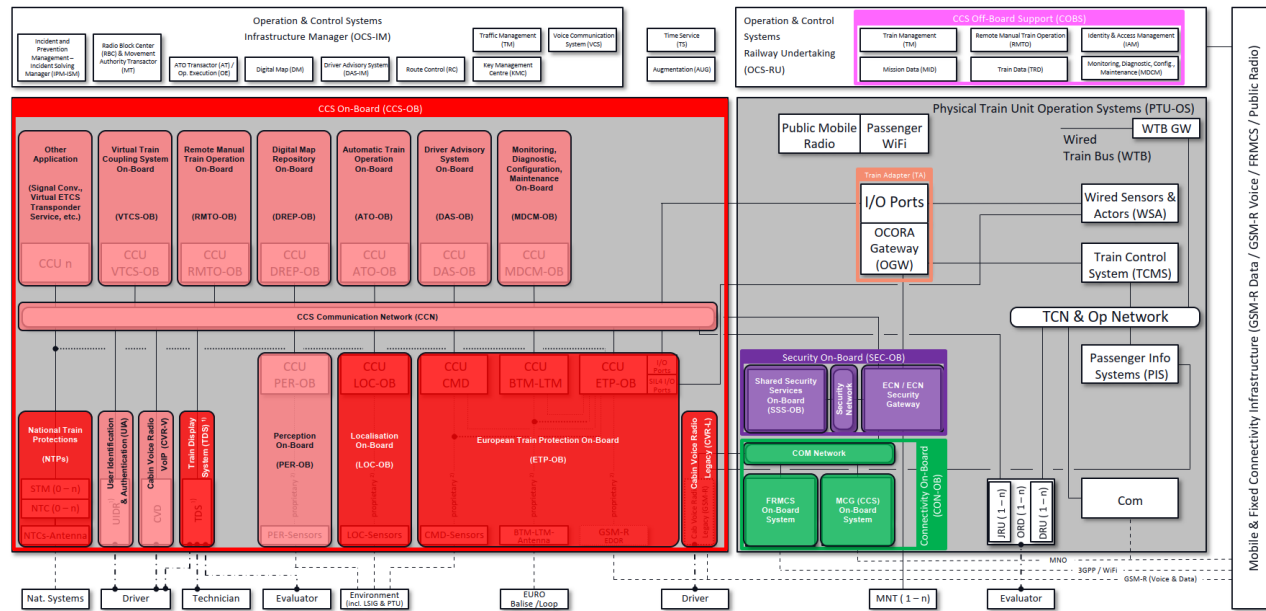


Figure 2: OCORA standard architecture

### 2.1 Train Adapter (TA): Actual and target OCORA scenarios

As the overall OCORA ecosystem is under development, we may have along the coming years different scenario to be considered for the testing of the FVA functionalities.

An incremental deployment of the FVA SW features inside the Hosting HW (TA) will likely go through the following situations:

- FVA functions embedded in the ETCS  
TA HW implemented into the ETCS solution
- FVA functions deployed with an own HW solution  
TA HW implemented in the own FVA HW supplier solution
- FVA functions deployed as a SW to be integrated in external devices  
TA HW target requirements defined
- FVA functions deployed as a SW to be integrated in the OCORA gateway or OCORA computing platform or separate computing unit  
TA as part of the OCORA standard solution

## 2.2 FVA environment

The following figure provides the context diagram of the FVA for the initial stage of the OCORA architecture:

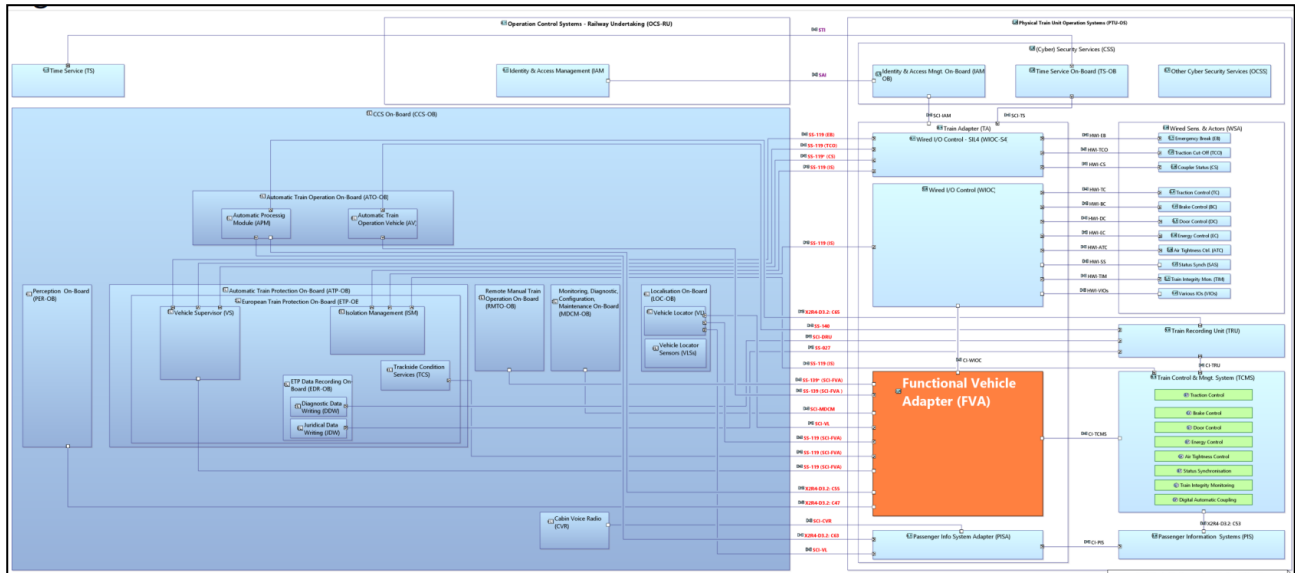


Figure 3: FVA Functional interfaces [5]

Based on this, the Functional Vehicle Adapter, as described in this version of the document:

- provides and integrates one interface “SS-119 (SCI-FVA)” with three components of the “ETCS on-board” application (“Vehicle Supervisor (VS)”, “Trackside Condition Services (TCS)” and “Vehicle Locator (VL)” ),
- provides and integrates one interface “SCI-MDCM” with the “Monitoring, Diagnostic, Configuration, Maintenance On-Board (MDCM-OB)” component

The Functional Vehicle Adapter also integrates the “SS-139 (SCI-FVA)” interface provided by the “ATO Vehicle (AV)” component.

At this stage of the document, interfaces are restricted for ATO GoA 1/2, therefore the following interfaces displayed in the diagram, which are only relevant in the context of Automatic Train Operation On-Board (ATO-OB) with GoA 3 & 4, are not referenced here:

- SS 139\* (SCI-FVA) with the “Remote Manual Train Operation On-Board (RMTO-OB)” component
- X2R4-D3.2: C55 interface with the “Automatic Processing Module (APM)” component
- X2R4-D3.2: C47 interface with the “Perception On-Board (PER-OB)” component ‘



### 3 Functional Vehicle Adapter Testing Strategy

The subsystems or components are specified or designed according to the top-down principle and tested according to the bottom-up principle [20]. During the integration activities, subsystems or components are assembled and installed to form an integrated system of higher level. Tested software components are to be combined step by step and systematically into larger units or with their target hardware and tested as a composite in each case. Finally, the embedded system is to be tested into its target environment at common interfaces.

Testing activities shall demonstrate that these subsystems or components work as specified in the (functional, performance...) specifications to perform their intended function.

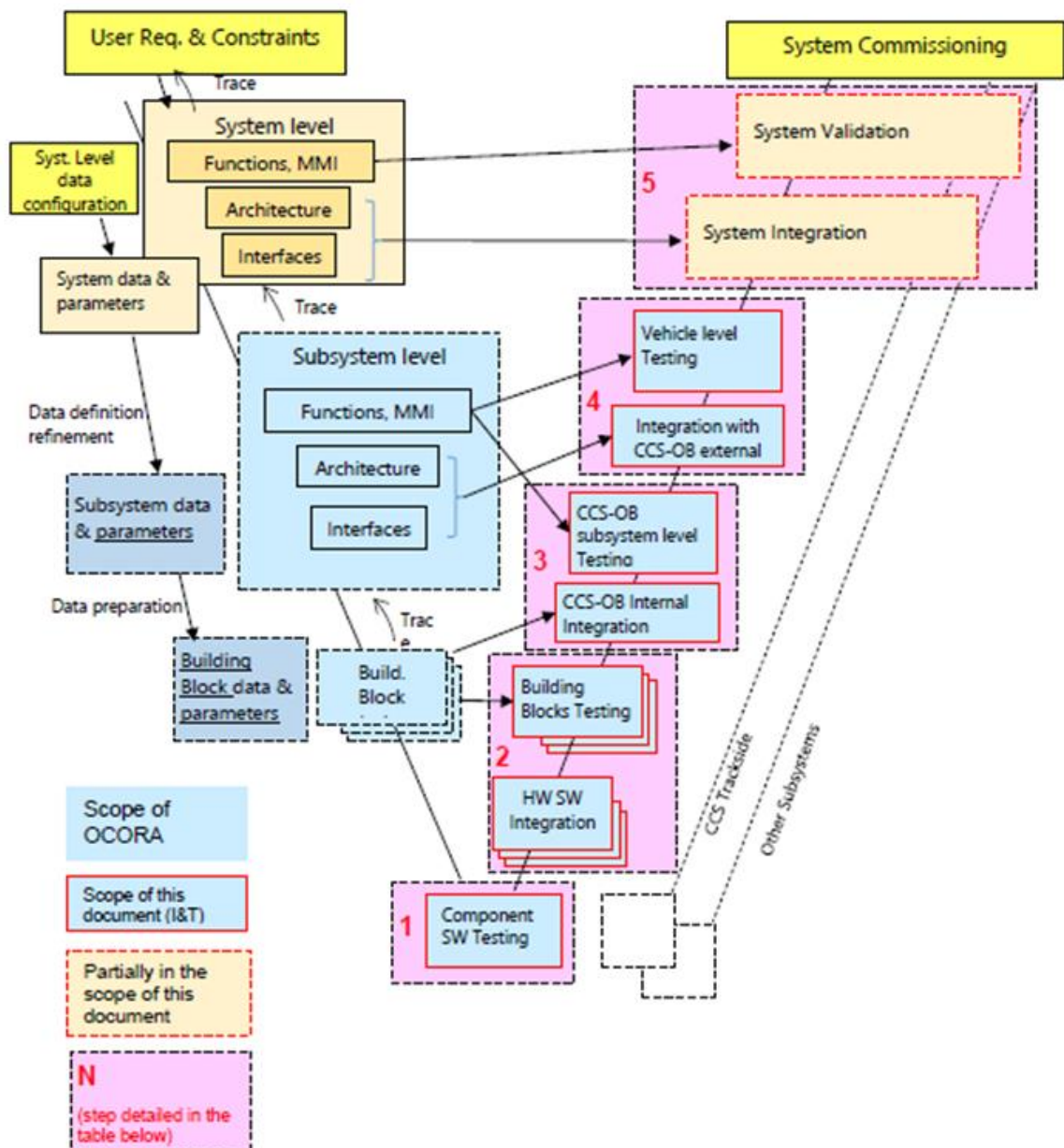


Figure 4: V cycle

### 3.1 Scope of Testing

Functional Vehicle Adapter (FVA) Test Plan and corresponding tests are intended here as level of testing where the FVA, seen as a software component, is tested as a sub-system in the OCORA platform. The purpose of this level of test is to expose faults in the behaviour of the FVA itself.

Tests are especially important in systems like OCORA whose software may have changing requirements, and new patches of code could be developed and deployed during the life cycle. When these patches are grouped together to form one software, this type of testing shall be executed.

Integration of the FVA is managed via an integration plan (21) describing the scope, approach, resources, and schedule of intended integration activities.

Tests on the FVA are managed via a Test Plan (this document) that describes the test strategy, objectives, schedule, estimation, deliverables, and resources.

The Test Plan serves also as a blueprint to conduct testing activities as a defined process, which will be monitored and controlled by the test manager.

The scope of the Test Plan (this document) focusses on the level 2 of the V cycle [20] for the Integration and Test activities sequencing. The target is the testing of the FVA Software in its hosting Hardware

| Level  | Activity     | Scope  | Documentation                                       | Factory /Site | Responsible                         |
|--|--------------|--|---|---------------|-------------------------------------|
| 2<br>OCORA<br>Functional<br>Vehicle<br>Adapter<br>Block<br>level | –<br>Testing | Functional Vehicle Adapter Blocks are tested individually (Verification and Validation). | OCORA<br>Functional<br>Vehicle Adapter<br>Test Plan | Factory       | Functional Vehicle Adapter supplier |

Table 1: Testing steps [20]

Note: At level 2, generic interfaces [refer to 4.7] will be tested and the validation of the specific interface according to configuration of the FVA will be completed later during the integration in the vehicle (level 4 as defined in the testing guideline document). This activity will be then defined in other documents, like Site CCS-OB Integration and Test Plans.

## 4 Testing steps

This chapter further specifies the test steps and identifies the corresponding activities, roles and responsibilities, applicable means, and tools as well as the required deliverables.

Testing activities are to be organized following subsequent steps:

1. Define the Test Objectives
2. Support resource planning (optional and recommended step)
3. Define Test Environment (means and tools)
4. Support schedule and estimation
5. Identify Test Deliverables
6. Define Test Cases and Test Criteria
7. Execute tests
8. Report tests results

### 4.1 Step 1: Define the Test Objectives

|                                   |  |
|-----------------------------------|--|
| <b>Activities</b>                 | <p>Tests objectives should target the correctness of the implemented functions and properties where possible errors should be detected. For this purpose, test cases are to be defined in such a way that as many errors as possible can be found and tests can be carried out as efficiently as possible</p> <p>It shall be checked, through exhaustive tests, as described in detail in the Testing guideline [20], that FVA Blocks are working correctly at this early stage, even if the complete correct behaviour can only be checked in the next testing levels (especially at level 4 – Vehicle level).</p> <p>It is feasible and recommended to cover this activity by equivalent measures during requirement engineering and management.</p> |
| <b>Roles and responsibilities</b> | <p>FVA supplier<br/>The FVA supplier is responsible for the moderation of the activities and shall lead the analysis, as well as produce the deliverables mentioned below.</p> <p>Train Adapter (TA) supplier<br/>The TA supplier shall closely work together with the FVA supplier to identify and define the relevant content.</p> <p>ETCS/ATO on-board supplier<br/>The ETCS/ATO on-board supplier provides support to the analysis, as required, and not already covered by requirement engineering and management.</p>  |
| <b>Means and tools</b>            | <p>Requirement management tool – highly recommended</p> <p>Document management tool – highly recommended</p>   |
| <b>Deliverables</b>               | <p>FVA supplier</p> <p>Subset of requirements for testing</p>  |

### 4.2

## 4.3 Step 2: Support Resource Planning (optional and recommended step)

|                                   |  |
|-----------------------------------|--|
| <b>Activities</b>                 | Define the project team members (testing) to make sure resources and responsibility are properly allocated along the project execution.  |
|                                   | Main operative role to be considered are the following:  |
| <b>Roles and responsibilities</b> | <b>Test Manager</b><br>Manage the whole testing activities within the project; Define the testing project directions; Assure appropriate direct and indirect resources needed for the project execution    |
|                                   | <b>Tester</b><br>Identifying and describing appropriate test techniques/tools/automation architecture/test cases; Verify and assess the Test Approach; Execute the tests, Log results, Report the defects. |
|                                   | <b>Developer in Test</b><br>Implement the test cases, test program, test suite etc.<br>Describe manual test procedures<br>.....  |
|                                   | <b>Test Administrator</b><br>Builds up and ensures Test Environment and assets are managed and maintained. Support Tester to use the test environment for test execution.                                  |
|                                   | <b>SQA member</b><br>In charge of quality assurance Check to confirm whether the testing process is meeting specified requirements   |
| <b>Means and tools</b>            | Testing tool to automate the testing, simulate the user operation, generate the test results   |
| <b>Deliverables</b>               | Budget allocation for the testing phase: people and resources:   |
|                                   | Planning and definition of the team members by name (unambiguously).   |
|                                   | Budget allocation of the main technical resources (computers, etc.) making sure that these will be dedicated and available during the testing phase  |

## 4.4 Step 3: Define test environment (means and tools)

|                                   |   |
|-----------------------------------|---|
| <b>Activities</b>                 | Define the environment for FVA testing<br>Detail list and design of the hardware and software to be used during the testing at this level, to assure and verify the (correct) function of FVA functionalities   |
|                                   | Define, if needed, an appropriate set of configurations for the test environment<br>Deliver proof that the tests are applicable for any other possible allowed configuration or alternatively develop a concept for detecting any possible configuration faults.<br><i>Alternatively, the tests can be performed for each possible configuration.</i> |
| <b>Roles and responsibilities</b> | <b>FVA supplier</b><br>The FVA supplier shall lead these activities in close consultation with the TA supplier and the ETCS supplier.<br>The FVA supplier shall as well ensure to have a reproducible test environment (official tool version, tool configuration management to manage)   |
|                                   | <b>Train Adapter supplier</b><br>The TA supplier shall participate in selecting an appropriate test environment and defining the means and tools to be used   |

|                        |  |
|------------------------|--|
|                        | <p>ETCS/ATO on-board supplier</p> <p>The ETCS/ATO on-board supplier shall participate in selecting an appropriate test environment and defining the means and tools to be used</p> <p>It has also to parametrize / configure the ETCS/ATO on-board according to the two specifications: 1. Definition of functions as specified by the vehicle owner / RU; 2. Definition of the interface between CCS on-board and the RST (according to SS-119 hard-wired or serial connections are valid).</p> |
| <b>Means and tools</b> | <p>Simulation – highly recommended</p> <p>A proper simulation environment needs to be defined for the test execution</p>   |
|                        | <p>Automated test execution – highly recommended</p> <p>Capability to run tests with a proper level of automation (for example for regression test)</p>  |
| <b>Deliverables</b>    | <p>Set of documents defining and describing the test environment.</p> <p>.....</p>   |

## 4.5 Step 4: Support schedule and estimation

|                                   |   |
|-----------------------------------|---|
| <b>Activities</b>                 | Break out the testing activities into smaller tasks adding the planning and the estimation for the more relevant set of activities to be allocated by responsibility, time schedule and forecasted effort   |
| <b>Roles and responsibilities</b> | <p>FVA supplier</p> <p>The FVA supplier shall lead these activities in close consultation with the TA supplier and the ETCS/ATO on-board supplier.</p>  |
| <b>Means and tools</b>            | Project planning tools  |
| <b>Deliverables</b>               | <p>Test Plan schedule and resources allocation containing at minimum the following headlines:</p> <ul style="list-style-type: none"> <li>• Creation of the test specification</li> <li>• Execution of the specified Tests</li> <li>• Creation of the Test Reports</li> <li>• Completion of the Test Delivery milestones</li> <li>• ...</li> </ul> |

## 4.6 Step 5: Identify Test Deliverables

|                                   |   |
|-----------------------------------|---|
| <b>Activities</b>                 | Test Deliverables is the list of all the documents, tools and other components that have to be developed and maintained in support of the testing activity.   |
| <b>Roles and responsibilities</b> | <p>FVA supplier</p> <p>The FVA supplier shall lead these activities in close consultation with the TA supplier and the ETCS supplier.</p>   |
| <b>Means and tools</b>            | Documentation to be delivered in the agreed project milestone   |
| <b>Deliverables</b>               | Test deliverables to be provided before testing phase:  |
|                                   | <ul style="list-style-type: none"> <li>• Test Plans document.</li> <li>• Test Cases documents</li> <li>• Test design specifications.</li> <li>• .....</li> </ul>  |
|                                   | Test deliverables to be provided during the testing:  |
|                                   | <ul style="list-style-type: none"> <li>• Test Scripts</li> <li>• Simulators.</li> <li>• Test Data</li> <li>• Test Traceability Matrix</li> <li>• Error logs and execution logs.</li> <li>• .....</li> </ul> |
|                                   | Test deliverables to be provided after the testing cycles are over:   |

|  |   |
|--|---|
|  | <ul style="list-style-type: none"> <li>• Test Results/reports</li> <li>• Defect Report</li> <li>• Installation/ Test procedures guidelines</li> <li>• Release notes</li> <li>• .....</li> </ul> |
|  | <ul style="list-style-type: none"> <li>•</li> </ul>   |

## 4.7 Step 6 Define Test Cases and Test Criteria

|                                   |   |
|-----------------------------------|---|
| <b>Activities</b>                 | <p>Suspension criteria and Exit criteria are to be defined for each test prior to their execution.</p> <p>Suspension criteria:<br/>If the suspension criteria are met during testing, the active test cycle will be suspended until the criteria are resolved.</p> <p>Exit criteria<br/>The exit criteria positive results of the test are necessary before proceeding to the next phase of development</p>   |
| <b>Roles and responsibilities</b> | <p>FVA supplier</p> <p>The FVA supplier is responsible for the definition of the Test Criteria</p>  |
| <b>Means and tools</b>            | <p>Requirement management tool – highly recommended</p> <p>Document management tool – highly recommended</p>  |
| <b>Deliverables</b>               | <p>Test criteria for each test case</p> <p>Other specific activities to be considered for the test cases</p> <ul style="list-style-type: none"> <li>• Description and rational of the selected means and tools to be used to specify test cases, which verify the correct realization of the FVA functions</li> <li>• Specific (among the test cases specified above) test cases, which specifically prove the correct implementation according to SUBSET-119 and SUBSET-139. For the moment, there is no test cases in SUBSET-119 and SUBSET-139 so they have to be defined as a deliverable of this step.</li> <li>• Interaction with the OCORA API (under definition) or equivalent capability to configure an I/O port, capability to configure a specific signal in compliance with the standard configuration.</li> <li>• Test of the interfaces to TCMS, ETCS and ATO (HW input and output).</li> <li>• Test of the serial I/O</li> <li>• HW tests cases : If the supplier uses an “universal” TA HW, it can rely on a validation already performed in the past. If the supplier uses a specific TA HW, it has to validate it : electrical/mechanical adaptation</li> </ul> <p>....</p> <p>Non-functional tests</p> <ul style="list-style-type: none"> <li>• Non-functional (e.g., Performance tests, Maintainability tests, Environmental (climate, EMC) tests, Load tests, Stress tests, Endurance tests) to verify the correct function of the test object during expected and specified conditions.</li> </ul> <p>....</p> <p>Regression tests</p> <p>...</p> <p>User tests</p> <ul style="list-style-type: none"> <li>• Optional Test cases to be performed by the end users under real-life conditions, which in this case refers to operational scenarios. These should be identified in close consultation with the ETCS/ATO supplier.</li> </ul> <p>....</p> <p>Cybersecurity tests</p> |

|  |  |
|--|--|
|  | <ul style="list-style-type: none"> <li>• Tests cases covering the risk of cyber-attacks</li> <li>• A security software testing that intends to uncover vulnerabilities of the system and determine that its data and resources are protected from possible intruders</li> <li>...</li> </ul> |
|  | Subset of requirements for testing   |

## 4.8 Step 7: Execute tests

|                                   |   |
|-----------------------------------|---|
| <b>Activities</b>                 | Prepare test execution environment including test data and test scripts<br>Apply test cases in line with the Test specification<br>Fill and sign the test report check list for the corresponding test case.<br>Execute tests taking notes of the results on the corresponding documentation for the specific test case.  |
| <b>Roles and responsibilities</b> | FVA supplier<br>Responsible for the preparation of the test environment, staff enrollment and test execution. Involvement of the TA supplier, ETCS/ATO on-board supplier<br>Train Adapter supplier<br>Involvement in the test environment preparation (TA HW) and support for the test execution.<br>ETCS/ATO on-board supplier<br>Provide information as needed. |
| <b>Means and tools</b>            | Test environment<br>Qualified staff for the test execution<br>Test specification and test protocol template<br>Automated test execution   |
| <b>Deliverables</b>               | Test protocols  |

## 4.9 Step 8: Report tests results

|                                   |  |
|-----------------------------------|--|
| <b>Activities</b>                 | Report results (OK / NOK)  |
|                                   | Criteria used to determine whether each test item has passed, or failed testing (use criteria defined in Step 6) shall be clearly specified before the execution of the tests  |
|                                   | (if applicable) Deal with non-compliance<br>Define courses of action for all negative test results.  |
|                                   | (if applicable) correct test specification   |
|                                   | (if applicable) Deal with open points<br>Pass open points to later testing stages, in coordination with the responsible stakeholder for these later activities.  |
| <b>Roles and responsibilities</b> | FVA supplier<br>The FVA supplier is responsible for the delivery of the test report documentation.<br>Train Adapter supplier<br>The TA supplier takes an active role in cooperation with the FVA supplier in reviewing the test report<br>ETCS/ATO on-board supplier<br>The ETCS/ATO on-board supplier provides information as needed. |
| <b>Means and tools</b>            | Check list - recommended   |
|                                   | Test report template   |
|                                   | Dataset used for the test execution (as applicable)  |



|                     |   |
|---------------------|---|
| <b>Deliverables</b> | <p>Test Report: document that contains the results of the different tests and the analysis result (this step)</p> <p>Test Data : data used in test execution (attachment to test report)</p> <p>Defect Reports : document that identifies and describes a defect detected by a tester (can be part of test report)</p> <p>Correction of the test specification (if applicable) with an updated document version</p> |
|---------------------|---|



## 5 Evolution Management

The FVA SW supplier shall produce an impact assessment with each new SW version deployment, regarding the compatibility to the current system versions and, in general, follows the principle described in the OCORA-TWS07-020\_RAMSEvolution-management [19].