OCORA

Open CCS On-board Reference Architecture

Train Adapter Block Integration Plan

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Revision history

Version	Change Description	Initial	Date of change
0.01	First issue for comment	EdP LS	29.03.2022
0.02	Revision before detail comment. Integration of pending parts. Introduction, tests scope, use cases.	EdP LS	19.04.2022
1.00	Reorganization of the document. Changes from different feedback received.	EDP BJ LA CG ML	07.06.2022

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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-BWS03-010 – Introduction to OCORA

[5] OCORA-BWS04-010 – Problem Statements

[6] OCORA-TWS01-011 – System Requirements

[7] OCORA-TWS01-030 – System Architecture

[8] OCORA-TWS09-010 – 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, in order to be easily customized to the vehicle.

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

The FVA SW, in the OCORA Gateway, 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 [7] 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 CI-TCMS, CI-WIOC, SCI-FVA and SCI-VL. [Figure 3 (FVA) context diagram – Initial Stage]

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, 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 [4] and the Problem Statements [5] are available.

1.1 Context of the document

This document is part of OCORA Testing Strategy [8] where the scope is to address, for each main building block of the OCORA architecture, a separate integration plan where integration and testing, either in factory or on site, are managed as depicted on the sketch below.

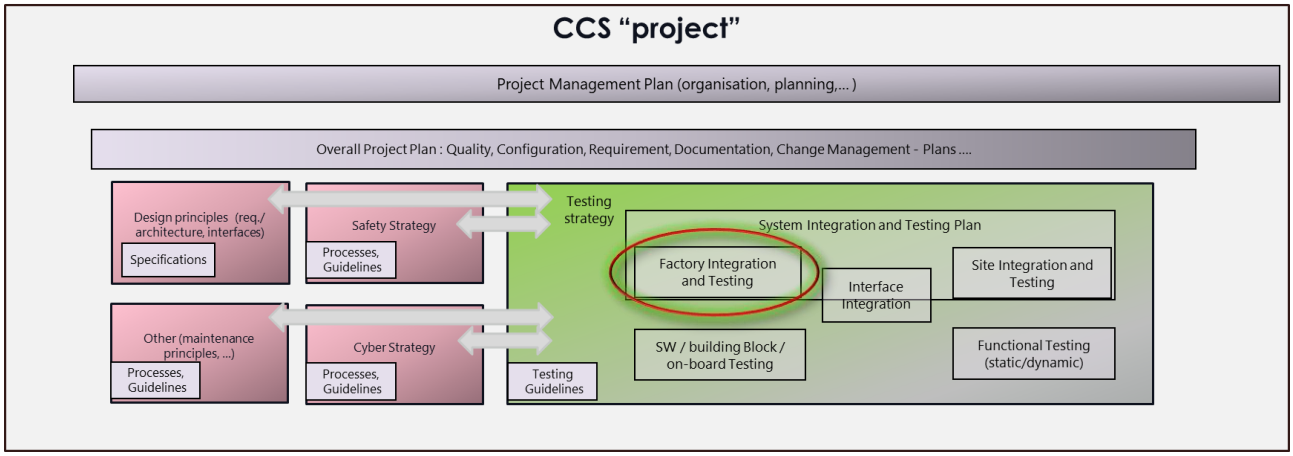

Figure 1 CCS "project"

1.2 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 integrated.

For the scope of this document the same consideration related to the integration are valid for any type of appropriate HW hosting the FVA SW. The Integration Plan will consider all the physical 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 integration 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 integrated together
- FVA SW integration in the TA HW hosting the solution (OCORA standard or eventually alternative)

1.3 Applicability of the document

The document is currently considered informative but may become mandatory 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.

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)

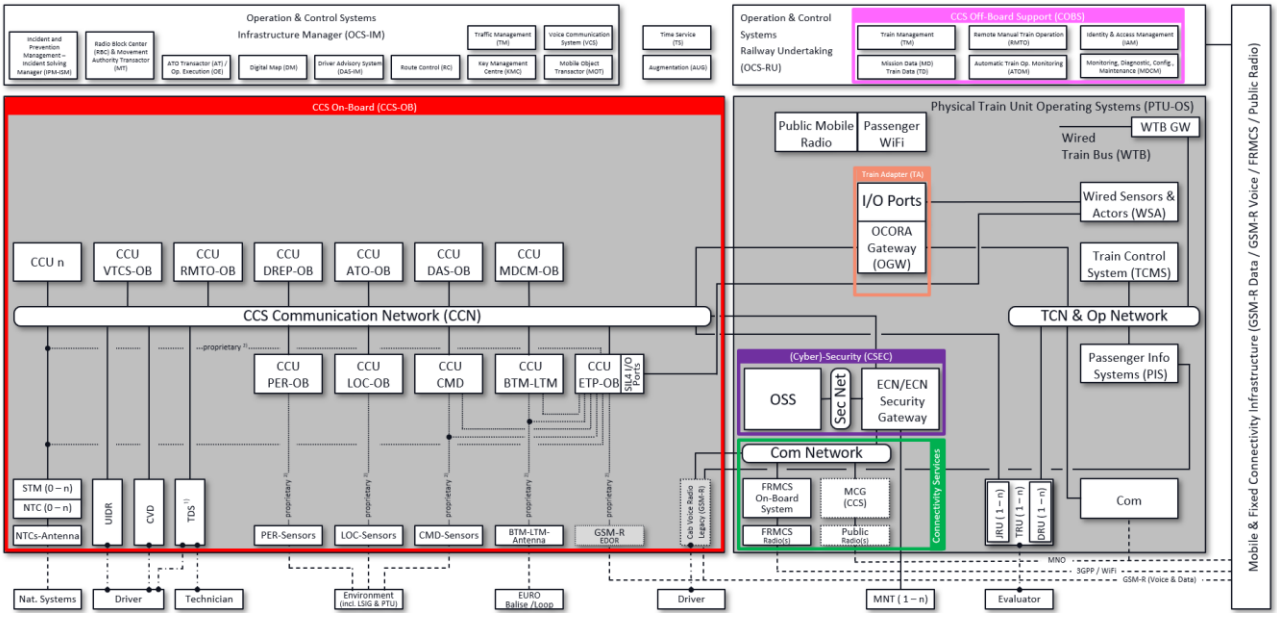

Figure 2 OCORA standard architecture

2.1 Train Adapter (TA): Current 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 integration of the FVA functionalities.

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

a) FVA functions integrated in the ETCS
   - TA HW implemented into the ETCS solution

b) FVA functions deployed with an own HW solution
   - TA HW implemented in the supplier solution

c) FVA functions deployed as a SW to be integrated in external devices
   - TA HW target requirement defined

d) FVA features 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:

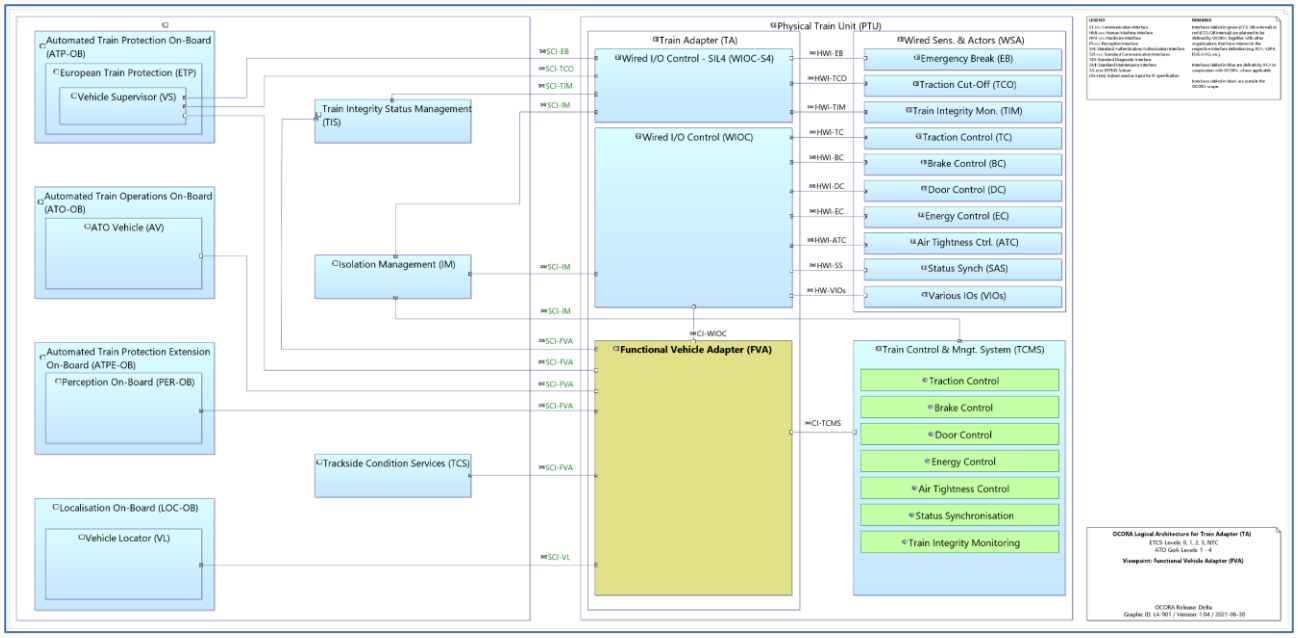

Figure 3 (FVA) context diagram – Initial Stage

Based on this, the Functional Vehicle Adapter as described in this version of the document, provides a Standard Communication Interface (SCI) “SCI-FVA” and integrates one interface “SCI-VL” to the “ETCS on-board” application that in the context diagram is displayed with the four components “Vehicle Supervisor (VS)”, “Train Integrity Status Management (TIS)”, “Trackside Condition Services (TCS)” and “Vehicle Locator (VL)”.

The Functional Vehicle Adapter also provides the “SCI-FVA” interface to the ‘ATO Vehicle’ (AV) application.

3 Functional Vehicle Adapter Integration Strategy

The subsystems or components are specified or designed according to the top-down principle and integrated according to the bottom-up principle [8]. 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 integrated into its target environment at common interfaces. Integration activities shall demonstrate that these subsystems or components work correctly together as defined by the interfaces: they interact correctly as specified in the interface specifications to perform their intended function.

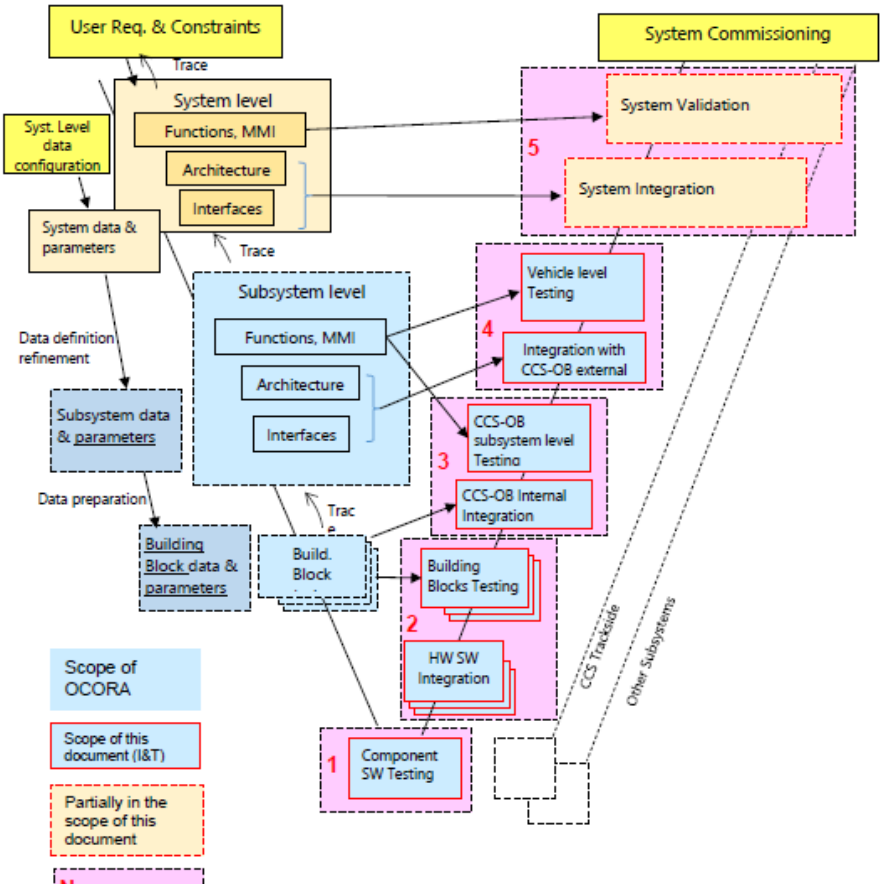

Figure 4 V cycle

3.1 Scope of integration (and testing)

Functional Vehicle Adapter (FVA) Integration plan and corresponding integration tests are intended here as level of testing where the FVA, seen as a software component, is combined and tested as a sub-system in the

OCORA platform. The purpose of this level of integration is to expose faults in the interaction between the integrated units and to ensures effective functioning across modules when combined.

Integration is 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.

One of the most important reasons to conduct integration tests is to create critical user-based scenarios and make sure they function correctly. Individual components of the software will need to communicate properly when grouped, adapting and responding to multiple possible results.

Integration also verifies that groups of modules or units of coding interact properly with Application Programming Interface (API). This lays the foundation for acceptance testing toward the end of the project, ensuring a user-friendly end product. If the FVA is planned to be deployed on the OCORA Safe Computing Platform, it shall be checked its compliance to it.

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

According to the content of the Building Block Integration Plan described in the Testing guideline [8] the Integration Plan document shall:

Define integration process (steps identification) for the FVA.

- Identify activities for each step.
- Identify roles and responsibilities for each step.
- Identify means and tools for each step.
- Identify deliverables for each step (e.g., Integration Report).

The integration plan shall identify, for the integration activities that require a part of Testing, the test items, the features to be tested, the testing tasks, who will do each task, degree of tester independence, the test environment, the test design techniques and entry and exit criteria to be used.

The scope of the Integration plan focusses on the level 2 of the Integration and Test activity sequencing. The target is the integration of the FVA Software inside its hosting Hardware.

Level	Activity	Scope	Documentation	Factory /Site	Responsible
2 – OCORA Functional Vehicle Adapter Block level	Integration	SW of the n Component(s) that are part of one same Train Adapter Block are integrated together. Integration with one or several HW is also performed at this step.	OCORA Functional Vehicle Adapter Integration Plan	Factory	Functional Vehicle Adapter supplier

Table 1 Integration steps

Integration tests will consist of:

1. Integration of the FVA SW with TA hosting hardware
2. Integration of the FVA SW and its configurations capabilities
3. Integration of the FVA SW with the standard OCORA ETCS/ATO interface

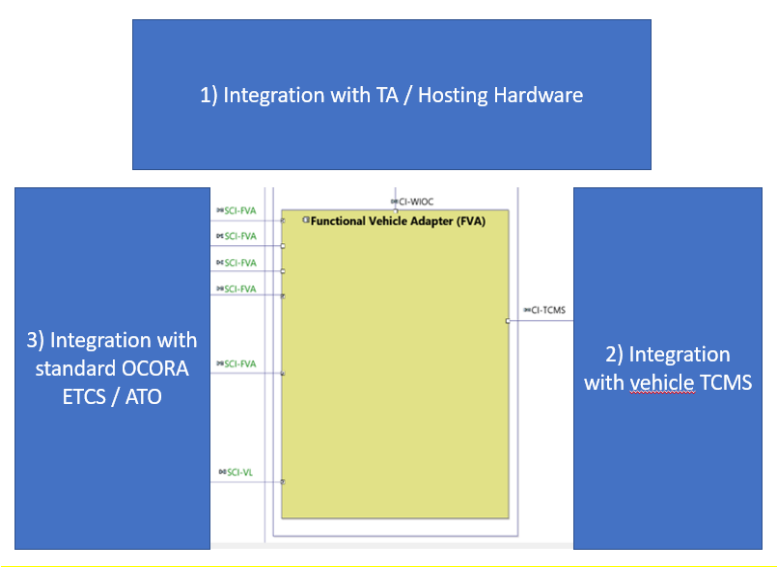

Figure 5 Integration scope

And more detailed:

Integration of the FVA SW with TA hosting hardware

FVA SW prerequisites and documentation

- The FVA SW is completed including its configuration capabilities
- All needed tests foreseen by the supplier have been successfully executed and are properly documented.

FVA SW download and checks

- Download of the SW according to a clearly defined procedure in its target HW, including a procedure for the verification of the correctness (SW version, LEDs indications, diagnostic messages, etc.)
- Procedure to be executed in case of first verification
- Procedure to be executed in case of changes / regression tests
- Verification of the correct integration

FVA interaction with the TA hosting HW

- The interaction with the TA hosting HW (capability to configure an I/O ports, capability to configure a specific signal …) will be tested by means of the application of standard configuration and verification of the expected results (detail test case to be developed).

Integration of the FVA with the TCMS interface

FVA SW static tests

- Test of the interfaces: Serial inputs and outputs
    - The different inputs expected by the FVA from the TCMS will be forced statically (serial bus) on the vehicle side and verified in the FVA if these variables are received correctly. Results are documented.
    - The different outputs from the FVA to the TCMS will be forced statically (serial bus) on the FVA side and verified on the vehicle side if these variables are sent correctly. Results are documented.
- Test of the interfaces: HW I/O inputs and outputs
    - The different inputs expected by the FVA from the TCMS will be forced statically (hardwired HW) on the vehicle side and verified in the FVA if these signals are received correctly. Results are documented.
    - The different outputs from the FVA to the vehicle will be forced statically (hardwired HW) on the FVA side and verified on the vehicle side if these signals are sent correctly. Results are documented.
    - The different functions (logic between inputs and outputs) possibly implemented in the FVA will have to be verified to prove the correct computation. Results are documented.

Integration of the FVA with the standard OCORA interface

- Test of the standard OCORA interface: Serial inputs and outputs
    - The different inputs expected by the ETCS on-board from the FVA will be forced statically (serial bus) on the FVA and verified in the ETCS on-board if these variables are received correctly.
    - The different outputs from the ETCS on-board to the FVA will be forced statically (serial bus) on the ETCS on-board and verified in the FVA if these variables are received correctly. Results are documented.
    - The different inputs expected by the ATO on-board from the FVA will be forced statically (serial bus) on the FVA and verified in the ETCS on-board if these variables are received correctly.
    - The different outputs from the ATO on-board to the FVA will be forced statically (serial bus) on ATO on-board and verified in the FVA if these variables are received correctly. Results are documented.
- Test of the HW I/O input and output (in case are used, not defined in the OCORA solution)
    - The different inputs expected from the ETCS will be forced statically (HW) and the expected output will be verified and documented.
    - The different input expected from the ATO will be forced statically (HW) and the expected output will be verified and documented.

3.2 Steps of the main activities

Main activities are to be organized following subsequent steps:

1. Identify requirements, which are relevant for integration
2. Define test environment (incl. means, see further below)
3. Specify test cases
4. Execute tests (incl. preparation)
5. Analyze results + how to deal with non-compliance / if applicable, correct test specification

4 Integration steps

This chapter further specifies the steps (as defined in chapter 3.2) and identifies the corresponding activities, roles and responsibilities, applicable means, and tools as well as the required deliverables.

4.1 Step 1: Identify requirements

Activities	Check specification(s) Analyze existing specifications concerning the FVA and identify the requirements, which are relevant for integration the FVA with its immediate environment. *It is feasible and recommended to cover this activity by equivalent measures during requirement engineering and management.*
Roles and responsibilities	FVA supplier The FVA supplier is responsible for the moderation of the activities and shall lead the analysis, as well as produce the deliverables mentioned below.
	Train Adapter (TA) supplier The TA supplier shall closely work together with the FVA supplier to identify and define the relevant content.
	ETCS/ATO on-board supplier The ETCS/ATO on-board supplier delivers the preceding requirements on system / subsystem level and provides support to the analysis, as required, and not already covered by requirement engineering and management.
Means and tools	Requirement management tool – highly recommended
	Document management tool – highly recommended
Deliverables	Subset of requirements for integration

4.2 Step 2: Define integration environment

Activities	Define the environment for FVA integration Define the hardware and software to be used during the integration at this level, to ensure and verify the (basic) function of FVA in its system context (as defined in chapter 2.2).
	Define an appropriate configuration for the integration (e.g. default configuration) Deliver proof that the integration activities are applicable for any other possible allowed configuration or alternatively develop a concept for detecting any possible configuration faults.
Roles and responsibilities	FVA supplier The FVA supplier shall lead these activities in close consultation with the TA supplier ant the ETCS supplier.
	Train Adapter supplier The TA supplier shall participate in selecting an appropriate test environment and defining the means and tools to be used – especially concerning the TA interfaces (and relevant functions).
	ETCS/ATO on-board supplier The ETCS/ATO on-board supplier shall participate in selecting an appropriate test environment and defining the means and tools to be used – especially concerning the ETCS/ATO interfaces (and relevant functions).
Means and tools	Simulation – highly recommended A proper simulation environment needs to be defined for the integration
	Automated test execution - recommended Capability to run tests with a proper level of automation (for example for regression test)
Deliverables	Integration plan (project specific)
	Proof of applicability for other configurations (if applicable)

4.3 Step 3: Specify test cases

Activities	Select test types for integration Analyze the requirements identified in Step 1 and the integration environment defined in Step 2 to select appropriate types of tests – using the means and tools described below.
	Specify test cases for integration Use the selected means and tools to specify test cases, which verify a correct and working integration of the FVA to its environment (as defined in chapter 2.2).
Roles and responsibilities	FVA supplier The FVA supplier is responsible for the moderation of and shall lead the activities in cooperation with the TA supplier, as well as for producing the deliverables mentioned below.
	Train Adapter supplier The TA supplier takes an active role in cooperation with the FVA supplier in defining test means and specifying test cases.
	ETCS/ATO on-board supplier The ETCS/ATO on-board supplier provides information as needed to specify the test cases.
Means and tools	Functional tests – highly recommended Functional tests shall demonstrate the correct and complete fulfillment of the relevant functional requirements and interface specifications. The complete list of the functional test is detailed in the test plan, in the integration plan (this document) is to be foreseen: -The interaction with the TA hosting HW (capability to configure an I/O ports, capability to configure a specific signal …) in compliance with the standard configuration. -Test of the interfaces to TCMS, ETCS and ATO (HW I/O input and output).
Deliverables	Integration specification Test Cases : documented set of procedures which a tester uses to determine whether a system under test satisfies requirements or works correctly Test Scripts : set of instructions that is performed on a system under test to verify that the system performs as expected Test Data: data used in software test execution

4.4 Step 4: Execute integration tests

Activities	Prepare integration environment according to Step 3 Select test case and analyze the integration specification as defined in the Step 3 Coordinate participation of suppliers (see below) and prepare integration environment according to results from step 2, including test data and test scripts. Analyze and be prepared to fill and sign the integration protocol for the corresponding test case. Execute tests taking notes of the results on the corresponding documentation for the specific test case. / Perform all mandatory tests as defined in step 3, as well as the recommended and highly recommended ones selected, with participation of suppliers as needed.
Roles and responsibilities	FVA supplier Responsible for the preparation of the test environment, staff enrollment and test execution. Involvement of the TA supplier, ETCS supplier and OCORA representative.
	Train Adapter supplier Involvement in the test environment preparation (TA HW) and support for the test execution.
	ETCS/ATO on-board supplier Provide information as needed.
Means and tools	Integration environment
	Qualified staff for integration
	integration specification and integration protocol template
	Automated test execution
Deliverables	Integration protocols

4.5 Step 5: Analyse results

Activities	Analyse results (OK / NOK)
	Criteria used to determine whether each test item has passed, or failed integration (including possible suspension or resumption criteria) shall be clearly specified before the integration
	(if applicable) Deal with non-compliance Define courses of action for all negative test results.
	(if applicable) correct integration specification
	(if applicable) Deal with open points Pass open points to later testing or integration stages, in coordination with the responsible stakeholder for these later activities.
Roles and responsibilities	FVA supplier The FVA supplier is responsible for the delivery of the integration report documentation.
	Train Adapter supplier The TA supplier takes an active role in cooperation with the FVA supplier in reviewing the integration report
	ETCS/ATO on-board supplier The ETCS/ATO on-board supplier provides information as needed.
Means and tools	Check list - recommended
	Integration report template
	Dataset used for the integration (as applicable)
Deliverables	Integration Report: document that contains the results of the different tests and the analysis result (this step) Test Data : data used in integration (attachment to integration report) Defect Reports : document that identifies and describes a defect detected by a integrator (can be part of integration report) Correction of the integration specification (if applicable) with an updated document version

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.