

OCORA

Open CCS On-board Reference Architecture

Testing Strategy Requirements

This OCORA work is licensed under the dual licensing Terms EUPL 1.2 (Commission Implementing Decision (EU) 2017/863 of 18 May 2017) and the terms and condition of the Attributions- ShareAlike 3.0 Unported license or its national version (in particular CC-BY-SA 3.0 DE).



Document ID: OCORA-TWS09-011

Version: 1.0

Date: 31.05.2022

Revision History

Version	Change Description	Initials	Date of change
1.0	Official version for OCORA Release R2	JB	31.05.2022

Table of Contents

1	Introduction	5
1.1	Purpose of the document	5
1.2	Applicability of the document	5
1.3	Context of the document	5
1.4	Requirements Engineering Process	6
2	Requirements	7
2.1	Testing Levels	7
2.2	Scope and Capabilities	7
2.3	Actors, Process and Methods	15
2.4	Tools and Environment	25

References

Reader's note: please be aware that the document ids in square brackets, e.g. [OCORA-BWS01-010], as per the list of referenced documents below, are 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.

[\[OCORA-BWS01-010\] – Release Notes](#)

[\[OCORA-BWS01-020\] – Glossary](#)

[\[OCORA-BWS01-030\] – Question and Answers](#)

[\[OCORA-BWS01-040\] – Feedback Form](#)

[\[OCORA-BWS03-010\] - Introduction to OCORA](#)

[\[OCORA-BWS04-010\] - Problem Statements](#)

[\[OCORA-TWS01-030\] – System Architecture](#)

[\[OCORA-TWS05-010\] – Requirements – Management Guideline](#)

[\[OCORA-TWS09-010\] - Testing - Strategy](#)

1 Introduction

1.1 Purpose of the document

The purpose is to gather the high-level requirements that are specified in the Testing - Strategy [\[OCORA-TWS09-010\]](#).

This document is addressed to experts in the CCS domain and to any other person, interested in the OCORA concepts for on-board CCS. The reader is invited to provide feedback to the OCORA collaboration and can, therefore, engage in shaping OCORA. Feedback to this document and to any other OCORA documentation can be given by using the feedback form [\[OCORA-BWS01-040\]](#).

If you are a railway undertaking, you may find useful information to compile tenders for OCORA compliant CCS building blocks, for tendering complete CCS system, or also for CCS replacements, functional upgrades or for life-cycle reasons.

If you are an organisation interested in developing CCS building blocks according to the OCORA standard, information provided in this document can be used as input for your development.

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 published as part of an OCORA Release, together with the documents listed in the release notes [\[OCORA-BWS01-010\]](#). Before reading this document, it is recommended to read the Release Notes [\[OCORA-BWS01-010\]](#). If you are interested in the context and the motivation that drives OCORA we recommend to read the Introduction to OCORA [\[OCORA-BWS03-010\]](#), and the Problem Statements [\[OCORA-BWS04-010\]](#). The reader should also be aware of the Glossary [\[OCORA-BWS01-020\]](#) and the Question and Answers [\[OCORA-BWS01-030\]](#).

1.4 Requirements Engineering Process

This OCORA requirement document is developed, using the Requirements Management Guideline [OCORA-TWS05-010]. The requirements are engineered in a top-down manner:

- As a starting point all **"Stakeholder Requirements"** towards the OCORA initiative (**A-Level requirements**) are captured and formalised.
- In a second step, the **"Program- and Design Requirements"** (**B-Level requirements**) are developed. These requirements define tools, processes, methodologies and design rules to be used within the program and to be considered during the system analysis and the system design/architecture work.
- As a next step, the A- and B-Level requirements are further developed in the MBSE analysis to become **"System Requirements"** (**C-Level requirements**).
- As part of the MBSE architecture work, building blocks are identified taking into account the MBSE analysis (C-Level requirements). All applicable requirements (A-Level, B-Level, and C-Level) are apportioned to the identified building blocks, resulting in **"Building Block Requirements"** (**D-Level requirements**), forming the OCORA tender templates, together with the applicable program & design requirements.

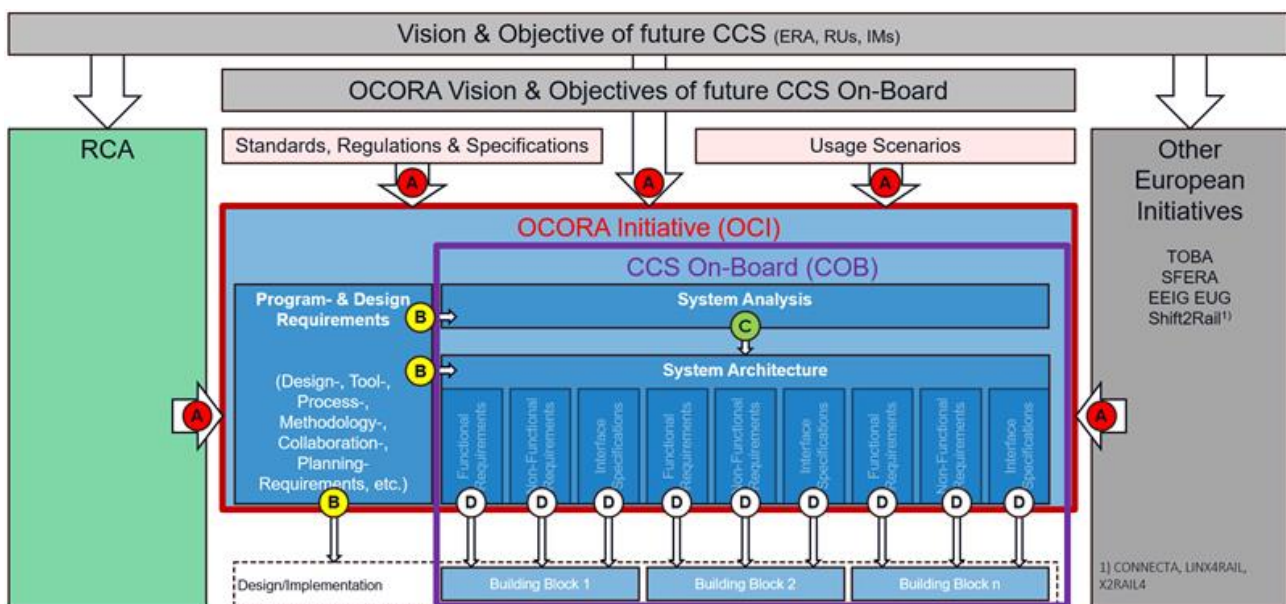


Figure 1 OCORA Requirements Engineering Process

Please note, that the A-Level requirements are applicable to the OCORA Initiative (OCI) while the B- and C-Level requirements are targeted towards the CCS On-Board System (COB) and its architecture. D-Level requirements are applicable to the respective building blocks.

2 Requirements

These requirements have been extracted from the Testing - Strategy [OCORA-TWS09-010].

2.1 Testing Levels

The testing levels used in OCORA are presented in detail in the Testing - Strategy [OCORA-TWS09-010] and summarized here:


- 0 - Platform Level: Qualification (HW/low SW level) only,
- 1 - Component Level: SW Testing only,
- 2 – OCORA Core Building Block level: integration and testing activities,
- 2' – Peripheral or Connectivity Block level: integration and testing activities,
- 2" – Train Adapter Block level: integration and testing activities,
- 3 – CCS OB level: integration and testing activities,
- 4 – Vehicle level: integration and testing activities,
- 5 – System level: integration and testing activities.

2.2 Scope and Capabilities

The following high-level requirements specify the expectations regarding the scope of the Integration and Testing activities for OCORA projects.


OCORA-1251, B-Level - The Integration & Testing Strategy shall allow to integrate, verify and validate the system under consideration of the OCORA collaboration which is CCS Onboard subsystem (CCS-OB), as well as its internal and external interfaces.

L1	L2	L3	L4	L5	Not level specific
	X	X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	–
Category	Non-functional
Acceptance Method	Process Review


OCORA-7316, B-Level - The Testing Strategy shall particularly focus on the parts of the CCS-OB for which OCORA gives a high level of specification including for the functional requirements (“OCORA core” scope).

L1	L2	L3	L4	L5	Not level specific
	X	X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	-
Category	Non-functional
Acceptance Method	Process Review


OCORA-1252, B-Level - The Integration & Testing Strategy shall consider the peripheral devices and connectivity devices which are part of the CCS-OB for which OCORA is providing interface specifications, high-level functional requirements, and non-functional requirements (basically, all requirements and specifications needed to ensure “plug & play”-like exchangeability).

L1	L2	L3	L4	L5	Not level specific
	X	X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	–
Category	Non-functional
Acceptance Method	Process Review


OCORA-1253, B-Level - The Integration & Testing Strategy shall allow to integrate, verify and validate the part of the Train Adapter (TA, which is itself a part of the Physical Train Unit) for which OCORA aims at providing requirements, a standardized interface specification, and design guidelines.

L1	L2	L3	L4	L5	Not level specific
	X		(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	–
Category	Non-functional
Acceptance Method	Process Review


OCORA-1254, B-Level - The Integration & Testing Strategy shall allow to verify and validate the modularity properties of the CCS-OB and the TA as defined in [\[OCORA-TWS01-030\] – System Architecture](#).

L1	L2	L3	L4	L5	Not level specific
		X	(X)		

Status	 Draft
Classification	Requirement
Rationale	–
Category	Non-functional
Acceptance Method	Process Review


OCORA-1255, B-Level - The Integration & Testing Strategy shall allow to verify and validate that the building blocks within the CCS-OB and the TA support the whole functional scope of OCORA, for all grades of automation.

L1	L2	L3	L4	L5	Not level specific
	X	X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1256, B-Level - The Integration & Testing Strategy shall address cybersecurity issues: depending on the security category of the application, building block or subsystem,

L1	L2	L3	L4	L5	Not level specific
	X	X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-7317, B-Level - Testing activities shall be used (if needed) to check that the cybersecurity requirements have been correctly fulfilled (refer to [\[OCORA-TWS01-030\] – System Architecture](#)).

L1	L2	L3	L4	L5	Not level specific
	X	X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	-
Category	Non-functional
Acceptance Method	Process Review


OCORA-1257, B-Level - The Integration & Testing Strategy shall take into account that the configuration for a specific implementation is opened and may include only a subset of the building blocks or components: Testing Strategy is able to address these different scopes of functionality, while remaining consistent and complete in regards with the building blocks and components implemented.

L1	L2	L3	L4	L5	Not level specific
		X			

Status	 Draft
Classification	Requirement
Rationale	–
Category	Non-functional
Acceptance Method	Process Review


OCORA-1258, B-Level - The Integration & Testing Strategy shall take into account that the functionality of some of the hardware components may vary.

L1	L2	L3	L4	L5	Not level specific
X	X	X			

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1259, B-Level - The Integration & Testing Strategy shall define system tests composed of several test types that are used to verify different categories of requirements:

General requirement allocation	L1	L2	L3	L4	L5	Not level specific
Functional tests: these tests demonstrate that the test object fulfils the functional requirements and interface specifications assigned to this test object. These tests include ERTMS Tests (e.g. Subset 76).	X	X	X	(X)	(X)	
Safety tests	X	X	X	(X)	(X)	
Non-functional tests: performance tests, Maintainability Tests, Environmental (climate, EMC) Tests, Load tests, Stress tests, Endurance tests	X	X	X	(X)	(X)	
User tests: testing by end users who perform specific tasks under real-life conditions.					(X)	
Cybersecurity tests		?	X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1260, B-Level - The Integration & Testing Strategy shall consider degraded modes for each kind of test type defined above.

L1	L2	L3	L4	L5	Not level specific
X	X	X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	–
Category	Non-functional
Acceptance Method	Process Review


OCORA-1261, B-Level - The Integration & Testing Strategy shall allow system tests to be classified into two categories, depending on where and how they are performed:

General requirement allocation	L1	L2	L3	L4	L5	Not level specific
Factory Acceptance Tests	X	X	X	(X)	(X)	
Site Acceptance Tests				(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	–
Category	Non-functional
Acceptance Method	Process Review

OCORA-1262, B-Level - The Integration & Testing Strategy shall define the different levels of integration, verification and validation (like system test, sub-system test, component test...).

L1	L2	L3	L4	L5	Not level specific
					X


Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review

2.3 Actors, Process and Methods

The following high-level requirements specify the expectations regarding the actors involved and the processes and methods used during the Integration and Testing activities for OCORA projects.


OCORA-1263, B-Level - The Testing activity shall be started as early as possible in the process.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1264, B-Level - The OCORA initiative shall propose early testing steps.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1265, B-Level - The requirements shall be mastered (and their releases) during the whole cycle of development and validation.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1266, B-Level - The Testing documentation shall be well structured down to test cases.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1267, B-Level - The Interface Integration Plans for each interface shall be well structured (according to each interface) and mastered with clear steps (what/how/who...).

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1268, B-Level - The Interface Integration Plans shall converge between all stakeholders involved.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1269, B-Level - Each milestone of the Integration & Testing process shall be clearly defined.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1270, B-Level - The Integration & Testing effort shall be adapted accordingly to the needs of each step.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1271, B-Level - The risk of having many actors /many tools... shall be reduced by having a common environment (eg MBSE and its Testing) where specific tools are limited to stakeholders' specific activities.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Design Review


OCORA-1272, B-Level - A system integrator (or system integrators but with an overall system integrator above) shall be designated.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1273, B-Level - A clear process shall be proposed for bugs/anomaly tracing until corrections are made (among the different stakeholders) supported by ad hoc tools.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review


OCORA-1274, B-Level - When possible, safety demonstration shall also rely on additional and complementary methods, other than test and validation (use of formal method for instance).

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Demonstration


OCORA-1275, B-Level - The Integration & Testing Strategy shall lead to a minimal effort in case of an update of a component (additional cases can be provided in refined requirements):

General requirement allocation	L1	L2	L3	L4	L5	Not level specific
Software update						X
Addition of a new CCS-OB – vehicle interface						X
Replacement of a building block (e.g. replacement of LOC-OB due to a change of localization sensors – VLSS - or localization component - VL)						X
Replacement of an adapter (e.g. FVA replaced)						X
Addition of a new peripheral device (e.g. BTM, LTM...)						X
Hardware exchange (e.g. new processor)						X
Cybersecurity upgrade						X

Status	 Draft
Classification	Requirement
Rationale	–
Category	Non-functional
Acceptance Method	Design Review


OCORA-1276, B-Level - The Integration & Testing Strategy shall be organized in well-defined successive and complementary steps. An example is given below:

General requirement allocation	L1	L2	L3	L4	L5	Not level specific
Integration and testing of the HW (operating system test cases, bus communication test cases: load and performance tests)	X	X				
Integration of the runtime environment (testing of the interfaces between OCORA runtime environment and vehicle apps by using vehicle app simulators)		X				
Integration of CCS-OB building blocks (overall and operational use cases with trackside simulated), with simulated peripheral/connectivity devices and then real devices		X	X			
Integration of a CCS-OB to a reference vehicle with trackside simulated, real balises and run basic ERTMS functions on a test track and a set of operational use cases			X	(X)	(X)	
CCS-OB and Interoperability with Trackside in Lab			X	(X)	(X)	
Test Reference Vehicle on Reference Track: interoperability on reference track with real trackside			X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Design Review


OCORA-1277, B-Level - The Integration & Testing Strategy shall define for every level of integration, verification and validation the appropriate verification and validation methods (e.g. review, inspection, black-box testing...) to be used.

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review

OCORA-1278, B-Level - For each level of integration, verification and validation, a report containing the proofs that the required testing activities have been correctly carried out shall be provided by the actor in charge of this level.

L1	L2	L3	L4	L5	Not level specific
					X


Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Process Review

2.4 Tools and Environment

The following high-level requirements specify the expectations regarding the tools and more generally the test environment used for the Integration and Testing activities for OCORA projects.


OCORA-1279, B-Level - The Testing Strategy shall rely on a test environment automatized as far as possible.

L1	L2	L3	L4	L5	Not level specific
X	X	X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Design Review

OCORA-1280, B-Level - A powerful test environment allowing configuration testing, degraded modes...shall be available.

L1	L2	L3	L4	L5	Not level specific
		X			

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Design Review


OCORA-1281, B-Level - A “reference” test environment shall be proposed and mastered.

L1	L2	L3	L4	L5	Not level specific
	X	X		(X)	

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Design Review


OCORA-1282, B-Level - The Testing Strategy shall rely on a flexible line representation, where all particular and relevant configurations can be added.

L1	L2	L3	L4	L5	Not level specific
?	?	X		(X)	

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Design Review


OCORA-1283, B-Level - Early verification and validation using model-in-the-loop simulation shall be foreseen

L1	L2	L3	L4	L5	Not level specific
					X

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Design Review


OCORA-1284, B-Level - The test environment shall support model-in-the-loop, software-in-the-loop and hardware-in-the-loop testing.

L1	L2	L3	L4	L5	Not level specific
X	X	X	X	(X)	

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Design Review

OCORA-1285, B-Level - A common reusable set of scenarios shall be maintained with an incremental approach at each system release.

L1	L2	L3	L4	L5	Not level specific
		X	(X)	(X)	

Status	 Draft
Classification	Requirement
Rationale	—
Category	Non-functional
Acceptance Method	Design Review