OCORA

Open CCS On-board Reference Architecture

Guiding Principles

Collaboration and Design Principles

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Version	Change Description	Initial	Date of change
1.00	Official version for OCORA Delta Release	JH	30.06.2021
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2.10	Update based on brush up and editorial work	RM	31.05.2023

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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-BWS03-010 – Introduction to OCORA

[6] OCORA-BWS04-010 – Problem Statements

1 Introduction

1.1 Purpose of the document

OCORA has developed a comprehensive and coherent set of collaboration and design principles to provide guidance for the OCORA team in the planning and execution of the OCORA program portfolio. It serves as well as for its interaction with its environment, primarily the railway community. OCORA publishes this set of principles:

- as a guideline for its own activities;
- to inform stakeholders about what can be expected from OCORA and what OCORA expects from its members;
- to avoid ambiguities on OCORA intentions.

Therefore, it is suggested to read this document together with the OCORA Introduction, ref. [5].

In this document two categories of leading principles are addressed:

1. Collaboration principles
2. Design principles

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 [4].

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

If you are an organization interested in developing on-board 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 informative. 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 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]. If you are interested in the context and the motivation that drives OCORA we recommend to read the Introduction to OCORA [5], and the Problem Statements [6]. The reader should also be aware of the Glossary [2] and the Question and Answers [3].

2 OCORA collaboration principles

The OCORA collaboration is established primarily with the objective to transform the CCS market to achieve the economic and business interests of its founding members. OCORA is convinced that this is necessary to support the drive for automation and digitalisation of the involved railways themselves, and serve and benefit key institutional and industrial stakeholders.

OCORA acts according to key principles defined in the MoU and CoC on which the collaboration is based.

1. OCORA is first and foremost a technical collaboration platform for its members. OCORA output will be made available to any stakeholder of the railway community.
2. As expressed in the CoC, OCORA acts in full conformity with existing competition law under any circumstances and within the existing sectoral regulatory framework. Proposals formulated by OCORA will for example be registered for further treatment through existing channels like CER or EUG.
3. Although OCORA aims at standardising the CCS OB function, it does not envisage to set up a formal, de jure standard. However, OCORA will develop for its members and third parties specifications for procurement purposes.
4. Acknowledging that the sector has to be able to manage its legacy, currently available system versions (e.g., ERTMS B3) will as a matter of fact be the starting point for the migration towards the envisaged OCORA platform. The OCORA architecture intends to fulfil current TSI functional requirements to enable compatibility with the existing rolling stock and infrastructure configurations. Nevertheless, when configuring the migration process, OCORA intends to take due account of breakthrough concepts within the direct railway perspective and out of it (e.g., the automotive cyclical, concurrent engineering approach, allowing for cumulative, simultaneous product research and development cycles). Modularity on a system level (hardware, HW/SW interface, software applications, etc.) shall allow for a software based functional evolution under compatibility control. This approach will allow for a certain measure of stability for major parts of the system, while at the same time allowing for rapid replacement or innovation of key elements thereof.
5. OCORA as an independent collaboration of railways primarily seeks consensus between stakeholders and partners on the preferential way forward. But it is also aware of the need to remain in a position where it can articulate specific railway views. Therefore, OCORA intends to keep its autonomous position despite supporting ongoing developments such as the establishment of Europe's Rail JU. OCORA believes that to effectively impact relevant developments, it should remain independent while at the same time being deeply involved and supporting such developments. Autonomy will ensure the balanced, qualified and authentic contribution of railway points of view, opinions and expertise to important European programs and institutions.
6. OCORA believes that it needs to stay aware of the interests of other stakeholders in the railway community as a solid foundation for constructive and productive dialogue and discussion. It should also keep a keen eye on opportunities to find joint solutions which satisfy the interests of the community as a whole and, as much as possible, of its individual members.

OCORA has developed and adheres to a number of leading principles in order to achieve its business objectives. These principles will guide any dialogue and collaboration with partners in the railway community.

1. **Openness**: OCORA is an open collaborative technical platform open to all railway companies. This includes IMs and RUs. It is based on sharing and making publicly available its deliverables for the benefit of the railway sector.
2. **Modularity**: OCORA intends to decompose the CCS OB subsystem into an optimal, i.e., reasonable, number of standardized building blocks. System modularity is the basis for a modular safety approach and exchangeability, supporting different life cycles.
3. **Simplification**: OCORA intends to manage the exponentially increasing complexity of CCS systems by migrating from the current paper based one to a model-based system engineering approach. This will allow for a more systematic and concurrent requirement specification development process. Furthermore, OCORA plans to isolate, in its architecture, the functional blocks that will become obsolete in the foreseeable future (e.g. GSM-R radio, class B systems, current balise technology). This is the basis to easily simplify OCORA based implementations once the respective functions are not needed anymore.
4. **Independence**: OCORA intends to minimize the dependencies between different building blocks and components, such as dependencies between hardware, software and peripherals. This provides the basis for a modular product-based CCS system approach.
5. **Evolvability**: continuous updates and upgrades are paramount to the railway digitalization. Following these ideas, OCORA intends to introduce secure upgradability and interchangeability. This will speed-up the integration of future innovations in a flexible manner and provide a solid basis for introducing game changers such as FRMCS or ATO.

Both the corporate objectives themselves and the translation of those principles in design principles, which provide the preconditions to achieve those objectives, are discussed in the next chapters.

3 OCORA design principles

3.1 Introduction

Design principles explain how and why system design enables RUs to achieve business objectives and, therefore, always have an economic rationale. They are not necessary to explain how or why a system works or performs but clarify how a system supports the corporate goals of its users[1].

The CCS OB system have become important cost post for rolling stock life cycle, operational performance and transportation capabilities. Defining design principles is of paramount importance to manage financial, operational and performance risks by design. This requires, foremost, providing the preconditions for effective life cycle management of the CCS system as part of the rail vehicle. It means allowing differentiation between systems or system elements with varying life expectancies.

For the current generation of CCS OB solutions, these requirements imply moving away from the current CCS architectures. Any (minor) change in these monolithic architectures almost automatically affects the integrated whole. In the end, the subsequent need to replace entire systems and repeat authorization processes, combined with the persistent complexity and performance issues damages the economic viability of both users and suppliers. It also prevents early adoption of innovations and slows down the automation of railway processes.

To establish evolvability, close sector collaboration is necessary. It will help get in charge of change and configuration management of both technology and standards developments. These should be brought in line content and management wise. Moreover, there will be an effect on both standards' development and ownership. Instead of standards leading to product development (and so obsolescence), OCORA believes the logical chain of action should be product development leading to tested and proven standards. Therefore, development cycles should be drastically decreased to allow for speedy adoption and absorption of state of art technology developments. This asks for different approaches towards standards management processes, and shared ownership of the ensuing standards, driving harmonisation and interoperability. Evolvability will be achieved only in case of shared sector responsibility for technology and standards development. Furthermore, European ambitions regarding an innovative, automated and digitalized rail network will materialize.

[1] See e.g.: Maier, Mark W. and Rechtin, Eberhardt. *The Art of Systems Architecting*, CRC Press, Inc. USA.

3.2 Definitions

One of OCORA's goals is to improve the maintainability of the ETCS system, focussing on the ETCS On-Board system. The total costs of ownership of an ETCS On-Board system needs to be reduced by factors and updates and upgrades must be deployable within month rather than years.

Having a modular architecture with a well-defined number of building blocks is a prerequisite to improve the maintainability of any complex system. The OCORA understanding of a building block is as per the definition below.

- A **Building Block** is a sourceable unit of the CCS on-board system (hardware and/or software), having standardised functionality, standardised PRAMSS requirements (including Tolerable Functional Failure Rate [TFFR], Safety Integrity Level [SIL] and Safety Related Application Conditions [SRAC]), standardised interfaces (on all OSI Layers) towards other building blocks and/or external systems.

  Building Blocks are separately sourceable from different suppliers and capable of being integrated by a third party.

  There are 2 types of building blocks: a) Hardware Building Blocks and b) Software Building Blocks.

- **Hardware Building Blocks** consist of hardware and typically software that provide the building block's functionality. They exclusively communicate with each other and with external systems through the CCS Communication Network (CCN) using standardised interfaces.

- **Software Building Bocks** consist of software that provide the building block's functionality. They are deployed on an instance of the Generic Safe Computing Platform (SCP) and shall communicate with each other through the standardised Platform Independent Application Programming Interface (PI-API). Communication with computing platform external building blocks and systems is realised by the Computing Platform (integrating with the CCN).

  Software Building Blocks are portable i.e., they may be deployed on different Computing Platform implementations.

A modular architecture, consisting of building blocks as per the definition above, allows for individual exchangeability (interchangeability) and migrateability (upgradeability) of its building blocks. The OCORA understanding of these terms are as follows:

Exchangeability (Interchangeability) is the ability to replace one or multiple building blocks with (a) respective building block(s) of (an)other supplier(s), without affecting other building blocks of the train or the overall CCS on-board system.

Migrateability (Upgradability) is the ability to introduce changes to one or multiple building blocks, without affecting other building blocks or the overall CCS on-board system.

To improve maintainability and availability of any system, the number of hardware elements should be kept at a minimum. To reduce the number of hardware elements needed for a CCS On-Board system, functionality should be implemented in portable software applications and not as functionality running on dedicated hardware. Once functionality is implemented in software applications (software building blocks) the portability (platform independence) of the software building becomes a prime requirement to ensure exchangeability (interchangeability) of software building blocks.

Portability (Platform Independence) is achieved when a functional application, based on the generalized abstraction, runs un-changed on different (computing) platform implementations. For this, the functional application shall only use external functions through a defined application programming interface (API).

To further improve the maintainability, especially to protect the investments, any complex system must ensure its evolvability. To ensure evolvability of a CCS-On-Board system, a standardized communication infrastructure and well defined, open interfaces of the building blocks are needed.

Evolvability (Flexibility) is the ability to extend the functionality of an CCS On-Board system without the involvement of the original supplier and to easily adopt to new technologies.

Modularity with the purpose of having “plug and play”-like exchangeability as defined in the OCORA context, requires detailed interface specifications as well as harmonized requirement specifications (functional and non-functional) for all building blocks. Defining and maintaining these interfaces and requirements to the level needed for the desired “plug and play”-like exchangeability, requires a substantial effort. Also, increases in integration testing and acceptance efforts as well as the costs to maintain the interface and requirement specifications must be considered.

Therefore, the granularity of the decomposition needs to be a result of a well-balanced analysis of the effort against the business needs (expected benefits). Due to the high effort needed to develop the necessary interface and requirement specifications, a roadmap on how the modularity can evolve is essential.

This document proposed a modularization granularity and its roadmap. OCORA believes that the proposed granularity is reasonable, and the proposed roadmap is feasible.