OCORA

Open CCS On-board Reference Architecture

RAMS – Optimised Approval Process

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Management Summary

The overall purpose of this document is to present a discussion and an analysis of the current approval process, which is defined in EU Directive 2018/545 [24], and to make a first step towards a new one; tailored from the current process to optimise it thanks to the new OCORA modular architecture.

Starting from the current approval process, this document proposes to define a tailored and optimised approval process adapted to a modular safety approach which remains compatible with the requirements of EU Directive 2018/545 [24]. Therefore, several ideas, pain points and benefits were collected in workshops to this topic with representatives from DB, NS, SBB and SNCF. Moreover, there is an explaining example with the overall new Functional Vehicle Adapter (FVA) given.

Revision history

Version	Change Description	Initial	Date of change
0.01	Gamma Release as a starting point	JB	31.03.2022
1.01	First draft for R2 release	JB	12.05.2022
1.10	First review for R2 release	LS	09.06.2022
2.01	First update for R3	JB	11.11.2022
2.10	Update following TW07 comments	JB	23.11.2022
2.20	Final version for R3	JB	01.12.2022
2.30	Update for R4	VI	12.06.2023
2.31	This document served as input for the ERJU System Pillar PRAMS domain and will be continued there. It remains published for information purposes only.	MM	24.11.2023

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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-BWS02-010 – Executive Summary Slide Deck

[6] OCORA-BWS02-030 – Technical Slide Deck

[7] OCORA-BWS03-010 – Introduction to OCORA

[8] OCORA-BWS04-010 – Problem Statements

[9] OCORA-TWS04-011 – FVA requirements

[10] OCORA-TWS07-010 –Modular Safety Strategy

[11] OCORA-TWS07-020 –Evolution management

[12] OCORA-TWS07-030 – SRAC/AC Management

[13] OCORA-TWS07-050 – RAM Strategy

[14] OCORA-TWS07-060 - Configuration Management Concept

[15] OCORA-TWS07-100 – CENELEC Phase 1 – Concept

[16] OCORA-TWS09-110 – Train Adapter Block Integration Plan

[17] EN 50126-1:2017-10 – Railway Applications – The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 1: Generic RAMS Process

[18] EN 50126-2:2017-10 – Railway Applications – The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 2: Systems Approach to Safety

[19] EN 50128:2011-06 – Railway Applications – Communication, signalling and processing systems - Software for railway control and protection systems

[20] EN 50129:2018-11 – Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling

[21] EN 50506-1: 2007: Railway applications — Communication, signalling and processing systems — Application Guide for EN 50129 — Part 1: Cross-acceptance

[22] TSI CCS: 02016R0919 - EN - 16.06.2019 - 001.001 - 1: COMMISSION REGULATION (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union, amended by Commission Implementing Regulation (EU) 2019/776 of 16 May 2019 L 139I#

[23] SUBSET-119: ERTMS/ETCS - Train Interface FFFIS

[24] Directive 2018/545 - COMMISSION IMPLEMENTING REGULATION (EU) 2018/545 of 4 April 2018 establishing practical arrangements for the railway vehicle authorisation and railway vehicle type authorisation process pursuant to Directive (EU) 2016/797 of the European Parliament and of the Council

[25] *Final Report Summary - MODURBAN (Modular urban guided rail systems)*. Cordis EU Research Results. (2011, April 14). Retrieved June 2, 2022, from https://cordis.europa.eu/project/id/516380/reporting

[26] Regulation (EU) No 402/2013 – COMMISSION IMPLEMENTING REGULATION (EU) No 402/2013 on the common safety method for risk evaluation and assessment and repealing Regulation (EC) No 352/2009

[27] OCORA-BWS09 – Acceptance of Global Standards

[28] VDB Studie ‘Die Zukunft der SChiene soll rasch beginen’ September 2019

1 Introduction

1.1 Purpose of the document

The purpose of this document is to present an analysis of the current approval process defined in Directive 2018/545 [24] and to discuss the possibility and the need to develop a new one, tailored from the current one to optimise it considering the new modular architecture introduced by OCORA. Starting from the current approval process, a future intention would be to propose an optimised approval process adapted to OCORA modular safety approach.

Today, feedback of many RUs shows that the approval process for railway vehicles takes too long and is too costly, especially for train types or fleet that are usually managed as independent projects. Therefore, in this paper the pain points of the current approval process were identified. Also, the current approval process introduced by the 4th Railway Package is considered too costly (in terms of labour and time).

One great advantage of the modular architecture introduced by OCORA is that it allows to widely use the concept of a “reference system” as defined in the CSM-RA [26] to avoid “one-off” project certifications and accelerate the overall approval process. Furthermore, modular architecture is supposed to provide various advantages for both new and retrofit projects.

This process as shown in

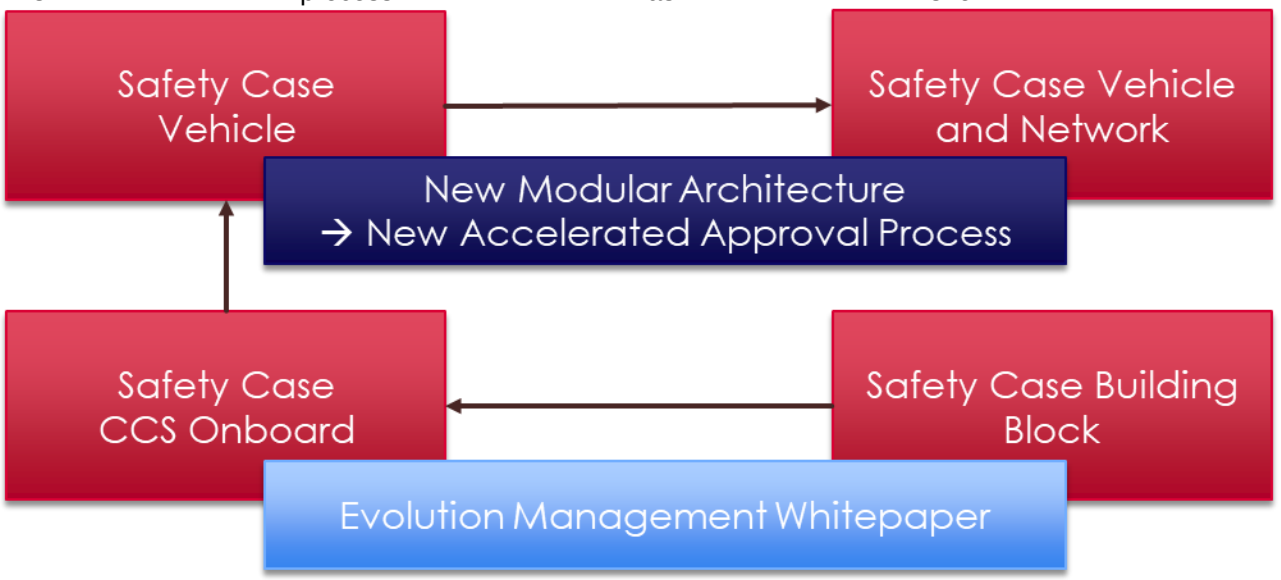

Figure 1 shall allow the use of standardised parts (as defined by OCORA) which could be used to build the ‘reference system’ as defined in CSM-RA [26] from risk assessment to the certification (i.e. the whole safety lifecycle). Cross-acceptance (refer to §7) up to the highest GASC has to be optimised at maximum to ensure that all generic parts are only certified once and then cross-accepted on different parallel projects (i.e., installed on different RST).

This process shall also consider the results of the Acceptance of Global Standards BWS09 of OCORA to ease the integration of “non-railway” parts into CCS OB construction without complete recertification. The management of the “evolutions” of already certified systems should be dealt separately and will be described later.

Optimisation of the current process involving current EVC as monolithic systems with proprietary interfaces is out of scope.

The document is structured in the following manner:

1. Introduction
2. Analysis of the current approval process

3. Stakeholder Analysis
4. Pain Point Analysis
5. Benefits of OCORA for the approval process

The overall RAMS strategy is shown in **Figure 2**.

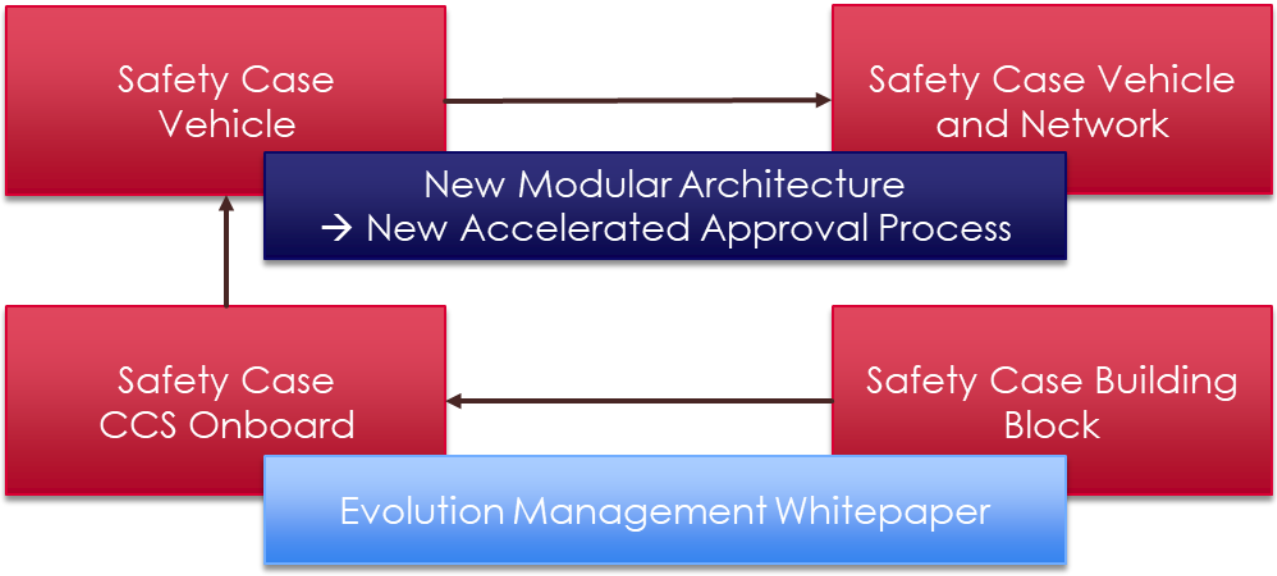

Figure 1 Safety Cases and new approval process

This document shall serve as an input for the definition of a new optimised approval process to be developed at a future stage within OCORA and/or within the EU-Rail-System Pillar.

The 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, complete on-board CCS system, or on-board CCS replacements for functional upgrades or life-cycle reasons.

If you are an organisation 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 present 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.

The future process shall be applicable in case of complete retrofit of CCS OB by new OCORA compliant ones. Furthermore, it shall be applicable to new fleets equipped with OCORA compliant CCS OB.

In case of management of evolution in fleets already equipped with OCORA compliant CCS OB (I.e., when new re-certification and new vehicle authorisation becomes mandatory, (EU) 2018/545) [24], this process shall be strongly connected to the “Evolution process management” [11].

As a clarification, in this document the current approval process is analysed to identify relevant process steps which might benefit from OCORA. A complete new OCORA approval process shall be defined at a later stage.

It is considered that the new approval process should benefit from the concept of RAMS Modular Safety to avoid a complete recertification and focus on changes, whenever it is possible.

1.3 Context of the document

This document, introduced in OCORA Modular Safety Strategy [10], 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 them. If you are interested in the context and the motivation that drives OCORA it is recommended to read the Introduction to OCORA [7], and the Problem Statements [8]. The reader should also be aware of the Glossary [2] and the Question and Answers [3].

The Whitepaper on Optimised Approval Process is connected to other RAMS deliveries which are also part of the release. The following **Figure 2** presents the link between these different deliverables. It must be noticed that the Whitepapers on SRAC/AC Management [12], on Evolution Management [11], discussion on Optimised Approval Process (current document) and on RAM Strategy [13] are additional documents besides the documents according to the formal CENELEC V cycle Documentation (represented in brown in the figure below) required for the new modular approach.

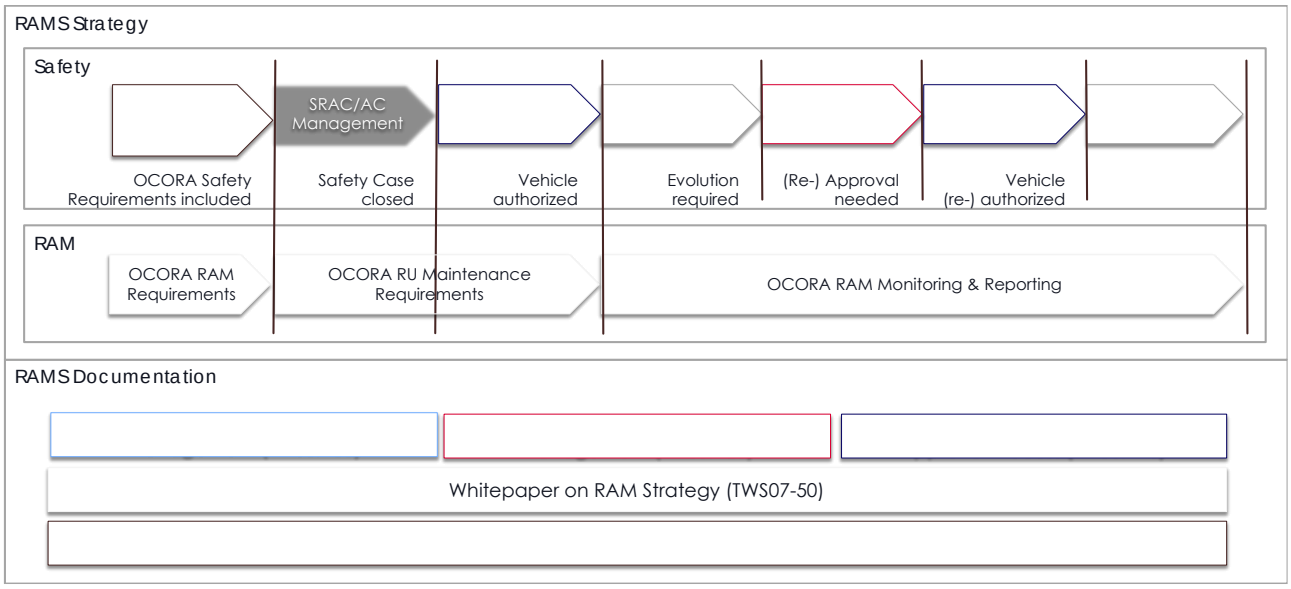

Figure 2 OCORA RAMS Strategy and RAMS Documentation

Currently, RUs are not satisfied with current approval process for the following reasons:

- Approval takes too much time (feedback from the market, NSA needs 5 months)
- Approval process is not flexible (e.g., when implementing new ETCS Baseline in vehicle)
- Processes are too complex and thus too costly (see **Table 2**)
- Not focusing on the modifications (i.e., sometimes an update of an approval process means complete recertification)

This is partly due to the monolithic approach of the current CCS-OB. A “monolithic” approach as used in OCORA refers to an integrated HW/SW installation, project specific adapted, where only the original vendor can modify it. The current ETCS on board systems provided by the historical most important manufacturers in Europe are typical monolithic approach.

Today, each CCS-OB needs project specific customisation (to a degree) and cannot be 1:1 reused on other fleets. Furthermore, due to other issues (e.g., poor management, time/cost assessment) some projects are managed as a “one-off” project and scarcely benefit from previous certifications of other fleets.

To overcome the pain points above, the Optimised Approval Process aims on faster and more efficient approvals by using modularity, reuse (across vehicles and suppliers) and avoiding the risk for a full recertification.

The new modularity coming with OCORA (e.g., independent building blocks) is an opportunity to make evolution on the current approval process. This should ease the use of generic cross-accepted elements (BB or complete CCS OB). This should aim at making the approval process more efficient (faster deployment) and better understandable. As a result, more frequent evolutions in CCS-OB systems may be possible.

2 Analysis of current approval process

In the following, this chapter deals with describing the current workflow for the approval process from the CCS-OB up to the final APoM (Authorisation for Placing on the Market). This first approach is done for the scenario of a complete retrofit, meaning the integration of a new CCS-OB (made according to current monolithic approach) into an existing vehicle (RST). Additional scenarios will be provided in a second step into the optimised approval process (in a future release of OCORA).

The goal of this activity is to see from today's situation where are the pain points related to the current approval process and where the modularity concept of OCORA can help at improving it without degrading the overall RAMS level. To give an example, the release of a new ETCS Baseline (set of specifications) often results in changes to many ETCS components (e.g., peripheral equipment), which lead to a disproportionately long approval process (including safety case). Therefore, the goal is to release a new/modified OCORA approval process, based on modularity.

Starting point for this approach is the first activity performed during the workshop in Berlin on 26.10.2021, which corresponding result is presented in **Figure 3**. The picture also presents a time aspect where the gates dates do not correspond to realistic cases. Realistic dates shall be provided in a future release of the document. This timeline presents the amount of work to be performed in a sequential mode from the new CCS-OB to the new APOM.

The context taken is an update of the monolithic CCS-OB system to fulfil TSI CCS 2022 (no reference is available yet). As this new release of the TSI CCS will not lead to a revolution of the current CCS-OB systems, it can be concluded likely, that the current CCS-OB systems will be widely reused by the manufacturers to propose the future ones compatible with the new TSI CCS 2022. It must be noticed that OCORA will not be part or mentioned by TSI CCS 2022.

Based on that, the assumption is taken that this kind of evolution at vehicle level will fit in the "article 14 (d)" case defined by Directive (EU) 2018/545 [24]:

> *(d) a **change that requires a new authorisation** according to the criteria set out in Article 21(12) of Directive (EU) 2016/797.*
>
> *Article 21(12) of Directive (EU) 2016/797 - Vehicle authorisation for placing on the market 12.*
>
> *In the **event of renewal or upgrading of existing vehicles** which already have a vehicle authorisation for placing on the market, **a new vehicle authorisation for placing on the market shall be required if**:*
>
> *[…]*
> *(b) the **overall safety level of the vehicle** concerned **may be adversely affected by the works envisaged**; or […]*

This is because TSI CCS 2022 will require the conformity to the UNISIG SUBSET-119 [23] as mandatory. Several critical functions, such as the emergency brakes are covered by this subset.

Once the type of modification is chosen, the RU can create a requirement book for its new vehicle where the request for the CCS-OB supplier to get an update of the system in conformity with TSI CCS 2022 will be mentioned.

Based on that, the CCS-OB supplier can update his current system or propose a new one with, at the end, a successful TSI CCS 2022 assessment (e.g., NoBo and ISA certificated).

From that point, the CCS-OB supplier or the RU can integrate the CCS-OB system into different vehicles. Besides the fact that Subset-119 [23] became mandatory, the latter is unfortunately not sufficient in its current state to ensure a smooth integration with any vehicle type. For that reason, the CCS-OB system must be adapted to fit the different legacy vehicle types where it must be deployed. This leads to some complications as of today.

Indeed, the non-homogeneity of the CCS-OB system prevents to reuse it directly thanks to the cross-acceptance concept originally defined in EN 50506-1 [21] which is now withdrawn. This means that, from this step, parallel projects must be defined (refer to the different fleet lines in the bottom of Figure **3**). Based on the unavailability of a generic train adapter between CCS and RST world, the CCS-OB integration cannot be realised as “reference system” as defined by CSM-RA [26]:

> *(20) ‘reference system’ means a system proven in use to have an acceptable safety level and against which the acceptability of the risks from a system under assessment can be evaluated by comparison.*

This means that redundant integration activities inducing high costs will be required to spread the new release of the CCS-OB system in the different vehicle fleets. Furthermore, it could not be directly reused in an additional fleet which is today equipped with another CCS-OB system (i.e., from a different supplier), still because of lack of a common train adapter.

From that point, these parallel project developments, at vehicle level, will unfortunately be spread again in branches with more parallel development when each fleet is integrated in different networks; a SASC is mandatory at this level for each couple vehicle & network to get the final APOM for each fleet on dedicated network.

At the end of the roll-out activities by the RUs, the total cost of the new CCS-OB deployment will likely be astronomic. Therefore, one of the big game changers that must be introduced by OCORA is to define a strategy to develop a ‘reference system’ for each RU at the highest level possible to optimise at maximum the reuse of components and vehicle to limit at the strict minimum the specific application implementation (i.e., when integrating into a network and apply for an APOM). This will be developed in the future release of OCORA.

VTA: Vehicle Type Autorisation (refer to 2018/545 and its Guideline)
APIS: Authorisation for the placing in service of fixed installations (refer to 2018/545)
APOM: Autorisation for Placing on the Market (refer to 2018/545 and its Guideline)
(4) '**network**' means the lines, stations, terminals, and all kinds of fixed equipment needed to ensure safe and continuous operation of the Union rail system;

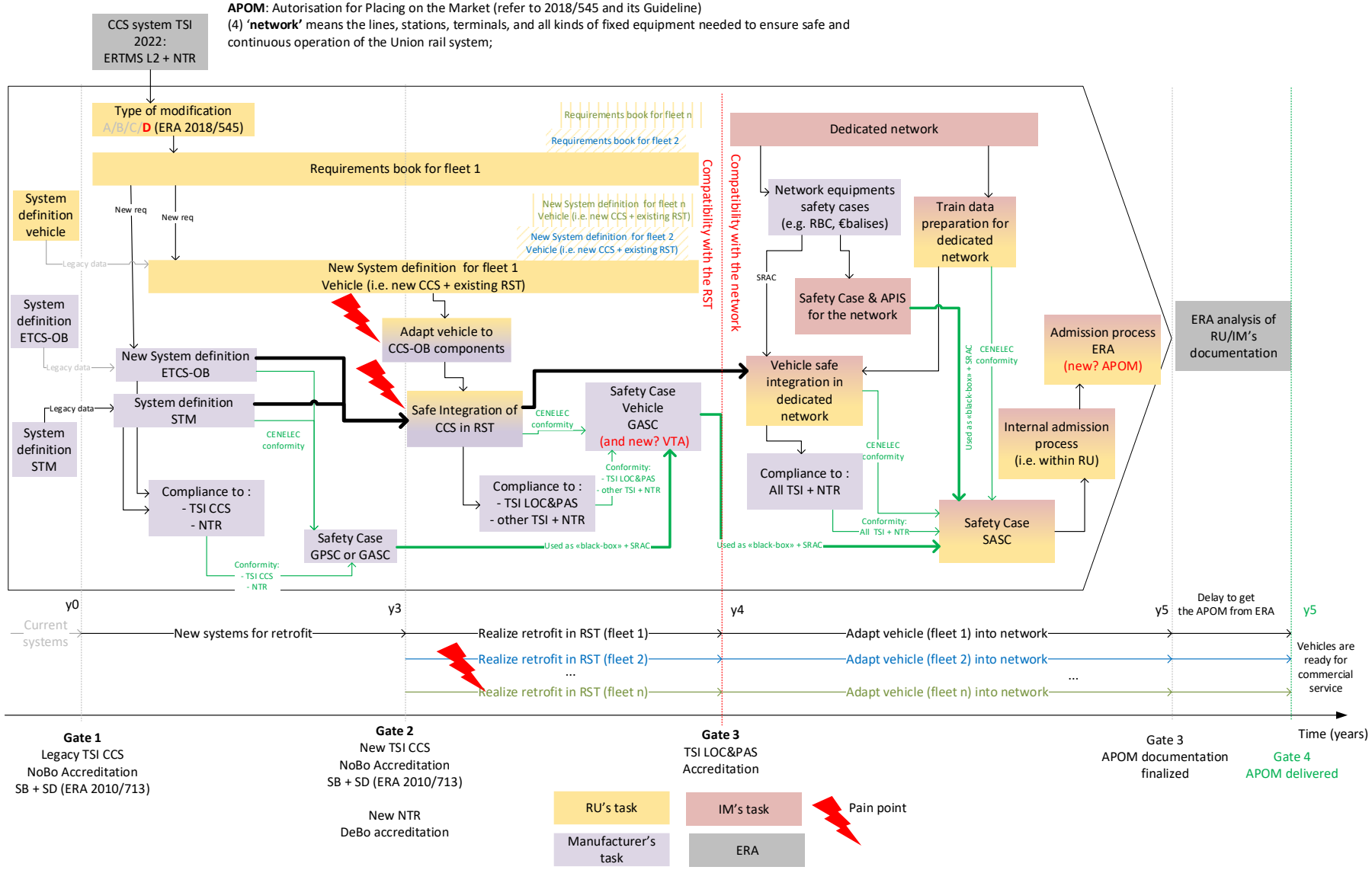

Figure 3 Current approval process in case of CCS-OB retrofit

3 Stakeholders' analysis

Before proposing a new optimised approval process, it is necessary to analyse the involved stakeholders regarding their influence as well as their attitude towards this new process based on the Modular Safety Strategy introduced in [10]. **Figure 4** presents a coarse overview and classification of the stakeholders of existing approval and approval processes. The stakeholders represented as the integrators, assessors and auditors (brown colour), the suppliers of ETCS components, train manufacturers or Railway Undertakings (RUs, blue colour) as well as the involved organizations as the ERA or UNISIG (red colour) are classified according to their influence on the OCORA Modular Safety process design (Strong vs. Weak influence) as well as their attitude towards a Modular Safety approach (Against or for Modular Safety).

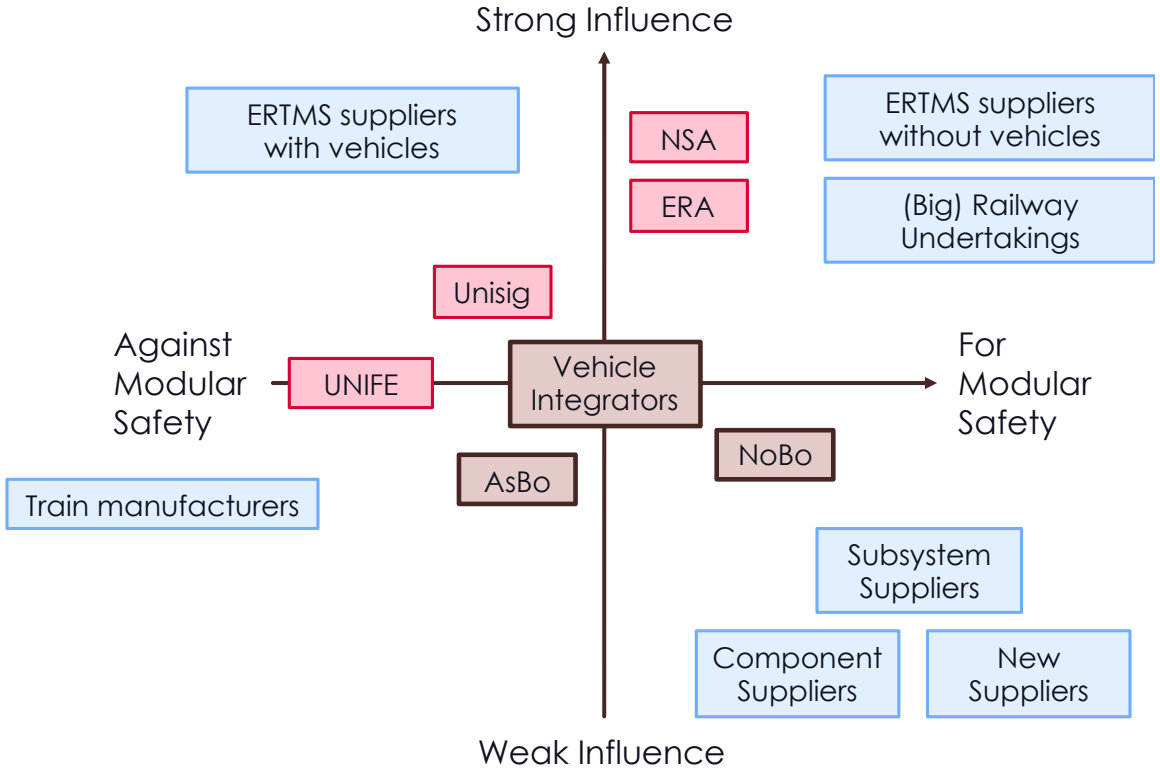

Figure 4 Stakeholders' overview

In addition to this coarse overview the stakeholders' perspective has been analysed in detail. The results of the main stakeholders marked in blue colours in **Figure 4** are presented. Hereby the stakeholders' attitude as well as their amount of influence on the OCORA program have been concretised and extended with an evaluation of the stakeholders' expectations and challenges regarding the OCORA project, especially the Modular Safety Strategy. A detailed analysis of the relevant organizations and auditors (marked red and brown colours in **Figure 4**) will be presented within the next release of this whitepaper.

Expectations from OCORA?	Challenges regarding OCORA?	Amount of influence on the OCORA program?
European Railway Agency (ERA)		
- Long term vision (remove national rules, new regulations) - Expects a long-term evolution of the CCS OB system - Improve the approval process to extend its use to any RU (i.e., national and international) and decrease costs for approval - Open the market to new players - Increase interoperability and add new functionalities (e.g., FRMCS, ERTMS L3, ATO GoA2 to GoA4)	- Need agreement of all stakeholders (e.g., when deploying a new regulation) - Long taking processes to deploy OCORA stakeholders' requirements and to get new/updated regulations - Compromise may not satisfy everyone	- HIGH: ERA manages the approval Process of the whole system, defines the new regulations; can decide to refuse/block or integrate the approval of future OCORA compliant systems into the current approval Process
Current suppliers (e.g., ERTMS suppliers **with vehicles** like Alstom, Siemens, Thales, Stadler, Hitachi, CAF)		
- Keep status quo regarding the monolithic approach of existing functions defined by TSI CCS - Smaller generic systems decrease the production/ recertification costs, but lots of reorganization may be required inside the company	- Need a lot of investment to create OCORA compliant systems - However, lot of investments done in the past for the current CCS OB systems (e.g., monolithic approach)	- VERY HIGH: If they do not want to follow OCORA, no equipment will be produced
New suppliers (e.g., ERTMS suppliers **without vehicles** like the signaling company, Kontron)		
- Chance to integrate a new important market and not only sell their product to the Current Suppliers but also directly to the RU's - A strong stable architecture design to avoid lost in R&D; similar to the TSI evolutions	- Lack of ETCS/safety experts - Lack of investment capabilities - Lot of R&D investment necessary - Limited testing capacities - Lack of trust from RU's (long time is usually required)	- VERY LOW - Today they are not directly involved into the railway market. In best cases, they are suppliers of the Current Suppliers (e.g., HaslerRail)
Big Railway Undertakings (RUs)		
- Expect at least the same performance/RAM as today (shouldn't be decreased) - Reduced costs for ETCS-OB - Lower delays to get equipped vehicles (retrofit projects) - Lower delays to get evolutions (e.g., new game changers, bug fixing) of the ETCS OB - Lower dependencies between ETCS OB and RS and for the supply of spare parts	- Lack of low level (e.g., LRU) Design experience on CCS-OB systems - High investments for the OCORA program itself. Can be risky if it takes too long to be finalised or worst cancel - Lots of compromises for the final shape of OCORA call for tenders' requirements - Limiting the overall assessment costs of OCORA compliant system	- Full because they are the OCORA program
Small Railway Undertakings (RUs) or Leasing companies		
- Expect at least the same performance/RAM as today (shouldn't be decreased) - Reduced costs for ETCS-OB - Lower delays to get equipped vehicles (retrofit projects) - Lower delays to get evolutions (e.g., new game changers, bug fixing) of the ETCS OB - Lower dependencies between ETCS OB and RS and for the supply of spare parts - Benefits could help small RUs to avoid bankruptcy and improve their business. Today, the huge costs of maintenance/retrofit activities can be a huge problem.	- Not involved in the OCORA program or even as reviewer. OCORA could miss some interesting hints for the program - Lack of ETCS/safety expert	No influence so far because they are not part of OCORA and neither any European organization and neither any standardization organization such as UIC, CENELEC, Shift2Rail, Europe's Rail.

Table 1 Perspective of Stakeholders

4 Pain points analysis

4.1 Pain points brainstorming

As mentioned above, in a workshop held in Berlin in October 2021, pain points and potential risks were identified by DB / SBB / NS / SNCF experts, which could jeopardise the success of applying a modular safety approach for on-board CCS. These pain points and pitfalls were clustered and are summarised in the table below, indicating the relevance of these pain points with respect to the optimised approval process aimed for by OCORA:

Subject	Pain Points/Pitfalls	Relevance to Optimised Approval Process

Complex Integration of onboard CCS modules	• Unclear interface definitions:
	  ○ Too generic/abstract
	  ○ Too complex
	  ○ Spongy interfaces
	  ○ Errors in definitions
	• Too many and ambiguous SRACS
		YES
		(Partial: assure coherence of modular evidence / approval steps)

Stakeholder management	• Missing awareness regarding within RUs(e.g., lack of Business Cases, unrealistic Business Cases, not enough communication and visibility) • Exclusive contracts between RUs and ETCS system suppliers instead of market competition • Important stakeholders (e.g., other RUs, manufacturers) may not been identified as stakeholders • Blocking attitude towards OCORA from manufacturers • Feedback and change requests from external stakeholders may not been send in or not properly processed by OCORA • Unclear allocation of roles/tasks/responsibilities for the stakeholders involved in OCORA compliant systems, no allocation of responsibility on a system level • Responsibilities may not be defined in line with contractual relations	NO
Synchronization of OCORA with its environment	• OCORA may not enough aligned with latest technologies (e.g., ATO, FRMCS) • Railway regulations (TSI, CSM) / standards (CENELEC) may not fit to OCORA • Regulations/standards evolves faster or slower than needed by OCORA	YES (Partial: handle contradiction and inconsistence in requirements)
OCORA program management	• No or reduced funding (e.g., less skilled people) • OCORA requirements may be ignored by important projects • RUs invest money in proprietary solutions (e.g., tools, equipment) • Balance of power between OCORA and UNIFE within ERJU may fail • OCORA initiative not enough supported by ERA • First “OCORA approved train” could have problems	NO
Wrong architecture design	• OCORA focuses on SW architecture without considering HW: This could lead to unrealistic requirements for the HW • Create a “revolution” (e.g., totally new design) in the CCS-OB instead of an “evolution” as mentioned by UNIFE. This prevents the re-use of existing components from the industry	YES (partial à convey knowledge about the new architecture to approval entities)
Prototype	• No prototype / ‘proof of concept’ is realised • Prototype not in line with full OCORA requirements	NO
Complex Risk Assessment/Safety	• More complexity (because of the integration steps) in the approval process (first and further assessments)	YES

Subject	Pain Points/Pitfalls	Relevance to Optimised Approval Process
Assessment/ Approval	• Higher initial effort for the whole safety activity (more documentation at each step)	

Table 2 Pain points brainstorming

4.2 Pain points regarding modularity levels

During the workshop, pain points were identified and analysed with respect to the current situation, meaning without modular safety and with respect to the expected situation when a modular safety approach for on-board CCS (CCS-OB) would be used. The results of this analysis are presented in the table below. The second column indicates whether the pain point applies currently, and the third column indicates reasons if and why such pain points could still exist despite or due to the Modular Safety Approach and what should be done to address these pain points. Finally in the last column is indicated whether the pain point could be addressed or mitigated through the optimised approval process.

#	Pain point	No modular safety	With modular safety (last step of OCORA development)	Relevance to optimised approval process
1	Interfaces when integrating systems to build a fully equipped train	Pain point currently exists: - time to market very long - high cost because of the monolithic approach (partially, in case of integration with new suppliers)	Pain point could still exist, because: - more complexity because of lot of suppliers to handle - more responsibility for the RU (responsible for the overall synchronisation) - more skills required from RU to handle that (in case this task is not subcontracted) - Some RUs could have an advantage when developing a modular structure	YES (definition of responsibilities regarding the approval process, deadline dependencies, faster and easier approval, but pain point is rather a technical issue that goes beyond the approval process only)
2	RST suppliers specify the "non-interoperable" interfaces of today before TSI	Different proprietary solutions live jointly and lead the supplier to create branches of their products to fit each train type	Not applicable All OCORA requirements for call for tenders will be available and connected to the TSI	NO
3	Management of NTR	Pain point currently exists:	Would still exist Out of "Modular safety" scope	NO
4	Cross-acceptance between ISA involved in the whole "approval process"	Pain point currently exists	Paint point could still exist Mitigation: OCORA should provide standardised template for OCORA (and ISA) reports to avoid "grey areas"	YES
5	Long Vehicle approval process	Pain point currently exists (partially)	Paint point could still exist Mitigation: Deployment of: - Evolution Management process - Optimised Approval Process - Use of new TA to fit several train types	YES

#	Pain point	No modular safety	With modular safety (last step of OCORA development)	Relevance to optimised approval process
6	Changes to existing equipped train difficult because of new/modified external constraints	Pain point currently exists	Pain point could still exist Mitigation: Deployment of the SRAC/AC Mngt - Definition of new standardised interfaces within OCORA - Use of new TA to fit several train types	NO
7	Lack of investment capabilities for possible new suppliers	Pain point currently exists (because of the high complexity of the monolithic EVC)	Pain point could still exist Mitigation: - OCORA brings a new way to create CCS OB systems - OCORA defines a cross-acceptance process for other sectors (e.g., avionics) [27]	YES (partial à optimised approval process expected to reduce time and cost for approval, but covers only one aspect of this pain point)
8	Risk of an unsuccessful (e.g., delayed, too costly, not at the good functional level) first OCORA roll-out by an RU	Not applicable	Pain point could exist, because: - not enough support from OCORA (in the documentation) to the RU - roles are not well defined - Approval process is not efficient - bad OCORA requirements (interfaces, testing…) - political issues (= lobbying?) further analysis to be added in OCORA R4	YES (partial à more efficient approval process, only one aspect of this pain point)
9	OCORA is not yet used into RU's call for tenders	Pain point currently exists	Pain point could still exist, because: - no communication from OCORA to promote our activities - no connection with TSI CCS - OCORA not connected to purchase department - OCORA specifications not (yet) at sufficient degree of maturity	NO
10	Complexity of the CCS OB	Pain point currently exists	Pain point could still exist. Mitigation: - The complexity remains, but the clarity for the component and a reduction of interpretations among suppliers will be reduced. Therefore, it will be easier to handle the complexity	YES (partial --> optimised approval process expected to facilitate approval, although it will not reduce the technical complexity of the CCS OB as such)
11	No mutualization or capitalization of past experience between RUs/Suppliers in project (i.e., every time, a new project must almost restart from scratch)	Pain point currently exists (partially)	Pain point could still exist. Mitigation: - The participation of OCORA to the *System Pillar of ERJU* with new processes should help (e.g. handling a central configuration management)	YES

Table 3 Identified pain points regarding modularity levels

5 Benefits of OCORA for the approval process

In the following **Table 4**, the benefits and ideas of OCORA for the approval process should be shown. Many new ideas for improvement of the approval process were collected in the workshop. These shall be the basis for development and release of a new approval process with the help of OCORA.

#	Benefits of a Modular Safety concept	New ideas for improvement
1	Systematic approach for safe evolutions	Common European call for tenders; this leads to create interoperable products by the suppliers which could follow the same systematic evolution strategy under definition by OCORA
2	Easier and faster evolution management	Define a standardised evolution management process [11]
3	No modular safety => No benefit in OCORA *(ERJU in the future)*	Defining a whole CCS compliant system based on prototypes (within the different OCORA WS) and then deploy our approval process to get the final approval. => this should help to ensure that our strategy is valid (BB definition and approval process) and should give confidence for the RU to follow us.
4	Cost saving: total cost of ownership lower than now	Benefit from existing modularization => try to get some return of experience of other sectors where module has already been successfully deployed.
5	Cost efficiency: today the price of a full approval process can be very high	Use the EU "Partnership of innovation" contract
6	Standardization and reinforcement of the SRAC process between RU's and Manufacturers	- OCORA decompose the system independent from the existing vendors in a structured way to support this process - Would standardize the Approval Process because also the system is consistent
7	Safety assessment facilitated (e.g., for defining safety relevance of changes)	Synchronize/harmonize the requirements with "supplier-processes" to get faster
8	Enabling the large ETCS rollout (i.e., the definition of the FVA helps at using the same OCORA compliant on different fleets). This leads to an easier retrofit activities because the same equipments are deployed	New way of working for the whole sector
9	Win-Win business case with suppliers (e.g., smaller generic LRU are less costly to sustain for the manufacturers)	Get REX from MODSafe and MODUrban projects for modularity used/proposed in urban railway transport.[25] Note: Analysis of results from MODUrban and MODsafe projects show that the modularity proposed in these projects for Urban Railway Transport Control Systems is not very useful for OCORA, since modularity stops at a level equivalent to our OCORA system´s scope (i.e., doesn´t go beyond Carbone Controller, which is the equivalent of our onboard CCS).
10	Fast integration of new technologies	Cooperate with vehicle suppliers
11	Enabler for upgradeability	Cross-acceptance between sectors (avionics/car industry)
12	Longer lifetime of ERTMS systems	Outsourcing possible
13	More players (more RU's and more suppliers) lead to more competition and more products to be sold (price decreased)	Separate the integration steps to avoid the vendors locks in today systems
14	Less market-entries barriers	*This idea must be developed in OCORA Release 4.*

#	Benefits of a Modular Safety concept	New ideas for improvement
15	Smaller LRU decrease the complexity of the ETCS on-board system (including safety)	Cooperation with ETCS suppliers
16	Smaller LRU aims at avoiding "grey areas" related to testing and monitoring	*This idea must be developed OCORA Release 4.*
17	A deeper standardization of the interfaces decreases the risks of safety issues at interfaces levels thanks to standardised test scope, monitoring mechanisms...	*This idea must be developed in OCORA Release 4.*
18	Smaller systems aim at increasing their test coverage	Time to market will be shorter
19	Less complex systems will ease their (re)assessments (e.g., ISA, NoBo)	Acceleration of the approval process could be reached
20	Less complex systems drastically decrease their time to market	*This idea must be developed in OCORA Release 4.*

Table 4 Benefits of OCORA for the approval process

6 Key enabler for an optimised approval process

One main reason for the optimised approval process is, that it is a key enabler for the large roll outs of ETCS. Different studies on European level as well as on national e.g., in Germany [28] show a massive increase of vehicle retrofit projects (factor 6-8 compared to today's number of First of Class FOC vehicles, i.e., 130 FoC for Germany). This questions the actual project by project approach and calls for a separation of enabling the vehicle by means of a Train Adapter (FVA) and the integration of the On-board Unit in a second step to decouple both activities.

To do so, an efficient cross-acceptance concept from GPSC to (partially SASC) as defined in section 7 OCORA had to be established, as no standardisation exists on the CCS-OB / RST connexion (i.e., SUBSET-119 [23] will only become mandatory from the new release of TSI CCS 2022).

In this context, the concept of a Train Adapter (TA) has been developed into OCORA to ensure the transition between conventional EVC systems to OCORA compliant ones on existing rolling stocks (refer to section 2). This functionality has been identified as a key benefit to enable the deployment of standard CCS OB system in vehicle equipped of different types of networks, functionalities… The different transition steps from today to a future vehicle, equipped with one single bus, are presented in [6]. The one integrating the FVA is presented on **Figure 5**.

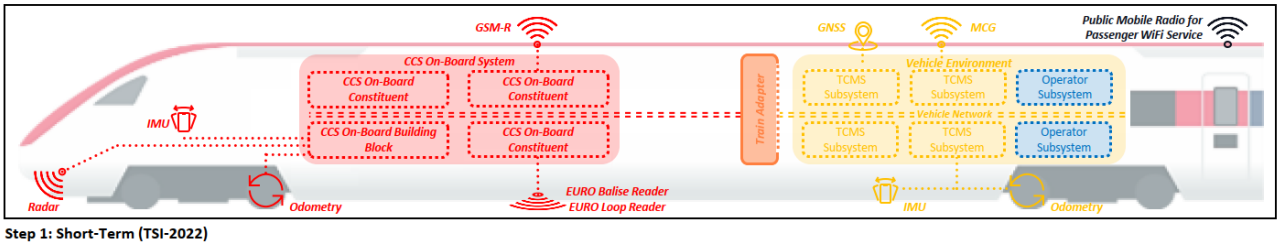

Figure 5 Short term vision of OCORA (TSI 2022)

The use of an efficient element as the TA aims at helping to mitigate the pain points: 2, 5 and 6 in **Table 3** to finally reach benefit 8 in **Table 4**.

The definition of the set of requirements for the future calls for tender is managed by the TWS04 of OCORA which has already publish an important list of them in [9]. Deeper analyses will be performed in OCORA R4 to complete this set of requirements, so that an OCORA CCS OB system can be deployed in any type of rolling stock for retrofit projects.

Its successful definition and implementation will also allow each RU to define a single CCS-OB system as "reference system" (refer to section 7) to be deployed in the RU's largest fleet possible without repeating a complete certification every time, but a delta assessment focusing on the specificities of each rolling stock instead. The complete procedure for such optimised assessments will be developed in a future release of OCORA.

7 Cross-acceptance

The purpose of this section is to introduce ideas for facilitating the cross-acceptance between CCS OB modules. Two main targets are pursued:

- define criteria for cross-acceptance between GPSC/GASC and see how to reduce at maximum the level of assessment activities at Specific level (such as a reference system 100% validated on the first or biggest project and then reused later up to 80% with focus on topology and configuration differences for the next Specific Application Safety Case)
- define a template or at least key hints for OCORA ISA reports.

The issue of cross-acceptance is critical in view of the massive ETCS retrofit rolling stock projects planned in the future, for which it is considered that the current certification/authorisation process will not allow to meet the expected targets for a timely deployment.

7.1 Background

The notion of cross-acceptance for railway applications was first introduced in EN 50129. Cross-acceptance is defined as the *„status achieved by a product that has been accepted by one authority to the relevant standards and is acceptable to other authorities without the necessity for further assessment“*.

As further indicated in the standard, cross-acceptance applies for Generic Products or Generic Applications, but not for Specific Applications. The general principle of cross-acceptance is to reuse the already existing safety evidence (based on a safety case and an independent safety assessment) of a generic product or a generic application as part of the safety evidence to be provided for a specific application that is developed using such generic products or applications. The intention is thus to limit as much as possible the effort for the safety demonstration and the independent safety assessment of a specific application by concentrating this effort on the specificities of the (context specific) application.

A similar concept was introduced by the CSM-RA, with the “Reference System” risk acceptance principle (see section 7).

7.2 Application of cross-acceptance for OCORA modular safety

The concept of cross-acceptance seems in principle perfectly applicable to CCS OB modular safety, if we consider the modules or building blocks of the CCS OB aimed for in OCORA as generic products or applications. In fact, the idea of OCORA Modular Safety is to extend the concept of cross-acceptance to a lower level of specification than is currently the case with generic applications and generic products. Thus, based on generic safety cases produced for the CCS OB modules (with their independent safety assessment) it should be possible in theory to generate a major part of the safety cases for the generic and specific applications that are assembling these modules, and concentrate the safety demonstration and assessment effort for CCS OB applications on safe integration and configuration issues (and possibly context specific issues for specific applications). As a corollary to this, this would be expected to limit the number of duplicated tests for similar solutions in different contexts (i.e., different specific applications), thereby reducing considerably the time for certification/authorisation of the CCS OB systems. This is of particular importance considering the large-scale deployment of CCS OB systems in many different parallel projects that is envisaged in the future.

However, a challenge for modular cross-acceptance would be to ensure sufficient confidence in the level of safety provided by the modules and evidenced through their generic safety cases and independent safety assessment. Such confidence is necessary for the integrator of an CCS OB application, who is ultimately responsible for the safety of the whole CC OB application and for the safety assessor of this application. Therefore, it is important to strengthen this confidence by establishing certain rules and conditions regarding modular cross-acceptance to facilitate and speed-up certification/authorisation of similar CCS OB systems to be deployed in parallel projects.

7.3 Conditions for cross-acceptance

The following documents provide relevant information regarding cross-acceptance, which could be used for defining rules and conditions for OCORA modular cross-acceptance:

- CLC/TR 50506-1: "Application Guide for EN 50129, Part 1 – Cross acceptance" *(now withdrawn)*
- CSM-RA
- RFU-STR-016 (NB-Rail Recommendation for use): Acceptance of Assessment Reports on Safety Prepared by other Parties

7.4 CLC/TR 50506-1

The Technical Report CLC/TR 50506-1 which was released as a guide to EN 50129 on the topic of cross-acceptance provided some quite detailed recommendations for the cross-acceptance of generic products or applications. However, this document has now been superseded by the new version of EN 50129 [19], although in this new version no such details can be found on the topic of cross-acceptance.

Nevertheless, it is proposed within OCORA to take as a basis the principles and conditions set out in CLC/TR 50506-1 and adapt them to the context of CCS OB modular safety for defining rules for modular cross-acceptance. The main content of CLC/TR 50506-1 is reproduced below:

The basic premises for cross-acceptance

The cross-acceptance of a product, system or process is implicitly founded on a number of key assumptions and conditions namely

a. *the product, system or process has been specified, designed and developed by a competent, capable and reputable organisation,*
b. *the product, system or process has been scrutinised, analysed and assessed through a rigorous process to assure its relevant safety, environmental and technical performance and this process has been documented at an appropriate level of detail,*
c. *the product, system or process has been evaluated for its compliance with regulatory requirements and best practice standards and codes of practice,*
d. *the assessment has been peer reviewed and the product, system or process approved or certified by a relevant competent body or authority in its native environment implying tolerability of its risks subject to specified constraints and controls,*
e. *the product, system or process has preferably got a demonstrable record of adequate verification, validation and testing or trouble-free operation in its native environment,*
f. *the product, system or process has potential for a wider scope of application beyond its initial native environment either in its original state, or through small-scale redesign and adaptation,*
g. *there is a perceived or real safety or environmental benefit or need in adapting the product, system or process for use in new (target) environments,*
h. *there is an implicit or explicit record of the above conditions and assumptions which can be made available to relevant third parties as deemed appropriate*.

Principles of cross-acceptance

The framework for systematic cross-acceptance developed and proposed in CLC/TR 50506-1 comprises 7 key principles as indicated below.

a)	**Establish a credible case for the native (baseline) application**
b)	**Specify the target environment and application**
c)	**Identify the key differences between the target and native cases**
d)	**Specify the technical, operational and procedural adaptations required to cater for the differences**
e)	**Assess the risks arising from the differences**
f)	**Produce a credible case for the adaptations adequately controlling the risks arising from the differences**
g)	**Develop a generic or specific cross-acceptance case**

Figure 6 7 key of CLC/TR 50506-1

CLC/TR 50506-1 provides details on each of these principles. These principles shall be further analysed for their applicability and adaptation for OCORA modular cross-acceptance.

7.4.1 CSM-RA

The cross-acceptance principles of CLC/TR 50506-1 are very similar to the requirements defined in the CSM-RA for the use of a reference system for risk evaluation (see extract below):

2.4. **Use of reference system and risk evaluation**

2.4.1. The proposer, with the support of other involved actors, shall analyse whether one, several or all hazards are appropriately covered by a similar system that could be taken as a reference system.

2.4.2. A reference system shall satisfy at least the following requirements:

(a) it has already been proven in-use to have an acceptable safety level and would therefore still qualify for approval in the Member State where the change is to be introduced;

(b) it has similar functions and interfaces as the system under assessment;

(c) it is used under similar operational conditions as the system under assessment;

(d) it is used under similar environmental conditions as the system under assessment.

2.4.3. If a reference system fulfils the requirements listed in point 2.4.2, then for the system under assessment:

(a) the risks associated with the hazards covered by the reference system shall be considered as acceptable;

(b) the safety requirements for the hazards covered by the reference system may be derived from the safety analyses or from an evaluation of safety records of the reference system;

(c) these safety requirements shall be registered in the hazard record as safety requirements for the relevant hazards.

2.4.4. If the system under assessment deviates from the reference system, the risk evaluation shall demonstrate that the system under assessment reaches at least the same safety level as the reference system, applying another reference system or one of the two other risk acceptance principles. The risks associated with the hazards covered by the reference system shall, in that case, be considered as acceptable.

2.4.5. If at least the same safety level as the reference system cannot be demonstrated, additional safety measures shall be identified for the deviations, applying one of the two other risk acceptance principles.

Figure 7 Cross-acceptance principles of CLC/TR 50506-1

Furthermore, the CSM-RA states (Article 15, §5):

> *When a system or part of a system has already been accepted following the risk management process specified in this Regulation, the resulting safety assessment report shall not be called into question by any other assessment body in charge of performing a new assessment for the same system. Mutual recognition shall be conditional upon demonstration that the system will be used under the same functional, operational and environmental conditions as the already accepted system, and that equivalent risk acceptance criteria have been applied.*

Based on this requirement, OCORA will define a common framework for specifying functional, operational and environmental conditions so that at building block and CCS level, the conditions for cross acceptance can be clearly determined based on the differences between similar specific applications.

OCORA will define a template of document for each side project compared to a reference system to highlight the differences for: functional, operational, and environmental conditions topics. The goal is to standardise and facilitate the conditions for cross-acceptance to avoid each time to request a new APOM.

	Reference System	**New train 1**	**New train n**
Functional conditions	< Function 1 Function 2 … Function n>	< Identical to reference system>	< Function 2 Function 3 … Function n+1 >
Operational conditions	< Condition 1 Condition 2 … Condition n >	< Condition 1 Condition 3 … Condition n-1 >	< Identical to reference system >
Environmental conditions	< Condition 1 Condition 2 … Condition n >	< Identical to reference system >	< Identical to reference system >

Table 5 Benefits of OCORA for the approval process

This approach shall be further discussed in OCORA (but also most likely within ERJU) and should be developed in consultation with Notified Bodies (e.g., through the involvement of NB Rail).

7.4.2 RFU-STR-016

Although meant for the acceptance by Notified Bodies of ISA or AsBo reports for their TSI conformity assessment (where there is a requirement in the TSI for a safety assessment either against CSM or against CENELEC) this RFU published by NB Rail defines conditions for acceptance of ISA safety assessment reports that could also apply more generally to the context of cross-acceptance for generic products or applications (and by extension generic CCS OB modules). These conditions are reproduced below:

Conditions related to ISA Independence and competency

> *The ISA shall have the level of independence as defined in the CENELEC standard EN 50128 (fig. 2 of ref. 8)/EN 50129 (fig. 6 of ref. 9) depending on the SIL of the item under assessment.*
>
> *The NoBo shall assess if the proposed ISA fulfils the requirements of at least one of the following three cases:*
>
> 1. *Accreditation to ISO/IEC 17020 for CENELEC standards EN 50126, EN 50128 (ref. 8), EN 50129 or EN 50657 covering the relevant technical scope (RST, CCO, CCT).*
>   a. *Type A meets the requirements for independence and competence without additional provisions.1*
>   b. *Type B and C meet the requirements for competence and additionally require the demonstration of the necessary level of independence including impartiality requirements to EN 50128 respectively EN50657 and EN 50129.*

2. *Accreditation to ISO/IEC 17065 for CENELEC standards EN 50126, EN 50128, EN 50129 or EN 50657 and covering the relevant technical scope (either RST, CCO, CCT) in respect to the product. Note: In this case the CAB's certificate and associated evaluation reporting shall be provided to the NoBo.*
3. *Non-accredited ISAs shall demonstrate to the NoBo how they meet the level of competence and independence as defined in subsection 1). The NoBo shall also take into account the civil and penal liability context in which the NoBo operates, because especially in this case the responsibility for evaluation lies with the NoBo. If a NoBo receives an ISA report from the same non-accredited ISA (in the same project or in another project) again within 24 months, then the NoBo may decide to accept the previous assessment of the competence and independence and no new assessment is necessary. If the NoBo receives an ISA report of a non-accredited ISA after 24 months of the last assessment of the competence and independence of this ISA, a new assessment is necessary by this NoBo.*

Conditions related to the ISA Assessment Results

The following acceptance criteria apply to the ISA-report. These shall be evaluated by the NoBo. Additional evidence or supporting information may be requested by the NoBo if required to enable the evaluation of these criteria:

1. *The assessment techniques applied by the ISA (review of documents, audits, testing, modelling, simulations, combinations of methods, etc.) are well defined and documented and can be evaluated by the NoBo based on the received evidence as appropriate.*
2. *The definition of the product/installation (which includes its description, documentation, hardware and software configuration, the configuration of the tools for development, test, maintenance, environmental and operational conditions, etc.) matches the assessment scope of the NoBo and no conditions have been identified which are in contradiction to the intended use.*
3. *The specifications, standards and other normative documents used as basis for the independent safety assessment are well defined, complete, appropriate and traceable to all requirements of the applicable TSI and CENELEC standards.*
4. *The complete set of requirements (functional, safety, environmental, etc.) to the product/installation is traceable and consistent with the requirements established by the Applicant for the intended use of the product/installation.*
5. *The hazards are systematically and comprehensively identified, well documented and analysed. The associated risks have been systematically assessed and suitable mitigation measures have been identified throughout as safety requirements.*
6. *All safety requirements have been allocated to functions of the product/installation, to operational measures or to associated SRACs. This shall include appropriate allocation of SIL.*
7. *Verification & Validation evidence demonstrates that the product/installation fulfils the complete set of requirements (including associated SIL). Any deviations identified during Verification & Validation are appropriately identified and their impact has been analysed to still fulfil the set of requirements.*
8. *SRACs (including exported constraints) have been established by the applicant and are confirmed by the ISA.*
9. *The ISA report*
   a. *covers the complete scope of the product/installation/environmental and operational conditions,*
   b. *is clear and positive in its statements,*
   c. *covers the relevant aspects of the safety & quality management process (requirements management, design techniques including modelling or simulations, configuration management, change management, independent review of documents, auditing, testing, verification, validation, etc. - list may not be exhaustive),*
   d. *is in accordance with the conclusions of the validation report and the safety case.*
10. *The NoBo can confirm by its evaluation that the product/installation in a specific project is covered by the scope of the ISA report. If necessary, several ISA reports may in combination cover this scope.*

These conditions shall be further analysed for their applicability and adaptation for OCORA modular cross-acceptance.

7.5 Next steps

Based on the premises presented above, OCORA will establish conditions and rules for the cross acceptance of CCS OB building blocks. This shall also include a proposal for a common template for safety assessment reports to facilitate cross-acceptance of these reports for similar applications.

8 OCORA stakeholder management

To deploy the concept of modular architecture from the CCS-OB constituents (i.e. building blocks) up to the top system level throughout the different homologation steps required, all stakeholders involved must be clearly defined.

Indeed, even if this OCORA architecture will aim at realizing more efficient lifetime management of the CCS-OB systems thanks to a standardised evolution management process [11] and an optimised approval process (the present document), the split of responsibilities of this system will nevertheless become more complex from a project organisation point of view.

In present projects, the CCS-OB supplier is often also the rolling stock supplier, and their safe integration is ensured by this supplier. This presents the advantage of simplified organization from a contracting entity point of view but prevent the flexibility of using equipment from different suppliers.

This organisation needs to be adapted to fit future projects involving OCORA compliant building blocks. This section defines a list of standardised roles / stakeholders that must be assigned by the contracting entity when realizing the call for tender. This section proposes to clarify:

- the tasks and responsibilities for each stakeholder,
- the interactions and expectations between each of them,
- the business incentives helping at choosing which type of company can hold the role.

8.1 Stakeholder identification and interactions

To avoid grey areas where no one is responsible or unnecessary redundant activities between suppliers, a clear list of tasks and deliveries is defined for each stakeholder chosen by the contracted entity.

In addition, all interactions and therefore deliverables between them are also defined and must be agreed in the call for tender phase. This point is a struggle in current projects for sharing technical information when different suppliers (which are often competitors) are involved. **Figure 8** provides a graphical representation of the OCORA stakeholders' interactions.

It must be noticed that the current version of the present document does not properly address the concept of a standardised configuration management process (e.g. to quickly and automatically deploy new Sw version(s) or new set(s) of parameters for the building blocks). A first discussion document [14] has been created late in R3 and will be further developed in R4. When a better maturity will be acquired on this topic, the following **Figure 8** and **Table 6** will be updated to add the tasks, responsibilities for each stakeholder and the interactions between them.

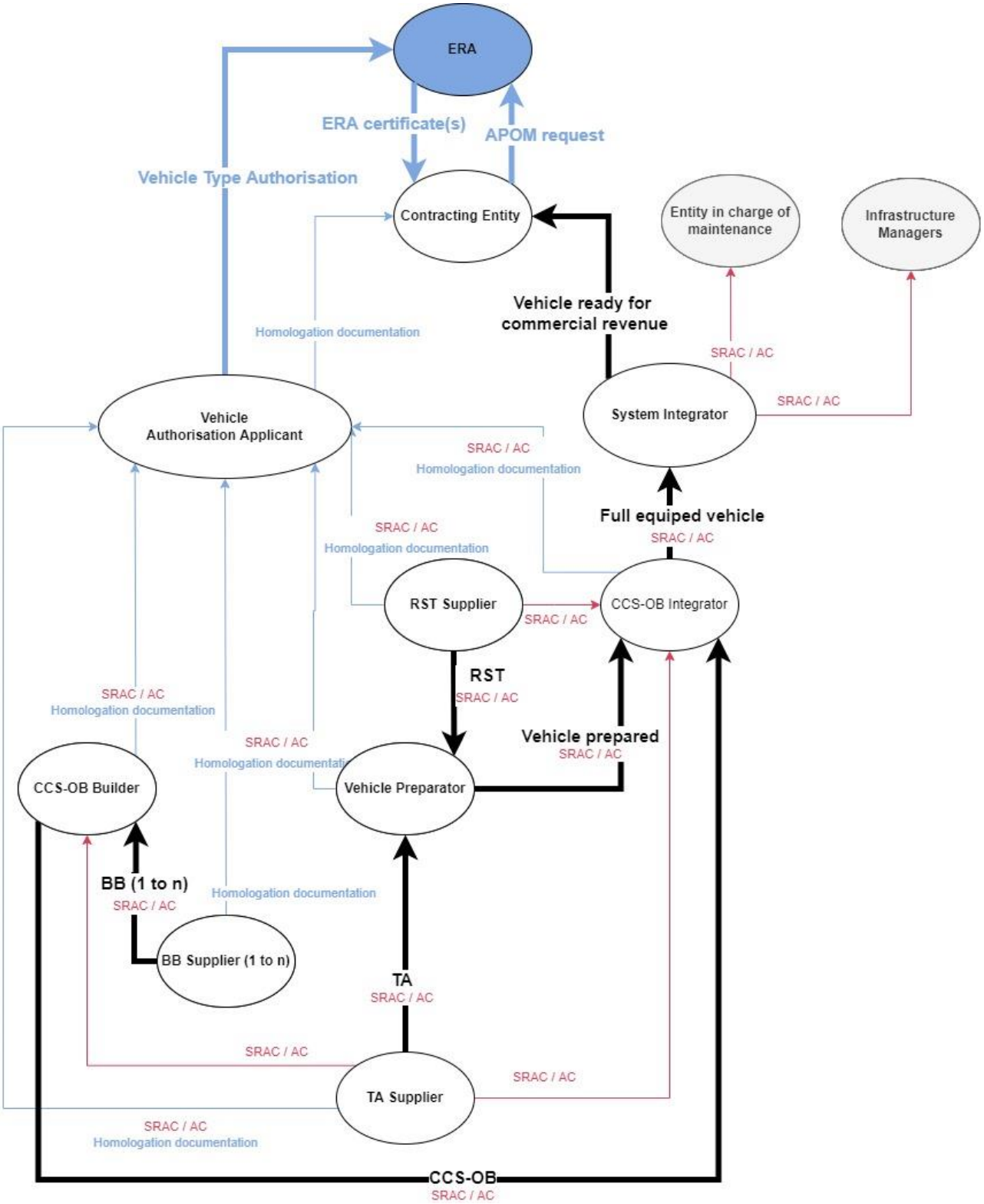

Figure 8 Stakeholder interactions

The detail of each interaction is provided in **Table 6** below.

Role / Stakeholder	Main responsibilities / Tasks the Stakeholder is in charge of	
Contracting Entity (CE)	Top authority in the project, which is involving OCORA compliant systems *'Contracting Entity' means a public or private entity which orders the design and / or construction or the renewal or upgrading of a subsystem (i.e., Directive 2016/798 and Directive 2016/797)*	
Inter connection (Inputs and Outputs)	**Inputs:** - Political orders and business incentives - Return of experience on previous projects	**Outputs:** - Emit the tenders/bids for all stakeholders - Contracts (i.e., requirements) for all stakeholders
System Integrator (SI)	- Performing the safe integration of the Vehicle and its dedicated network (e.g., ERTMS line (n)), - Realizing the data preparation: Vehicle into network (main technical task), - Realizing the Specific Application Safety Case (train + network), - Managing the other assessment types (e.g., NoBo, DeBo), Requiring the Application for Placing On the Market (APOM) to the ERA (official document allowing the train to be placed in commercial revenue)	
Inter connection (Inputs and Outputs)	**Inputs:** - OCORA integration/test requirements at System level => from OCORA project - Integration, configuration and test requirements => (CE) / Infrastructure Manager (IM) - NNTR => (VAA) - TSI OPE (+ possible other TSIs), Directive 2018/545 (Authorisation for Placing On the Market (APOM))	**Outputs:** - Vehicle in operation => (CE) - SRAC/AC => Infrastructure Manager (IM) / Entity in Charge of Maintenance (ECM) Application documentation (in case (SI) holds Vehicle Authorisation Applicant role) => ERA / (CE)
Vehicle Authorization Applicant (VAA)	- Realizing the Generic Application Safety Case (full equipped vehicle), - Managing the other assessment types (e.g., NoBo, DeBo), - *(if requested)* **Requiring the Vehicle Authorisation to the ERA and to the NSAs (National safety Authorities) → official document allowing the train to be placed in commercial revenue**	
Inter connection (Inputs and Outputs)	**Inputs:** - TSI CCS, LOC&PAS, Directive 2018/545 (Vehicle Type Authorization) - NNTR => (VAA)	**Outputs:** - Homologation documentation => ERA / (CE) Application documentation => ERA / (CE)
CCS-OB Integrator (COBI)	- Defining the functionalities required from the CCS-OB (depending on the project request) - Designing the complete integration phase (e.g., electrical drawings, mechanical specifications) - Assign the above tasks to the Vehicle Preparator, CCS OB Builder and TAS - Realising the safe integration of the CCS OB into the RST - Physical integration of the CCS OB into vehicle - Testing the complete vehicle in the scope of OCORA, TSI CCS/TSI LOC&PAS using the CCS OB and RST as black boxes - Realising the data preparation of the CCS OB on the dedicated RST - Realizing the Generic Application Safety Case (full equipped vehicle), Managing the other assessment types (e.g., NoBo, DeBo),	
Inter connection (Inputs and Outputs)	**Inputs:** - OCORA integration/test requirements at Vehicle level => from OCORA project - Integration, configuration and tests requirements => (RSTS) / (CE)* - TSI CCS, LOC&PAS, - NNTR => (VAA)	**Outputs:** - Full vehicle => (VAA) - SRAC/AC => (VAA) / (SI) Homologation documentation => (VAA)
Rolling Stock Supplier (RSTS)	- Realising the RST (in case of new project) - Retrofitting old equipments (e.g., TCMS) (if needed) - Realising safety demonstration of critical parts: application of CSM and/or CENELEC standards - Managing the NoBo assessment (e.g., TSI LOC&PAS)	

<table>
<tr><th>Role / Stakeholder</th><th colspan="2">Main responsibilities / Tasks the Stakeholder is in charge of</th></tr>
<tr><td>Inter connection (Inputs and Outputs)</td><td>Inputs:
- Contract presenting the modifications/adaptations required on the RST for the retrofit => (CE) / (VP)
- TSI LOC&PAS (if applicable**)
- NNTR => (VAA)</td><td>Outputs:
- RST itself => (VP)
- SRAC/AC => (VP) / (COBI) / (VAA)
Homologation documentation (if applicable) => (VAA)</td></tr>
<tr><td rowspan="2">Vehicle Preparator (VP)</td><td colspan="2">- Realizing the safe integration of the TAS into the RST
- Testing signals and bus(es) present in the RST
- Testing the "legacy" signals existing between driver and RST which are not involving the CCS-OB system (if any). This is to ensure that OCORA does not disturb other proprietary signals.
- The detailed activities will be defined by the FVA team in a dedicated document.

Note: This document will not be available until at least 2024.</td></tr>
<tr><td>Inter connection (Inputs and Outputs)</td><td>Inputs:
- -Integration, configuration and test requirements => (RSTS) / (CE)*
- Technical documentation of the RST (drawing, electrical wiring schema) => (RSTS) / (CE)*
- TSI LOC&PAS (if applicable**)
- NNTR => (VAA)</td><td>Outputs:
- Vehicle prepared => (COBI)
- SRAC/AC => (COBI) / (VAA)
- Homologation documentation (if applicable) => (VAA)

*Especially for old trains, the original (RSTS) will not be contacted to get RST data of the train network. This will likely be done by the "user" of the RST (i.e., RU).

**When retrofitting trains built prior to TSI LOC&PAS, modifications may be done on the RST to be compliant to the TSI for concerned parts (e.g., doors, TCMS, braking systems) (this option remains subject to the application of the rules within the relevant TSI)</td></tr>
<tr><td rowspan="2">CCS-OB Builder (COBB)</td><td colspan="2">- Design the cabinet / rack and its electrical wiring
(OCORA might have to require standardised combinations)
- Assemble the BB in their electrical/mechanical cabinet/rack,
- Realising the safe integration of the selected BB,
- Configuration of the BBs for the concerned ETCS project(s)
- Validating the CCS-OB according to OCORA test requirements (i.e., test bench and procedures),
- Performing the further modifications of the CCS-OB (e.g., new BB, exchanges, new configuration...)
- Realizing the Generic Application Safety Case (most of cases) or the Specific Application Safety Case (few cases) of the full CCS-OB,
- Managing the other assessment types (e.g., ISA, NoBo, DeBo)
=> (in most cases) generic system that can be deployed on different fleets without modifications (same configuration or NO configuration is possible)</td></tr>
<tr><td>Inter connection (Inputs and Outputs)</td><td>Inputs:
- OCORA integration / test requirements at CCS-OB level => from OCORA project
- CCS-OB requirements (e.g., which BB to be integrated) => CE
- TSI CCS</td><td>Outputs:
- CSCS OB itself => (COBI)
- SRAC/AC => (COBI) / (VAA)
- Homologation documentation
=> (VAA)</td></tr>
<tr><td>Building Block Supplier (BBS)</td><td colspan="2">- Designing the BB according to OCORA requirements,
- Realizing the BB according to OCORA requirements,
- Validating the BB according to OCORA tests requirements (i.e., test bench and procedures),
- Realizing the Generic Product Safety Case (BB scope),
- Performing the further modifications of the BB according to OCORA requirements (e.g., new functionalities, improvements),
- Managing the other assessment types (e.g., ISA, NoBo, DeBo)

=> "off the shelf products" sent with all required certificates</td></tr>
</table>

<table>
<tr><th>Role / Stakeholder</th><th colspan="2">Main responsibilities / Tasks the Stakeholder is in charge of</th></tr>
<tr><td>Inter connection (Inputs and Outputs)</td><td>Inputs:
- OCORA requirements of the BB(n) => from OCORA project
- TSI CCS</td><td>Outputs:
- BB itself => (COBB)
- SRAC/AC => (COBB) / (VAA)
Homologation documentation => (VAA)</td></tr>
<tr><td>Train Adapter Supplier (TAS)</td><td colspan="2">- Designing the TA according to OCORA requirements,
- Realizing the TA according to OCORA requirements,
- Validating the TA according to OCORA tests requirements (i.e., test bench and procedures),
- Realizing the Generic Product Safety Case (TA scope),
- Performing the further modifications of the BB according to OCORA requirements (e.g., new functionalities, improvements),
- Managing the other assessment types (e.g., ISA, NoBo, DeBo)
- Identify which signals / functionalities are required/possible to be implemented into the TA

=> "off the shelf product" send with all required certificates</td></tr>
<tr><td>Inter connection (Inputs and Outputs)</td><td>Inputs:
- OCORA requirements of the FVA => from OCORA project
- Special case requirements (i.e., related to the RST networks itself) => (RSTS)
- TSI CCS / TSI LOC&PAS</td><td>Outputs:
- TAS itself => (VP)
- SRAC/AC => (VP) / (COBB) / (VAA) / (COBI)
Homologation documentation => (VAA)</td></tr>
<tr><td colspan="3">Responsibilities: Each Stakeholder has, in the contract offer a risk cost that cannot exceed its assigned part of the project offer (e.g., 20%). Therefore, e.g., the FVA supplier, cannot be responsible of the complete fail of the project even if this system induces delays or accidents.</td></tr>
</table>

Table 6 Tasks, responsibilities, and interactions for OCORA stakeholders

8.2 Business incentives

This section aims at supporting any contracting entity when realizing its call for tenders. Indeed, to ensure a successful OCORA project realization, and most of all for the first one(s), the choice of the companies to be assigned to one or several roles is a critical phase. To help at making relevant and project safe choices, the following table provides hints and recommendation to realize the assignment.

Role / Stakeholder	Business incentives for taking one or more Role/s as Stakeholder (By market players) *(Based on tasks and responsibilities of Table 5)*			
	Big Railway Undertakings (RUs) (*e.g., DB, SNCF, NS, SBB, RENFE, ÖBB…)*	**Rolling Stock Suppliers** (*e.g., Alstom, Siemens, Thales, Stadler, Hitachi, CAF…)*	**Traditional CCS Supplier** *(e.g., Thales, Hitachi, Alstom, Siemens, CAF…)*	**3rd Suppliers from other markets** *(e.g. Automobile, Aviation)* **/ New suppliers** (e.g., ERTMS suppliers **without vehicles** like the signaling company, Kontron)
Contracting Entity (CE)	- Financial strength to cover project risks - Legal responsibility to provide transport service - Years of return of experience on the role - Existing structure for contractual management within RU (e.g., juridical, EU founding) - Negotiation power with equipment providers (for the big RUs), (e.g., prices, priorities, technologies)	No obvious business incentives to be (CE).	No obvious business incentives to be (CE).	- Leasing companies may be candidates - Consulting company from historical RU (e.g., MASTERIS for SNCF, DB Systemtechnik, NedTrain for NS) - Big engineering companies pushing into new markets thanks to their know-how and engineering and project infrastructure.
System Integrator (SI)	- Years of return of experience in this role ⇨ already skilled - Strong connexion with the IM ⇨ time saving, influence on the network itself. During the integration, RU & IM can also tune some operating conditions directly because they own the whole system - RU & IM want to keep the “know-how” from their knowledge and experience - Financial strength to cover project risks	- FOR SMALL Rus which don’t have the engineering skill - Interesting for the (RSTS). If it also delivers (most) network equipment ⇨ master of the entire equipment and therefore less risk of complication during integration - To be mentioned in the (CE) contract: *“The (SI) chooses its Vehicle and (COBI) and the (BBS). Therefore, (SI) can address and select members and products from its own company as long as they comply the (CE)’s expectations (e.g., OCORA)”*	No obvious business incentives to be (SI).	- Consulting company from historical RU (e.g., MASTERIS for SNCF, DB Systemtechnik, NedTrain for NS) - Big engineering companies pushing into new markets thanks to their know-how and engineering and project infrastructure.

Role / Stakeholder	Business incentives for taking one or more Role/s as Stakeholder (By market players) *(Based on tasks and responsibilities of Table 5)*			
	Big Railway Undertakings (RUs) (*e.g., DB, SNCF, NS, SBB, RENFE, ÖBB…)*	**Rolling Stock Suppliers** (*e.g., Alstom, Siemens, Thales, Stadler, Hitachi, CAF…)*	**Traditional CCS Supplier** *(e.g., Thales, Hitachi, Alstom, Siemens, CAF…)*	**3rd Suppliers from other markets** *(e.g. Automobile, Aviation)* **/ New suppliers** (e.g., ERTMS suppliers **without vehicles** like the signaling company, Kontron)
Vehicle Authorization Applicant (VAA)	- Today RUs own/are responsible for the vehicle (including the entire documentation for RST and CCS) ⇨ therefore, the benefit to master all activities at the same level *(e.g., safety case and vehicle authorization)*	- Years of return of experience in this role *(Their vehicle fleet)* - "Know how" on RST which is not yet standardised - Own the infrastructure and personnel to perform this activity - To be mentioned in the (CE) contract: *"The (VP) chooses its (COBI) and (BBS) (including TA). Therefore, it can address and select members and products from its own company as long as they comply the (CE)'s and (SI)'s expectations (e.g., OCORA)"*	Only if (COBS) is also the (RSTS) ⇨ therefore, master of the systems of the entire train	- Railway engineering/consulting companies - New (BBS) (e.g., HASSLER, KONTRON) can get access to new markets and new type of activities - Combining with lower activities may be beneficial: (CE) + (SI) + Vehicle Assembler or Vehicle Assembler + (COBI) + Vehicle Enabler
CCS-OB Integrator (COBI)	- Master the technical integration of CCS into Vehicle ⇨ more flexibility to: organize project retrofit (*e.g., free choice of CCS providers)*, realize maintenance activities long-term (e.g., after the CCS-OB end of warranty) - New skills developed to hold the role: *new market sell service to external contracts with other RUs (e.g., for leasing companies, other countries VP activities)*	Only if (RSTS) is also the (COBB).	- Master the CCS-OB - This can be coupled with the activity of (COBB) for profit maximisation and additional service.	- Railway engineering/consulting companies - New (BBS) (e.g., HASSLER, KONTRON) can get access to new markets and new type of activities - Combining with lower activities may be beneficial: *(e.g., TAS definition, Vehicle enabler…)*

Role / Stakeholder	Business incentives for taking one or more Role/s as Stakeholder (By market players) *(Based on tasks and responsibilities of Table 5)*			
	Big Railway Undertakings (RUs) (*e.g., DB, SNCF, NS, SBB, RENFE, ÖBB…)*	**Rolling Stock Suppliers** (*e.g., Alstom, Siemens, Thales, Stadler, Hitachi, CAF…)*	**Traditional CCS Supplier** *(e.g., Thales, Hitachi, Alstom, Siemens, CAF…)*	**3rd Suppliers from other markets** *(e.g. Automobile, Aviation)* **/ New suppliers** (e.g., ERTMS suppliers **without vehicles** like the signaling company, Kontron)
Rolling Stock Supplier (RSTS)	- RUs are used to realise safety demonstrations and managing NoBo assessments. *Note: DB and SNCF used to be (RSTS).*	- Rolling Stock suppliers are Rolling Stock suppliers in the industry. - Rolling Stock suppliers are used to realise safety demonstrations and managing NoBo assessments.	Only if it is also the (RSTS) ⇨ therefore, master of the systems of the entire train	- Assumption: genuine (RSTS) not interested in building the TA for a dedicated train type: ⇨ New market for third companies (e.g., railway consulting companies, engineering companies) This could be combined with other roles such as (VP)
Vehicle Preparator (VP)	- Knowledge and return of experience on old/special vehicles (e.g., yellow fleet) to be retrofitted and which are out of warranty (e.g., new TCMS updates, electrical/mechanical adjustments). Therefore, new need to replace them completely	- Knowledge on the vehicle still on warranty. - The (RSTS) can provide its own TA solution for the whole fleet ⇨ new spare parts not present in the original contract - The (RSTS) can negotiate to “refresh” some old RST: - New version of TCMS - New ETCS may need new wiring and/or cabinets… - New other mechanical/electrical equipment - To fit the new CCS-OB system	Only if it is also the (RSTS) ⇨ therefore, master of the systems of the entire train	- Assumption: genuine (RSTS) not interested in building the TA for a dedicated train type: ⇨ New market for third companies (e.g., railway consulting companies, engineering companies) This could be combined with other roles such as (VP)

Role / Stakeholder	Business incentives for taking one or more Role/s as Stakeholder (By market players) *(Based on tasks and responsibilities of Table 5)*			
	Big Railway Undertakings (RUs) (*e.g., DB, SNCF, NS, SBB, RENFE, ÖBB…)*	**Rolling Stock Suppliers** (*e.g., Alstom, Siemens, Thales, Stadler, Hitachi, CAF…)*	**Traditional CCS Supplier** *(e.g., Thales, Hitachi, Alstom, Siemens, CAF…)*	**3rd Suppliers from other markets** *(e.g. Automobile, Aviation)* **/ New suppliers** (e.g., ERTMS suppliers **without vehicles** like the signaling company, Kontron)
CCS-OB Builder (COBB)	No obvious business incentives to be (COBB).	No obvious business incentives to be (COBB).	- The CCS Supplier can select BB coming from its company (as long as they respect the (CE) criteria) - As the traditional CCS supplier master the whole ETCS on-board system, they will also be able to provide most, or all type of BB and therefore choose them to make an easier integration - Holding this role also means keeping in charge of projects where their monolithic ETCS were involved. Otherwise, they can be "replaced" by new company (e.g., non-European competitors, based outside of Europe)	- Railway engineering/consulting companies - New (BBS) (e.g., HASSLER, KONTRON) can get access to new markets and new type of activities

Role / Stakeholder	Business incentives for taking one or more Role/s as Stakeholder (By market players) *(Based on tasks and responsibilities of Table 5)*			
	Big Railway Undertakings (RUs) (*e.g., DB, SNCF, NS, SBB, RENFE, ÖBB…)*	**Rolling Stock Suppliers** (*e.g., Alstom, Siemens, Thales, Stadler, Hitachi, CAF…)*	**Traditional CCS Supplier** *(e.g., Thales, Hitachi, Alstom, Siemens, CAF…)*	**3rd Suppliers from other markets** *(e.g. Automobile, Aviation)* **/ New suppliers** (e.g., ERTMS suppliers **without vehicles** like the signaling company, Kontron)
Building Block Supplier (BBS)	No obvious business incentives to be (BBS).	- Can be beneficial, if ⇨ BB covered in CCS cell	- New market opportunities: ⇨ access to new retrofit projects where the company was not involved before while dealing with the monolithic approach *(i.e., other ETCS supplier, other vehicle supplier company)* - Position or privilege regarding the delivery of the first BBS ⇨ have the know-how and therefore be able to deliver products before new players enter the market - As the traditional CCS supplier master the whole ETCS on-board system, they be able to provide most or all type of BB and thereby be involved in the widest scope possible of retrofit projects /new projects	- New players are expected to reach the railway market thanks to the modularity focus on: ⇨ LOC-OB *(today they are only discussing with the ETCS suppliers and not with the final customer)* ⇨ TDS *(today they are only discussing with the ETSC suppliers and not with the final customer)* ⇨ New CCS functionalities (e.g., perception, MDCM, DAS, ATO) ⇨ The non-safe BB / Sw BB

Role / Stakeholder	Business incentives for taking one or more Role/s as Stakeholder (By market players) *(Based on tasks and responsibilities of Table 5)*			
	Big Railway Undertakings (RUs) (*e.g., DB, SNCF, NS, SBB, RENFE, ÖBB…)*	**Rolling Stock Suppliers** (*e.g., Alstom, Siemens, Thales, Stadler, Hitachi, CAF…)*	**Traditional CCS Supplier** *(e.g., Thales, Hitachi, Alstom, Siemens, CAF…)*	**3rd Suppliers from other markets** *(e.g. Automobile, Aviation)* **/ New suppliers** (e.g., ERTMS suppliers **without vehicles** like the signaling company, Kontron)
Train Adapter Supplier (TAS)	- The RUs can design a TA that fits its whole fleet to be retrofitted (including various (RSTS)) ⇨ this requires skills on train networks which are not obvious to RUs - For very old RST without support by (RSTS), only RUs still have the knowledge of those RST.	- They master their own train networks on all type variations of vehicles - They can define a single TA that fits all (or maybe 90%) of their company's RST and deploy it on several various projects later	Only if it is also the (RSTS) - therefore, master of the systems of the entire train - On retrofit projects, it is beneficial if the company has already realised a TAS with the same train connection (e.g., TCMS) or a legacy EVC monolithic system compliant with this train's connection	- Assumption: genuine (RSTS) not interested in building the TA for a dedicated train type: ⇨ New market for third companies (e.g., railway consulting companies, engineering companies) - This could be combined with other roles such as (VP)

Table 7 Business incentives when choosing the stakeholders