

# OCORA

Open CCS On-board Reference Architecture

## CCS On-board Retrofit

### Guideline for Projects

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## Revision history

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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 references 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
- [7] OCORA-TWS01-030 – System Architecture
- [8] OCORA-TWS04-010 – Functional Vehicle Adapter – Introduction
- [9] SUBSET-139, ATO over ETCS - ATO-OB / TCMS FFFIS, version 0.1.0
- [10] SUBSET-119, ERTMS/ETCS – Train Interface FFFIS, version 1.2.10
- [11] OCORA-TWS07-040\_RAMSOptimized Approval Process
- [12] SUBSET-147, ERTMS/ETCS and ATO over ETCS FFFIS part: CCS Consist Network Communication Layers version 0.1.10

# 1 Introduction

## 1.1 Purpose of the document

The purpose of the document is to specify what a supplier shall consider in an ETCS/ATO onboard retrofit project to avoid some of the problems stated in the OCORA problem statements [6] and, in more detail, the approach and methodology to be used and the documents to be generated, as intermediate formal deliverable, for the interfaces with the vehicle TCMS, with the ETCS and ATO onboard systems [9][10]. This document has been generated based on the experiences within the Stuttgart retrofit project of Deutsche Bahn.

This document is addressed to experts in the CCS domain and to any other person, interested in the OCORA concepts for onboard 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 a complete onboard CCS system, or for onboard CCS replacements for functional upgrades or for life-cycle reasons.

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

## 1.2 Applicability of the document

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

## 1.3 Context of the document

This document is published as part of an OCORA Release, together with the documents listed in the Release Notes [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].

The interface specification defined in this document is based on the OCORA approach for integrating the CCS onboard with the vehicle by means of a Functional Vehicle Adapter. Therefore, it is suggested to previously read the introduction document to the Functional Vehicle Adapter [8] that illustrates the context of the Functional Vehicle Adapter itself.

## 2 CCS-OB – TCMS interface

OCORA requests the standardization of the interface between the CCS and the vehicle (TCMS) to implement standard ETCS/ATO functionality as a product. This to come to a modular design, given as input for the today supplier specific solutions.

The target is a complete FFF interface based on the relevant subsets [9][10], to cover the interoperability targets, but also considering today's supplier specific and operationally in use signals. To reach “plug & play” like exchangeability, all vehicle or solution specific adjustments are obtained via parametrization of an intermediate FVA (Functional Vehicle Adapter) for dedicated functions. This allows a standard ETCS/ATO functionality as a product (not as a project). In other words- the vehicle specific implementation shall be done in the FVA and not in the EVC/OBU to keep the interface stable for fleet wide modifications including various different vehicle types.

The figure below describes the migration steps:

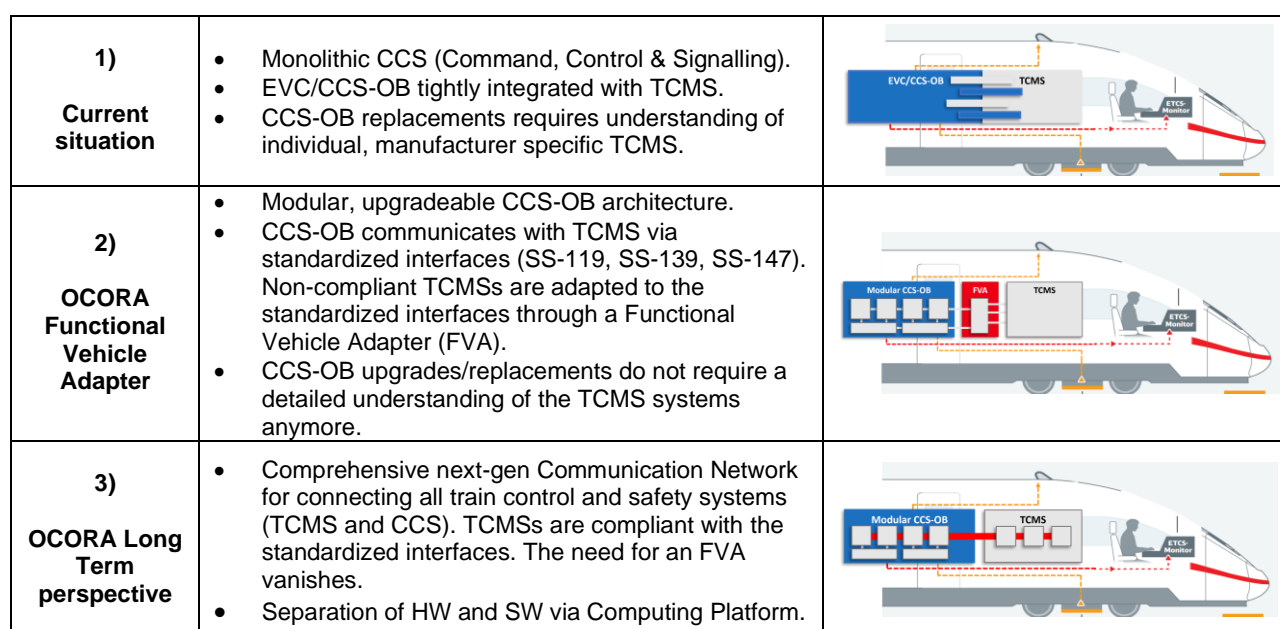


Figure 1 - CCS-OB – TCMS interface

State of the art is the step 1, “Current situation”. Where suppliers are offering their EVC/CCS-OB solution to be integrated in different fleets (different vehicles with potentially unknown TCMS signals).

Today for each project there is a need for a specific study, coming to a specific solution, where decisions on the adjustment to be made inside the current TCMS (when necessary, involving the OEM supplier) or on the signal interpretation and consolidation in the EVC/ OBU are made.

In that respect, the OCORA goal, in favor of the modularity, is to reach a standard FFF interface for the CCS-OB obtained from the vehicles via a FVA dedicated module (step 2 “OCORA Functional Vehicle Adapter”) or via OEM native implementation (step 3 “OCORA Long Term perspective”) based on the actual subsets [9][10].

To move from step 1 “Current situation” to the next steps 2) or 3), decoupling by fact the CCS-OB interface from the specificity of the envisaged vehicle type, is necessary to extend the definition of the CCS-OB/ETCS-ATO interface completing its FFF definition adding, on top of the interoperability portion well described in the subsets, the specific needed signals already independently identified by the different current solutions (supplier specific) already in place. To facilitate this harmonization and come to a proposal (CCS-OB FFF standard interface) it is regarded as necessary to include a detailed analysis of the current solutions.

On top of the different initiatives already running inside the industry (UNISIG) and study stimulated around the OCORA program, this document aims to request the needed details in form of proposed formal deliverables to be requested in the future projects (step 1). These deliverables can later be used as pragmatic knowledge

base to reach a common understanding and agreement on the delta to be considered, on top of the actual subsets [9][10], for a complete definition of a standard FFF interface. These deliverables can later be used as pragmatic knowledge base to reach a common understanding and agreement on the delta to be considered, on top of the actual subsets [9][10], for a complete definition of a standard FFF interface.

It shall also be mentioned, that the standardization of the communication layer [12] is going on in parallel (aimed for 2025), which is a further enabler for the FFFIS.

The Chapter 3 describes the OCORA long term objective.

The Chapter 4 describes the OCORA short term target to be executed in standard projects to come.

The Chapter 5 lists the detail requirements to be included in future bids and their rationales.

### 3 Long-term objectives

While the OCORA long-term objectives are explained within the published documents, which have been listed in chapter 1, this guideline is an intermediate step to approach the following objectives: to prepare market participants for the expected shift in standard modularity of building blocks, modular safety and commercial- and engineering roles.

Further details of the expected functionality of the FVA and the foreseen interface specification [9][10][12] are also part of the OCORA published documents. These are to be considered as the future aim which shall be introduced and facilitated to the railway industry with the contractual requirement of this guideline.

In addition to the framework known from the referred OCORA documents, this guideline will introduce the below listed subjects to the retrofit projects of the near future:

- Pre-cursor to OCORA implementation:
  - o The contractual requirement to apply this guideline will layout the basis of information exchange and responsibility distribution needed for the modularity aspired by OCORA. While this retrofit guideline document version is an intermediate approach ahead of future more detailed versions, which are still under discussion within the OCORA workstream.
- Pre-cursor to modular safety concept and optimized approval:
  - o The approach of modular safety is one of the concepts of OCORA. For the scope of this guideline, it means that the interface definition of each vehicle type will have to be documented and has to be provided by the train manufacturer and the CCS onboard supplier. With this information the FVA can be introduced as universal interface module, as described in the FVA introduction documents.
- Financial benefit
  - o By requiring the application of this guideline in the tender, bidding and engineering of the upcoming retrofit projects. The information exchange, interface definition, functionality description and roles will be established and thereby facilitate the first step to develop the FVA.
  - o The information collected by different implementations will be the base to propose a standard interface, which allows the development of standard applications for the CCS onboard, that can be smooth integrated without further vehicle specific modifications. It will be a reasonable balance between the technical possibilities and a reasonable effort on side of the FVA implementation.

#### 3.1 Possible separation of responsibilities

A change from a project by project, integrated approach towards a modular architecture calls for a new split of responsibilities to make it a benefit for all involved parties and to reduce the overall effort by means of reusability. Following this vision, the OCORA RAMS workstream is elaborating an optimized approval process [11] which will require the definition and separation of specific commercial and engineering roles and

responsibilities. These following roles are under consideration and shall be required in the retrofit projects:

System Integrator (SI): Can be RU or 3<sup>rd</sup> party/new supplier

Team in charge of:

- performing the safe integration of the Vehicle into a dedicated track network (e.g., ERTMS line XYZ),
- 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),
- submitting the Application for Placing On the Market (APOM) to the ERA (official document allowing the train to be placed in commercial revenue)
- (If requested) processing the Vehicle Authorisation to the ERA (ending in an official document allowing the train to be placed in commercial revenue)

Vehicle Preparator: Can be RU or train manufacturer but is unlikely to be a traditional CCS supplier or 3<sup>rd</sup> party/new supplier

Team in charge of:

- support the safe integration of the CCS-OB into the RST.
  - testing signals and bus(es) present in the RST, basically testing the interface.
  - testing the "legacy" signals existing between driver and RST which are not involving the CCS-OB system (if any). This is to ensure that CCS-OB integration does not disturb other proprietary signals.
- the detailed activities will be defined in chapter 4.

CCS Onboard Integrator (CI): Neither RU nor train manufacturer but is traditionally the CCS supplier or a 3<sup>rd</sup> party/new supplier

Team in charge of:

- formalizing 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 Train Adapter Supplier (TAS)
- certifying 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
- data preparation (parametrisation) of the CCS-OB for the dedicated RST
- realizing the Specific Application Safety Case (full equipped vehicle),
- managing the other assessment types (e.g., NoBo, DeBo),

Vehicle Integrator (VI): Can be either RU, train manufacturer, traditional CCS supplier or 3<sup>rd</sup> party/new supplier

The responsibilities of the Vehicle Integrator are still to be defined.

Building Block Supplier (BBS): Can be either RU, train manufacturer, traditional CCS supplier or 3<sup>rd</sup> party/new supplier

The responsibilities of the Building Block Supplier are still to be defined.



Train Adapter Supplier (TAS): Can be either RU, train manufacturer, traditional CCS supplier or 3<sup>rd</sup> party/new supplier

The responsibilities of the Train Adapter Supplier are still to be defined.

The table below shows the separation of roles within the present state of the development of the optimized approval process. While technically it is possible that any player in a retrofit project can take any of the roles, it is likely that RU, train manufacturer and traditional CCS supplier will take possession of the roles as shown in the table. The introduction of new suppliers to the market maybe one of the outcomes of the role definition and contractually defined separation.

ROLE/ Player	RU	Train manufacturer	Traditional CCS supplier	3 <sup>rd</sup> /new supplier
Vehicle Preparator (SI)	Can be	Can be	x	x
System Integrator (SI)	Can be	X	Can be	Can be
Vehicle Integrator (VI)	Can be	Can be	Can be	Can be
CCS-OB Integrator (CI)	X	X	Can be	Can be
Building Block Supplier (BBS)	Can be	Can be	Can be	Can be
Train Adapter Supplier (TAS)	Can be	Can be	Can be	Can be

The separation of the roles should be required in the retrofit tenders to facilitate the basis for the performance increase in the approval and certification process for the different vehicle classes. By introducing the standard separation of the roles, the modular re-certification approach can be established.

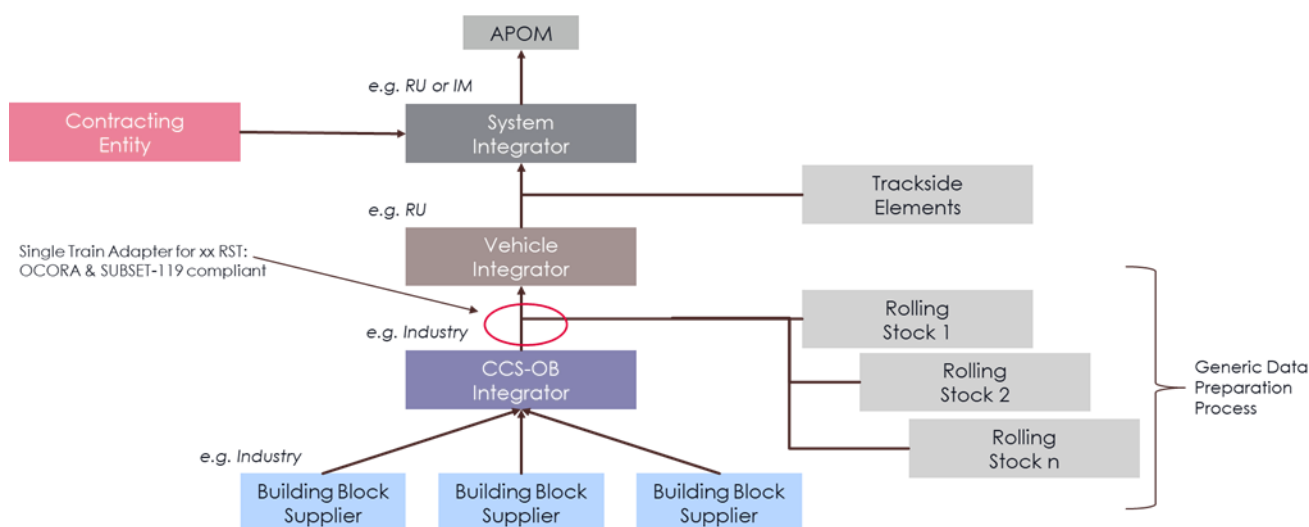


Figure 2 - Roles overview

The figure above shows an overview of the interaction of the roles and the position of the train adapter which will include the FVA. The intention is to conceive the FVA as such to be included in most or all available rolling stock combination to act as signal converter and buffer between vehicle integrator and CCS-OB integrator. Thus, introducing a module which can cover all possible variations of rolling stock with CCS-OB signals.

First step: focus on vehicle preparation, which is the scope of the guideline for now and part of the short-term deliverables in chapter 3.

Knowing that the roles above are not distinguished in the present projects the exchange of information of the signals will be the first basis between the present Vehicle Integrator (supplier of the vehicle, as of today) and the System Integrator (Contracting entity/ holder of the vehicle i.e. RU). The requirements how this information exchange can be established is detailed in chapter 5.

Future steps to be taken: focus on the later project phases of projects with tenders which can require this guideline.

In later project phases the roles should become part of the contract framework and thereby introduce an obligation for information exchange and collaboration, but also separate responsibilities for the final product stages.

### 3.2 Possible implementation of additional functionality

Older vehicle classes may not have a TCMS system, as explained in the FVA introduction. In this case it may be necessary to generate certain standard signals for the CCS onboard systems to satisfy functionalities which use the standard interface to the FVA/TCMS. Another functionality of the FVA will be the conversion of train specific signals to a standard format for the CCS onboard systems, if an older generation of vehicle class does not provide such signal format.

This way the FVA acts as the interface converter or standard interface signal generator to ensure defined and train independent signal formats towards the CCS onboard.

The information exchange of train supplier and CCS onboard supplier will be required by the contracting entity by requiring the application of this guideline to exchange the list of signals with all the formats and requirements of the different signals.

The modularity can only be achieved if the level of conversion of the FVA fits to most or all available rolling stock variants and vehicle classes.

The FVA, as part of the train adapter, should follow the evolution strategy of OCORA. Since this strategy is still under discussion this guideline will require to follow the “significance process and matrix” of the TWS07 RAMS Evolution document. When parts of the CCS onboard will be changed, the significance matrix process shows the steps to be taken to analyse if an evolutionary change can be categorized as minimal, medium or high in terms of criticality for safety related aspects.

The result of this analysis would provide insight if a new certification, a letter of support per modification or only an annual letter of support with the list of all annually occurred modifications is needed. The process to evaluate this significance is part of the next OCORA releases and cannot yet be taken as reference for this guideline but will be taken into account in future updates.

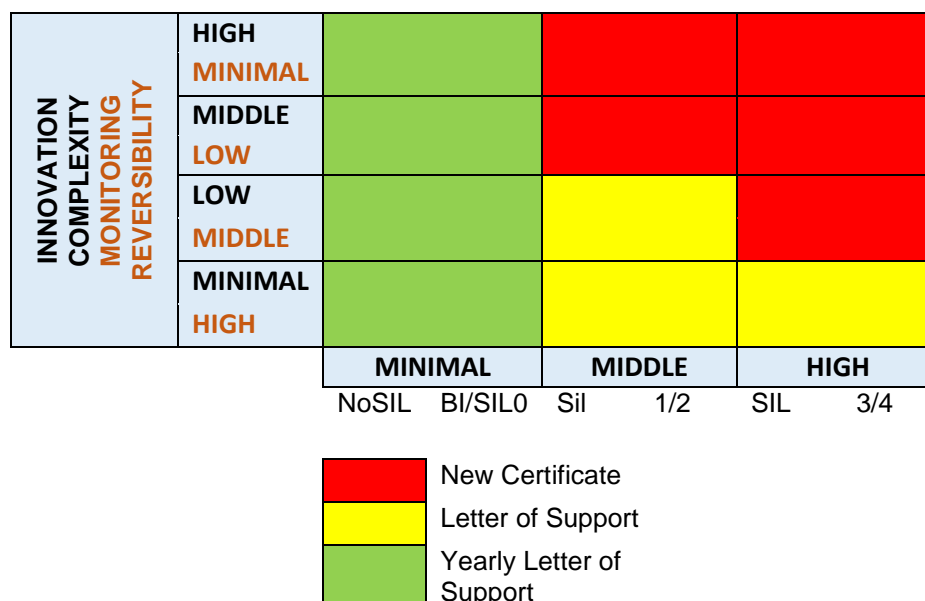


Figure 3 - Significance matrix of TWS07 RAMS Evolution

The following criteria aim at choosing the line in the matrix in the figure 1 above from “MINIMAL” to “HIGH”.

Based on the combination between minimal, middle and high the need to apply for a new certificate, a letter of support or a yearly letter of support will be defined. Since the FVA will convey and convert signals between TCMS and CCS onboard and the modularity of the building blocks within the CCS is not yet given. The modifications will likely be middle and high at all initial evolutionary stages of the FVA.

## 4 Short-term approach

The vehicle preparation will be asked as explicit part of the contractual requirements, as formal intermediate deliverable. For this, the players have to exchange the information and details needed to clearly define the interface between TCMS / FVA and CCS onboard, based on chapter 5 of the FVA introduction document [8].

Based on OCORA concepts, new tenders have to require the application of this guideline. Furthermore, the roles and the contractual obligation and the compliance to exchange all needed information for the interface definition between contracting entity, vehicle integrator and CCS onboard integrator has to be an essential requirement for bid placement acceptance.

Requirements to fulfil for each role are identified in more detail in chapter 5 for each project engineering phase. In the present state of this guideline the emphasis is put on the vehicle preparation phase for the purpose to facilitate the required information exchange of all signals according to the relevant subsets [9][10] as well as proprietary additional signals for the individual vehicle types.

The CCS onboard supplier is the integrator and the vehicle preparator in the projects of today, whereas the future setup of the OCORA role structure will allow further separation of the roles and thereby open the door for new players and new suppliers for parts of the project work packages and responsibilities.

The ETCS/ATO interface to the TCMS of the vehicles which will require a retrofit for ETCS/ATO onboard capability has to be documented and made available to all onboard supplier/ integrator, vehicle owner and contractual entity. The product requirement specification for system interfaces of either ETCS/ATO onboard or TCMS has to include the needed modifications and input signal details as listed per phase in chapter 5.

With a successful documentation of the interface specification, the basis will be created for the development of the FVA in future OCORA phases. Since the resulting interface specification is the first step for the standardization of the common interface specification and the modularisation goal of OCORA.

Without the mandatory contractual deliverable, the documentation will remain hidden in the monolithic design

roles which only require internal information exchange instead of documenting the interfaces within the concept and design phases during retrofit. The number of vehicle and system variants will require an increased throughput of retrofit projects. This can be achieved with the interface definitions, by then clustering similar vehicle classes to groups of interface combination. In this way, more retrofit projects can be completed by identifying the similar vehicle preparation steps needed in relation to the similar interface combinations.

To motivate the tendering and bidding parties for the upcoming retrofit projects, the requirement “OCORA Release 3 compatible” will have to be listed among the specified project framework requirements. With the introduction of this, the learning and broader definition of the TCMS to ETCS/ATO onboard interfaces will improve to more reliable vehicle preparation and project planning based on reuse among projects.

Since the OCORA compatibility will also emphasise on the definition of the roles and their responsibility, as described in chapter 3, the project organisations will automatically take steps towards the modularity needed for the long-term aspired optimized approval process. By leaning towards the OCORA compatibility, the process establishment and retrofit project handling will improve from each retrofit project in a learning curve for role and interface definition.

With the maturity of the application of this guideline, the guideline itself will evolve and include the lessons learned. The goal is a full OCORA modularity in the future. This will have to evolve in several iterations until the interfaces can be standardised, the project roles be defined, separated, and fixed during the project phases, and in future modular safety and optimized modular approvals can be achieved.

One of the future steps should be the implementation of the roles and their responsibilities in more clarity. Having the roles separated and the interfaces standardised, the room will be established for additional suppliers to provide building blocks and modules or processes to the projects. The aim is to create the ability for contracting entities and the railway industry to retrofit and roll-out the ETCS onboard to the present rolling stock in Europe.

These are the immediate steps required by this guideline:

1. Contractual obligation to apply this guideline in tenders for the ETCS/ATO retrofit projects
2. Call for OCORA compliance in tenders.
3. Define roles such as onboard building block supplier, vehicle integrator, CCS onboard integrator, vehicle preparator and contracting entity<sup>1</sup>
4. Prepare the projects and vehicles according to the guideline, providing knowledge of all TCMS-ETCS/ATO onboard signals and defining the interfaces in clarity.

## 4.1 CCS-OB – TCMS interface in retrofit projects

Target of this document are “retrofit projects”. It is assumed that the vehicles have a modern TCMS architecture with a bus system (e.g. MVB, ETH, CAN) where most of the signals needed to be implemented for the ETCS/ATO onboard retrofit are already present and do not have to be generated for the new systems.

It is likewise assumed that the ETCS/ATO onboard building blocks proposed by the supplier is part of a well-established product development roadmap with an available generic application which is configured with added specific applications for each specific project.

### 4.1.1 Application of this guideline in the retrofit projects

The main intention of this document is to support a formal information exchange to be established by contract, with a proper formal milestone, grouping activities that are supposed to be executed anyhow in the flow of the current contracts, formalising a set of documents as demonstration of the activity of adaptation of the interface between the vehicle TCMS and the ETCS/ATO onboard systems.

Just as example, for the scope of clarity, evidence required in relation to the TCMS to ETCS/ATO onboard interface will contain information like the following (specified more in detail in subsequent chapters of this

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<sup>1</sup> these roles can be taken by the same entities

document):

- Signal interfaces
- Project configuration
- TCMS changes
- Signal adaptations (formats to be adapted/converted)
- Parametrization (signal adaptation, vehicle, and project specific, generic application configuration)
- Additional signals and/or product specific functions, which are not listed within the Subset, and the reason why
- Test specifications/procedures/results/pass-fail criteria, use cases
- All other relevant documents...

Projects related to old vehicles, without TCMS present, are classified as special cases. Although not completely out of scope for this document, they are not the main target and require specific discussion and dedicated solutions. New vehicles designs are also not in the main target of this document since the ETCS/ATO onboard integration is supposed to be already managed, following the same principle of this document, in the main contract.

#### 4.1.2 Split of the deliverables in the standard project phases

Every project phase requires specific deliverables which are listed in chapter 5. All those deliverables are part of the contractual volume to be named in the tenders for the retrofit project to enable the application of this guideline and enforce the exchange of interface signal specifications.

The information delivered in the different phases are not the same and require the exchange of documents which will separate the specification by part, subsystem, and position in the execution planning.

#### 4.1.3 Embedding the Guideline in the main contract

Already in the tenders of the upcoming retrofit projects this guideline and the requirement of OCORA compatibility has to be part of the mandatory items. It would increase the motivation of potential bidders if the application of this Guideline would lead to partial EU funding. This way the industry would have a direct incentive for compliance.

## 5 Requirements per project phase

The vehicle preparation phase shall be seen as intermediate deliverable in standard projects with a focus on the CCS-OB – TCMS interface.

### 5.1 Important note

This part of the document aims to support the OCORA strategy as described in the above chapters. To prepare the scenario for the future interfaces between different scope of work, specific requirements are here expressed in relation to the vehicle preparation phase scope of work.

Other activities related to the whole project are not considered here unless necessary (will be eventually added in future version where other project phases will be detailed).

It is anyhow to be outlined that, for the specific projects to come, it is the organisation responsible for the whole project (typically the purchasing organisation that publishes the calls for bids) that need to develop a concept how the whole contract will be organized.

In case the principle described with this document will be used as a whole, the organisation must be consistent with the roles described in current chapter 3.1.

Following requirements will apply to 2 different roles.

- Contracting Entity (*vehicle owner / RU*)
- Supplier (*CCS onboard bidder / supplier*)

### 5.2 Vehicle Preparation – Pre-Bidding phase

No requirement yet defined here related to the vehicle preparation

### 5.3 Vehicle Preparation – Bidding phase

#### 5.3.1 Reference the 'Project Guideline' document in the call for tender.

*The Contracting Entity must reference the 'Project Guideline' document (this document) in the call for tender.*

##### 5.3.1.1 Rationale

*The 'Project Guideline' formally defines the deliverables during the project. These are needed for proper project execution and to ensure that all know-how is properly documented.*

#### 5.3.2 Functions required from the CCS onboard

*The Contracting Entity must issue a specification defining which functions are required from the CCS onboard (e.g. ETCS Levels, ETCS Modes, Track Conditions, ATO GoA level, interoperability specification versions, etc.).*

##### 5.3.2.1 Rationale

For clarity concerning the used signals.

To document the leading requirements for parametrisation of the CCS onboard systems. Based on this information the contractor can estimate the required efforts.

### 5.3.3 Vehicle interface documentation

*The Contracting Entity in the call for tender must deliver an up-to-date interface description of the current TCMS (Rolling Stock) towards the CCS Onboard for each involved vehicle type (including sub-variants), including the information of the former supplier.*

#### 5.3.3.1 Rationale

The Contractor needs this information to elaborate his offer. Based on this information he will estimate the efforts and clarify how the new interface can be implemented.

### 5.3.4 Information needed from the TCMS system at the bidding stage

*The supplier, in his offer, has to demonstrate his capability to implement the vehicle interface (typically on the TCMS system) and indicates the planned actions for having proper information and tools to evaluate the project feasibility and realisation, during the contract execution.*

*The vehicle interface implementation needs to be adjusted for a proper flow of information between the TCMS and the ETCS/ATO onboard systems, as necessary.*

#### 5.3.4.1 Rationale

For the implementation of an ETCS/ATO onboard system into an existing vehicle, detailed information on the existing inner data flow and protocols of the vehicle TCMS are needed. Being the ETCS/ATO onboard interfaces to the vehicle defined in [9][10], it is important, for the project implementation, to make a preliminary evaluation of the possible existing gaps and eventually to assess the capability to introduce changes in the TCMS system or equivalent measures.

In case of changes in the TCMS vehicle system that will require relevant approval for operations by the authorities, this will have to be outlined and must be evaluated considering the applicable rules (at least EN50126:2017, EN50128:2011, EN50129:2018; EN50159:2010).

For a successful project execution, the main modifications needed on the vehicle TCMS original system, must be outlined and described with the corresponding rationale.

The individual signals available from the specific vehicle TCMS (INPUTs/OUTPUTs) need to be mapped with the signals defined in the interface specifications SUBSET-034 / SUBSET-119 / SUBSET-139. This represents a complete picture of the interface between the TCMS and ETCS/ATO onboard functions.

At its best those capability shall be supported by an agreement with the vehicle manufacturer during the bidding stage, where both, project concept and updates, are managed in a co-design phase.

## 5.4 Vehicle Preparation - Project kick-off phase

### 5.4.1 Project plan

*The contracting entity has to deliver a project plan (at deliverables level) indicating in which time frame the vehicle preparation phase shall be realised.*

#### 5.4.1.1 Rationale

For clarity related to the time plan of the vehicle preparation phase.

### 5.4.2 Communication concept

*The contracting entity has to deliver a communication concept (who is reporting to whom), how the activities for the vehicle preparation phase will be synchronised between the different involved organisations.*



#### 5.4.2.1 Rationale

For clarity related to the specific communication during the Vehicle Preparation phase

## 5.5 Vehicle Preparation – Design phase

### 5.5.1 Integration concept

*The supplier has to deliver an Integration concept document describing how the CCS Onboard is integrated into the Rolling Stock for each involved vehicle type (including sub-variants). This document describes all required signals, how these signals are available on Rolling Stock side, indication if a Train Adapter component is used, which functions are provided by the Train Adapter (including the description of mathematical functions, if any).*

#### 5.5.1.1 Rationale

Target of the OCORA solution is to have always the same and standardised interface between the ETCS/ATO onboard applications and the TCMS / vehicle. To fulfil this goal, it might be needed to adapt data to actors / from sensors on the vehicle for specificities of the vehicle. In the OCORA solution this adaptation function is executed in a component called Functional Vehicle Adapter SW. The interface of this intermediate component to the ETCS/ATO onboard shall fulfil the Interface Specifications [9][10] and, as per target, be connectable to any CCS Onboard subsystem adhering to those defined interfaces.

The transformation of the vehicle real input/output data into the Interface Specifications [9][10] needs to be formalized and described.

### 5.5.2 Interface specification

*The supplier has to deliver an Interface specification describing at FFFIS level the interface from CCS Onboard towards the Rolling Stock (TCMS and / or other) for each involved vehicle type (including sub-variants) --> The interface that must be implemented on the CCS Onboard side (ideally the standardised interface can be applied), and it must also be implemented on Rolling Stock side (either by the TCMS directly or through a Train Adapter).*

#### 5.5.2.1 Rationale

The complete signal list related to the project specific interface of the TCMS vehicle system (including needed specific customer requirement agreements) with the ETCS/ATO onboard systems needs to be documented.

In the intermediate phase, where some signals coming from the TCMS possibly need to be transformed to meet the interface specifications, this has to be highlighted (FVA functionality). It includes, for instance, the possible use of default values or the activation/deactivation of functionalities.

In case of use of signals not clearly expressed in the interface specifications [9][10], these must be emphasized with an exhaustive rationale for the specific need (for example special signal needed by a standard product, diagnostic signal not described in detail in the interface specifications, optional product specific feature, etc).

In case of no use of one or more signals defined in the Interface Specifications [9][10], the rationale must as well be clearly detailed for each signal (for instance functions not used in the specific vehicle, feature not used in the specific project, etc).

A document containing those information needs to be agreed with the customer project team.

### 5.5.3 Bus mapping

*The complete mapping of the Bus System related to the loop TCMS/ETCS/ATO must be defined and formalized at the beginning of the project execution.*

#### 5.5.3.1 Rationale

The Bus Mapping contains the complete lists of the signals exchanged between devices and shall reflect what agreed in the different relevant document.

#### 5.5.4 Safety relevant signals

*The supplier has to deliver a concept how the safety relevant signals at the level of this interface are handled for each involved vehicle type (including sub-variants), also considering the justification / evidence in the safety case.*

##### 5.5.4.1 Rationale

Is requested a concept for the safety signals for the specific Vehicle Preparation phase. This information will have to be integrated in the overall project safety analysis but will remain documented also specifically for this phase in preparation for the future project structures where the target is to have the Vehicle Preparation phase decoupled from the overall project.

#### 5.5.5 Documentation of TCMS modifications

*The supplier has to deliver a document describing the required modifications on the TCMS for each involved vehicle type (including sub-variants).*

##### 5.5.5.1 Rationale

To improve the visibility on what was the problem and what was the reason that brought to a specific change in the TCMS. Detail explanations of the reasons is seen valuable for the scope of this document.

#### 5.5.6 Test Plan

*The supplier must deliver a test plan defining how the interface of the rolling stock toward the CCS Onboard will be tested for each involved vehicle type (including sub-variants). This includes defining a test strategy, where it will be tested (laboratory, vehicle, etc.), how it will be tested (automated test, manual test, etc.).*

##### 5.5.6.1 Rationale

The testing should be independent from the way the interface has been implemented and the assumption is to develop in future a test methodology (including documents and tools) that can be applied to every vehicle.

#### 5.5.7 Interface test specification

*The supplier must deliver a test specification of the interface from the Rolling Stock (TCMS) towards the CCS Onboard for each involved vehicle type (including sub-variants).*

##### 5.5.7.1 Rationale

Testing should be independent from the way the interface has been implemented and the assumption is to develop in future a test methodology (including documents and tools) that can be applied to every vehicle.

#### 5.5.8 Interface test specification

*The supplier must deliver a test specification of the interface from the CCS Onboard towards the Rolling Stock (TCMS) for each involved vehicle type (including sub-variants).*

##### 5.5.8.1 Rationale

Testing should be independent from the way the interface has been implemented and the assumption is to develop in future a test methodology (including documents and tools) that can be applied to every vehicle.

### 5.5.9 Project configuration/parameters

*The supplier must deliver a document describing all adjustable parametrisation items of the ETCS/ATO applications with the description of the project specific parametrisation settings.*

*All these parametrisation items will have to be clearly listed and defined including the rationale behind the value of each item.*

#### 5.5.9.1 Rationale

All specific information related to the ETCS/ATO onboard project that needs to be used by the offered system will be collected in a structured file.

For each configuration item it is requested to know the rationale, and specifically where it is used in the SW application (all instances).and for which functionality.

For instance, information can be used for activating / deactivating some functionality, to influence / modify the values of existing variables (as an example scaling factors), as parameters in predefined functions etc.

It is requested to have an exhaustive description for each configuration parameter possibly in a dedicated document.

## 5.6 Vehicle preparation – Implementation phase

### 5.6.1 Interface test Report

*The supplier has to deliver a test report from testing the interface of the Rolling Stock (TCMS) towards the CCS Onboard for each involved vehicle type (including sub-variants).*

#### 5.6.1.1 Rationale

The fulfilment of these interfaces needs to be proven with a dedicated direct test procedure.

As a temporary solution it might be also acceptable to only test the interface within the already foreseen functional tests, as long as each single variable of the interface can be referred, and its use proven.

The CCS Onboard supplier will have to develop a test procedure that fulfils the Interface Specifications [\[9\]\[10\]](#), including a test environment for automatic testing.

The project specific solution will be then tested according to this test procedure showing the final fulfilment of the defined interface.

It is expected that the test environment built for the testing is generic and reusable in any other CCS Onboard retrofit project based on the Interface Specifications [\[9\]\[10\]](#). And it cannot only be used for the specific project solution.

### 5.6.2 Interface test Report

*The supplier has to deliver a test report from testing the interface of the CCS Onboard towards the Rolling Stock (TCMS) for each involved vehicle type (including sub-variants).*

#### 5.6.2.1 Rationale

The fulfilment of these interfaces needs to be proven with a dedicated direct test procedure.

As a temporary solution it might be also acceptable to only test the interface within the already foreseen functional tests, as long as each single variable of the interface can be referred, and its use proven.

The CCS Onboard supplier will have to develop a test procedure that fulfils the Interface Specifications [\[9\]\[10\]](#), including a test environment for automatic testing.

The project specific solution will be then tested according to this test procedure showing the final fulfilment of

the defined interface.

It is expected that the test environment built for the testing is generic and reusable in any other CCS Onboard retrofit project based on the Interface Specifications [9][10]. And it cannot only be used for the specific project solution.

### 5.6.3 Integration test specification

*The supplier has to deliver a test specification of the integration test for each involved vehicle type (including sub-variants).*

#### 5.6.3.1 Rationale

The testing should be independent from the way the interface has been implemented and the assumption is to develop in future a test methodology (including documents and tools) that can be applied to every vehicle.

## 5.7 Vehicle preparation – Functional test phase

### 5.7.1 Integration test report

*The supplier has to deliver a test report of integration testing: integration of the CCS Onboard into the rolling stock for each involved vehicle type (including sub-variants).*

#### 5.7.1.1 Rationale

The testing should be independent from the way the interface has been implemented and the assumption is to develop in future a test methodology (including documents and tools) that can be applied to every vehicle.

## 5.8 Further project phases

Yet, no requirements have been defined related to the further project phases, such as Integration, Manufacturing, Integration, Commissioning, Acceptance and Operation.