OCORA

Open CCS On-board Reference Architecture

System Architecture

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Revision history

Version	Change Description	Initial	Date of change
1.04	Official version for OCORA Delta Release	AL	30.06.2021
1.05	Improved quality of graphics	AL	09.07.2021
2.01	Official version for OCORA Release R1	AL	03.12.2021
2.20	Official version for OCORA Release R2	AL	24.06.2022
3.00	Official version for OCORA Release R3	AL	08.12.2022
4.00	Official version for OCORA Release R4	AL	30.06.2023

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References

Reader's note: please be aware that the numbers in square brackets, e.g. [1], as per the list of referenced documents below, is used throughout this document to indicate the references to external documents. Wherever a reference to a TSI-CCS SUBSET is used, the SUBSET is referenced directly (e.g., SUBSET-026). OCORA always reference to the latest available official version of the SUBSET, unless indicated differently.

[1] OCORA-BWS01-010 – Release Notes

[2] OCORA-BWS01-020 – Glossary

[3] OCORA-BWS01-030 – Question and Answers

[4] OCORA-BWS01-040 – Feedback Form

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

[6] OCORA-BWS03-020 – Guiding Principles

[7] OCORA-BWS04-010 – Problem Statements

[8] OCORA-BWS05-010 – Road Map

[9] OCORA-TWS01-035 – CCS On-Board (CCS-OB) – Architecture

[10] OCORA-TWS04-010 – Functional Vehicle Adapter – Introduction

[11] OCORA-TWS04-011 – Functional Vehicle Adapter – Requirements

[12] OCORA-TWS04-012 – Functional Vehicle Adapter – Standard Communication Interface Specification

[13] OCORA-TWS04-013 – Functional Vehicle Adapter – Design Guideline

[14] OCORA-TWS06-010 – (Cyber-) Security – Project Security Management Plan

[15] OCORA-TWS06-030 – (Cyber-) Security – Concept

[16] OCORA-TWS07-060 – Configuration Management – Concept

[17] TOBA, On-Board FRMCS Functional Requirements Specification, TOBA-7510

[18] UIC, FRMCS User Requirements Specification, FU-7100

[19] UIC, FRMCS Functional Requirements Specification, FU-7120

[20] UIC, FRMCS System Requirements Specification, AT-7800

1 Introduction

1.1 Purpose of the document

The purpose of this document is to provide the wider context of the CCS On-Board architecture and to identify all systems of interest to OCORA.

This document is addressed to experts in the CCS domain and to any other person, interested in the OCORA concepts for CCS On-Board. 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].

1.2 Applicability of the document

The document is considered informative. Subsequent releases of this document will be developed based on a modular and iterative approach, evolving within the progress of the OCORA collaboration.

1.3 Context of the document

This document is published as part of an OCORA Release, together with the documents listed in the Release Notes [1]. If you are interested in the context and the motivation that drives OCORA we recommend reading the Introduction to OCORA [5], the Guiding Principles [6], and the Problem Statements [7]. The reader should also be aware of the Glossary [2] and the Question and Answers [3].

2 Scope

The main goal of OOCRA is to define a CCS On-Board (CCS-OB) reference architecture, consisting of a reasonable number of plug and play-like building blocks[1]. The CCS-OB System interacts with the following actor groups:

- Operation Control Systems – Infrastructure Manager (OCS-IM)
- Operation Control Systems – Railway Undertaking (OCS-RU)
- Physical Train Unit Operation Systems (PTU-OS)
- Trackside Systems and Environment (TSE)
- Human Actors (HUA)
- Maintenance Equipment (MTE)
- Other Systems

The currently identified building blocks and actor groups for CCS-OB are identified in Figure 1 and Figure 2.

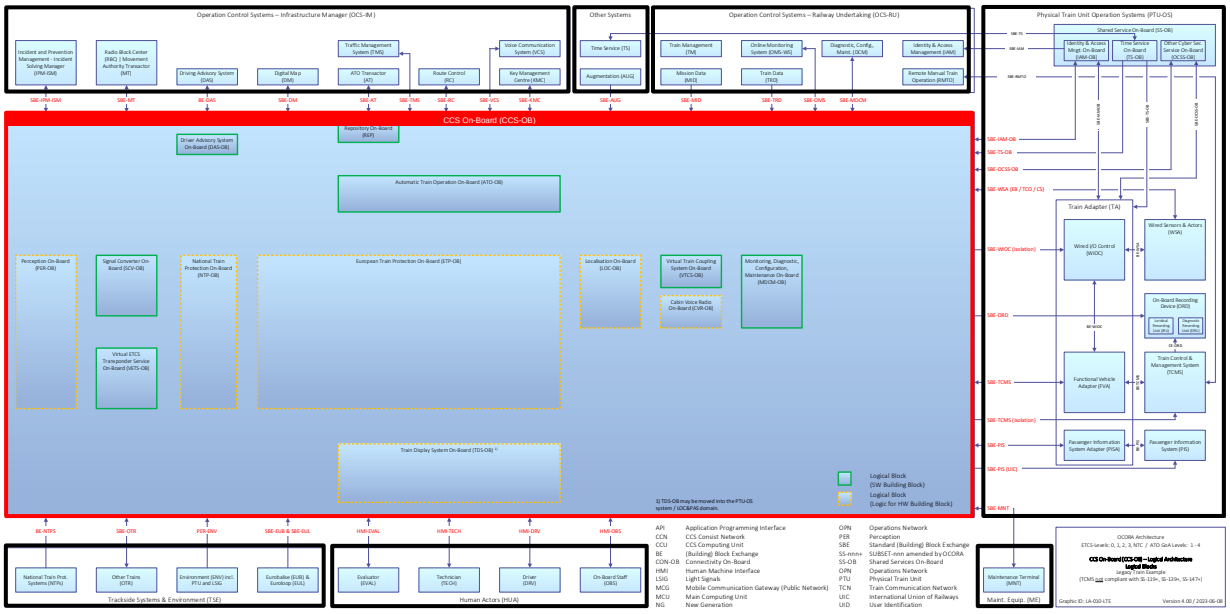

Figure 1: CCS On-Board logical blocks and actor groups

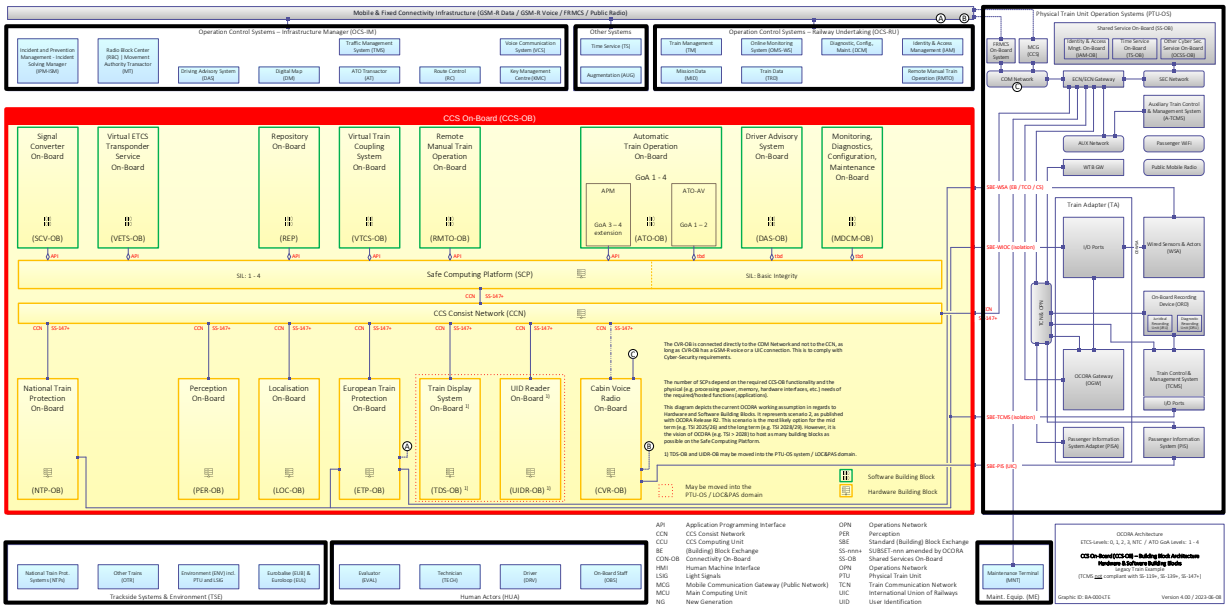

Figure 2: CCS On-Board building blocks and actor groups

[1] refer to [2] for a definition of building blocks

Although the main focus of OOCRA is currently on the CCS On-Board (CCS-OB) system, other systems interacting with the CCS-OB are also of interest and hence in scope of the OCORA initiative. So far, OCORA has identified the following systems of interest:

- Control-Command and Signalling On-Board (CCS-OB)
- Train Adapter (TA)
- Shared Services On-Board (SS-OB)
- Connectivity Services On-Board (CONS-OB)
- CCS Off-Board Support System (COBSS)

Note that the Connectivity On-Board Services (CONS-OB) system is only depicted in the physical architecture. OCORA is assessing whether or not CONS-OB should be included in the functional architecture also.

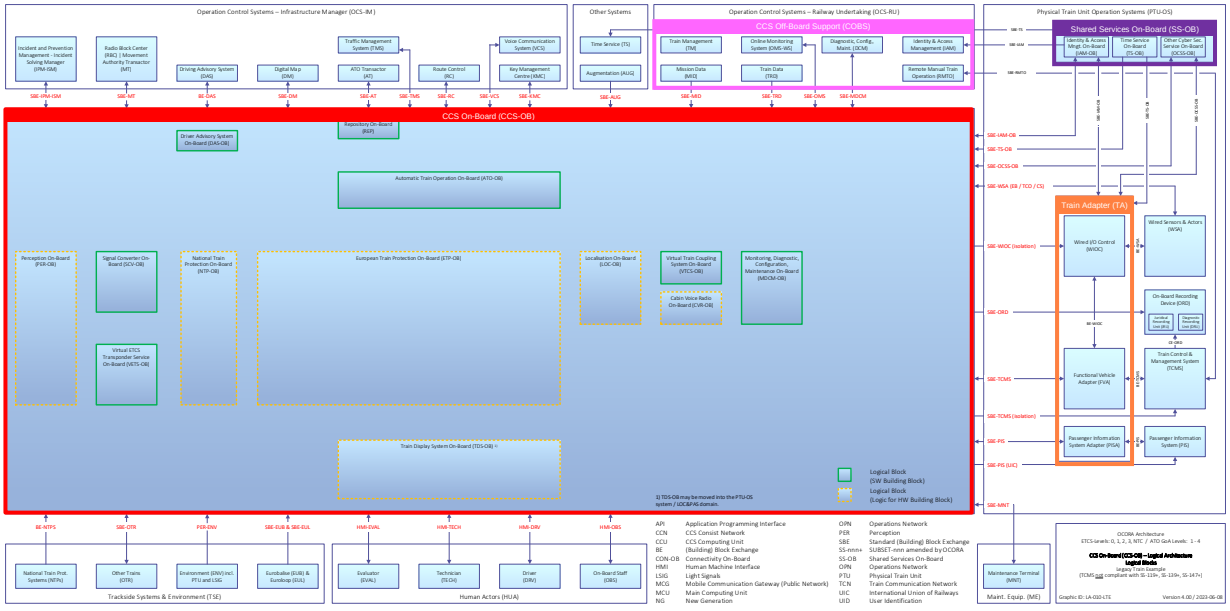

Figure 3: Systems in scope of OCORA – logical architecture – legacy train example

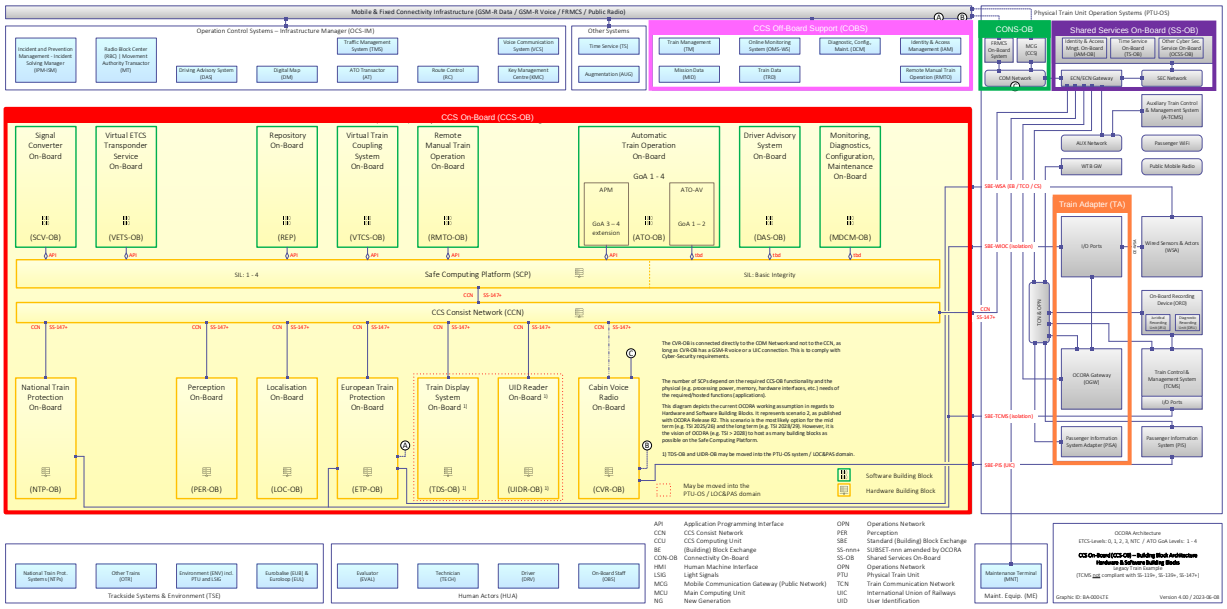

Figure 4: Systems in scope of OCORA – physical architecture – legacy train example

Figure 3 and Figure 4 depict the different systems of interests in the OCORA logical and in the OCORA physical reference architecture. Both representations are based on a CCS-OB that is integrated in a legacy train (TCMS not compliant with SS-119+, SS-139+, and SS-147+)[2]. In case of the integration with a new generation train (TCMS fully compliant with SS-119+, SS-139+, and SS-147+) the need for the Train Adapter (TA) disappears.

Remark: The Train Display System On-Board (TDS-OB) and the User Identification Reader On-Board (UIDR-OB) are currently depicted as a part of the CCS-OB system (refer to Figure 4). OCORA is evaluating, whether or not the two building blocks should be moved out of CCS-OB. In this case, another system of interest might be added to the architecture diagrams.

The following chapters of this document briefly describe the different system of interest to OCORA and provide references to further documentation, if available for the respective system.

[2] SS-nnn+ refers to the ERA SUBSET with the number “nnn”. The “+” refers to the OCORA amendment for the respective ERA subset.

3 CCS On-Board (CCS-OB)

The CCS On-Board (CCS-OB) system interacts with the following systems of interests to OCORA: Train Adapter (TA) system, the Shared Services On-Board (SS-OB) system, the CCS Off-Board Support (COBS-OB) system, and the Connectivity Services On-Board (CONS-OB) system, depicted only in the physical architecture.

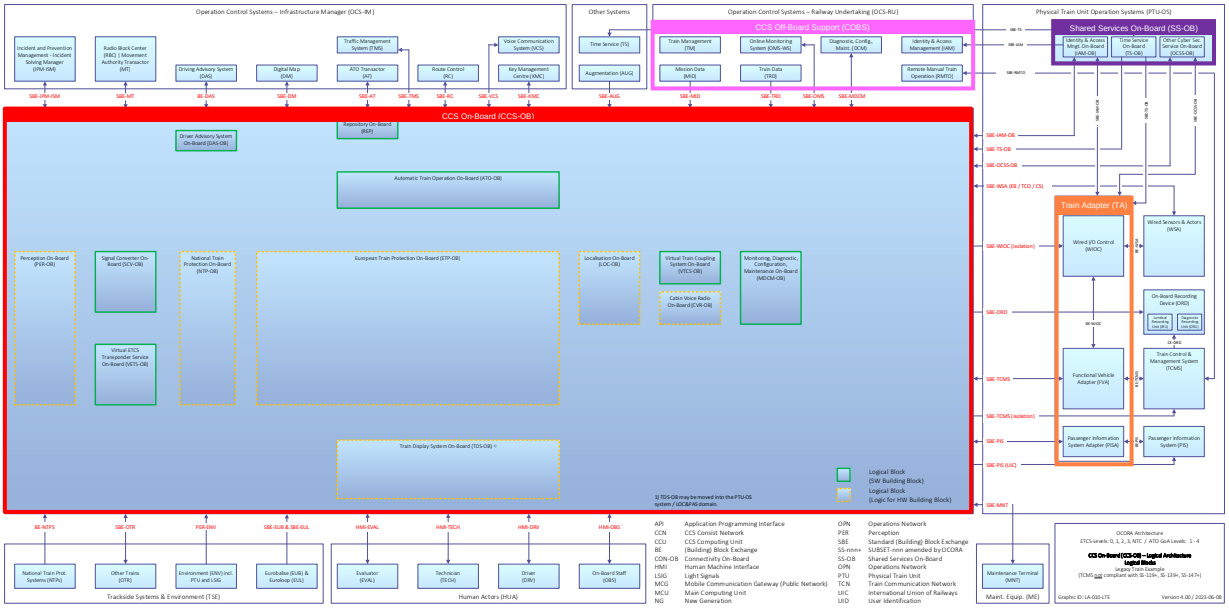

Figure 5: CCS-OB interaction with systems of interest to OCORA – logical architecture

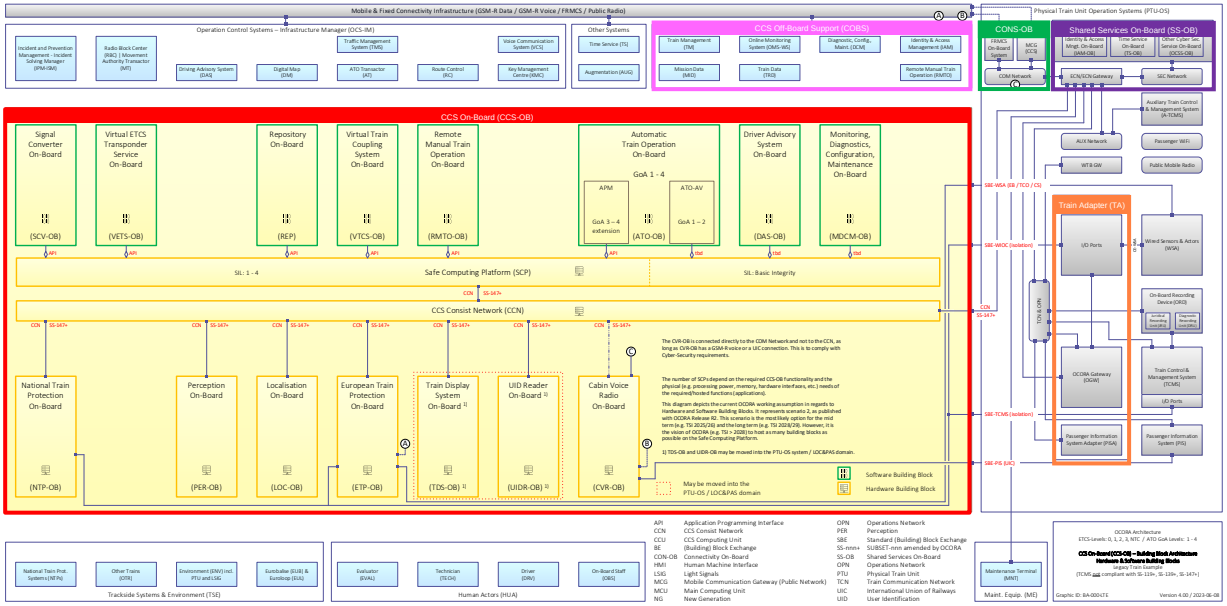

Figure 6: CCS-OB interaction with systems of interest to OCORA – physical architecture

In addition, the CCS-OB interacts with the Operation Control Systems – Infrastructure Manager (OCS-IM), the Trackside Systems and Environment (TSE), the Maintenance Equipment (MNE), with Human Actors (HUA), and with “Other Systems”.

Today's CCS-OB systems typically include the following functional blocks:

- European Train Protection On-Board (ETP-OB)
- Localisation On-Board (LOC-OB)[3]
- Train Display System On-Board (TDS-OB)[4]
- National Train Protection On-Board (NTP-OB)
- Cabin Voice Radio On-Board (CVR-OB)

Future CCS-OB system may include the following additional functional blocks:

- Monitoring, Diagnostic, Configuration, Maintenance On-Board (MDCM-OB)
- Localisation On-Board (LOC-OB)[5]
- Driver Advisory System On-Board (DAS-OB)
- Automatic Train Operation On-Board (ATO-OB)
- Perception On-Board (PER-OB)
- Repository On-Board (REP)
- Remote Manual Train Operation On-Board (RMTO-OB)
- Signal Converter On-Board (SCV-OB)
- Virtual ETCS Transponder Service On-Board (VETS-OB)
- Virtual Train Coupling System On-Board (VTCS-OB)

Today's CCS-OB systems typically include the following main hardware elements (not depicted in the graphics above):

- European Vital Computer (EVC)
- Balise Transmission Modul (BTM)[6]
- ETCS Driver Machine Interface (ETCS DMI)[6]
- Odometry (ODO)[6]
- Data Communication Infrastructure (GSM-R, Ethernet, MVB, etc.)
- Cabin Voice Radio On-Board (CVR-OB)
- National Train Protection On-Board (NTP-OB)

To cover today's needs for ETCS, Cabin Voice, and NTP, OCORA currently envisions that future CCS-OB systems are consisting of the following main building blocks that are integrated with each other via standardised interfaces:

- European Train Protection On-Board (ETP-OB)
- Train Display System On-Board (TDS-OB)
- User ID Reader On-Board (UIDR-OB)
- Localisation On-Board (LOC-OB)
- CCS Communication Network (CCN)
- Cabin Voice Radio On-Board (CVR-OB)
- National Train Protection On-Board (NTP-OB)

Remark: the FRMCS communication is provided as part of the Connectivity Services On-Board (CONS-OB).

[3] odometry functionality only
[4] ETCS DMI only
[5] odometry + continuous absolute positioning
[6] Vender specific integration with EVC

To cover the needs for the future, the following building blocks can be added to CCS-OB:

- Safe Computing Platform (SCP)
- Automatic Train Operation On-Board (ATO-OB)
- Driver Advisory System On-Board (DAS-OB)
- perception On-Board (PER-OB)
- Monitoring, Diagnostics, Configuration, Maintenance On-Board (MDCM-OB)
- Signal Converter On-Board (SCV-OB)
- Virtual ETCS Transponder Service On-Board (VETS-OB)
- Repository On-Board (REP),
- Virtual Train Coupling System On-Board (VTCS-OB)
- Remote Manual Train Operation On-Board (RMTO-OB)

Detailed information on the CCS-OB system is available in [9].

4 Train Adapter (TA)

The Train Adapter (TA) system interacts with the CCS On-Board (CCS-OB) system, the Shared Services On-Board (SS-OB) system, the Wired Sensors and Actors (WSA), the Train Control and Management System (TCMS), and the Passenger Information System (PIS).

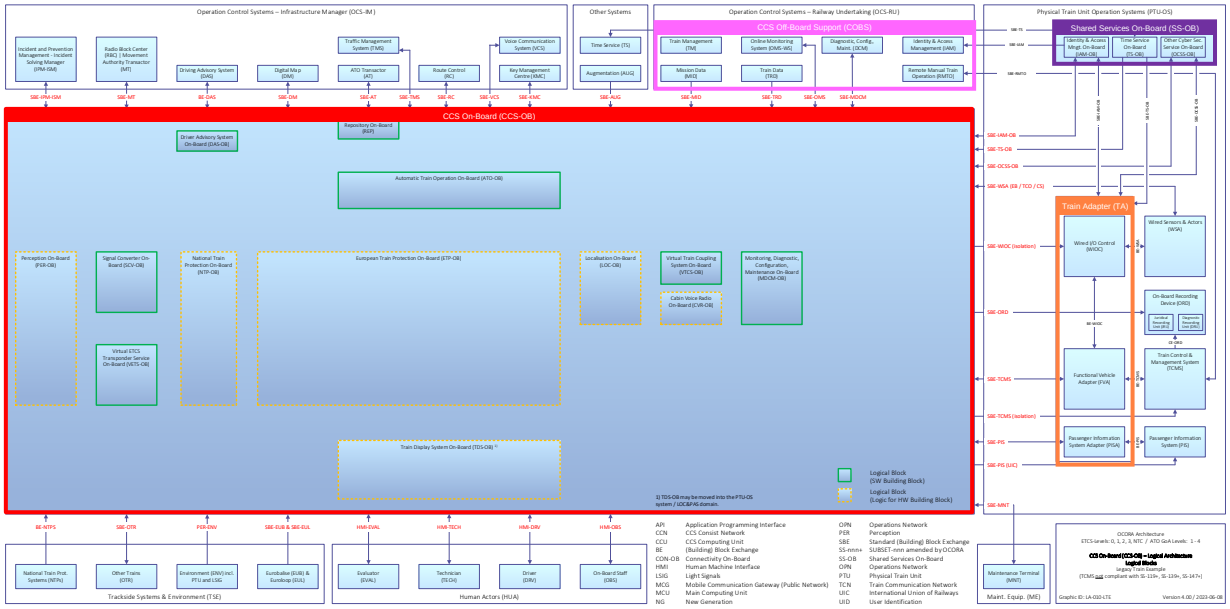

Figure 7: TA interaction with systems of interest to OCORA – logical architecture

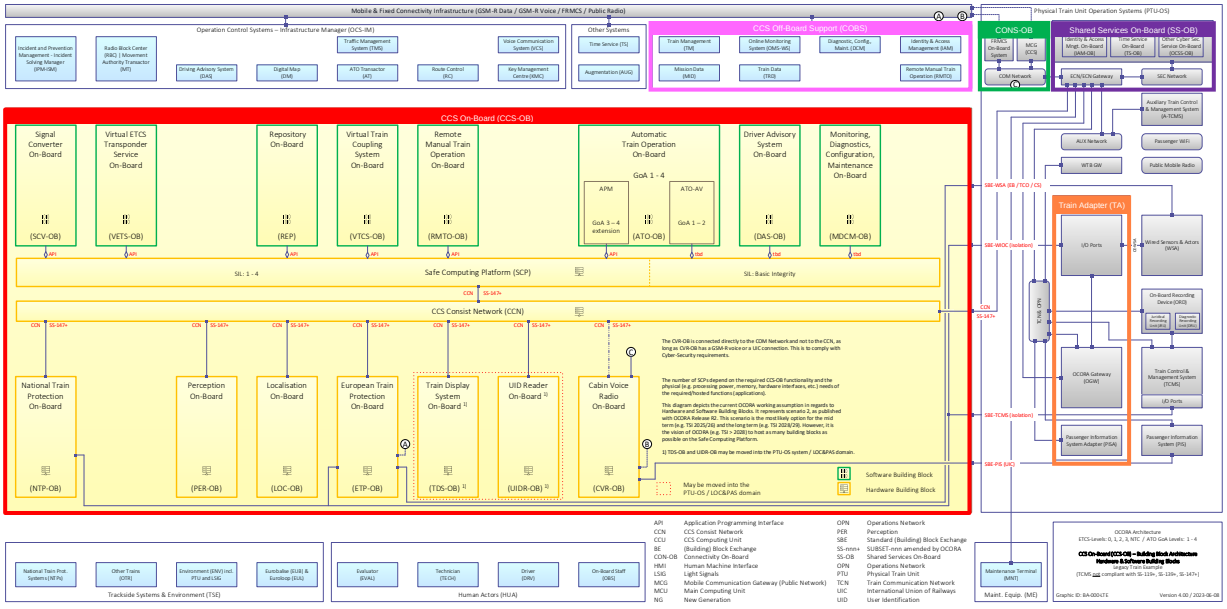

Figure 8: TA interaction with systems of interest to OCORA – physical architecture

The goal of the Train Adapter (TA) system is to allow for the CCS On-Board (CCS-OB) to communicate through a standardised interface with the train by abstracting the specificities of each train. This allows using the very same CCS On-Board (CCS-OB) system on different train types.

The Train Adapter (TA) includes the following functional blocks:

- Wired I/O Control (WIOC)
- Functional Vehicle Adapter (FVA)
- Passenger Info System Adapter (PISA)

From a hardware point of view, the Train Adapter (TA) consist of the following elements:

- OCORA Gateway (OGW)
- I/O Ports
- Passenger Information System Adapter (PISA)

Whether all the Train Adapter (TA) functional blocks are required, or only part of it, depends on the architecture of the train and the specific implementation. On a new generation train (TCMS fully compliant with SS-119+, SS-139+, and SS-147+)[7], neither the Functional Vehicle Adapter (FVA) nor the Wired I/O Control (WIOC) is needed. This means that in the long term, these two functional blocks will no longer be used and will eventually disappear.

Detailed information on the Train Adapter (TA) system, focussing on the Functional Vehicle Adapter (FVA), is available in [10], [11], [12], and [13]. Further information on the WIOC and PISA will be provided in subsequent releases of the OCORA documentation.

[7] SS-nnn+ refers to the ERA SUBSET with the number “nnn”. The “+” refers to the OCORA amendment for the respective ERA subset.

5 Shared Services On-Board (SS-OB)

The Shared Services On-Board (SS-OB) interacts with the CCS On-Board (CCS-OB) system, the Train Adapter (TA), the CCS Off-Board Support (COBS) system and with “Other Systems”. It addresses the cyber security aspects for the on-board systems by providing on-board security services and the segmentation of the different networks based on an appropriate zoning concept.

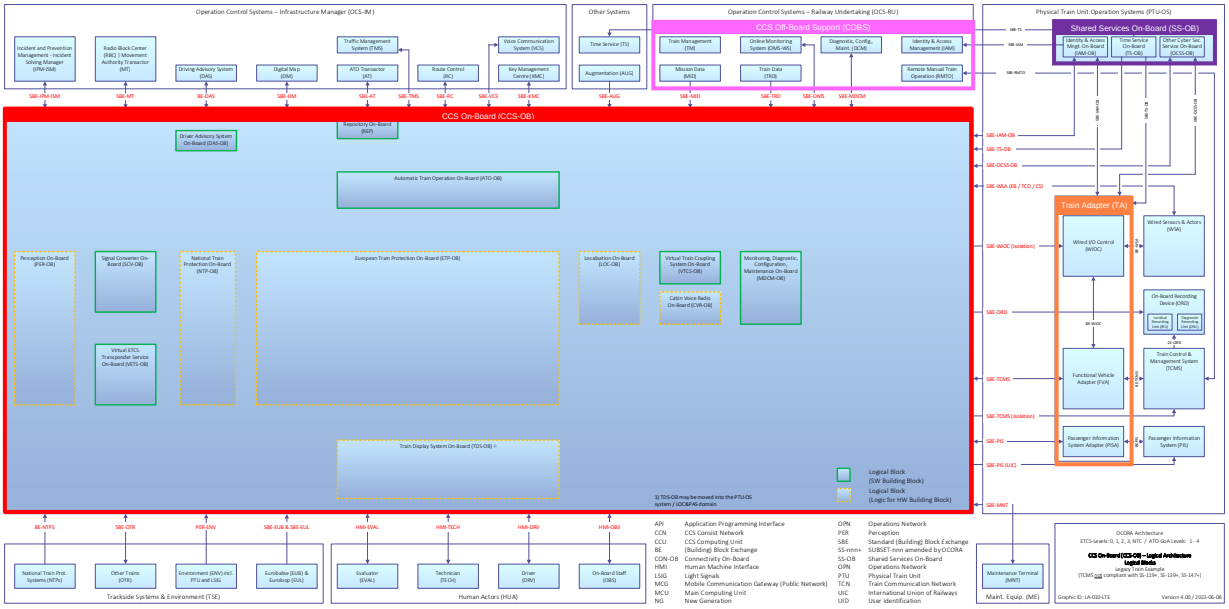

Figure 9: SS-OB interaction with systems of interest to OCORA – logical architecture

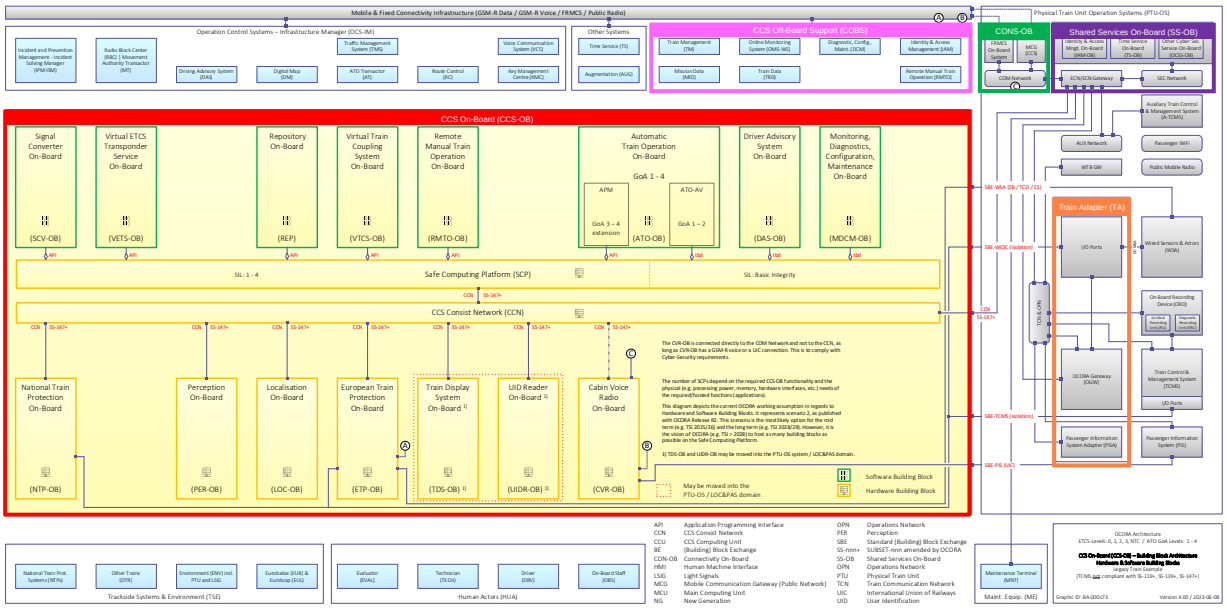

Figure 10: SS-OB interaction with systems of interest to OCORA – physical architecture

The SS-OB encompasses the applications and services to assure cyber secure operations of the On-Board systems and networks. Although the SS-OB are not in the prime focus of OCORA, the architecture and network topology discussion do consider the SS-OB and its required components in regard to the allocation and integration of the following services:

- **Time Service On-Board (TS-OB):** On-board time service ensuring synchronized absolute on-board time with off-board systems and providing this absolute time to all on-board systems. This absolute time is primarily used for non-safe on-board functions and eventually also for safe on-board functions.
- **Identity and Access Management On-Board (IAM-OB)**
- **Other Cyber Security Services (OCSS):** this includes services such as Central Logging, Backup, Asset Inventory, Intrusion Detection (continuous security monitoring), and Public Key Infrastructure.

The SS-OB includes the following hardware:

- **Security Network:** this is a standard IP network over Ethernet IEEE 802.3 where the security systems, providing the On-Board Security Services (OSS), are attached. This separation from the other On-Board networks allows the implementation of the required zoning model to address the cybersecurity requirements.
- **ECN/ECN Gateway:** this is a central element for the on-board security and for all communication between systems. It routes the traffic between the different networks / zones and acts as firewall between them.
- **Shared Services Systems**

Detailed information on the SS-OB system is available in [14], and [15]. Further information will be provided in subsequent releases of the OCORA documentation.

6 Connectivity Services On-Board (CONS-OB)

The Connectivity Services On-Board (CONS-OB) provide the communication between On-Board and trackside systems.

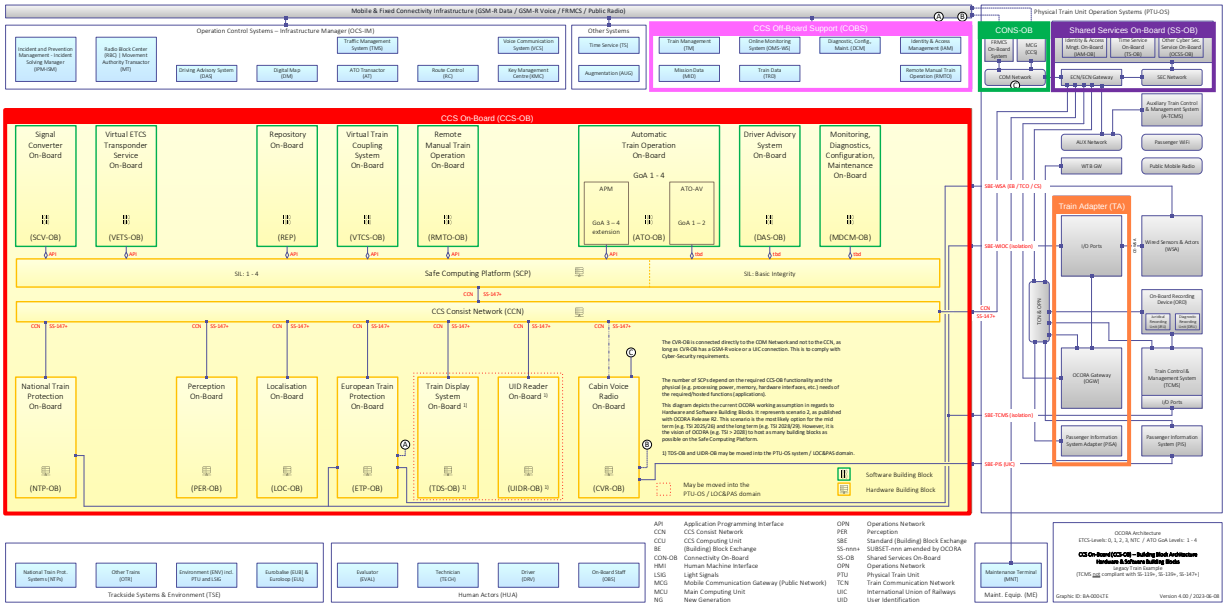

Figure 11: CONS-OB interaction with systems of interest to OCORA – physical architecture

Note that the CONS-OB system is only depicted in the physical architecture. OCORA is assessing whether or not CONS-OB should be included in the functional architecture also.

The FRMCS On-Board System implements the required functionalities and services providing the connectivity for the CCS Systems with the RBC (for ETCS L2/L3 networks), with ATO trackside (ATO-AT) and with the RCA compliant CCS Data Centres respectively.

The Mobile Communication Gateway (MCG CCS) provides train to track-side connectivity for certain On-Board CCS functions (e.g., remote maintenance) in case the trackside service is not available through FRMCS (e.g., trackside only provides GSM-R and no FRMCS). Depending on the vehicle, it may also provide track-side connectivity for the systems connected to the Train Communication Networks (e.g., TCMS and PIS).

The systems providing the connectivity services reside on a separate communication network to allow its services to be shared with other, non-CCS applications. This assures, that cybersecurity aspects are covered, and appropriate zoning models can be applied to the On-Board communication networks.

Detailed information on the CONS-OB system is available in [17], [18], [19] and [20].

7 CCS Off-Board Support (COBS)

The CCS Off-Board Support (COBS) system interacts with the Shared Service On-Board (SS-OB), the CCS On-Board (CCS-OB) system, the Operation Control Systems – Infrastructure Manager (OCS-IM), and the respective human actors (not shown on the logical architecture).

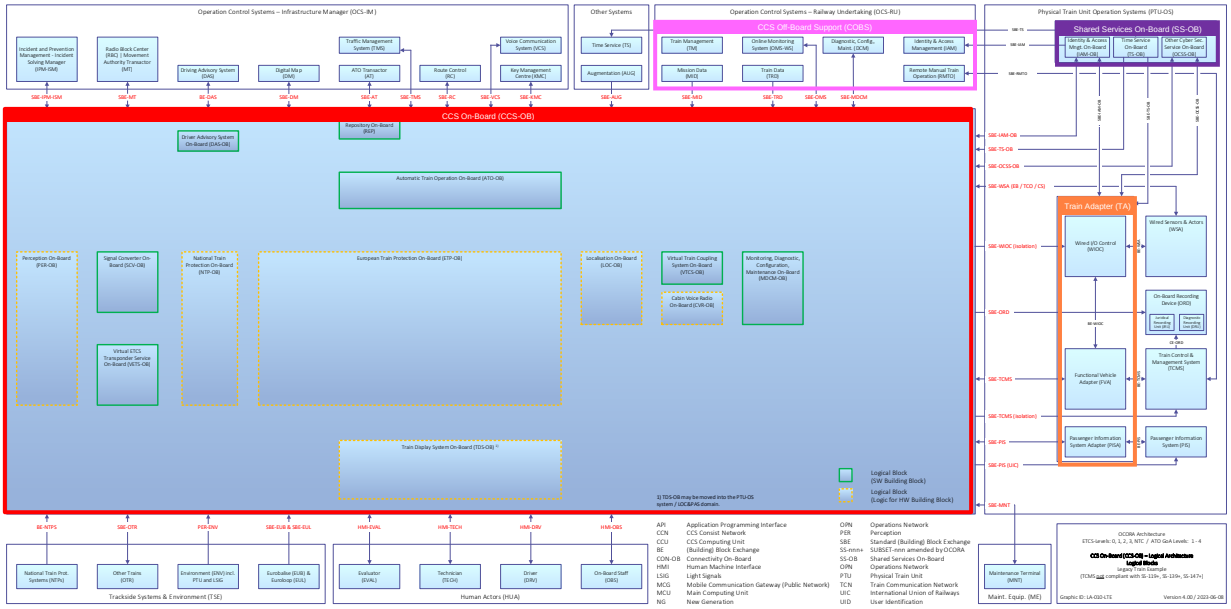

Figure 12: COBS interaction with systems of interest to OCORA – logical architecture

The COBS includes the following functional blocks:

- Monitoring, Diagnostic, Configuration, Maintenance (MDCM)
- Identity and Access Management (IAM)
- Remote Manual Train Operation (RMTO)
- Train Management (TM)
- Mission Data (MID)
- Train Data (TRD)

More information on the COBS system, especially in regard to the MDCM is available in [16]. Further information will be provided in subsequent releases of the OCORA documentation.