OCORA

Open CCS On-board Reference Architecture

CCS On-Board (CCS-OB)

Architecture

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Management Summary

This document is the 7th edition of the OCORA CCS On-Board Architecture. It is focussing on the CCS On-Board architecture only. It represents a significant step forward towards an open, modular, exchangeable, migratable, portable, and evolvable CCS On-Board system. Whilst considering economical aspects, modular safety, as well as cyber-security and sector feedback, a reasonable number of plug-and-play like building block have been confirmed with this release.

The development of the OCORA System Architecture follows an iterative approach, evolving within the progress of the OCORA collaboration. With this release, OCORA made its fourth step in using Model Based Systems Engineering (MBSE) based on the Arcadia methodology.

OCORA has started using the Capella MBSE tool for developing the logical architecture, well knowing that the Arcadia methodology proposes to start with the operational- and system-analysis before diving into the development of the logical architecture.

It has been a deliberate decision to develop a logical and physical architecture in parallel to conducting the operational- and system-analysis (refer to document [11] to review the current status of the operational- and system-analysis). For the following reasons, OCORA decided to deviate from the strict Arcadia proposed approach:

The CCS On-Board system is considered a sub-system of the overall CCS system which includes CCS on-board and CCS trackside. OCORA favours the development of the operational- and system-analysis on a system and not on a sub-system level. This is to ensure the proper development of the end-to-end functionality and to minimize integration efforts at a later stage. The collaboration with RCA for developing system capabilities has continued. However, OCORA aims to develop and communicate its ideas for the CCS On-Board in parallel. This can be done best through a high-level logical and physical architecture.

The CCS On-Board system is a well-known system that exists today and is already documented to a certain extent on a logical- and physical architectural level. Starting from this status quo architecture and applying the OCORA Guiding Principles [6], the OCORA Design-Requirements [10], the OCORA Stakeholder-Requirements [22], and the OCORA Program-Requirements [23], has dramatically accelerated the development of a 1st versions of the OCORA System Architecture. The currently proposed logical and physical architecture will be iteratively adjusted and concluded once functions are being allocated to logical components (typically after completion of the system analysis phase). During the latter process, new logical components may evolve, some may be combined, and others may disappear entirely.

OCORA aims to develop its CCS On-Board architecture in close collaboration with other programs and sector initiatives (e.g., EU-Rail, RCA, TOBA, EEIG ERTMS UG LWG, CONNECTA, LinX4Rail, X2Rail-4, UNISIG/UNIFE, etc.). Most of these programs have not yet performed and documented the operational- and systems-analysis but have developed a logical and/or physical architecture. To fit in the overall railway / CCS landscape and to facilitate understanding and communication between the different programs, OCORA adopts logical and physical components from other programs wherever reasonable. Adjustments will be performed iteratively at different points in time, concluding in a final logical architecture after completion of the functional allocation process.

The currently proposed OCORA logical architecture is a result of a close collaboration with RCA, EUG-LWG, X2Rail-4, and to some extend the Tauro project. Also, results from discussions in the context of Europe's Rail Joint Undertaking (ERJU) System Pillar ramp-up are considered in this release. The OCORA logical architecture will continue to evolve alongside with the developments in the mentioned programs.

The currently proposed physical architecture was developed in collaboration with UIC TOBA regarding connectivity, S2R CONNECTA regarding on-board communication, and RCA regarding the safe computing platform. The OCORA physical architecture will continue to evolve alongside with the developments in those programs and incorporate changes due to the advancing logical architecture.

Revision history

Version	Change Description	Initial	Date of change
1.00	Official version for OCORA Release R1	AL	10.06.2022
2.21	Official version for OCORA Release R3	AL	14.07.2022
3.00	Official version for OCORA Release R3	ML AL	08.12.2022

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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-BWS08-010 – Methodology

[10] OCORA-TWS01-010 – Design Requirements

[11] OCORA-TWS01-020 – Operational & System Analysis

[12] OCORA-TWS01-030 – System Architecture

[13] OCORA-TWS01-100 – Localisation On-Board (LOC-OB) – Introduction

[14] OCORA-TWS01-101 – Localisation On-Board (LOC-OB) – Requirements

[15] OCORA-TWS01-112 – Automatic Train Protection On-Board (ATP-OB) – MLM Interface Analysis

[16] OCORA-TWS02-010 – CCS Communication Network – Evaluation

[17] OCORA-TWS02-020 – CCS Communication Network – Proof of Concept (PoC)

[18] OCORA-TWS03-010 – SCP – Computing Platform for Railway Applications – Whitepaper

[19] OCORA-TWS03-020 – SCP – High-Level Requirements

[20] OCORA-TWS03-030 – SCP – Initial Specification of the PI API between Application and Platform

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

[22] OCORA-TWS05-020 – Stakeholder Requirements

[23] OCORA-TWS05-021 – Program Requirements

[24] OCORA-TWS08-010 – MDCM-OB – Introduction

[25] OCORA-TWS08-030 – MDCM-OB – SRS

[26] ERA_ERTMS_015560 – ETCS Driver Machine Interface

[27] EUG 22E126 – LOC-OB System Definition & Operational Concept, Version 1.0, 2022-05-30

[28] EUG 22E135 – LOC-OB Risk Analysis, Version 1.0, 2022-06-17

[29] RCA.Doc.14 – RCA Terms and Abstract Concepts, Version 1.1, 2022-10-19

[30] RCA.Doc.35 –System Definition, Version 0.2 (0.A), 2020-09-11

[31] RCA.Doc.35 – System Architecture, Version 0.3, 2021-07-02

[32] RCA.Doc.40 – RCA Architecture Poster, Version 0.4 (0.A), 2022-04-26

[33] RCA.Doc.54 – Solution Concept – MAP, Version 0.3, 2022-04-22

[34] RCA.Doc.58 – Digital Map – PHA Preliminary Hazard Analysis, Version 0.5, 2021-12-15

[35] RCA.Doc.59 – Digital Map – System Definition, Version 0.5, 2022-04-22

[36] 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

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

[38] X2R3-D6.1: X2R3-WP06-D-ANS-001-03 – Deliverable 6.1 – Virtual Train Coupling System Concept and Application Conditions, Version 2.0, 2019-01-15

[39] X2R4-D3.2: X2R4-WP03-D-ALS-009-012 – Deliverable D3.2 – GoA3/4 Specification, Version 0.1.4, 2022-04-04

1 Introduction

1.1 Purpose of the document

The purpose of this document is to document and communicate the current status of the OCORA CCS On-Board reference architecture.

This document is addressed to experts in the CCS domain and to any other person, interested in the OCORA concepts for on-board CCS. The reader is invited to provide feedback to the OCORA collaboration and can, therefore, engage in shaping OCORA. Feedback to this document and to any other OCORA documentation can be given by using the feedback form [4].

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

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

1.2 Applicability of the document

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

1.3 Context of the document

This document is published as part of an OCORA Release, together with the documents listed in the release notes [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], the Guiding Principles [6], the Problem Statements [7], and the Road Map [8].The reader should also be aware of the Glossary [2] and the Question and Answers [3].

The wider context of the OCORA system architecture is provided in document [12]. Therefore, reading document [12] prior to reading this document will be helpful to better understand the context and the content of this document.

2 Scope

The scope of this document and the main scope for OCORA is the CCS On-Board (CCS-OB) system as depicted in the following logical and physical architecture diagrams (red boxes). Refer to document [12] for an overview of all systems of interest for OCORA.

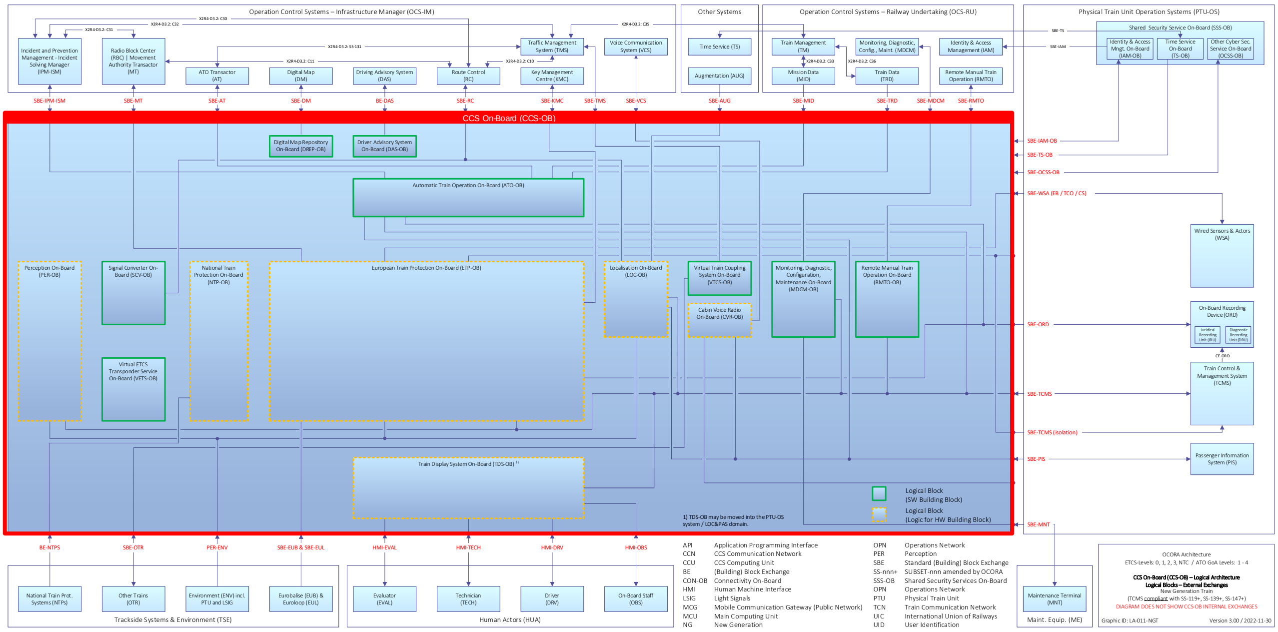

Figure 1: Scope – logical architecture – new generation train

Notes: 1) TDS-OB may be moved into the PTU-OS / LOC&PAS domain.

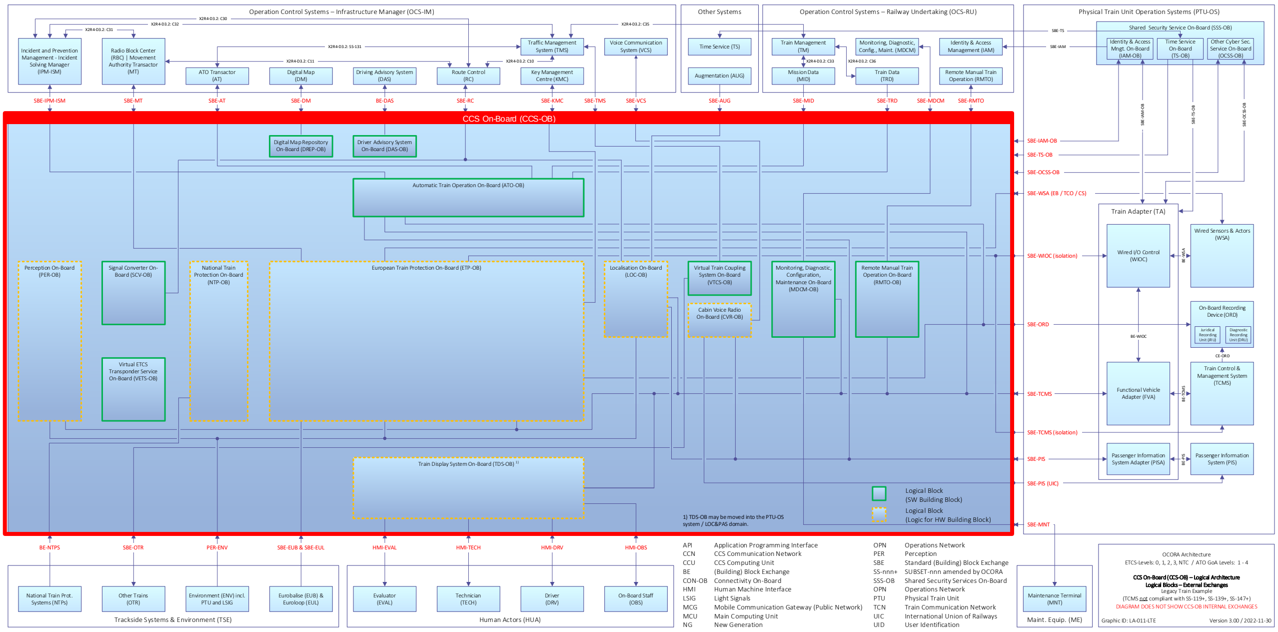

Figure 2: Scope – logical architecture – legacy train example

Notes: 1) TDS-OB may be moved into the PTU-OS / LOC&PAS domain.

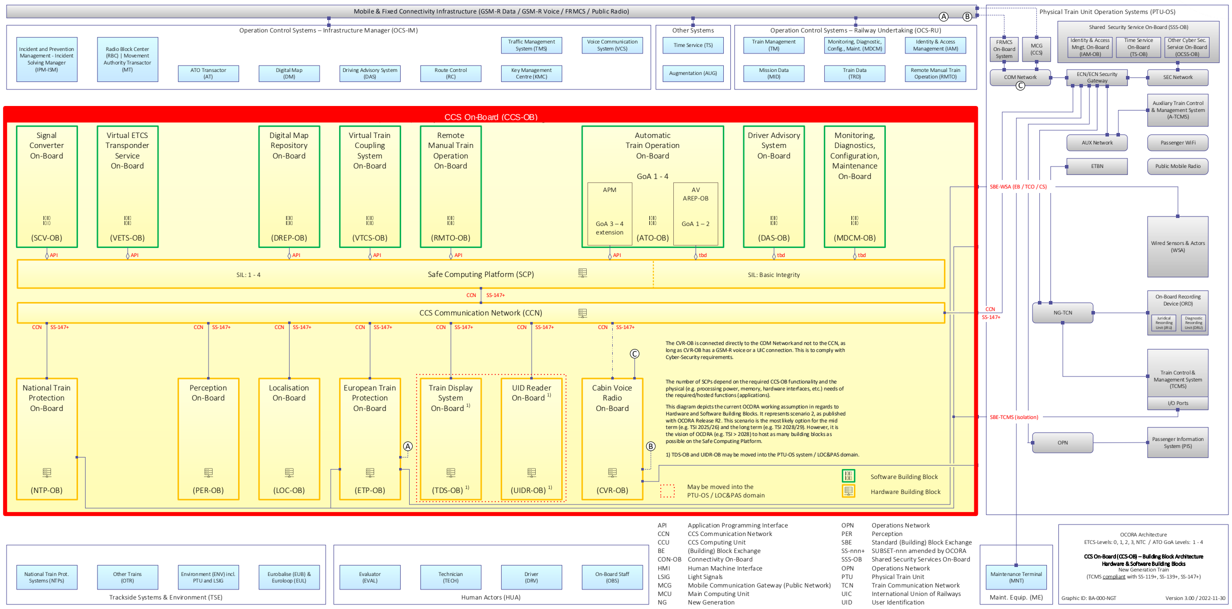

Figure 3: Scope – physical architecture – new generation train

Notes: 1) TDS-OB may be moved into the PTU-OS / LOC&PAS domain.

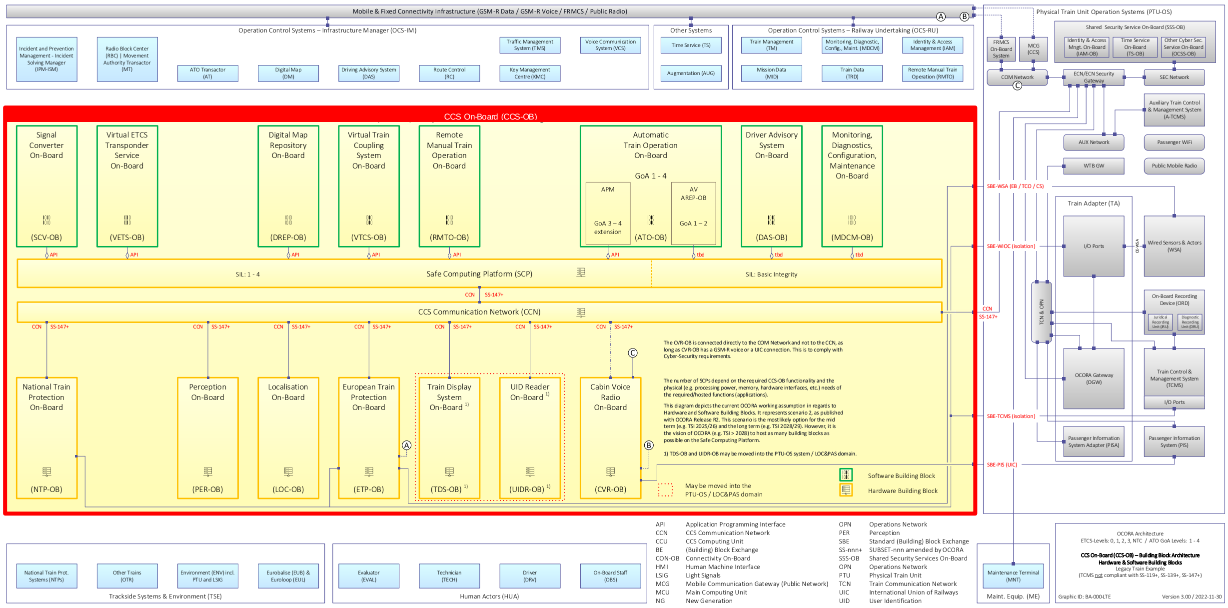

Figure 4: Scope – physical architecture – legacy train example

Notes: 1) TDS may be moved into the PTU-OS / LOC&PAS domain.

OCORA aims at providing the architecture for a CCS On-Board (CCS-OB) solution that is compliant with trains equipped with a New Generation – Train Control Network (NG-TCN) while also supporting legacy trains. It further aims at standardizing the CCS-OB in such a way that the same CCS-OB architecture can be used for legacy and NG-TCN based trains.

To develop this proposal for the logical and physical architecture, the OCORA Guiding Principles [6], the OCORA Design-Requirements [10], the OCORA Stakeholder-Requirements [22], and the OCORA Program-Requirements [23] were considered. The architecture was also developed in collaboration with RCA, Shift2Rail (CONNECTA, LINS4RAIL, X2RAIL-4, TAURO), TOBA, SFERA, and EEIG EUG.

While defining the logical and physical architecture, OCORA has identified components for the CCS-OB (blocks inside the red boxes) and their interaction with external systems (actors). All identified components, and actors depicted in Figure 1, Figure 4, and Figure 3 are described further in subsequent chapters of this document.

Components are defined as a piece of hardware and/or software, providing one or more functionalities. A component is used to structure functionality within building blocks. It implements and encapsulates one or more behaviour (business logic) and exposes services via defined interfaces to other components.

The components within the CCS-OB as identified in Figure 1, Figure 4, and Figure 3 support ETCS L0 – L3, level NTC, ATO GoA1 – GoA4 over ETCS (refer to requirement OCORA-58 in [22]), GSM-R and/or FRMCS connectivity, and the potential to implement NNTRs (Notified National Technical Rules). ETP-OB (ETCS) is the primary ATP, hence always present (refer to requirement OCORA-56 in [22])

The configuration for a specific implementation may include only a subset of the components represented in Figure 1, Figure 4, and Figure 3. But not only the number of deployed components can differ between implementations. The functionality of some of the physical components (Figure 4, and Figure 3) may vary also. For example: on one vehicle the ETP-OB (ETCS) functionality and the ATO-OB functionality are deployed on separate hardware (refer to Figure 4), while another supplier may decide to use a safe computing platform for combined ETP-OB (ETCS) and ATO-OB functionality (refer to Figure 3). To achieve this, the independence of software from hardware is paramount and therefore an important topic to OCORA. Refer to documents [18], [19], and [20] for further details on the safe computing platform.

The components identified in Figure 1, Figure 4, and Figure 3 represent just a high-level view, abstracting many details. For example: The CCN, shown as a single block, is in fact a complex component with many sub-components and configuration options, depending on the needs of the RU/supplier (refer to documents [16], and [17]).

3 Actors

The actors for CCS-OB are identified on the logical and on the physical architecture. They are grouped as follows:

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

All actor groups (white boxes) and the individual actors are depicted in the following logical and physical architecture diagrams and are described in the following chapters.

3.1 Logical Actors

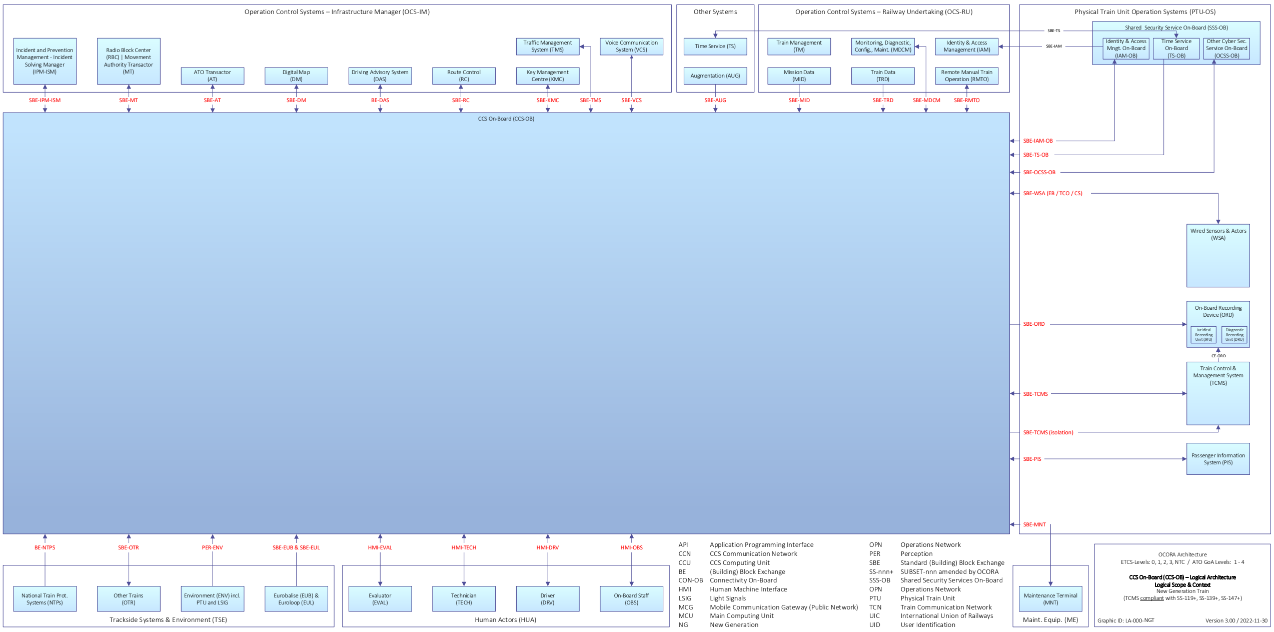

Figure 5: Logical Actors – new generation train

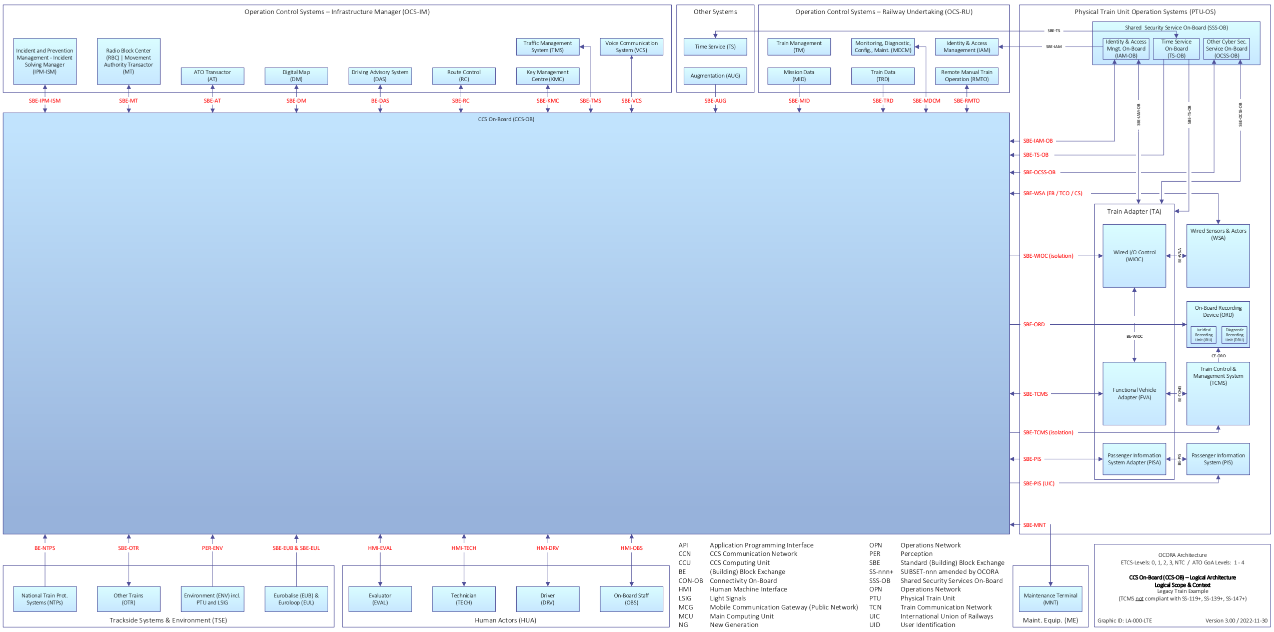

Figure 6: Logical Actors – legacy train example

3.1.1 Operation Control Systems – Infrastructure Manager (OCS-IM)

3.1.1.1 Incident and Prevention Management – Incident Solving Manager (IPM-ISM)

Information on the Incident and Prevention Management – Incident Solving Manager (IPM-ISM) is available in X2Rail-4 document [39].

Abstract from X2Rail-4 document [39]: *The Incident and Prevention Management – Incident Solving Manager (IPM-ISM) component predicts the geographical, temporal and resource-related impact of events on scheduled railway operation. Solving processes are aligned and prioritised. Specified routines are created to resolve Non-Regular Situations with a minimal impact on railway operation. Planned routines are executed and assisting entities coordinated. An Incident is monitored and managed during his whole lifecycle from the first recognition to the dissolution. SIL: to be defined.*

3.1.1.2 Radio Block Center (RBC) & Movement Authority Transactor (MT)

The Radio Block Centre (RBC) is a specialised computing device with Safety Integrity Level 4 (SIL 4) for generating Movement Authorities (MA) and transmitting it to trains. It gets information from Signalling control and from the trains in its section. It hosts the specific geographic data of the railway section and receives cryptographic keys from trains passing in. The RBC provides the trains with MAs until leaving the section. RBC have a standardised interface (SUBSET-026) to trains but have no standardised interface to the signalling control systems.

Movement Authority Transactor (MT) is replacing the Radio Block Center (RBC) in an RCA system. The interface between the train and the MT is the same as the interface between the train and the RBC. During the transition phase from RBCs to the MTs the train may communicate with RBCs and MTs, depending on its location and the infrastructure provided for that location.

The Movement Authority Transactor (MT) communicates with the registered ETCS capable vehicles. Among others, it translates the movement permissions to ETCS Movement Authorities and sends them to the vehicle. Only radio based ETCS is supported by the MT. In the other direction, it receives the train position reports from the vehicle and forwards them to the Object Aggregation (OA).

Detailed information on the Movement Authority Transactor (MT) is available in document [30].

3.1.1.3 ATO Transactor (AT) / Operational Execution (OE)

Information on the ATO Transactor (AT) is available in RCA document [30] and [32] while information on the Operational Execution (OE) is available in X2Rail-4 document [39].

Abstract from RCA document [30]: the *ATO Transactor (AT) distributes automatic train operation Journey Profiles, to the On-Board Unit of individual Railway Vehicles. It provides status information and execution progress in the form of Status Report Packet (STR) received from the On-Board Unit. It handles Journey Profile Request Packet (JPReq) and Segment Profile Request Packet (SPReq). It translates Operational Plans into Journey Profile Packet (JP) and Segment Profile Packet (SP) as specified in CCS TSI ATO over ETCS SUBSET-126.*

Abstract from RCA document [32]: the *ATO Transactor (AT) distributes automatic train operation journey profiles, to the CCS on-board of Physical Train Units.*

Abstract from X2Rail-4 document [39]: *The Operational Execution (OE) component supervises all GoA3/4 trains. SIL: not safety related. Note: this component is called ATO-TS in GoA2 specifications.*

3.1.1.4 Digital Map (DM)

Information on the Digital Map (DM) is available in X2Rail-4 document [39] and in RCA documents [33], [34], and [35].

Abstract from X2Rail-4 document [39]: *The Digital Map (DM) component shares infrastructure data with relevant applications like:*

- *ATO – Vehicle (ATO-AV): Segment Profiles*
- *Automatic Processing Module (APM): track zones and associated infrastructure elements*
- *Localization (LZ) (outside the scope of GoA3/4): landmarks*
- *Signal Converter (SCV) (outside the scope of GoA3/4): lineside signal information*

Assumptions:

- *DM is structured in different layers for providing services to relevant applications (application engineering is required for each layer).*
- *DM manages static data but also dynamic data like TSR.*

SIL: to be defined.

3.1.1.5 Driving Advisory System (DAS)

The Driver Advisory System (DAS) of the infrastructure manager application is a non-safe application. It generates, together with the Driver Advisory On-Board (DAS-OB) application, detailed driver advice for adhering to the planned timings while driving energy efficient. The DAS is responsible for conflict detection and calculation of new target train timings, that are forwarded to the DAS-OB application. The DAS is responsible for calculating an energy efficient speed profile to achieve the pre-planned and dynamically updated train timings. The DAS communicates with the DAS-OB, using the SFERA specification or any proprietary (vendor specific) specification.

The DAS is not needed for lines that provide ATO functionality and for vehicles that have ATO-OB functionality deployed, since the ATO Transactor (AT) / Operational Execution (OE), and ATO On-Board (ATO-OB) already include DAS functionality.

3.1.1.6 Route Control (RC)

The Route Control (RC) provides to the CCS-OB an interlocked (safe) train path uniquely assigned to a train/vehicle. This information is seen useful to fetch the required map data for the train path ahead and to validate the determined position by the LOC-OB against track selectivity, e.g., at start-up after vehicle has moved during power-off mode (degraded mode). It might also be used to determine track selectivity, e.g., if the vehicle position is known prior to passing a switch point and to decide whether it turned left or right. Furthermore, RC data may be needed for the Incident and Prevention Management (IPM-OB) to make the proper decision in case an obstacle is detected.

In RCA terminology, a route is defined as a Movement Permission (MP) that is an authorisation for a particular track bound movable object to move in a defined direction, with a defined speed, along a defined path (a contiguous stretch of TrackEdgeSections) on the track network.

The RC data is needed for every OCORA based CCS On-Board system in need to determine track selectivity.

Information on the Route Control (RC) is available in document [39].

3.1.1.7 Traffic Management System (TMS)

Abstract from RCA Document [29]: The Traffic Management System (TMS) is part of the Planning System and provides permanent control across the network, automatically plans the movement of trains and logs train movements as well as detects and solves potential operational conflicts.

3.1.1.8 Key Management Centre (KMC)

The Key Management Centre (KMC) is a system managed by the infrastructure manager and is responsible for the generation, installation, update, and deletion of the authentication keys needed to establish a safe connection between a trackside entity belonging to its domain and any on-board entity operating in its domain.

Further information on the KMC is available in SUBSET-114 and SUBSET-137.

3.1.1.9 Voice Communication System (VCS)

The Voice Communication System (VCS) is the trackside counterpart to the Cabin Voice Radio (CVR) and provides all required functionalities on trackside to establish and answer voice calls between On-Board staff (e.g., train driver, train attendant) and trackside staff (e.g., operation control centre staff).

3.1.2 Other Systems

3.1.2.1 Time Service (TS)

The Time Service (TS) is a centralized master clock at trackside to keep the trackside systems (e.g., safe data centres) and On-Board systems in sync with each other.

3.1.2.2 Augmentation (AUG)

The Augmentation (AUG) is a means of improving – "augmenting" – the positioning system's performances, such as integrity, accuracy, or availability thanks to the use of external information. (source EUG-S2R JWG).

Augmentation data leads to more accurate localisation information (along-track position, along-track speed) and faster estimation of accurate localisation after start-up of the LOC-OB in operation. It enhances GNSS localisation information to support functionalities such as track selectivity.

While GNSS augmentation data through space-based augmentation systems (SBAS) can be consumed directly by GNSS receivers (see also [27]), the purpose of this system function is to receive augmentation data through a terrestrial dissemination service with the advantage of not being always dependent on the visibility of augmentation satellites.

Augmentation data is not limited to GNSS and could be supporting information such as temporary slippery conditions (rail friction coefficient) that can be regarded by the sensors and/or fusion logic to improve the overall performance.

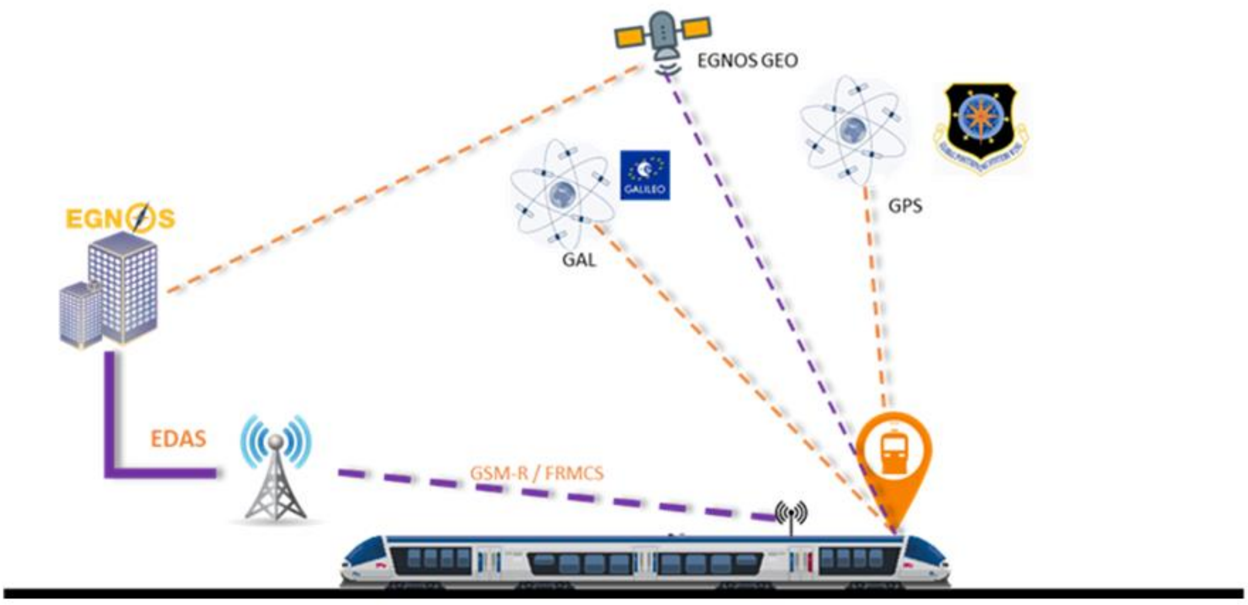

Figure 7: Augmenting GNSS position data

3.1.3 Operation Control Systems – Railway Undertaking (OCS-RU)

3.1.3.1 Train Management (TM)

X2Rail-4 definition as per document [39]: This trackside logical component supervises the train missions, provides the Mission Profile to ATO-AV (remark from OCORA: via AT to AV) and permits remote control actions on TCMS.

3.1.3.2 Mission Data (MID)

The Mission Data (MID) actor exchanges information (e.g., mission profile) with the Mission Data (MD) component On-Board.

Information on the Mission Data (MD) is available in X2Rail-4 document [39].

Abstract from X2Rail-4 document [39]: *the Mission Data (MD) component interfaces with RU to manage the Mission Profile. SIL: not safety related.*

3.1.3.3 Monitoring, Diagnostic, Configuration, Maintenance (MDCM)

The Monitoring, Diagnostic, Configuration, Maintenance (MDCM) is part of the CCS Off-Board Support (COBS) system. It includes the following basic functionality:

- Asset management for CCS-OB
- Diagnostic and monitoring of CCS-OB
- Configuration management for CCS-OB
- Software Management for CCS-OB software
- Automatic Train Operation Monitoring

The Automatic Train Operation Monitoring allows to monitor the operations of all trains of a railway undertaking, independent from the suppliers of the trains. Real-time position and speed information are provided to the operator and compared to the schedule. Significant deviations are highlighted to the operator and possibly forwarded to the current infrastructure manager. In addition, any technical limitations (e.g., door issues, traction issues, brake issues, etc.) a train has, are notified to the operator, and possibly forwarded to the current infrastructure manager's system.

The ATOM is considered to be mandatory for operators with trains running under ATO GoA 3/4 but may be useful also for ATO GoA 1/2 or for trains not equipped with ATO functionality.

Further Information on the MDCM is available in the OCORA documents [24] and [25].

3.1.3.4 Train Data (TRD)

The Train Data (TRD) actor exchanges information (e.g., vehicle database) with the Train Data (TD) component On-Board required for the mission.

Information on the Train Data (TD) is available in X2Rail-4 document [39].

Abstract from X2Rail-4 document [39]: *The Train Data (TD) component interfaces with RU to manage the train information required for the mission. Assumption: the train data must be reliable. Provide Train Protection parameters (REP) will use this data and TCMS/DAC information to build safety related data. SIL: to be defined.*

3.1.3.5 Identity & Access Management (IAM)

Abstract from RCA definition as per document [31]: The Identity & Access Management (IAM) authenticates and authorizes users and technical systems and grants or denies access to the system. Therefore, it will need to store the credentials to authenticate the entities. Supports the implementation of an ISO27001 / IEC 62443 compatible architecture.

3.1.3.6 Remote Manual Train Operation (RMTO)

The Remote Manual Train Operation (RMTO) allows for remote driving of trains. The system receives video streams, real-time position and speed information, allowing to control a train from a central site.

The RMTO system is considered to be mandatory for operators with trains running under ATO GoA 3/4 but may be useful also for ATO GoA 1/2 or for trains not equipped with ATO functionality.

3.1.4 Physical Train Unit Operation Systems (PTU-OS)

3.1.4.1 Time Service On-Board (TS-OB)

The Time Service On-Board (TS-OB) provides a service that allows all On-Board components to have their time in synch with a master clock and therefore in synch with each other and the trackside systems (e.g., safe data centres). The time base is assumed to be UTC and components in need to display the time can convert it to local time based on the systems time zone settings. The TS-OB functionality is significant to simplify diagnostic and analysis tasks and is important for ATO operations, and other aspects (e.g., used to timestamp the output of the localisation system with the validity time of the information provided).

3.1.4.2 Identity & Access Management On-Board (IAM-OB)

The Identity & Access Management On-Board (IAM-OB) is part of the Shared Security Service On-Board (SSS-OB) and integrates with the trackside Identity & Access Management providing the central management for the identification, authentication and authorisation of devices and applications to resources and functions of the CCS On-Board and trackside systems.

For the identification, the IAM System manages a unique ID for each entity (e.g., device, application). The granularity, on what level the system will identify entities is not yet defined. It can reach from one single ID for the overall CCS On-Board system to IDs for any single device connected to the CCN and to any application, running on the OCORA Platform.

For the authentication of a device or an application, the solution could be based on the Public Key Infrastructure (PKI) or Message Authentication Codes (MAC) using symmetrical encryption mechanisms like AES.

The access to resources and functions is centrally managed by roles and granted on a Need-to-Know principle to limit unauthorised access to resources and functions within the CCS On-Board system.

3.1.4.3 Other Cyber Security Services (OCSS)

Besides the Identity & Access Management On-Board (IAM-OB) and the Time Service On-Board (TS-OB) additional services, such as central logging, backup, asset inventory, intrusion detection and public key infrastructure will be required as part of the Shared Security Services On-Board (SSS-OB).

3.1.4.4 Wired I/O Control (WIOC) – Legacy Train

The Wired I/O Control (WIOC) provides connectivity between Wired Sensors and Actors and the CCS-OB through the FVA, where functions are executed with SIL<4. The mapping logic between Wired Sensors and Actors and the CCS-OB is executed within the FVA.

In addition, the Wired I/O Control (WIOC) also provides a direct connection between CCS-OB and the Wired Sensors to signal the isolation status of the CCS-OB.

3.1.4.5 Wired Sensors and Actors (WSA)

The Wired Sensors and Actors (WSA) include all Sensors and Actors that are directly wired to the CCS-OB or in case of the legacy train, connected to the Wired I/O Control (WIOC) of the Train Adapter (TA).

3.1.4.6 On-Board Recording Device (ORD) << Train Recording Unit (TRU)

The On-Board Recording Device (ORD) includes the Juridical Recording Unit (JRU) and the Diagnostic Recording Unit (DRU). The ORD is located at the train control (vehicle) domain. The JRU records data from the European ETP-OB (ETCS On-Board) and ATO-OB systems while the DRU is recording data from other vehicle on-board systems, for instance the TCMS. In the future, other functions than ETP on-board residing in the CCS domain also have a need to record juridical data. Hence, further data is proposed to be recorded in the JRU memory. Whether this memory is a specific hardware, separated from the hardware available to record DRU data, or the JRU and DRU hardware are combined into one common unit, or even in the same physical memory, depends on the products available in the market. At least, the two JRU and DRU need to be handled separately at logical level.

For every OCORA based CCS On-Board system an ORD is installed to record data.

3.1.4.7 Functional Vehicle Adapter (FVA) – Legacy Train

The Functional Vehicle Adapter (FVA) is a piece of software deployed either on the Safe Computing Platform (SCP), on a separate CCS Computing Unit (CCU), or on the OCORA Gateway (OGW). Its job is to provide OCORA unified and standardised interfaces (SCI-FVA and SCI-MDCM) for the CCS-OB Software to access vehicle functions and vehicle information. Furthermore, it uses a specific interface (SCI-VL) to provide localisation information to the TCMS. Although the TSI-CCS SUBSET-034, SUBSET-119, and SUBSET-139 are defining the interfaces to the TCMS system, vehicles from different suppliers and especially from different generations have still different interfaces implemented. This adapter allows to map, on a functional level, the commands sent, and the information received from a specific TCMS into the (OCORA) CCS-OB standard. This includes that the FVA can likewise be used to integrate vehicles through wired connections.

Remark: Sometimes the FVA is also called Train Interface Unit (TIU). However, the TIU is not clearly defined. Sometimes it refers to the functional level of the interface with the vehicle, while in another context a piece of hardware is meant. To avoid confusion, OCORA does not use the term TIU.

Detailed information on the Functional Vehicle Adapter (FVA) is available in document [21].

3.1.4.8 Train Control & Management System (TCMS)

The Train Control & Management System (TCMS) typically includes the following functionalities, relevant for CCS-OB:

- Traction Control
- Brake Control
- Door Control
- Energy Control
- Air Tightness Control
- Status Synchronisation
- Train Integrity Monitoring
- Digital Automatic Coupling

The TCMS connects to the CCS On-Board (CCS-OB) through the Functional Vehicle Adapter (FVA), using the PTU-OS internal CI-TCMS interface. However, in the long term the TCMS might connect directly to the CCS On-Board (CCS-OB) without having a Functional Vehicle Adapter (FVA) in between. In the latter case it will implement the standardised interfaces SCI-FVA and SCI-VL.

In addition, there is a direct interface (SCI-IS) between the TCMS and the Isolation Management component (ISM) of the European Train Protection On-Board (ETP-OB).

3.1.4.9 Passenger Info System Adapter (PISA) – Legacy Train

The Passenger Information System Adapter (PISA) is a non-safe piece of software deployed either on the Safe Computing Platform (SCP), or on a separate CCS Computing Unit (CCU), or on the OCORA Gateway. Its job is to allow communication between the standardise CCS-OB and the proprietary Passenger Information System (PIS).

Furthermore, the Passenger Information System Adapter (PISA) might have an interface (X2R4-D3.2: C47) to the Automatic Processing Module (APM). However, the functions and details allocated to this interface are still being worked out within the X2Rail-4 organisation. Only then the interface can be properly standardised.

3.1.4.10 Passenger Information System (PIS)

The Passenger Information System (PIS) typically includes the following functionalities, relevant for CCS-OB:

- Passenger announcement from the operation control centre of the IM or the RU (OCS-IM, OCS-RU), the Train Driver (DRV), or the On-Board Staff (OBS)
- Communication between Train Driver (DRV) and On-Board Staff (OBS)
- Providing position and speed information to passengers

Remark: The PIS does not include the network provided for passenger internet services.

3.1.5 Trackside Systems & Environment

3.1.5.1 National Train Protection Systems (NTPs)

Any kind of national Automatic Train Protection (ATP) system installed at trackside.

3.1.5.2 Other Trains (OTR)

The Other Trains (OTR) actor represents another train, which may be required by the CCS-OB related to the interactions for the virtual train coupling and the cabin voice radio activities.

3.1.5.3 Environment (ENV) incl. Physical Train Unit (PTU) and Light Signal (LSIG)

Environment provides information about conditions, influencing the railway operation. It can be trackside or vehicle based.

3.1.5.4 Eurobalise (EUB) & Euroloop (EUL)

The Eurobalise (EUB) is a transponder, mounted on the track, which can communicate with a train passing over it, compliant to the ERTMS/ETCS specifications.

Detailed information on the Eurobalise is available in SUBSET-036

The Euroloop (EUL) is a transponder loop mounted along the track, which can communicate with a train passing along, compliant to the ERTMS/ETCS specifications.

Detailed information on the Euroloop is available in SUBSET-044.

3.1.6 Human Actors

3.1.6.1 Evaluator (EVAL)

The Evaluator (EVAL) is a person evaluating data stored in the TRU.

3.1.6.2 Technician (TECH)

The Technician (TECH) is a person performing preventive and corrective maintenance tasks.

3.1.6.3 Driver (DRV)

The Driver (DRV) is a person capable and authorised to drive trains, including locomotives, shunting locomotives, work trains, maintenance railway vehicles or trains for the carriage of passengers or goods by rail in an autonomous, responsible, and safe manner. Source: Directive 2007/59/EC of the European Parliament and of the Council.

3.1.6.4 On-Board Staff (OBS)

The On-Board Staff (OBS) is the personnel of the Railway Undertaking (RU), escorting the Passenger Train.

The Train Attendant is responsible for Passenger and Train service.

3.1.7 Maintenance Equipment

3.1.7.1 Maintenance Terminal (MNT)

The Maintenance Terminal (MNT) is a laptop that can indirectly be connected to the CCN (through the ECN/ECN Security Gateway) to perform maintenance tasks on all CCS On-Board components. Maintenance tasks should include the monitoring and downloading of diagnostic data, executing service commands (e.g., reboot of a specific component) and installing updates (new software, configuration, etc).

Multiple MTs can be connected to every OCORA based CCS On-Board system.

Further details will be provided in subsequent versions of the OCORA architecture documentation.

3.2 Physical Actors

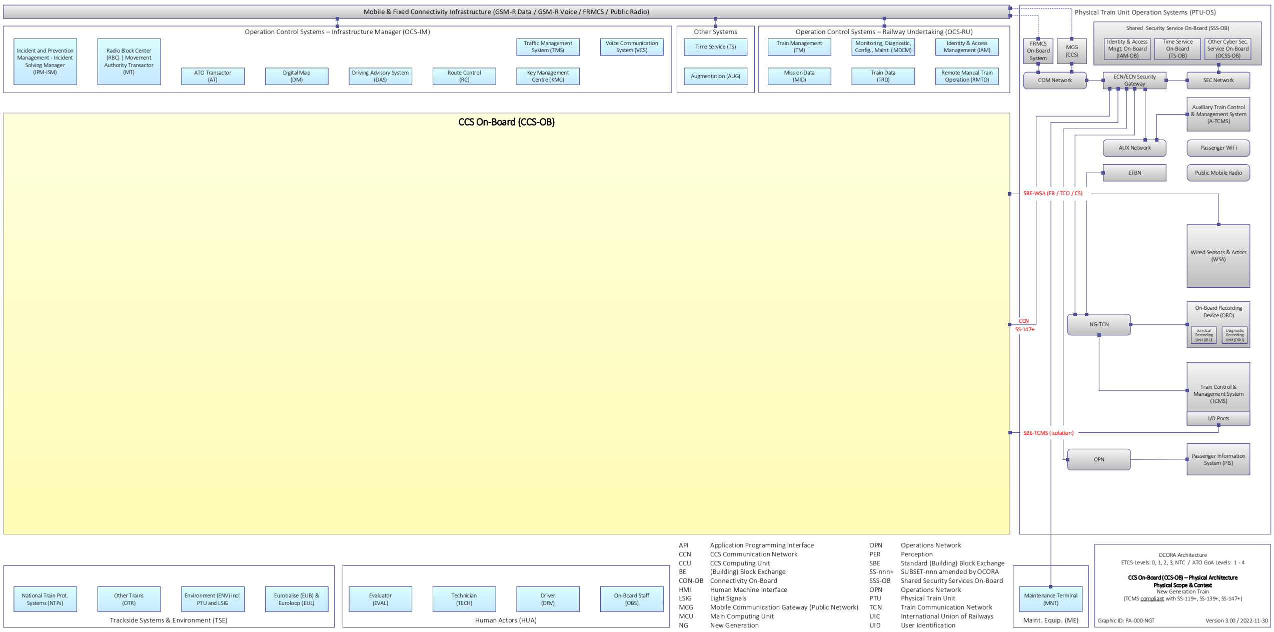

Figure 8: Actors – physical architecture – new generation train

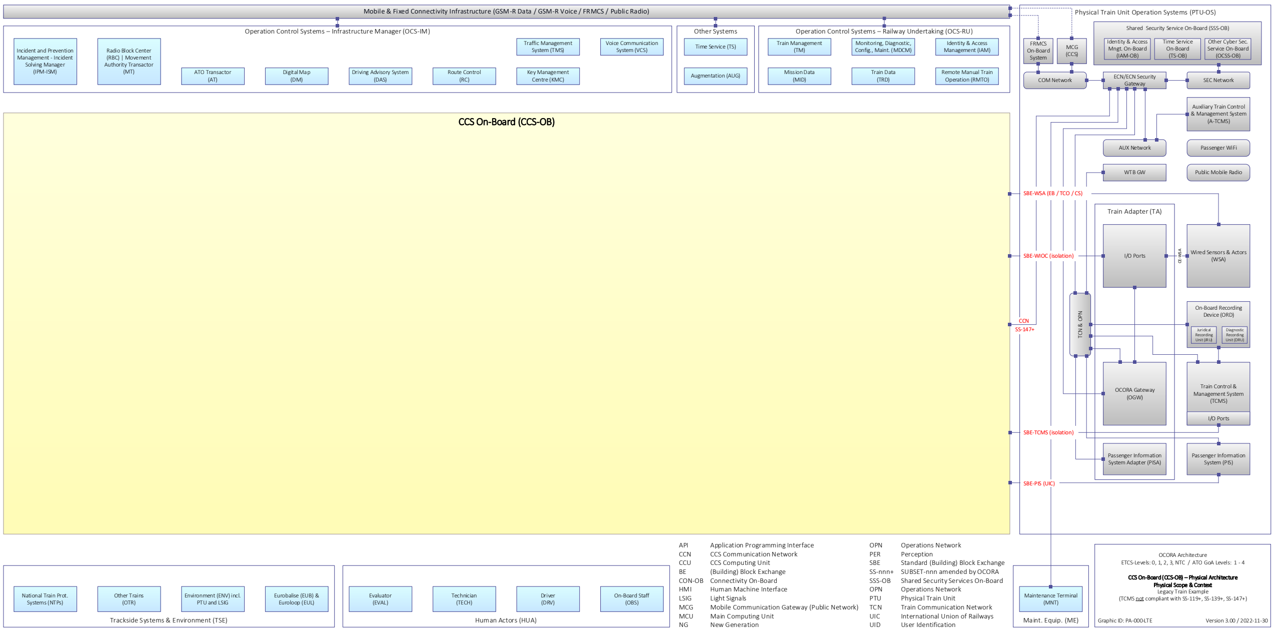

Figure 9: Actors – physical architecture – legacy train example

3.2.1 Physical Train Unit Operation Systems (PTU-OS)

3.2.1.1 ECN/ECN Security Gateway

The ECN/ECN Security Gateway is a network component providing cyber secure interconnection between the different On-Board network zones (e.g., CCS/TCMS, Operator, Connectivity).

The ECN/ECN Security Gateway is installed on every OCORA based CCS On-Board system, monitors, and filters all traffic between the connected networks based on the configured security policies (e.g., IP source address, IP destination address, Source port, etc.).

3.2.1.2 Wired Sensors & Actors (WSA)

Wired Sensors and Actors (WSA) are actuators directly activated by the CCS-OB to trigger the Emergency Brake (EB) and the Traction Cut-Off (TCO) on the PTU-OS and sensors directly used by the CCS-OB to receive the Coupler Status (CS) from the PTU-OS.

3.2.1.3 Train Control & Management System (TCMS) I/O Ports

The I/O Ports of the Train Control & Management System are directly activated by the CCS-OB to signal the isolation status of the Automatic Train Protection On-Board (ATP-OB) to the TCMS.

3.2.1.4 Train Adapter (TA) I/O Ports – Legacy Train

The I/O Ports of the Train Adapter (TA) are directly activated by the CCS-OB to signal the isolation status of the Automatic Train Protection On-Board (ATP-OB) to the PTU-OS.

3.2.1.5 Passenger Information System (PIS)

The physical actor, Passenger Information System (PIS), represents the hardware required by the functionality for the Passenger Information System.

4 Building blocks

OCORA aims to introduce “plug & play”-like exchangeability for the CCS On-Board building blocks.

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

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

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

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

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

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

OCORA clusters the functional components for assigning functionality to building blocks as depicted in Figure 10 for a new generation train and Figure 11 representing an example of a legacy train.

These diagrams depict the current OCORA working assumption in regards to Hardware and Software Building Blocks. It represents scenario 2, as published with OCORA Release R2. This scenario is the most likely option for the mid term (e.g. TSI 2025) and the long term (e.g. TSI 2028). However, it is the vision of OCORA (e.g. TSI > 2028) to host as many building blocks as possible on the Safe Computing Platform.

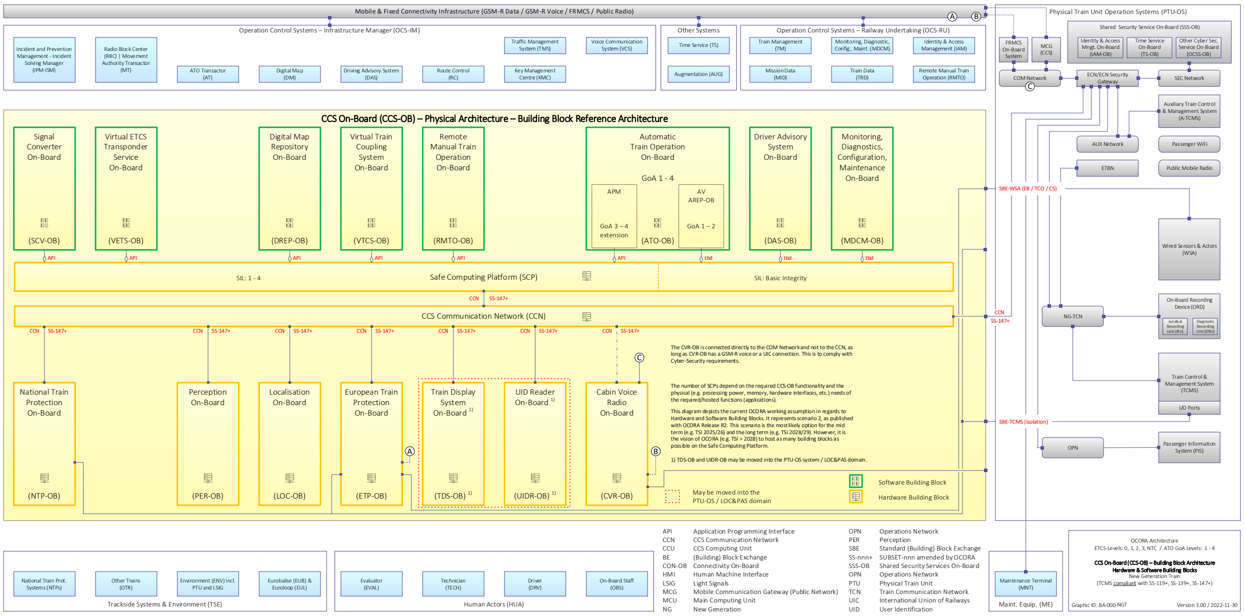

Figure 10: Hardware & Software Building Blocks – new generation train

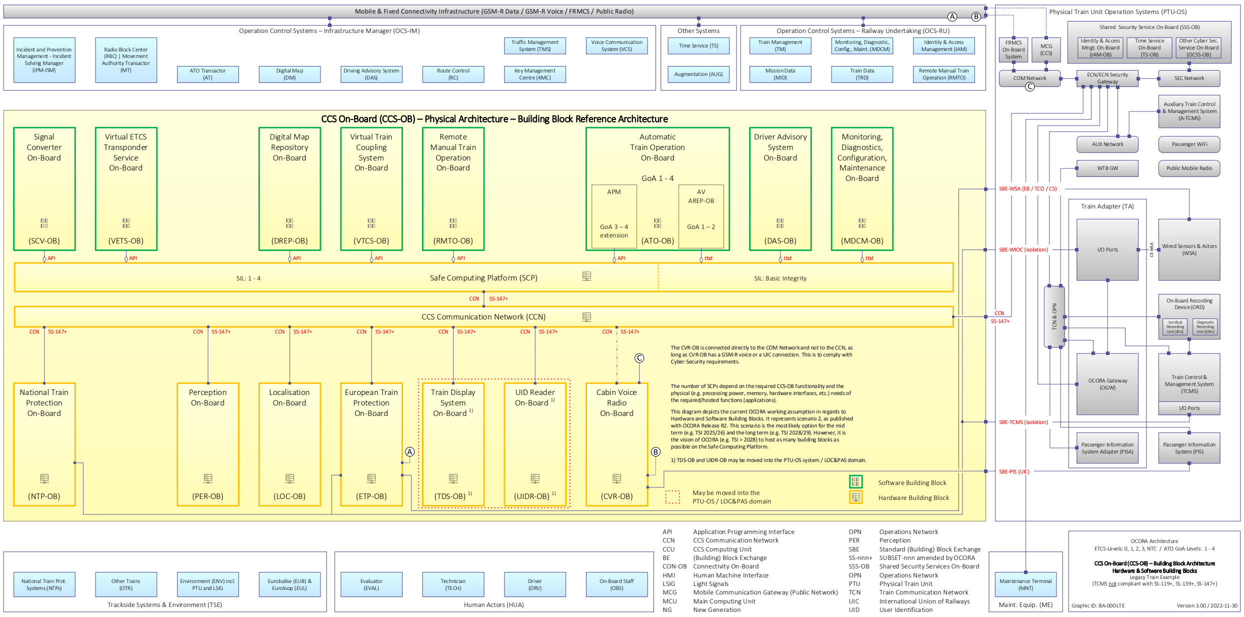

Figure 11: Hardware & Software Building Blocks – legacy train example

4.1 Signal Converter On-Board (SCV-OB)

Abstract from X2Rail-4 document [39]: *The Signal Converter (SCV) is in the train and converts the information coming from optical signals into SUBSET-026 compliant information*.

4.2 Virtual ETCS Transponder Service On-Board (VETS-OB)

The VETS component generates virtual ETCS telegrams based on the current location and using information provided by the Digital Map Repository On-Board (DREP-OB).

4.3 Automatic Train Operation On-Board (ATO-OB)

Detailed information on the Automatic Train Operation On-Board (ATO-OB) is available in the X2Rail-4 document [39].

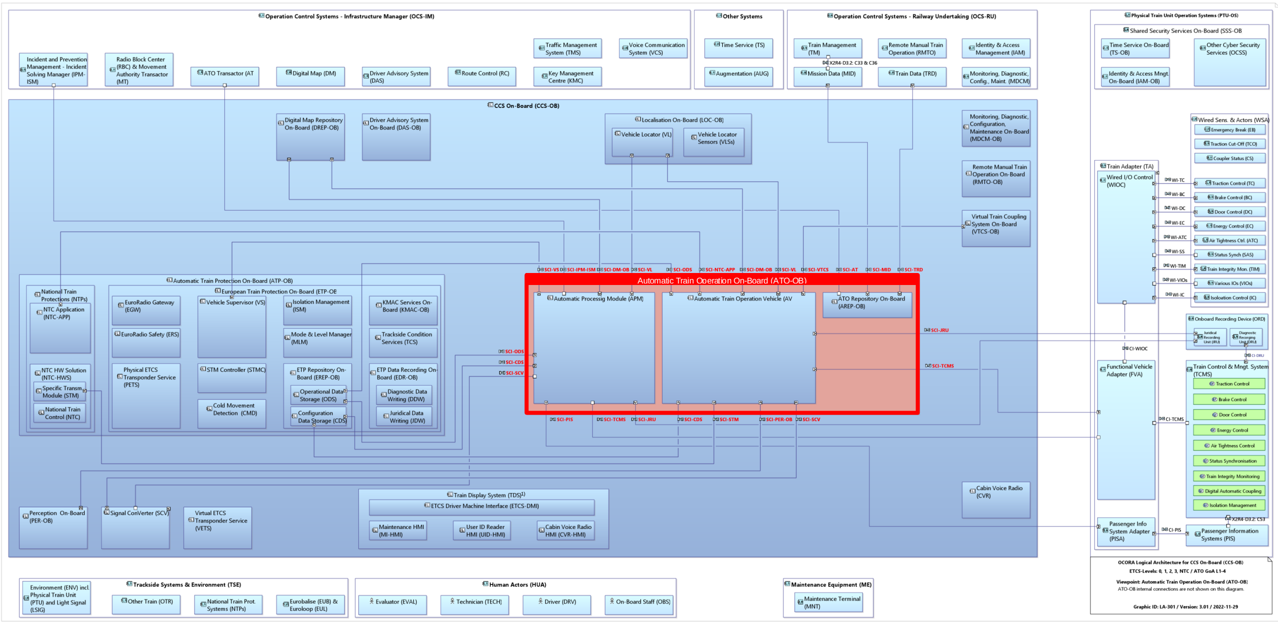

Figure 12: Automatic Train Operation On-Board (ATO-OB)

Notes: refer to Appendix D4 for large scale representation
1) may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn: respective subset contains information for the interface.

4.4 Digital Map Repository On-Board (DREP-OB)

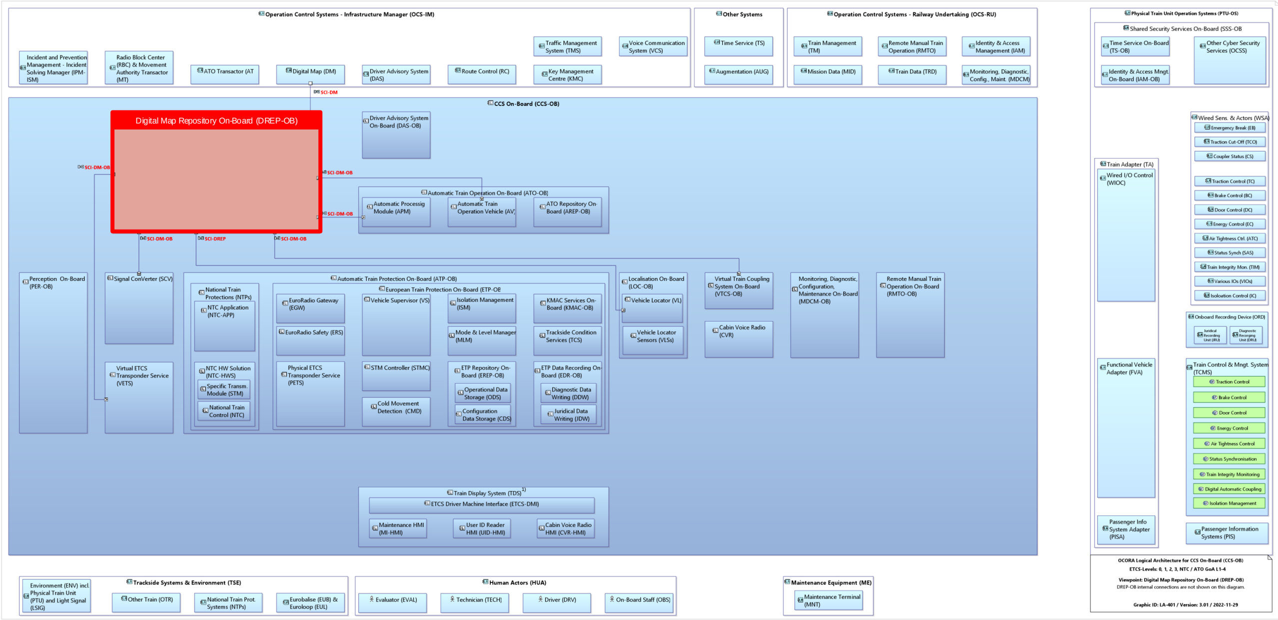

Figure 13: Digital Map Repository On-Board (DREP-OB)

Notes: refer to Appendix D5 for large scale representation
1) may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn: respective subset contains information for the interface.

The logical component DREP-OB is a safe service deployed on the OCORA computing platform. The DREP-OB provides topology and topography data (a.k.a. map data) that are certified for the usage in safety-relevant On-Board applications / services (e.g., VL, VS, PER-OB) up to SIL4. The service guarantees that the map data fulfils the quality criteria stated by trackside, e.g., accurate, precise, reliable, complete, and up-to-date map data. The DREP-OB uses its own On-Board data storage that is updated, if required, using the trackside Digital Map (DM) service.

Examples of possible digital map objects/attributes are (with reference to the RCA topology concept): track edge, track node, track edge point (balise, track radius, gradient, cant, speed profile marker), and track edge section (tunnel, platform edge).

Example of service usage: The Vehicle Locator (VL) service uses the digital map repository (DREP-OB) to place sensor measurements into a common reference frame such that this data can be interlinked as part of a fusion algorithm. For example, a position determined by balise and relative path measurement (odometer) is geo-referenced and fused with an absolute GNSS position before being mapped back to a position on the track edge to improve the accuracy and confidence of the actual train position.

Detailed information on the Digital Map Repository On-Board (DREP-OB) is available in document [39]. Information on the Digital Map (DM) in general is also available in RCA documents [33], [34], and [35].

Further details will be provided in subsequent versions of the OCORA architecture documentation.

4.5 Driver Advisory System On-Board (DAS-OB)

The Driver Advisory System On-Board is an optional and non-safe and not necessarily standardised application typically calculating an energy efficient speed profile to achieve the pre-planned and dynamically updated train timings. It is either following the SFERA standard or any non-standardised vendor or IM specific specification. The DAS-OB is not needed for vehicles that have ATO-OB deployed and are operating on lines that provide ATO functionality, since the ATO-OB already includes DAS functionality.

The DAS-OB typically generates detailed driver advice for adhering to the planned timings while driving energy efficient. The trackside Driver Advisory System (DAS) or the Traffic Management System (TMS) is responsible for conflict detection and calculation of new target train timings, that are forwarded to the DAS-OB and evaluated accordingly. The typical integration of DAS-OB application is defined EN 15380-4. The DAS-OB can also operate standalone (e.g., without integration into the vehicle).

The DAS-OB application can be deployed on OCORA based CCS On-Board system, depending on the requirements of the rail network, the RU operates in. The DAS-OB installed on an OCORA platform can receive kinematic data from LOC-OB through the standardised interface SCI-VL. Vehicles can have multiple DAS-OB installed, depending on the network the vehicle operates in, one or the other is used. Also, a combination of DAS-OB and ATO-OB is feasible (see also Figure 14 and Figure 15). This might be especially interesting during transition periods from DAS-OB to ATO-OB.

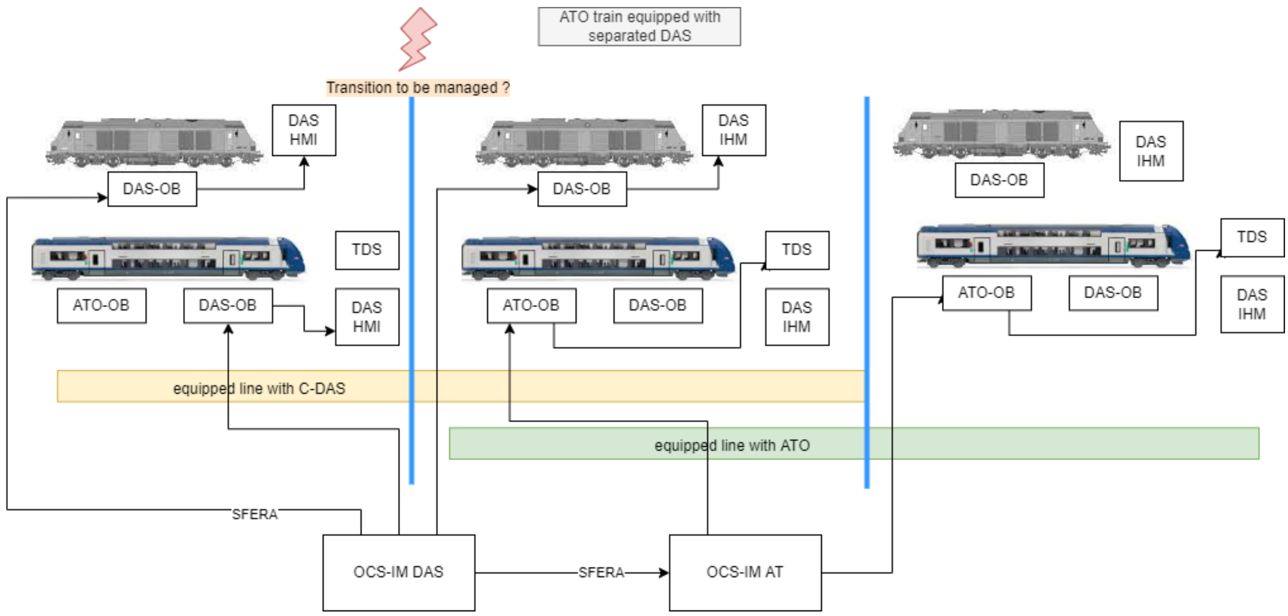

Figure 14: Train equipped with ATO-OB and DAS-OB operating in different networks

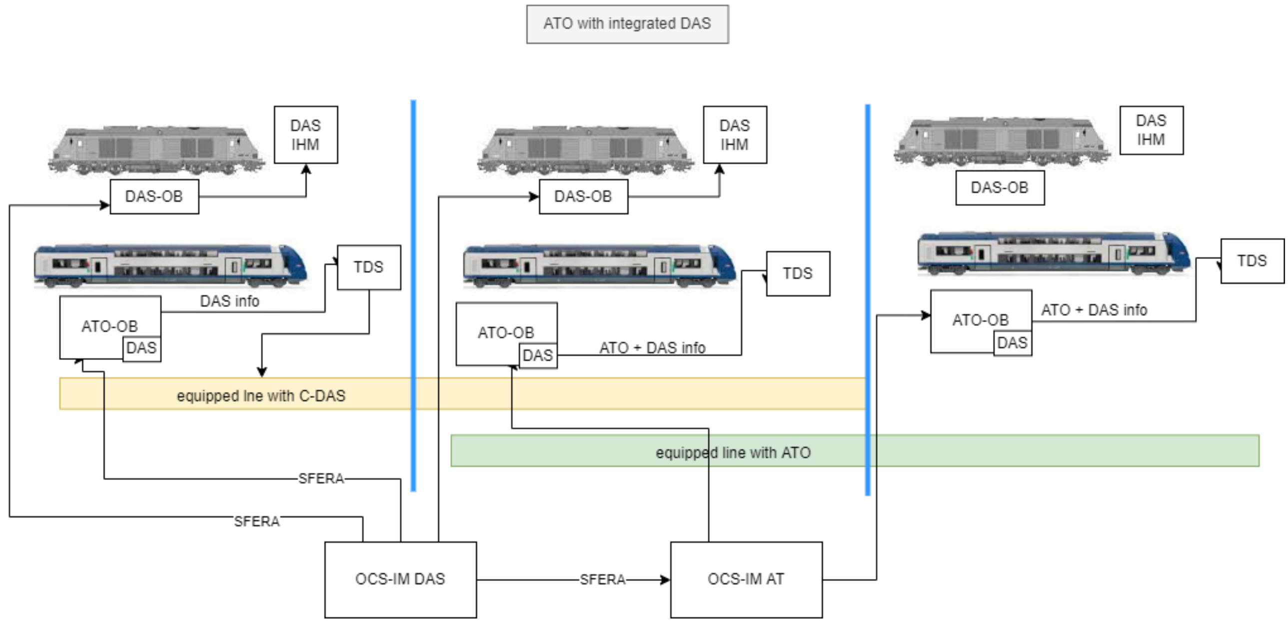

Figure 15: Train using DAS-OB functionality from ATO-OB operating in different networks

4.6 Virtual Train Coupling System On-Board (VTCS-OB)

The Virtual Train Coupling System On-Board (VTCS-OB) provides all functionality needed for trains to drive in a virtual coupling mode. Refer also to document.

Further information is available in X2Rail-3 document [38].

4.7 Remote Manual Train Operation On-Board (RMTO-OB)

The Remote Manual Train Operation On-Board (RMTO-OB) allows for remote driving of trains. The system provides real-time position and speed information, combined with video streams to RMTO, allowing to control a train from a central site.

The RMTO-OB system is considered to be mandatory for operators with trains running under ATO GoA 3/4 but may be useful also for ATO GoA 1/2 or for trains not equipped with ATO functionality.

4.8 Monitoring, Diagnostics, Configuration, Maintenance (MDCM-OB)

The MDCM-OB is an OCORA CCS-OB building block that provides standardised services for monitoring, diagnostic, configuration, and maintenance tasks to onboard and trackside clients.

For remote monitoring and diagnostic tasks, the MDCM-OB collects relevant data from onboard systems and forwards it to trackside clients via the FRMCS On-Board or the Mobile Communication Gateway (MCG CCS).

For local monitoring and diagnostic tasks (onboard the vehicle), the MDCM-OB provides relevant data for the Maintenance Terminal (MNT) or the Train Display System On-Board (TDS-OB).

For the configuration of onboard equipment, the corresponding MDCM-OB services can be either used locally through the Maintenance Terminal, or remotely through the Monitoring, Diagnostic, Configuration, Maintenance (MDCM) trackside server application.

Remarks:

- Technically, the MDCM-OB is deployed on the OCORA CCS-OB computing platform or on a dedicated hardware.
- MDCM-OB services are typically used by RUs and potentially by IMs. Other potential MDCM-OB stakeholders/users are, for example, CCS-OB or train providers.
- MDCM-OB data services and associated data channels can be configured for data-driven or demand-driven operation.
- Onboard equipment which is configurable through the MDCM-OB includes CCUs, network components and peripheral devices.
- When it comes to MDCM-OB configuration services, RUs will use them for vehicle configuration, such as equipment configuration, calibration, and software updates.
- The MDCM-OB services will process the data (as far as possible) in a transparent manner. That is, the content of the data, in particular configuration data, is not in MDCM-OB scope.

Detailed information on the Monitoring, Diagnostics & Configuration Management On-Board (MDCM-OB) is available in document [24].

4.9 Safe Computing Platform (SCP)

The computing platform provides the infrastructure required for operating OCORA's modular, software-component-based, distributed functional CCS On-Board applications. Safety and non-safety critical applications shall be able to coexist on the same platform and may even run on the same computing hardware.

The incentive to postulate an open, standardised computing platform is directly derived from the OCORA problem statements, key principles, objectives, and design statements as described in [5] and [7].

Todays deployed CCS On-Board systems are proprietary, monolithic vendor specific solutions, creating undesired vendor lock-ins resulting in very high cost of ownership. High-priced changes and extensions stall advancements and impede new game-changing technologies.

Safety functions implemented by CCS On-Board systems demand adherence to railway specific standards during development, operation, and maintenance of the entire systems. The stringent homologation processes imposed by CENELEC (standards such as EN50126, EN50128, EN50129) is exorbitantly expensive and time consuming when applied to proprietary, monolithic products in every (type of) rolling stock.

OCORA aims to mitigate the problem by breaking down the CCS On-Board system into different layers and components with defined, open interfaces that can be developed, tested, and certified independently.

The proposed computing platform provides a communication focused abstraction layer; a construction kit for building functional applications, agnostic of the underlying operating system, board support package, hypervisor, and hardware.

Today's monolithic solutions block innovative new application development due to

- lacking support for new functions, sensors, and actuators
- lacking ability to cope with increased/different processing requirements (like real-time/non-real time)
- lacking support for calculation intense machine learning algorithms that require GPU hardware processing.

The OCORA computing platform pursues to address these issues by abstracting the underlying hardware, board support package and operating system. An open, unified platform independent API shall open the door to platform agnostic application development while entrusting the computing platform internals to experienced vendors.

Industrial and technological readiness are essential, when deploying new CCS components. To meet this target, a computing platform that is deployed on a large scale must have been extensively field tested (e.g., to ensure reliability in operation). It will take several computing platform iterations to achieve all OCORA goals (e.g., full hardware independency may not be achieved in the first computing platform generation). Along the journey, applications' portability will be indispensable to leverage implementation and certification effort across the evolving computing platform generations.

Detailed information on the Computing Platform is available in the following documents:

- Computing Platform – Whitepaper [18]
- Computing Platform – Requirements [19]
- Computing Platform – Initial Specification of the PI API between Application and Platform [20]

4.10 CCS Communication Network (CCN)

The CCS Communication Network (CCN) allows direct communication between all CCS On-Board components connected to it and eventually with external systems, such as the TCMS. The CCN is the most central part of the OCORA architecture and is the basis for achieving modularity that results in "plug & play" -like exchangeability of all identified building blocks. The CCN is a TSN Ethernet based network with the use of SDTv2/v4 as safety layer. On session layer (OSI layer 5, refer to OCORA OSI definitions in document [9]) different protocols (e.g., TRDP 2.0, OPC UA PubSub over TSN, DDS/RTPS over TSN) are possible. At the final stage, the CCN will be specified on all layers together with Shift2Rail CONNECTA/Safe4RAIL projects in the new IEC 61375 standards series.

Information regarding the requirements used for evaluating the CCN and the respective evaluation can be found in document [16].

4.11 National Train Protection On-Board (NTP-OB)

The NTPs provides Automatic Train Protection functionality on national level. The NTPs can be either a dedicated NTC HW Solution (NTC-HWS) or it can be deployed as NTC Application (NTC-APP) running on the OCORA computing platform.

The NTPs is foreseen to be deployed on every OCORA based CCS On-Board system in need of NTP.

NTC HW Solution (NTC-HWS)

The NTC-HWS is a dedicated hardware solution implementing the national Automatic train protection solution with the NTC and STM components.

The NTC-HWS is foreseen to be deployed on every OCORA based CCS On-Board system in need of NTP. Refer to Appendix D4 on page 116 to locate the NTC-HWS component in the OCORA architecture.

Further details will be provided in subsequent versions of the OCORA architecture documentation.

National Train Control (NTC)

The National Train Control (NTC) implements the national Automatic Train Protection functionality on dedicated hardware. It communicates with other OCORA components, namely the STM and can also use the functionality of other components connected to the CCN (e.g., DRU).

The NTC is foreseen to be deployed on every OCORA based CCS On-Board system in need of NTP. Refer to Appendix D4 on page 116 to locate the NTC component in the OCORA architecture.

Further details will be provided in subsequent versions of the OCORA architecture documentation.

Specific Transition Module (STM)

The Specific Transmission Module (STM) provides the connection between the ETCS system (in case of OCORA the CCN) and the National Train Control System (NTC). The STM and the NTC are often closely integrated, hence the term STM is often used, when referring to the NTC system.

The STM is foreseen to be deployed on every OCORA based CCS On-Board system in need of NTP. Refer to Appendix D4 on page 116 to locate the STM component in the OCORA architecture.

Further details will be provided in subsequent versions of the OCORA architecture documentation.

NTC Application (NTC-APP)

The National Train Controls Applications (NTC-APP), deployed on the OCORA computing platform, are safe applications in charge of ensuring Automatic train protection based on national systems. NTC-APPs, implemented on the OCORA computing platform, must communicate, as a minimum, with the Mode and Level Manager (MLM) and can use their specific sensors and actuators. In addition, they can take advantage of the standard OCORA interfaces. E.g., location information can be received from the Vehicle Locator (VL), data can be recorded in the DR-OB, DMI can be used, the TCMS can be accessed through the Functional Vehicle Adapter (FVA) and the NTC-APPs can also access balise telegrams through the ETCS Transponder Service (ETS) in order to get the packet 44 information.

Multiple NTC-APPs can be deployed on OCORA based CCS On-Board system, depending on the requirements of the rail network, the RU wants to operate in. Refer to Appendix D4 on page 116 to locate the NTC-APPs in the OCORA architecture.

Further details will be provided in subsequent versions of the OCORA architecture documentation.

4.12 Perception On-Board (PER-OB)

The PER-OB logical component is deployed on every OCORA based CCS On-Board system in need of ATO GoA 3 or GoA 4 functionality. In case of light signalling perception, the PER-OB may also be used for GoA1-2 operations. Refer Appendix D4 on page 116 to locate the PER-OB component in the OCORA architecture.

4.13 Localisation On-Board (LOC-OB)

Localisation On-Board (LOC-OB) contains the Vehicle Locator (VL) and Vehicle Locator Sensor (VLS) functionality. The Figure 16 identifies the LOC-OB component in the overall CCS-OB architecture and depicts all interfaces to all currently know CCS-OB actors and CCS-OB components.

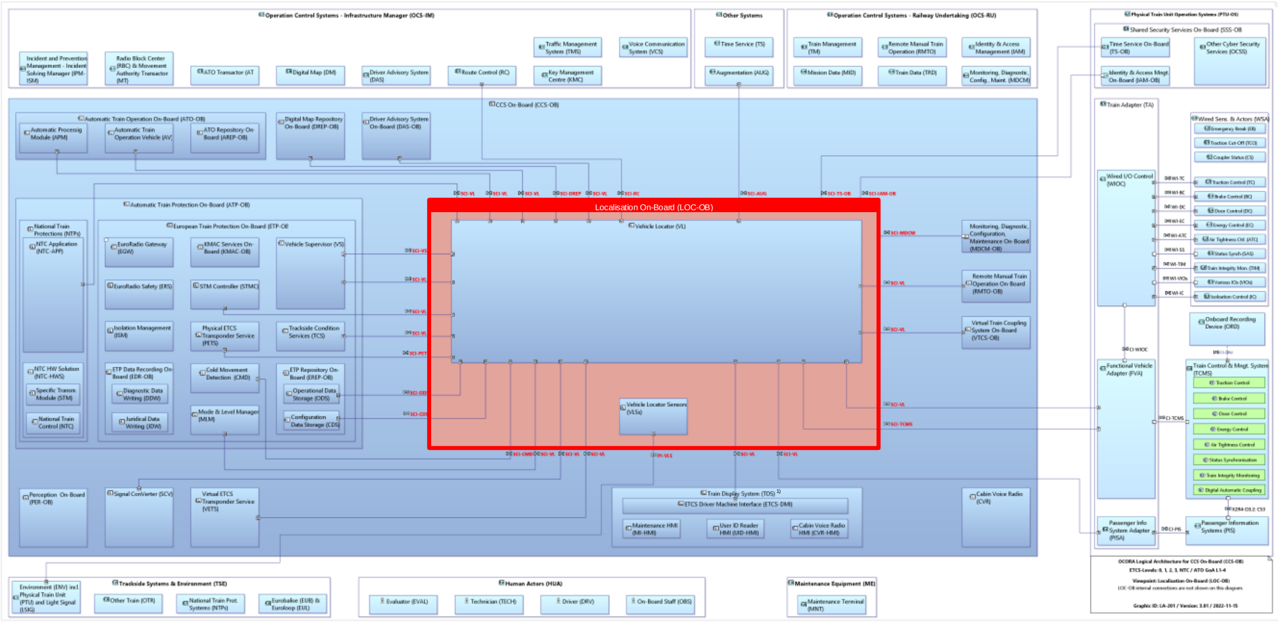

Figure 16: Localisation On-Board (LOC-OB)

Notes: refer to Appendix D3 for large scale representation
1) may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn: respective subset contains information for the interface.

4.13.1 Interfaces

The following table lists all LOC-OB interfaces. Refer to Figure 16 to identify the currently foreseen LOC-OB communication partners. The interface of the type "Provider (P)" indicates that the LOC-OB building block is providing this interface. The interface of the type "Consumer (C)" indicates that the LOC-OB building block uses these interfaces.

Name	Description	Type
SCI-VL	Standard Communication Interface – Vehicle Locator	Provider (P)
SCI-DREP	Standard Communication Interface – Digital Map Repository	Consumer (C)
SCI-RC	Standard Communication Interface – Route Control	Consumer (C)
SCI-AUG	Standard Communication Interface – Augmentation	Consumer (C)
SCI-TS-OB	Standard Communication Interface – Time Service On-Board	Consumer (C)
SCI-IAM-OB	Standard Communication Interface – Identity and Access Management On-Board	Consumer (C)
SCI-MDCM-OB	Standard Communication Interface – Monitoring, Diagnostic, Configuration, Maintenance	Consumer (C)
SCI-TCMS	Standard Communication Interface – Train Control & Management System	Consumer (C)
PI-VLS	Perception Interface – Vehicle Locator Sensors	Consumer (C)
SCI-CMD	Standard Communication Interface – Cold Movement Detection	Consumer (C)
SCI-CDS	Standard Communication Interface – Configuration Data Storage	Consumer (C)
SCI-ODS	Standard Communication Interface – Operational Data Storage	Consumer (C)
SCI-PETS	Standard Communication Interface – Physical ETCS Transponder Service	Consumer (C)
SCI-VS	Standard Communication Interface – Vehicle Supervisor	Consumer (C)

Table 1 LOC-OB Interfaces

Note: Standard Communication Interfaces for which the LOC-OB is the service provider (P), shall be exposed on the CCN to be available to an arbitrary number of current and future applications.

4.13.2 Functional Components

Vehicle Locator (VL)

The Vehicle Locator (VL) is a safe CCS On-Board logical component that uses localisation sensor data and supporting information to provide train location output information safely and reliably. The Vehicle Locator (VL) is able to provide the absolute and relative position of the front end of the train, train orientation information as well as kinematic parameters such as speed, acceleration, or rotational angles; hence, the VL is more than just a logical odometry component. The VL is deployed on every OCORA based CCS On-Board system.

In today's ETCS implementations, the LOC-OB functionality is part of the monolithic ETCS On-Board Unit. Since innovation cycles for the LOC-OB are expected to occur more frequently than for the remaining part of the ETCS On-Board Unit (e.g., Automatic Train Protection - On-Board (ATP-OB)), it is essential that the LOC-OB is a separate logical component, containing just the functionality needed to locate safely and reliably the train and its orientation on the track and determining associated kinematic parameters of the vehicle. With a separation of the LOC-OB functionality, guiding principles such as modularity and single-responsibility are fulfilled leading to reduced complexity in terms of testing and certification of conformity. Standardising the external interfaces of LOC-OB allows to leverage new localisation technologies in the future without the need to modify the remaining part of the ETCS On-Board functionality. Moreover, the LOC-OB architecture intends to break the strong coupling of the on-board ETCS logic and balise technology (LRBG) to allow vendors to produce industry-independent localisation products by adhering to the standardised interfaces.

These are very important aspects, since the LOC-OB is requiring a safe implementation and already many changes for the CCS on-board, impacting the LOC-OB, are foreseeable. New functionalities (game changers) with potential impact on the LOC-OB are:

- FRMCS
- ATO
- Train integrity detection for ETCS L3
- GNSS augmentation
- Digital map

It is the goal of the OCORA architecture team to build a LOC-OB model that is mostly agnostic to these changes, and where not possible, does already consider the upcoming changes in the design. Further details will be provided in subsequent versions of the OCORA architecture documentation.

Appendix B contains, on a very high-level, a first proposed split of functionality between the VS, and VL, based on SUBSET-026, chapter 4.5. The OCORA architecture team is aware that splitting the functionality only based on the SUBSET-026, chapter 4.5 is not sufficient, because the subset does not provide all requirements. SUBSET-026 is providing the mandatory requirement specifications only. A more detailed separation and a first version of a VL model, identifying additional requirements to SUBSET-026, can be expected in subsequent OCORA documentation releases.

Further information can be found in the documents [13], [14], [27], and [28].

Vehicle Locator Sensors (VLS)

This logical component includes the functionality the locator sensors are providing. Further information can be found in the documents [13], [14], [27], and [28].

4.14 European Train Protection On-Board (ETP-OB)

The European Train Protection On-Board (ETP-OB) represents the core of the on-board part of the European Train Control System (ETCS). ETCS is the signalling and control component of the European Rail Traffic Management System (ERTMS). It is a replacement for legacy train protection systems and designed to replace the many incompatible safety systems currently used by European railways.

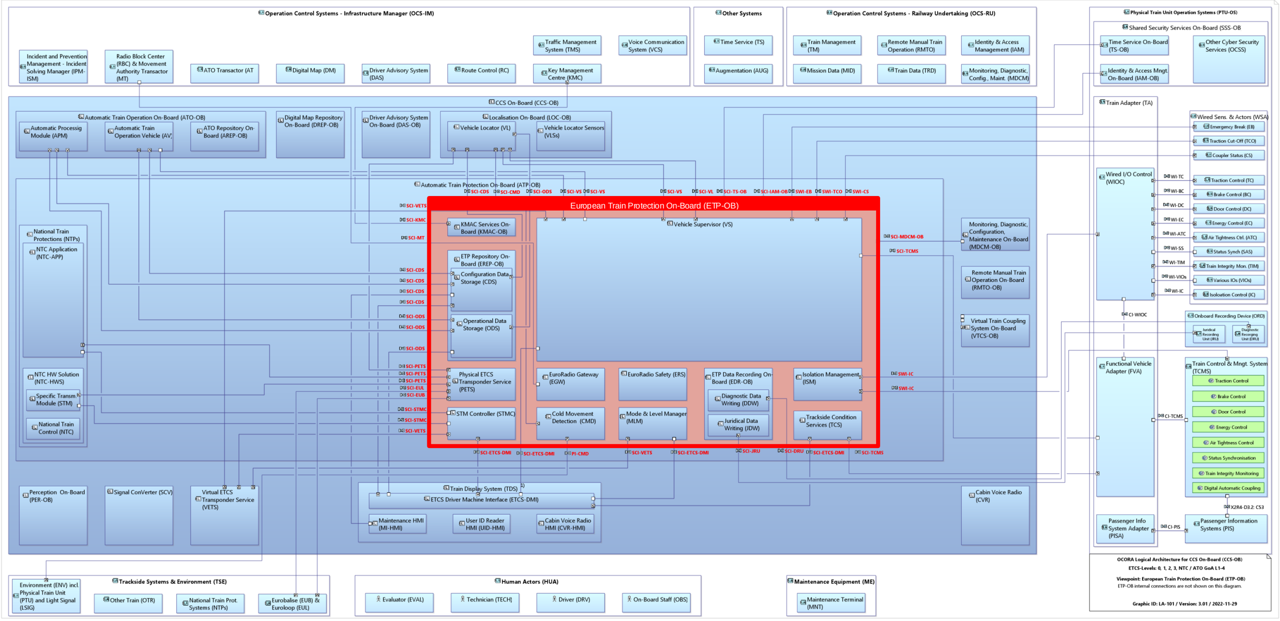

Figure 17: European Train Protection On-Board (ETP-OB)

Notes: refer to Appendix D2 for large scale representation
1) may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn: respective subset contains information for the interface.
SS-nnn*: respective subset does not address the interface but should contain the information in the future.

The European Train Protection On-Board (ETP-OB) is a building block that implements the core on-board part of the ETCS excluding functions expected to have independent lifecycles (e.g., connectivity, localisation, etc.). The ETP-OB is deployed on every OCORA based CCS On-Board system.

4.14.1 Interfaces

The following table lists all ETP-OB interfaces. Refer to Figure 17 to identify the currently foreseen ETP-OB communication partners. The interfaces of the type "Provider (P)" indicates that the ETP-OB building block is providing these interfaces. The interface of the type "Consumer (C)" indicates that the LOC-OB building block uses these interfaces.

Name	Description	Type
SCI-CMD	Standard Communication Interface – Cold Movement Detection	Provider (P)
SCI-ODS	Standard Communication Interface – Operational Data Storage	Provider (P)
SCI-VS	Standard Communication Interface – Vehicle Supervisor	Provider (P)
SCI-VL	Standard Communication Interface – Vehicle Locator	Consumer (C)
SCI-TS-OB	Standard Communication Interface – Time Service On-Board	Consumer (C)
SCI-IAM-OB	Standard Communication Interface – Identity and Access Management On-Board	Consumer (C)
SWI-EB	Standard Wired Interface – Emergency Brake	Consumer (C)
SWI-TCO	Standard Wired Interface – Traction Cut-Off	Consumer (C)
SWI-CS	Standard Wired Interface – Coupler Status	Consumer (C)
SCI-MDCM	Standard Communication Interface – Monitoring, Diagnostics, Configuration & Maintenance	Consumer (C)
SWI-IC	Standard Wired Interface – Isolation Control	Consumer (C)
SS-TCMS	Standard Communication Interface – Train Control & Management System	Consumer (C)
SCI-ETCS-DMI	Standard Communication Interface – ETCS DMI	Consumer (C)

Name	Description	Type
SCI-DRU	Standard Communication Interface – Diagnostic Recording	Consumer (C)
SCI-JRU	Standard Communication Interface – Juridical Recording	Consumer (C)
SCI-VETS	Standard Communication Interface – Virtual ETCS Transponder Service	Consumer (C)
PI-CMD	Perception Interface – Cold Movement Detection	Consumer (C)
SCI-STMC	Standard Communication Interface – STM Controller	C Consumer (C)
SCI-EUB	Standard Communication Interface – Eurobalise	C Consumer (C)
SCI-EUL	Standard Communication Interface – Euroloop	C Consumer (C)
SCI-PETS	Standard Communication Interface – Physical ETCS Transponder Service	Provider (P)
SCI-MT	Standard Communication Interface – Radio Block Centre (RBC) & Movement Authority Transactor (MT)	C Consumer (C)
SCI-KMC	Standard Communication Interface – Key Management Centre	C Consumer (C)

Table 2 ETP-OB Interfaces

Note: Standard Communication Interfaces for which the ETP-OB is the service provider (P), shall be exposed on the CCN to be available to an arbitrary number of current and future applications.

4.14.2 Functional Components

Vehicle Supervisor (VS)

The Vehicle Supervisor (VS) application, deployed on the OCORA computing platform, is a safe ETCS application (mandatory requirements are specified in SUBSET-026) in charge of calculating location specific speed limits (based on various inputs) and activating the braking system in case of speed limit overshoot. Location information is received from the Localisation On-Board (LOC-OB) building block.

In ETCS L2 and L3 mode, the VS interacts with the RBC or the MT respectively. It receives the movement authority (MA) and reports the train position (TPR) to the respective system. The VS is agnostic to the communication technology used. Therefore, communication via GSM-R as well as via FRMCS or any future technology is possible. The VS also displays to the driver the necessary information (including cab signalling in ETCS L1, L2 and L3). It supports all ETCS modes and ETCS levels defined in the TSI-CCS.

In today's ETCS implementations, the VS is part of the monolithic ETCS OBU. Since the VS is a safe application and is expected to have a very different technological life cycle than the Localisation On-Board (LOC-OB), it is essential that the VS is a separate component, containing just the minimum functionality needed to perform the supervision of the vehicle during ETCS operations. Appendix B contains, on a very high-level, a first proposed split of functionality between the VS, VL, and the MLM / STMC, based on SUBSET 026, chapter 4.5. The OCORA architecture team is aware that splitting the functionality only based on the SUBSET-026, chapter 4.5 is not sufficient, because the SUBSET does not provide all requirements. SUBSET-026 is providing the mandatory requirement specifications only. A more detailed separation and a first version of a VS model, identifying additional requirements to SUBSET-026, can be expected in subsequent OCORA documentation releases.

Isolating the VS-functionality from the Localisation On-Board- and MLM- / STMC-functionality has the positive side-effect that the complexity of the VS is reduced and a stable component with little need for changes can be developed. A very important aspect since the VS requires a safe implementation and already many changes for the CCS On-Board are foreseeable. For example, it is expected that changes will be introduced, and more functionalities will be added to CCS On-Board in the upcoming TSI-CCS revisions and through the introduction of new game changers, which are:

- FRMCS
- ATO
- Train integrity detection for ETCS L3 mode

It is the goal of the OCORA architecture team to build a VS model that is mostly agnostic to these changes, and where not possible, does already consider the changes in the design.

Further details will be provided in subsequent versions of the CCS-OB architecture documentation.

EuroRadio Gateway (EGW) & Safety Protocol (ERS)

To address the design principles of OCORA, the current EuroRadio Protocol as specified in SUBSET-037 needs to be divided into multiple parts allowing a split between safe-/ non-safe functionalities and to enable access to future mobile communication technologies such as FRMCS without changing the safe part of the upstream application (e.g., ETP-OB).

Figure 18 below illustrates the allocation of the divided functionalities (Safe Functional Module and Communication Functional Module) onto the OCORA Safe Computing Platform.

The Vehicle Supervisor (VS) and the EuroRadio Safety Layer (ERS) as Part of the ETP-OB component run on multiple instances to provide the appropriate safety integrity level (SIL) to the overall system. The EuroRadio Gateway acts as the gateway between the Safe Computing Platform and the external, non-safe entities (e.g., On-Board FRMCS). The EuroRadio Gateway is also responsible for the coordination between the legacy EDOR and the new FRMCS On-Board System and implements the FRMCS client realizing the loose coupling to the services of the On-Board FRMCS.

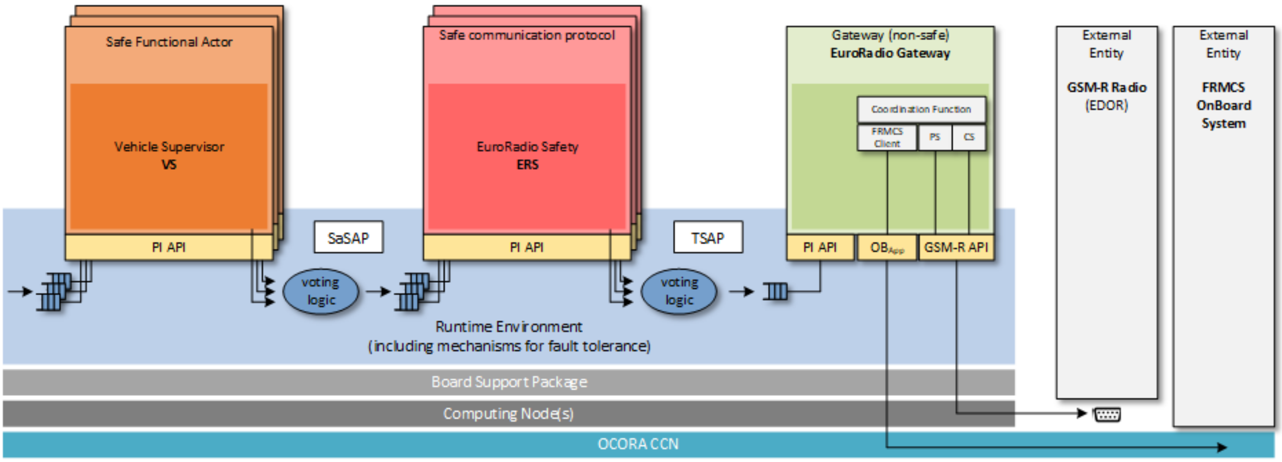

Figure 18: EuroRadio Safety allocation on the Safe Computing Platform

Mode and Level Manager (MLM)

The Mode & Level Manager (MLM) is a safe component of the ETP-OB in charge of managing the ETCS modes and levels. It ensures that the proper ETCS mode and level are active and manages the transitions from one mode or level to the other. In the latter context it also handles the handover between different RBCs. Furthermore, it makes sure that the correspondent information (e.g., current mode and level) is transmitted to the TCMS.

In today's ETCS implementations, the MLM is part of the monolithic ETCS OBU.

An analysis has been conducted in order to identify the information received and transmitted by the MLM. The result of the analysis is provided in document [15]. The methodology followed for the identification of input is based on the analysis of the SUBSET-026, chapter 4 (v3.6.0 incl. CR1238). The transition conditions provide the information needed by the MLM to compute mode and level state. We identify information already transmitted and specified in another logical component (FVA or HMI e.g.). The objective is to reuse information that are already defined. Document [15] contains multiple sheets:

- Transition condition: each condition id in the SUBSET-026, chapter 4.6.3 table are made up of elementary condition which are repeated several times through the table.
- Each elementary condition is listed with:
  - condition where they are involved
  - logical component which provides this information
- MLM IN: identify entry signal of the logical component. Elementary conditions are state of an information (desk open / desk close are elementary condition of the information cabin status e.g.) An

input signal contains one or several information (driver acknowledgment OS, SR, SH... e.g.). Information that are already defined are reused (FVA specification interface, SUBSET-121 e.g.)

- MLM OUT: output of the MLM and identification of the recipient logical component
- MLM function: list of function supported by MLM
- Open Point: Point to be discussed for future evolution of the document

It is planned to complete the analysis for a future OCORA release by adding the following information: trigger (time or event), time constraint, safety of information exchanged, identification of function which use the information in the MLM and functions which use the information in another logical component.

Further details will be provided in subsequent versions of the CCS-OB architecture documentation.

STM Controller (STMC)

The STM Controller (STMC) is a safe component of the ETP-OB in charge of managing the safety authority between ETCS and installed national ATP systems (STM / NTC). It ensures that the proper ATP system is active and manages the switch-over from ETCS to the national ATP system and vice versa. The STMC interacts with the national ATP systems as defined in SUBSET-035 and SUBSET-058. The STMC with the respectively integrated national ATP systems enable an automatic transition from ETCS to the national ATP system and vice versa while the vehicle is driving.

In today's ETCS implementations, the STMC is part of the monolithic ETCS OBU and corresponds to the STM Control Function defined in SUBSET-035.

Further details will be provided in subsequent versions of the CCS-OB architecture documentation.

Physical ETCS Transponder Service (PETS)

The PETS component reads the ETCS telegrams from the trackside installed infrastructure (Eurobalise and Euroloop) and forwards them to the CCS On-Board applications.

Cold Movement Detection (CMD)

The logical component CMD is a vehicle-based function that detects if the train has moved while the CCS-OB system was powered-off. The CMD function is especially needed in the migration phase. In the final phase, where the vehicle is "always on" and "always connected / located", the function may not be needed anymore.

It is under discussion, if CMD should also provide the magnitude of the cold movement (see also CR1345 – Threshold small movements). With the implementation of CR1350 (always connected, always reporting) CMD functionality on the vehicle may not be required anymore.

Isolation Management (ISM)

The logical component IM allows to isolate one or multiple ATP systems and informs the Physical Train Unit Operation Systems (PTU-OS) accordingly.

Trackside Condition Services (TCS)

The Trackside Condition Services (TCS) is a non-safe component of the ETP-OB in charge of managing the trackside condition information received from balises, RIU, or RBC. It calculates the remaining distance to specific trackside points and triggers the appropriate actions according to the location. Location information is received from the Localisation On-Board (LOC-OB) building block. Also, the TCS informs the driver about the trackside points: it sends the commands to display the different pictograms on the DMI depending on the trackside point and the relative location to it. Furthermore, it makes sure that the correspondent information is transmitted using the SCI-FVA interface via FVA to the vehicle, and the distance information is updated as needed. The TCS remains active during level transitions, including transition to level NTC.

Further details will be provided in subsequent versions of the CCS-OB architecture documentation.

ETP Repository On-Board (EREP-OB)

The logical component EREP-OB includes the Operational Data Storage (ODS) and the Configuration Data Storage (CDS) components.

Operational Data Storage (ODS)

The Operational Data Storage (ODS) is a data storage for saving quite dynamic data that is entered / provided during an operational day of a vehicle and has no relevance for long-time safeguarding. The operational data storage is separated from the ETCS components (e.g., VS) to make the data easily available to other applications that may need it (e.g., ATO-OB). The operational data storage contains data provided by the driver, the TCMS, I/O Ports, and possibly the device and configuration management. Examples of Operational Data is the driver id, the train running number, the status of a cab, etc. In subsequent versions of the OCORA specifications, the ODS will be specified in more detail.

Configuration Data Storage (CDS)

The Configuration Data Storage (CDS) stores static and semi-static data needed for the CCS On-Board system. The data storage is separated from the operational data, and it is separated from the ETCS components (e.g., VS) to make the data easily available to other applications that may need it (e.g., VL). The Configuration Data Storage contains data provided when commissioning a CCS On-Board system for the first time and is changed whenever configurations of the vehicle change (e.g., additional sensors, additional DMI, etc.). The data is entered by service technicians through the local maintenance terminal or via the remote maintenance. In both cases this occurs through the Monitoring, Diagnostics & Configuration On-Board (MDCM-OB) component. In subsequent versions of the OCORA specifications, the CDS will be specified in more detail.

The ETCS On-Board application should implement configuration capability for the train characteristics, the latter being independent from other configuration parameters. This to allow defining the train characteristics for different train types without affecting the certification of the whole ETCS On-Board application, the same also being valid in case of modifications.

Scope of OCORA is to reduce the variability of implementation of the CCS On-Board applications (i.e. ETCS On-Board application). This is achieved by properly defining what is expected from the ETCS On-Board application in terms of configurability (at the end this results in a list of requested configuration parameters).

Goal is that CCS On-Board applications from different suppliers can be exchanged between each other, but also that the same CCS On-Board application can be deployed on different train types with a minimal effort.

ETP Data Recording On-Board (EDR-OB)

The logical component EDR-OB includes the Juridical Data Writing (JDW) and the Diagnostic Data Writing (DDW) components.

Juridical Data Writing (JDW)

The component responsible for compiling JRU messages as per SS-027 and sending them to the JRU.

Diagnostic Data Writing (DDW)

The component responsible for compiling national diagnostic messages and sending them to the DRU.

KMAC Services On-Board (KMAC-OB)

The KMAC Services On-Board (KMAC-OB) is responsible for managing the authentication keys needed to establish a safe connection between the on-board and trackside entity. It communicates with the Key Management Centre (KMC) of the infrastructure manager using SS-114 and SS-137.

4.15 Train Display System On-Board (TDS-OB)

The Train Display System (TDS) provides Human Machine Interface (HMI) functionality to any CCS-OB and to PTU-OS applications (e.g., ETCS, Cabin Voice Radio, DAS, ATO, TCMS, etc.).

To narrow down the scope and functionality of the TDS-OB, OCORA has elaborated a collection of possible architectures which will be evaluated further in the upcoming OCORA releases.

a. The TDS is a software running on a **screen** controlling the **HMI elements** (screens, display areas, touch keys, and soft-keys) of the driver's desk (for a graphical representation refer to appendix C1).

b. The TDS is a software running on a **subsystem** like the ETP-OB CCU (A2) controlling the **HMI elements** (screens, display areas, touch keys, and soft-keys) of the driver's desk(for a graphical representation refer to appendix C2).

c. The TDS is a software running the ETP-OB CCU controlling the **HMI areas** of the driver's desk (for a graphical representation refer to appendix C3).

d. The TDS is a software running on its dedicated hardware controlling the directly connected **HMI elements** (screens, display areas, touch keys, soft-keys, and **external buttons**) of the driver's desk (for a graphical representation refer to appendix C4).

e. The TDS is a software running on its dedicated hardware controlling the directly connected **HMI elements** (screens, display areas, touch keys, and soft-keys) of the driver's desk (for a graphical representation refer to appendix C5).

f. The TDS consists of **HMI elements** (screens, display areas, touch keys, and soft-keys) of the driver's desk, including the necessary hardware and software to control the HMI elements (for a graphical representation refer to appendix C6).

g. The TDS consists of all **HMI elements** (screens, display areas, touch keys, soft-keys, and **external button**) of the driver's desk, including the necessary hardware and software to control the HMI elements (for a graphical representation refer to appendix C7).

h. The TDS is a software running on its dedicated hardware controlling the directly connected **HMI areas** including the **external buttons** of the driver's desk (for a graphical representation refer to appendix C8).

i. The TDS is a software running on its dedicated hardware controlling the directly connected **HMI areas** of the driver's desk (for a graphical representation refer to appendix C1C9).

OCORA is still evaluating what is the best option and will decide for one in a subsequent release.

The TDS-OB can be used by the CCS-OB and PTU-OS applications through the CCN (SUBSET-147) and possibly through some hard-wired connections to interact with the TDS-OB's hard keys.

The TDS-OB is capable to display essential information (e.g., fall-back speed) to the train driver, even if the ETCS is isolated.

The TDS-OB provides fail-over functionality from one screen to the other.

The TDS-OB can also handle safe and non-safe information in a standardised manner (indicating to the driver what information is informative and what information is essential).

Refer also to ongoing discussions in the following documents:

- CR1246 – Train Display System/ETCS on-board FFFIS
- SUBSET-121 – DMI-EVC Interface FFFIS.

4.16 UID Reader On-Board (UIDR-OB)

The User Identification Reader On-Board (UIDR-OB) building block is used to automate the identification process for drivers and service technicians. RFID card readers may be the most common option used at this point in time for the UIDR-OB. But as technology advances, fingerprint, face ID, etc. might become viable options. The OCORA specifications will be technology agnostic.

The UIDR-OB is currently considered an optional deployment on OCORA based CCS On-Board system. However, OCORA is in the process of evaluating, whether the UIDR-OB shall be part of the CCS-OB or of the PTU-OS system.

Further details will be provided in subsequent versions of the OCORA architecture documentation.

4.17 Cabin Voice Radio On-Board (CVR-OB)

The Cabin Voice Radio On-Board building block represents the current and future implementation of the On-Board voice communication system.

Current implementations consist of a tightly integrated control panel, a microphone, a loudspeaker, and a GSM-R voice radio and may also connect directly with the PIS through a legacy connection (e.g., UIC), the DMI and/or JRU through respective connections. In current implementations, the CVR-OB is only loosely integrated into the CCS domain, if at all. But with the upcoming migration from GSM-R to FRMCS options become available to share the new connectivity infrastructure, the FRMCS On-Board System, between the CCS data and cabin voice.

For the future, the CVR-OB implementation shall consider using the CCS Communication Network (CCN) for the integration with any other On-Board system like the Passenger Information System (PIS) or the Juridical Recording Unit (JRU), and it shall also allow to run the user interface on the Train Display System (TDS). The future CVR-OB implementation shall also allow to disable or even remove the GSM-R radio technology without impacting the functionality of the CVR-OB functionality.

5 Block exchanges

Block exchanges show the relationship between the different blocks. The CCS On-Board consists of physical and logical blocks, which can have CCS On-Board internal exchanges or external exchanges with the actors of the CCS On-Board. The different combinations of internal / external exchanges and physical / logical blocks are elaborated in the upcoming chapters.

5.1 Logical block exchanges – external

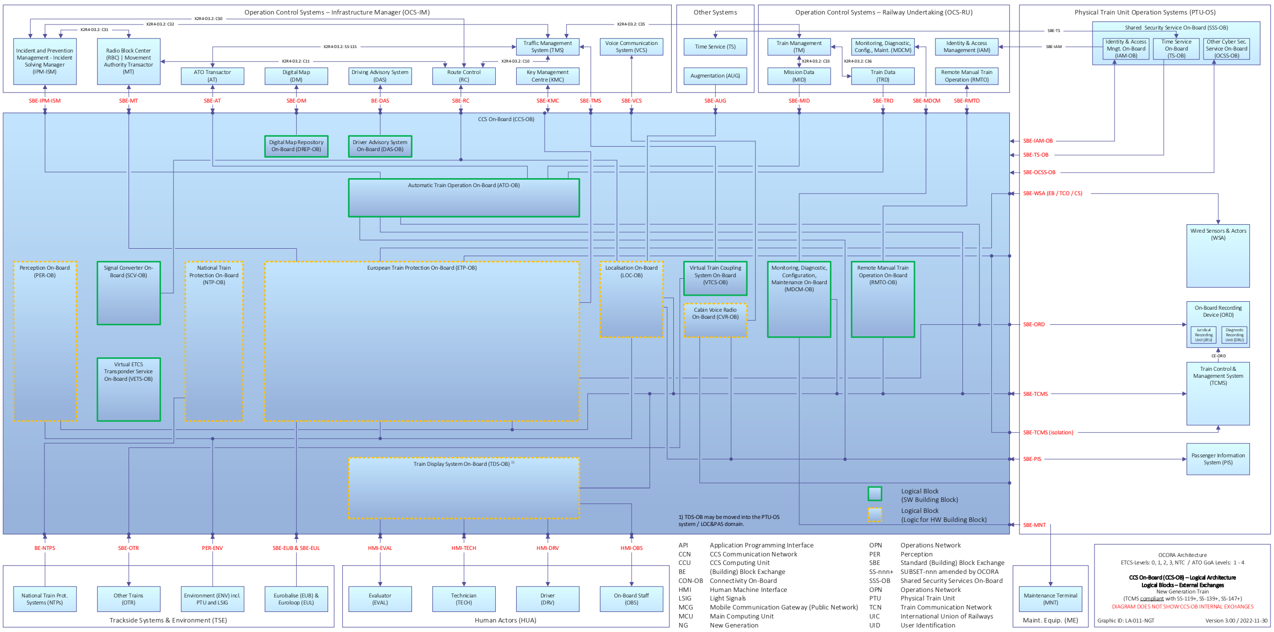

Figure 19: Logical block exchanges – new generation train

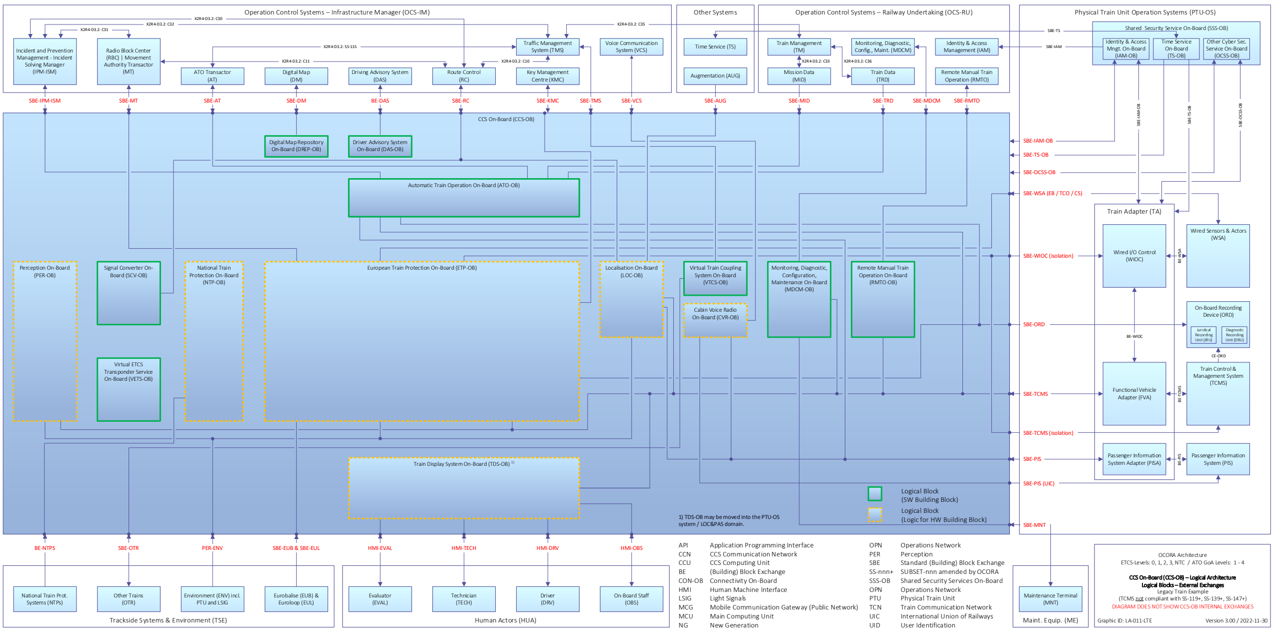

Figure 20: Logical block exchanges – legacy train example

5.2 Logical block exchanges – internal

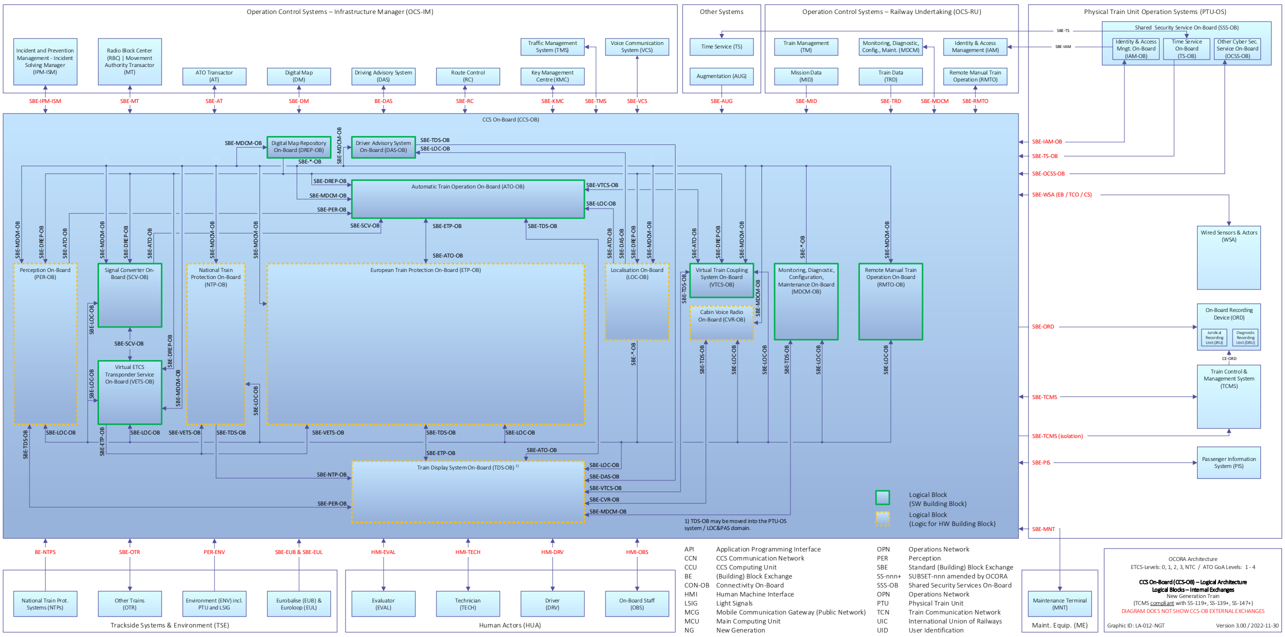

Figure 21: Logical block exchanges – new generation train

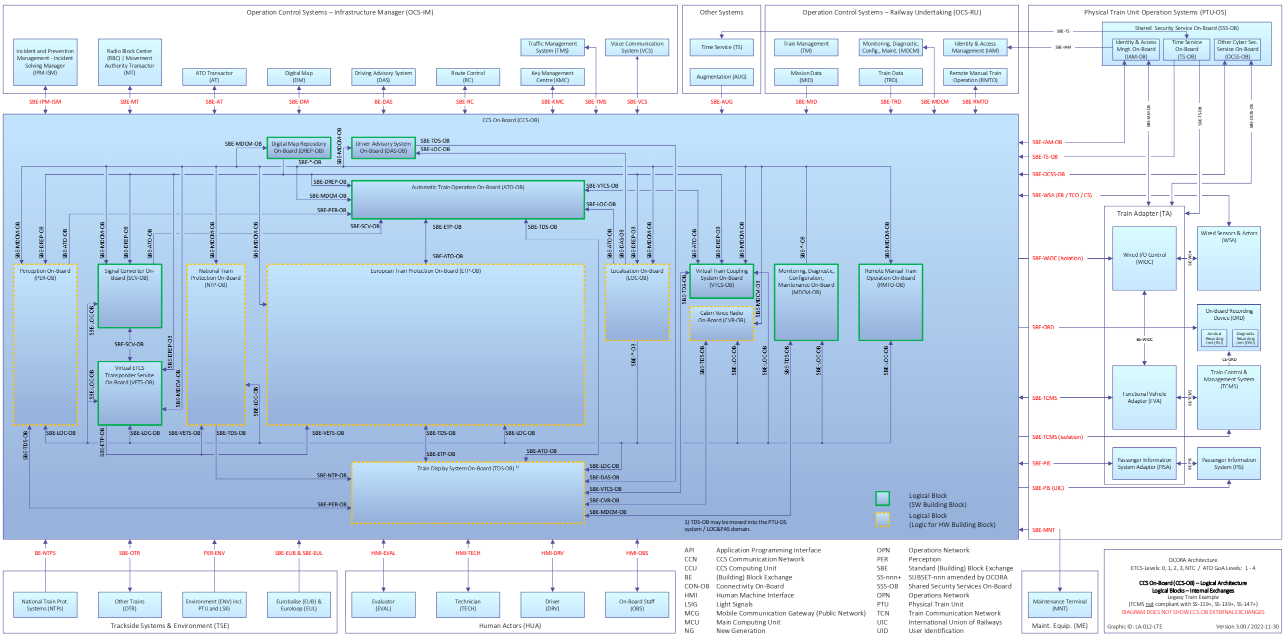

Figure 22: Logical block exchanges – legacy train example

5.3 Physical block exchanges

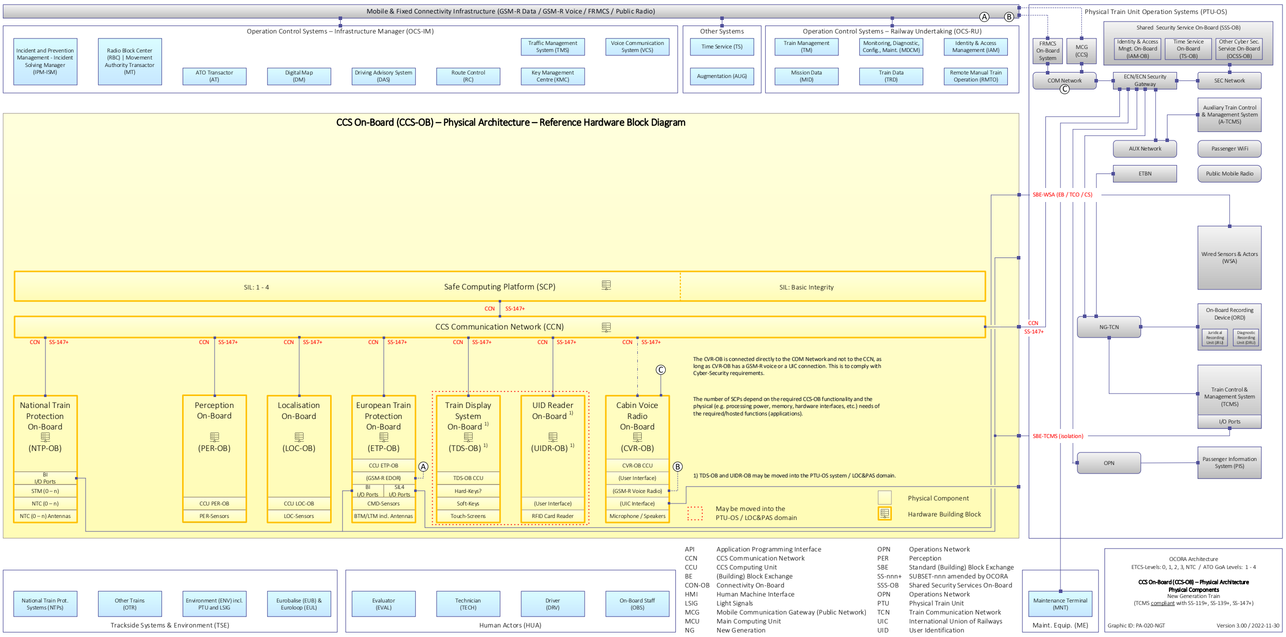

Figure 23: Physical block exchanges – new generation train

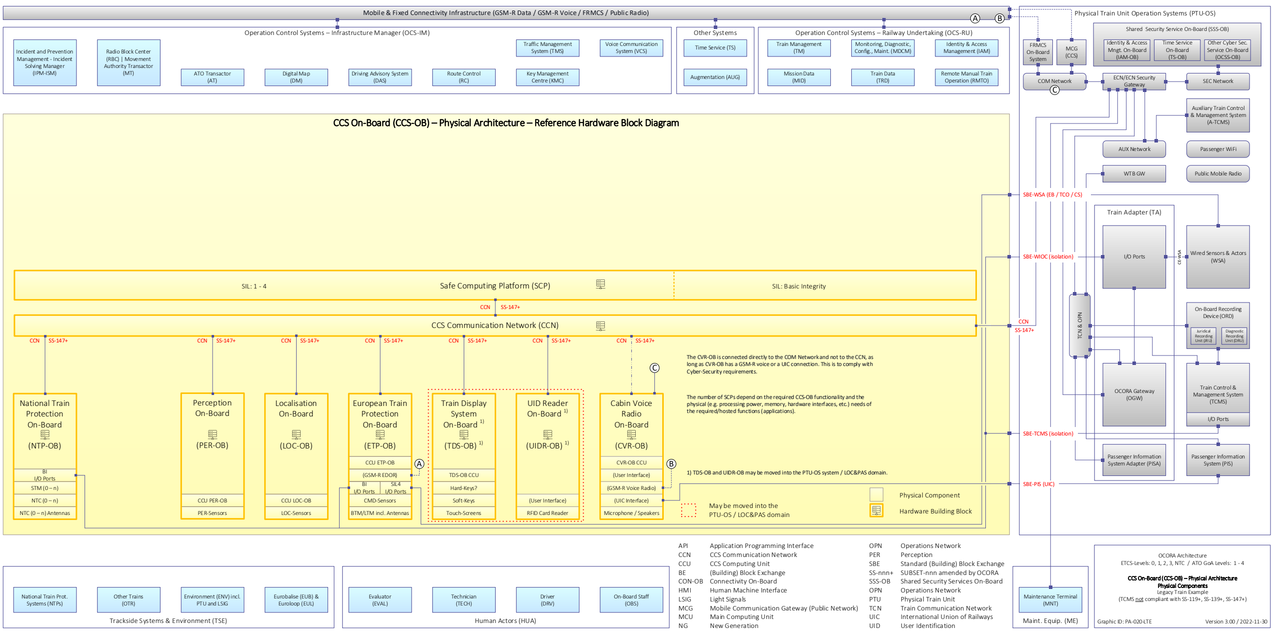

Figure 24: Physical block exchanges – legacy train example

Block exchanges are realized by one or multiple interfaces referenced and mapped in the following table.

Logical block exchange	Referenced interface
BE-DAS	CI-DAS
BE-NTPS	CI-NTP
HMI-DRV	HMI-CVR HMI-ETCS HMI-UID
HMI-EVAL	HMI-MI
HMI-TECH	HMI-ETCS HMI-UID HMI-MI
PER-ENV	PI-PER
SBE-AT	SCI-AT
SBE-AUG	SCI-AUG
SBE-DM	SCI-DM
SBE-EUB & SBE-EUL	SCI-EUB SCI-EUL
SBE-IAM-OB	SCI-IAM-OB
SBE-IPM-ISM	SCI-IPM-ISM
SBE-KMC	SCI-KMC
SBE-MDCM	SCI-MDCM
SBE-MID	SCI-MID
SBE-MNT	SCI-MNT
SBE-MT	SCI-MT
SBE-OBS	HMI-CVR
SBE-OCSS-OB	
SBE-ORD	SCI-JRU SCI-DRU
SBE-OTR	SCI-VTCS
SBE-PIS	SCI-PIS SCI-VL
SBE-PIS (UIC)	
SBE-RC	SCI-RC
SBE-RMTO	SCI-RMTO
SBE-TCMS	SCI-TCMS
SBE-TCMS (isolation)	SWI-IC
SBE-TMS	SCI-TMS
SBE-TRD	SCI-TRD
SBE-TS-OB	SCI-TS-OB
SBE-VCS	SCI-VCS
SBE-WIOC (isolation)	SWI-IC
SBE-WSA (EB / TCO / CS)	SWI-EB SWI-IC SWI-CS

Table 3 Mapping between logical block exchanges and interfaces

6 External interfaces

The external interfaces for CCS-OB are identified on the logical and on the physical architecture as depicted in the following diagrams (red labels).

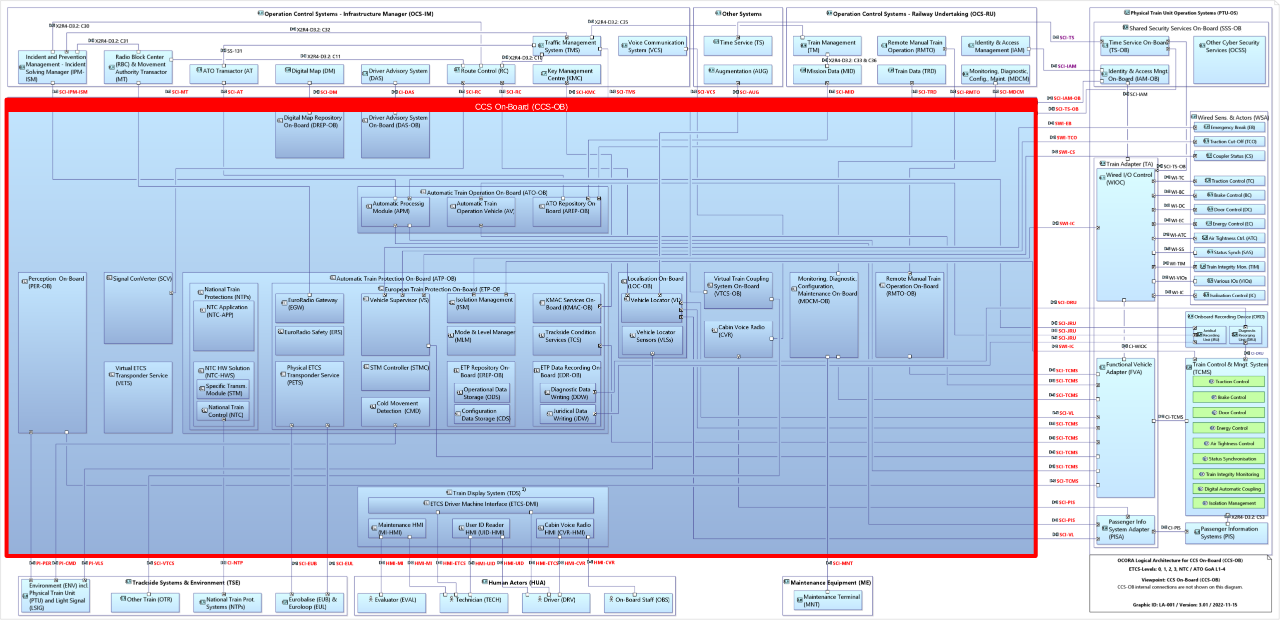

Figure 25: External interfaces – logical architecture

Notes: refer to Appendix D1 for large scale representation
1) TDS may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn: respective subset contains information for the interface.
SS-nnn*: respective subset does not address the interface but should contain the information in the future.

All interfaces are described in the following chapters. They are sorted alphabetically.

6.1 CI-DAS

This is the interface between Driver Advisory System On-Board (DAS-OB) and the Driver Advisory System (DAS). It is either following the SFERA standard or any non-standardised vendor or IM specific specification.

6.2 CI-NTP

This is the interface between the trackside National Train Protection systems (NTPs) and the On-Board National Train Control system (NTC).

This is a specific interface of the existing National ATP systems and is therefore not relevant for OCORA.

6.3 HMI-CVR

The HMI-CVR specifies the user interface between the On-Board Cabin Voice Radio (CVR) and its actors, the train driver (DRV) and the On-Board staff (OBS).

OCORA does not aim to standardize this interface.

6.4 HMI-ETCS

This is the interface between the Driver Machine Interface (refer to chapter 4.15) and the train driver (DRV) or the technician (TECH).

Standardization efforts for ETCS functionality are ongoing by the ERA. The specification must be extended to include ATO requirements (not in scope of OCORA).

Standardization of the user interfaces for Voice Radio, Diagnostics, Monitoring, Configuration, NTCs, and Driver Advisory Vehicle are not existing and OCORA does not plan, at this point in time, to work on those standards.

The interface is specified by the ERA in the ERA_ERTMS_015560 document [26].

6.5 HMI-MI

The HMI-MI specifies the user interface between the Maintenance HMI (MI-HMI) and the Technician (TECH) or the Evaluator (EVAL).

OCORA does not aim to standardize this interface.

6.6 HMI-UID

This is the interface between the User Identification Reader and the Train Driver (DRV) resp. Technician (TECH) or their UID card.

OCORA does not aim to standardize this interface.

6.7 PI-CMD

This is the perception interface between the Cold Movement Detection (CMD) and the environment (ENV). The sensors of the CMD are sensing the environment using different type of technologies.

6.8 PI-PER

This is the perception interface between the Perception On-Board (PER-OB) and the environment (ENV). The sensors of the PER-OB are sensing the environment using different type of technologies (e.g. LIDAR, camera, etc.).

6.9 PI-VLS

This is the perception interface between the Vehicle Locator Sensors (VLSs) and their environment (ENV). The VLSs are sensing the environment using different type of technologies (e.g. radar, camera, etc.)

6.10 SCI-AT

This is the standard communication interface between the ATO Transactor (AT) / Operational Execution (OE) and the ATO On-Board (ATO-OB). The interface is described in SUBSET-126.

6.11 SCI-AUG

This is the standard communication interface for Augmentation (AUG) data used to improve localisation quality.

6.12 SCI-DM

This is the standard communication interface between the trackside Digital Map (DM) service and the Digital Map Repository On-Board (DREP-OB) to

For further information refer to interface C 34 from X2R4 in document [39].

6.13 SCI-DRU

This is the standard communication interface of the Diagnostic Recording Unit (DRU) component that allows recording the data from the Diagnostic Data Writing (DDW) component for the National Train Protection (NTP) sub-system integrated though the Specific Transmission Module (STM) with the European train Protection On-Board (ETP-OB). However, the detailed DRU data is not defined and standardized. The to be recorded data is embedded in SUBSET-027 and allows a project or sub-system specific implementation.

6.14 SCI-EUB

This is the interface between the European Train Protection On-Board (ETP-OB, refer to chapter 4.14) or more specifically its Vehicle Supervisor (VS) component and the Eurobalise (EUB) depending on the operative ETCS level.

SUBSET-026 chapters 7 & 8 define this interface.

6.15 SCI-EUL

This is the interface between the European Train Protection On-Board (ETP-OB, refer to chapter 4.14) or more specifically its Vehicle Supervisor (VS) component and the Euroloop (EUL), depending on the operative ETCS level.

SUBSET-026 chapters 7 & 8 define this interface.

6.16 SCI-IAM-OB

The SCI-IAM-OB is the standard communication interface to use the services provided by the Identity & Access Management On-Board (IAM-OB).

Refer to Section 3.1.4.2 for details on the IAM-OB.

6.17 SCI-IPM-ISM

This is the standard communication interface between the Incident and Prevention / Incident Solving Manager (IPM-ISM) at trackside and the Automatic Processing Module (APM) of the ATO-OB component to exchange information about incidents and anomalies and to receives orders from trackside.

For further information refer to interface C 19 from X2R4 in document [39].

6.18 SCI-JRU

This is the standard communication interface of the Onboard Recording Device (ORD) that allows recording the data from the Automatic Train Operation Vehicle (AV) and the Automatic Processing Module (APM) components integrated into the Automatic Train Operation On-Board (ATO-OB). This interface is also used by the Juridical Data Writing (JDW) component to record data for the European Train Protection On-Board (ETP-OB).

There are already documents available, describing the information to be recoded from the different components onto the Onboard Recording Device (ORD). SUBSET-140 is a proposal for the Automatic Train Operation Vehicle (AV). The Interface C65 in Document [39] from X2R4 covers the Automatic Processing Module (APM) and SUBSET-027 describes the information to be recorded for the European Train Protection On-Board (ETP-OB). However, the access to the Onboard Recording Device (ORD) is not standardized yet.

Furthermore, OCORA may consider standardizing the Onboard Recording Device (ORD) read out format to facilitate data evaluation with a vendor independent evaluation software and integration into standardised remote monitoring.

6.19 SCI-KMC

This is the standard communication interface between the Key Management Centre (KMC) and the KMAC Services On-Board (KMAC-OB) whereas SS-114 specifies the offline interface and SS-137 the interface for the online key management.

Further information is available in SUBSET-114 and SUBSET-137.

6.20 SCI-MID

This is the standard communication interface between the Mission Data (MID) component at trackside and the ATO Repository On-Board (AREP-OB) to exchange mission profile and mission execution information.

For further information refer to interface C 1 from X2R4 in document [39].

6.21 SCI-MDCM

The SCI-MDCM is the interface to the OMS Wayside Server as specified in SS-149. It is assumed that the Monitoring, Diagnostic, Configuration, Maintenance System (MDCM) of the railway undertaking comprises the OMS Wayside Server.

The detection of wayside and on-board CCS system failures, whether imminent or already reality, supports reliable train operations. Issues might arise when failure reporting is delayed, or necessary repair work is postponed, let alone if failures remain undetected. Regular infrastructure and rolling stock maintenance activities often have of a cyclical character, implying that potential failures can remain hidden for quite some time, e.g., until the next inspection.

The SCI-MDCM interface aims at providing a harmonized European mechanism for sharing monitoring and diagnostic data generated by rolling stock, throughout the European rail network.

Detailed information about this interface is available in document SUBSET-149.

Further details will be provided in subsequent versions of the OCORA architecture documentation.

6.22 SCI-MNT

This is the standard communication interface between the Maintenance Terminal (MNT) and the Monitoring, Diagnostic, Configuration, Maintenance System On-Board (MDCM-OB). It allows to configure, monitor, diagnose and maintain the building blocks of the CCS-OB.

6.23 SCI-MT

This is the interface between the European Train Protection On-Board (ETP-OB, refer to chapter 4.14) or more specifically its Vehicle Supervisor (VS) component and the Radio Block Center (RBC) & Movement Authority Transactor (MT).

SUBSET-026 chapters 7 & 8 define this interface.

6.24 SCI-PIS

This is the standard communication interface of the Passenger Information System (PIS) for the integration with other systems or components like the Cabin Voice Radio (refer to 4.17) or the Automatic Processing module (APM). This interface is used by the Cabin Voice Radio and the Automatic Processing module (APM) make announcements to the passenger area of the train.

For further information on the integration with the APM refer to interface C 63 from X2R4 in document [39].

OCORA aims at standardizing this interface. Details will be provided in subsequent versions of the OCORA Architecture.

6.25 SCI-RC

The SCI-RC provides Train Routing Information (TRI) from the Route Control (RC) to the CCS On-Board (CCS-OB).

6.26 SCI-RMTO

The SCI-RMTO provides localisation, speed, and video data needed for remote train driving. The interface also transmits commands (acceleration, braking, etc.) from the remote train driver to the train.

6.27 SCI-TCMS

This is the standard communication interface of the Train Control & Management System (TCMS) for the integration with other On-Board systems respectively components.

- The Monitoring, Diagnostic, Configuration & Maintenance On-Board (MDCM-OB, refer to chapter 4.8) uses this interface to collect relevant information from the Physical Train Unit Operation Systems (PTU-OS) and provides it to the different components of the CCS On-Board (CCS-OB).
  Detailed information on the Monitoring, Diagnostic, Configuration & Maintenance On-Board (MDCM) component is available in document [24].
- The European Train Protection On-Board (ETP-OB, refer to chapter 4.14) or more specifically its Vehicle Supervisor (VS), its Trackside Condition Services (TCS) and the Isolation Management (ISM components use this interface to exchange data that is relevant for the ETCS On-Board.
- The Localisation On-Board (LOC-OB, refer to chapter 4.13) or more specifically its Vehicle Locator (VL) component uses this interface to is exchange data that is relevant for the Localisation On-Board (LOC-OB).
- The Automatic Train Operation On-Board (ATO-OB, refer to chapter 4.1) or more specifically its Automatic Train Operation Vehicle (AV) and the Automatic Processing Module (APM) component use this interface to exchange data that is relevant for the Automatic Train Operation.
  For further information on the interface C 55 refer to the X2R4 document [39]
- The Remote Manual Train Operation On-Board (RMTO-OB, refer to chapter 4.74.1) uses this interface to exchange data that is relevant in the context of Automatic Train Operation On-Board (ATO-OB) with GoA 3 & 4.

Details and functions of the Remote Manual Train Operation On-Board (RMTO-OB) have not been elaborated yet. Further details will be provided in subsequent versions of the OCORA architecture documentation.

- The Perception On-Board (PER-OB, refer to chapter 4.12) uses this interface to exchange data that is relevant in the context of remote driving (e.g., video streaming). For further information refer to interface C 47 from X2R4 in document [39].

6.28 SCI-TRD

This is the standard communication interface between the ATO Repository On-Board (AREP-OB) and the Train Data (TRD) component at trackside to exchange vehicle information.

Refer to interface C 24 in the X2R4 document [39] for further information.

6.29 SCI-TMS

This is the standard communication interface between the Virtual Train Coupling System On-Board and the Traffic Management System.

Refer to document [38] for further information.

6.30 SCI-TS-OB

The SCI-TS-OB is the standard communication interface of the On-Board time service (TS-OB) allowing all On-Board components to use a synchronized time.

Refer to Section 3.1.4.1 for details on the TS-OB

6.31 SCI-VCS

The SCI-VCS is the standard communication interface between On-Board Cabin Voice Radio (CVR) and the trackside Voice Communication System (VCS).

This is either the specific interface between the voice communication systems over the existing GSM-R, or the future FRMCS standard and is not further elaborated in this document.

6.32 SCI-VL

This is the standard communication interface provided by the Localisation On-Board (LOC-OB, refer to chapter 4.13) or more specifically its Vehicle Locator (VL) component. Through this interface the Vehicle Locator (VL) makes location information (absolute and relative position of the front end of the train unit, train orientation information as well as kinematic parameters such as speed, acceleration, or rotational angles) available to other components or sub-systems outside of the CCS On-Board (CCS-OB), typically these components are the Physical Train Unit Operation Systems (PTU-OS) and the Passenger Information System (PIS) using the Passenger Information System Adapter (PISA). The components which are involved in this data exchange depends on the system capabilities required from the vehicle in the specific project.

OCORA aims at providing a standard for this interface.

6.33 SCI-VTCS

This is the standard communication interface between the Virtual Train Coupling System On-Board (VTCS-OB) and the Other Train (OTR) to exchange information required by the virtual train coupling application.

Refer to document [38] from X2R3 for further information.

6.34 SWI-CS

This is the standard wired interface between the European Train Protection On-Board (ETP-OB, refer to chapter 4.14) or more specifically its Vehicle Supervisor (VS) component and Coupler Status (CS) connection on the Wired Sensors & Actors (WSA) actor to get specific information about the Coupler Status (CS) condition of the Physical Train Unit Operation Systems (PTU-OS).

Details and functions of the Coupler Status (CS) have not been elaborated yet. Further details will be provided in subsequent versions of the OCORA architecture documentation.

6.35 SWI-EB

This is the standard wired interface between the European Train Protection On-Board (ETP-OB, refer to chapter 4.14) or more specifically its Vehicle Supervisor (VS) component and the Wired Sensors & Actors actor (WSA) to control the Emergency Brake (EB) device of the Physical Train Unit Operation Systems (PTU-OS).

6.36 SWI-IC

This is the standard wired interface between the Isolation Management (ISM) an the Physical Train Unit Operation Systems (PTU-OS) to indicate, when the Automatic Train Protection On-Board (ATP-OB) is isolated.

6.37 SWI-TCO

This is the standard wired interface between the European Train Protection On-Board (ETP-OB, refer to chapter 4.14) or more specifically its Vehicle Supervisor (VS) component and the Wired Sensors & Actors actor (WSA) to control the Traction Cut-Off (TCO) device of the Physical Train Unit Operation Systems (PTU-OS).

Appendix A Train integration scenarios

OCORA has identified the following scenarios for integrating the OCORA CCS On-Board solution into the various type of trains. The scenarios listed are not exhaustive but provide a representative selection.

A1 Scenario A: CCN as physically separated network

This scenario applies to all cases where an OCORA compliant CCS System is integrated into a Train having a NG-TCN. The CCS-, NG-TCN-, Communication- and Operator networks are physically separated networks interconnected through an ECN/ECN Security Gateway. This scenario further assumes that all Peripheral Devices are OCORA compliant and are therefore directly connected to the CCN, following the OCORA interface standard. Refer to [16] for further details on related topology of this scenario.

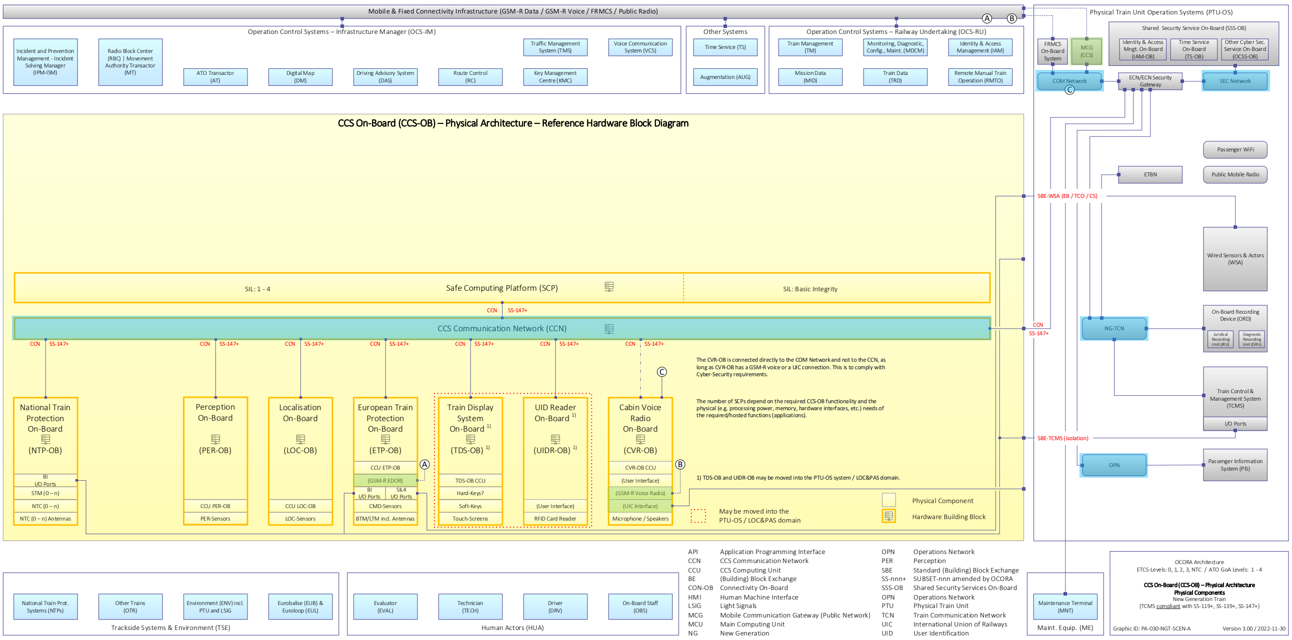

Figure 26: NG-TCN train – separate networks

Highlighted elements in Figure 26:

- Indication of physical segmentation between CCS, Train and other networks
- Components supporting legacy trackside infrastructure during migration phases

A2 Scenario B: CCN as logically separated network

This scenario applies to all cases where an OCORA compliant CCS System is integrated into a Train having a NG-TCN. The control system networks (CCN and NG-TCN) are using the same physical network while separated from the non-control networks (e.g., Operator Network) through the ECN/ECN Security Gateway. The common control system network is then logically segmented into different virtual networks (VLANs) based on its **functional domain** (CCS and TCMS systems). This scenario further assumes that all peripheral devices and connectivity devices are OCORA compliant and are therefore directly connected to the CCN, following the OCORA interface standard. Refer to [16] for further details on related topology of this scenario.

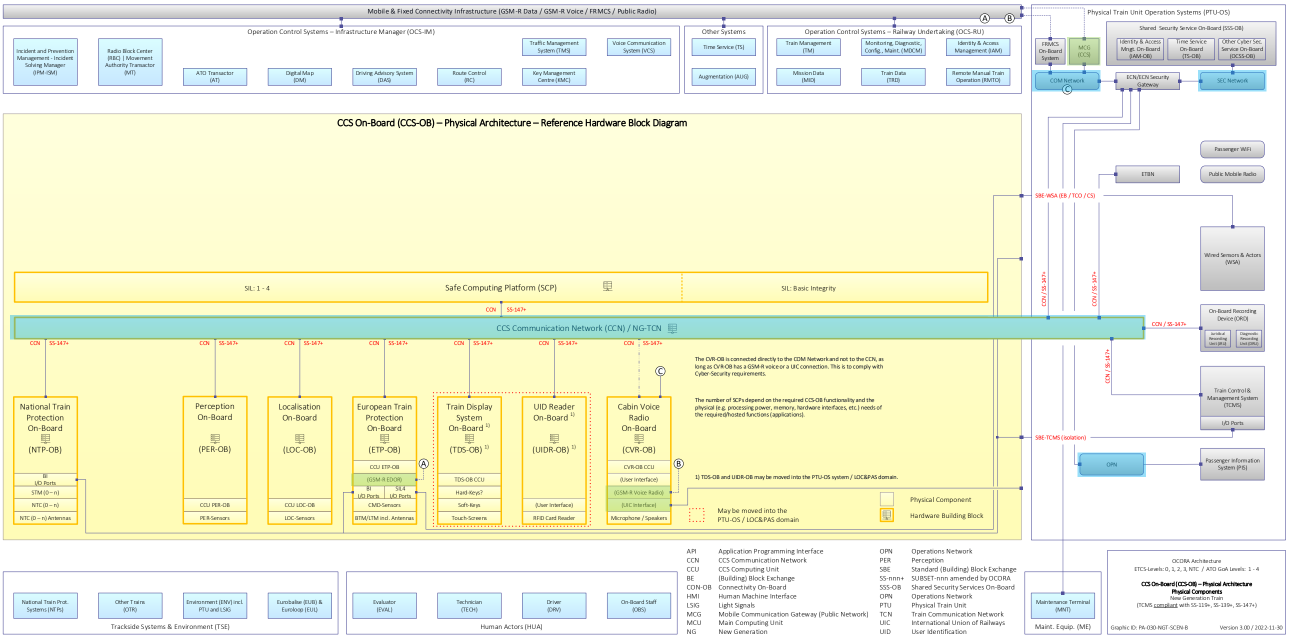

Figure 27: NG-TCN train – common network

Highlighted elements in Figure 27:

(light blue)	Common physical network for the CCS and TCMS systems separated from non-control systems
(light green)	Components supporting legacy trackside infrastructure during migration phases

A3 Scenario C: Common critical control network logically separated

This scenario applies to all cases where an OCORA compliant CCS System is integrated into a Train having a NG-TCN. The control system networks (CCN and NG-TCN) are using the same physical network while separated from the non-control networks (e.g., Operator Network) through the ECN/ECN Security Gateway. The common control system network is then logically segmented into different virtual networks (VLANs) based on its **criticality** (critical and non-critical control systems). This scenario further assumes that all peripheral devices and connectivity devices are OCORA compliant and are therefore directly connected to the CCN, following the OCORA interface standard. Refer to [16] for further details on related topology of this scenario.

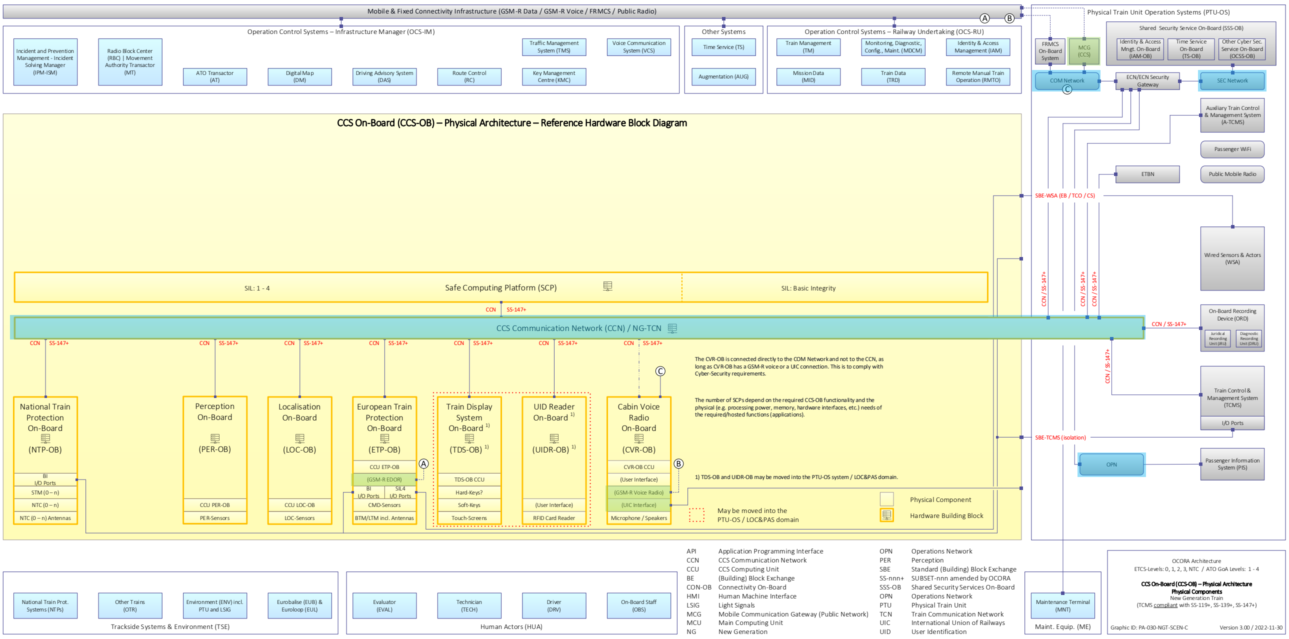

Figure 28: NG-TCN train – Common critical control network logically separated

Highlighted elements in Figure 28:

- Common physical network for the CCS and TCMS systems separated from non-control systems
- Components supporting legacy trackside infrastructure during migration phases

A4 Scenario D: Common critical control network physically separated

This scenario applies to all cases where an OCORA compliant CCS System is integrated into a Train having a NG-TCN. The critical-control systems (CCS and critical control components of the TCMS) are using the same physical network while physically separated from any other network (e.g., Operator network, Auxiliary network) through the ECN/ECN Security Gateway. This scenario further assumes that all peripheral devices and connectivity devices are OCORA compliant and are therefore directly connected to the CCN, following the OCORA interface standard. Refer to [16] for further details on related topology of this scenario.

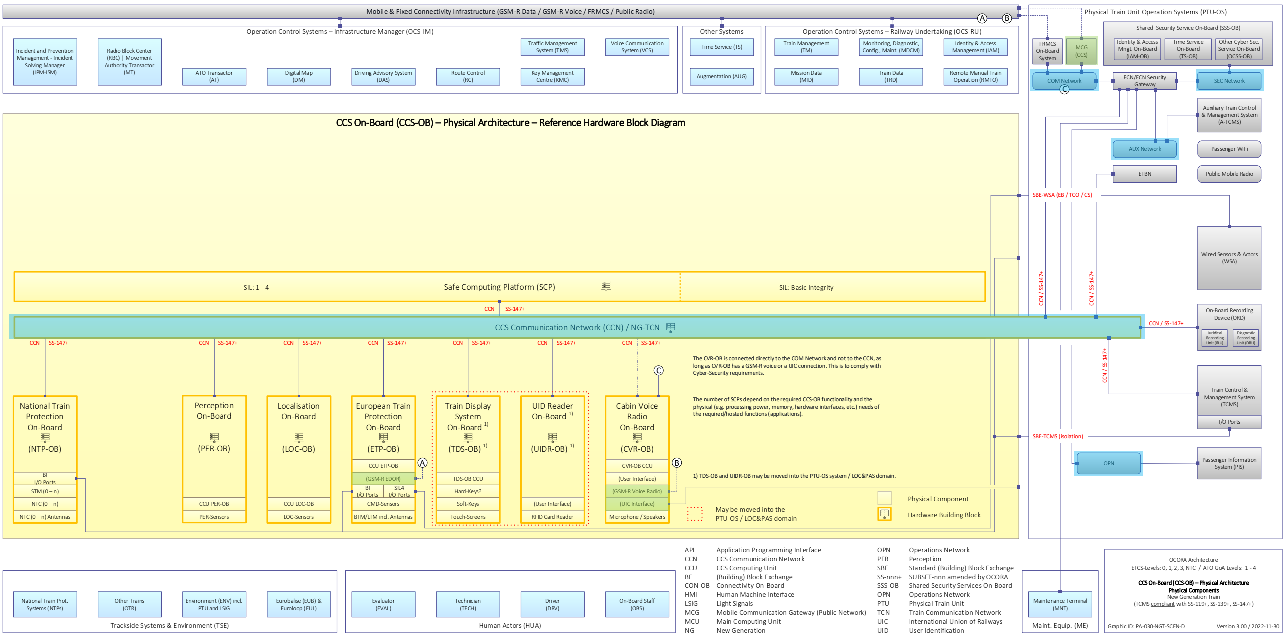

Figure 29: NG-TCN train – Common critical control network physically separated

Highlighted elements in Figure 29:

- (light blue) Common physical network for the critical control systems separated from other networks
- (light green) Components supporting legacy trackside infrastructure during migration phases

A5 Scenario for retrofit vehicles with OCORA compliant CCS peripherals

This scenario applies to all cases where an OCORA compliant CCS System is integrated into a legacy train that has no Ethernet based network for its train control. Hence, the communication with the TCMS is implemented through the OCORA Gateway and the respective Functional Vehicle Adapter (FVA). This scenario further assumes that all Peripheral Devices and Connectivity Devices are OCORA compliant and are therefore directly connected to the CCN, following the OCORA interface standard. Refer to [16] for further details.

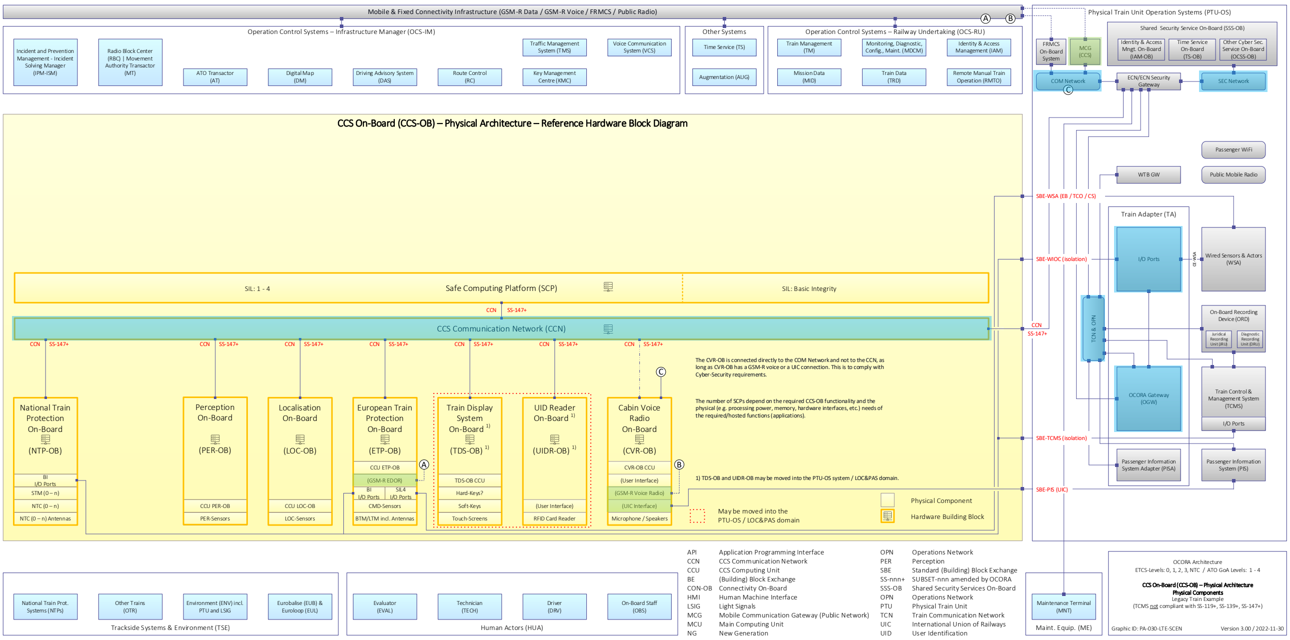

Figure 30: Legacy train – OCORA compliant CCS-OB peripherals

Highlighted elements in Figure 30:

- Components related to the integration between the CCS and Train
- Components supporting legacy trackside infrastructure during migration phases

Appendix B Relating functions from SUBSET-026

To support modularity, OCORA suggests implementing the current ETCS On-Board functionality in separate functional blocks. Among others, the following key functional blocks have been already identified in previous OCORA releases: VS = Vehicle Supervisor / VL = Vehicle Locator / MLM = Mode & Level Manager / STMC = STM Control. This list of functional blocks has now evolved and do so in subsequent releases of the OCORA documentation releases.

The following table assigns current ETCS On-Board functionality (as per SUBSET-026, chapter 4.5) to the respective functional block. It contains, on a very high-level, a first proposed split of functionality between the functional blocks identified so far. The OCORA architecture team is aware that splitting the functionality only based on the SUBSET-026, chapter 4.5 is not sufficient, because the SUBSET does not provide all requirements. SUBSET-026 is providing the mandatory requirement specifications only. A more detailed separation and identification of additional requirements to SUBSET-026 can be expected in subsequent OCORA documentation releases.

N°	On-Board Functions	Reference SUBSET-026	VS	VL	MLM	STMC	CMD	NTP	TCS	PETS	ODS	CDS	FVA	TS-OB	JDW	TDS
	Data Consistency															
1)	Check linking consistency	3.16.2.3 3.4.4	X[1]													
2)	Check Balise Group Message Consistency if linking consistency is checked	3.16.2.4.1 3.16.2.4.3	X[1]													
3)	Check Balise Group Message Consistency if no linking consistency is checked (because no linking information is available and/or because the function “check linking consistency is not active)	3.16.2.4.4	X[1]													
4)	Check Unlinked Balise Group Message Consistency	3.16.2.5	X[1]													
5)	Check correctness of radio messages	3.16.3.1.1	X													
6)	Check radio sequence	3.16.3.3	X													
7)	Check safe radio connection (only level 2/3)	3.16.3.4	X													
	Determine Train Speed and Position															
8)	Determine train position referenced to LRBG	3.6.1 3.6.4		X												
9)	Determine train speed, train acceleration	None		X												
10)	Determine train standstill		X													
11)	Determine Geographical Position	3.6.6	X	X[2]												
12)	Report train position when train reaches standstill	3.6.5.1.4 a)	X[3]													
13)	Report train position when mode changes to...1	3.6.5.1.4 b)	X[4]													
14)	Report train position when train integrity confirmed by driver	3.6.5.1.4 c)	X[4]													
15)	Report train position when loss of train integrity is detected	3.6.5.1.4 d)	X[4]													
16)	Report train position when train front/rear passes an RBC/RBC border (only level 2/3)	3.6.5.1.4 e) 3.6.5.1.4 k)	X[4]													
17)	Report train position when train rear passes a level transition border (from level 2/3 to 0, NTC, 1)	3.6.5.1.4f)	X[4]													
18)	Report train position when change of level due to trackside order	3.6.5.1.4 g)	X[4]													
19)	Report train position when change of level due to driver request	3.6.5.1.4 g)	X[4]													

[1] VS informs VL about valid Balise Groups
[2] In case of on-board localisation
[3] Content must be safe in future (L3 / moving block); Trigger for Report is “ns”

N°	On-Board Functions	Reference SUBSET-026	VS	VL	MLM	STMC	CMD	NTP	TCS	PETS	ODS	CDS	FVA	TS-OB	JDW	TDS
20)	Report train position when establishing a session with RBC	3.6.5.1.4 h)	X[4]													
21)	Report train position when a data consistency error is detected (only level 2/3)	3.6.5.1.4 i)	X[4]													
22)	Report train position as requested by RBC...	3.6.5.1.4	X[4]													
23)	... or Report train position at every passage of an LRBG compliant balise group	3.6.5.1.4 j)	X[4]													
	Manage MA															
24)	Request MA Cyclically respect to approach of perturbation location (T_MAR) or MA timer elapsing (T_TIMEOUTRQST) (only level 2/3)	3.8.2.3 a) and b)	X													
25)	Request MA Cyclically when “Start” is selected (only level 2/3)	4.4.11 5.4, 5.11	X													
26)	Request MA on reception of "track ahead free up to the level 2/3 transition location" (only level 0,1,NTC)	3.8.2.7.1	X													
27)	Request MA on track description deletion (only level 2/3)	3.8.2.7.3	X													
28)	Determine EOA/LOA, SvL, Danger Point, etc.	3.8.4 3.8.5	X													
29)	Handle Co-operative MA revocation (only level 2/3)	3.8.6	X													
30)	Manage Unconditional Emergency Stop	3.10	X													
31)	Manage Conditional Emergency Stop	3.10	X													
	Determine Most Restrictive Speed Profile, based on:															
32)	SSP	3.11.3	X													
33)	ASP	3.11.4	X													
34)																
35)	TSR	3.11.5	X													
36)	Signalling related speed restriction when evaluated as a speed limit	3.11.6	X													
37)	Mode related speed restriction	3.11.7	X													
38)	Train related speed restriction	3.11.8	X													
39)	STM max speed	3.11.2.2 g)	X													
40)	STM system speed	3.11.2.2 h)	X													
41)	LX speed	3.12.5.6	X													
42)	Speed restriction to ensure a given permitted braking distance	3.11.11	X													
43)	Override related speed restriction	5.8.3.6	X													
	Supervise Train Speed															
44)	Speed and Distance Monitoring based on MRSP, MA, release speed, gradient, mode profile, non-protected LX start location, and route unsuitability location	3.13 5.9.3.5 57.3.4 3.12.2.8 3.12.5.4	X													
45)	Speed and Distance Monitoring based on MRSP	4.4.10.1	X													
46)	Speed and Distance Monitoring based on MRSP, allowed distance to run in Staff Resp. mode	4.4.11	X													
47)	Ceiling Speed Monitoring only (no braking curve) based on MRSP	4.4.8.1.1 a) 4.4.18.1.3 a)	X													
	Supervise Train Movements															
48)	Backwards Distance Monitoring	4.4	X													
49)	Roll Away Protection	3.14.2	X													
50)	Reverse Movement Protection	3.14.3	X													
51)	Standstill Supervision	3.14.4 4.4.7.1.5	X													
52)	Supervise “danger for shunting” information and list of expected balises for shunting	4.4.8.1.1 b) and c)	X													

N°	On-Board Functions	Reference SUBSET-026	VS	VL	MLM	STMC	CMD	NTP	TCS	PETS	ODS	CDS	FVA	TS-OB	JDW	TDS
53)	Supervise “Stop if in SR” information and list of expected balises for Staff Responsible	4.4.11.1.3 c) and d)	X													
54)	Supervise signalling related speed restriction when evaluated as a trip order	3.11.6.4	X													
55)	Command Emergency Brake	4	X		tbd			X								
56)	**Determine Mode and Level**															
57)	Determine ERTMS/ETCS Mode	3.12.4 4.6			X											
58)	Determine ERTMS/ETCS level	5.10			X											
59)	**Other functions**															
60)	System Version Management	3.17	X													
61)	Manage Communication Session	3.5	X [4]													
62)	Delete Revoked TSR	3.11.5.5	X													
63)	Override (Trip inhibition)	5.8	X													
64)	Manage Track Conditions excluding Sound Horn, Non-Stopping Areas, Tunnel Stopping Areas and Big Metal Masses	3.12.1	X						X							
65)	Manage Track Conditions Sound Horn, Non-Stopping Areas, Tunnel Stopping Areas	3.12.1	X													
66)	Manage Track Condition Big Metal Masses	3.12.1	X							?						
67)	Manage Route Suitability	3.12.2	X													
68)	Manage Text Display to the driver	3.12.3	X													?
69)	Manage LSSMA display to the driver	4.4.19.1	X													?
70)	Manage RBC/RBC Handover (only level 2/3)	3.15.1 5.15	X [5]													
71)	Manage Track Ahead Free Request (only level 2/3)	3.15.5	X													
72)	Provide Fixed Values, and Default/National Values	3.18.1 3.18.2	X								X	X				
73)	Manage change of Train Data from external sources	5.17	X									X	X			
74)	Provide Date and Time	3.18.5												X		
75)	Provide Juridical Data	3.20													X	
76)	Inhibition of revocable TSRs from balises (only level 2/3)	3.11.5.12 3.11.5.13 3.11.5.14 3.11.5.15	X													
77)	Cold Movement Detection	3.15.8					X									
78)	Continue Shunting on desk closure (Enabling transition to Passive Shunting mode)	5.12.4			X											
79)	Manage “Stop Shunting on desk opening” information	4.4.20.1.8 4.4.20.1.9			X											
80)	Manage Virtual Balise Covers	3.15.9	X													
81)	Advance display of route related information	3.15.10	X													?

Table 4 Relating Functions from SUBSET-02

[4] OCORA aims to split safe from non-safe functionality. Hence, it might be reasonable to remove this functionality from the VS and have it implemented in a separate component. This will be elaborated in more detail in subsequent versions of this document.
[5] RBC handover might also be relevant for VL, e.g. digital map downloads

Appendix C TDS-OB Architectures to be evaluated

C1 A - TDS as software on a screen controlling HMI elements

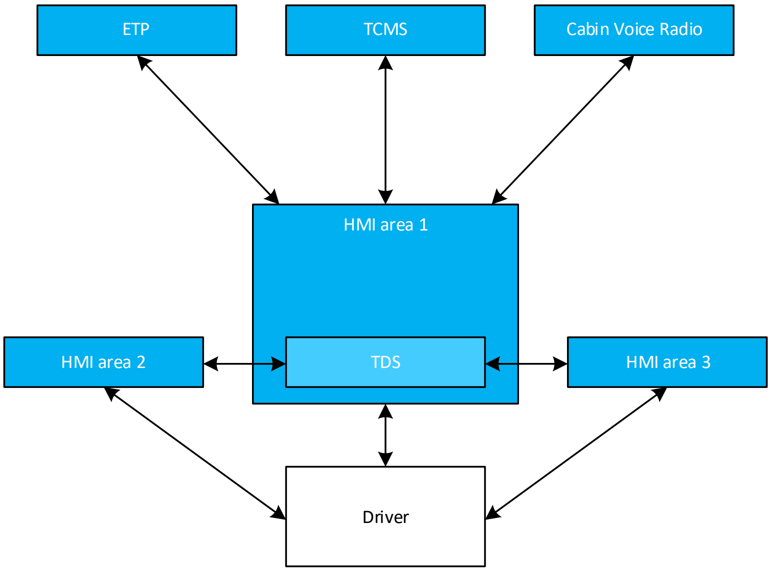

Figure 31: TDS as software on a screen controlling HMI elements (logical view)

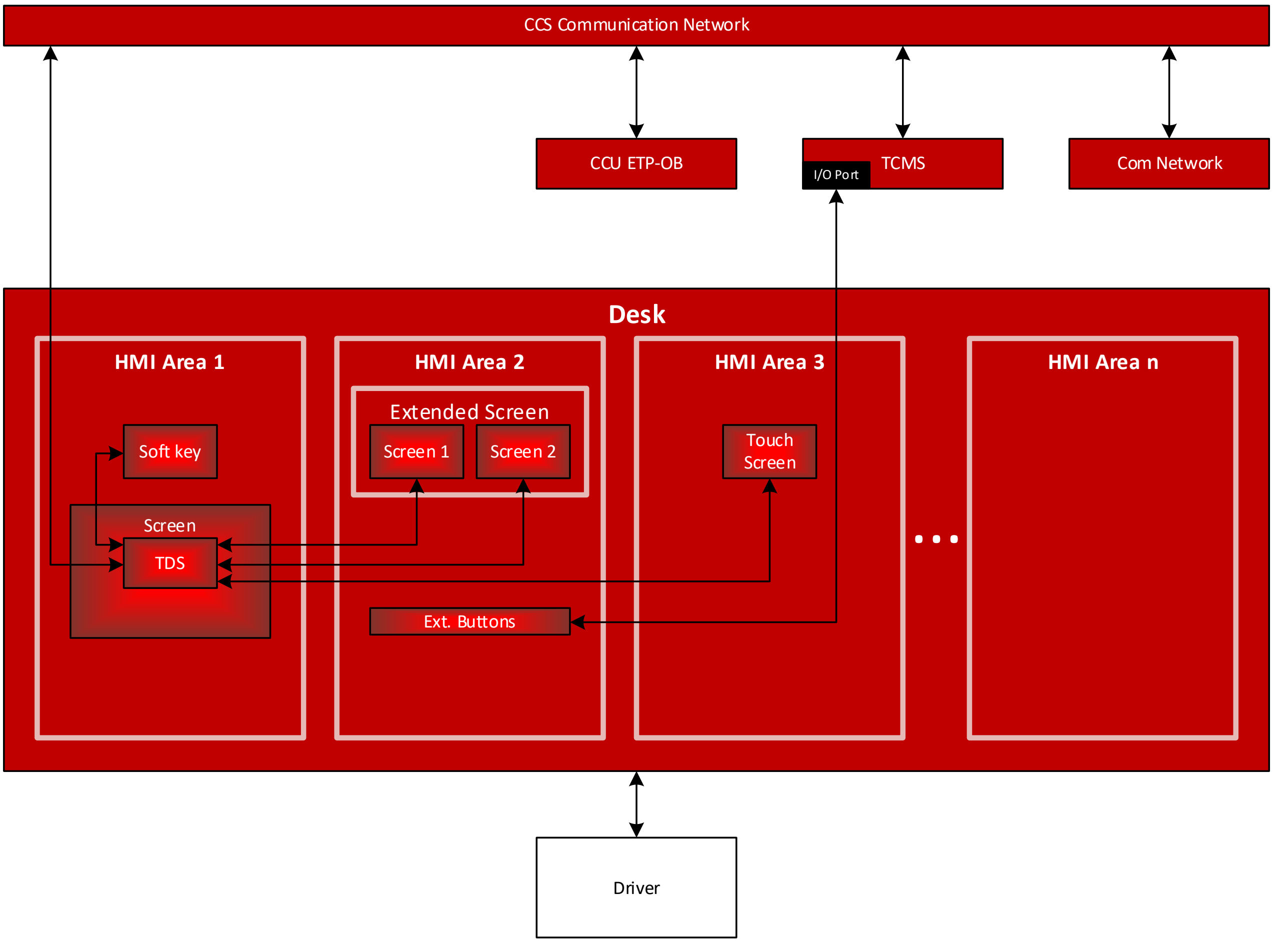

Figure 32: TDS as software on a screen controlling HMI elements (hardware view)

C2 B - TDS as software on a subcomponent controlling HMI elements

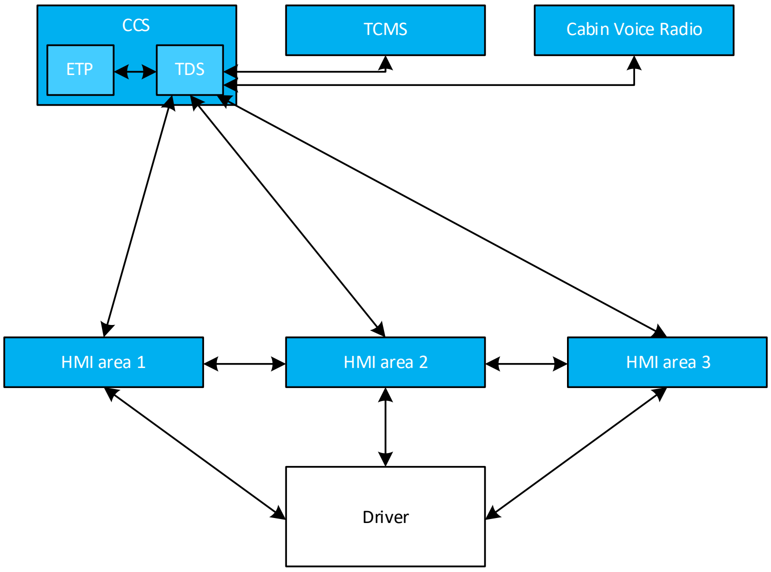

Figure 33: TDS as software on a subcomponent controlling HMI elements (logical view)

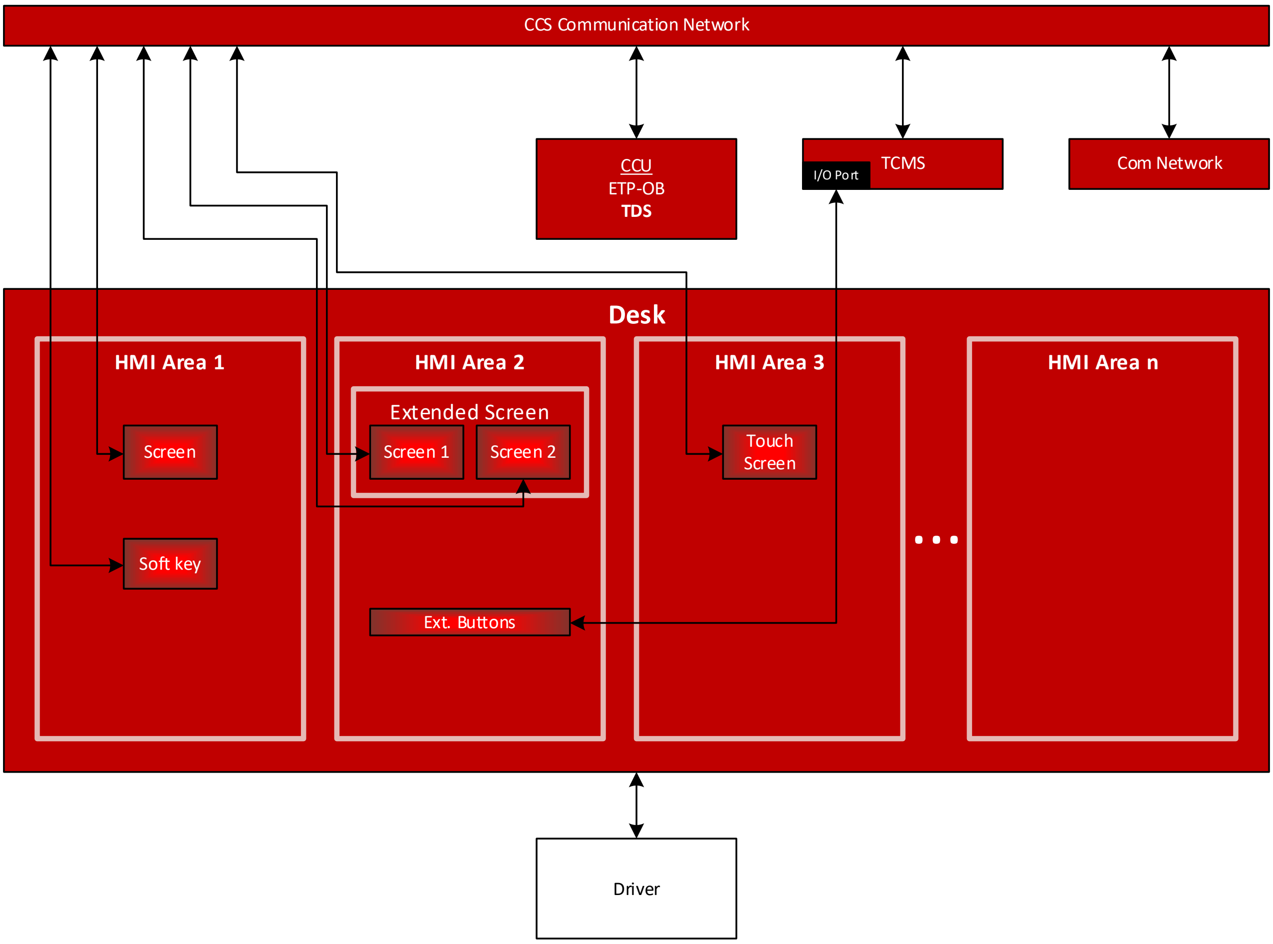

Figure 34: TDS as software on a subcomponent controlling HMI elements (hardware view)

C3 C - TDS software running on a subcomponent controlling HMI areas

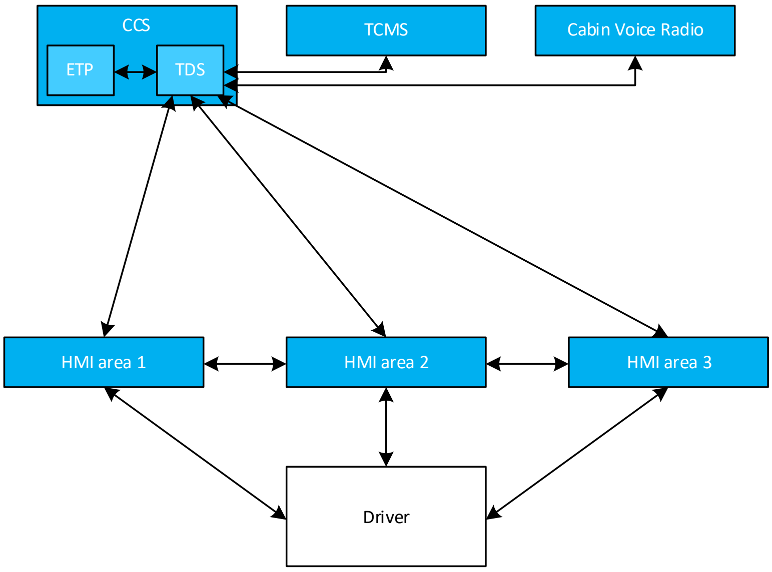

Figure 35: TDS software running on a subcomponent controlling HMI areas (logical view)

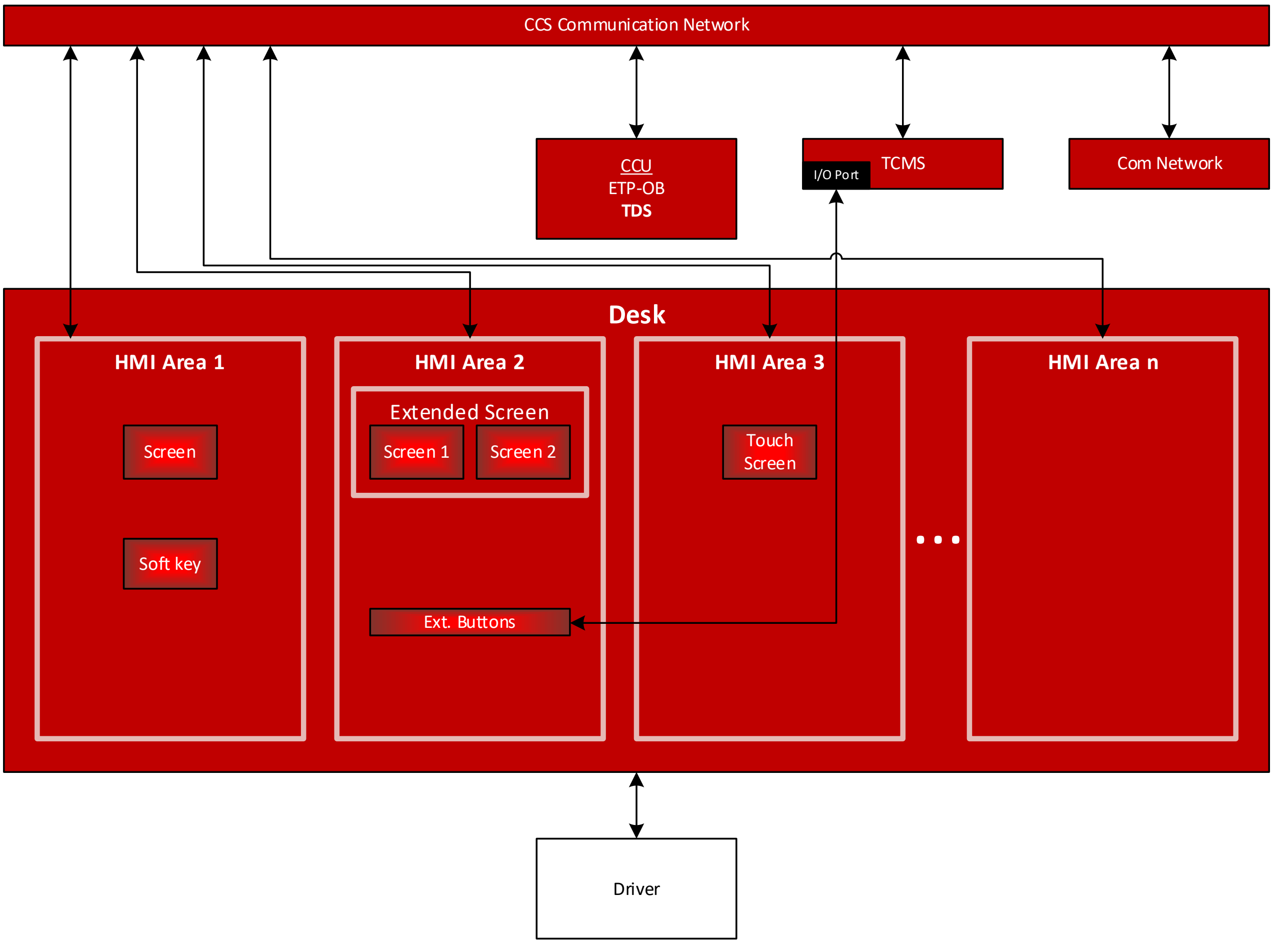

Figure 36: TDS software running on a subcomponent controlling HMI areas (hardware view)

C4 D - TDS software on dedicated HW controlling HMI elements including ext. buttons

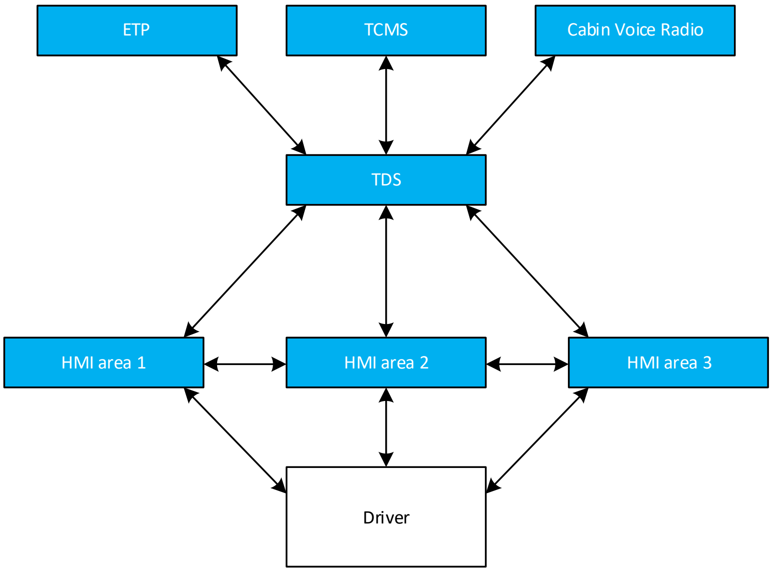

Figure 37: TDS SW on dedicated HW controlling HMI elements including ext. buttons (logical view)

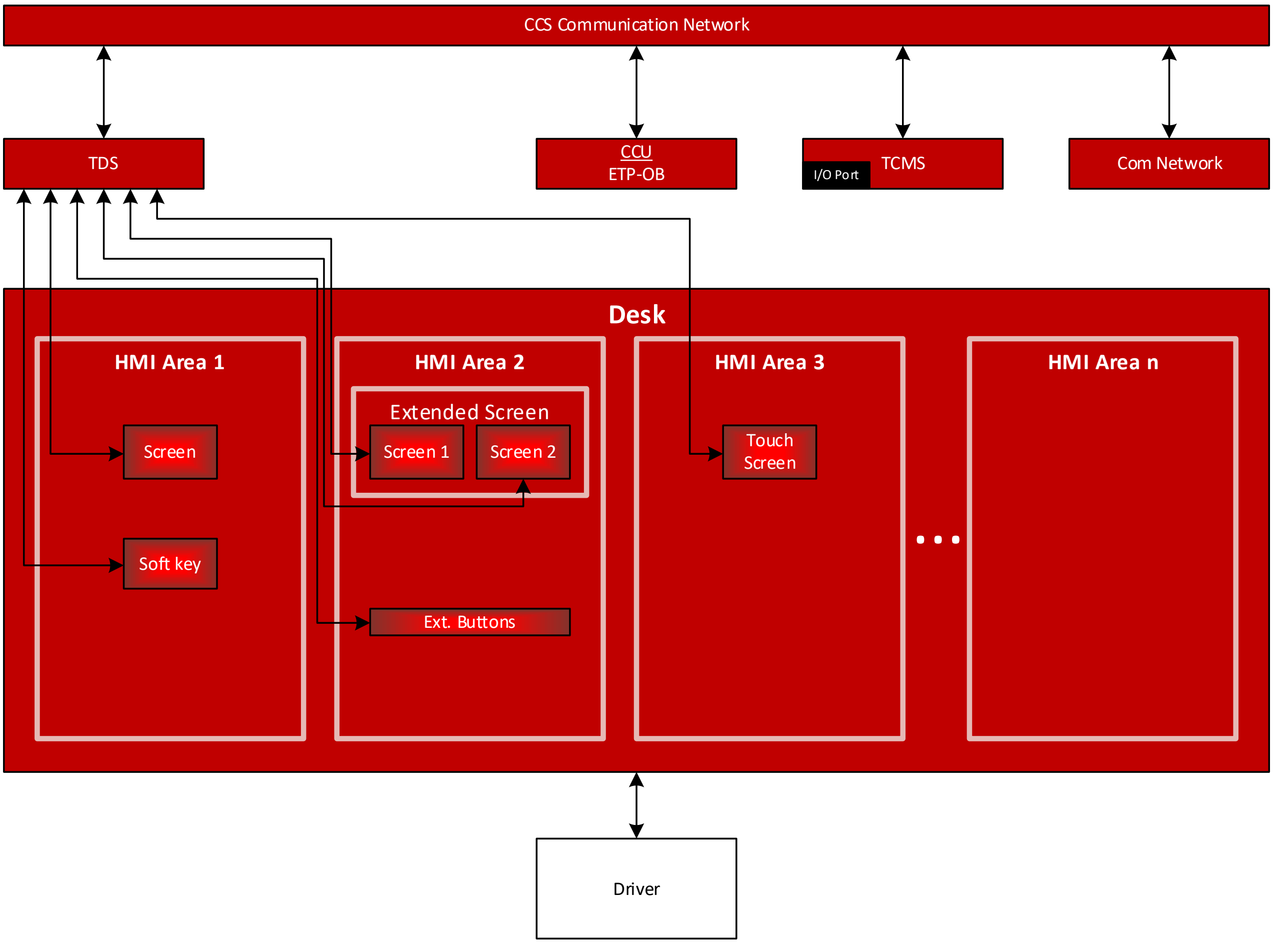

Figure 38: TDS SW on dedicated HW controlling HMI elements including ext. buttons (hardware view)

C5 E - TDS software on dedicated HW controlling HMI elements

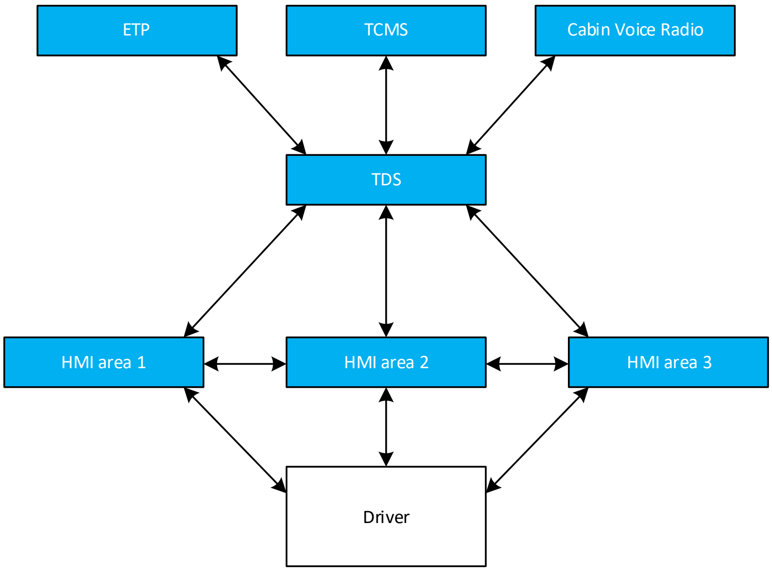

Figure 39: TDS software on dedicated HW controlling HMI elements (logical view)

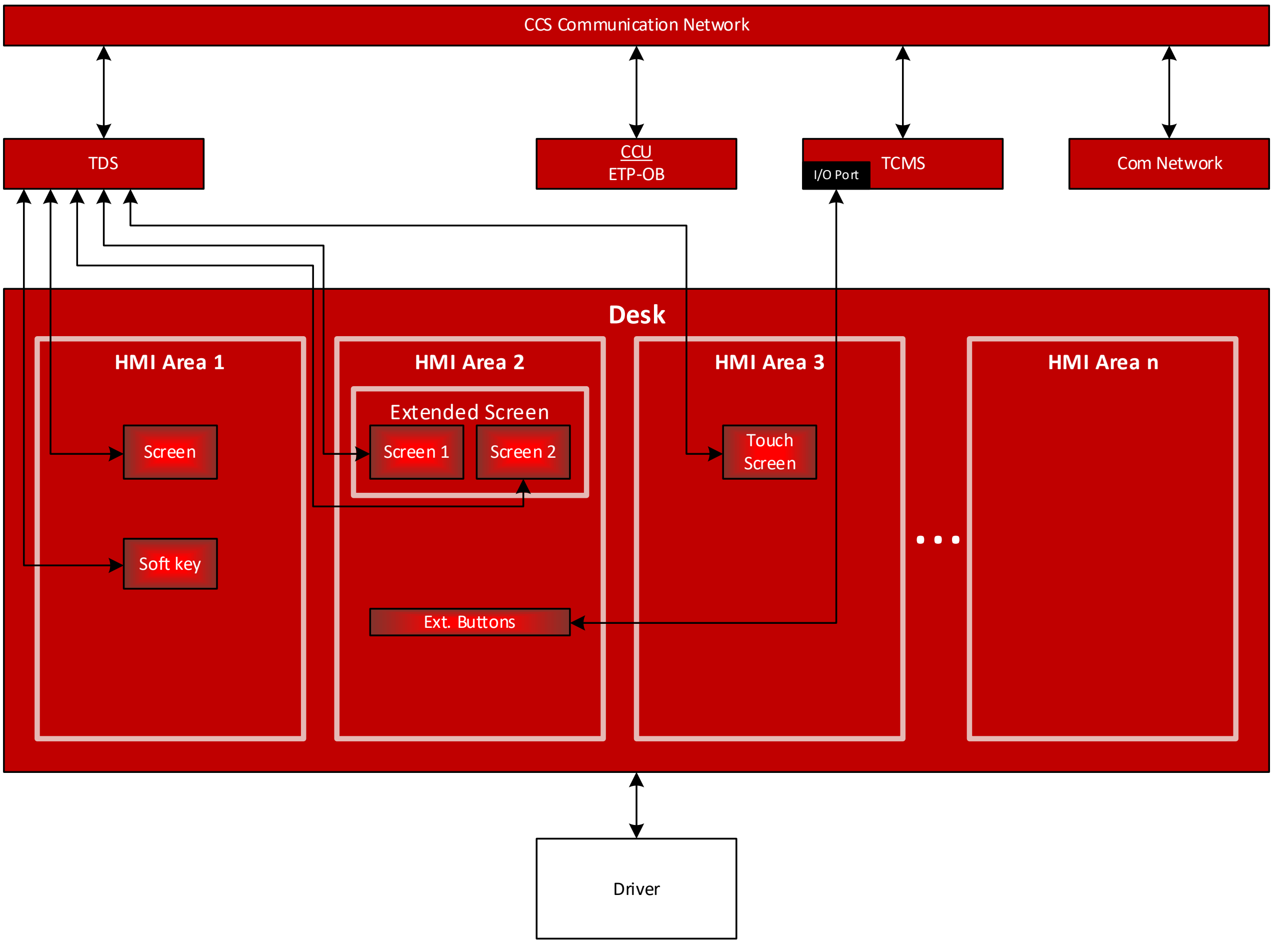

Figure 40: TDS software on dedicated HW controlling HMI elements (hardware view)

C6 F - TDS consisting of HMI elements, software and hardware

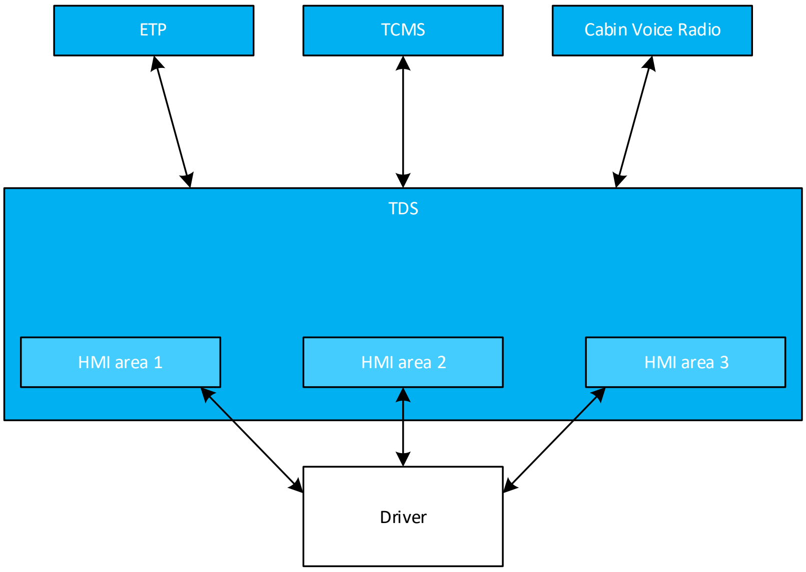

Figure 41: TDS consisting of HMI elements, software and hardware (logical view)

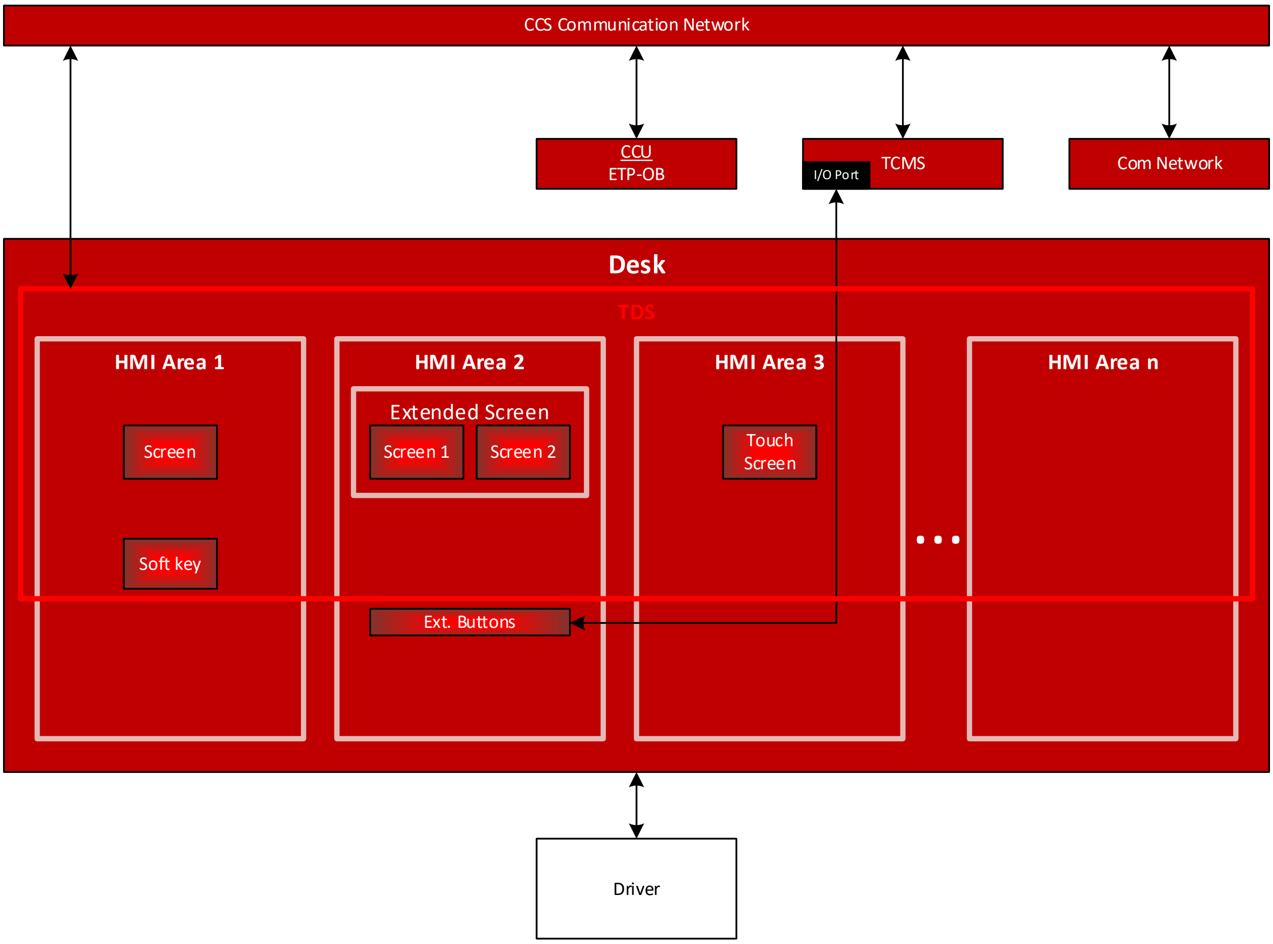

Figure 42: TDS consisting of HMI elements, software and hardware (hardware view)

C7 G - TDS consisting of HMI elements, software and hardware (including ext. buttons)

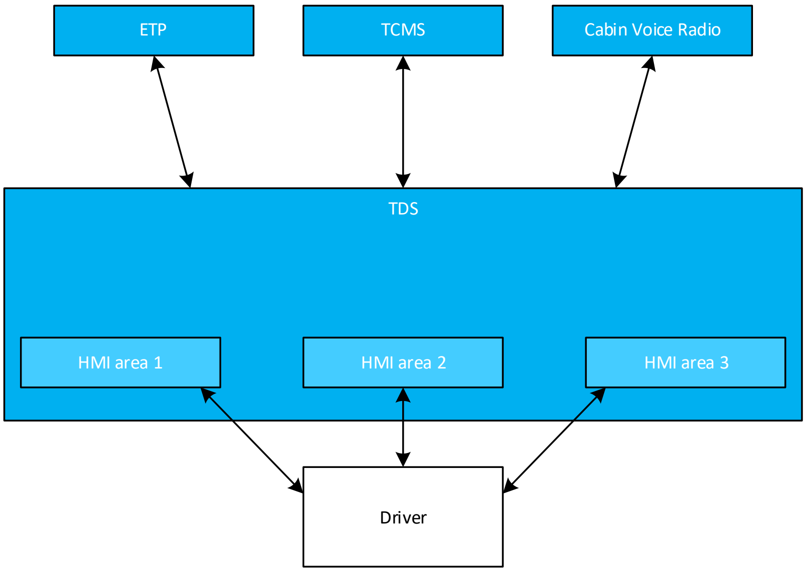

Figure 43: TDS as HMI elements, software and hardware (including ext. buttons) (logical view)

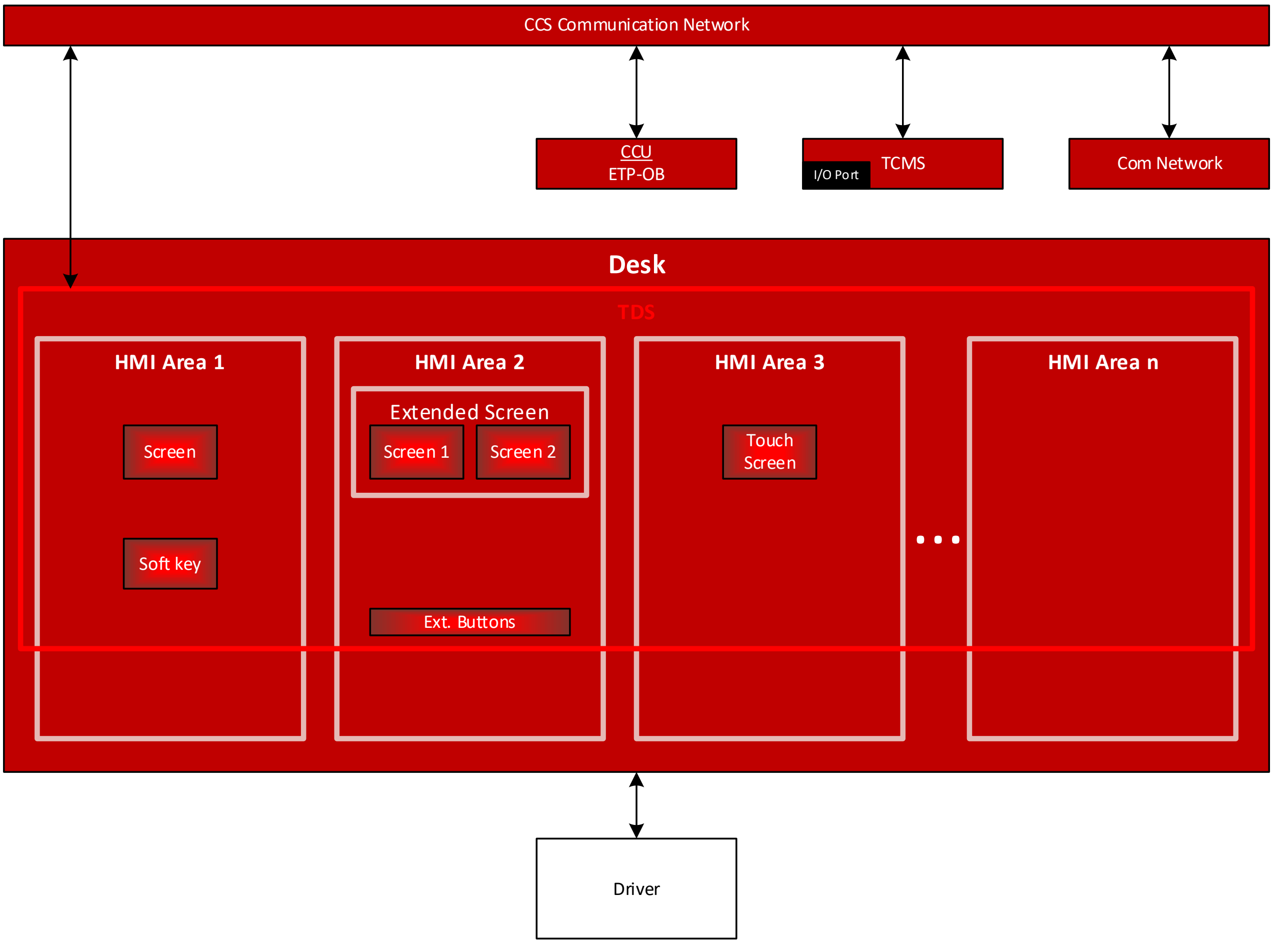

Figure 44: TDS as HMI elements, software and hardware (including ext. buttons) (hardware view)

C8 H - TDS software on dedicated HW controlling HMI areas including ext. buttons

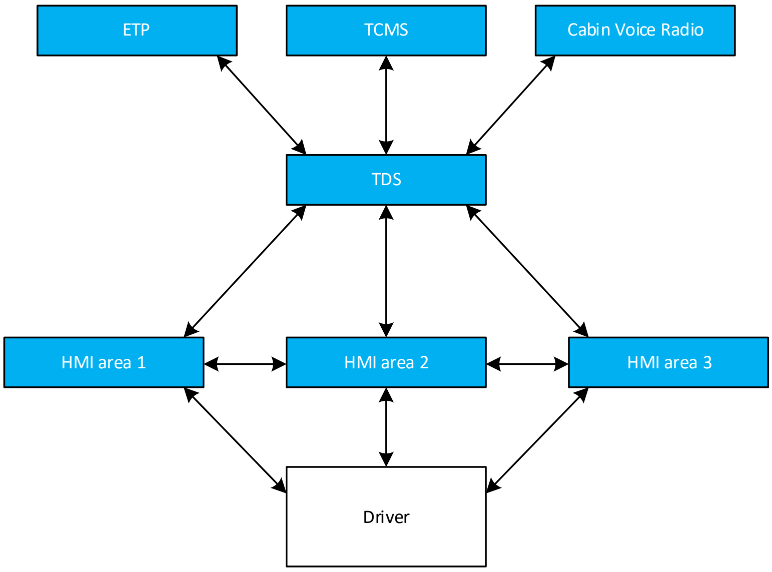

Figure 45: TDS software on dedicated HW controlling HMI areas including ext. buttons (logical view)

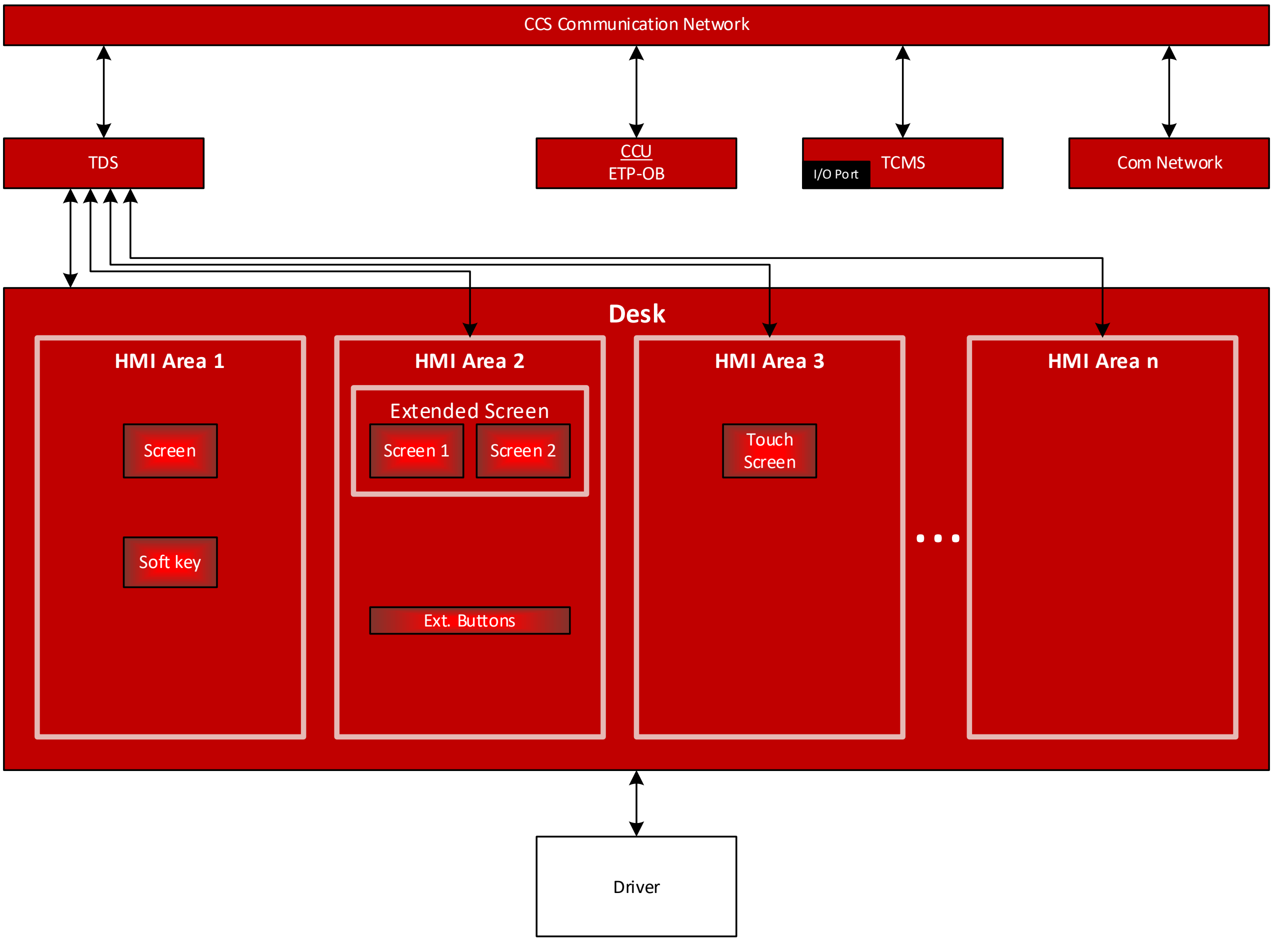

Figure 46: TDS software on dedicated HW controlling HMI areas including ext. buttons (hardware view)

C9 I - TDS software on dedicated HW controlling HMI areas

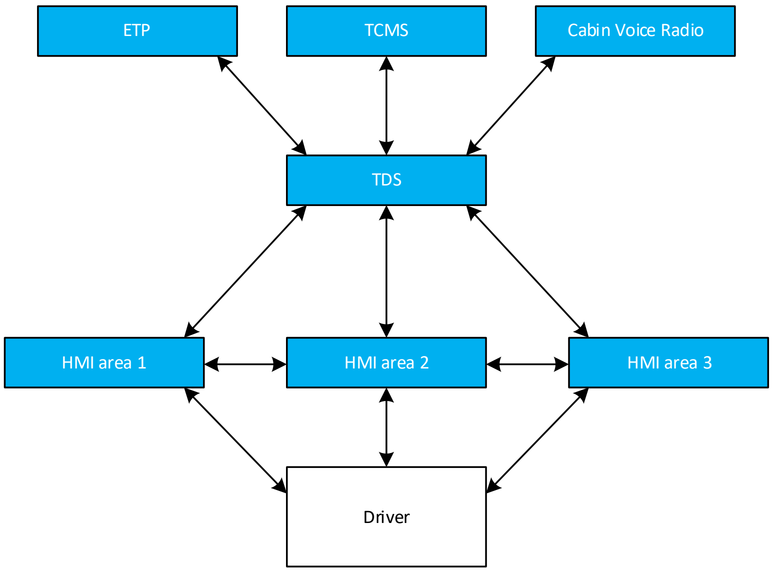

Figure 47: TDS software on dedicated HW controlling HMI areas (logical view)

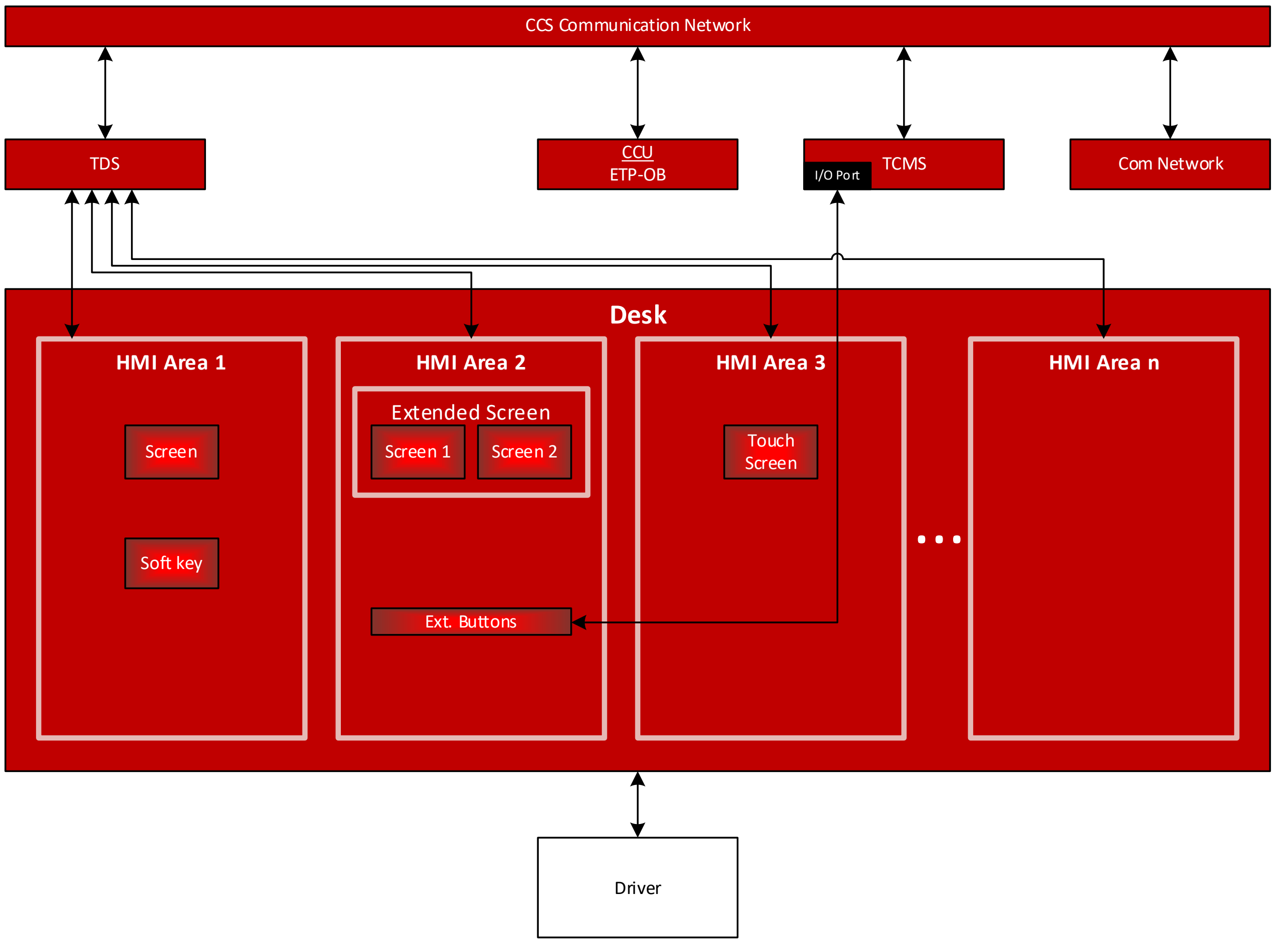

Figure 48: TDS software on dedicated HW controlling HMI areas (hardware view)

Appendix D Large scale graphics

This section contains large scale graphics of graphics used throughout the document.

D1 CCS-OB – External interfaces – logical architecture

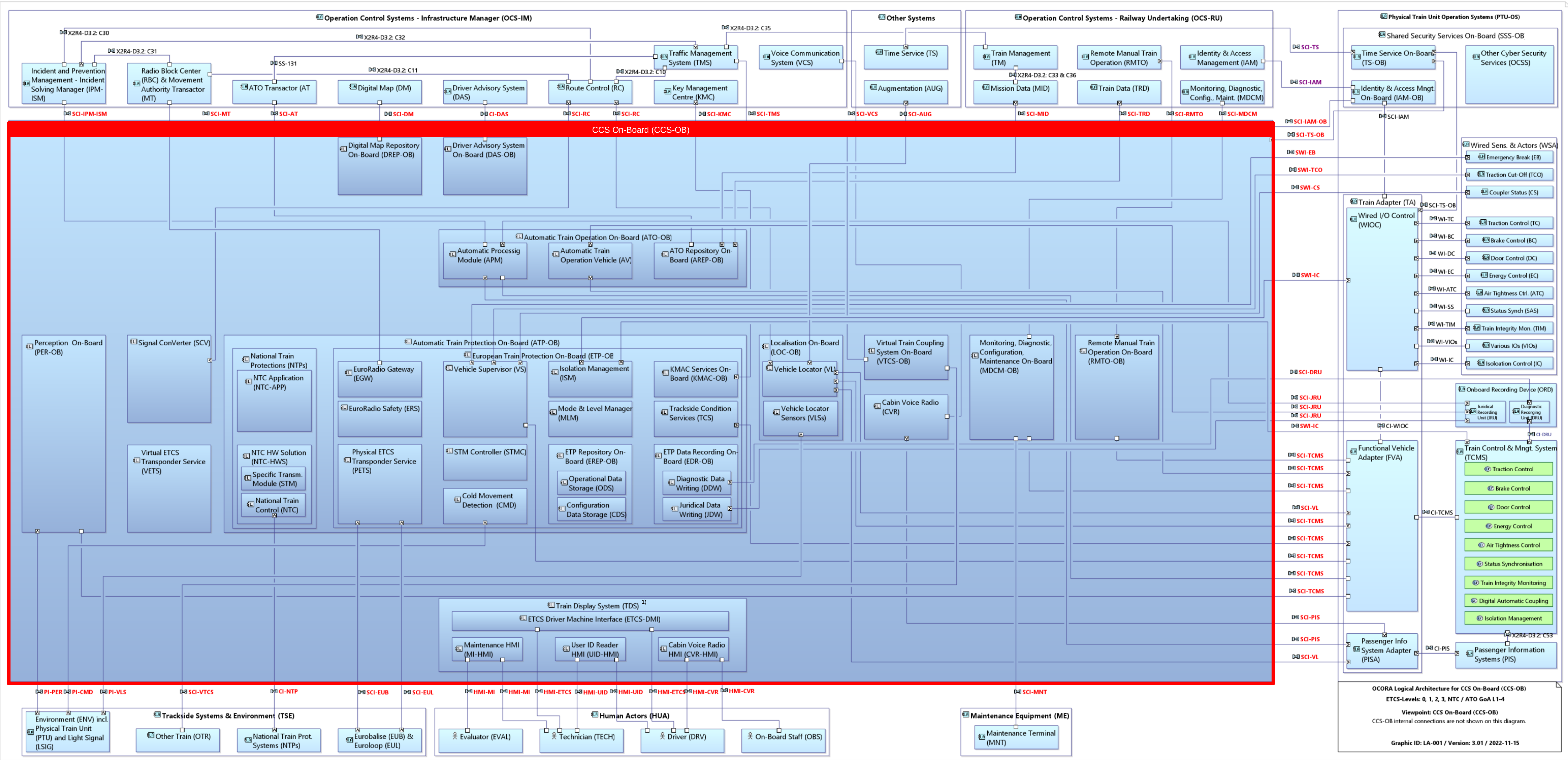

Figure 49: External interfaces – logical architecture (large scale representation)

1) may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn respective subset contains information for the interface.
SS-nnn* respective subset does not address the interface but should contain the information in the future.

D2 European Train Protection On-Board (ETP-OB) – logical architecture

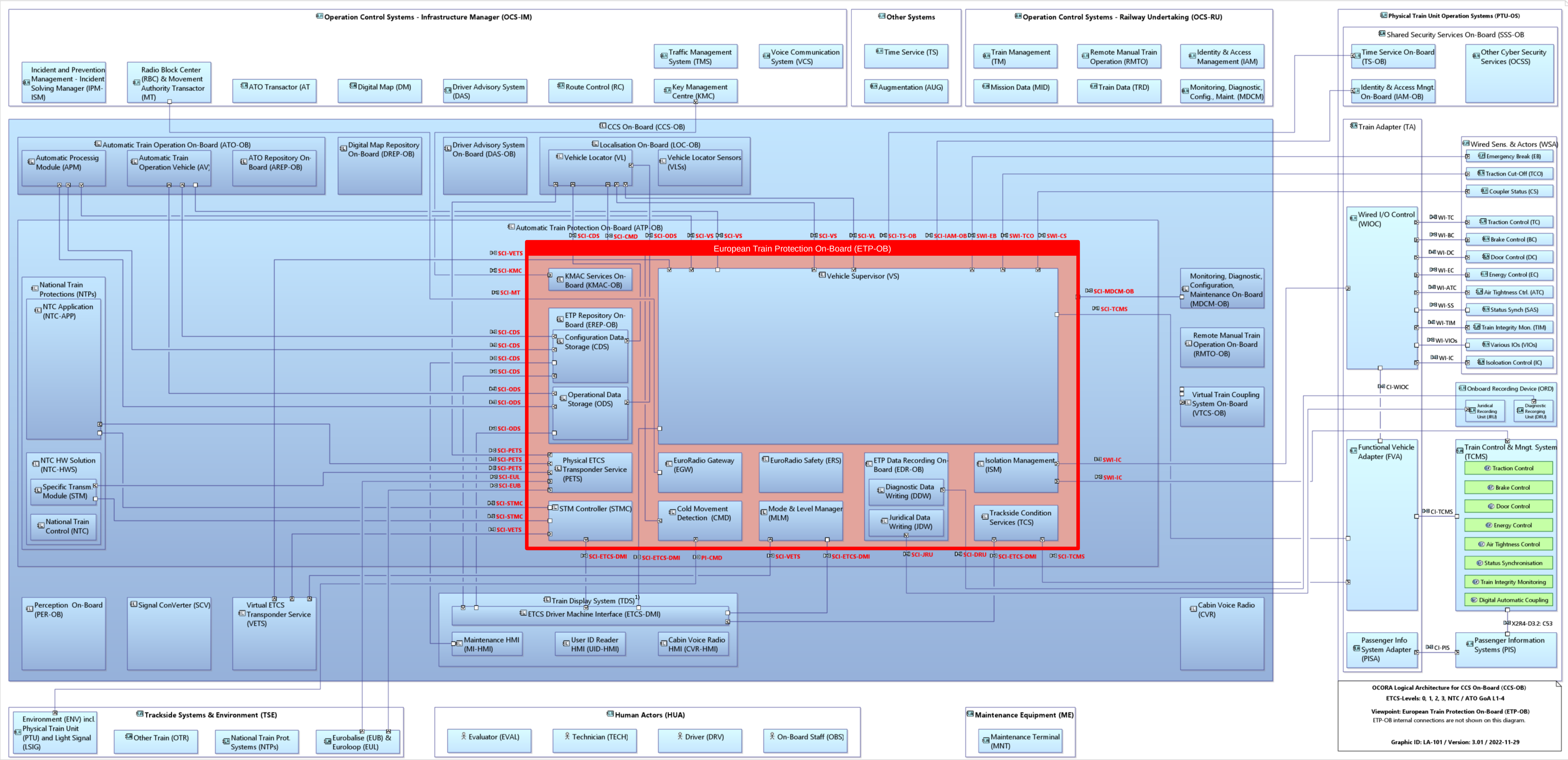

Figure 50: ETP-OB – logical architecture (large scale representation)

1) may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn respective subset contains information for the interface.
SS-nnn* respective subset does not address the interface but should contain the information in the future.

D3 Localisation On-Board (LOC-OB) – logical architecture

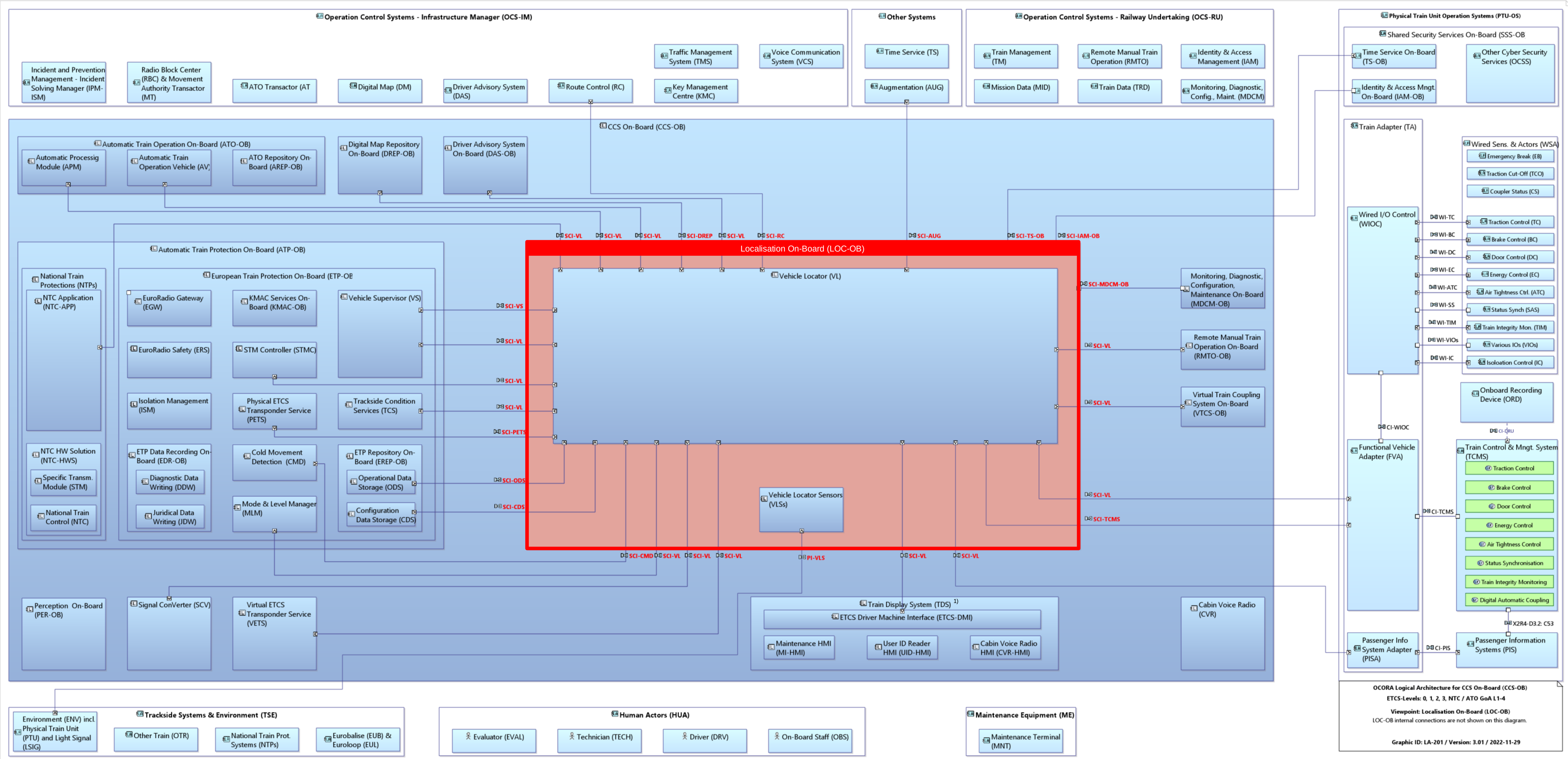

Figure 51: LOC-OB – logical architecture (large scale representation)

1) may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn respective subset contains information for the interface.
SS-nnn* respective subset does not address the interface but should contain the information in the future.

D4 Automatic Train Operation On-Board (ATO-OB) – logical architecture

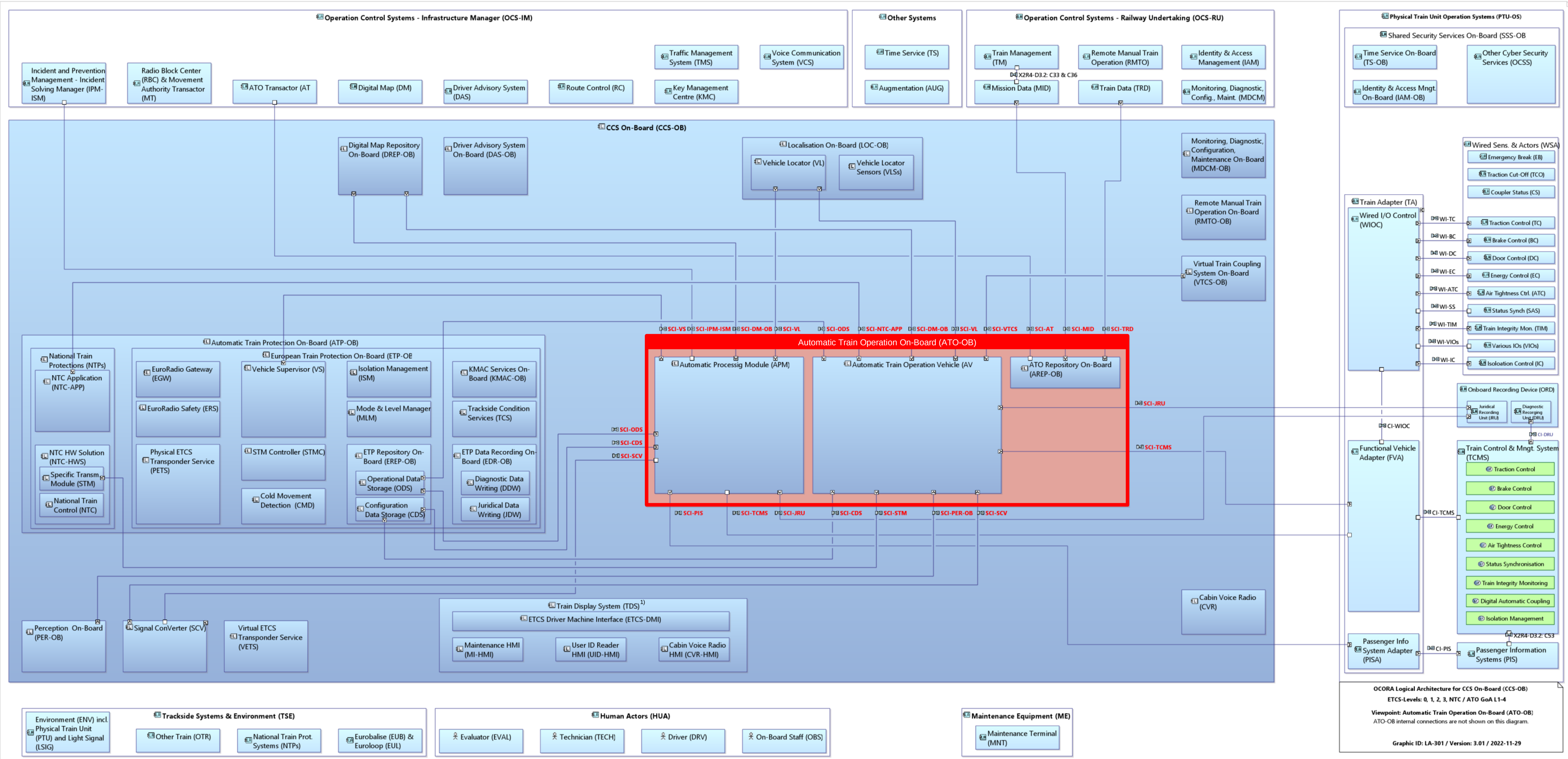

Figure 52: ATO-OB – logical architecture (large scale representation)

1) may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn respective subset contains information for the interface.
SS-nnn* respective subset does not address the interface but should contain the information in the future.

D5 Digital Map Repository On-Board (DREP-OB) – logical architecture

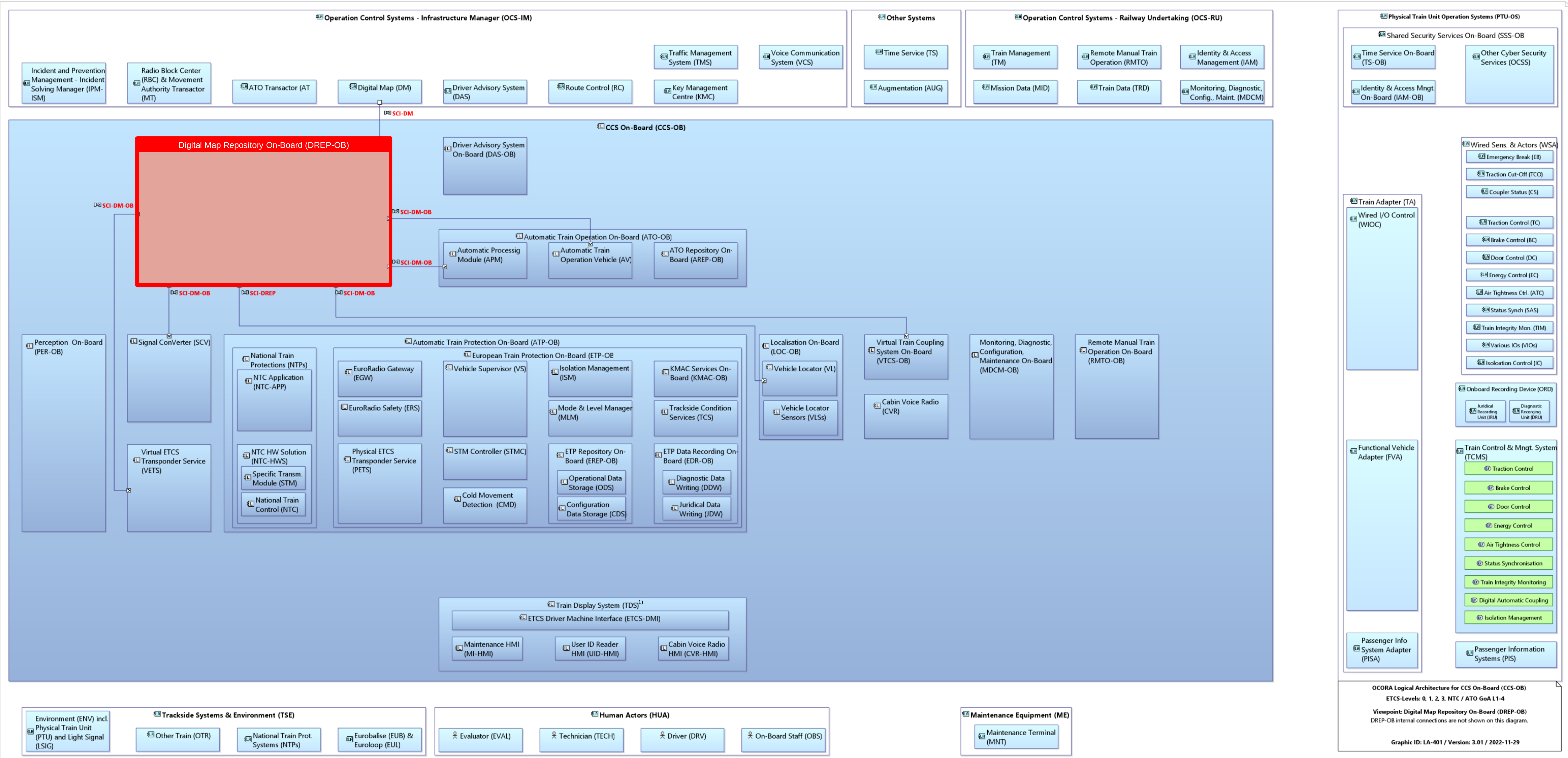

Figure 53: DREP-OB – logical architecture (large scale representation)

1) may be moved into the PTU-OS / LOC&PAS domain.
SS-nnn respective subset contains information for the interface.
SS-nnn* respective subset does not address the interface but should contain the information in the future.