OCORA

Open CCS On-board Reference Architecture

Localisation On-Bord (LOC-OB)

Introduction

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Table of contents

1 Introduction 5

1.1 Purpose of the document 5

1.2 Applicability of the document 5

1.3 Context of the document 5

2 Goals of the OCORA Localisation On-Board (LOC-OB) 6

2.1 Definition / Involved components / System context 6

2.1.1 Vehicle Locator (VL) 6

2.1.2 Vehicle Locator Sensors (VLS) 6

2.2 Why separating localisation from ETCS core? 6

3 Localisation principles 8

3.1 Current ETCS localisation principles 8

3.2 OCORA Localisation On-Board (LOC-OB) principles 9

4 Localisation in the context of the CCS-OB architecture 10

4.1 Logical architecture - Viewpoint CCS On-Board (CCS-OB) 10

4.2 Logical architecture - Viewpoint Localisation On-Board (LOC-OB) 10

4.3 List of LOC-OB actors and its interfaces 11

5 Implementation variants 15

Appendix A Large scale graphics 16

A1 Logical architecture for CCS-OB – Viewpoint CCS-OB 16

A2 Logical architecture for CCS-OB – Viewpoint LOC-OB 17

Table of figures

Figure 1 SUBSET-026, chapter 3, figure 13c describes how the confidence interval is calculated 8

Figure 2 SUBSET-041, chapter 5.3.1.1 describes the accuracy of distances measured on-board 9

Figure 3 Logical architecture - Viewpoint CCS On-Board (CCS-OB) 10

Figure 4 Logical architecture - Viewpoint Localisation On-Board (LOC-OB) 10

Figure 5 CCS-OB logical architecture – Viewpoint CCS-OB (large scale graphic) 16

Figure 6 CCS-OB logical architecture – Viewpoint LOC-OB (large scale graphic) 17

Table of tables

Table 1 List of LOC-OB actors and related interfaces 14
Table 2 Implementation variants describing the impacts of the optional LOC-OB actors 15

References

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

[1] OCORA-BWS01-010 – Release Notes

[2] OCORA-BWS01-020 – Glossary

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

[4] OCORA-BWS01-040 – Feedback Form

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

[6] OCORA-BWS04-010 – Problem Statements

[7] OCORA-TWS01-030 – System Architecture

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

[9] EUG 21E109 – Vehicle Locator Concept Architecture, LWG, version 1.0, 2021-07-15

[10] RCA.Doc.40 – RCA Poster, BL0, R2, Version 0.2 (0.B), Sprint 22, 2021-05-27

1 Introduction

1.1 Purpose of the document

The purpose of this document is to provide an overview of the envisioned OCORA Localisation On-Board (LOC-OB) system and to prepare for Europe's Rail Joint Undertakings System- & Innovation-Pillar.

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

1.2 Applicability of the document

The document is considered informative 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 the OCORA Release R1, together with the documents listed in the release notes [1]. Before reading this document, it is recommended to read the Release Notes [1]. If you are interested in the context and the motivation that drives OCORA we recommend to read the Introduction to OCORA [5], and the Problem Statements [6]. The reader should also be aware of the Glossary [2] and the Question and Answers [3].

Further information, especially the requirements LOC-OB has towards some of its actors, can be found in document [8].

2 Goals of the OCORA Localisation On-Board (LOC-OB)

2.1 Definition / Involved components / System context

The OCORA component Localisation On-Board (LOC-OB) consists of the Vehicle Locator (VL) and the Vehicle Locator Sensors (VLSs).

In the context of the concept architecture [9] published by the Localisation Working Group (ERTMS Users Group), the LOC-OB consists of the Vehicle Locator (VL) and the train-based Sensor Data.

As a side note, RCA's Vehicle Locator (VL) is seen as a more abstract and therefore high-level construct from the trackside point of view that covers the aspects of determining track occupancy. Hence, train-based sensors, map data, or even train length and train integrity information might be seen in RCA's Vehicle Locator (VL) definition.

2.1.1 Vehicle Locator (VL)

The Vehicle Locator (VL) is a safe CCS On-Board component that uses 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 an odometry component.

2.1.2 Vehicle Locator Sensors (VLS)

This logical component includes the functionality the locator sensors are providing. Sensor Data (train-based) is grouped into the following types [9]:

- GNSS Receiver. Autonomous geo-spatial positioning and time information based on satellite navigation systems.
- Inertial sensors. Provides the specific force, angular rate and the orientation of the body by using a combination of accelerometers, gyroscopes, and potentially magnetometers.
- Rotational sensors. Provides speed (e.g., tachometer, speed probe) and travelled distance (e.g., wheel revolution counter) measurements.
- Radar-based sensors. Distance and speed measurements, e.g., doppler radar, LiDAR, LGPR.
- Optical sensors. Sensors based on image acquisition and analysis to recognise known elements from trackside that may be referenced, e.g., visual odometry, object recognition.
- Other sources. Other not explicitly identified sources gathered/measured on-board that may provide useful input information to the VL (e.g., radio-based technologies like FRMCS, WLAN, Ultra-Wideband).

2.2 Why separating localisation from ETCS core?

The LOC-OB is deployed on every OCORA based CCS On-Board system. Refer to chapter 4.1 on page 10 to locate the LOC-OB component in the OCORA architecture.

In today's ETCS implementations, the LOC-OB is part of the monolithic ETCS OBU (On-Board Unit). Since the LOC-OB has a different technological life cycle than the Vehicle Supervisor (VS), it is essential that the LOC-OB is a separate component, containing just the functionality needed to locate safely and reliably the vehicle and its orientation on the track and determining associated kinematic parameters of the vehicle. Standardising the interfaces of LOC-OB allows new localisation technologies to be introduced more quickly in the future without the need to modify the VS functionality.

Isolating the LOC-OB- from the VS-functionality has the positive effect that the complexity of the LOC-OB is reduced. A very important aspect, 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 C of document [7] 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.

3 Localisation principles

3.1 Current ETCS localisation principles

In the current ETCS specification (see for more details SUBSET-026, chapter 3) the train position is determined always longitudinal along the route, regardless of the complexity of the track layout. The train position information defines the position of the train front in relation to a balise group. The balise group identifies a unique common reference location between the onboard and the trackside which is called last relevant balise group (LRBG). Therefore, the train position is the distance of the estimated train front end position from the last relevant balise group.

The train position information includes:

- The estimated train front end position, defined by the estimated distance between the LRBG and the front end of the train
- The train position confidence interval (sets the safety boundary for the estimated position), defined by the min/max safe front ends
- Directional train position information in reference to the balise group orientation of the LRBG (position of the train front end from the side of the LRBG, train orientation, train running direction).

The confidence interval to the train position shall refer to the distance to the LRBG and shall consider:

- On-board over-reading amount and under-reading amount (odometer accuracy plus the error in detection of the balise group location reference)
- The location accuracy of the LRBG (Q_LOCACC)

The confidence interval increases in relation to the distance travelled from the LRBG depending on the accuracy of odometer equipment until it is reset when another balise group becomes the LRBG.

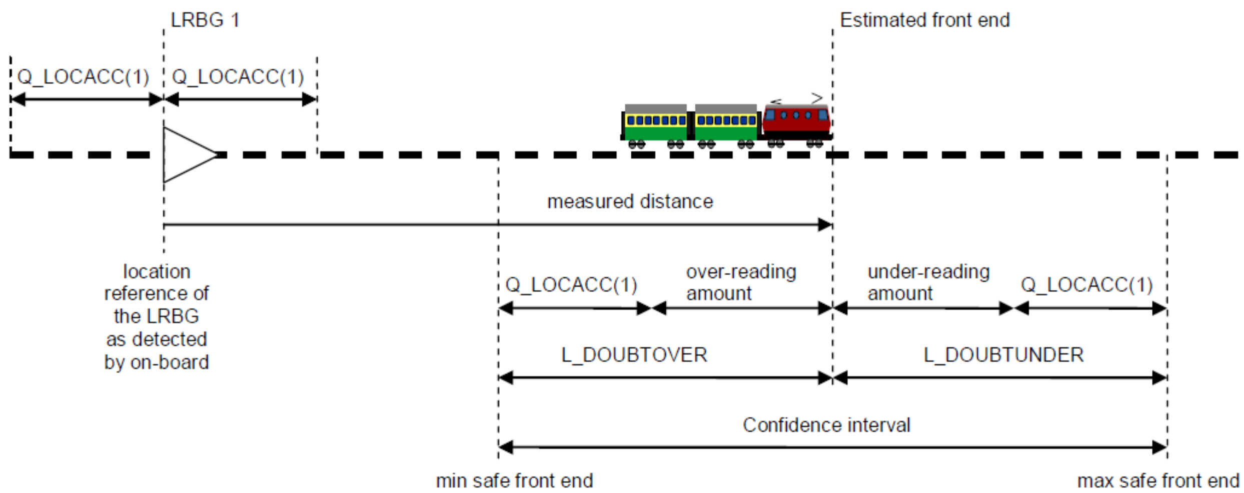


Figure 1 SUBSET-026, chapter 3, figure 13c describes how the confidence interval is calculated

The odometry system of current ETCS is based on wheel revolution counters and additional sensors (radar and/or accelerometer). The accuracy of the odometry is defined as a linear function from the last relevant balise group. The current specification for the performance of the odometry is described in SUBSET-041, chapter 5.3.1.1.

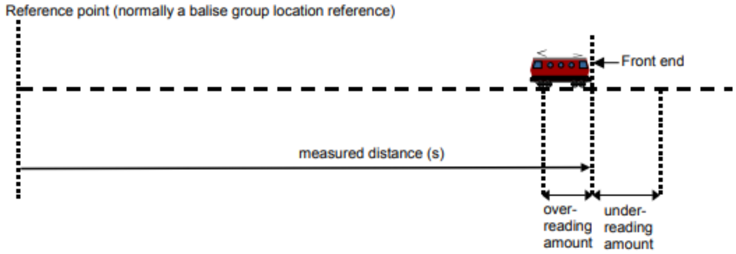
<table>
<tr><th>Description</th><th>Accuracy of distances measured on-board</th></tr>
<tr><td>Start Event</td><td>not applicable</td></tr>
<tr><td>Stop Event</td><td>not applicable</td></tr>
<tr><td>Value</td><td>for every measured distance s the accuracy shall be better or equal to ± (5m + 5% s), i.e. the over reading amount and the under reading amount shall be equal to or lower than (5m + 5% s).

</td></tr>
<tr><td>Notes</td><td>This performance requirement includes the error for the detection of a balise location, as defined in the Eurobalise specifications.
Also in case of malfunctioning the on-board equipment shall evaluate a safe confidence interval.</td></tr>
</table>

Figure 2 SUBSET-041, chapter 5.3.1.1 describes the accuracy of distances measured on-board

3.2 OCORA Localisation On-Board (LOC-OB) principles

The goal of the LOC-OB is to provide localisation information not only to the VS (core ETCS) and the AV (ATO Vehicle) as visualised by RCA [10], but also to other (future) actors which require different types of localisation information. Refer to chapter 4.1 on page 10 to locate the LOC-OB component in the OCORA architecture.

The LOC-OB can provide localisation information which complies with the current ERTMS/ETCS principle (a distance from a LRBG and a speed) called 1D positioning and can also provide additional localisation information such as:

- The absolute (3D) geographic positioning (Long, Lat, Alt),
- The vector acceleration within the 3D coordinate system based on the track axis,
- The vector velocity within the 3D coordinate system based on the track axis,
- The behaviour (roll, pitch, and yaw angles) of the coach where sensors are installed.

This localisation information is computed by the VL based on data provided by sensors and supporting information (e.g., digital map, augmentation data, routing information) upon availability. Refer to chapter 5 on page 15 for different implementation variants.

A more complete description of the desired localisation outputs and inputs can be found in the Vehicle Locator Concept Architecture, chapter 5.3 and 5.4 [9].

For providing the 1D positioning, VL is using a reference point. In a first approach the reference point is a LRBG, but to take full benefit of the Digital Map in the future any point of the map could be used as a reference point.

As a conclusion, the LOC-OB architecture facilitates to open the space for new sensor technologies to not least resolve the dependency to today's balises that are seen as a "single-technology choice" for reference points. Despite the tendency of reducing trackside assets such as balises and moving towards enhanced on-board localisation sensor technologies, the performance of the localisation system is seen as a key requirement and shall be further improved, i.e., higher accuracy of the estimated position/speed and (more regularly) reducing the confidence interval to a minimum.

4 Localisation in the context of the CCS-OB architecture

4.1 Logical architecture - Viewpoint CCS On-Board (CCS-OB)

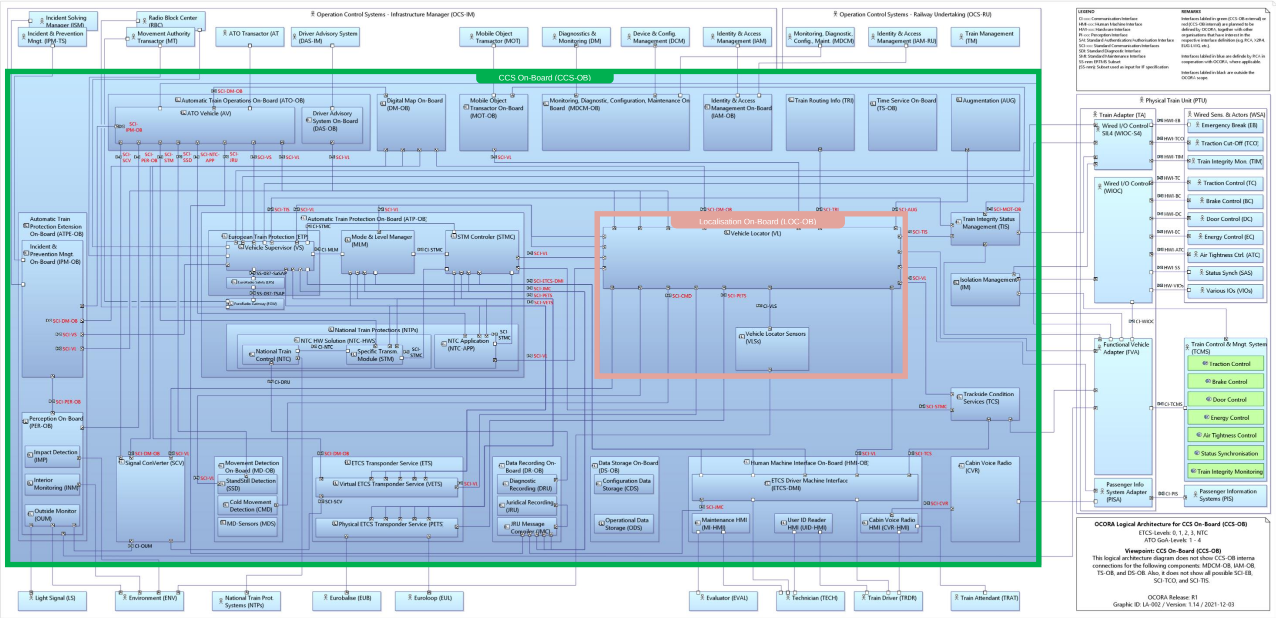


Figure 3 Logical architecture - Viewpoint CCS On-Board (CCS-OB)

(refer to Appendix A1 for large scale representation)

4.2 Logical architecture - Viewpoint Localisation On-Board (LOC-OB)

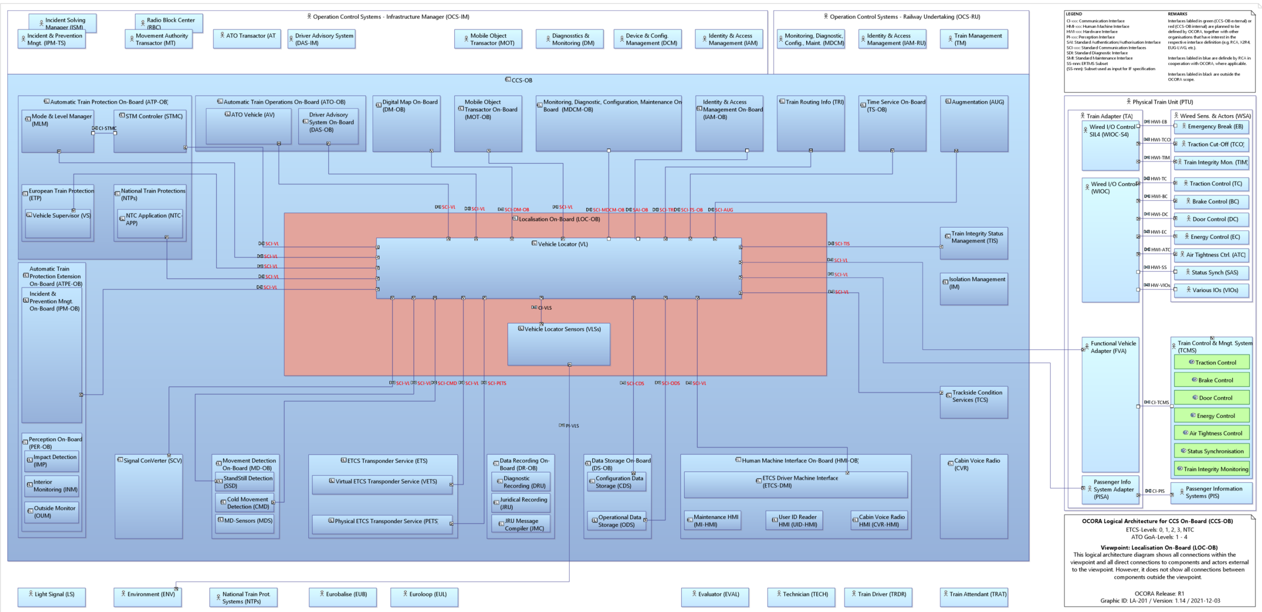


Figure 4 Logical architecture - Viewpoint Localisation On-Board (LOC-OB)

(refer to Appendix A2 for large scale representation)

4.3 List of LOC-OB actors and its interfaces

The actors interacting with the Localisation On-Board (LOC-OB) are listed in the table below. There are two types of actors. The “consumers” are actors that receive localisation information from LOC-OB through the interface SCI-VL. The “providers” are actors that provide information to LOC-OB. The latter are not using the SCI-VL interface but provide the information to LOC-OB through their specific interface.

Actor	Abbreviation	High-Level Description	Interface
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 Vehicle Locator (VL). In addition, information is received from the Balise Transmission Module (BTM) and the Loop Transmission Module (LTM) and processed adequately. In ETCS L2 and L3 mode, the VS interacts with the RBC or the APS-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.	SCI-VL
Mode & Level Manager	MLM	The Mode & Level Manager (MLM) is a safe component of the ETCS Core 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.	SCI-VL
STM Controller	STMC	The STM Controller (STMC) is a safe component of the ETCS Core 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.	SCI-VL
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.	SCI-VL
Incident & Prevention Management On-Board	IPM-OB	This logical component is in the train and should substitute Train Driver and Train Attendant responsibilities for reacting in case of an incident (Incident and Prevention Management - Onboard). It manages safe reflexive reactions, computed reactions, and safety procedures in cooperation with IPM-TS and ISM. This logical component is primarily used in case of GoA3/4 but may also assist the train driver in GoA1/2 operations.	SCI-VL
ATO-Vehicle	AV	The ATO Vehicle (AV) application, deployed on the OCORA computing platform, is a non-safe application for Automatic train operations. A safe extension is needed for GoA3 and GoA4 operations. This is provided by the Automatic Train Protection Extension On-Board (ATPE-OB). The AV in GoA2 – GoA4 controls the vehicle’s speed, using information received through the interface SS126. It also communicates with the Vehicle Supervisor (VS) over the interface SS130 (between AV and ETCS Core). Remark: AV is called ATO-OB in GoA2 Shift2Rail SUBSET-125.	SCI-VL

Actor	Abbreviation	High-Level Description	Interface
Driver Advisory System On-Board	DAS-OB	The Driver Advisory System On-Board is an optional and non-safe application calculating an energy efficient speed profile to achieve the pre-planned and dynamically updated train timings. It generates detailed driver advice for adhering to the planned timings while driving energy efficient. The trackside Driver Advisory 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 is not needed if ATO Vehicle (AV) is installed, since the AV already includes the DAS functionality. The implementation of DAS application on the OCORA computing platform is an open issue to be solved in subsequent versions of this document (unsafe information displayed on the driver DMI).	SCI-VL
Mobile Object Transactor On-Board	MOT-OB	The logical component MOT-OB communicates with various CCS On-Board logical components and communicates with the MOT. The need for this component is an open issue to be solved in subsequent versions of this document.	SCI-VL
Digital Map On-Board	DM-OB	The logical component DM-OB is a safe service deployed on the OCORA computing platform. The DM-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 DM-OB uses its own On-Board data storage that is updated, if required, using the functionality of the Monitoring, Diagnostic, Configuration, Maintenance On-Board (MDCM-OB) to propagate trackside map data (e.g., from Topo4) to the On-Board data storage.	SCI-DM-OB
Monitoring, Diagnostic, Configuration, Maintenance	MDCM-OB	The logical component MDCM-OB deployed on the OCORA computing platform, collects data relevant for local (through the Maintenance Terminal or DMI) and remote diagnostic and monitoring. For local maintenance, it provides the relevant data upon request to the Maintenance Terminal or DMI in a standardised format. For remote diagnostics and monitoring the data can be sent to multiple recipients (e.g., the RU of the vehicle, the IM the vehicle currently operates in, the vehicle provider, the CCS On-Board provider etc.). The owner of the vehicle can define in the vehicle's configuration (refer to Configuration Data Storage) what data is forwarded to which recipient(s). The MDCM-OB also allows for local (through the Maintenance Terminal) and remote (through the centralised DCM services) configuration of the vehicle's devices (CCUs, Gateway, Peripherals, etc.). The component can process data received by the IMs (network related operational data) and the RU (vehicle related operational and configuration data). The service also allows the RU to execute commands (e.g., reboot of a specific component) and allows to install updates (e.g., new software).	SCI-MDCM-OB
Identity & Access Management On-Board	IAM-OB	The Identity & Access Management On-Board (IAM-OB) is a service deployed on the OCORA computing platform. It integrates with the IAM System 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 be split into separate 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 applications, 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 3DES or 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.	SAI-OB
Train Routing Info	TRI	An interlocked (safe) train path uniquely assigned to a train/vehicle. This information is seen useful to validate the determined position by the Vehicle Locator (VL) against track selectivity.	SCI-TRI

Actor	Abbreviation	High-Level Description	Interface
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).	SCI-TS-OB
Augmentation	AUG	Augmentation of a positioning system is a method 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).	SCI-AUG
Train Integrity Status Management	TIS	The Train Integrity Status Management is a safe component deployed on the OCORA computing platform or the OCORA gateway. It provides the train integrity status in a standardised fashion to the OCORA software components. To provide the train's integrity status, multiple options are possible: a) train integrity determination on the train (e.g., through the TCMS), b) second localisation unit at the end of the train with On-Board determination of the train integrity, and c) second localisation unit at the end of the train with trackside determination of the train integrity. The TIS component ensures that all CCS applications that need to know the train's integrity status (including the coupler statuses, if applicable) are receiving the information through a standardised interface, independent of the option used. The train integrity status also includes the total safe train length (including the safe length over coupled compositions).	SCI-TIS
Functional Vehicle Adapter	FVA	The Functional Vehicle Adapter (FVA) is a piece of software deployed on the OCORA computing platform, on a separate computing unit, or on the OCORA Gateway. Its job is to provide an OCORA unified and standardised interface (SCI-FVA) for the OCORA 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 interface 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 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.	SCI-VL
Passenger Info System Adapter	PISA	The Passenger Information System Adapter (PISA) is a non-safe piece of software deployed on the OCORA computing platform, or on the OCORA Gateway. Its job is to provide an OCORA unified and standardised interface towards the Cabin Voice Radio (CVR), allowing the PISA to receive CCS information of interest to the PIS.	SCI-VL
Trackside Condition Services	TCS	The Trackside Condition Services (TCS) is a non-safe component of the ETCS Core 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 Vehicle Locator (VL). 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.	SCI-VL
ETCS Driver Machine Interface	ETCS-DMI	The ETCS-DMI component provides the functionality for any user interaction with the ETCS On-Board system.	SCI-VL

Actor	Abbreviation	High-Level Description	Interface
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 Vehicle). 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 detail.	SCI-ODS
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, Diagnostic, Configuration, Maintenance (MDCM-OB) component. In subsequent versions of the OCORA specifications, the CDS will be specified in detail.	SCI-CDS
Environment	ENV	Environment provides information about conditions, influencing the railway operation. It can be trackside or vehicle based.	PI-VLS
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.	SCI-PETS
Virtual ETCS Transponder Service	VETS	The VETS component generates virtual ETCS telegrams based on the current location using the Digital Map On-Board (DM-OB).	SCI-VL
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.	SCI-CMD
Stand Still Detection	SSD	The logical component SSD is a vehicle-based function that detects if the train is standing still. Depending on the consumer of this information, different levels of stand-still thresholds may apply. Remark from discussions with RCA: The SSD information is needed by the RCA-APS and must be provided by the vehicle. An example is the flank protection. It may be useful that a parked vehicle provides flank protection. The RCS-APS would need to know whether or not a vehicle is parked (SSD signal). There might be other scenarios where SSD information is needed/useful for RCA-APS (some of them already exist today). But for those scenarios it is not sufficient to report v=0, since this information is currently only reported in a resolution of 5 km/h, but RCA-APS would need to have a confirmed v=0 (performance and SIL-level currently unknown).	SCI-VL
Signal Converter	SCV	The Signal Converter (SCV) is in the train and converts the information coming from optical signals into SUBSET-026 compliant information.	SCI-VL

Table 1 List of LOC-OB actors and related interfaces

5 Implementation variants

In this section, the impact of inputs considered not mandatory for the LOC-OB system for OCORA Release 1.0 are briefly analysed and discussed.

The table is to be read as follows: *What is the impact/limitation on the LOC-OB system with or without "xyz" (e.g., TIS) information available.*

Component	With	Without
Train Integrity Status Management (TIS)	Safe train length and train integrity status from the Train Integrity Status Management (TIS) are critical inputs for LOC-OB to facilitate "cab anywhere supervision" in the future.	The LOC-OB must be physically located in the very first (leading) vehicle.
Digital Map On-Board (DM-OB) and Train Routing Info (TRI)	Digital maps together with Routing Information can be used as supporting information by the sensor fusion logic of the LOC-OB to fix positioning errors arising in GNSS/INS sensors (e.g., due to the gradient and curve of the tracks) and in general to improve the LOC-OB positioning performance when using GNSS/INS sensors. In addition, digital maps are considered as critical inputs needed by LOC-OB for safe absolute train positioning.	Errors arising in GNSS/INS sensors (e.g., due to gradient and curve of the tracks) cannot be properly addressed and might adversely impact the LOC-OB positioning performance.
Cold Movement Detection (CMD)	The last stored position and movement indicator provided by CMD is used to shorten the time needed to initialize the LOC-OB system after awakening from a non-power mode. Note: In the future, if the LOC-OB is 'always ON' then the CMD may not be necessary.	Increased initialisation time of the LOC-OB system until safe and preferably accurate localisation output is produced.
Augmentation (AUG)	A LOC-OB that uses GNSS sensors for safe absolute train positioning needs GNSS augmentation data (e.g., EGNOS) in order to improve the positioning accuracy and the safety logic.	Both safety and positioning performance of the safe absolute train positioning output of LOC-OB, making use of GNSS sensors, will be adversely impacted if no GNSS augmentation service is available/used.

Table 2 Implementation variants describing the impacts of the optional LOC-OB actors

Appendix A Large scale graphics

A1 Logical architecture for CCS-OB – Viewpoint CCS-OB

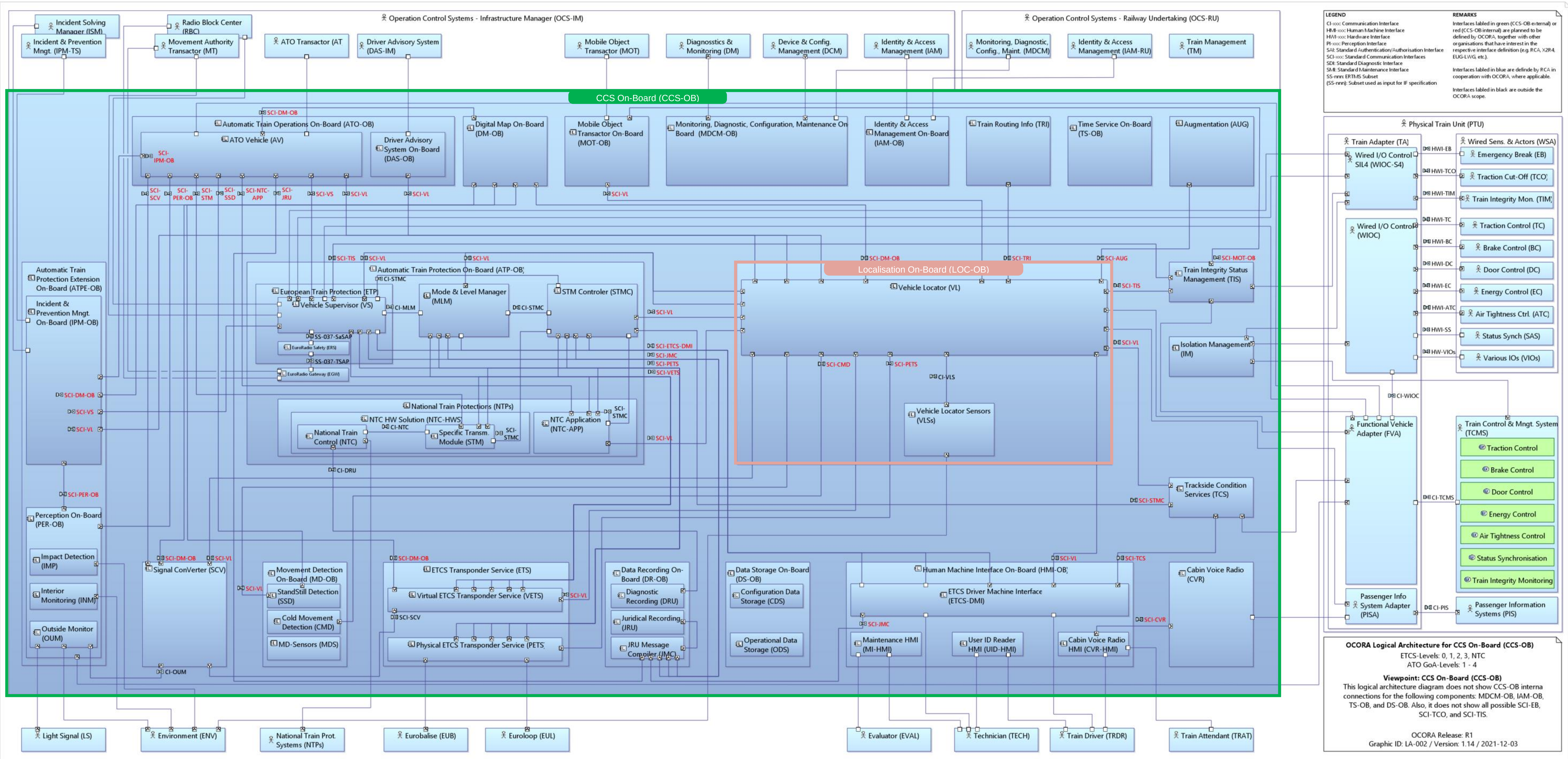


Figure 5 CCS-OB logical architecture – Viewpoint CCS-OB (large scale graphic)

A2 Logical architecture for CCS-OB – Viewpoint LOC-OB

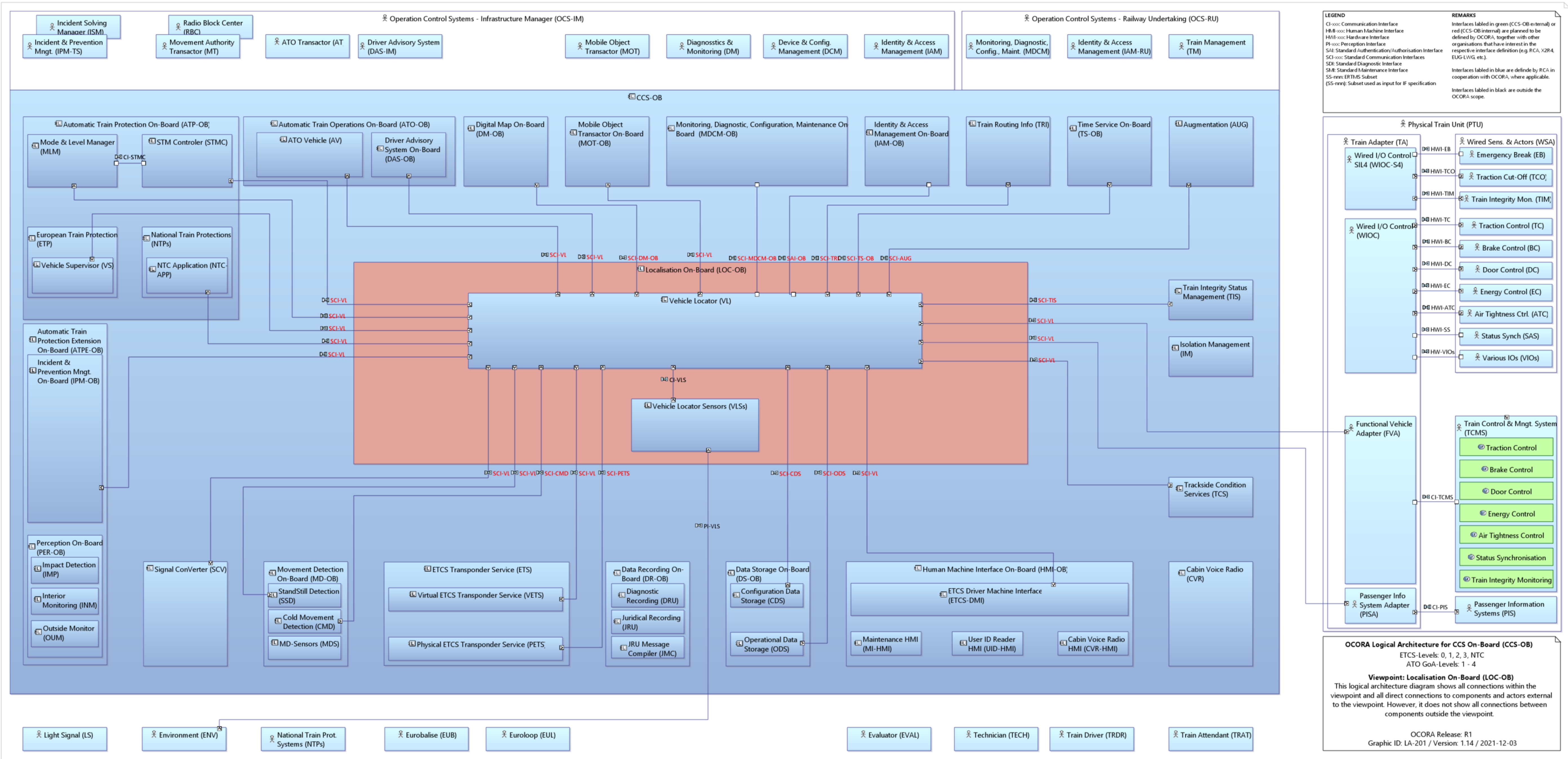


Figure 6 CCS-OB logical architecture – Viewpoint LOC-OB (large scale graphic)