

# OCORA

Open CCS On-Board Reference Architecture  
A Collaboration of 5 European Railway Undertakings



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## Technical Slide Deck

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- OCORA Roadmap
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  - Train Integration Scenarios
  - Network Topology Scenarios
- Safe Computing Platform (SCP)
- Configuration Management Concept
- Functional Vehicle Adapter (FVA)
- Modular Safety
- Methodology & Tooling
- Operational Concept



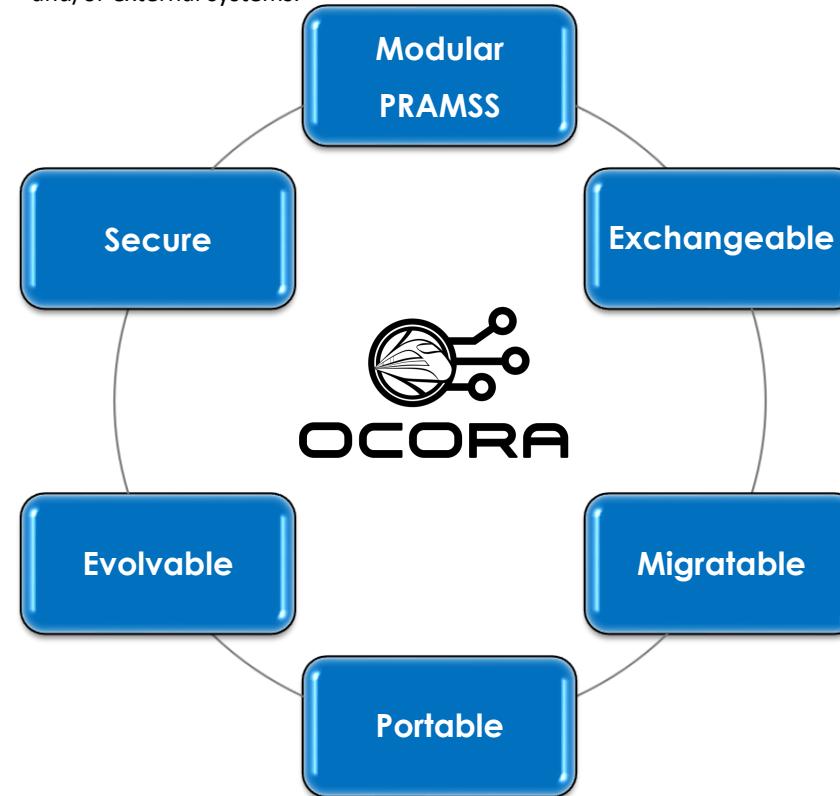
# OCORA Design Objectives

OCORA-BWS02-030 / v5.10 / 01.07.2024

**Ability to protect the CCS On-Board from attacks.** In context of OCORA security means the protection of (especially safety related communication and data used in) CCS on-board systems against threats (in particular cyber-attacks and hacks). To achieve this, all main security functionality like identify, protect, detect, respond and recover are considered.

**Ability to easily adapt the CCS On-Board to new technologies and to easily add new Building Blocks.** In the context of OCORA evolvability means the ability to easily adopt to new technologies or to extend the functionality of an on-board CCS system without the involvement of the original supplier.

**A reasonable number of Building Blocks are defined for CCS On-Board.** Each Building Blocks has 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.



**Ability to port CCS On-Board Software Building Blocks (software applications) from one computing platform to another.** In the context of OCORA portability is achieved when a functional application, based on the generalized abstraction, runs un-changed on different (computing) platform implementations. For this, the functional application shall only use external functions through a defined application programming interface (API).

**Ability to replace CCS On-Board Building Block.** In the context of OCORA exchangeability means the ability to replace one or multiple OCORA defined building blocks with (a) respective building block(s) of (an)other supplier(s), without affecting other building blocks of the train or the overall CCS on-board system.

**Ability to introduce changes to any CCS On-Board Building Block.** In the context of OCORA migrateability is the ability to introduce changes (bug-fixes, improvements, new functionality) to one or multiple OCORA defined building blocks, without affecting other building blocks or the overall CCS on-board system.



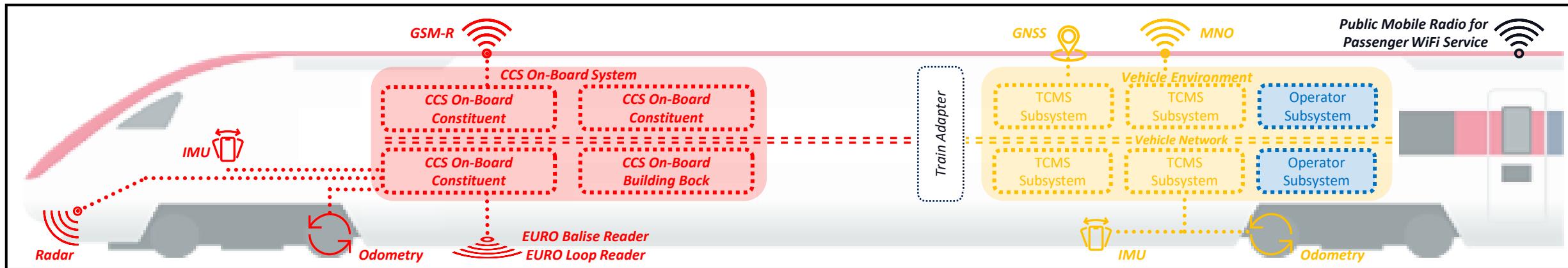
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# OCORA Roadmap

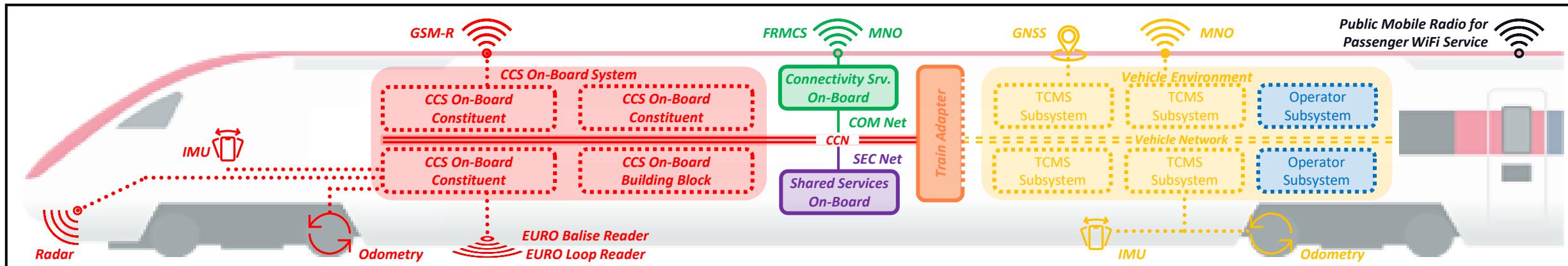
OCORA-BWS02-030 / v5.10 / 01.07.2024

# Technical Roadmap – Current Situation



## Step 0: Current Situation (TSI 2016)

Today, the proprietary CCS On-Board System (marked in red) is fully integrated in the proprietary Vehicle Environment (marked in yellow), complicating the life-cycle and obsolescence management of the CCS On-Board System.



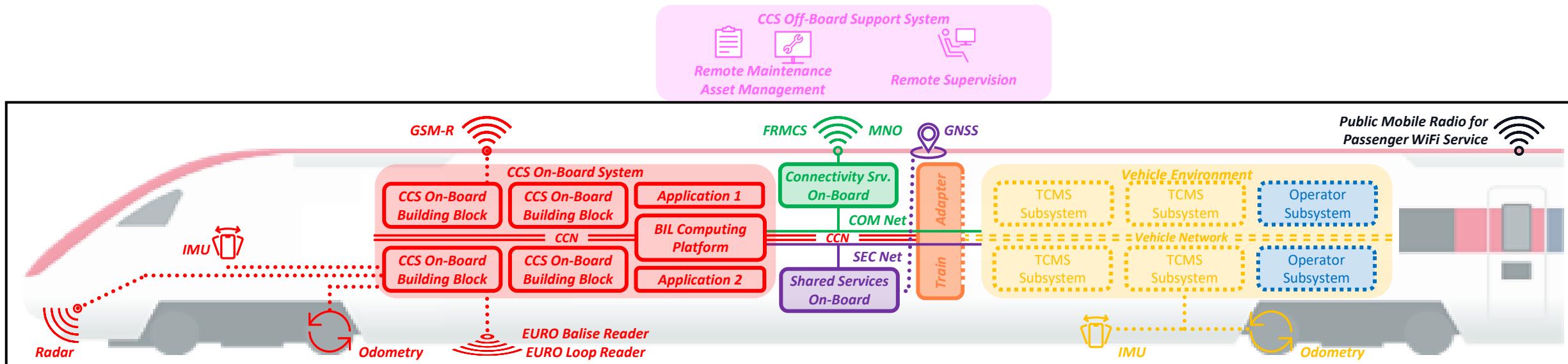
## Step 1: TSI CCS 2023

The interface between the proprietary CCS On-Board System and the Vehicle Environment is unambiguously standardised. The standardized CCS Communication Network (CCN) is available. The Connectivity Services over FRMCS or MNO are available for all (CCS) subsystems on a train. Shared Services provide synchronized time and continuous absolute localisation, and other means to allow secure operations. First version of the On-Board Monitoring System is available as part of the shared services.

### Benefits:

- Allows for a product-based approach for CCS-OB.
- Allows pre-certification (generic application) for TCMS.
- Basis for modularisation of CCS-OB.
- Single communication system for all on-board applications.
- Efficient solution for shared services such as:
  - Time Synchronisation.
  - Continuous absolute localisation.
  - Diagnostics.
  - Cyber-Security.

# Technical Roadmap Step 2 – Mid-Term



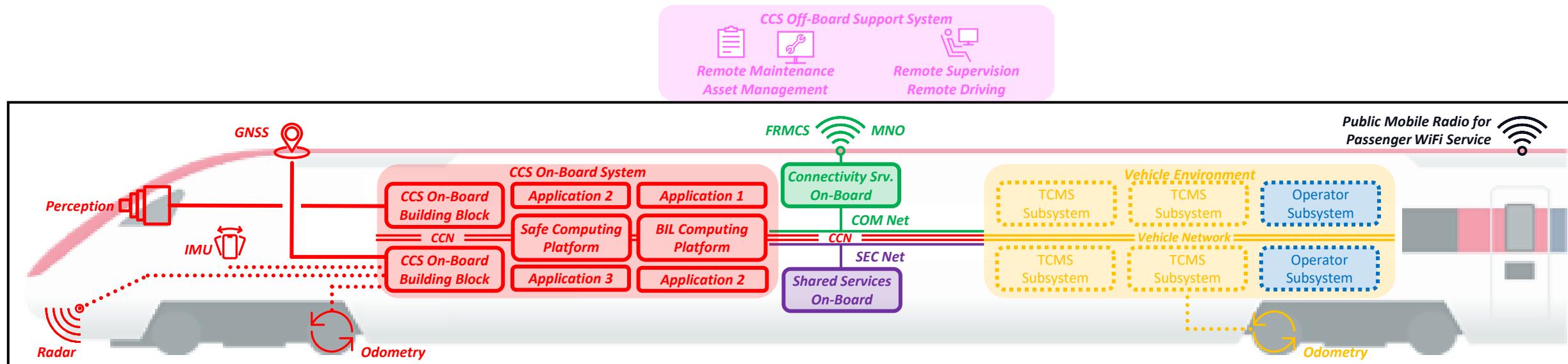
Step 2: Mid-Term (e.g. TSI >2023)

The CCS On-Board System consists of a reasonable number of Building Blocks. The CCS On-Board Building Blocks communicate with each other, with the Vehicle Subsystems and any Off-Board System via a fully standardized CCS Communication Network (CCN). Shared services support Remote Supervision, Remote Maintenance, and digitalized Asset Management.

## Benefits:

- Facilitates efficient maintenance.
- Allows for efficient asset management.
- Basis for a more efficient homologation.
- Allows for a product based approach for CCS-OB constituents.
- Allows pre-certification (generic product) for CCS-OB constituent.

# Technical Roadmap Step 3 – Vision



## Step 3: Vision

The standardised CCS On-Board Communication Network (CCN) is fully integrated with the Vehicle Network, allowing to interface from any CCS On-Board Application directly with any Vehicle Subsystems and vice-versa. The need for a Train Adapter vanishes and certain Applications from the Vehicle Environment may be hosted on the CCS On-Board BIL (Basic Integrity Level) Computing Platform.

The ATO functionality is fully developed and standardised up to GoA 3/4.

Due to the increased performance of the CCS On-Board localisation through better sensor fusion algorithms, the use of GNSS localisation, digital map data, and augmentation data, the EURO Balise and EURO Loop readers are not needed anymore.



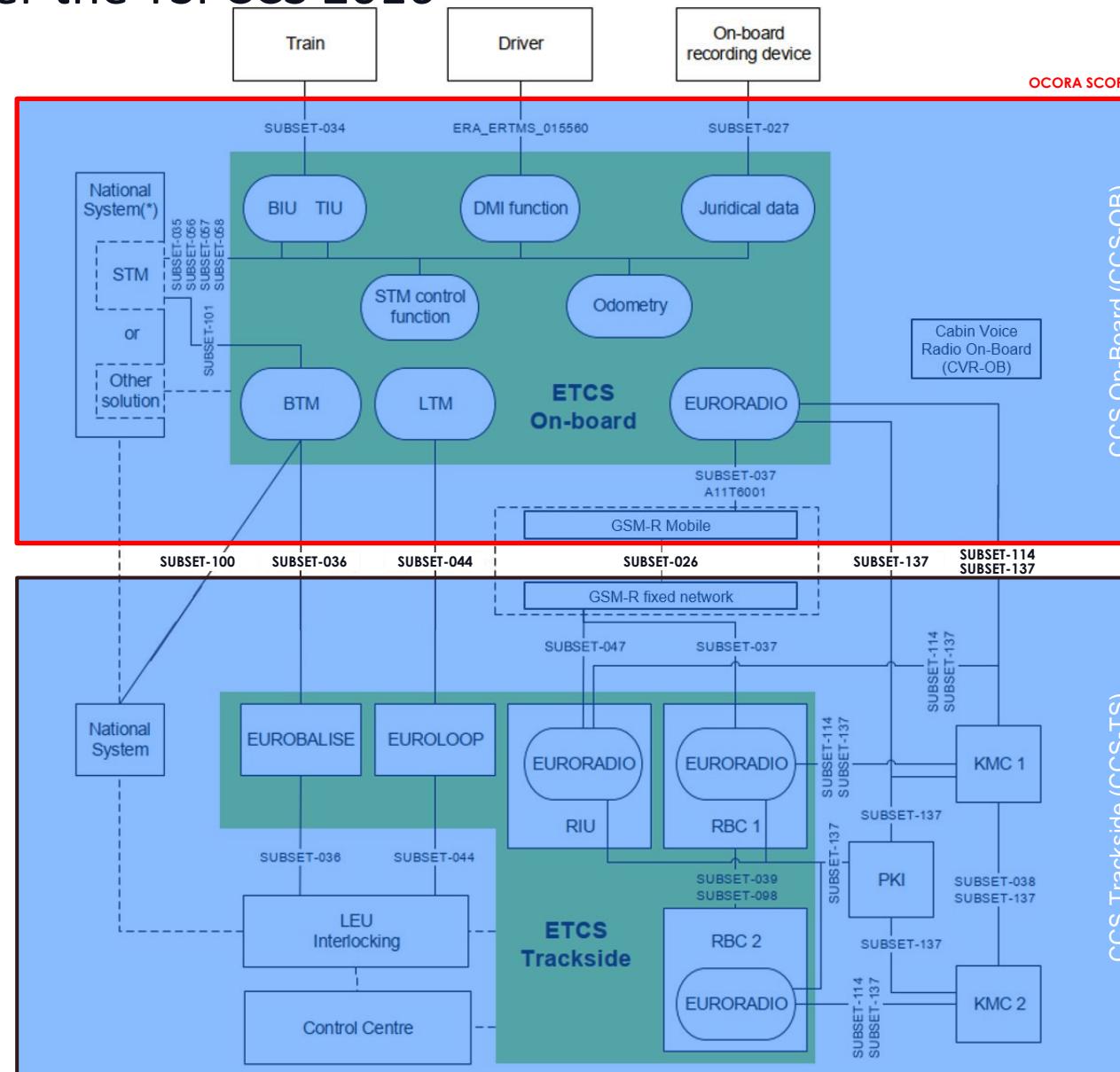
# Modularisation Roadmap Proposal

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# Modularisation as per the TSI

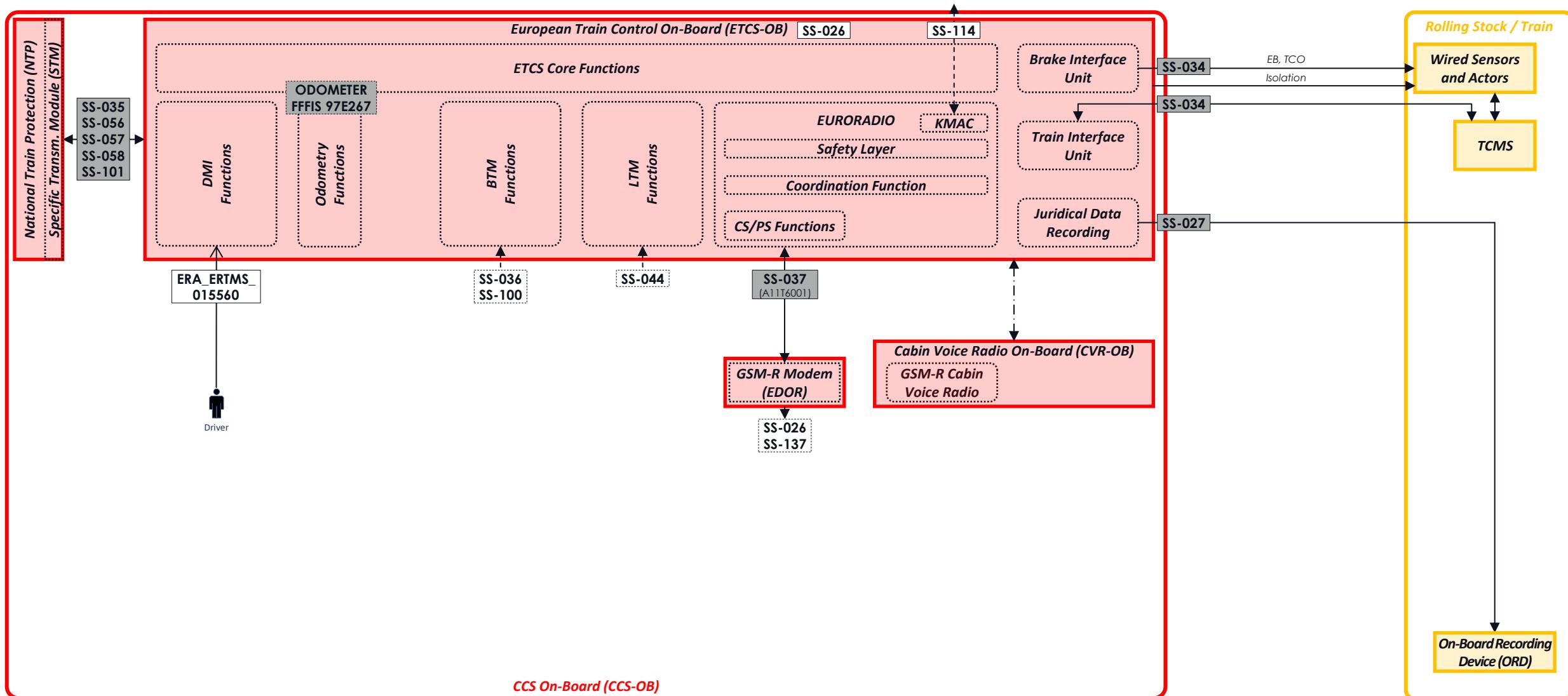
# Modularisation as per the TSI CCS 2016



# Modularisation as per TSI 2016 (amended in 2019 & 2020)



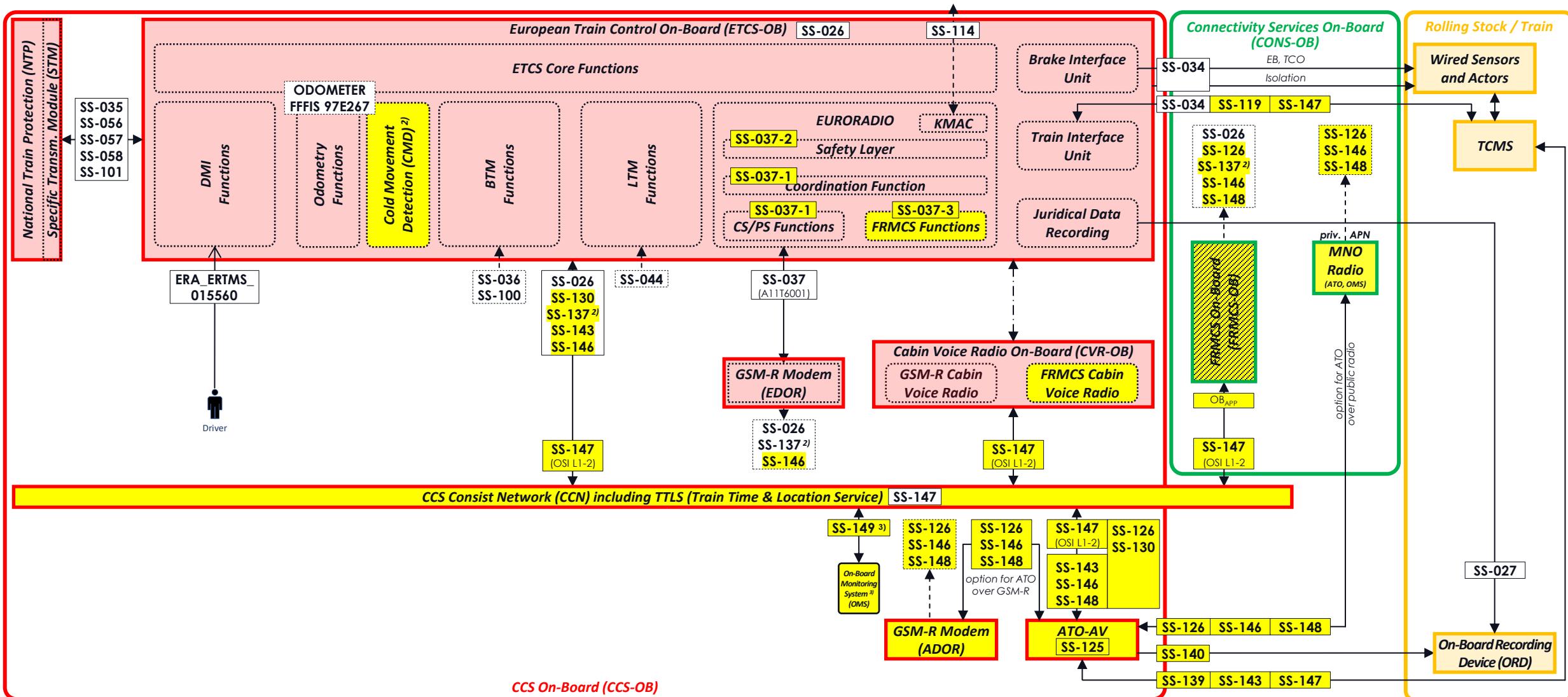
Functionality Level: ETCS and Cab Voice



# Modularisation as per TSI 2023<sup>1)</sup> (newly developed vehicle designs, requiring first authorisation)



Functionality Level: ETCS, Cab Voice, FRMCS (ready), ATO (GoA 1-2)



**Yellow marks**

changes introduced compared to TSI 2016

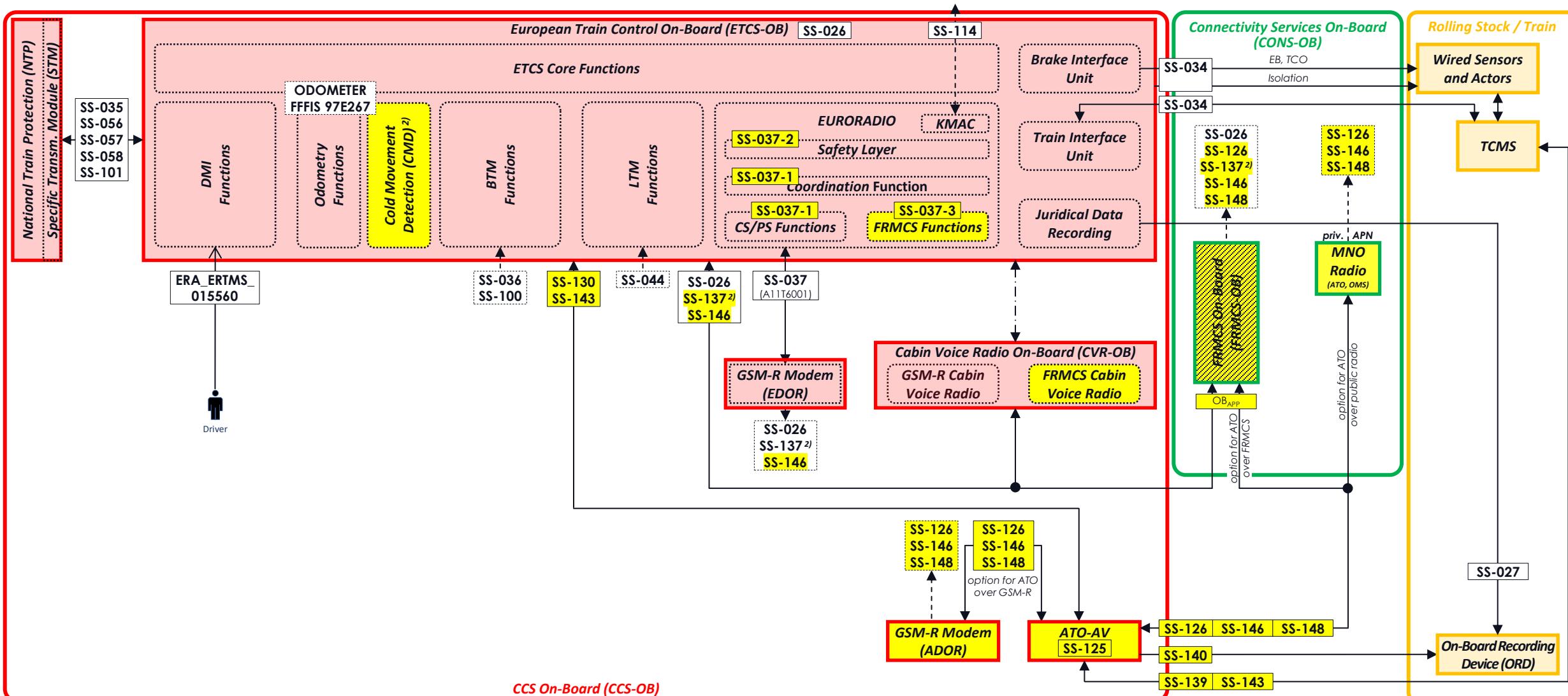
**Yellow diagonal stripes**

Not fully specified with TSI 2023 / FRMCS BLO

# Modularisation as per TSI 2023<sup>1)</sup> (existing vehicle designs)



Functionality Level: ETCS, Cab Voice, FRMCS (ready), ATO (GoA 1-2)



1) Including amendments for FRMCS

2) refer to related transition regime



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# OCORA Modularisation Roadmap Proposal

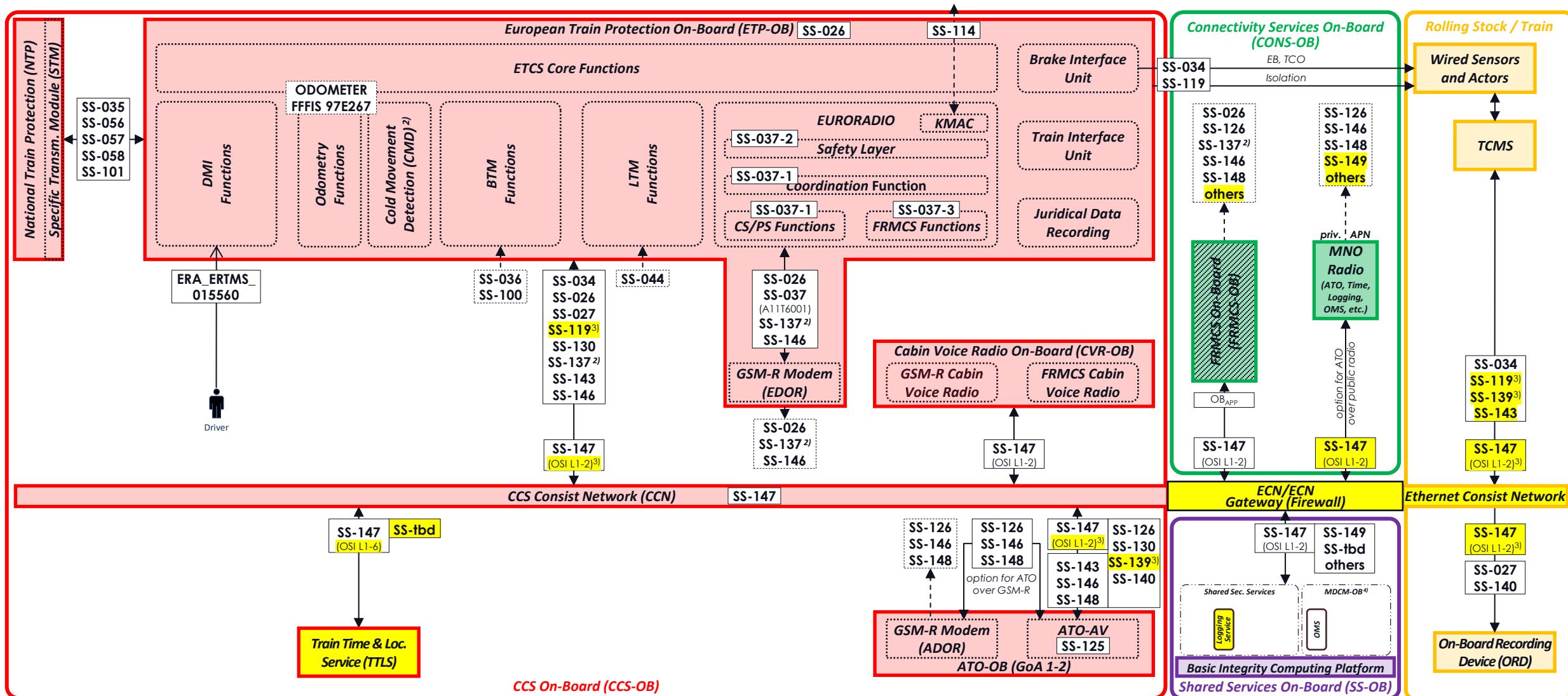
for new vehicles  
(based on TSI 2023)

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OCORA Modularisation proposal based on TSI 2023<sup>1)</sup> (new vehicles)



Functionality Level: ETCS, Cab Voice, FRMCS ready, ATO (GoA 1-2)



**Yellow marks** changes introduced compered to TSI 2023

 Not fully specified with TSI 2023 / FRMCS BLOC

OCORA

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SEARCHED INDEXED SERIALIZED FILED

----- logical grouping

-----> data exchange with track-side

→ optional, vendor specific integration

..... subsystem / function within a building block

## 1) Including amendments for FRMCS

2) refer to related transition regime

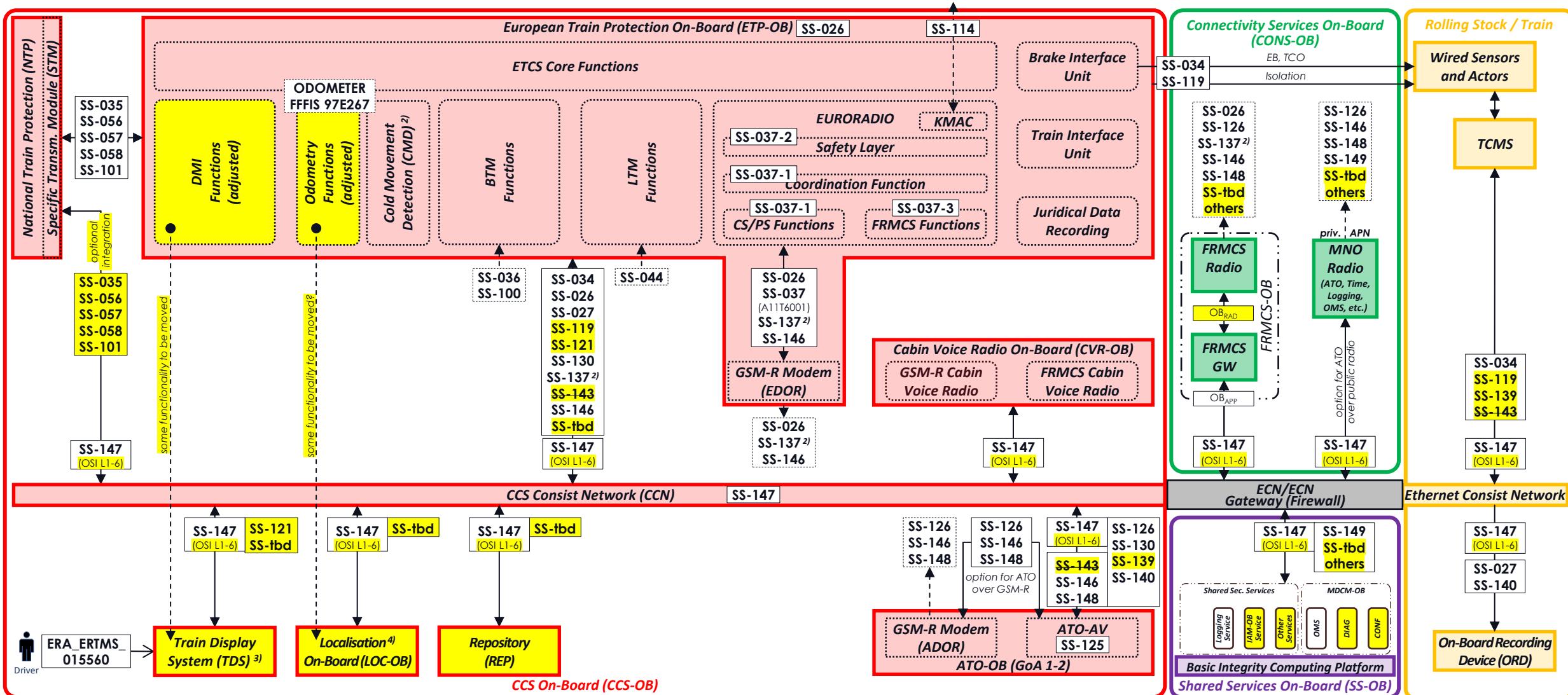
### 3) incl. OCORA addendum

4) incl. OCORA addendum

# OCORA Modularisation proposal for TSI >2023 (new vehicles)



Functionality Level: ETCS, Cab Voice, FRMCS, ATO (GoA 1-2), MDCM, TDS, LOC-OB, Shared Sec. Services, etc.



OCORA

Yellow marks

changes introduced to OCORA proposal, based on TSI 2023

OCORA-BWS02-030 / v5.10 / 01.07.2024

logical grouping

data exchange with track-side

optional, vendor specific integration

subsystem / function within a building block

4) LOC-OB includes the time service, but discussion is ongoing in ERJU to confirm this.

MDCM-OB: Monitoring, Diagnostics, Configuration, Maintenance On-Board

1) Including amendments for FRMCS

2) refer to related transition regime

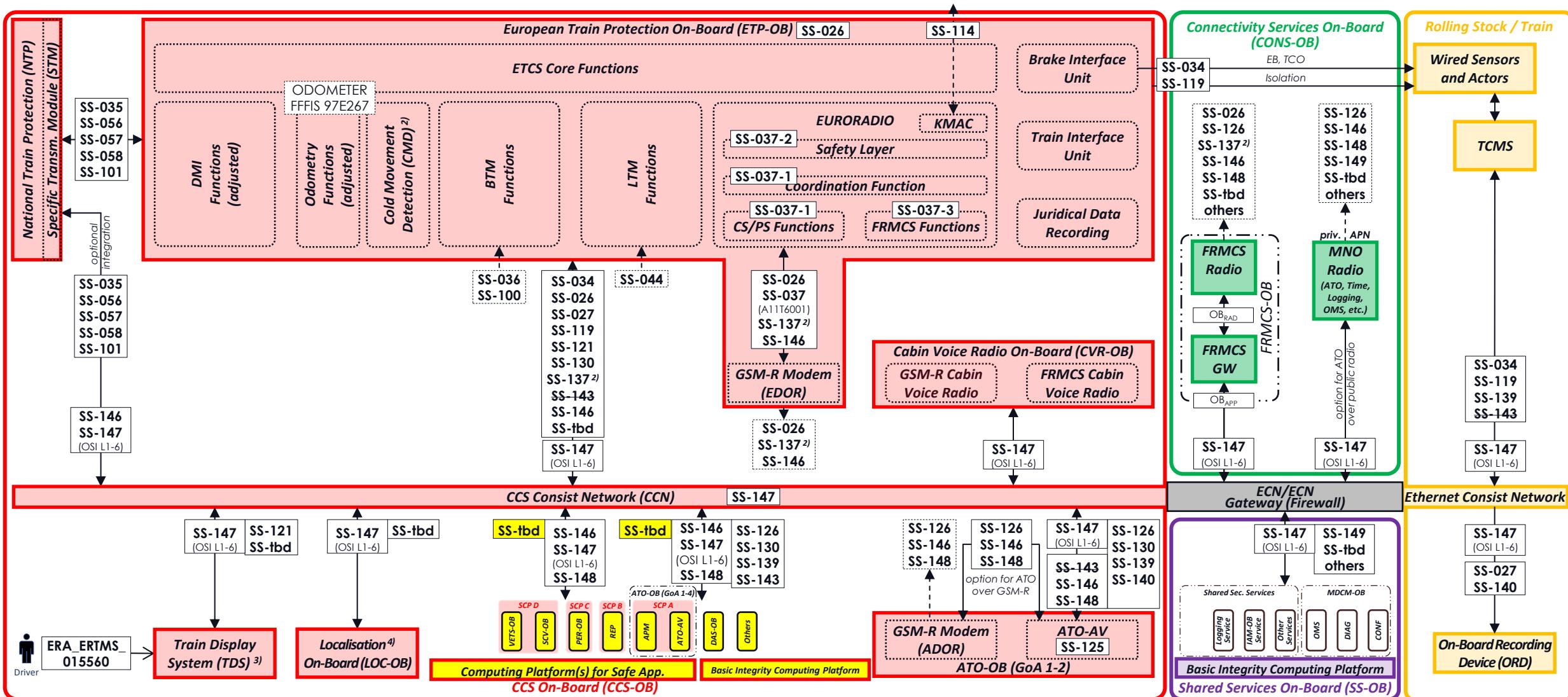
3) May be moved outside of CCS-OB

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# OCORA Modularisation proposal for TSI >>2023 (new vehicles)



Functionality Level: ETCS, Cab Voice, FRMCS, ATO (GoA 1-4), MDCM, TDS, LOC-OB, Shared Sec. Services, DM, etc.



OCORA

Yellow marks

changes introduced to OCORA proposal, based on TSI 2025/26

OCORA-BWS02-030 / v5.10 / 01.07.2024

logical grouping

data exchange with track-side

optional, vendor specific integration

subsystem / function within a building block

4) LOC-OB includes the time service, but discussion is ongoing in ERJU to confirm this.

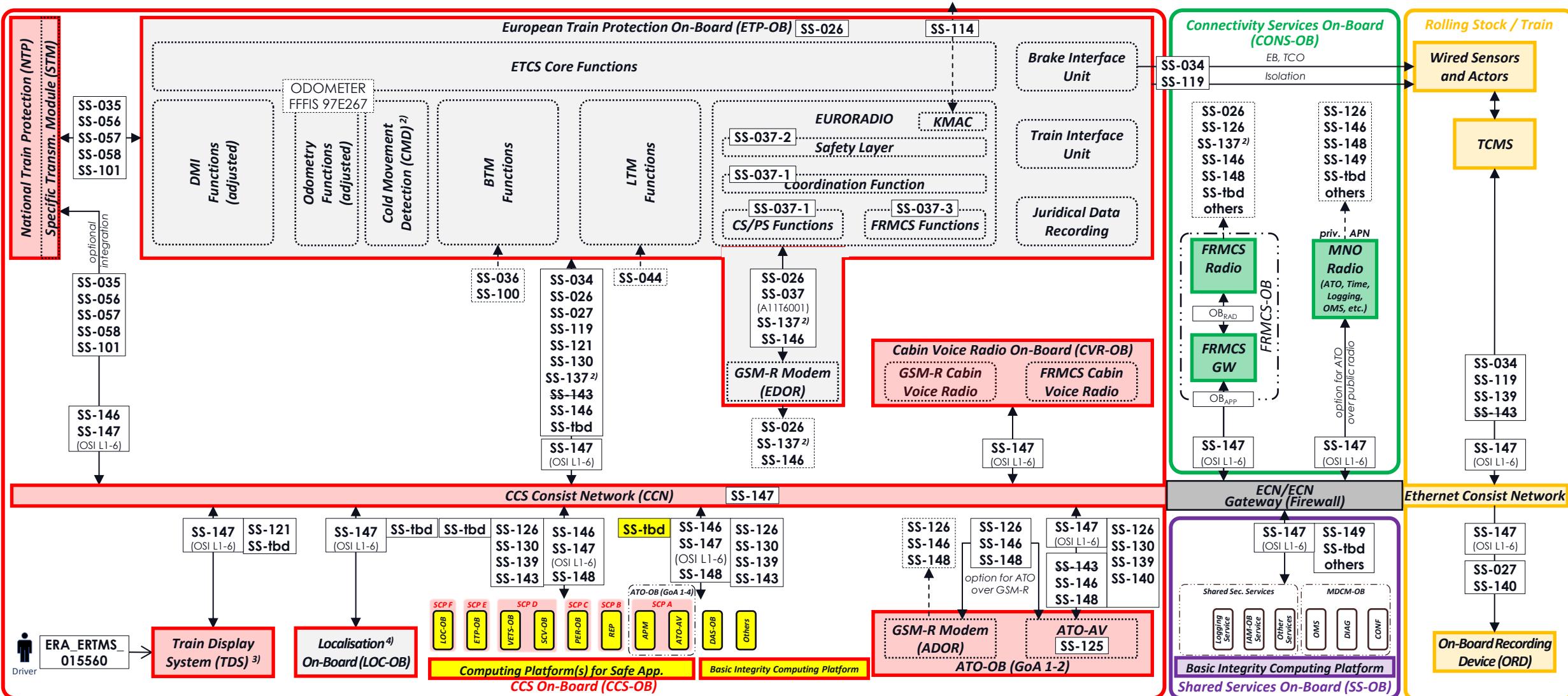
1) Including amendments for FRMCS

2) refer to related transition regime

3) May be moved outside of CCS-OB

MDCM-OB: Monitoring, Diagnostics, Configuration, Maintenance On-Board 19

Functionality Level: ETCS, Cab Voice, FRMCS, ATO (GoA 1-4), MDCM, TDS, LOC-OB, Shared Sec. Services, DM, etc.



logical grouping

data exchange with track-side

optional, vendor specific integration

subsystem / function within a building block

4) LOC-OB includes the time service, but discussion is ongoing in ERJU to confirm this.

1) Including amendments for FRMCS

2) refer to related transition regime

3) May be moved outside of CCS-OB



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# OCORA Modularisation

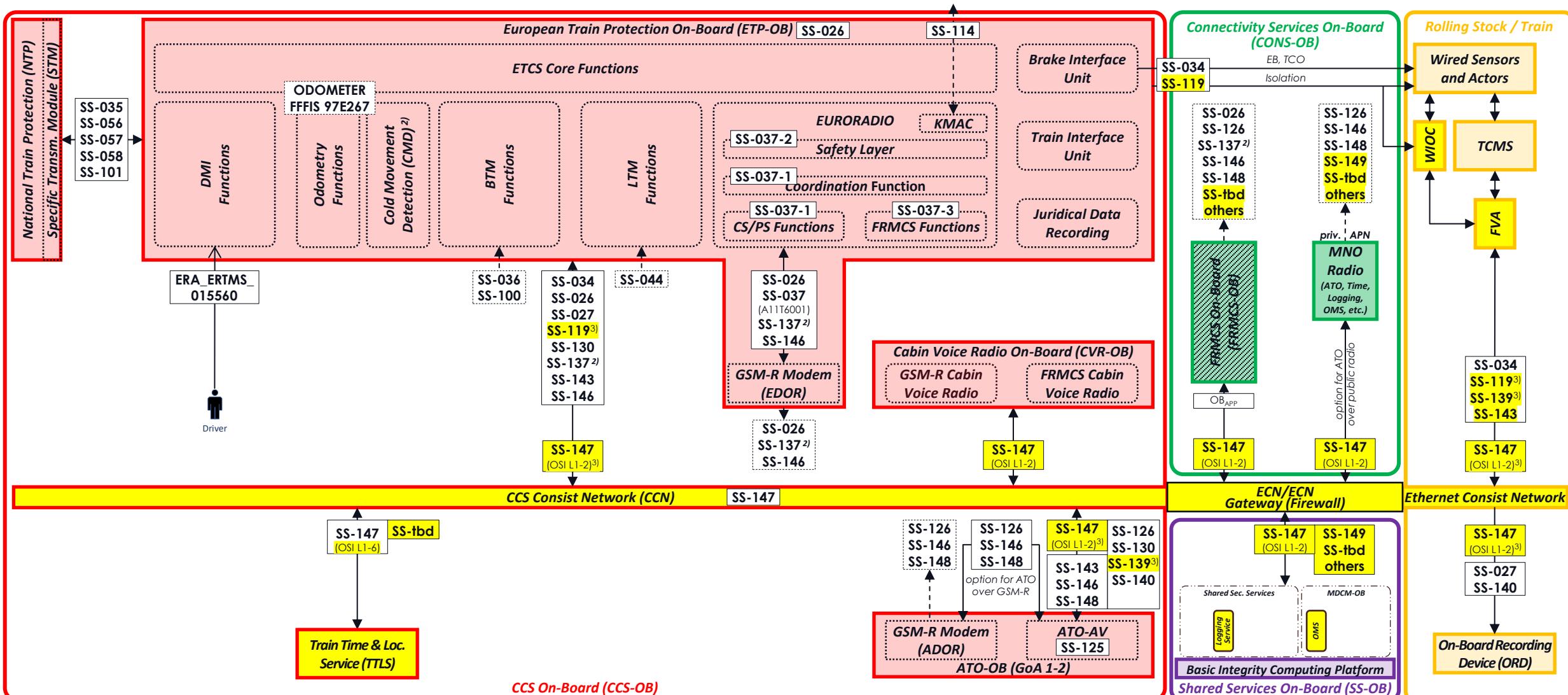
for ETCS upgrades & updates of vehicles in operation  
(based on TSI 2023)

OCORA-BWS02-030 / v5.10 / 01.07.2024

# OCORA Modularisation proposal based on TSI 2023<sup>1)</sup> (vehicles in operations)



Functionality Level: ETCS, Cab Voice, FRMCS (ready), ATO (GoA 1-2)



Yellow marks

changes introduced compared to TSI 2023



Not fully specified with TSI 2023 / FRMCS BLO



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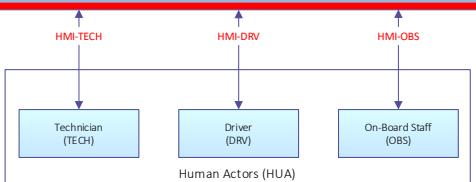
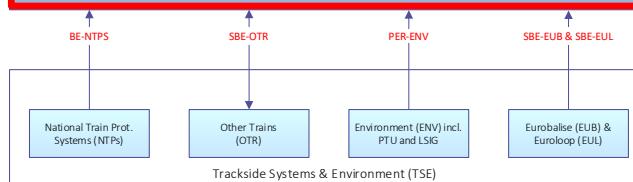
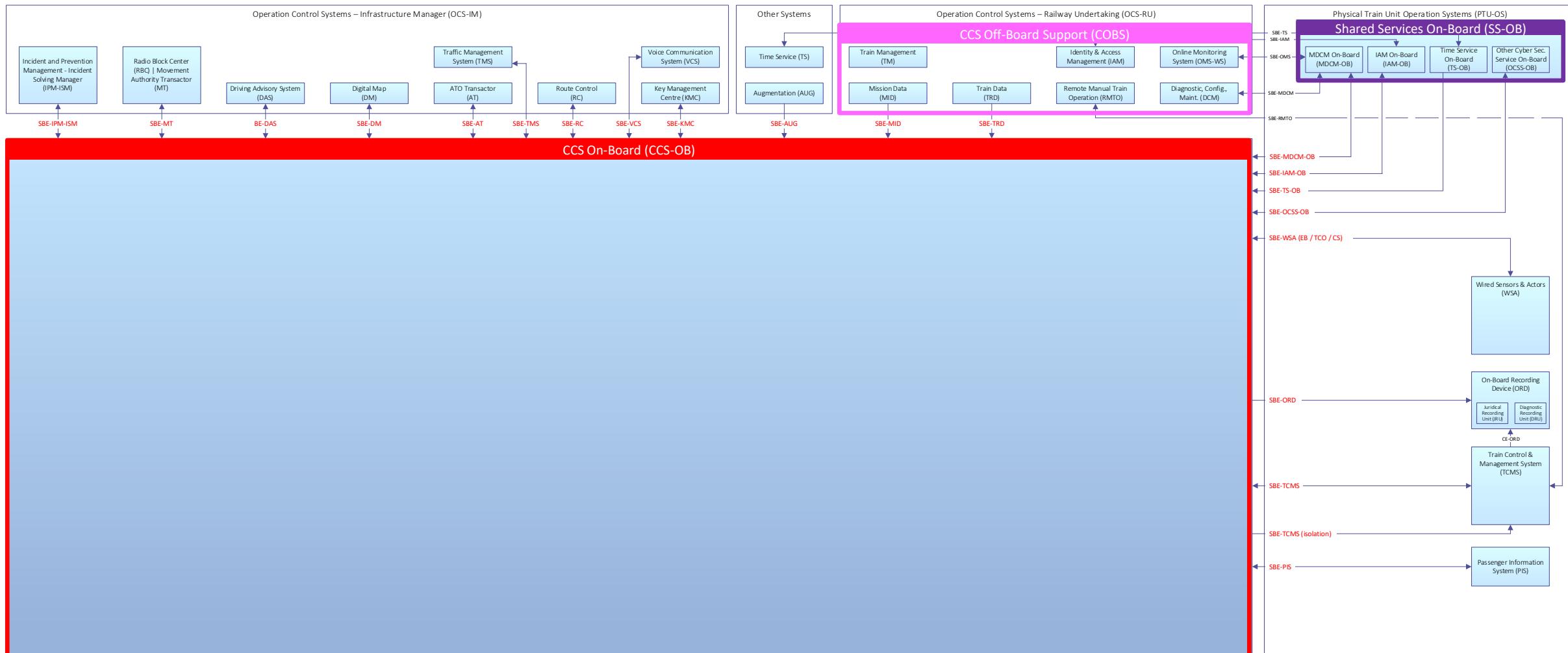


# OCORA Scope

## Logical & Physical Architecture

OCORA-BWS02-030 / v5.10 / 01.07.2024

# Logical Architecture – Scope & Context (New Generation Train)



API	Application Programming Interface
CCN	CCS Consist Network
CCU	CCS Computing Unit
BE	(Building) Block Exchange
CON-OB	Connectivity On-Board
HMI	Human Machine Interface
LSIG	Light Signals
MCG	Mobile Communication Gateway (Public Network)
MCU	Main Computing Unit
NG	New Generation
OPN	Operations Network
PER	Perception
SBE	Standard (Building) Block Exchange
SS-nnn+	SUBSET-nnn amended by OCORA
SS-OB	Shared Services On-Board
OPN	Operations Network
PTU	Physical Train Unit
TCN	Train Communication Network
UIC	International Union of Railways
UID	User Identification

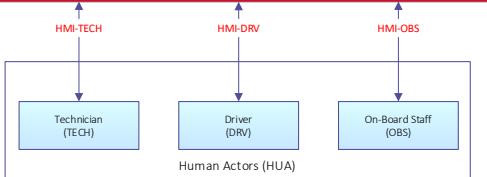
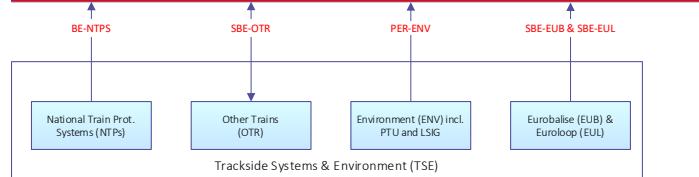
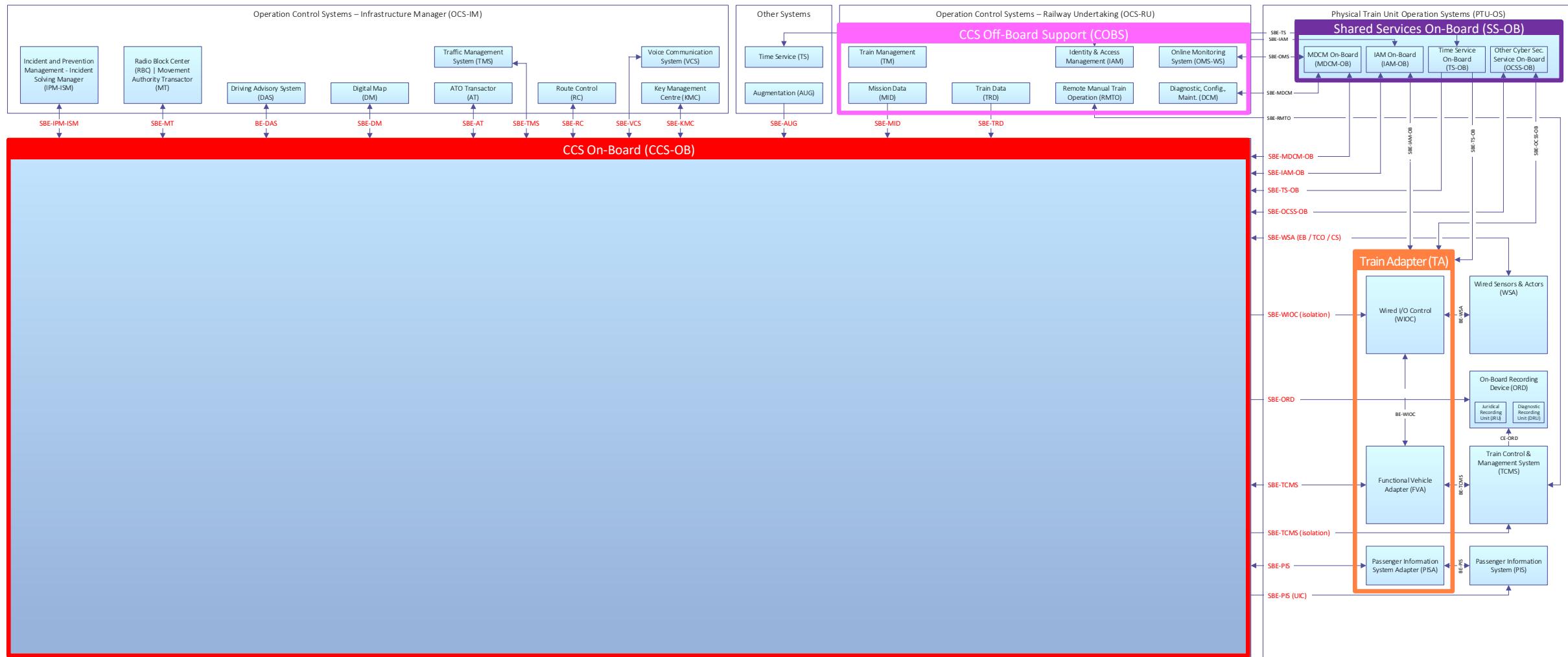
OCORA Architecture  
ETCS-Levels: 0, 1, 2, 3, NTC / ATO GoA Levels: 1 - 4  
**CCS On-Board (CCS-OB) – Logical Architecture**  
Logical Scope & Context  
New Generation Train  
(TCMS compliant with SS-119+, SS-139+, SS-147+)  
Graphic ID: LA-000-NGT Version 6.00 / 2024-05-30



# Logical Architecture – Scope & Context (Legacy Train Example)



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PI	Application Programming Interface	C
CN	CCS Consit Network	F
CU	CCS Computing Unit	F
E	(Building) Block Exchange	S
ON-OB	Connectivity On-Board	S
MI	Human Machine Interface	C
SIG	Light Signals	F
ICG	Mobile Communication Gateway (Public Network)	T
ICU	Main Computing Unit	L
G	New Generation	U

- Operations Network
- Perception
- Standard (Building) Block Exchange
- SUBSET-nnn amended by OCORA
- nn+ Shared Services On-Board
- B Operations Network
- Physical Train Unit
- Train Communication Network
- International Union of Railways
- User Identification

OCORA Architecture  
ETCS Levels: 0, 1, 2, 3, NTC / ATO GoA Levels: 1-4

CCS On-Board (CCS OB) – Logical Architecture

## CCS On-Board (CCS-OB) – Logical Architecture

### Logical Scope & Context

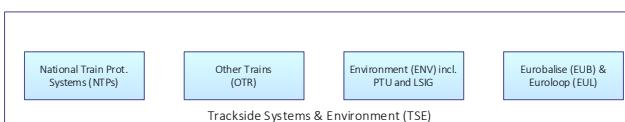
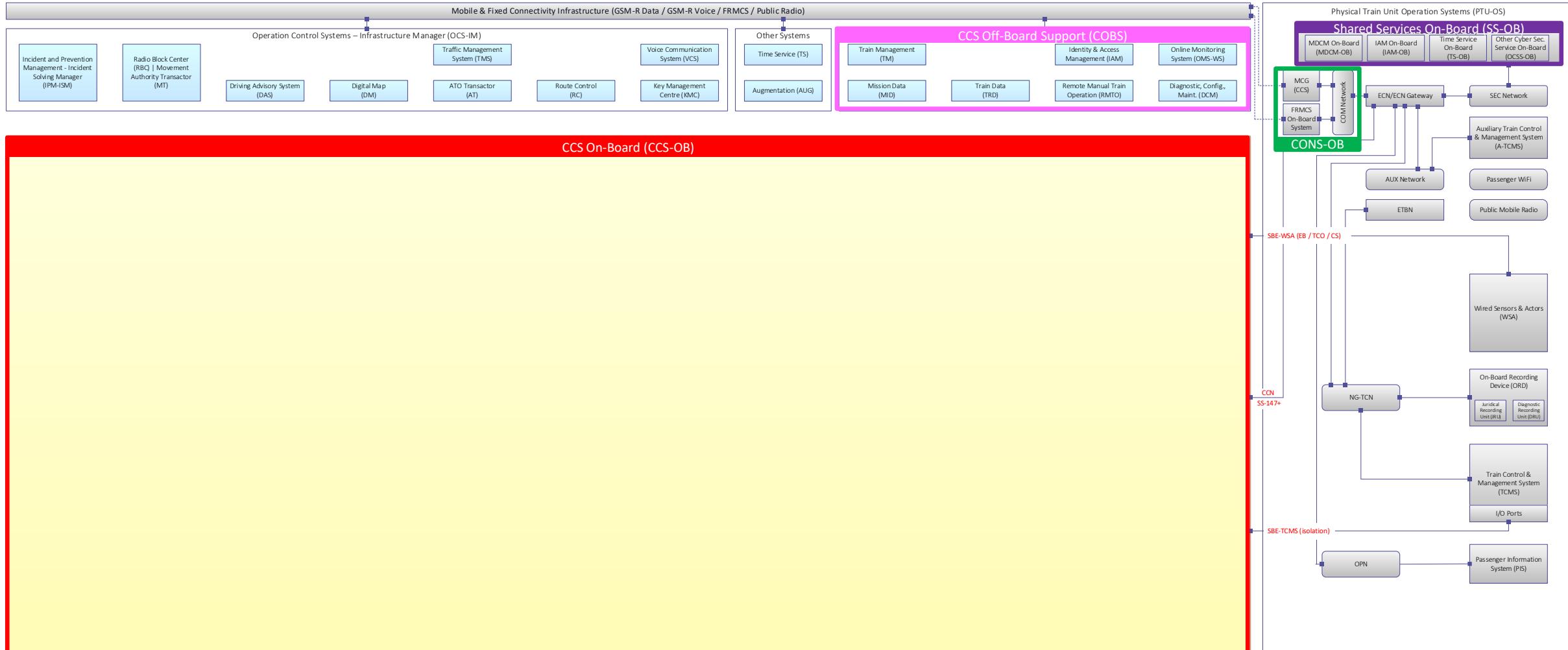
Legacy Train Example

(TCMS not compliant with SS-119+, SS-139+, SS-147+)

c ID: LA-000-LTE Version 6.00 / 2024



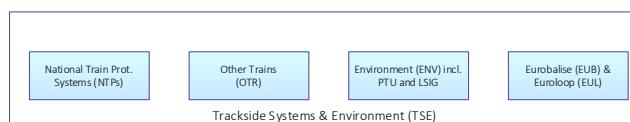
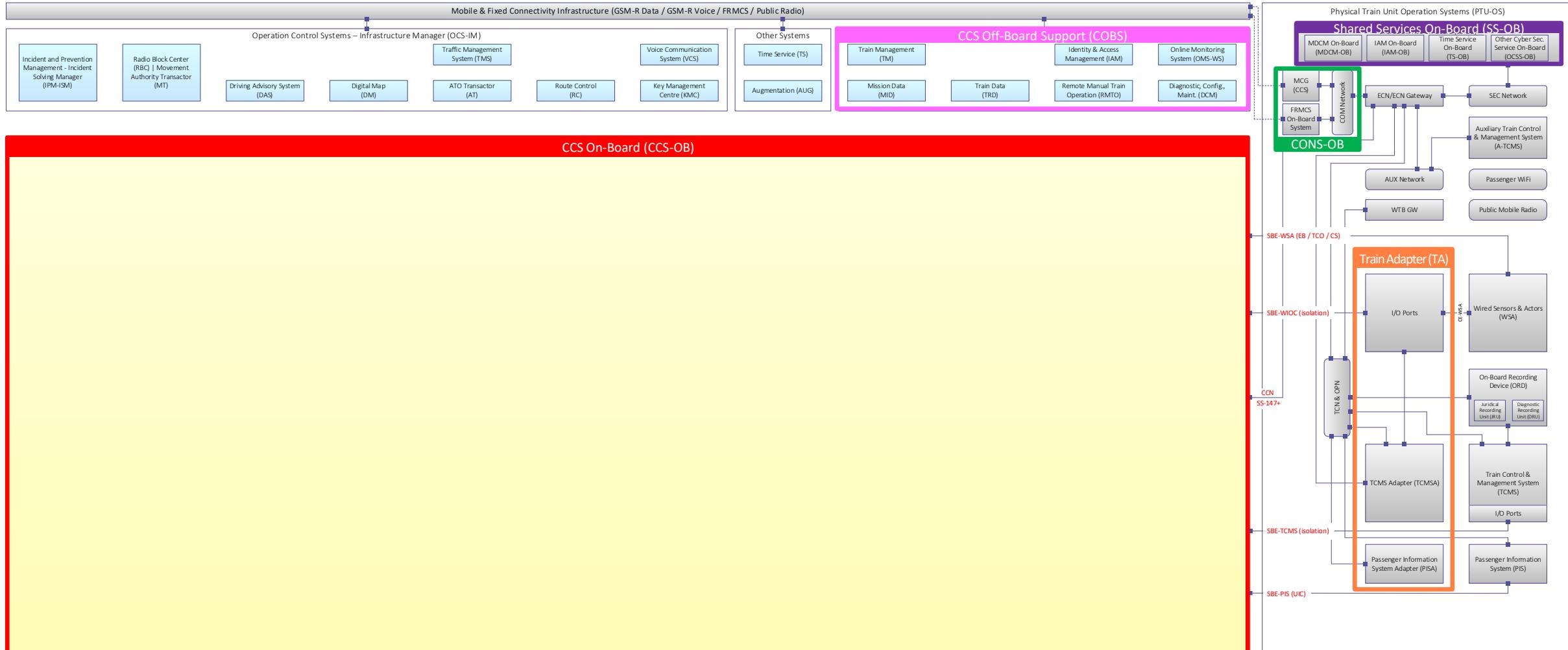
# Physical Architecture – Scope & Context (New Generation Train)



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OCORA Architecture  
ETCS-Levels: 0, 1, 2, 3, NTC / ATO GoA Levels: 1 - 4  
**CCS On-Board (CCS-OB) – Physical Architecture**  
Physical Scope & Context  
New Generation Train  
(TCMS compliant with SS-119+, SS-139+, SS-147+)  
Graphic ID: PA-000-NGT Version 6.00 / 2024-05-30

# Physical Architecture – Scope & Context (Legacy Train Example)



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ETCS-Levels: 0, 1, 2, 3, NTC / ATC GoA Levels: 1 - 4  
**CCS On-Board (CCS-OB) – Physical Architecture**  
Physical Scope & Context  
Legacy Train Example  
(TCMS not compliant with SS-119, SS-139, SS-147+)

Graphic ID: PA-000-LTE      Version 6.00 / 2024-05-30



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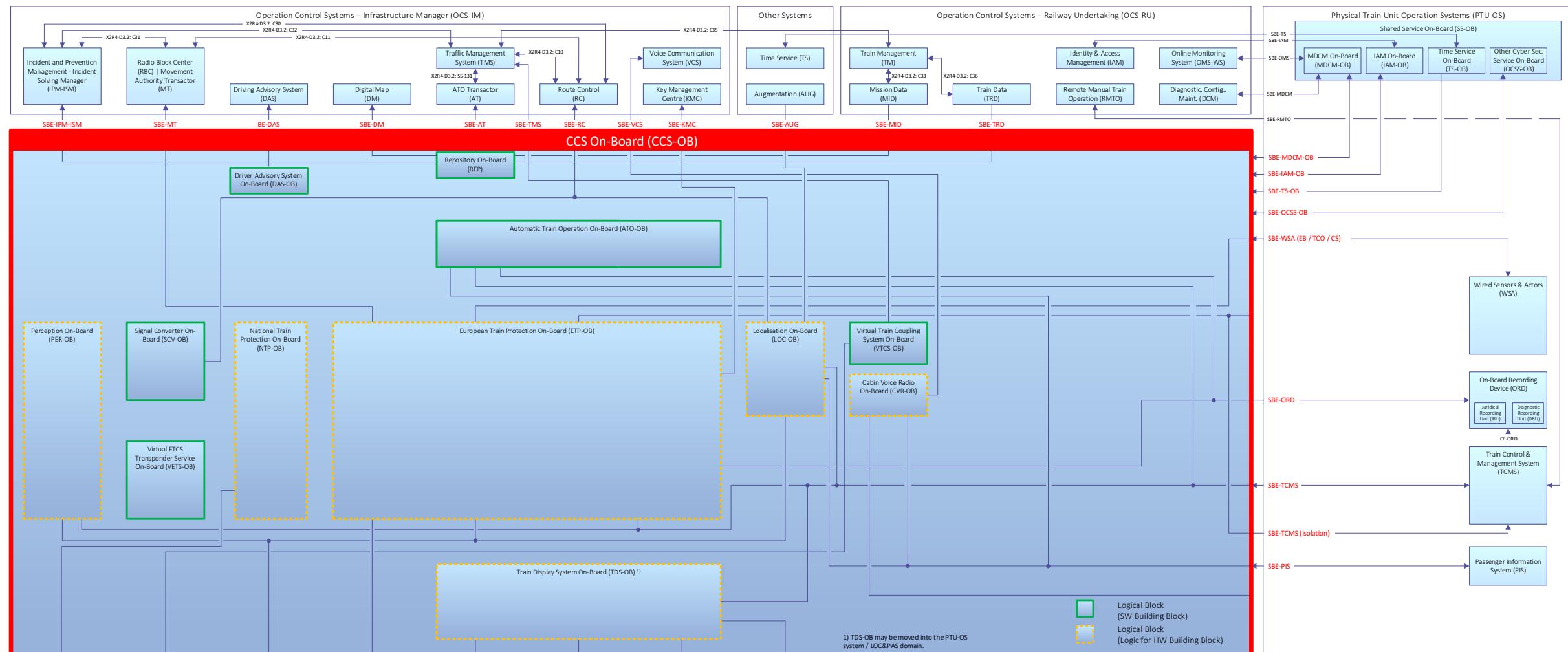


# CCS On-Board (CCS-OB)

## Logical Architecture

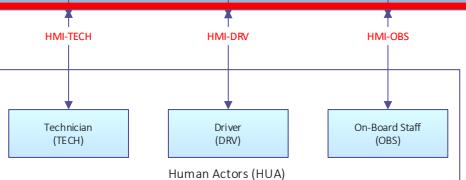
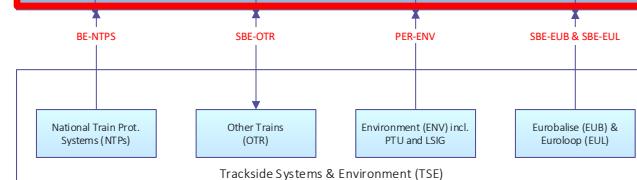
OCORA-BWS02-030 / v5.10 / 01.07.2024

# Logical Blocks – External Exchanges (New Generation Train)



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

■ Logical Block (SW Building Block)  
□ Logical Block (Logic for HW Building Block)



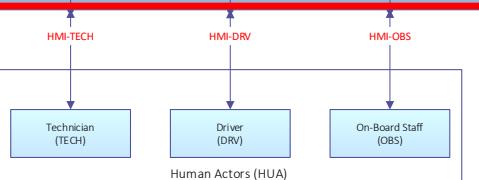
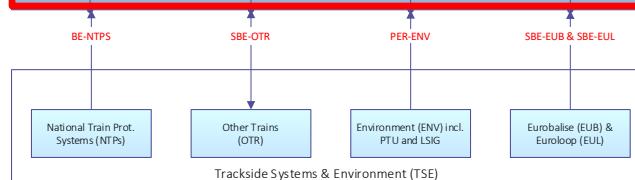
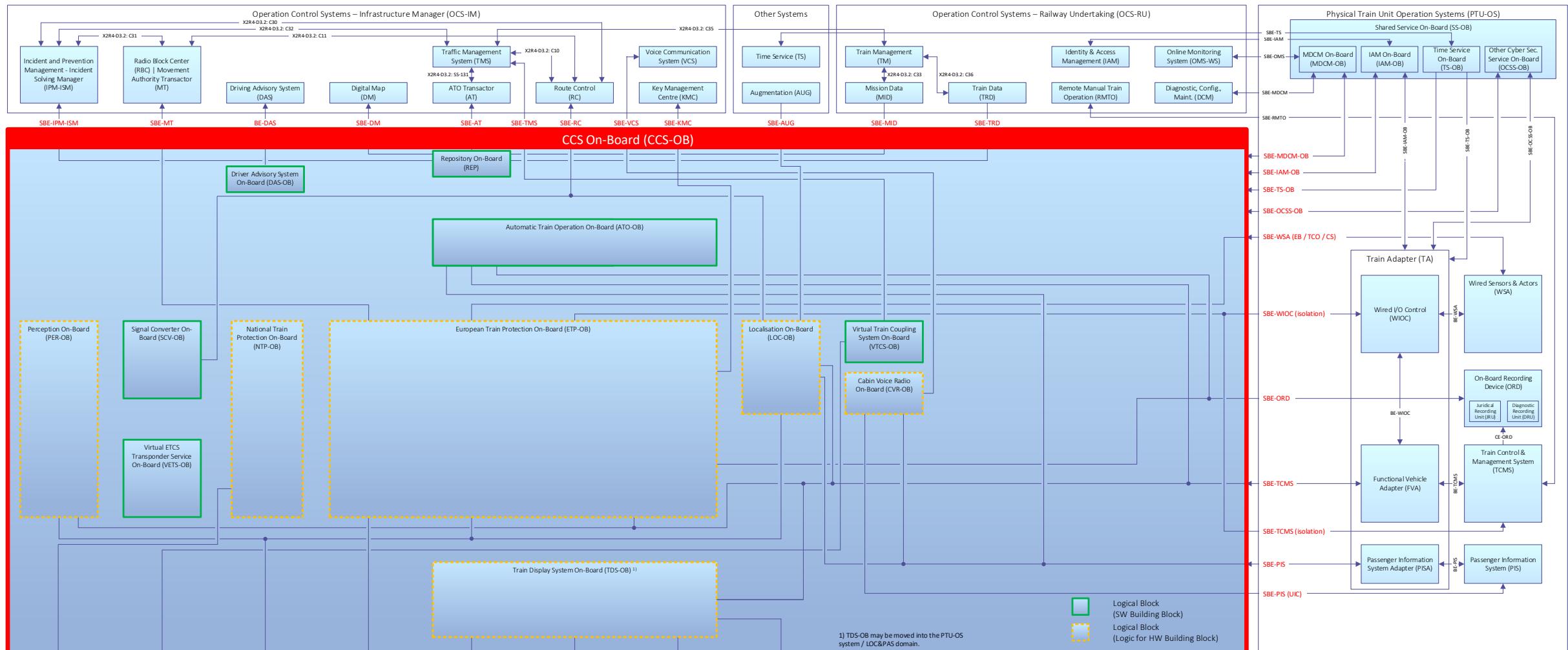
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OCORA Architecture  
ETCS-Levels: 0, 1, 2, 3, NTC / ATC GoA Levels: 1 - 4  
**CCS On-Board (CCS-OB) – Logical Architecture**  
**Logical Block – External Exchanges**  
New Generation Train  
(TCMS compliant with SS-119+, SS-139+, SS-147+)  
DIAGRAM DOES NOT SHOW CCS-OB INTERNAL EXCHANGES  
Graphic ID: LA-011-NGT Version 6.00 / 2024-05-30



# Logical Blocks – External Exchanges (Legacy Train Example)



API	Application Programming Interface
CCN	CCS Consist Network
CCU	CCS Computing Unit
BE	Standard (Building) Block Exchange
CON-OB	SUBSET-nnn amended by OCORA
HMI	Shared Services On-Board
LSIG	Operations Network
MCG	Physical Train Unit
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OCORA Architecture
ETCS-Levels: 0, 1, 2, 3, NTC / ATC GoA Levels: 1 - 4
<b>CCS On-Board (CCS-OB) – Logical Architecture</b>
<b>Logical Block – External Exchanges</b>
Legacy Train Example
(TCMS not compliant with SS-119+, SS-139+, SS-147+)
DIAGRAM DOES NOT SHOW CCS-OB INTERNAL EXCHANGES
Graphic ID: LA-011-LTE
Version 6.00 / 2024-05-30



# Logical Blocks – Internal Exchanges (New Generation Train)

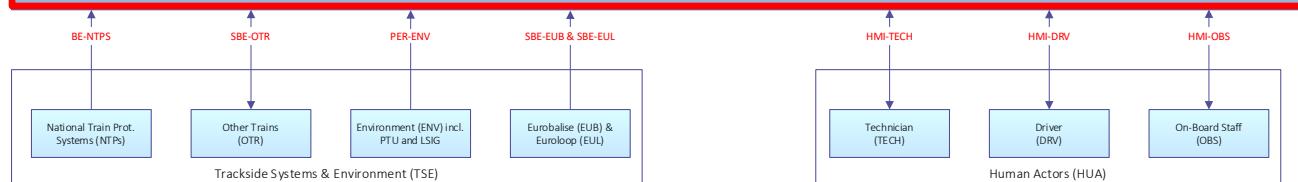
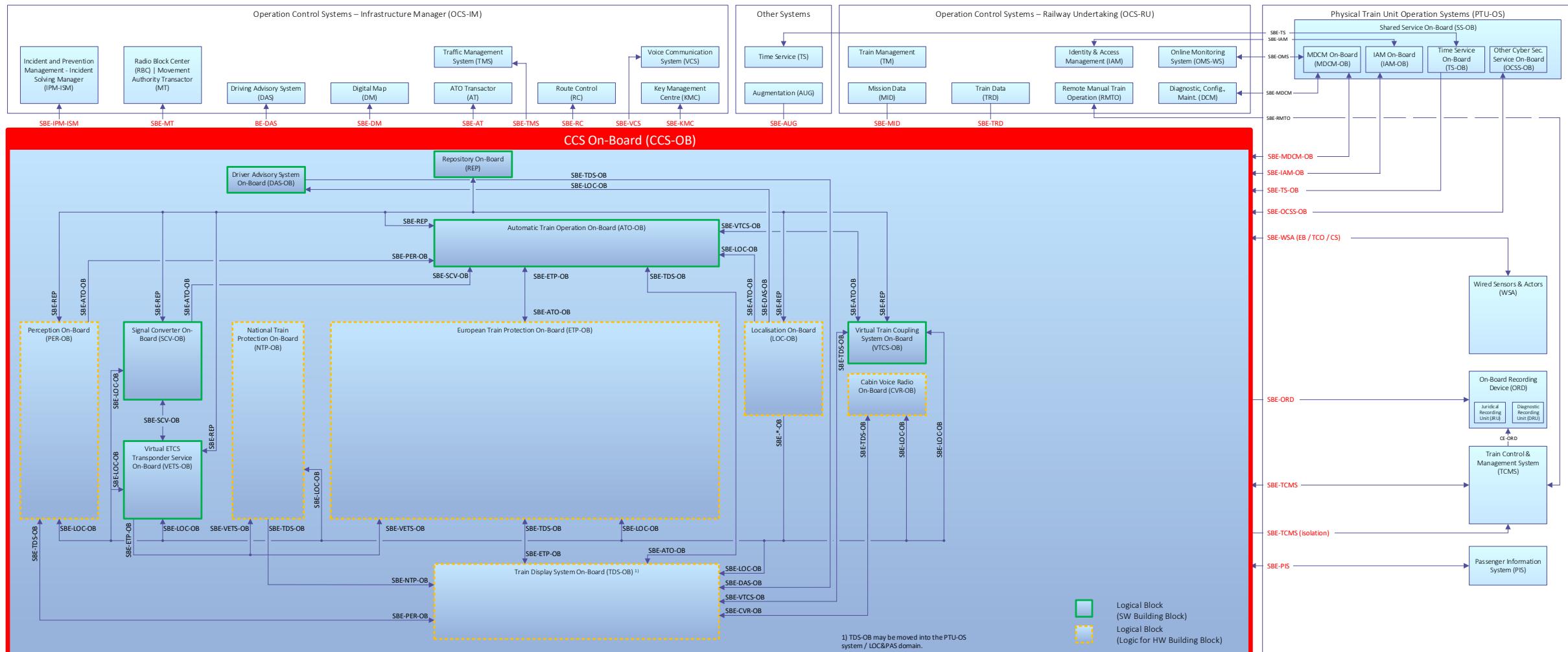




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The logo of Deutsche Bahn (DB) is displayed, consisting of the letters "DB" in a bold, red, sans-serif font, enclosed within a white square border.



I	Application Programming Interface	O
N	CCS Consist Network	P
U	CCS Computing Unit	S
	(Building) Block Exchange	S
N-OB	Connectivity On-Board	S
M	Human Machine Interface	O
G	Light Signals	P
CG	Mobile Communication Gateway (Public Network)	T
CU	Main Computing Unit	U
	New Connection	U

- Operations Network
- Perception
- Standard (Building) Block Exchange
- + SUBSET-nnn amended by OCORA
- Shared Services On-Board
- Operations Network
- Physical Train Unit
- Train Communication Network
- International Union of Railways
- User Identification

OCORA Architecture

## CCS On-Board (CCS-OB) – Logical Architecture

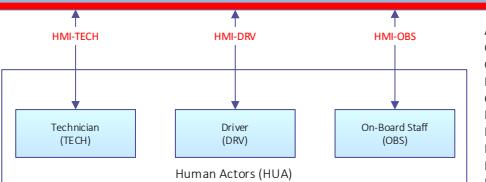
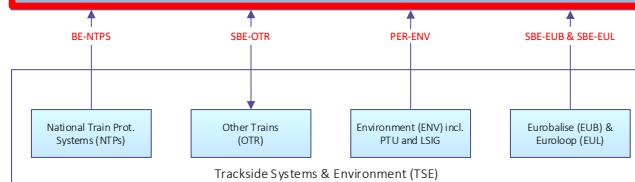
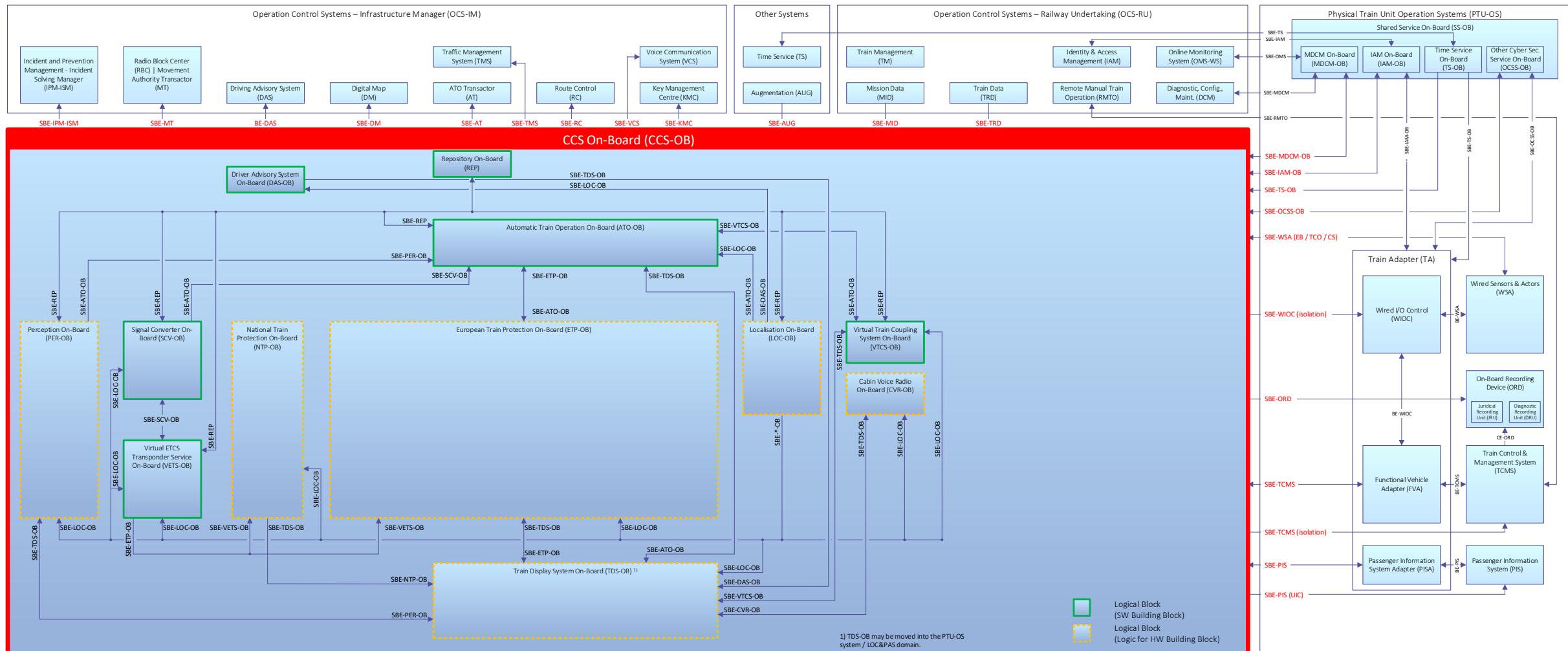
**Logical Blocks - Internal Exchanges**  
New Generation Train  
(TCMS compliant with SS-119+, SS-139+, SS-147+)  
**AGRAM DOES NOT SHOW CCS-OB EXTERNAL EXCHANGES**

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Graphic ID: LA-012-NGT Version 6.00 / 2024-05-30



# Logical Blocks – Internal Exchanges (Legacy Train Example)

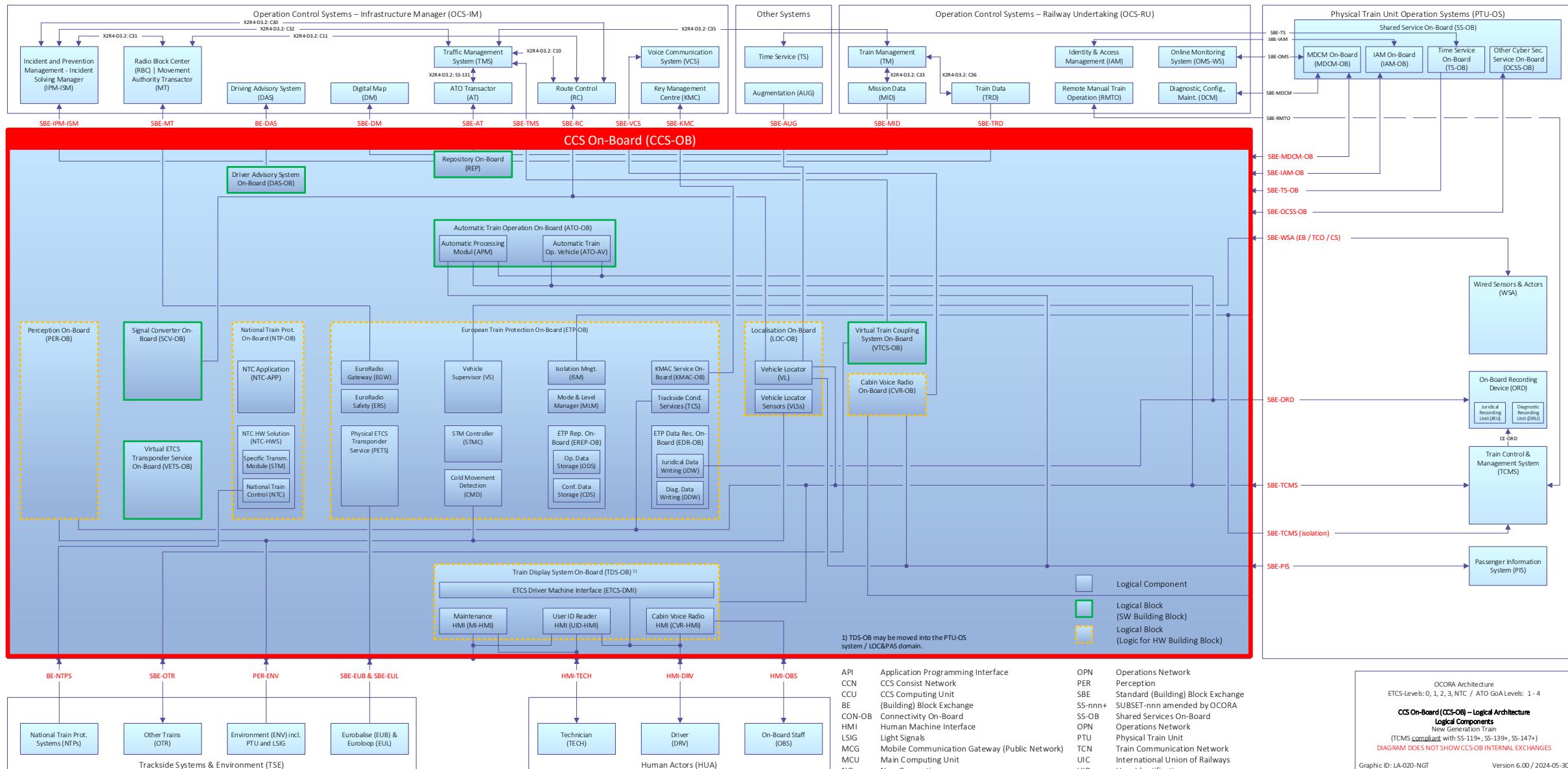


API	Application Programming Interface
CCN	CCS Consist Network
CCU	CCS Computing Unit
BE	Standard (Building) Block Exchange
CON-OB	(Building) Block Exchange
HMI	Connectivity On-Board
LSIG	Human Machine Interface
MCG	Light Signals
MCU	Mobile Communication Gateway (Public Network)
NG	New Generation
OPN	Operations Network
PER	Perception
SBE	Standard (Building) Block Exchange
SS-nnn+	SUBSET-nnn amended by OCORA
SS-OB	Shared Services On-Board
OPN	Operations Network
PTU	Physical Train Unit
TCN	Train Communication Network
UIC	International Union of Railways
UID	User Identification

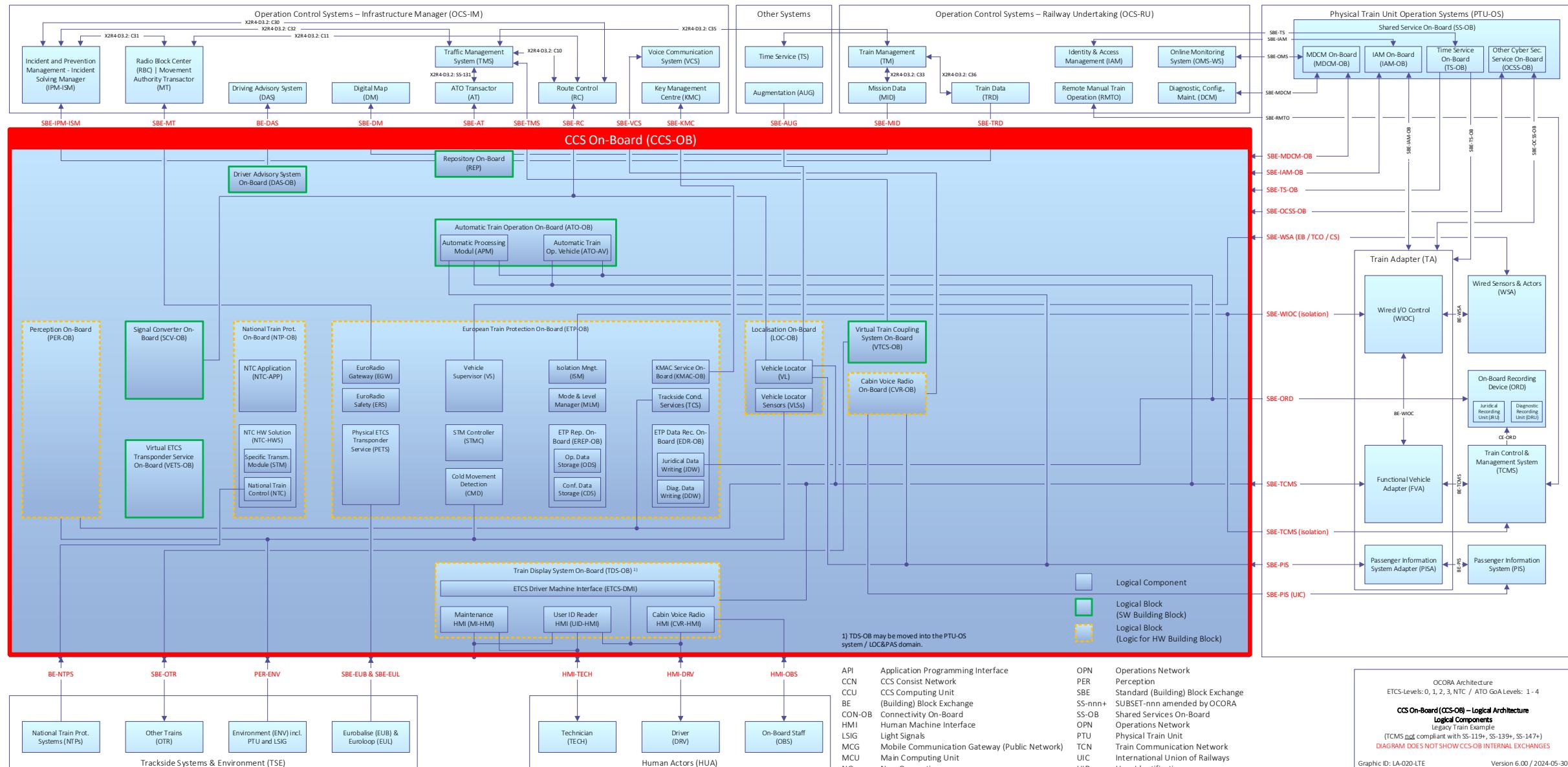
OCORA Architecture
ETCS-Levels: 0, 1, 2, 3, NTC / ATO GoA Levels: 1 - 4
<b>CCS On-Board (CCS-OB) – Logical Architecture</b>
<b>Logical Blocks – Internal Exchanges</b>
Legacy Train Example
ITCMs not compliant with SS-119+, SS-139+, SS-147+
DIAGRAM DOES NOT SHOW CCS-OB EXTERNAL EXCHANGES
Graphic ID: LA-012-LTE
Version 6.00 / 2024-05-30



# Logical Components (New Generation Train)



# Logical Components (Legacy Train Example)



OCORA Architecture

ETCS-Levels: 0, 1, 2, 3, NTC / ATO GoA Levels: 1-4

**CCS On-Board (CCS-OB) – Logical Architecture**

**Logical Components**

Legacy Train Example

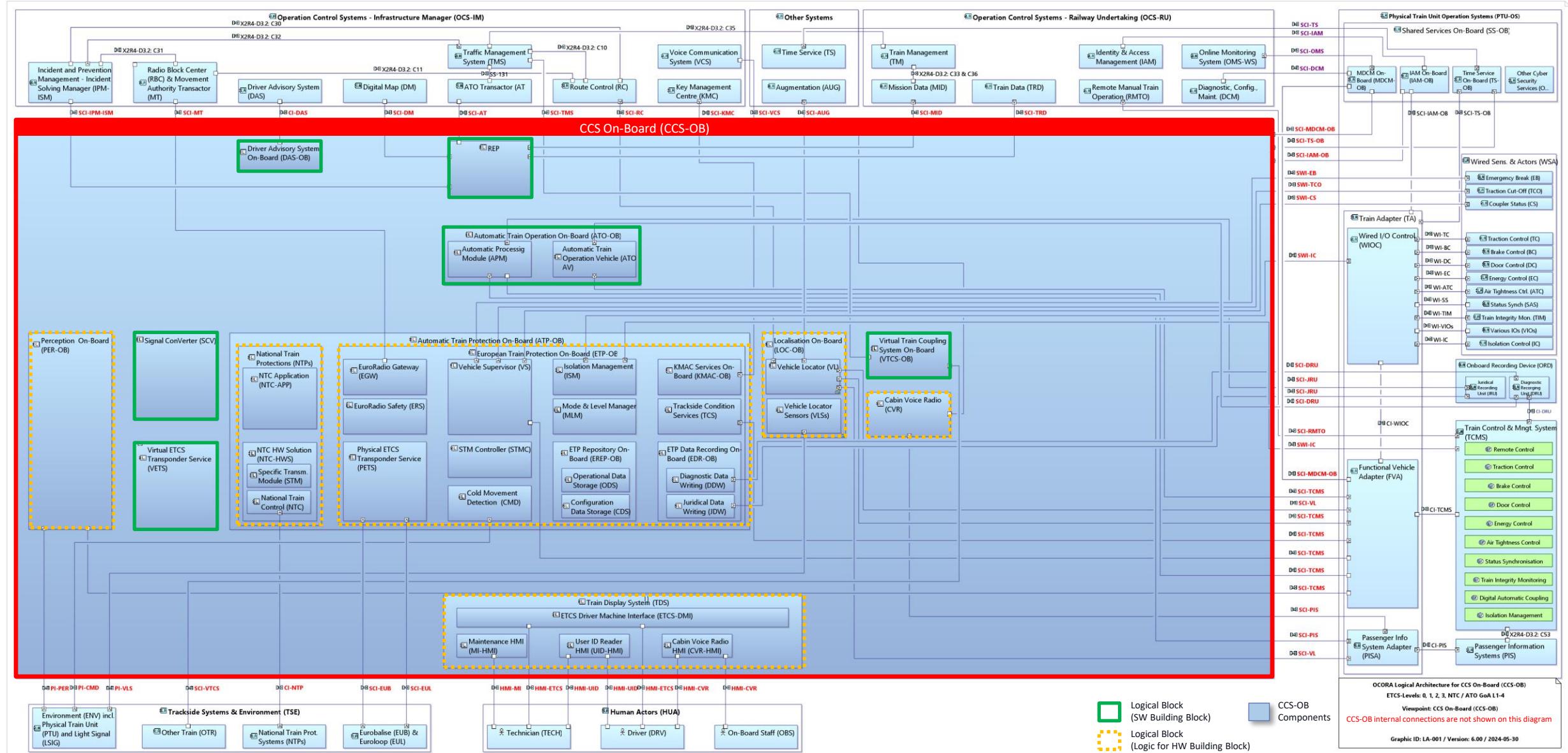
(TCMS not compliant with SS-119, SS-139, SS-147+)

DIAGRAM DOES NOT SHOW CCS-OB INTERNAL EXCHANGES

Graphic ID: LA-020-LTE

Version 6.00 / 2024-05-30

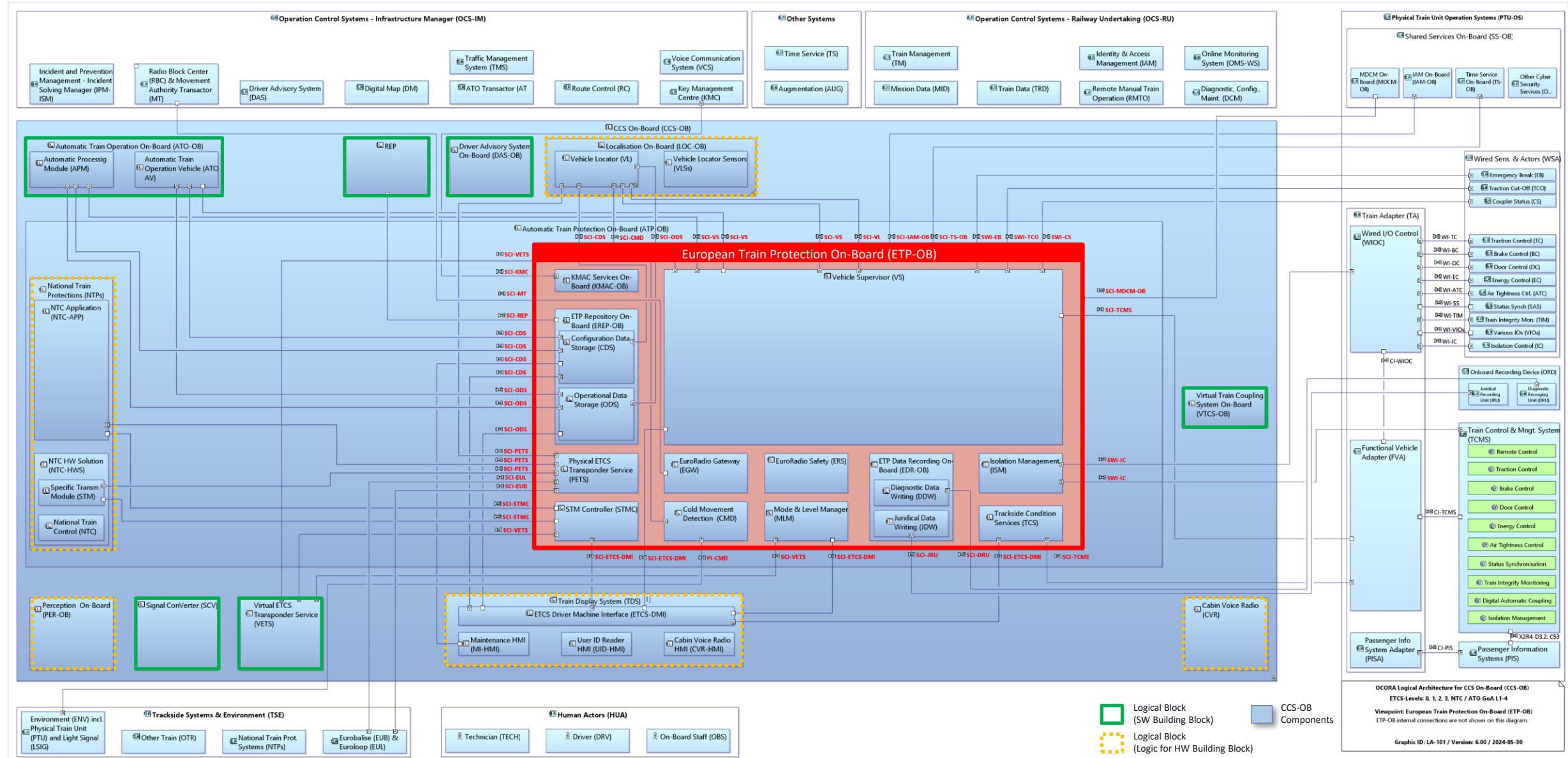
# External Logical Interfaces (Legacy Train Example)



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



# External Logical Interfaces – ETP-OB (Legacy Train Example)



Logical Block (SW Building Block)

Logical Block (Logic for HW Building Block)

CCS-OB Components

OCORA Logical Architecture for CCS On-Board (CCS-OB)

ETCS-Levels: 0, 1, 2, 3, NTC / ATO GoA L1-4

Viewpoint: European Train Protection On-Board (ETP-OB)

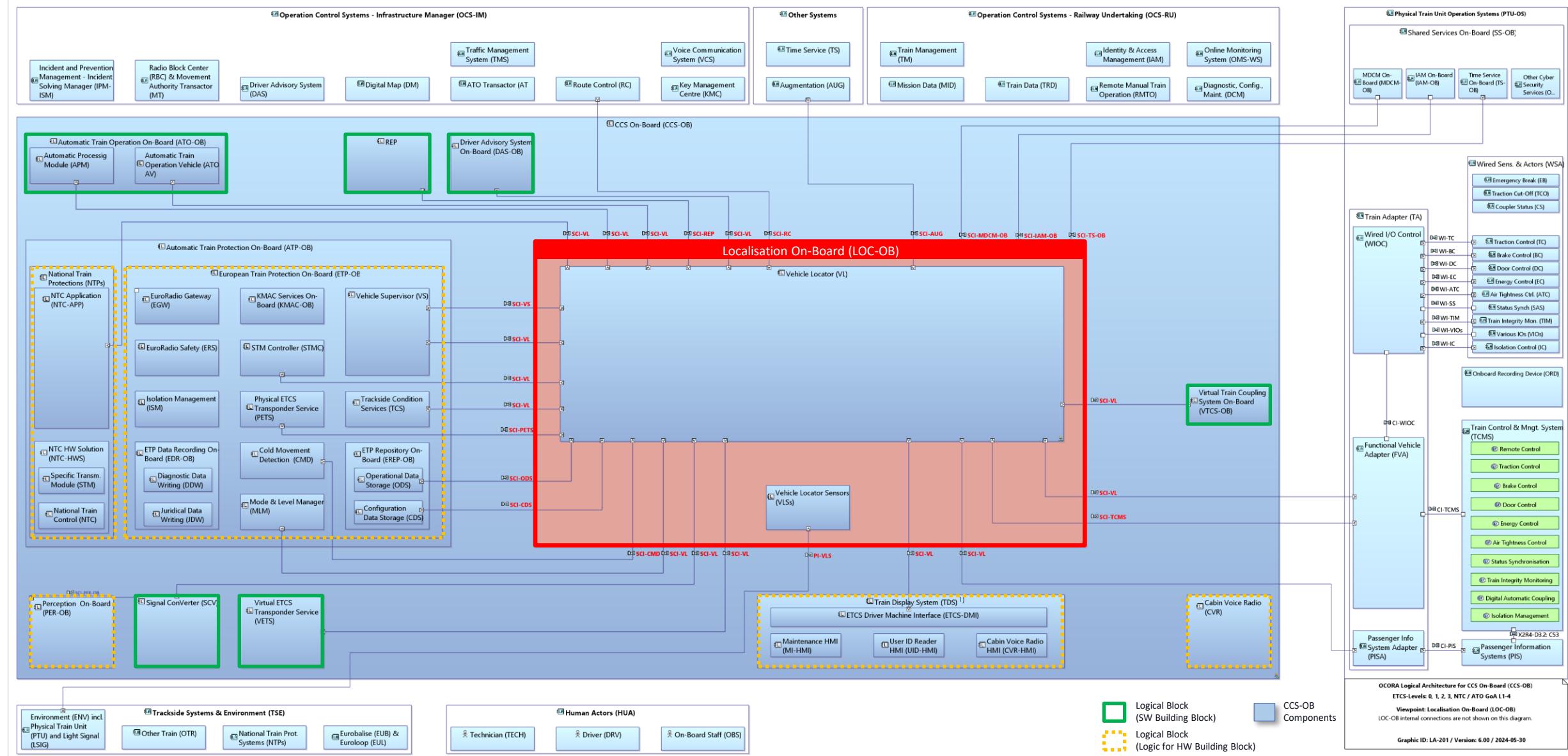
ETP-OB internal connections are not shown on this diagram.

Graphic ID: LA-101 / Version: 6.00 / 2024-05-30

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



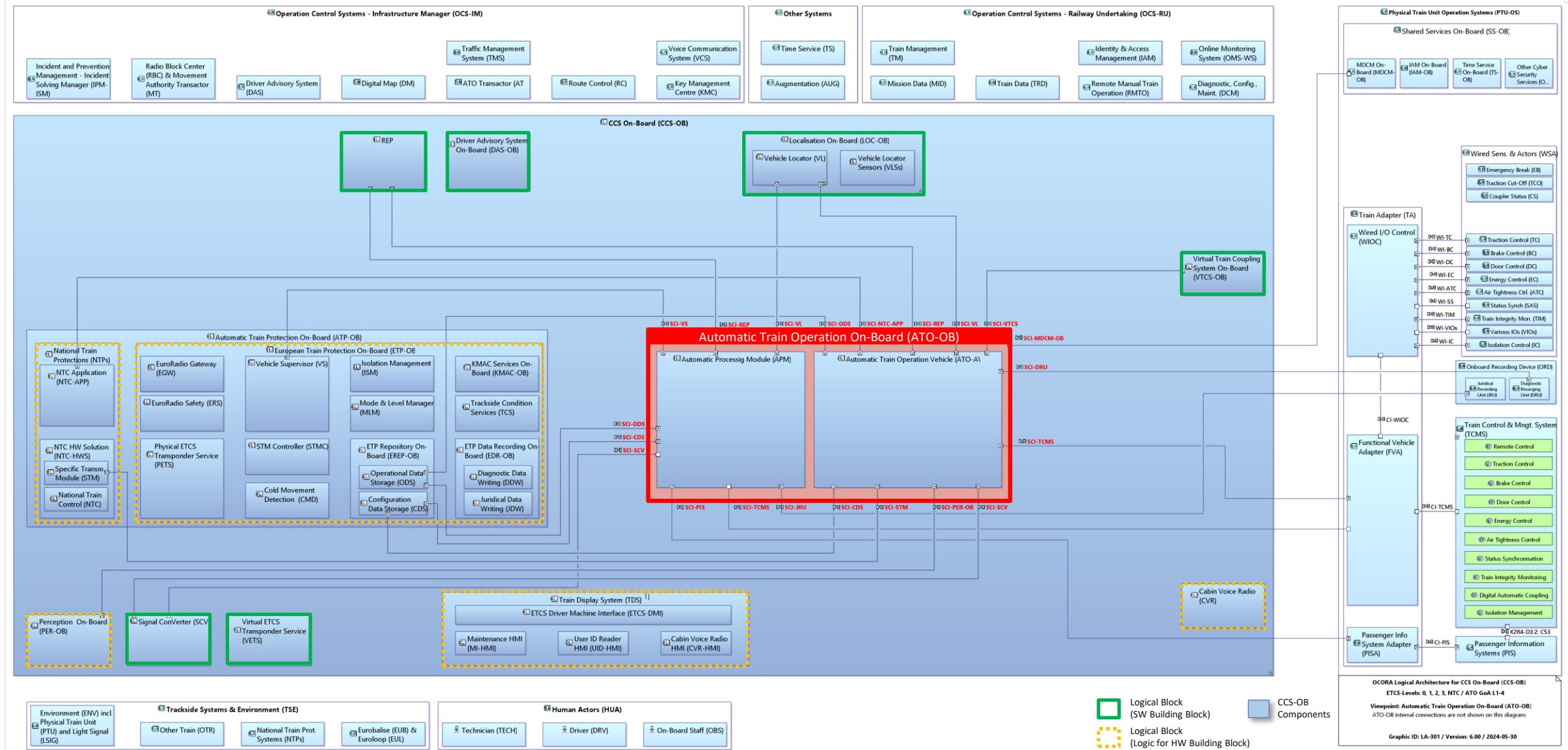
# External Logical Interfaces – LOC-OB (Legacy Train Example)



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



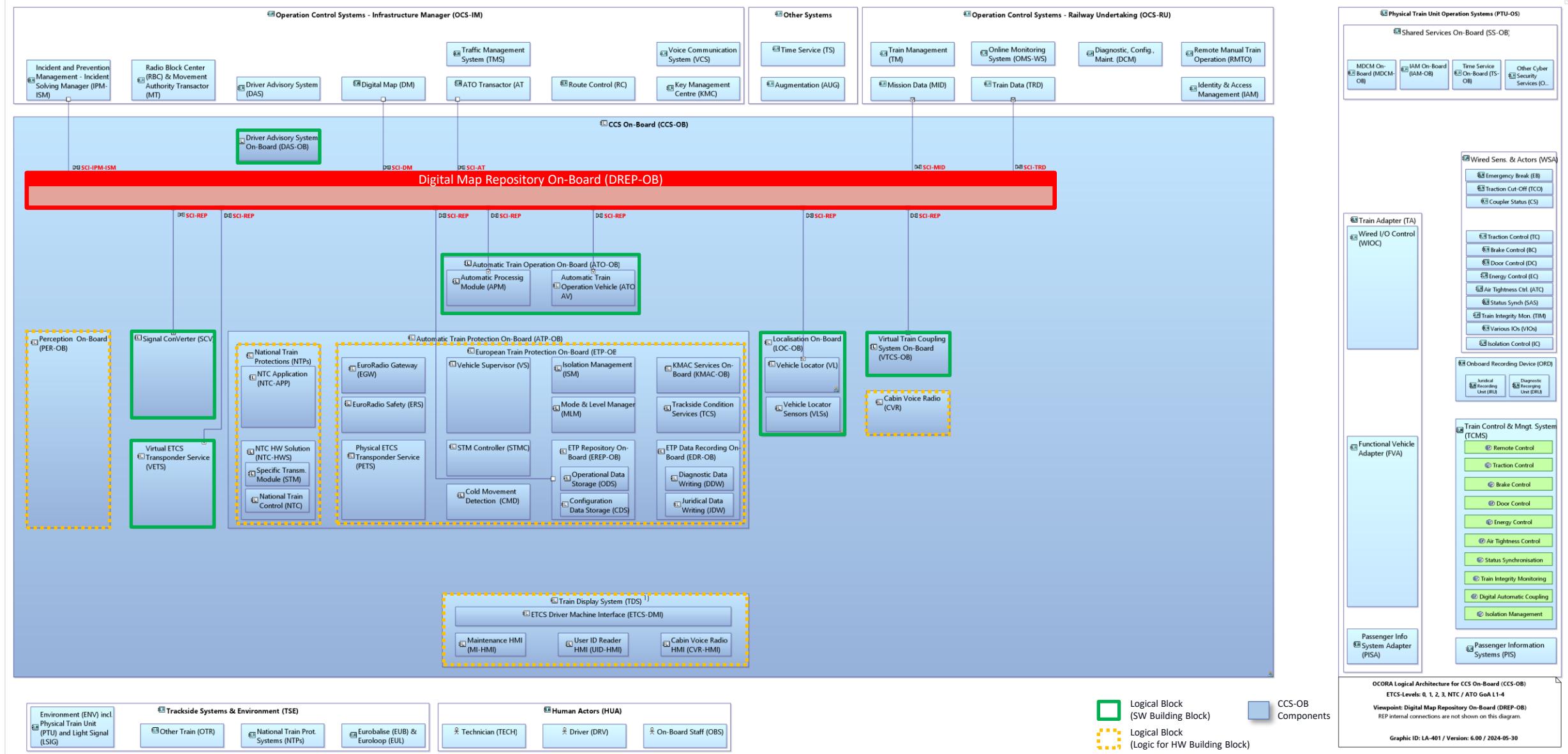
# External Logical Interfaces – ATO-OB (Legacy Train Example)



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



# External Logical Interfaces – REP (Legacy Train Example)



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





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# CCS On-Board (CCS-OB)

## Physical Architecture – Building Blocks

OCORA-BWS02-030 / v5.10 / 01.07.2024

## Definition

- 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 Blocks** 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.*

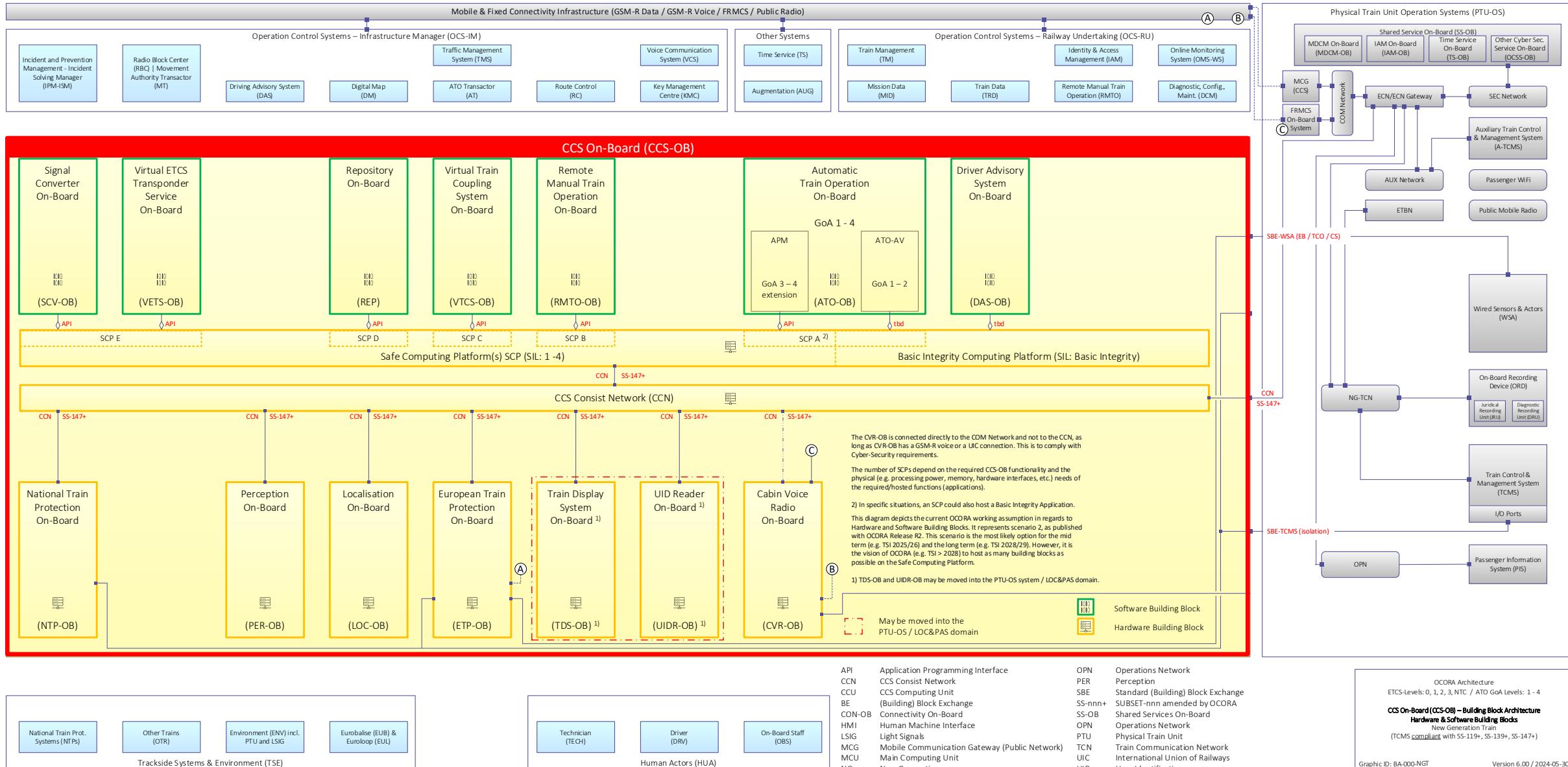


Building Blocks support the following OCORA design objectives:

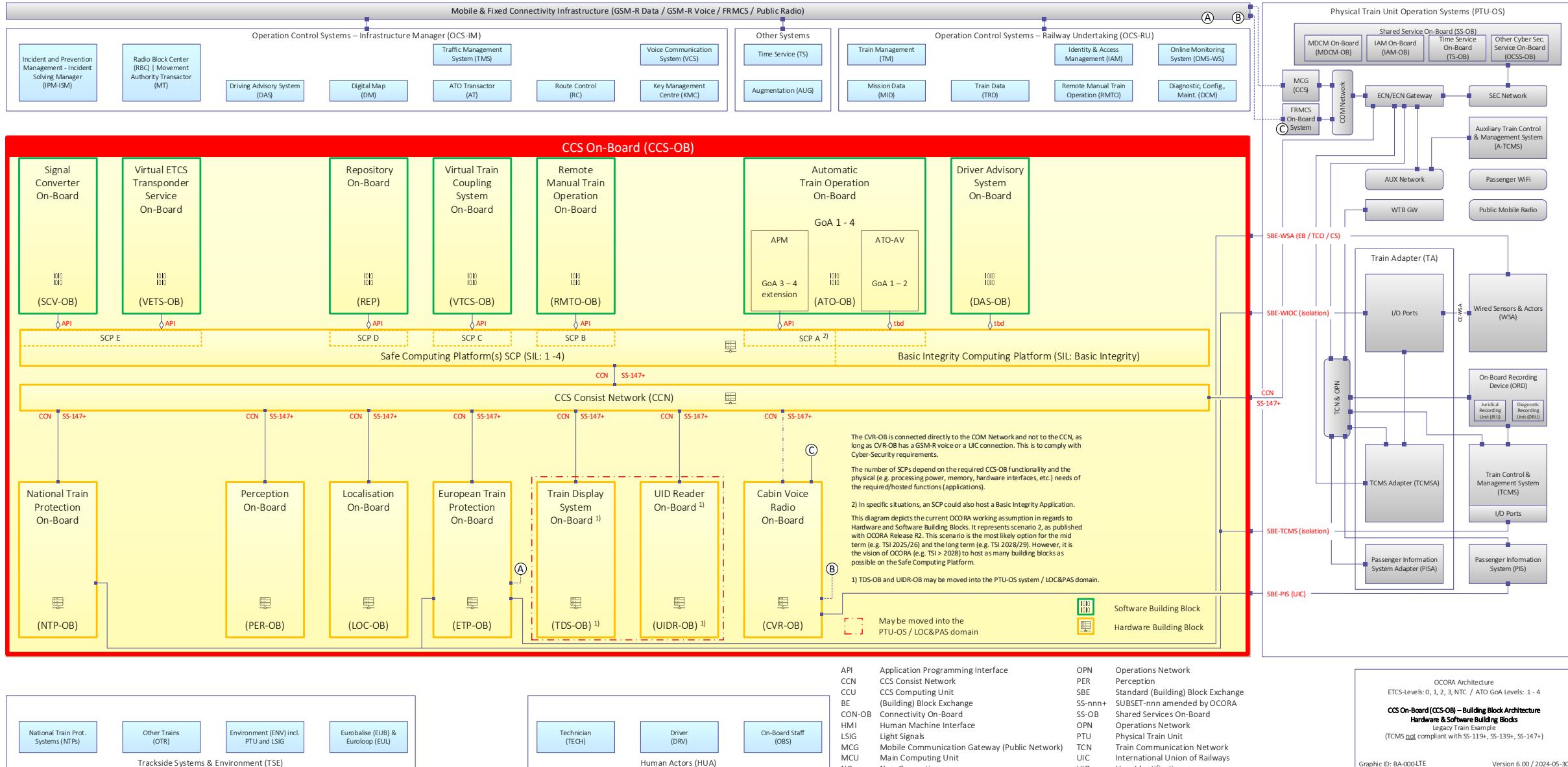
- **Exchangeability:** Building Blocks are individually exchangeable, by a third party integrator, with a building blocks of the same or of a different supplier without the involvement of any other building block supplier.
- **Migrateability:** Building blocks are individually migratable (introducing bug-fixes, improvements, new functionality), without affecting the other building blocks, unless changes on external interfaces are needed that are not backward compatible (note: backward in-compatible changes must be avoided, if possible).
- **Portability:** Software Building Blocks are portable. This means, that they runs un-changed, based on the generalized abstraction, on different (computing) platform implementations.
- **Evolvability:** Building blocks support the evolvement of the overall CCS.

Building Blocks also support the OOCRA vision for simplicity (reduced complexity) and for improved maintainability.

# CCS-OB Building Blocks (New Generation Train)



# CCS-OB Building Blocks (Legacy Train Example)





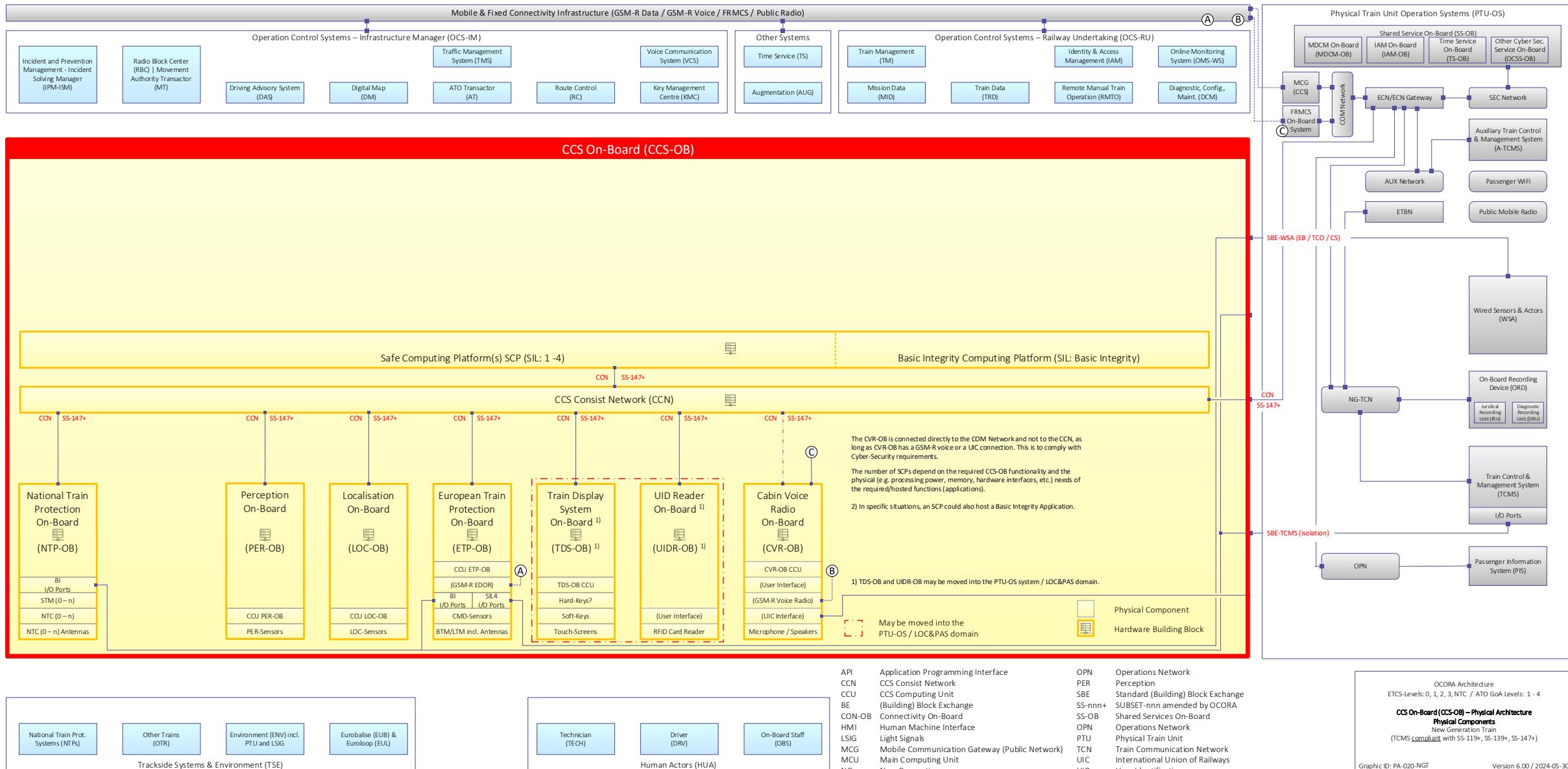
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# CCS On-Board (CCS-OB)

## Physical Architecture – Hardware Block Diagram

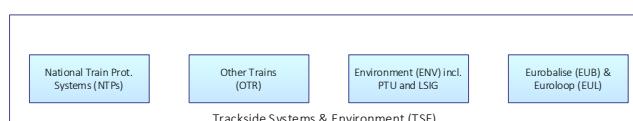
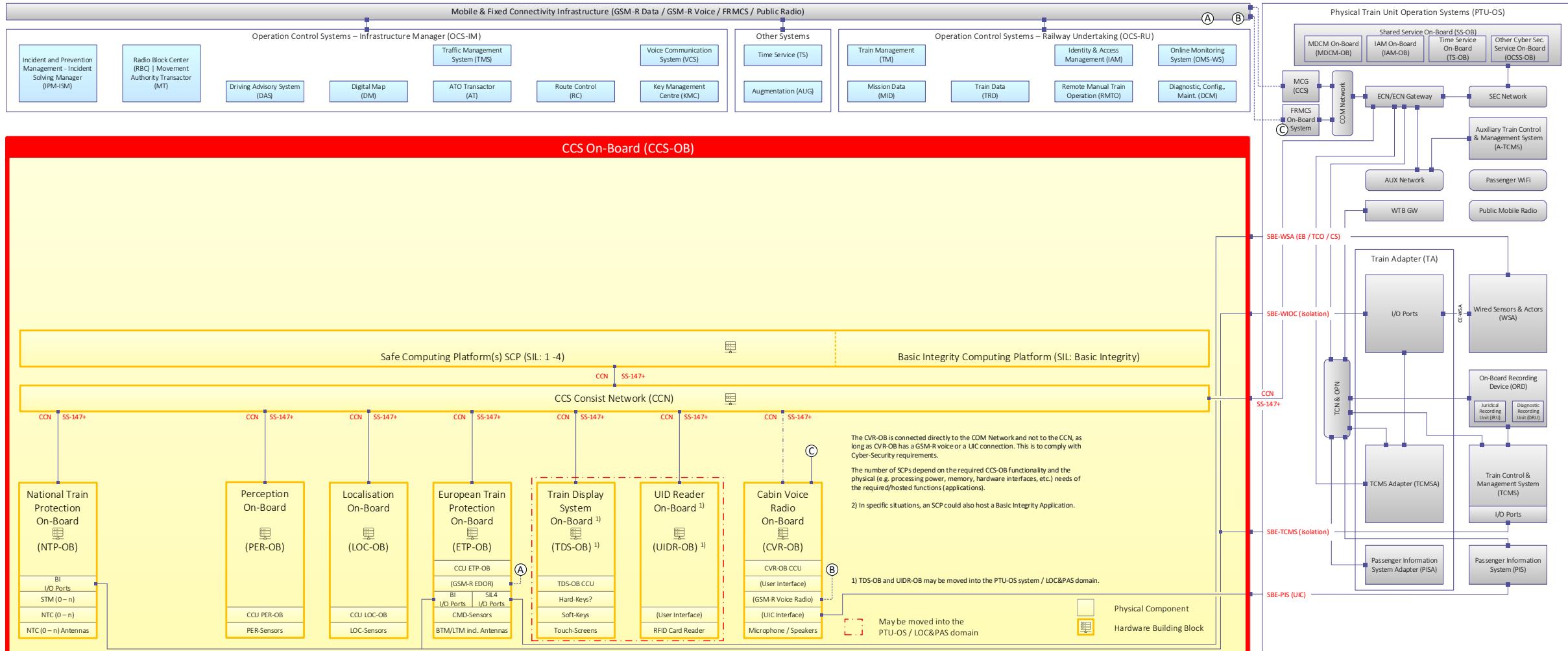
# CCS-OB Hardware Block Diagram (New Generation Train)



# CCS-OB Hardware Block Diagram (Legacy Train Example)



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API	Application Programming Interface	OPN	Operations Network	OCOR Architecture
CCN	CCS Consist Network	PER	Perception	ETCS-Levels: 0, 1, 2, 3, NTC / ATC GoA Levels: 1 - 4
CCU	CCS Computing Unit	SBE	Standard (Building) Block Exchange	
BE	(Building) Block Exchange	SS-nnn+	SUBSET-nnn amended by OCORA	
CON-OB	Connectivity On-Board	SS-OB	Shared Services On-Board	
HMI	Human Machine Interface	OPN	Operations Network	<b>CCS On-Board (CCS-OB) – Physical Architecture</b>
L SIG	Light Signals	PTU	Physical Train Unit	<b>Physical Components</b>
MCG	Mobile Communication Gateway (Public Network)	TCN	Train Communication Network	Legacy Train Example
MCU	Main Computing Unit	UIC	International Union of Railways	(TCMS <u>not</u> compliant with SS-119+, SS-139+, SS-147+)
NG	New Generation	UID	User Identification	



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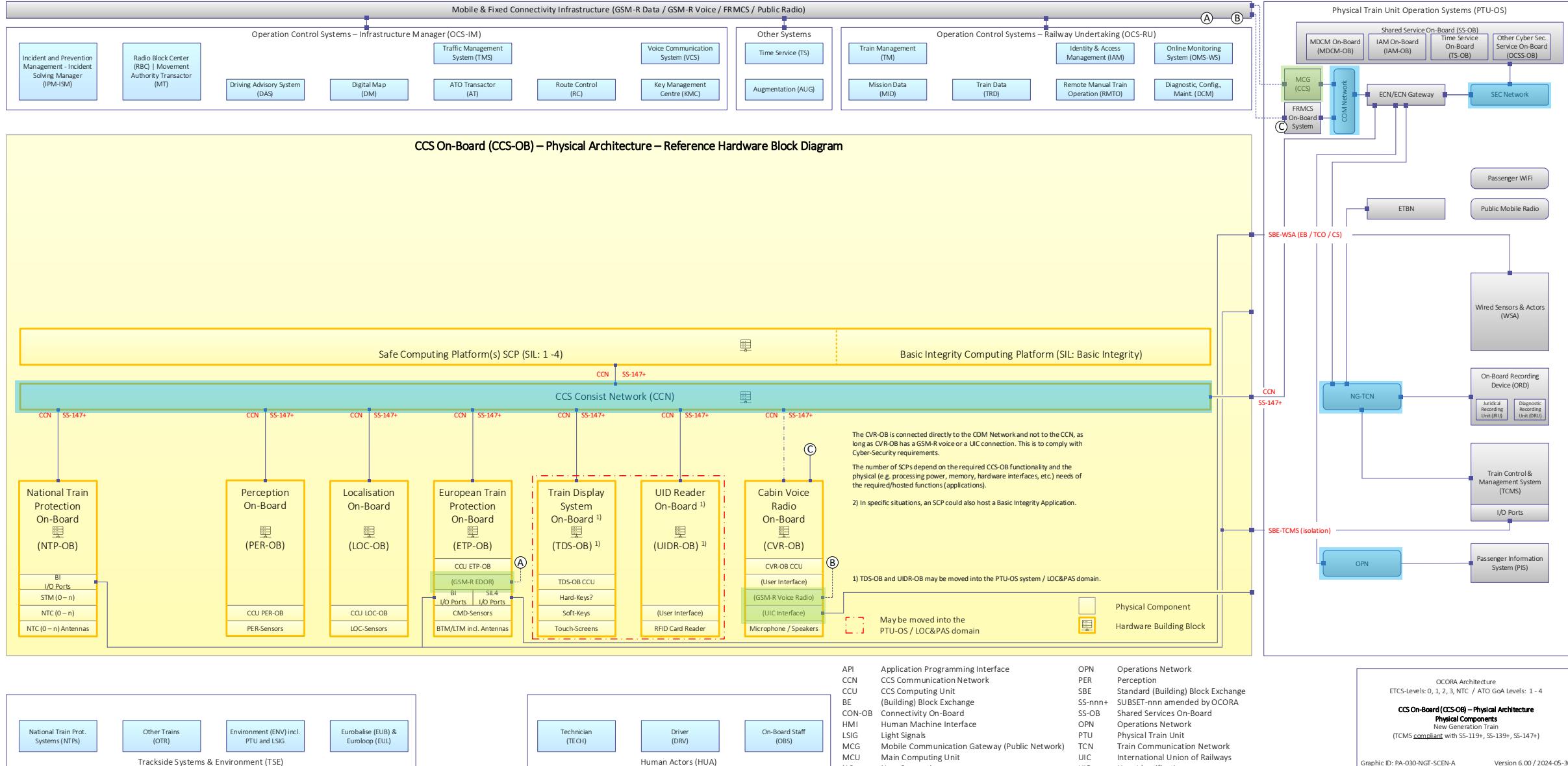


# CCS On-Board (CCS-OB)

Physical Architecture – Train Integration Scenarios

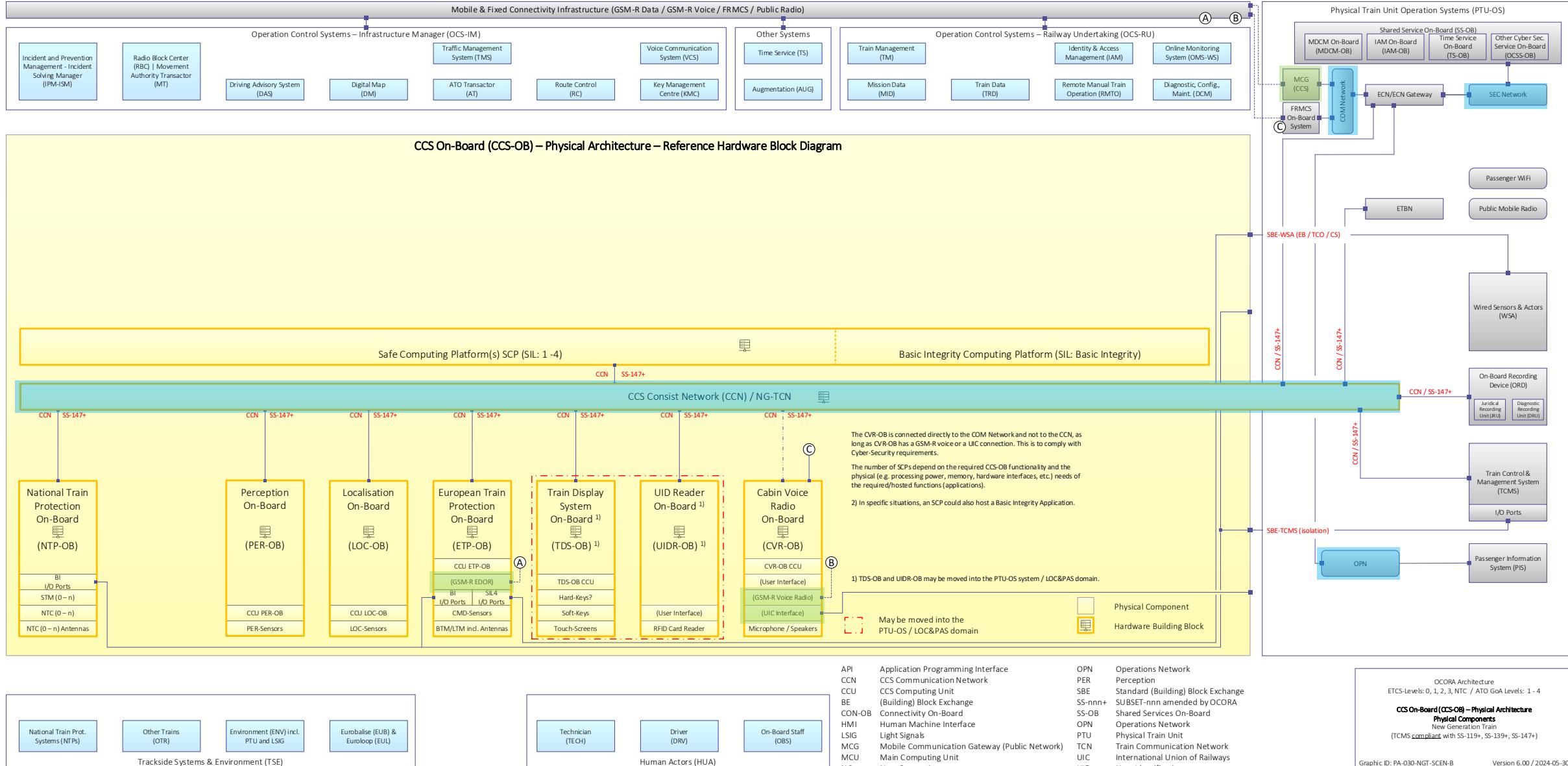
# NG-TCN Train – Scenario A

(CCN as physically separated network from Sec Net, Op Net, NG TCN and Com Net with support for legacy trackside infrastructure)



# NG-TCN Train – Scenario B

(CCN as logically separated network from NG TCN and physically separated from Sec Net, Op Net and Com Net with support for legacy trackside infrastructure)



# NG-TCN Train – Scenario C

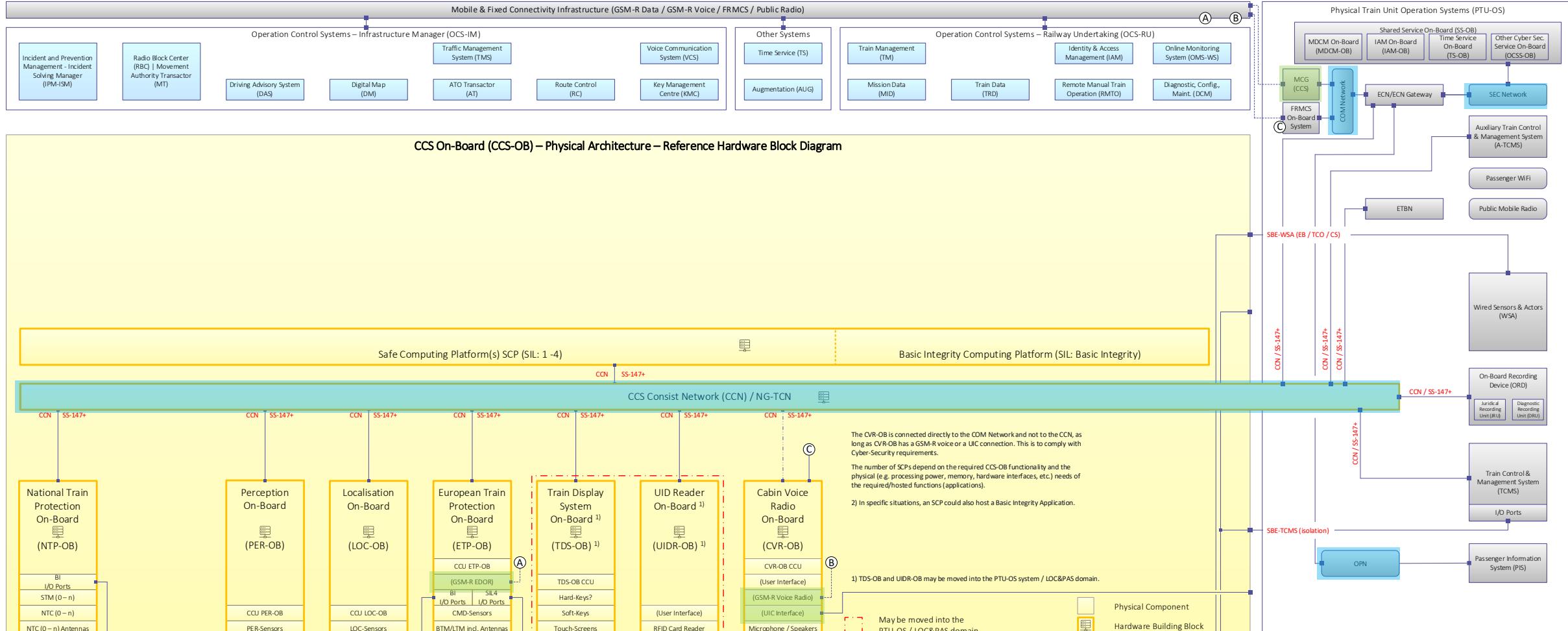
(Common CCN and TCMS network logically separated from A-TCMS and physically separated from Sec Net, Op Net and Com Net with support for legacy trackside infrastructure)



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ÖBB

DB



API	Application Programming Interface	OPN	Operations Network
CCN	CCS Communication Network	PER	Perception
CCU	CCS Computing Unit	SBE	Standard (Building) Block Exchange
BE	(Building) Block Exchange	SS-nnn+	SUBSET-nnn amended by OCORA
CON-OB	Connectivity On-Board	SS-OB	Shared Services On-Board
HMI	Human Machine Interface	OPN	Operations Network
LSIG	Light Signals	PTU	Physical Train Unit
MCG	Mobile Communication Gateway (Public Network)	TCN	Train Communication Network
MCU	Main Computing Unit	UIC	International Union of Railways
NG	New Generation	UID	User Identification

OCORA Architecture  
ETCS-Levels: 0, 1, 2, 3, NTC / ATC GoA Levels: 1 - 4

**CCS On-Board (CCS-OB) – Physical Architecture**

**Physical Components**

New Generation Train

(TCMS compliant with SS-119+, SS-139+, SS-147+)

Graphic ID: PA-030-NGT-SCEN-C

Version 6.00 / 2024-05-30

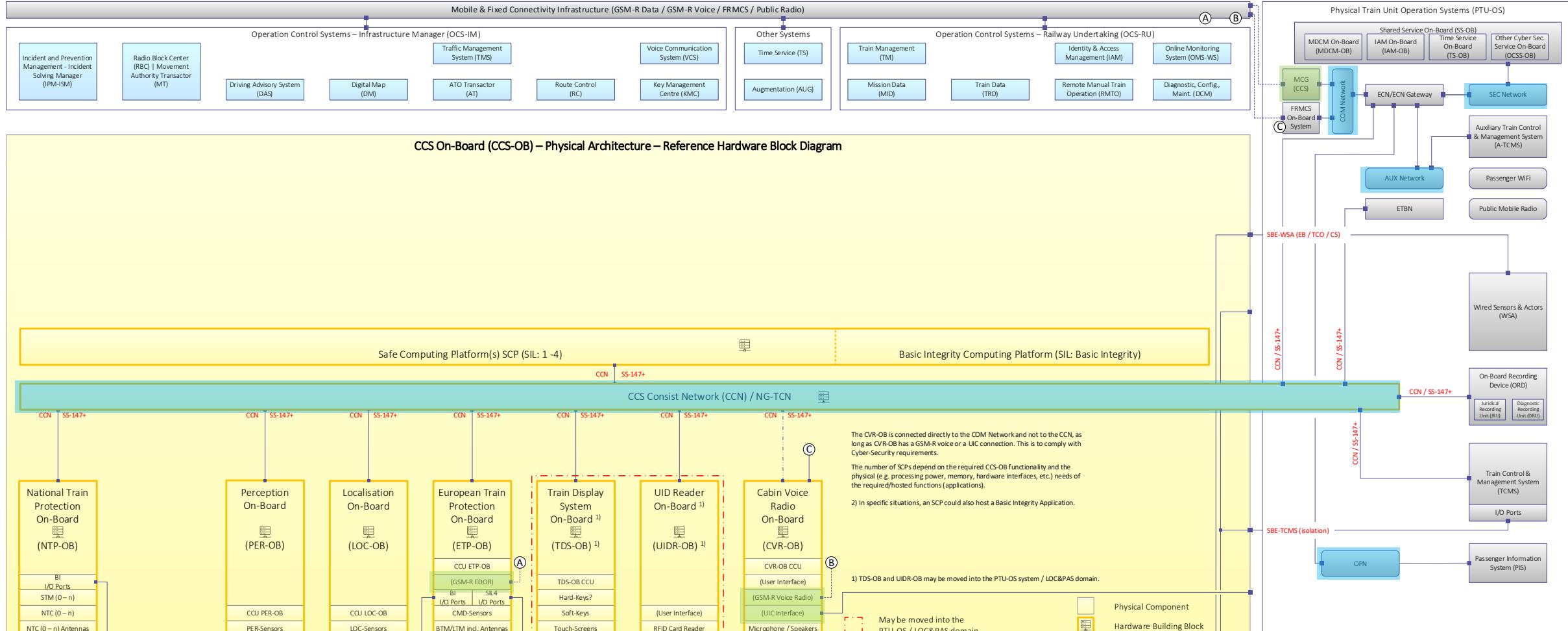


OCORA

OCRA-BWS02-030 / v5.10 / 01.07.2024

# NG-TCN Train – Scenario D

(Common CCN and TCMS network physically separated from A-TCMS, Sec Net, Op Net and Com Net with support for legacy trackside infrastructure)



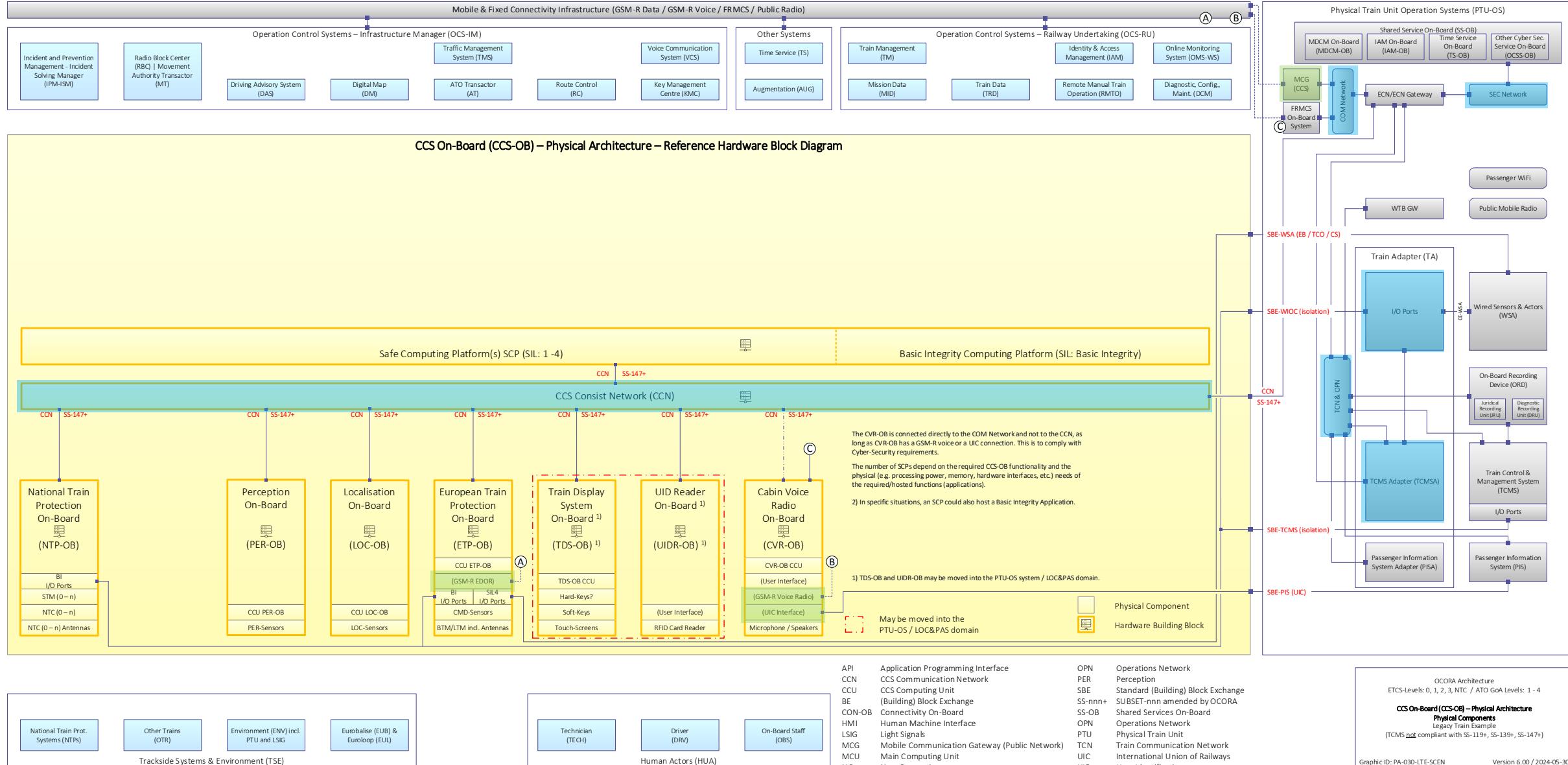
API	Application Programming Interface	OPN	Operations Network
CCN	CCS Communication Network	PER	Perception
CCU	CCS Computing Unit	SBE	Standard (Building) Block Exchange
BE	(Building) Block Exchange	SS-nnn+	SUBSET-nnn amended by OCORA
CON-OB	Connectivity On-Board	SS-OB	Shared Services On-Board
HMI	Human Machine Interface	OPN	Operations Network
LSIG	Light Signals	PTU	Physical Train Unit
MCG	Mobile Communication Gateway (Public Network)	TCN	Train Communication Network
MCU	Main Computing Unit	UIC	International Union of Railways
NG	New Generation	UID	User Identification

**OCORA Architecture**  
ETCS-Levels: 0, 1, 2, 3, NTC / ATC GoA Levels: 1 - 4

**CCS On-Board (CCS-OB) – Physical Architecture**  
**Physical Components:**  
New Generation Train  
(TCMS compliant with SS-119+, SS-139+, SS-147+)

Graphic ID: PA-030-NGT-SCEN-D Version 6.00 / 2024-05-30



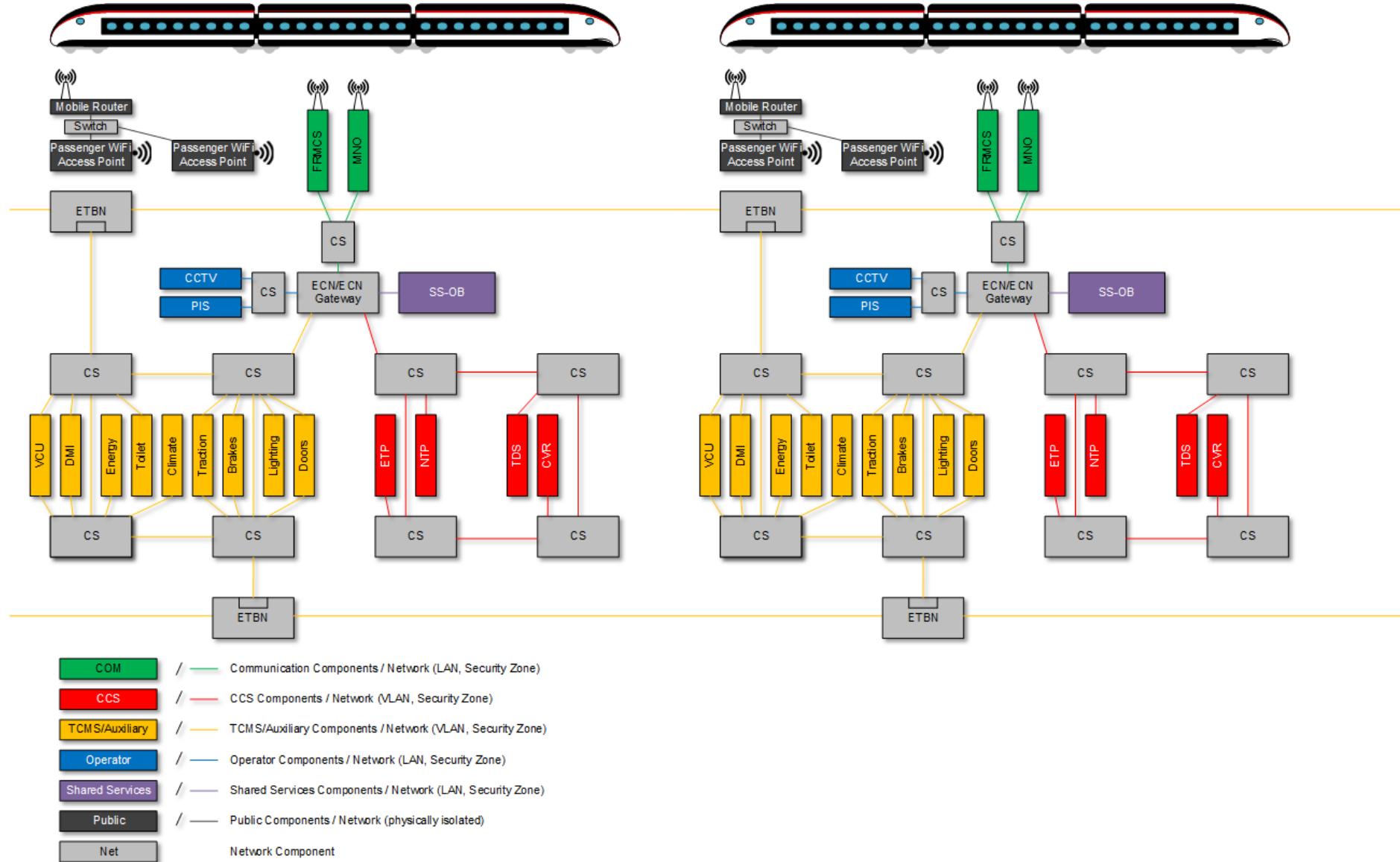




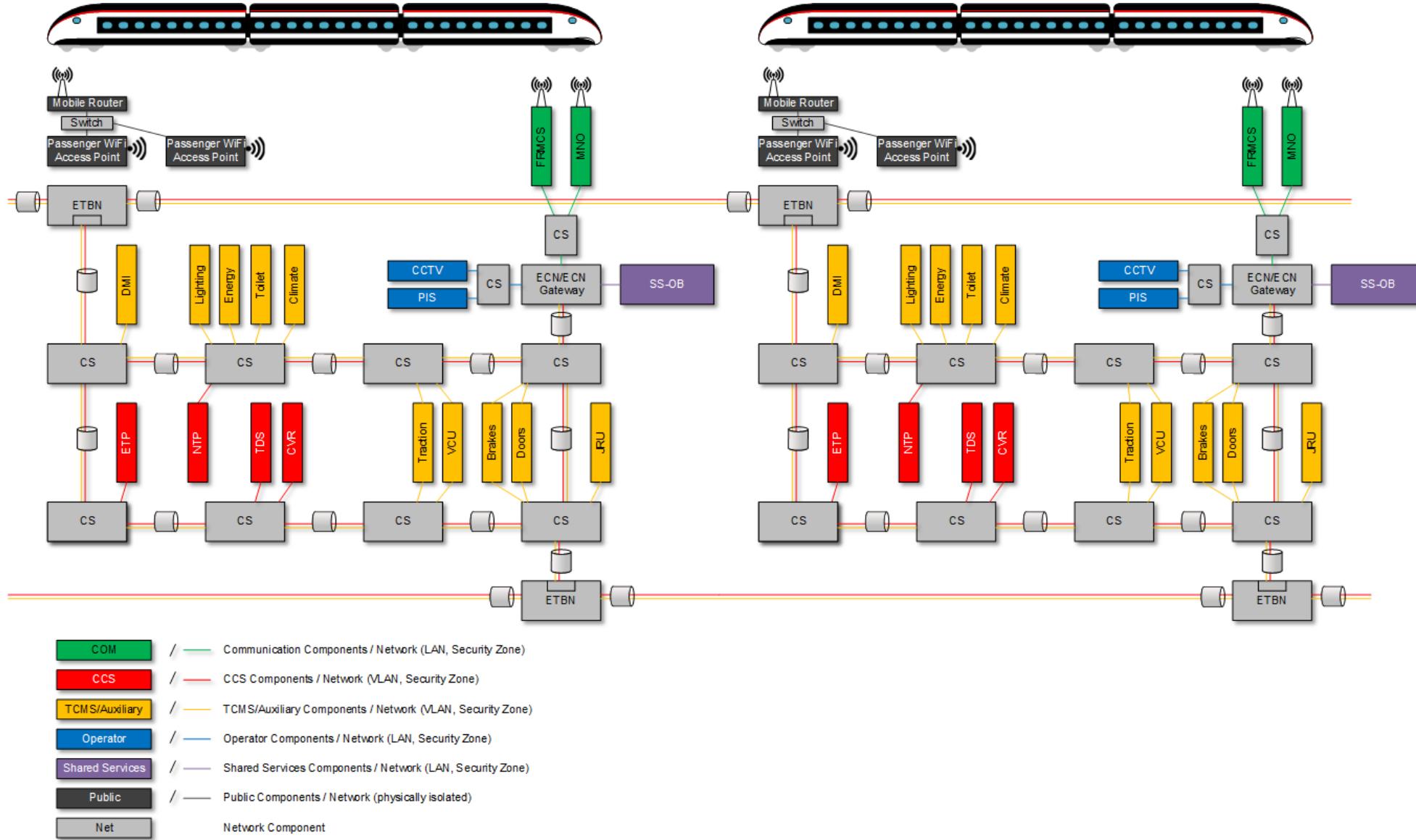
# CCS On-Board (CCS-OB)

Physical Architecture – Network Topology Scenarios

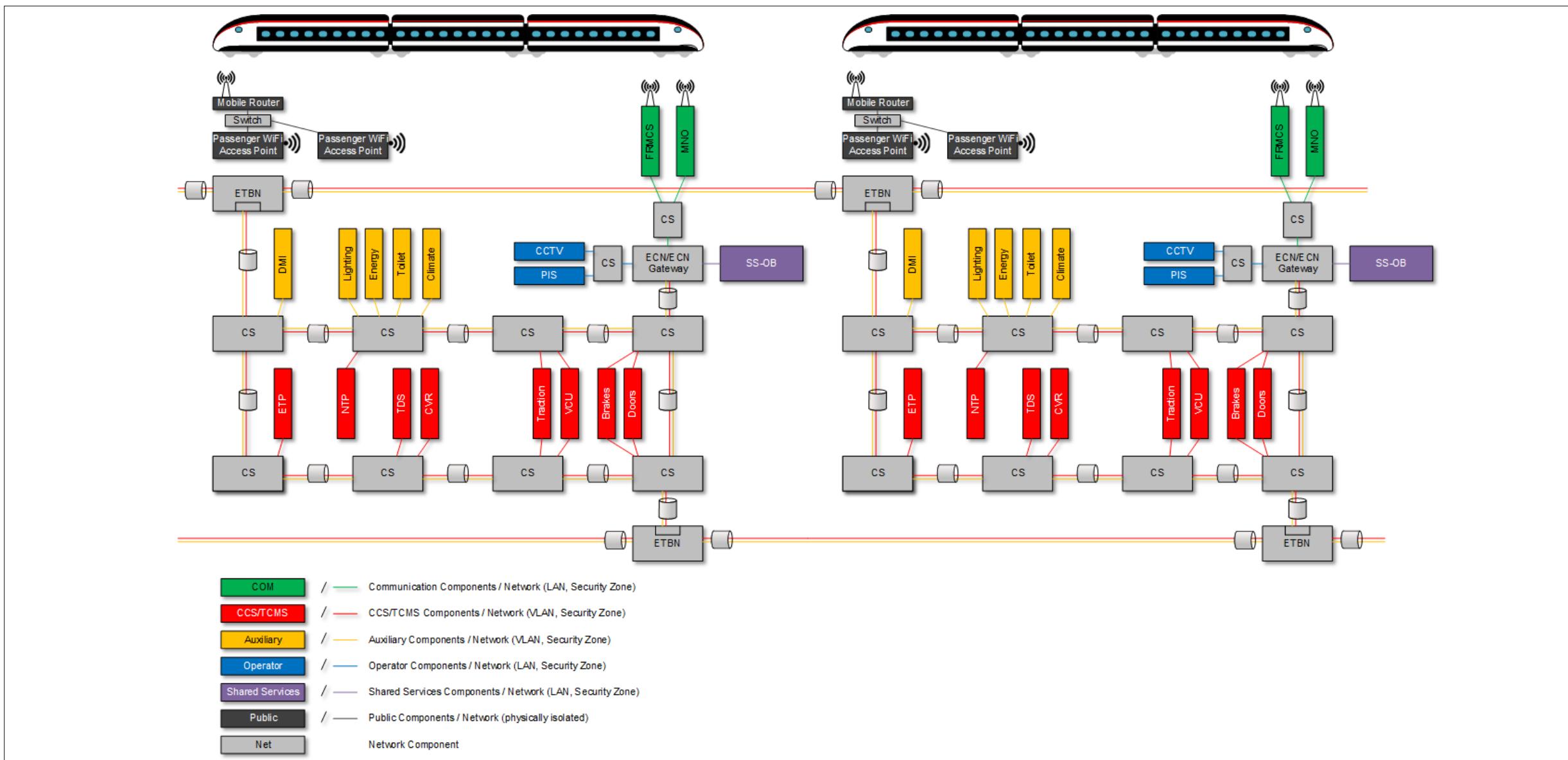
# Scenario A: CCN as physically separated network



# Scenario B: CCN as logically separated network



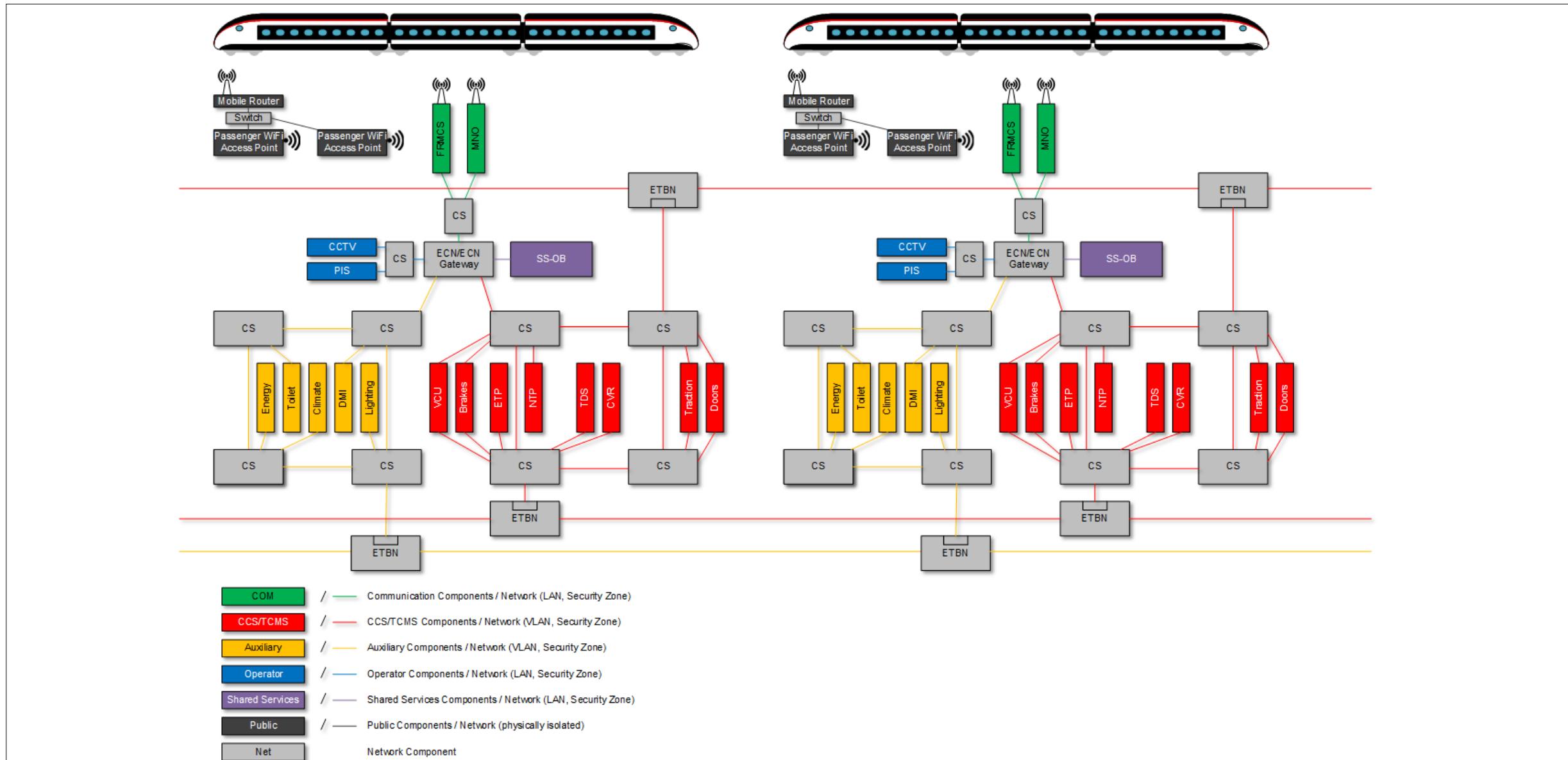
# Scenario C: Common critical control network logically separated



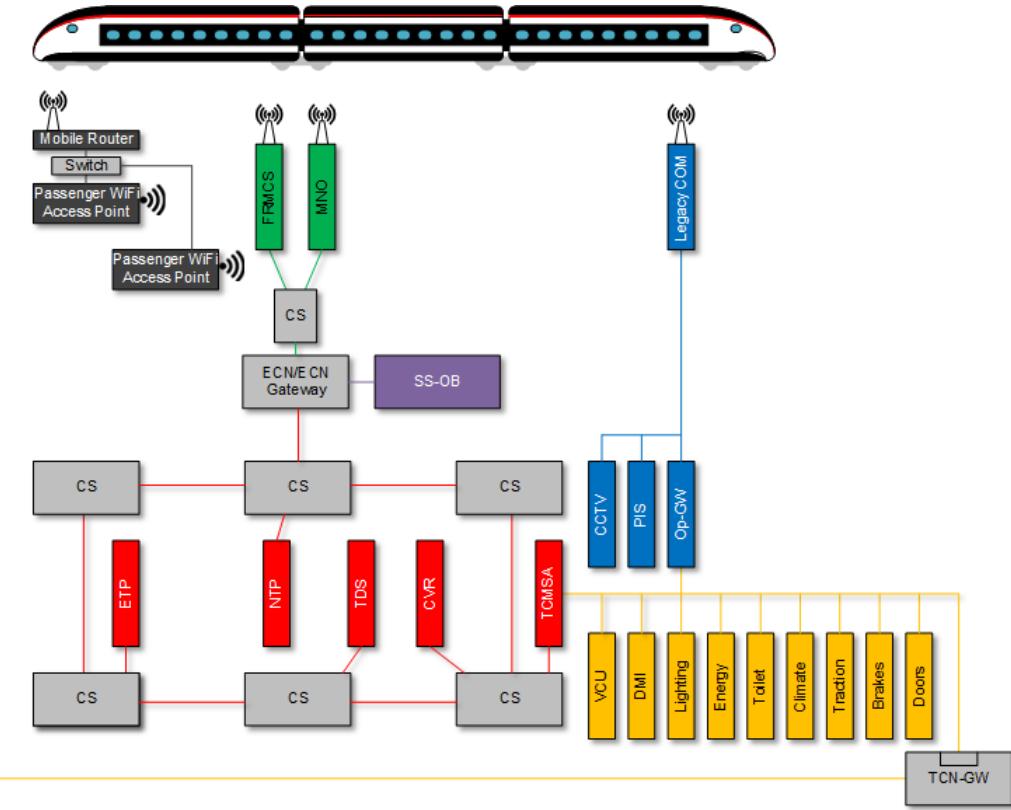
# Scenario D: Common critical control network physically separated



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# Legacy Train – Integration with OCORA-GW



<b>COM</b>	/	Communication Components / Network (LAN, Security Zone)
<b>CCS</b>	/	CCS Components / Network (VLAN, Security Zone)
<b>TCMS/Auxiliary</b>	/	TCMS/Auxiliary Components / Network (VLAN, Security Zone)
<b>Operator</b>	/	Operator Components / Network (LAN, Security Zone)
<b>Shared Services</b>	/	Shared Services Components / Network (LAN, Security Zone)
<b>Public</b>	/	Public Components / Network (physically isolated)
<b>Net</b>		Network Component

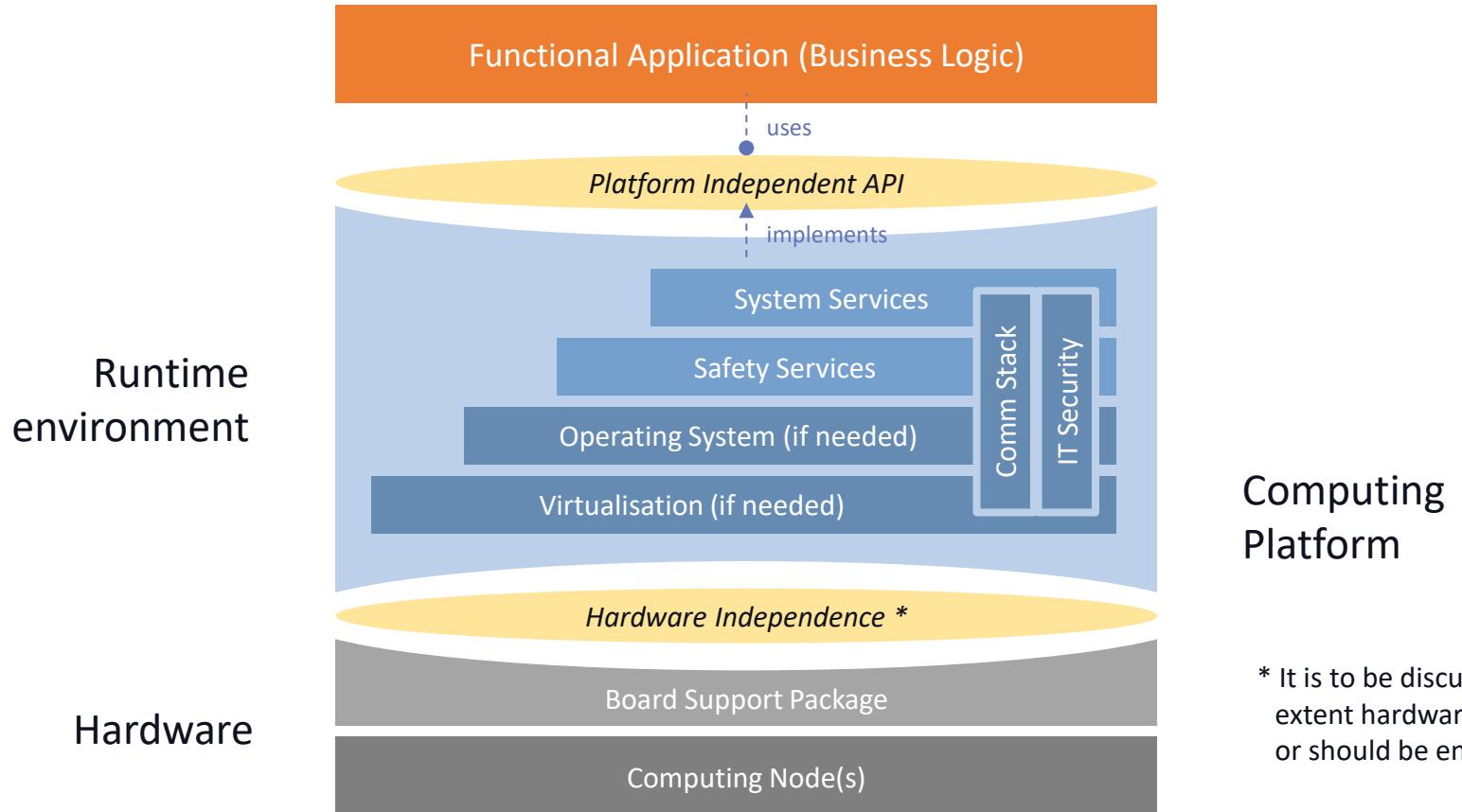
**Remark:** The network architecture of retrofit vehicles is only an example. Legacy architectures are always vehicle dependent and therefore the CCS integration is project specific.



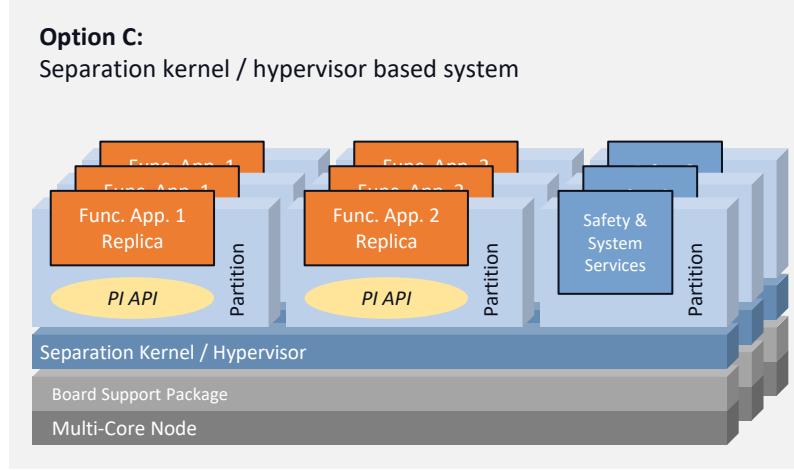
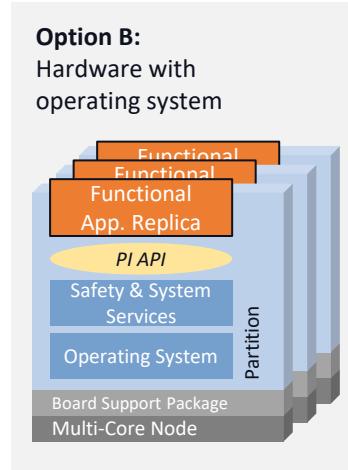
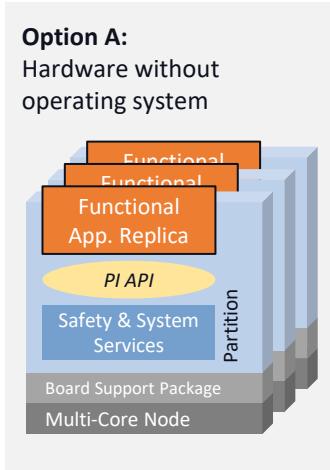


# Safe Computing Platform (SCP)

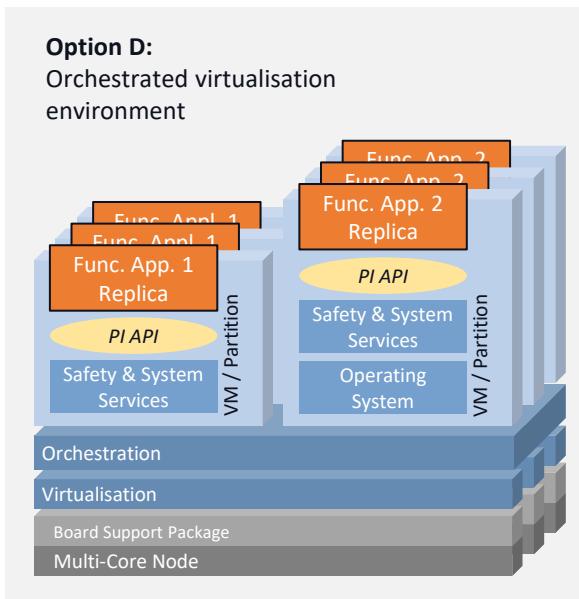
OCORA-BWS02-030 / v5.10 / 01.07.2024



# Computing Platform – Deployment Options



Likely options for **onboard** deployments



Likely option for **trackside** deployments

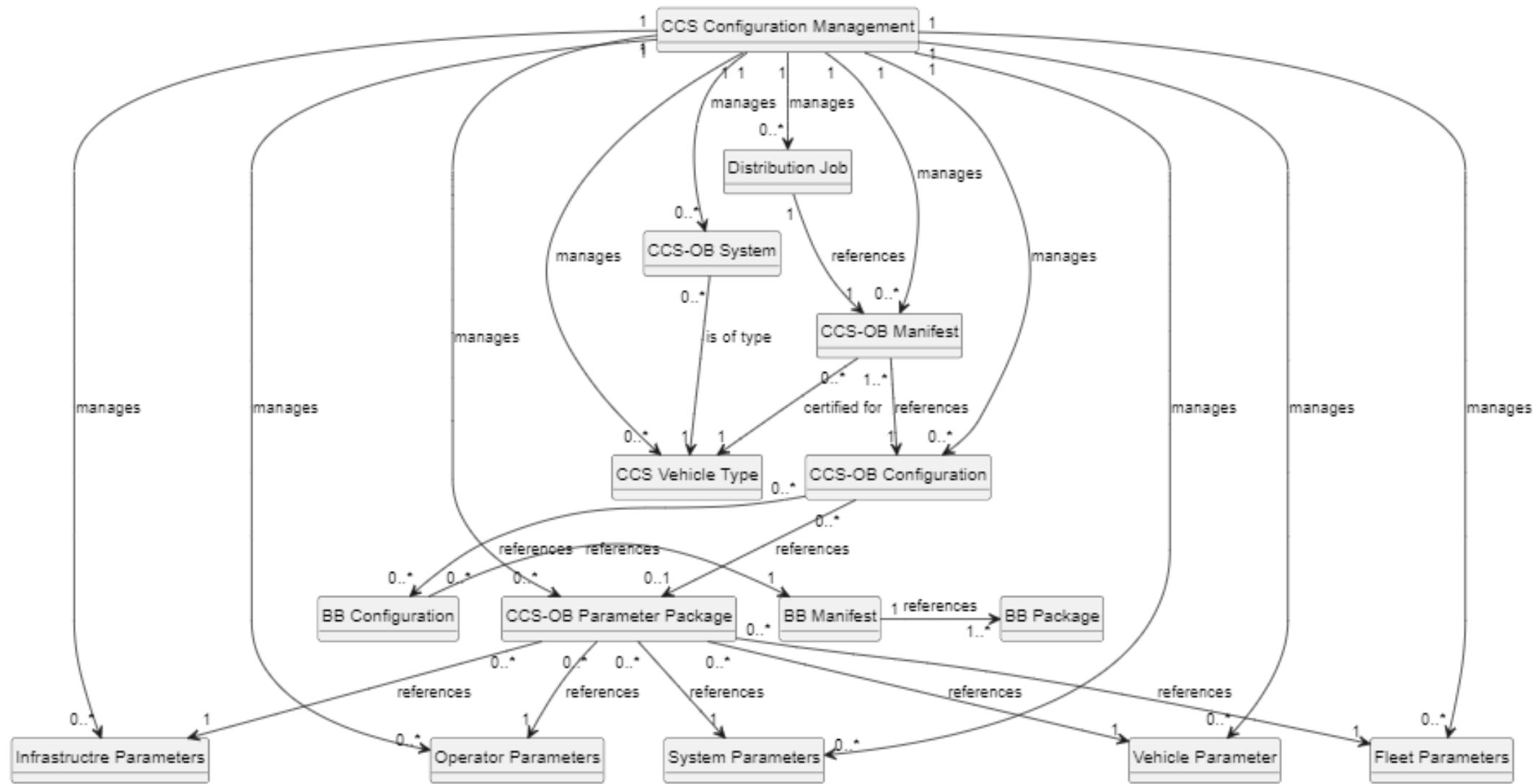
Platform options where applications are programmed against PI API  
*Approaches depicted in the diagram are non-exhaustive. The industry may propose different state-of-the-art solutions.*



# Configuration Management Concept

OCORA-BWS02-030 / v5.10 / 01.07.2024

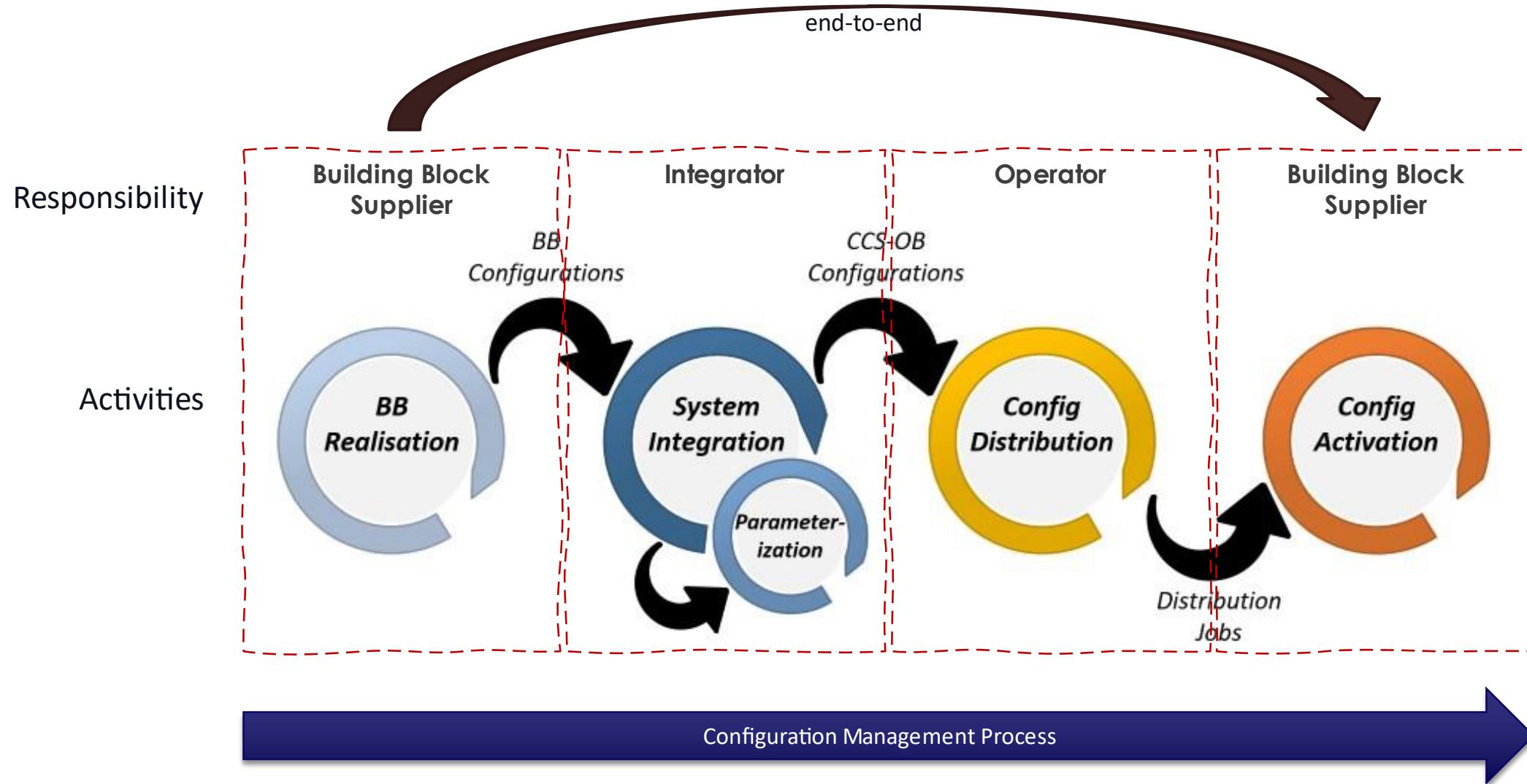
# Entity Relationship Diagram



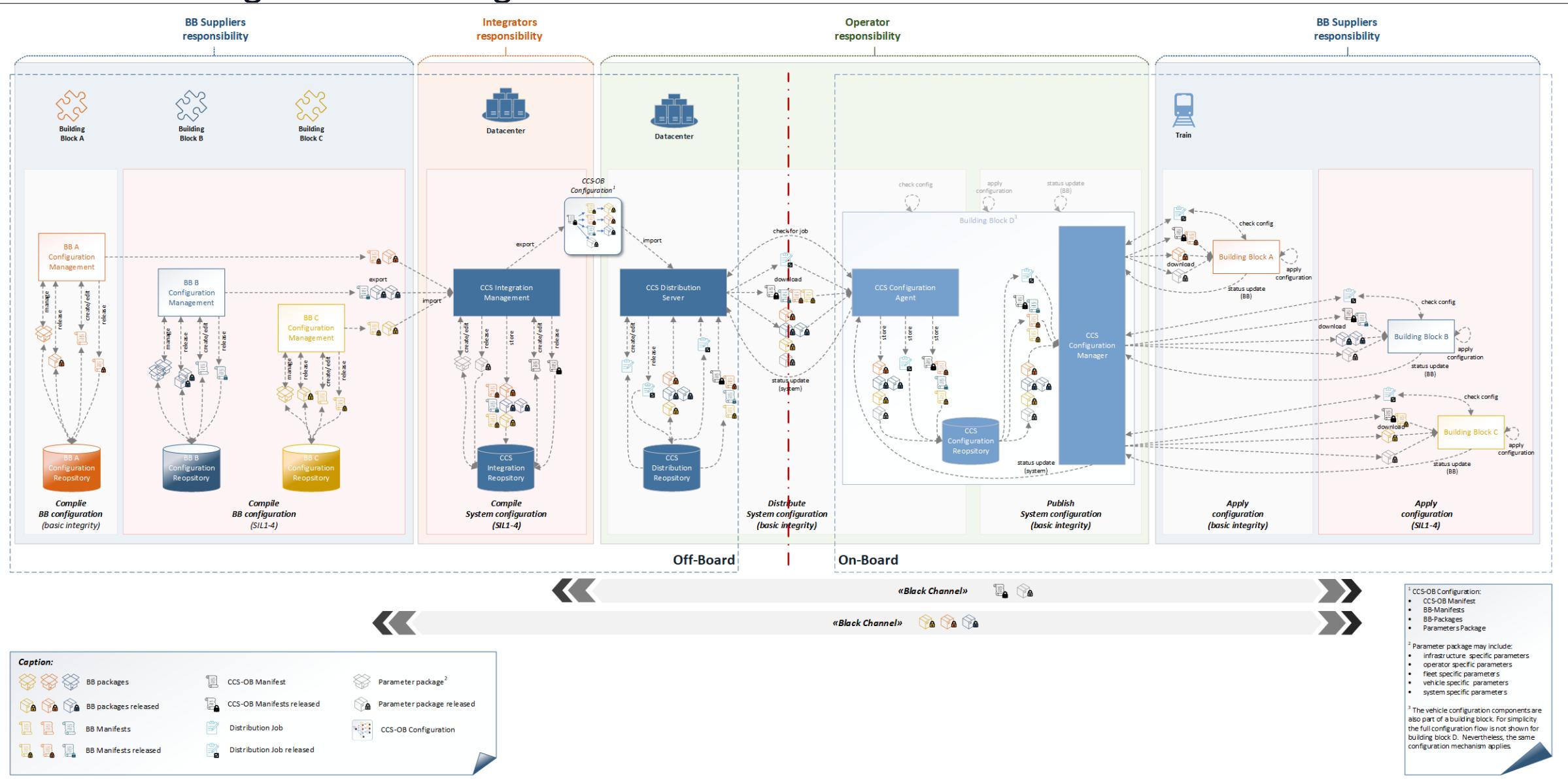
# Configuration Management Stakeholders & Activities

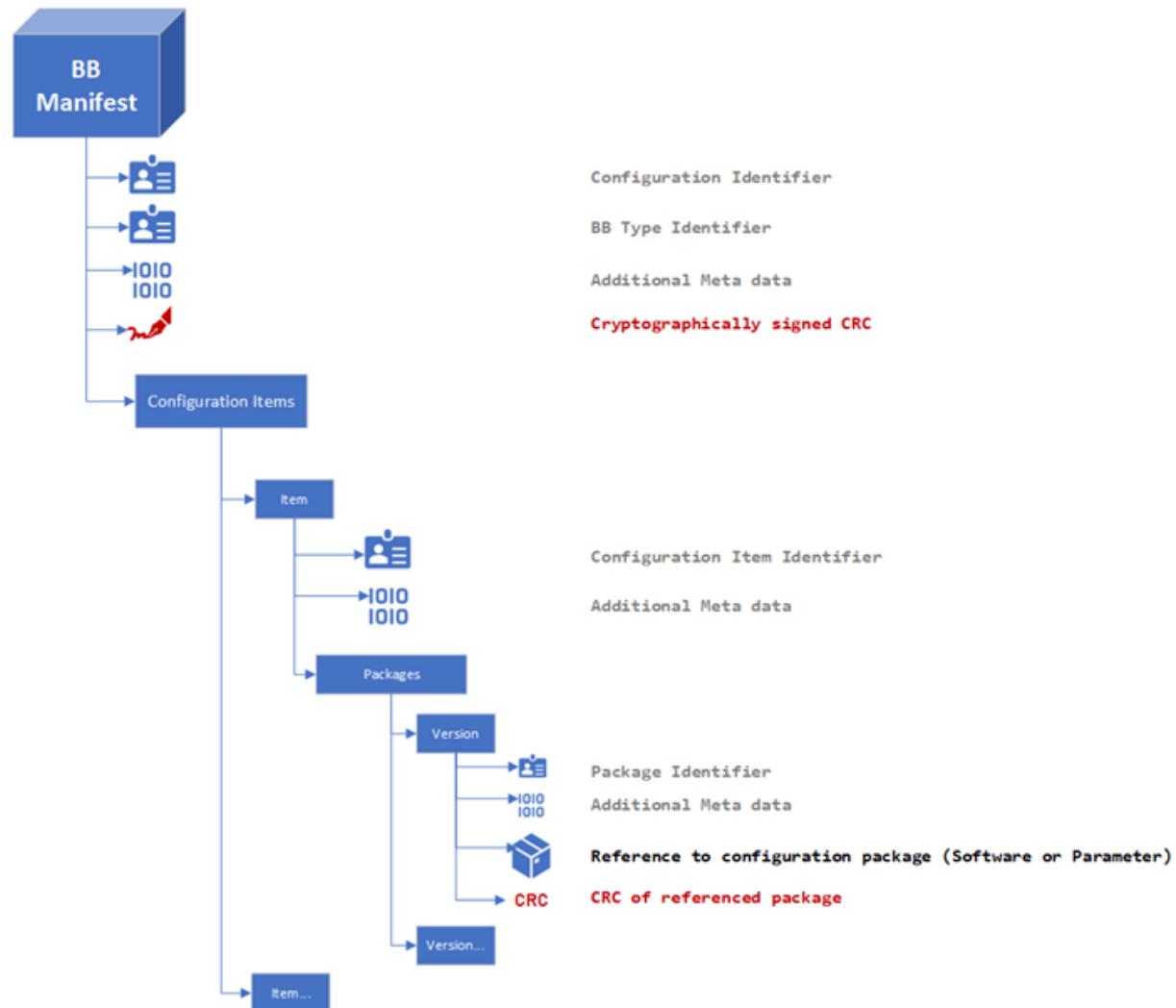


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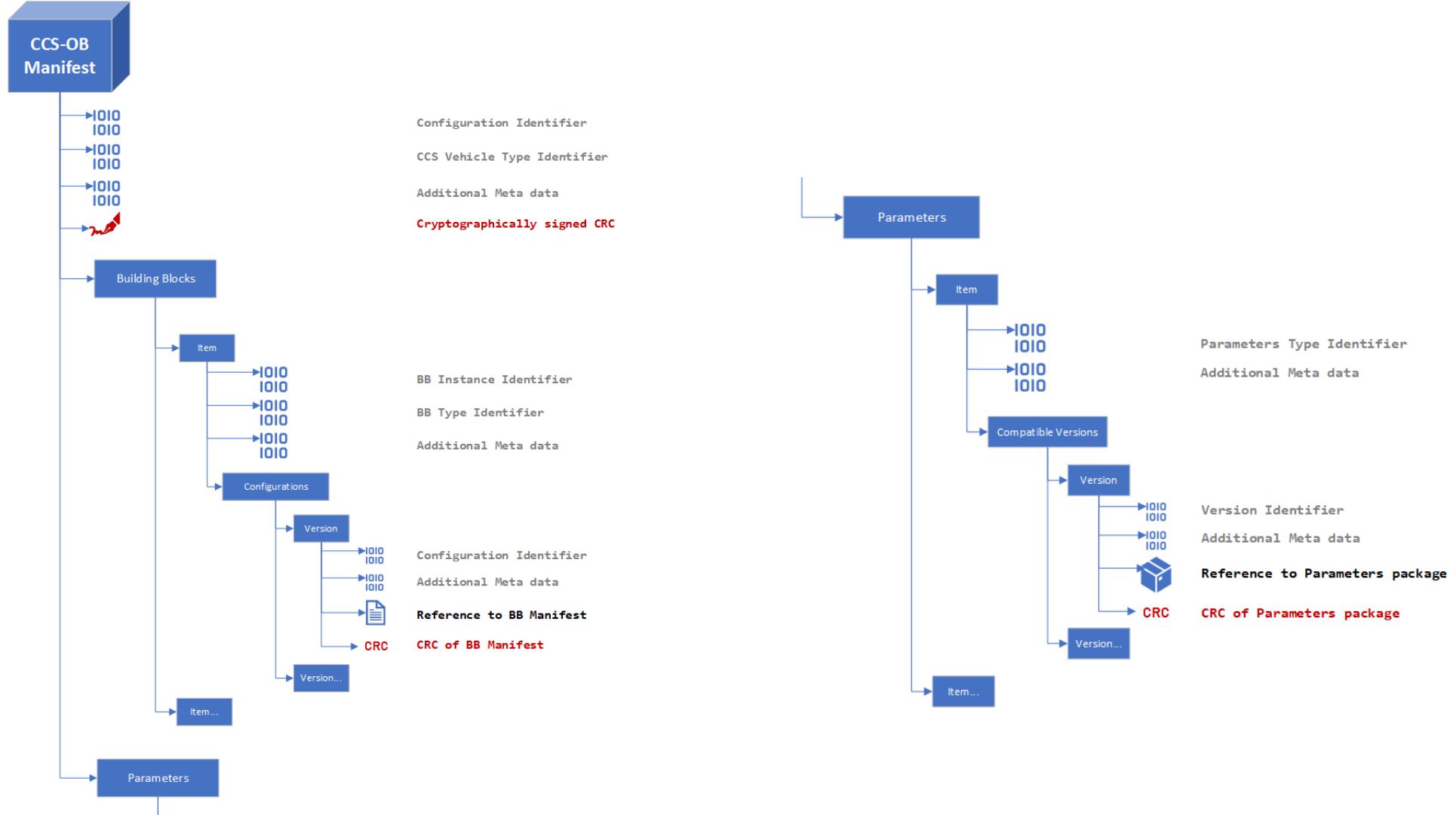


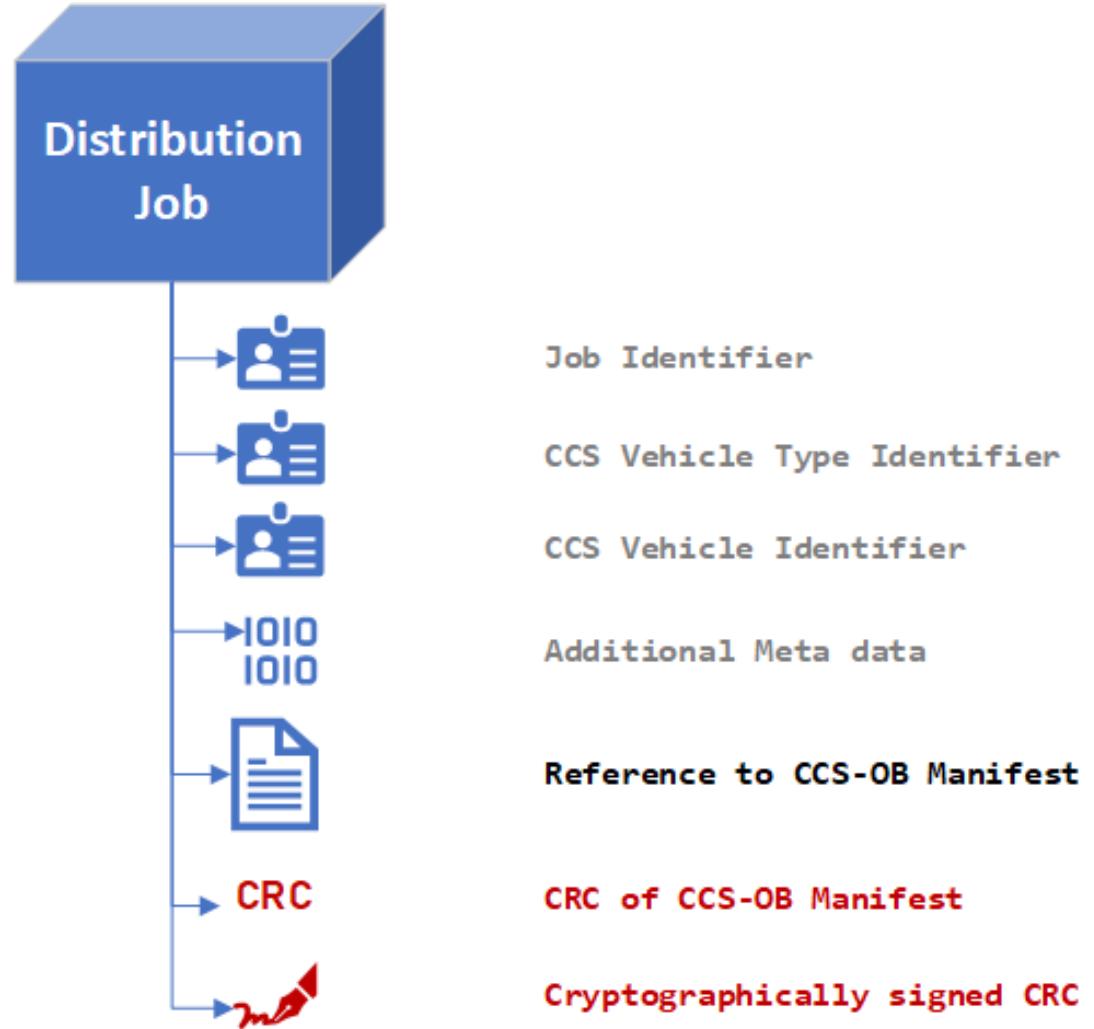
# Detailed Configuration Management Process



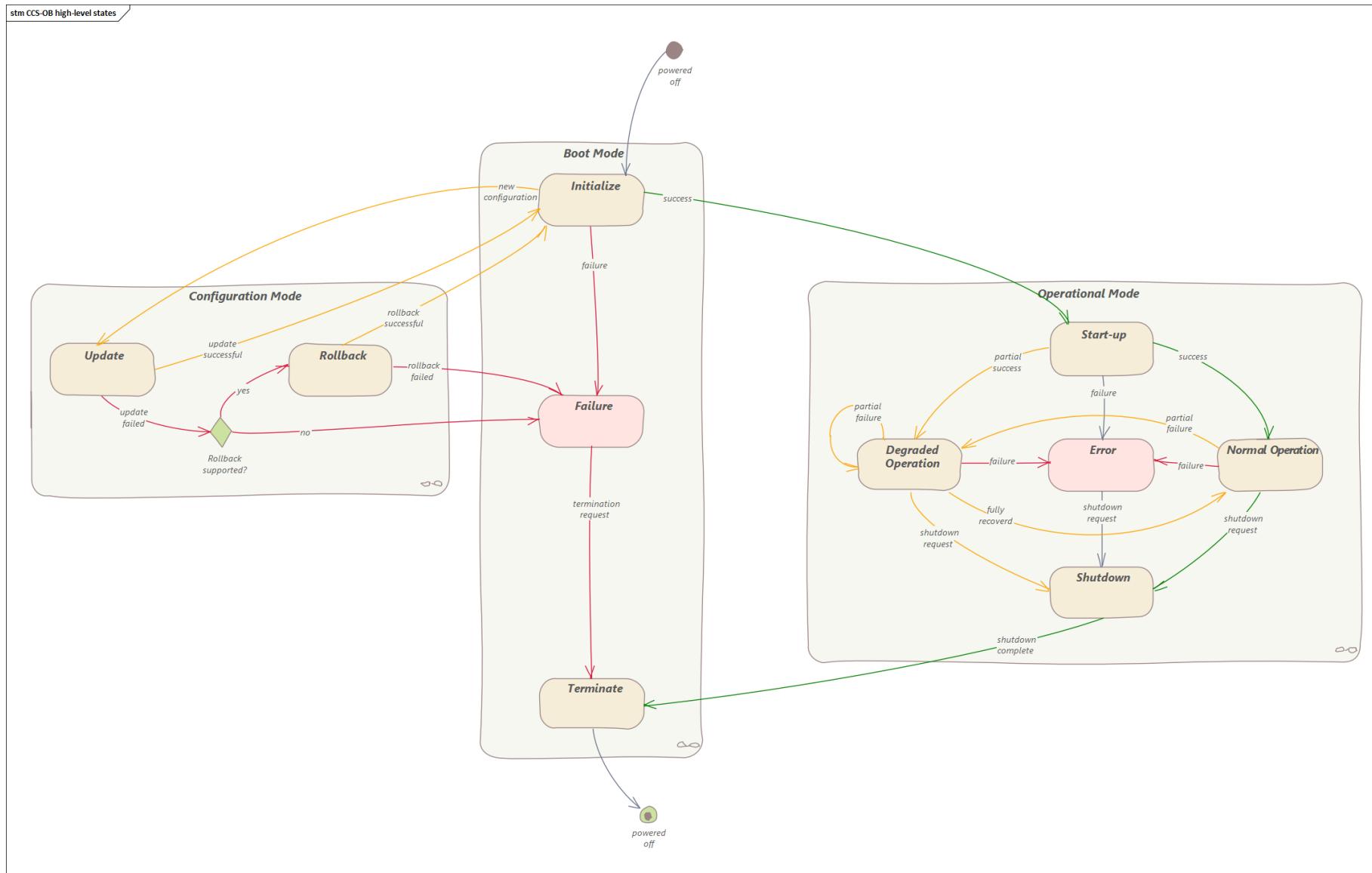


# CCS-OB Manifest





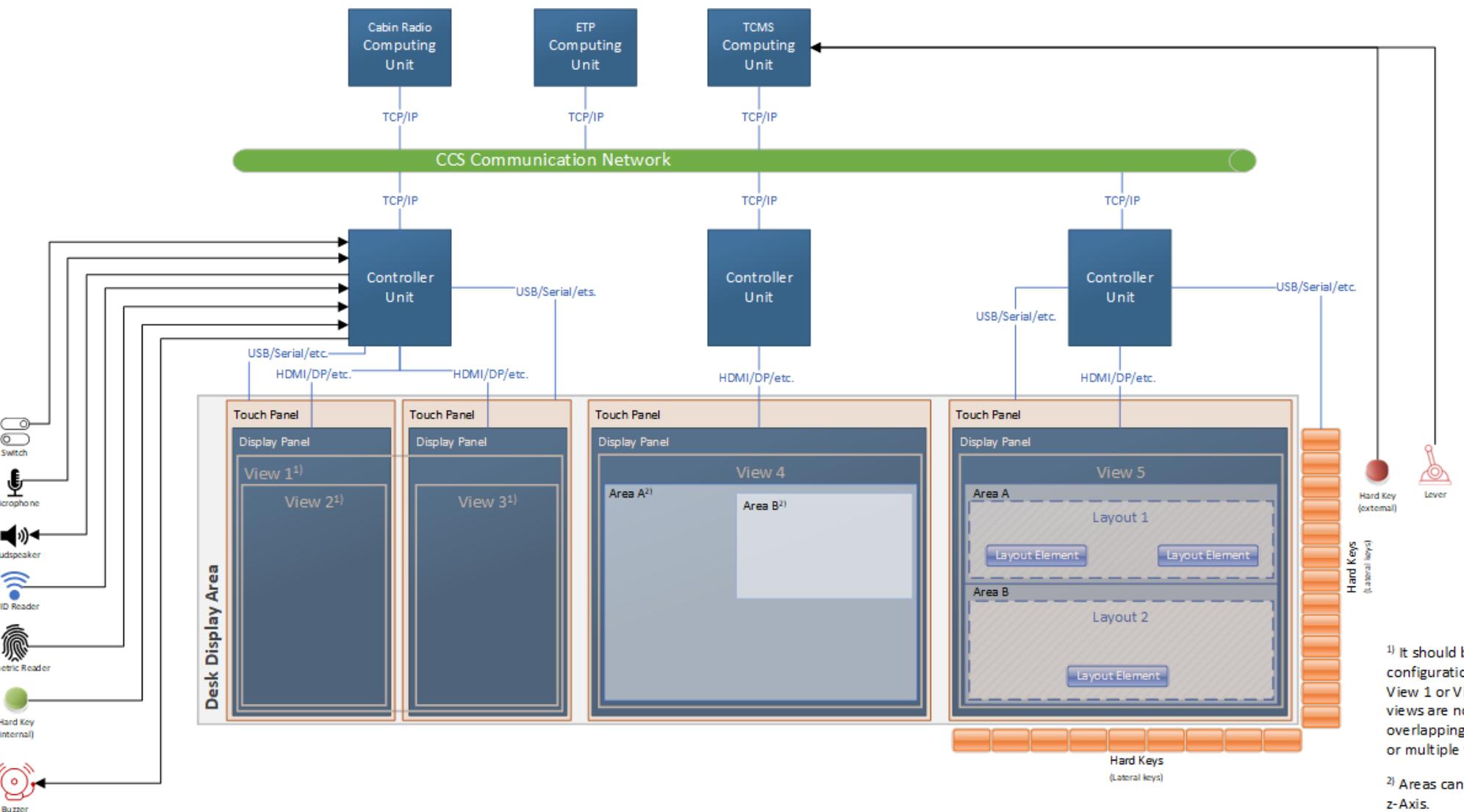
# Building Blocks Modes & States





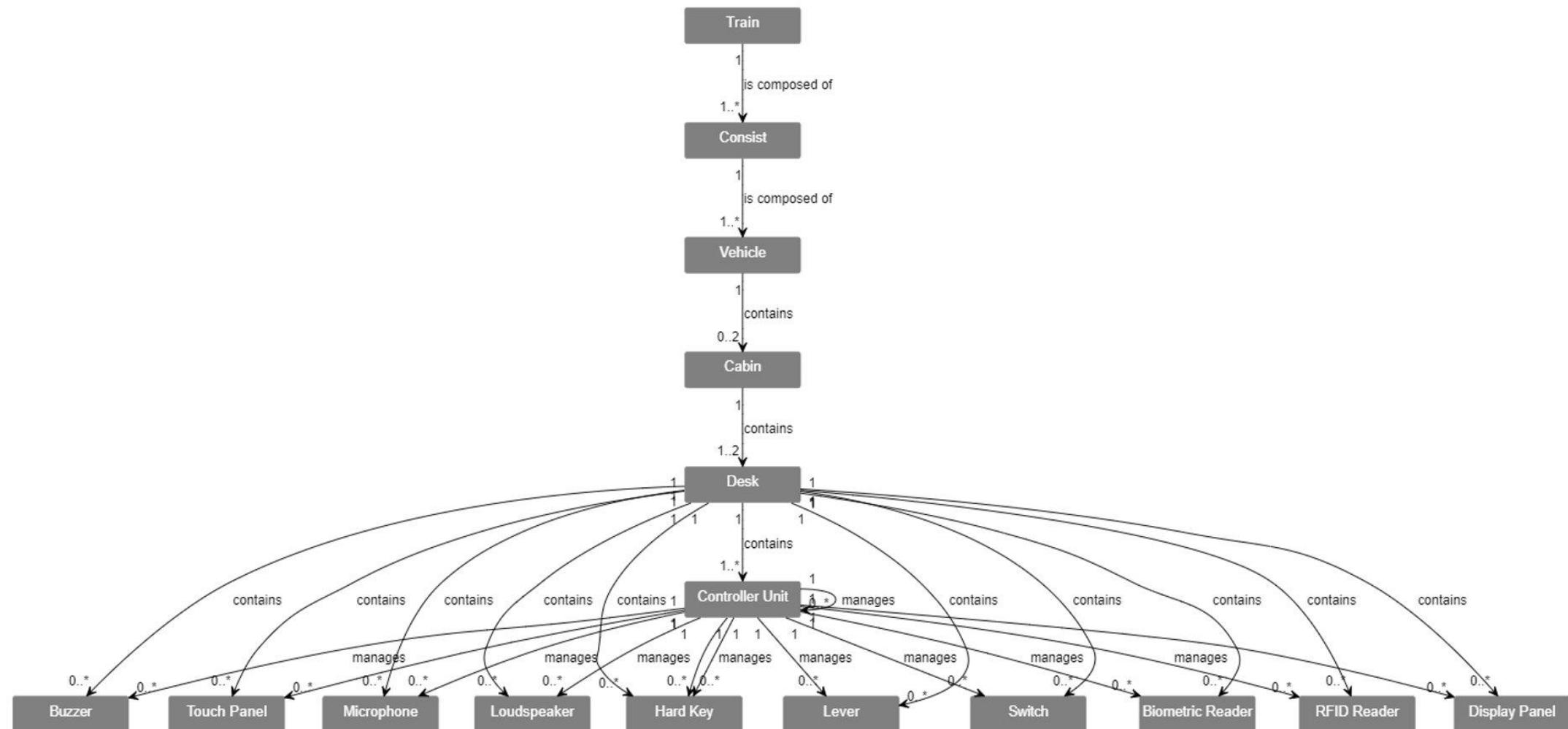
# Train Display System (TDS)

OCORA-BWS02-030 / v5.10 / 01.07.2024

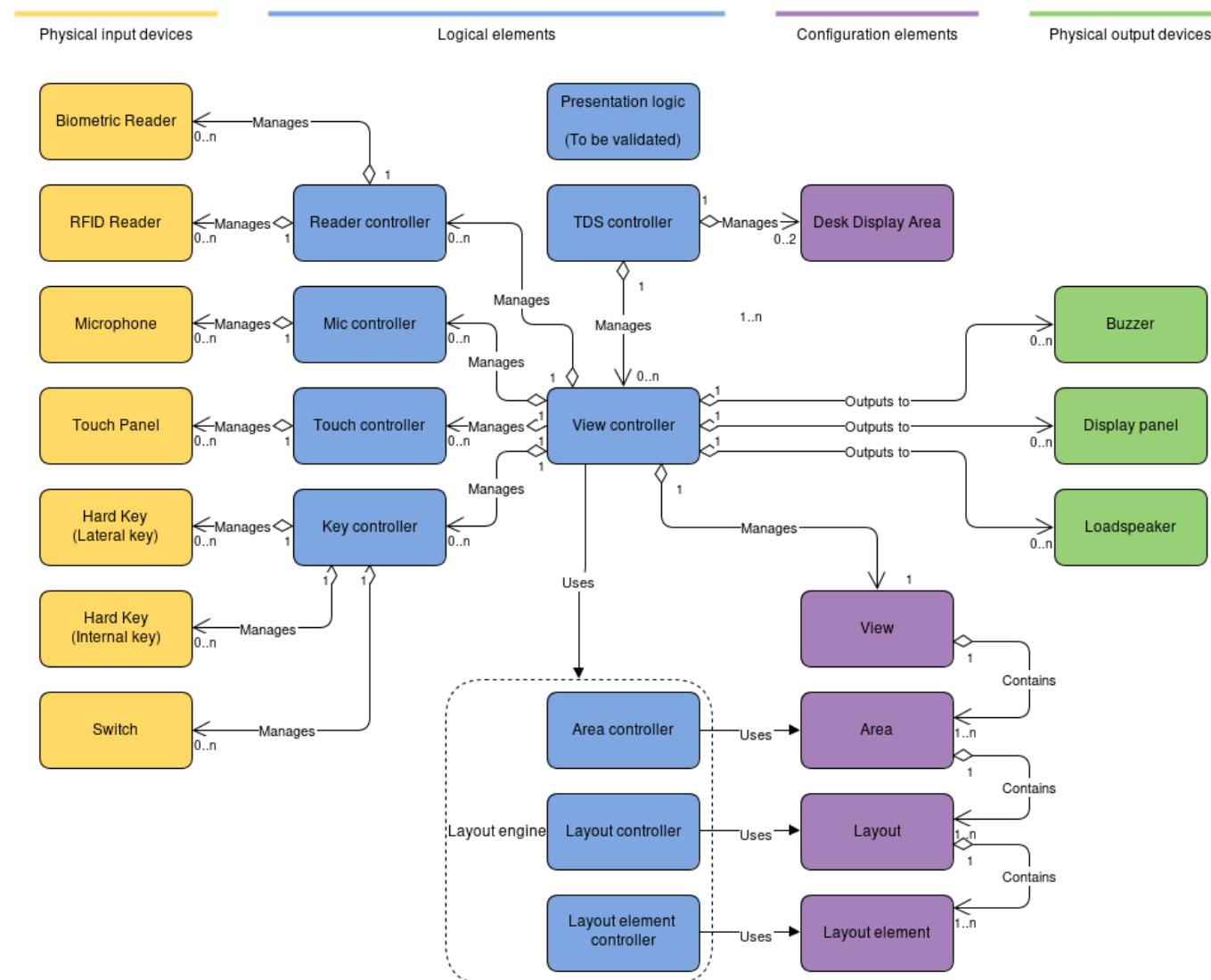


<sup>1)</sup> It should be noted that a valid configuration would have either View 1 or View 2 & View 3. Active views are not allowed to be overlapping. They always cover one or multiple full displays.

<sup>2)</sup> Areas can be overlapping and have a z-Axis.



# TDS – Logical Terminology



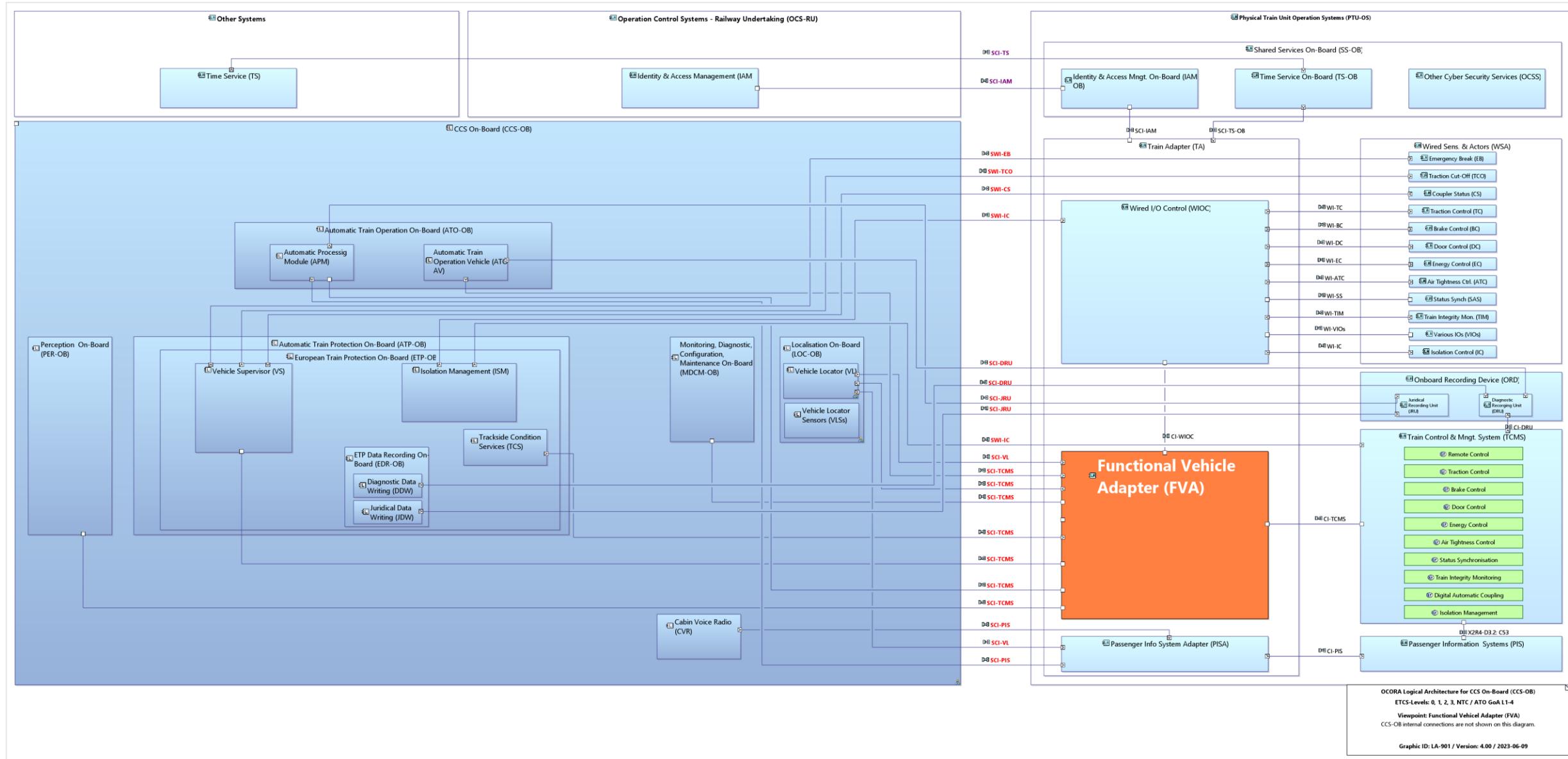


# Functional Vehicle Adapter (FVA)

OCORA-BWS02-030 / v5.10 / 01.07.2024

# Legacy Train Example – Focus FVA

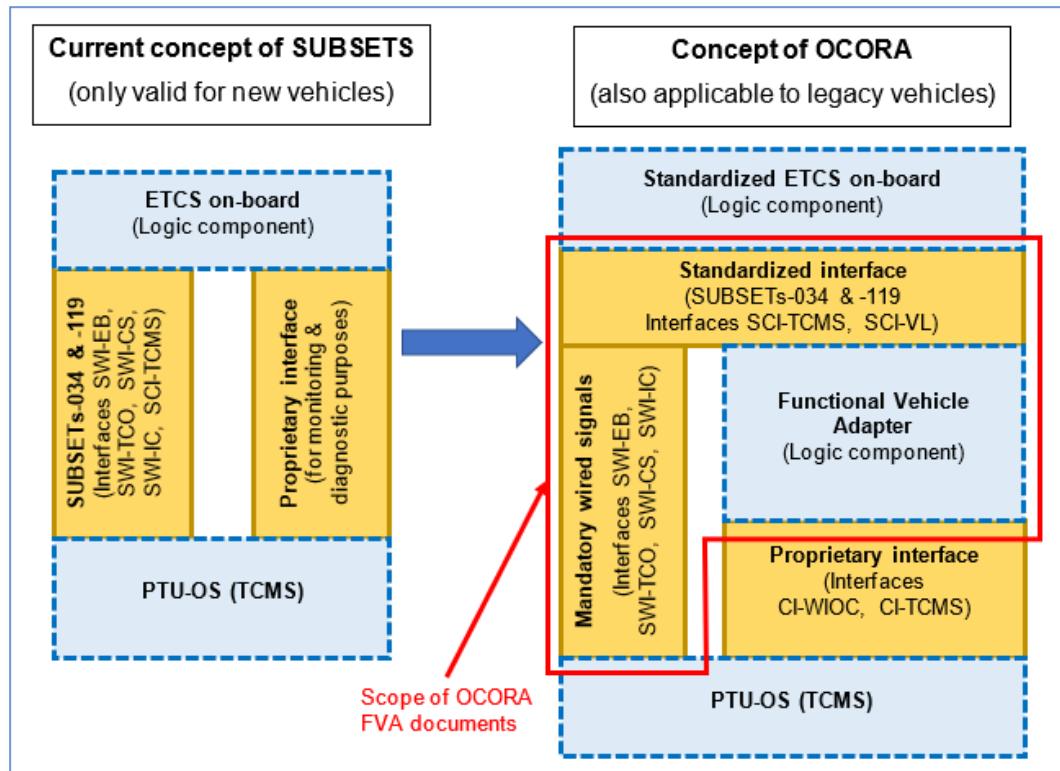
Actors and External Interfaces



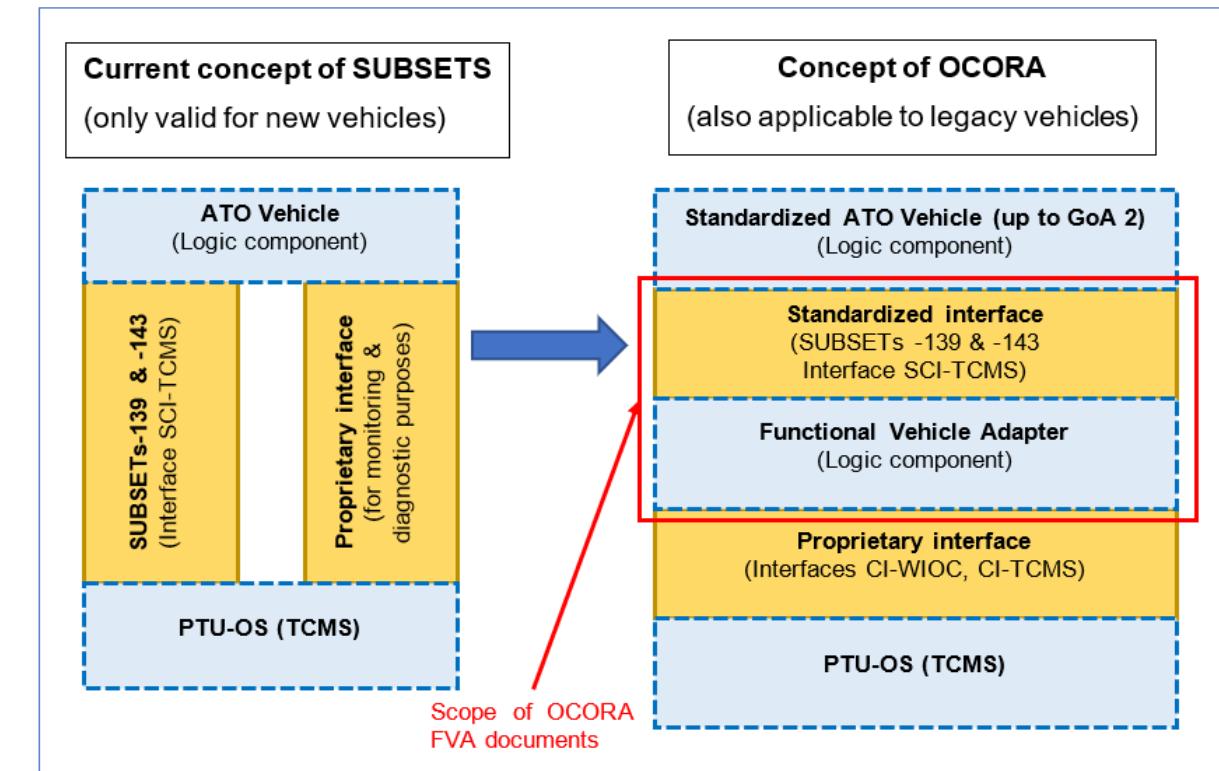
OCORA

OCORA-BWS02-030 / v5.10 / 01.07.2024

## ETCS

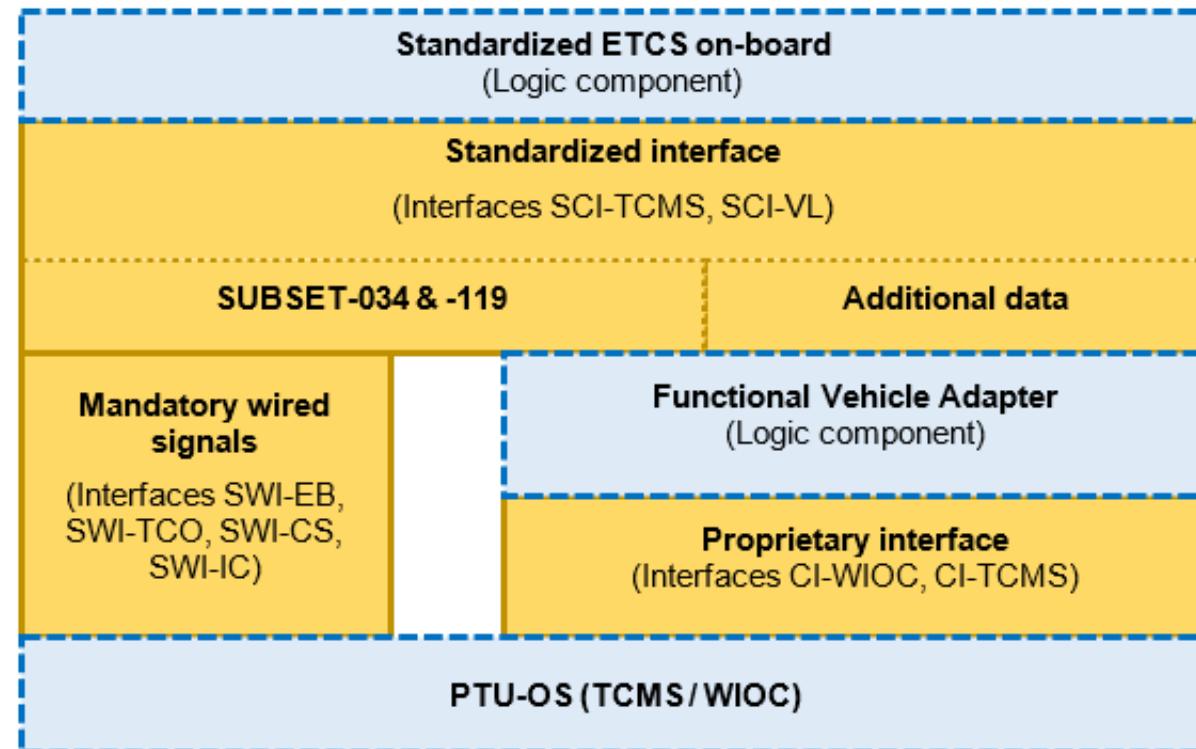


## ATO

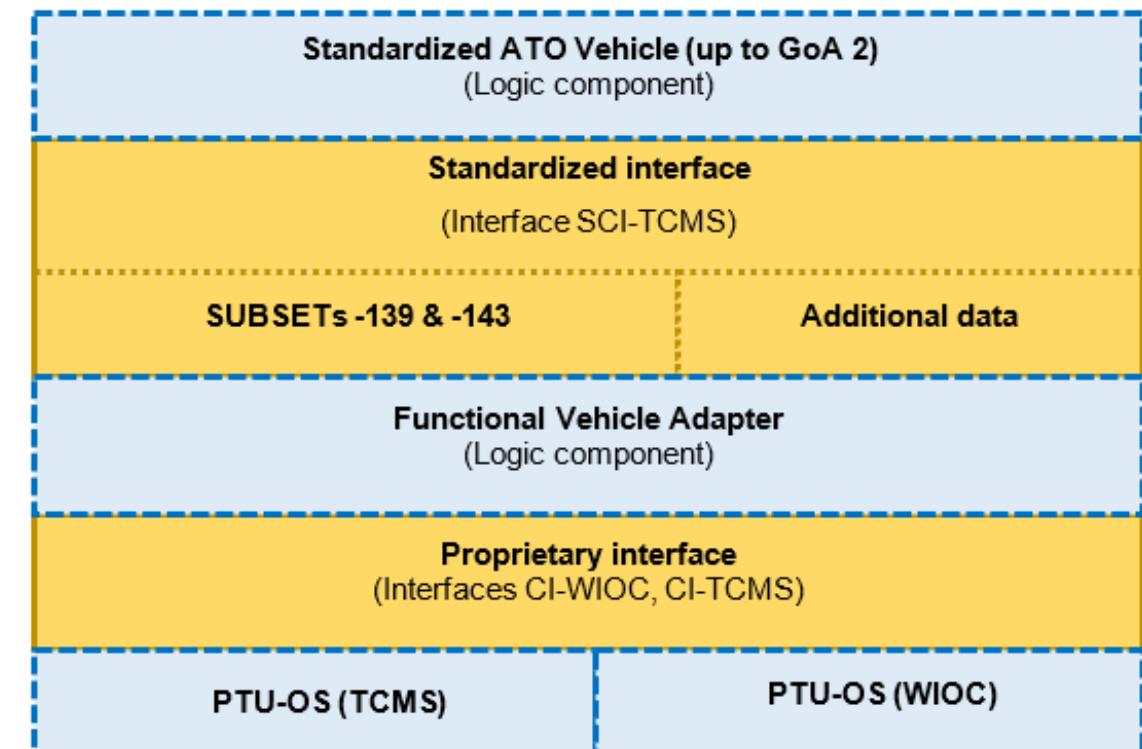


Details in Document: OCORA-TWS04-010 – Functional Vehicle Adapter - Introduction

## ETCS



## ATO



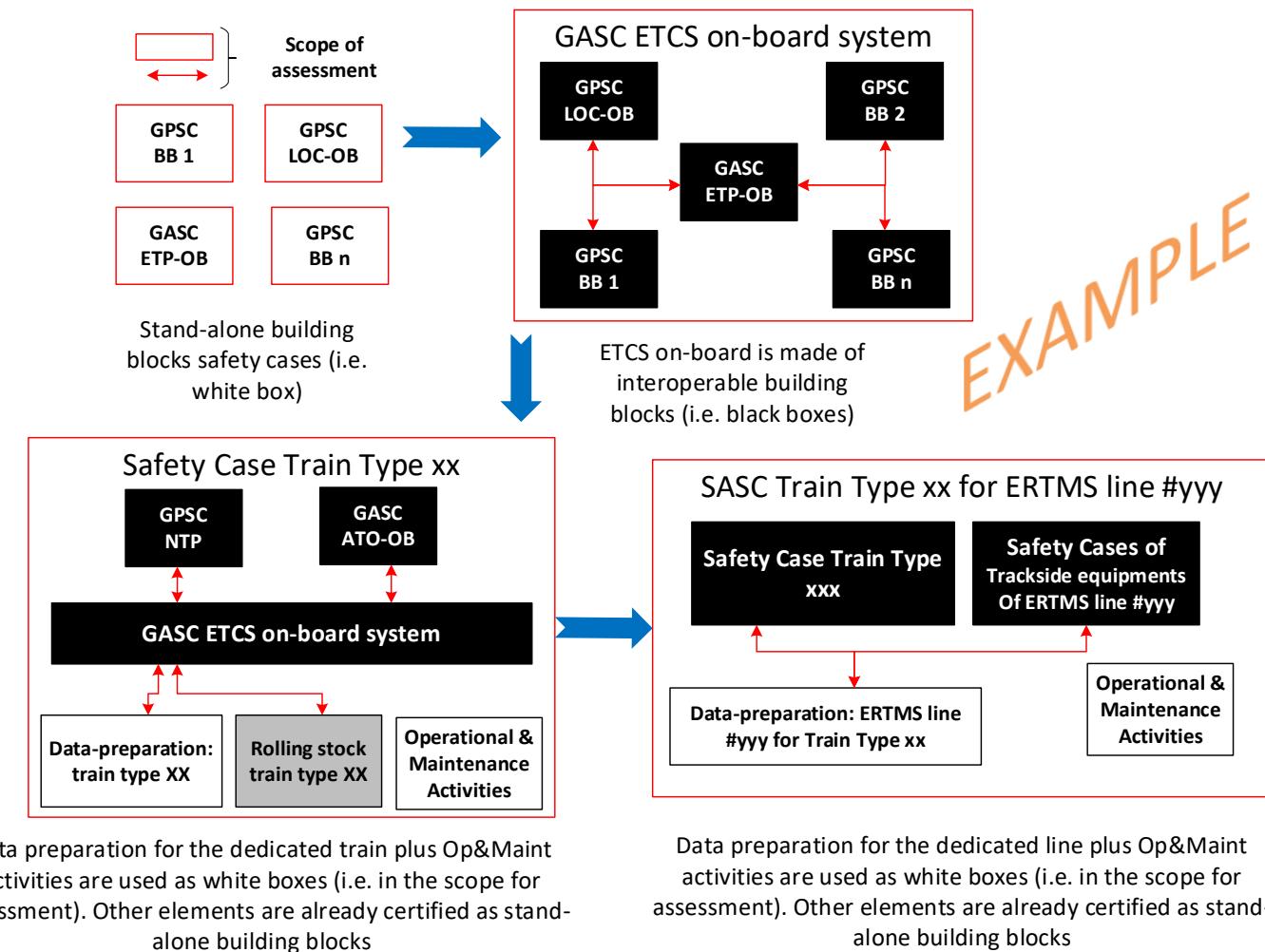
Details in Documents: OCORA-TWS04-013 – Design Guideline



# Modular Safety

OCORA-BWS02-030 / v5.10 / 01.07.2024

- Modular Safety defines the hierarchy between safety cases from building blocks to specific application(s).
- One of the main goal is to **reduce the certification efforts from BB to specific application(s)**; initial and re-certification by limiting the “Domino’s effect (propagation of modifications at all upper levels) without degrading the safety level of the analyses.
- Modular Safety shall also defines the safety elements to allow the homologation of stand-alone building blocks:
  - Hazardous events based on TSI CCS SUBSET-088
  - TFFR (Tolerable Functional Failure Rate) based on TSI CCS SUBSET-088
  - Safety requirements based on OCORA R3
  - Harmonised and generic set of SRAC/AC

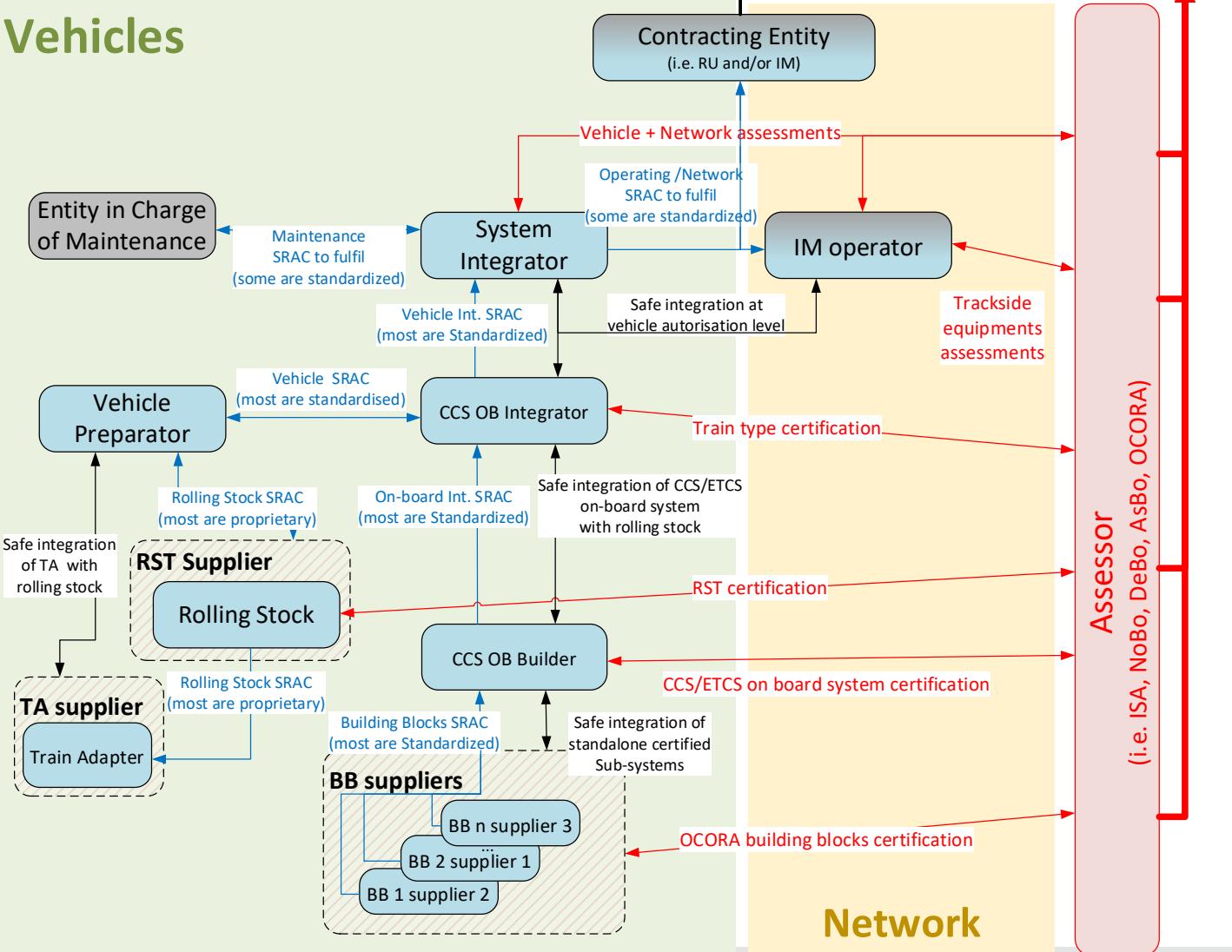


# OCORA – Modular Safety - Stakeholders

\*Who can apply for a vehicle authorisation?

The applicant for vehicle authorisation is the natural or legal person requesting an authorisation. The law does not impose a restriction on who can play the role of applicant: it can be a railway undertaking, an infrastructure manager, a manufacturer, an owner or a keeper.

## Vehicles



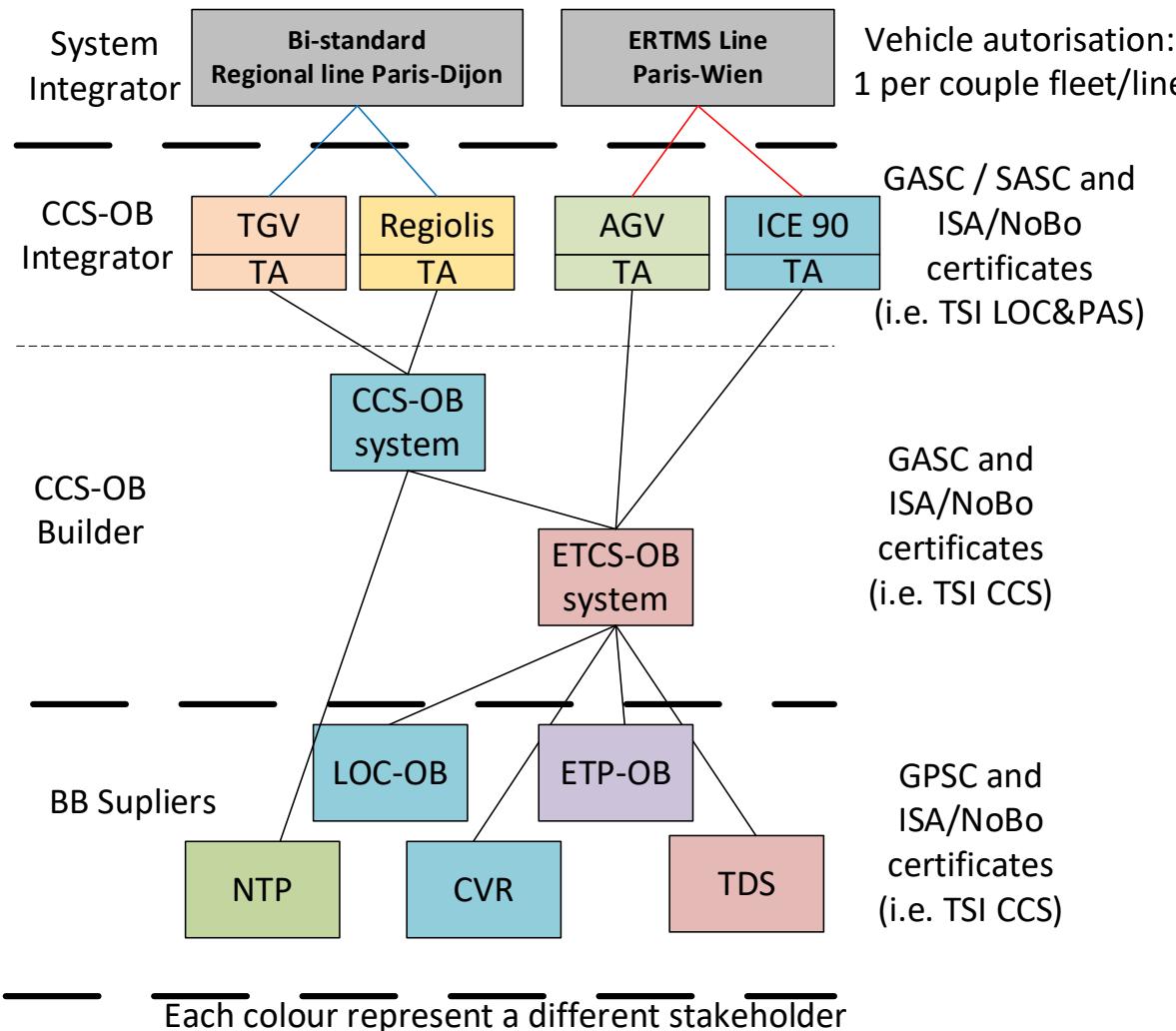
- **BB suppliers** shall create the building blocks and ensuring their certification (NoBo, OCORA, ISA...)
- **CCS-OB Builder** shall ensure the *safe integration* of the different BB and ensure its certification (NoBo, OCORA, ISA...)
- **TA Supplier** shall provide the train adapter according to the Vehicle Environment and ensure its certification (NoBo, OCORA, ISA...)
- **Vehicle Preparator** shall perform the *safe integration* of the TA in the Vehicle Environment
- **CCS-OB Integrator** shall perform the *safe integration* of the CCS-OB system in the prepared vehicle and ensure its certification (NoBo, OCORA, ISA/AsBo...)
- **System Integrator** in collaboration with the IM shall perform the *safe integration* of the full Vehicle in the selected network and ensure its certification (NoBo, DeBo, AsBo...)
- **Contracting Entity** shall realise the call for tenders for all stakeholders and handle the final Authorisation for Placing on the Market with the NSA/ERA

*safe integration* scope of activities is defined into:  
era\_1209-063\_clarification\_note\_on\_safe\_integration\_en



# OCORA – Modularity & Safety Approval

## Key roles



Case of two independent systems made of building blocks from different suppliers

- Different *reference systems* can be created:
  - ETCS-OB
  - CCS-OB
- The *reference systems* can be reused in any type of train thanks to the Train Adapters
- No re-certification is required for them => cross acceptance rules defined by OCORA are respected
- A reference system at train and then at system levels can be created and reuse as basis for all other vehicles equipped with the CCS/ETCS-OB system. Certifications focuses on the different conditions of use (to be defined post OCORA R3)
- That mutualises projects resources at RU's level on similar fleets and ease the process to get the Authorisation for Placing on the Market
- For the next certifications steps (during the lifetime), a generic and systematic approach defined by OCORA, based on CSM-RA will then help any stakeholder to handle easier (I.e. less delay and costs than today) the evolutions at any level

# OCORA – Modularity & Integration Tasks



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→ System Integrator

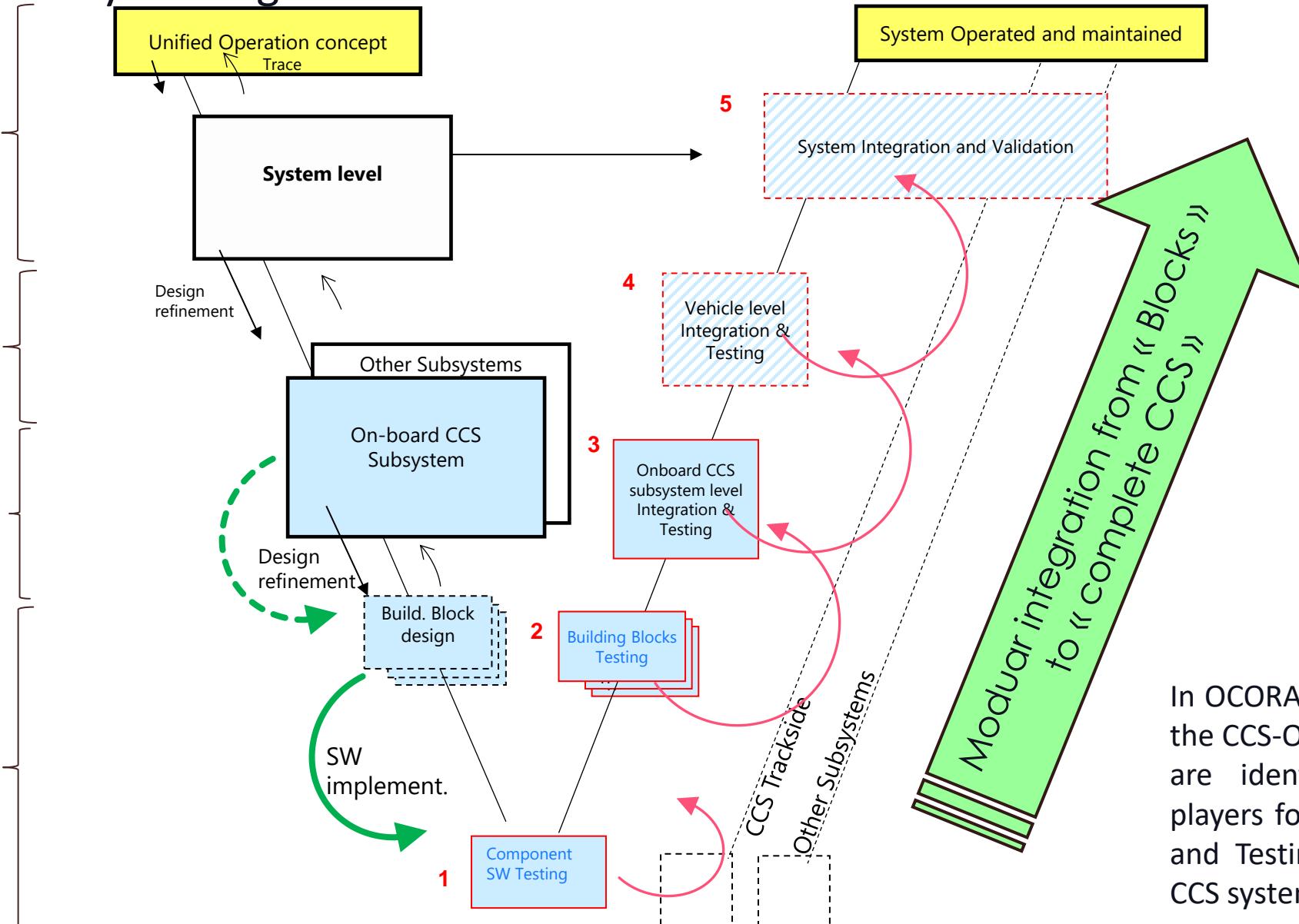
→ CCS-OB Integrator

→ CCS-OB Builder

→ Building Blocks Suppliers

Scope of OCORA

1, 2...: integration steps



In OCORA compliant projects, the CCS-OB builder/integrator are identified as the key players for Safety, Integration and Testing of the on-board CCS system.



OCORA

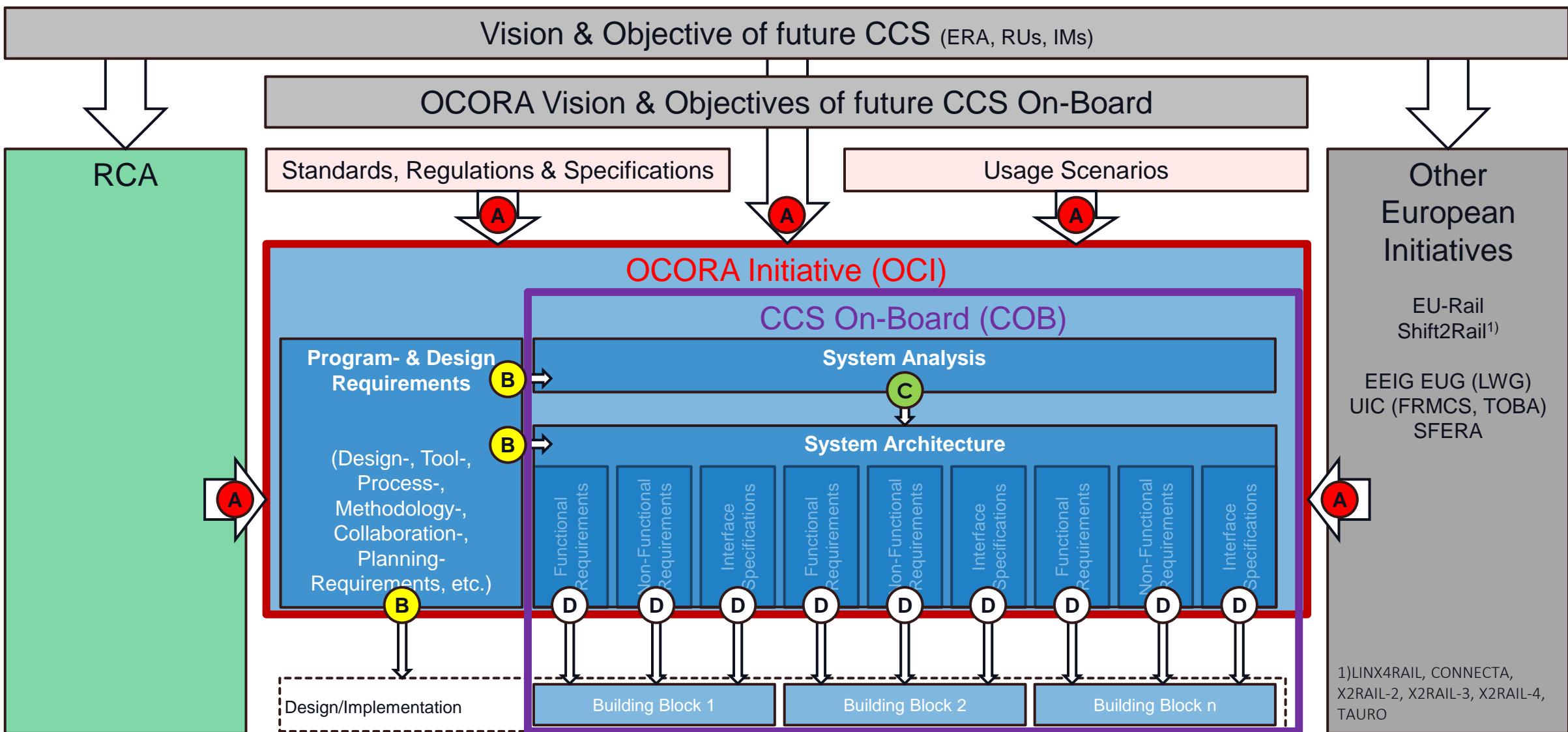
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# Methodology & Tooling

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## Structuring the Requirements

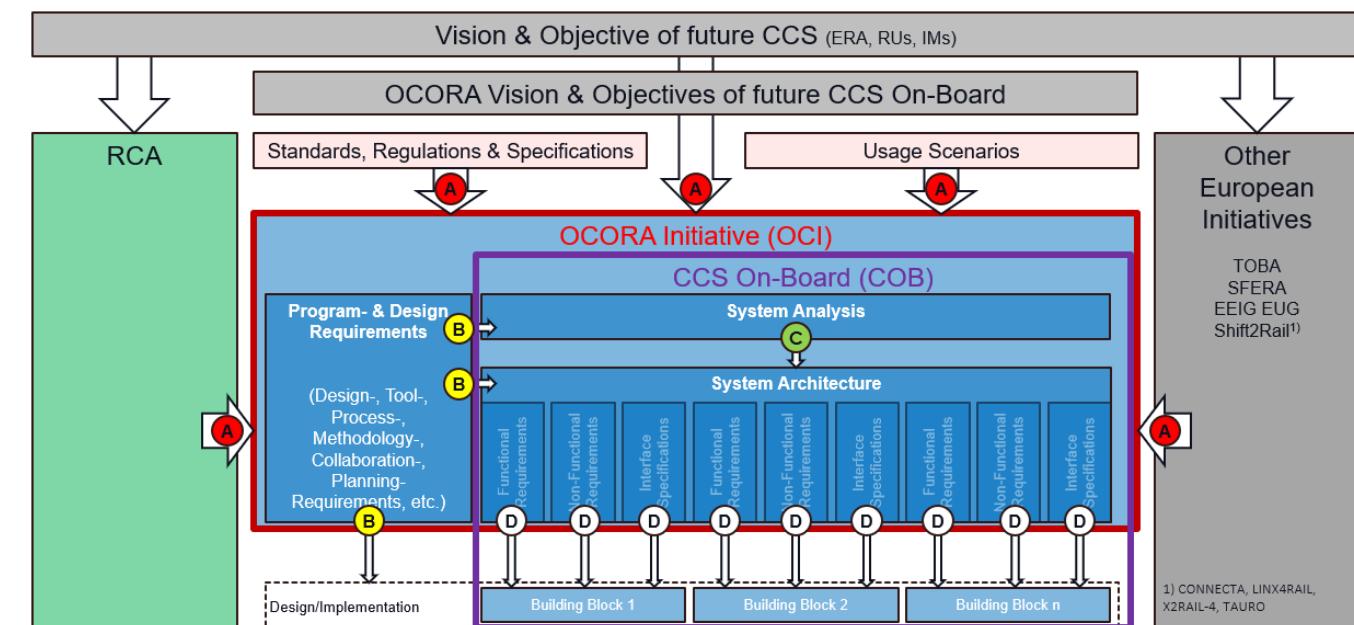


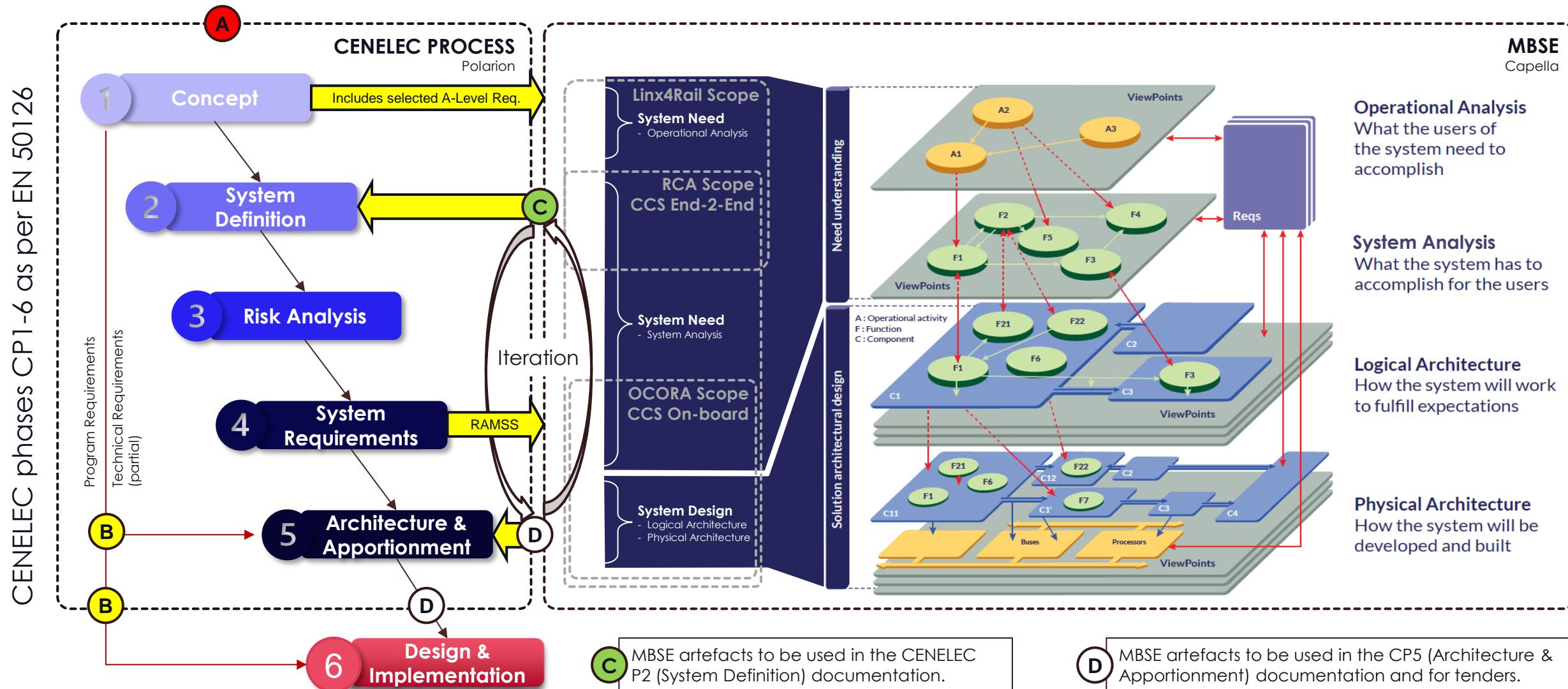
1)LINX4RAIL, CONNECTA,  
X2RAIL-2, X2RAIL-3, X2RAIL-4,  
TAURO

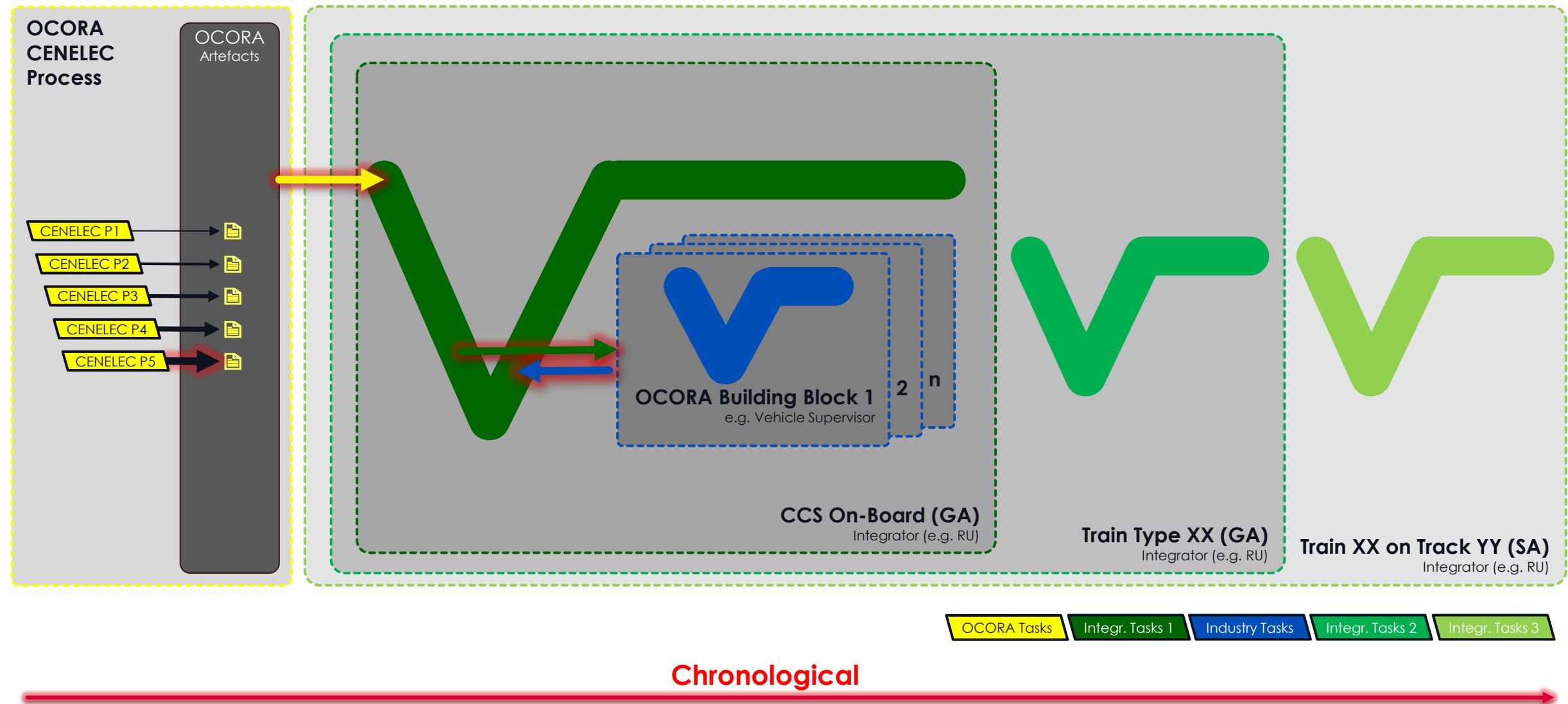
# OCORA Requirements Engineering

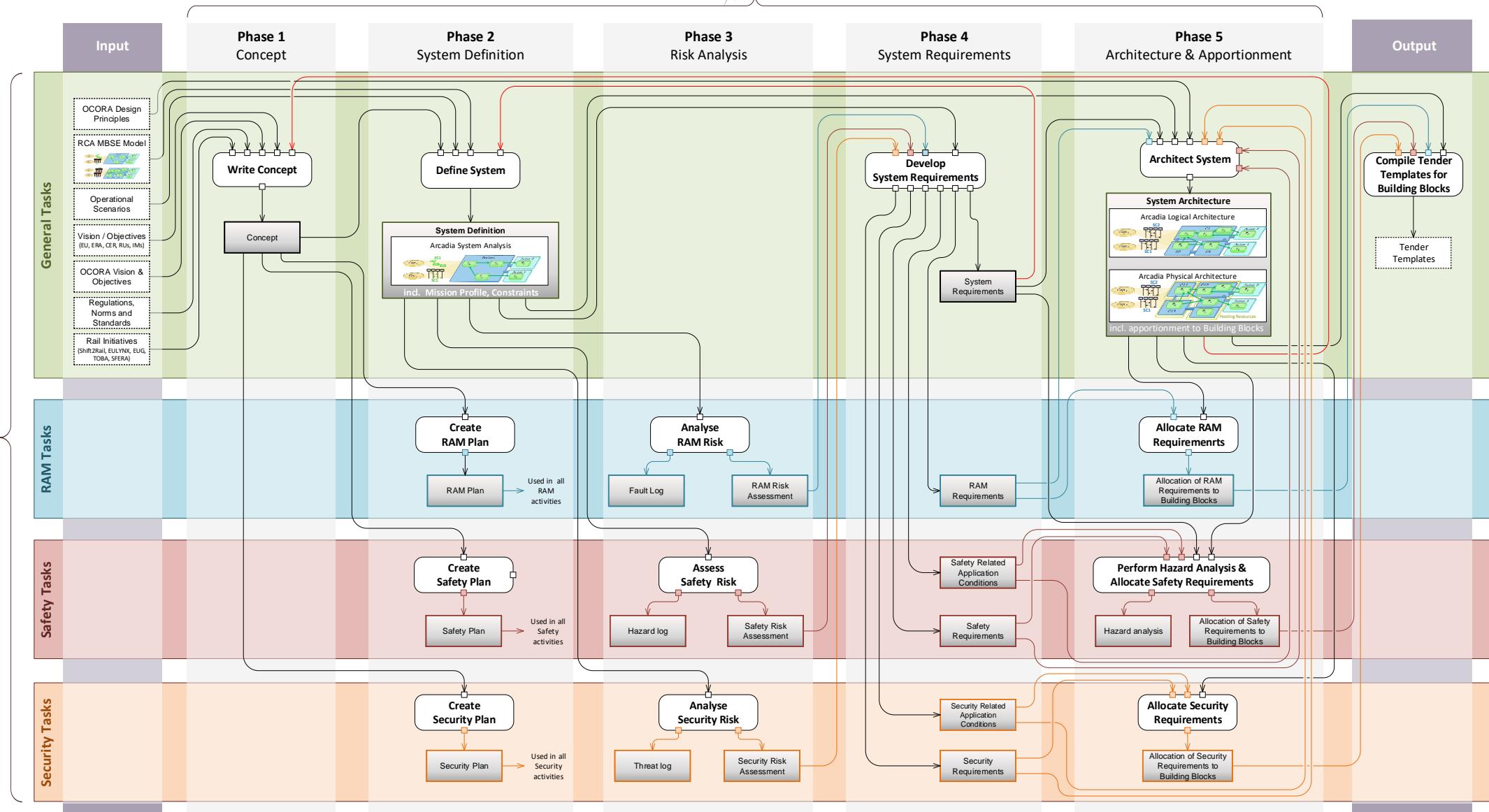
## Requirement Definitions

- A Stakeholder Requirements:** OCORA has to manage many different requirements, coming from many different stakeholders.
  - B Program- & Design Requirements:** The OCORA program defines tools, processes, methodologies and design rules to be used within the program and to be considered during the system analysis and the system design/architecture work.
  - C System Requirements:** Requirements in regards to the OCORA system are developed in the MBSE System Analysis (RCA & OCORA), taking into account the A- and B-Level Requirements.
  - D Building Block Requirements:** Requirements in regards to the OCORA building blocks are developed in the MBSE System Architecture (logical / physical), taking into account the MBSE System Analysis. The resulting documentation form the OCORA tender templates, together with the applicable program requirements.











SBB CFF FFS



# Operational Concept

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# Operational Concept Overview



## Live Cycle of Passenger, Freight, and Construction Trains

+/- 40 years overall life-time

