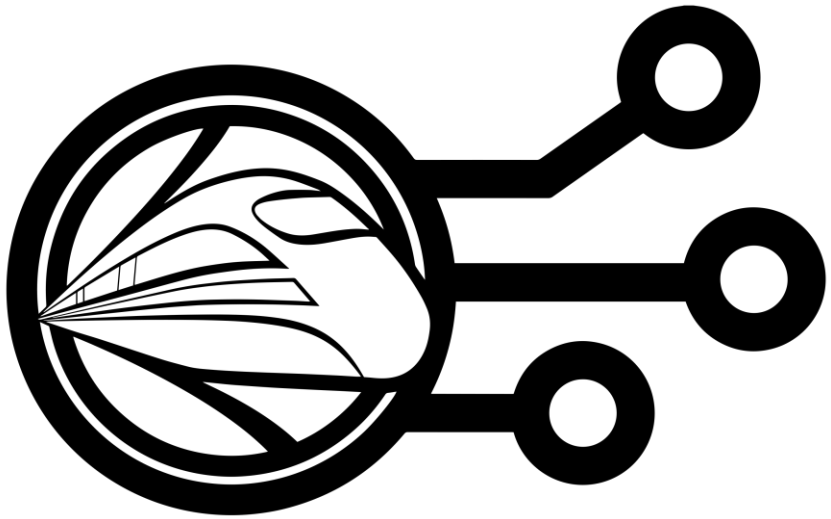

OCORA

Technical Slide Deck

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Presentation Overview

Logical Architecture
- Actors and External Interfaces
- Components and Internal Interfaces
- Automatic Train Protection On-Board (ATP-OB)
- Localisation On-Board (LOC-OB)
- Functional Vehicle Adapter (FVA)
- Envisioned Software Building Blocks (tentative)

Physical Architecture
- Final View
- Transition View
- Actors, External Interfaces
- Components, Internal Interfaces
- Envisioned Hardware Building Blocks (tentative)

Train Integration Scenarios
- Scenario 1: Legacy Train
- Scenario 2: NG-TCN Train (Separate Networks)
- Scenario 3: NG-TCN Train (Common Network)

Network Topology / Integration
- Scenario 1: Legacy Train
- Scenario 2: NG-TCN Train (Separate Networks)
- Scenario 3: NG-TCN Train (Common Network)
- Connecting Multiple Consists

Computing Platform
- High-Level Architecture
- Approaches

Functional Vehicle Adapter

Modular Safety

Security

Methodology & Tooling

Supporting Slides

Logical Architecture

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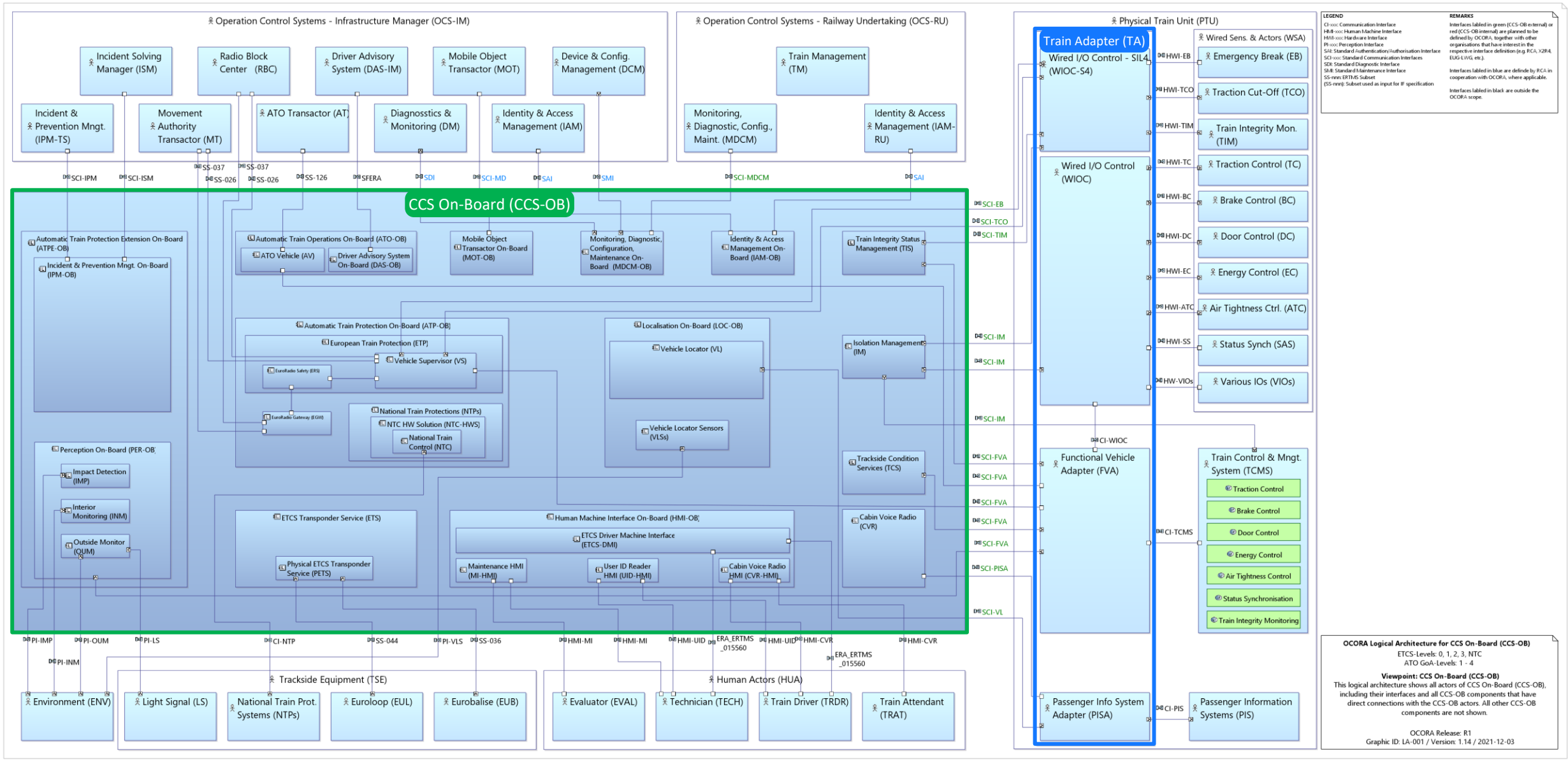
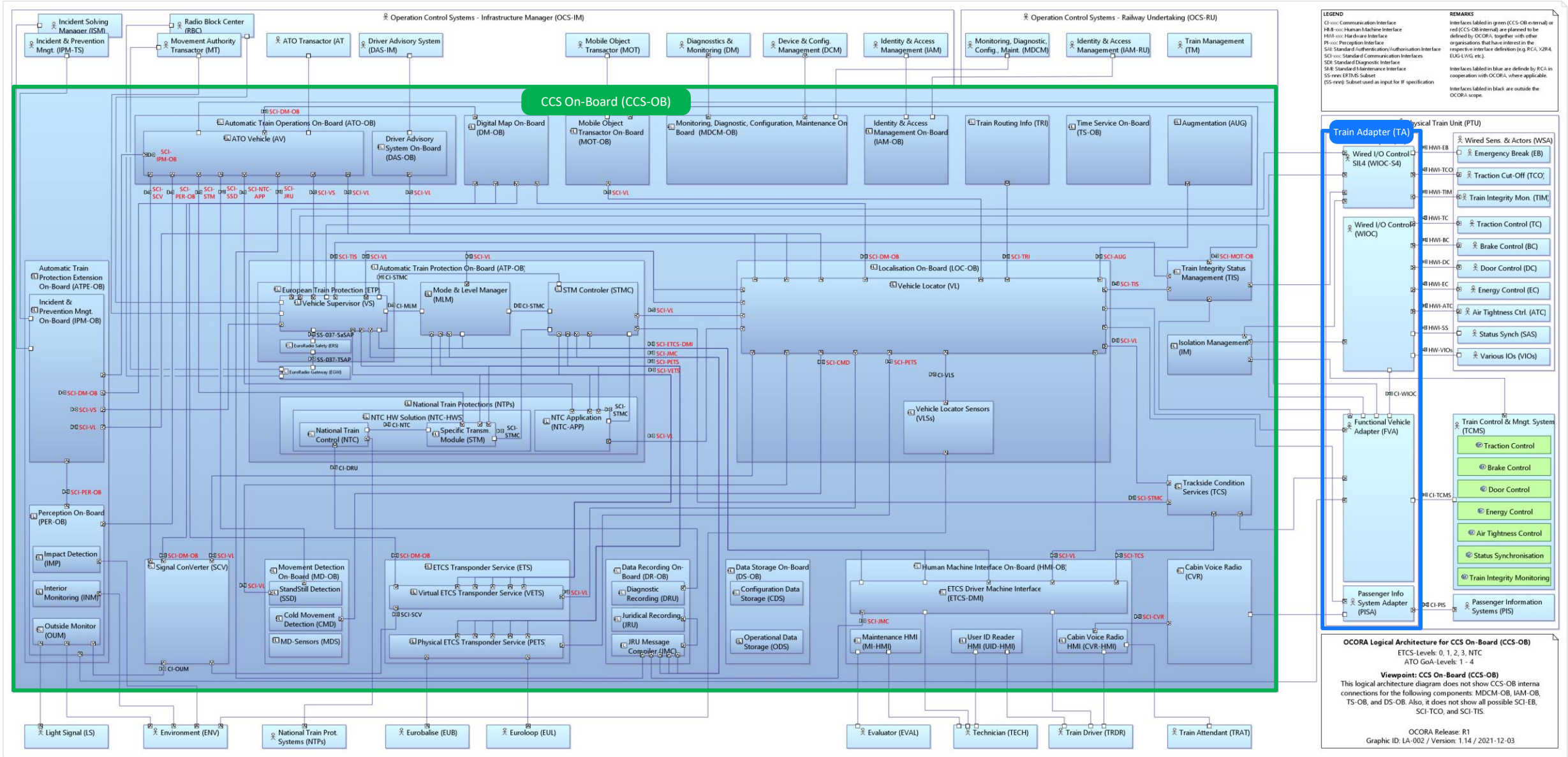
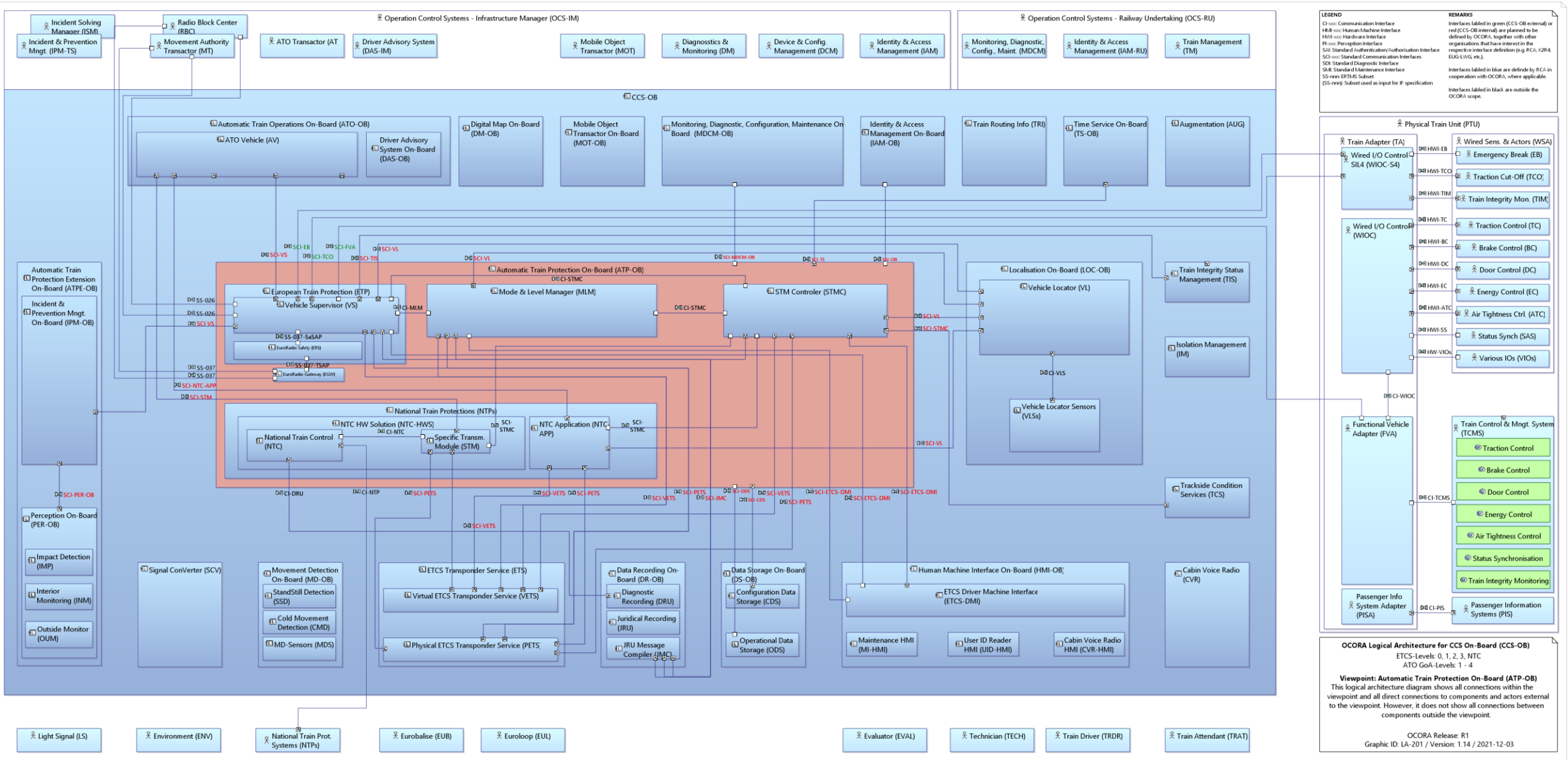
CCS On-Board (CCS-OB) Actors and External IFs (only CCS-OB components with external IFs shown)



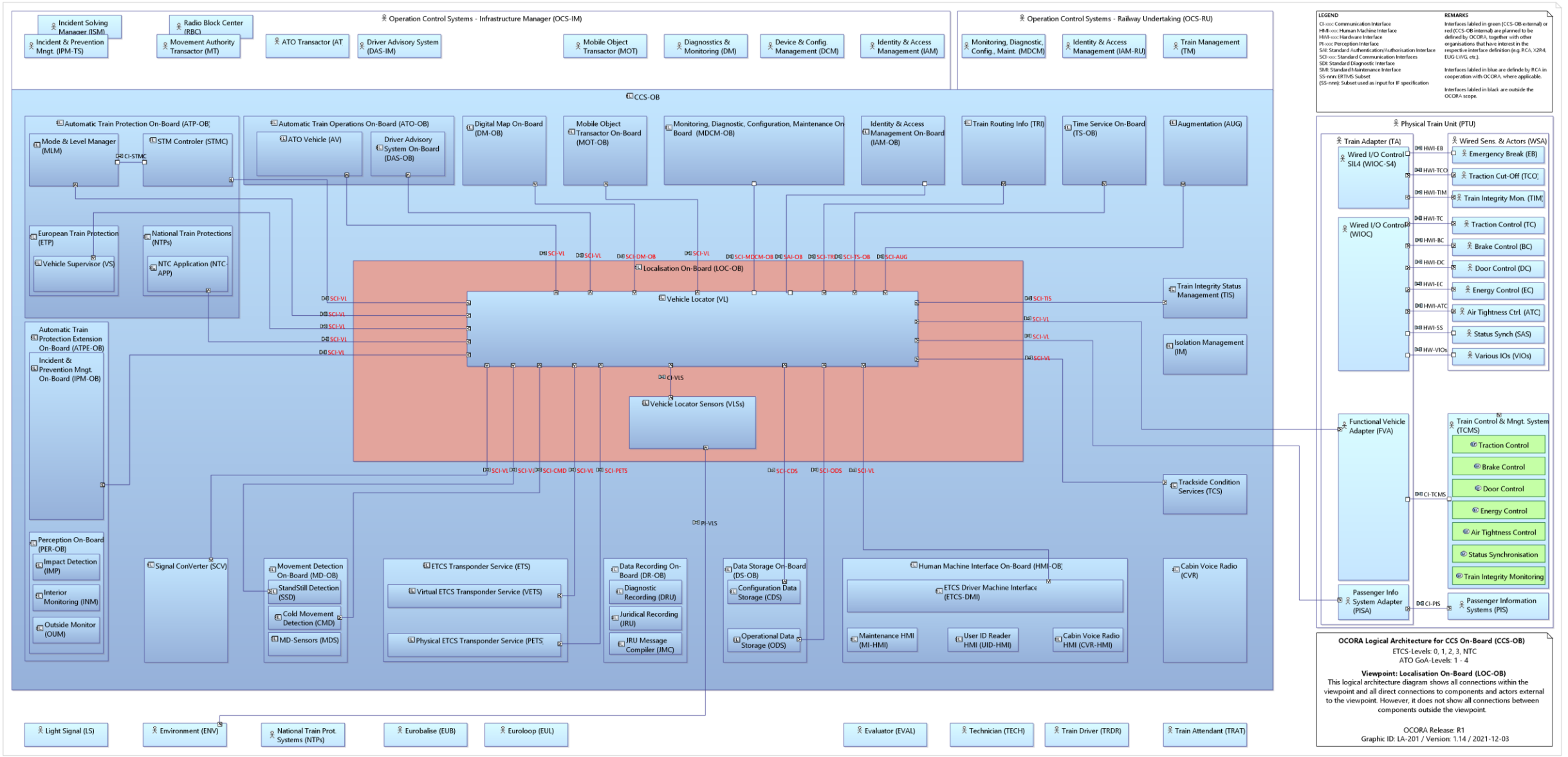
CCS On-Board (CCS-OB) Components and Internal IFs



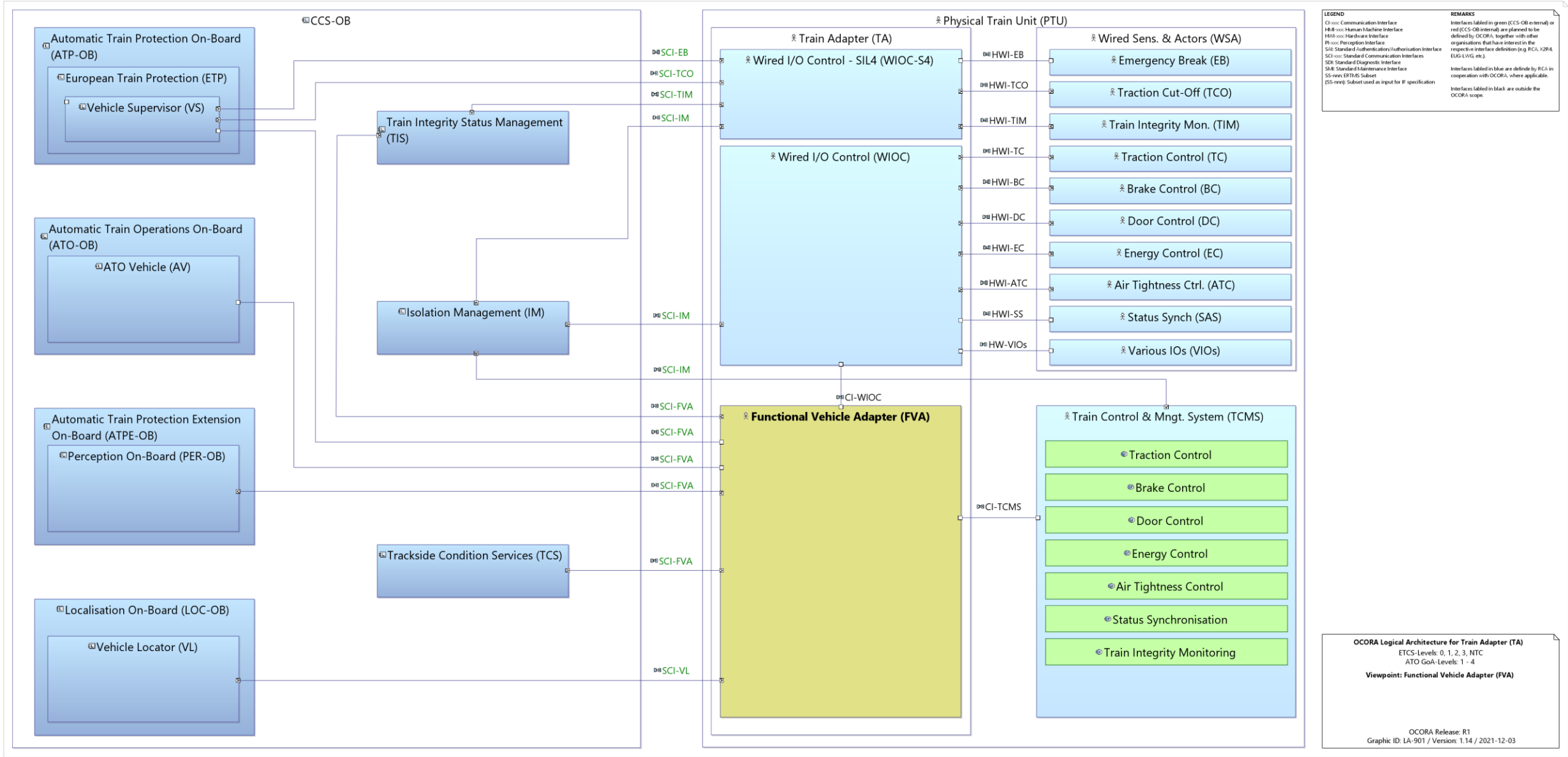
Automatic Train Protection On-Board (ATP-OB) Actors and External IFs



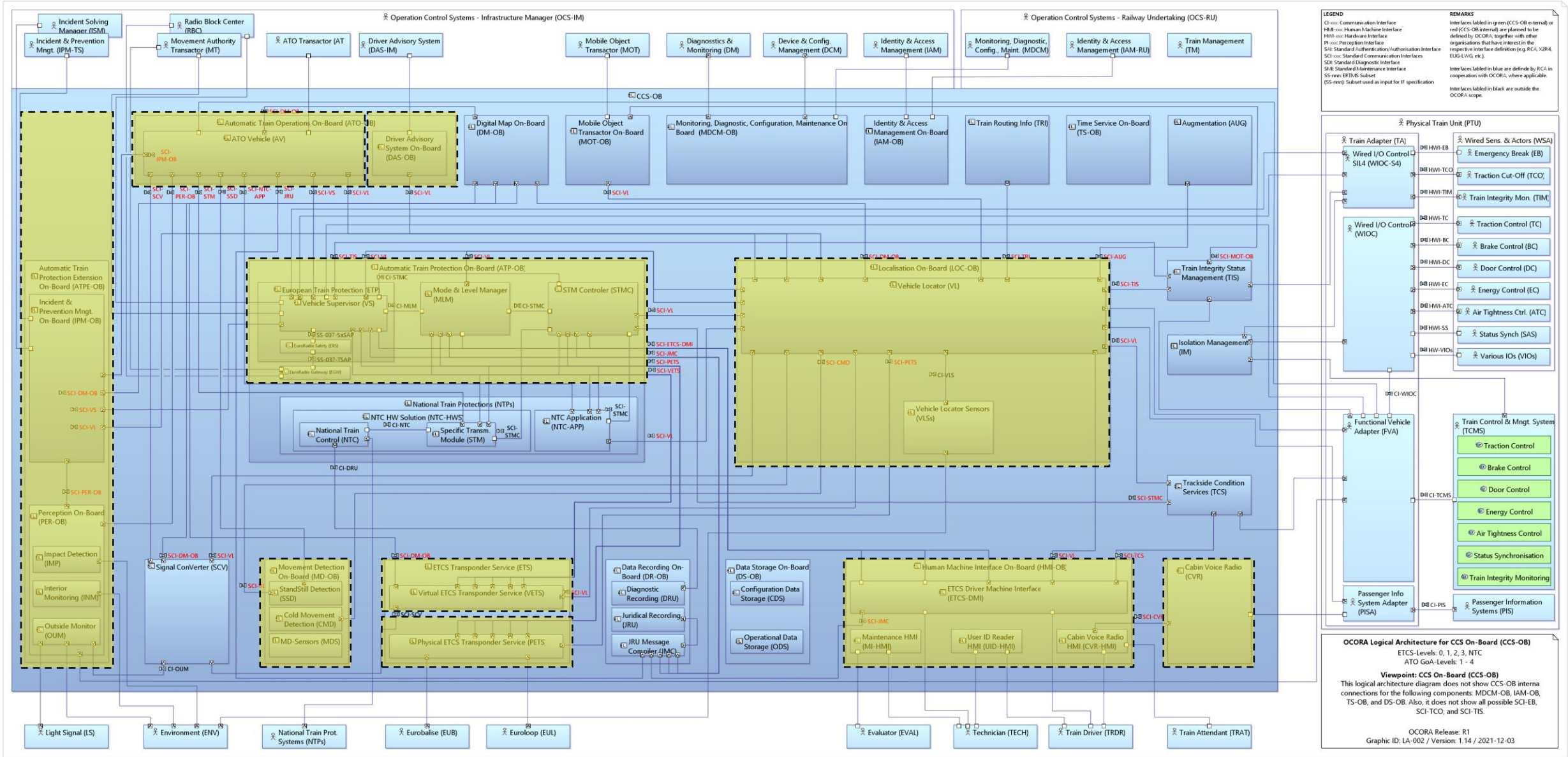
Localisation On-Board (LOC-OB) Actors and External IFs



Functional Vehicle Adapter (FVA) Actors and External IFs



OCORA envisioned software building blocks (tentative)



Physical Architecture

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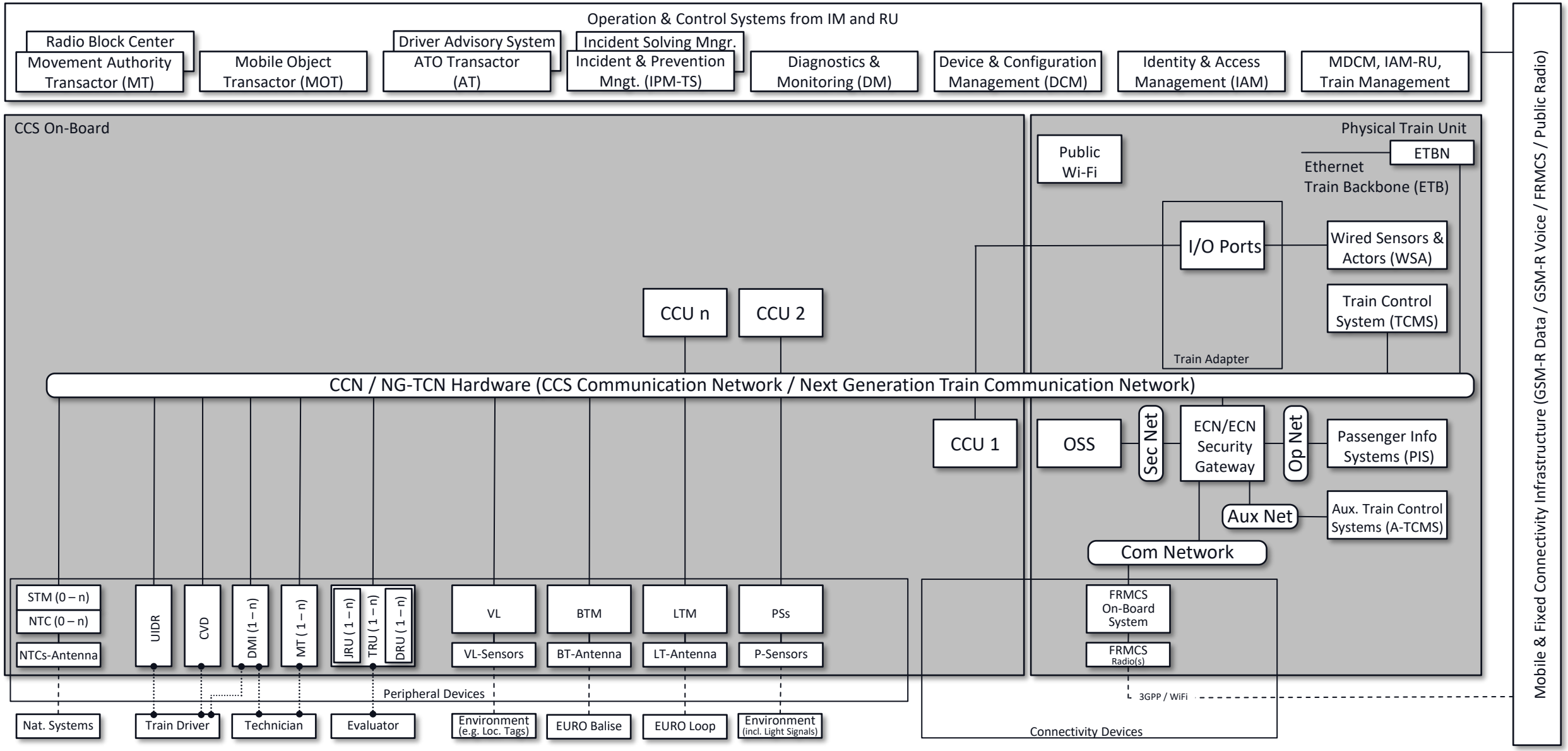
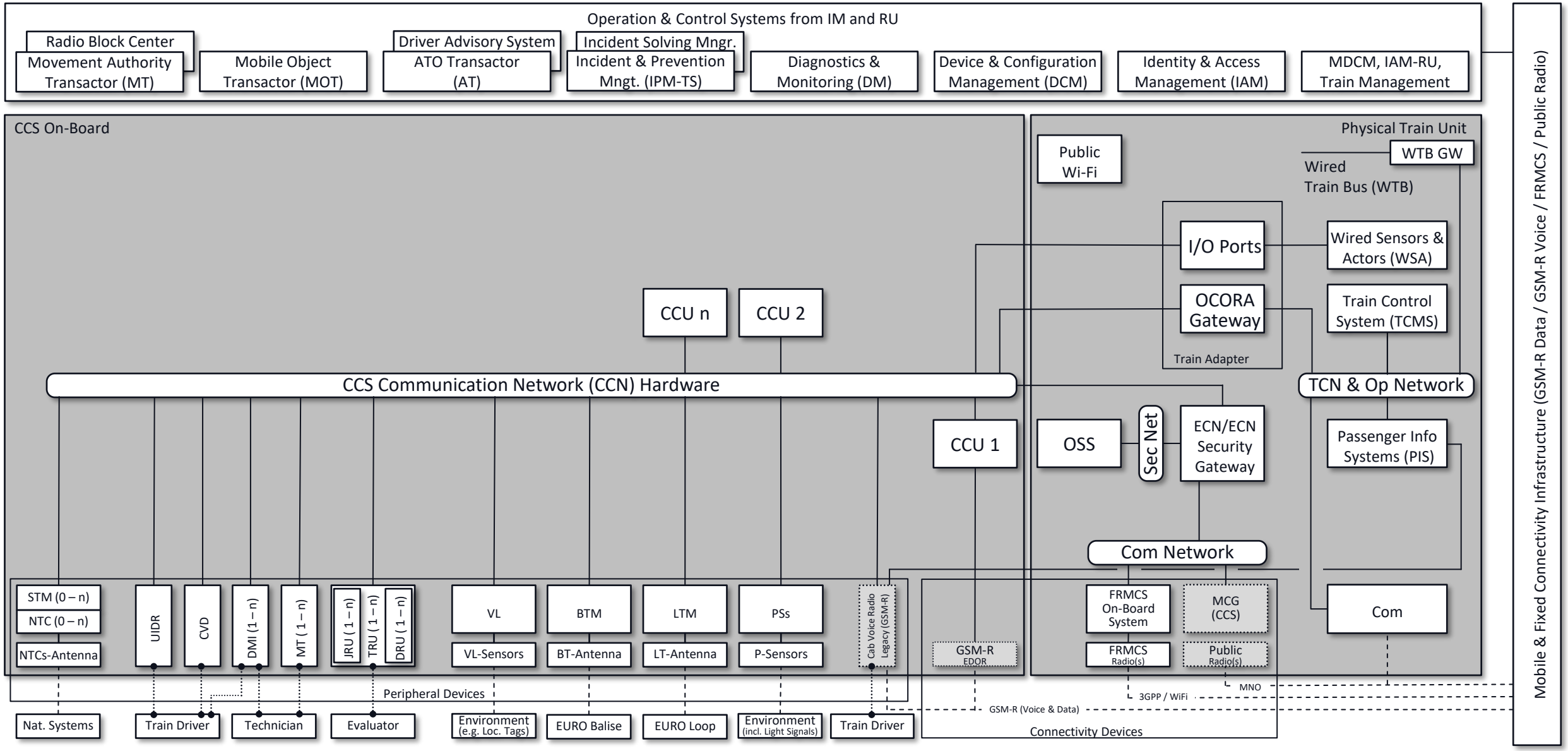
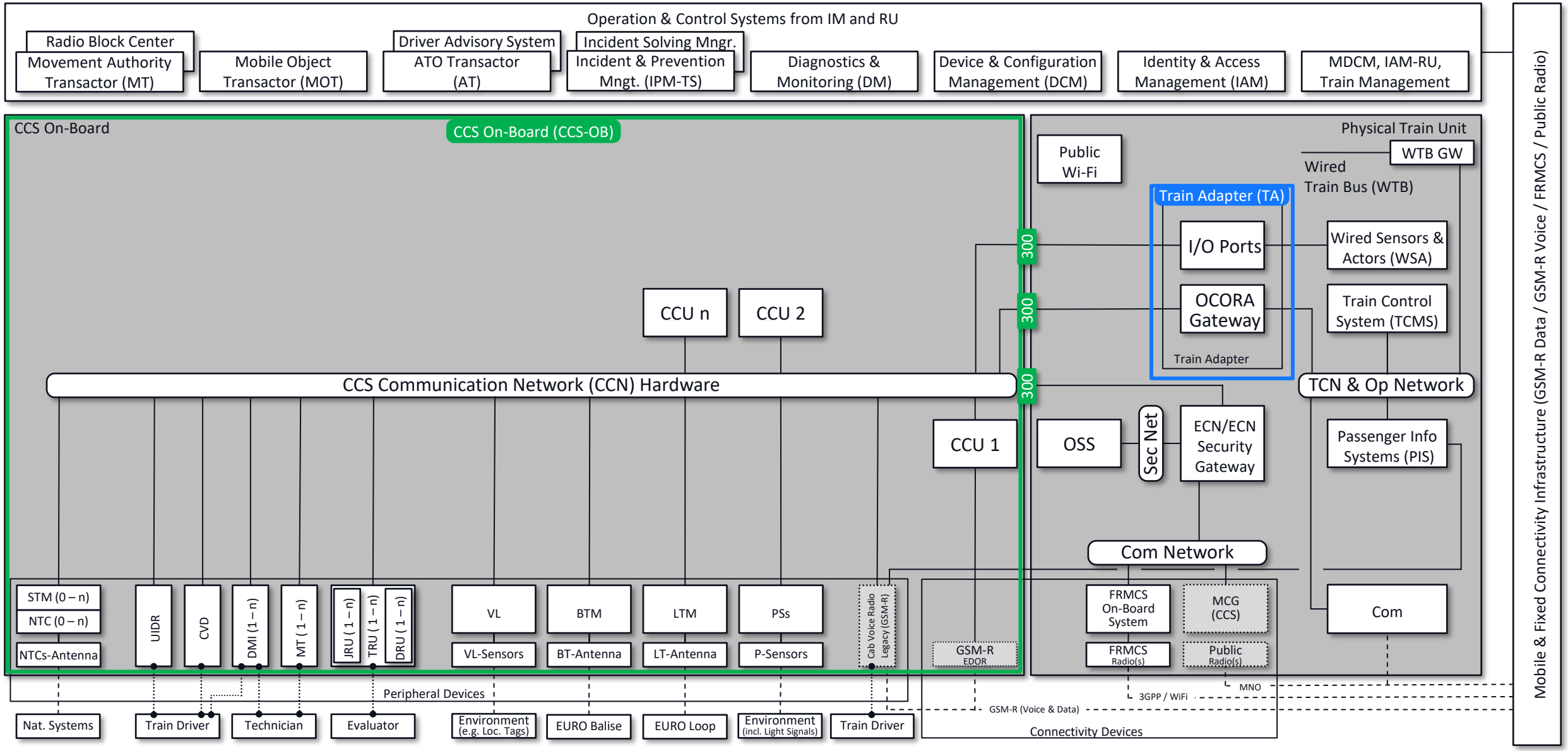
Physical Architecture – FINAL VIEW



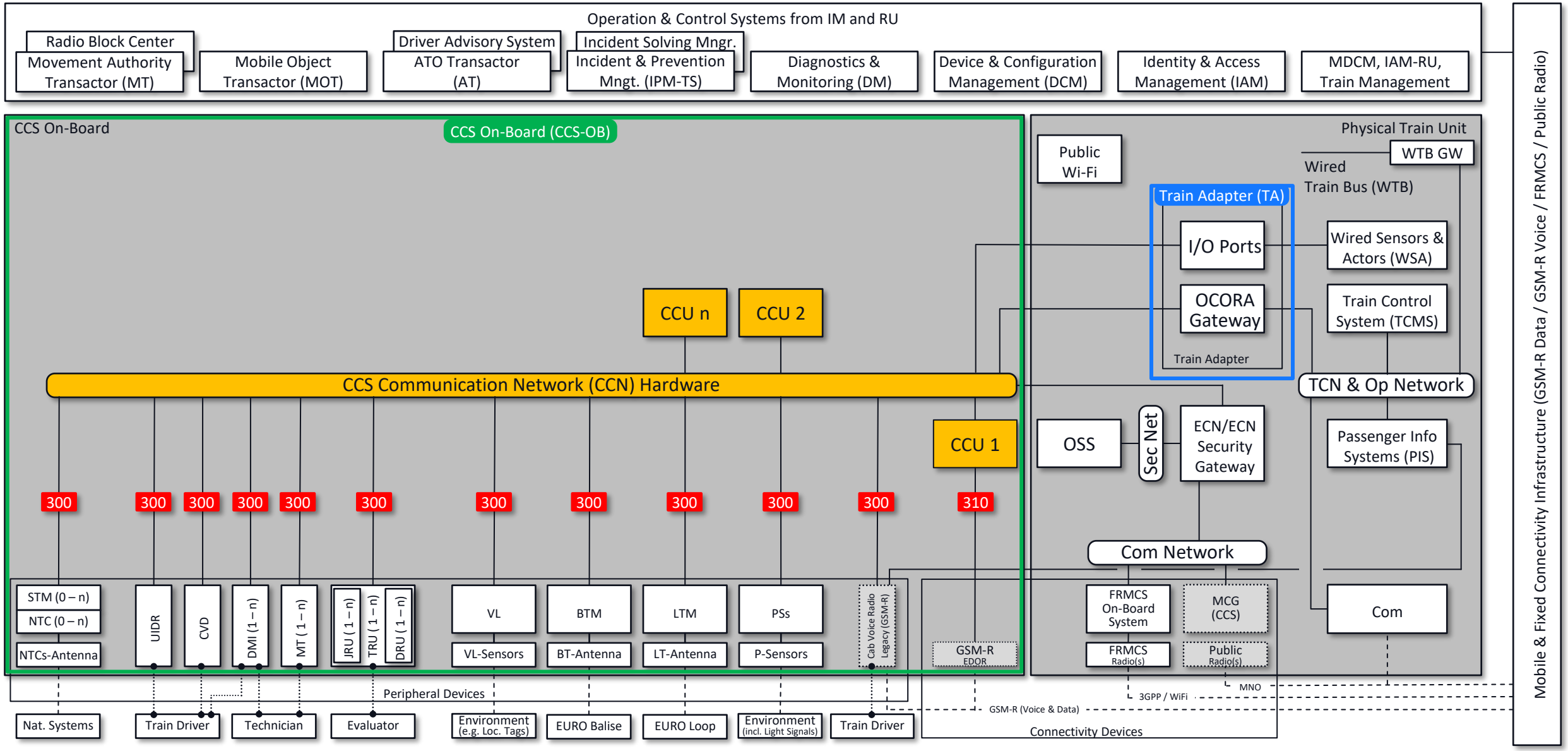
Physical Architecture – TRANSITION VIEW



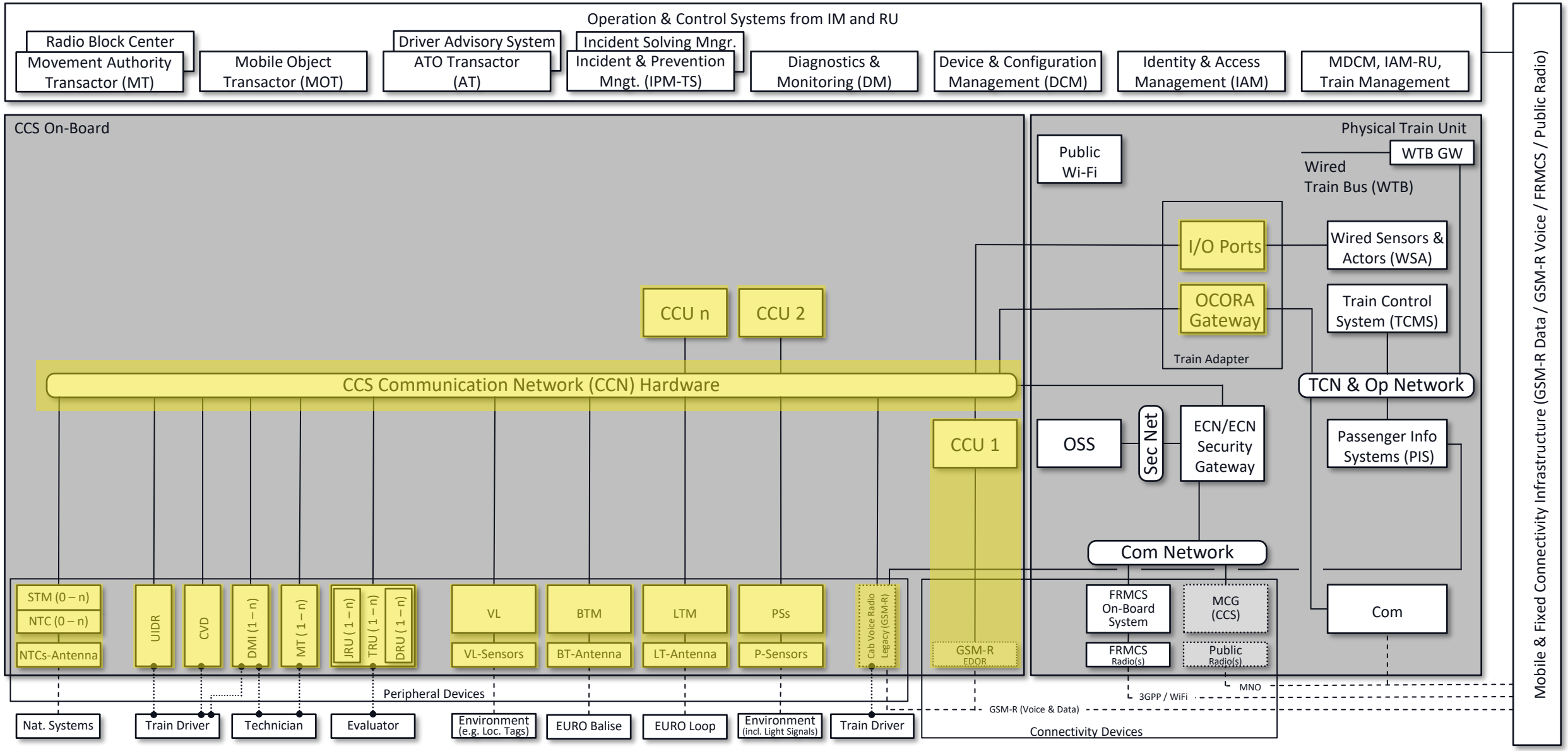
CCS On-Board (CCS-OB) and Train Adapter (TA) Actors and External IFs



CCS On-Board (CCS-OB) and Train Adapter (TA) Components and Internal IFs



OCORA envisioned hardware building blocks (tentative)



Train Integration Scenarios

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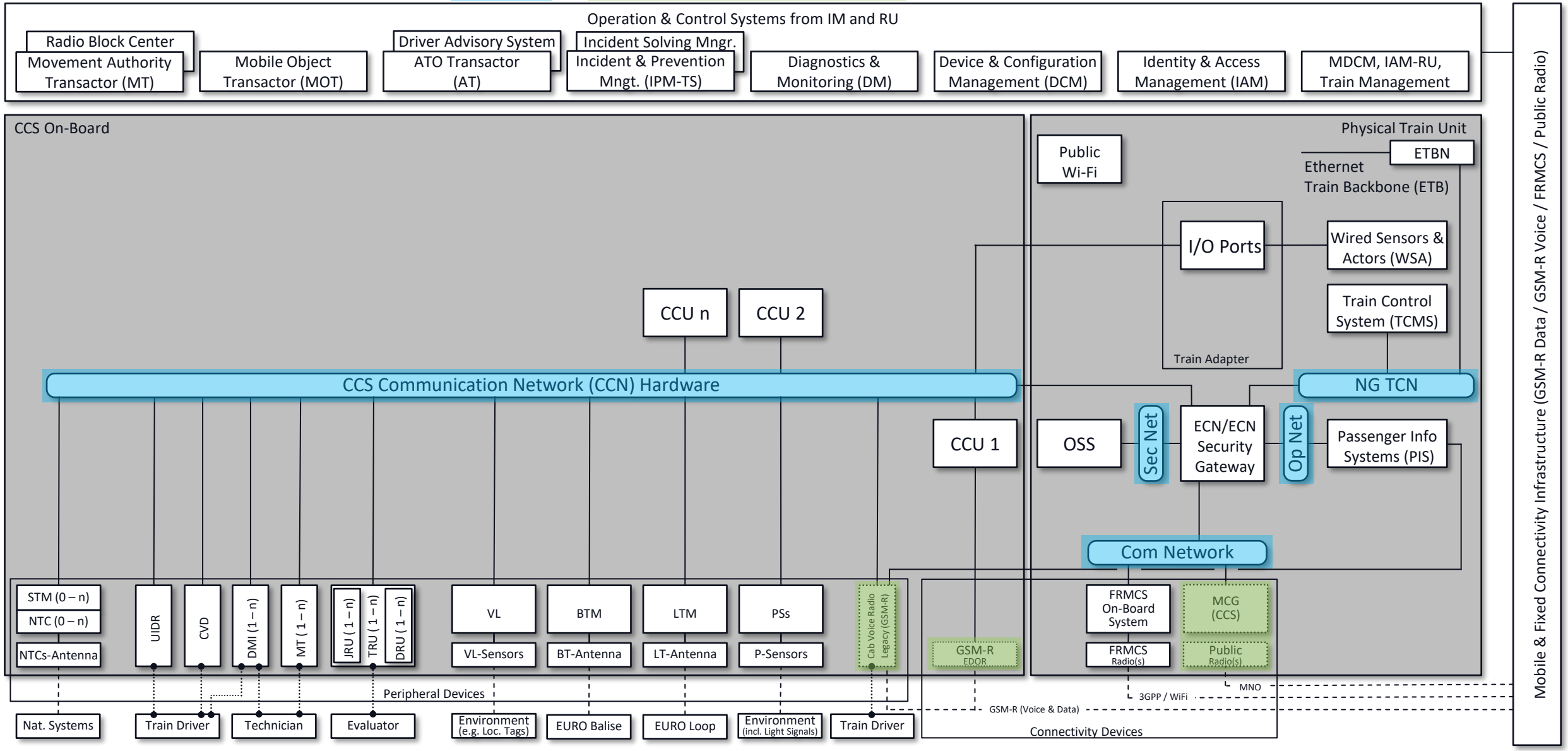
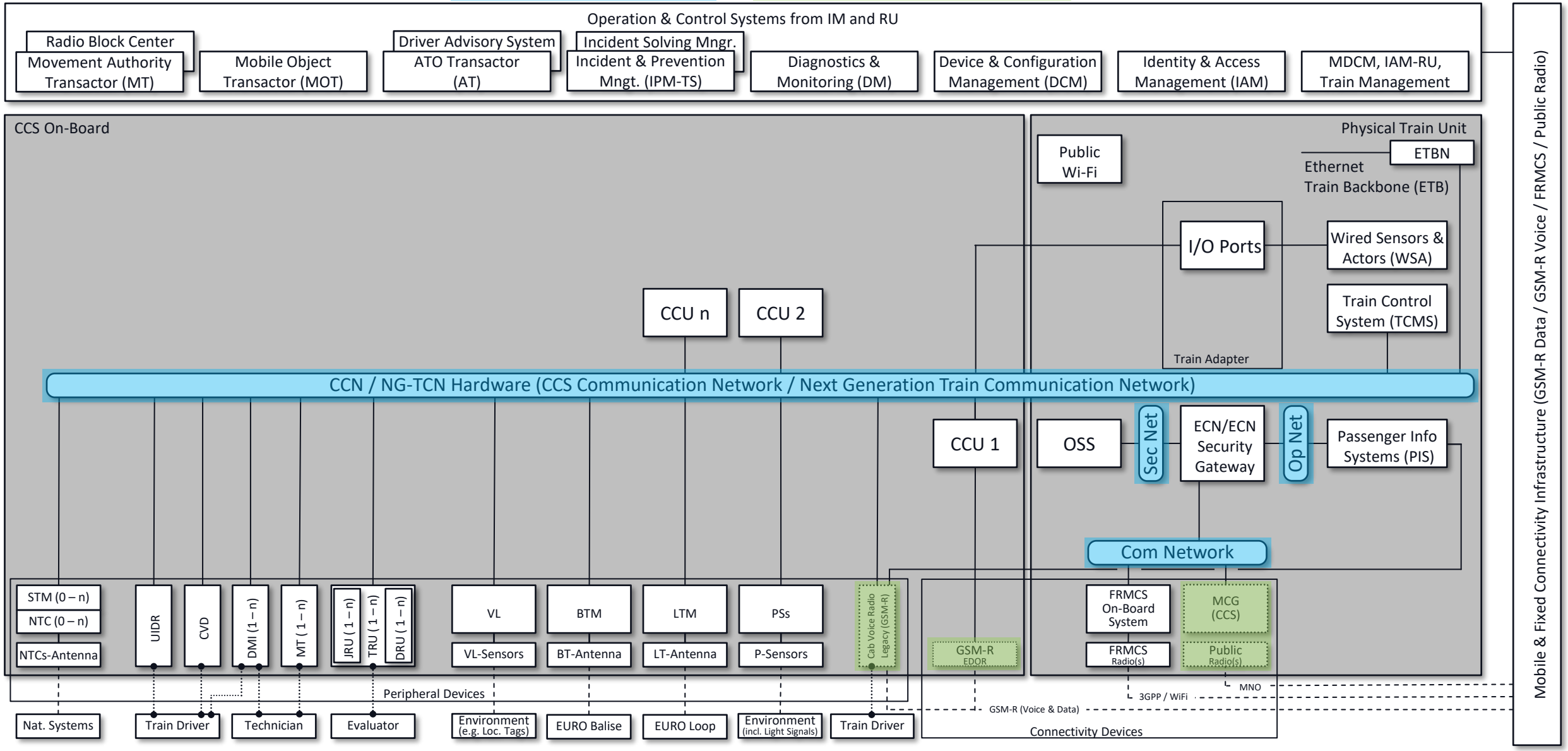
NG-TCN Train – Scenario A

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



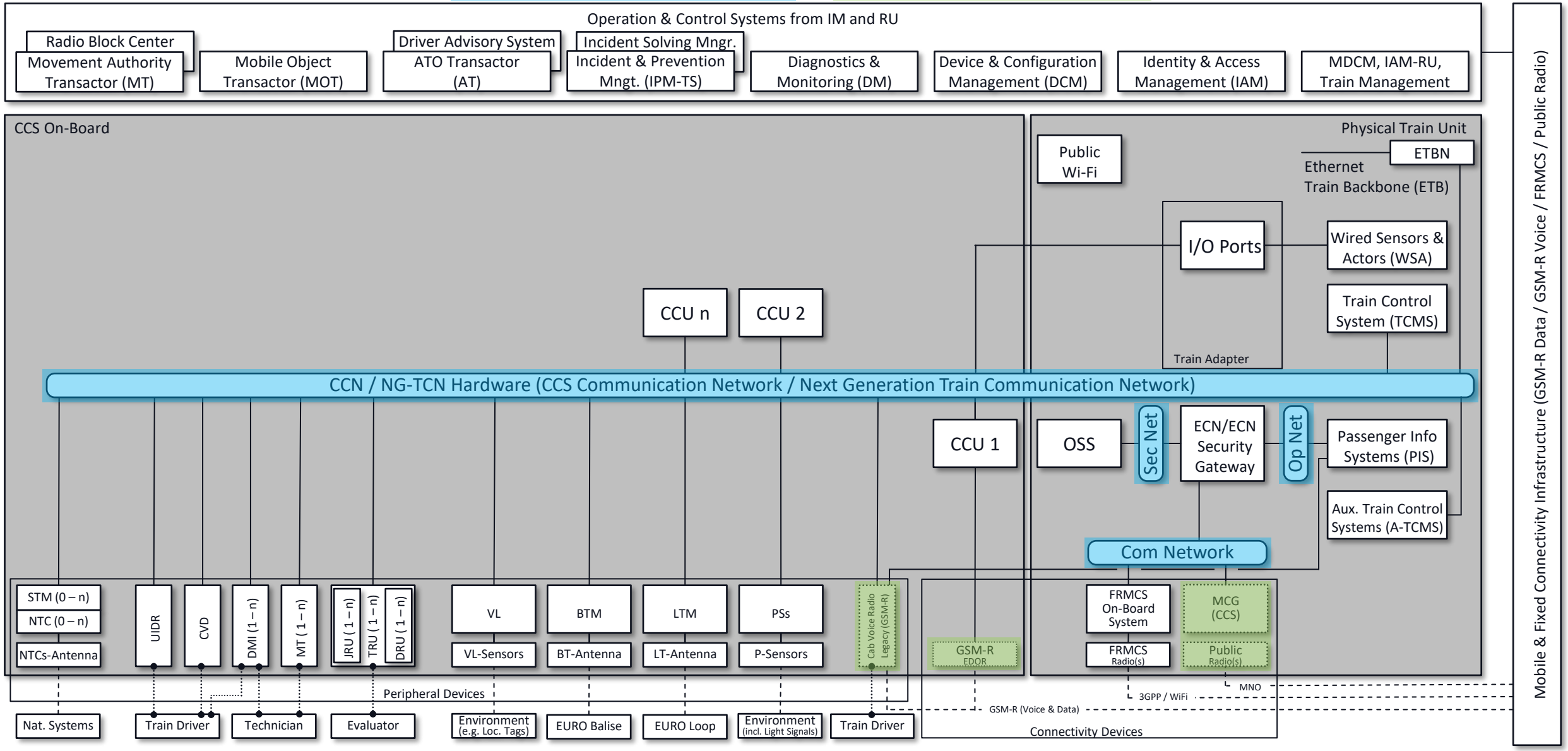
NG-TCN Train – Scenario B

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



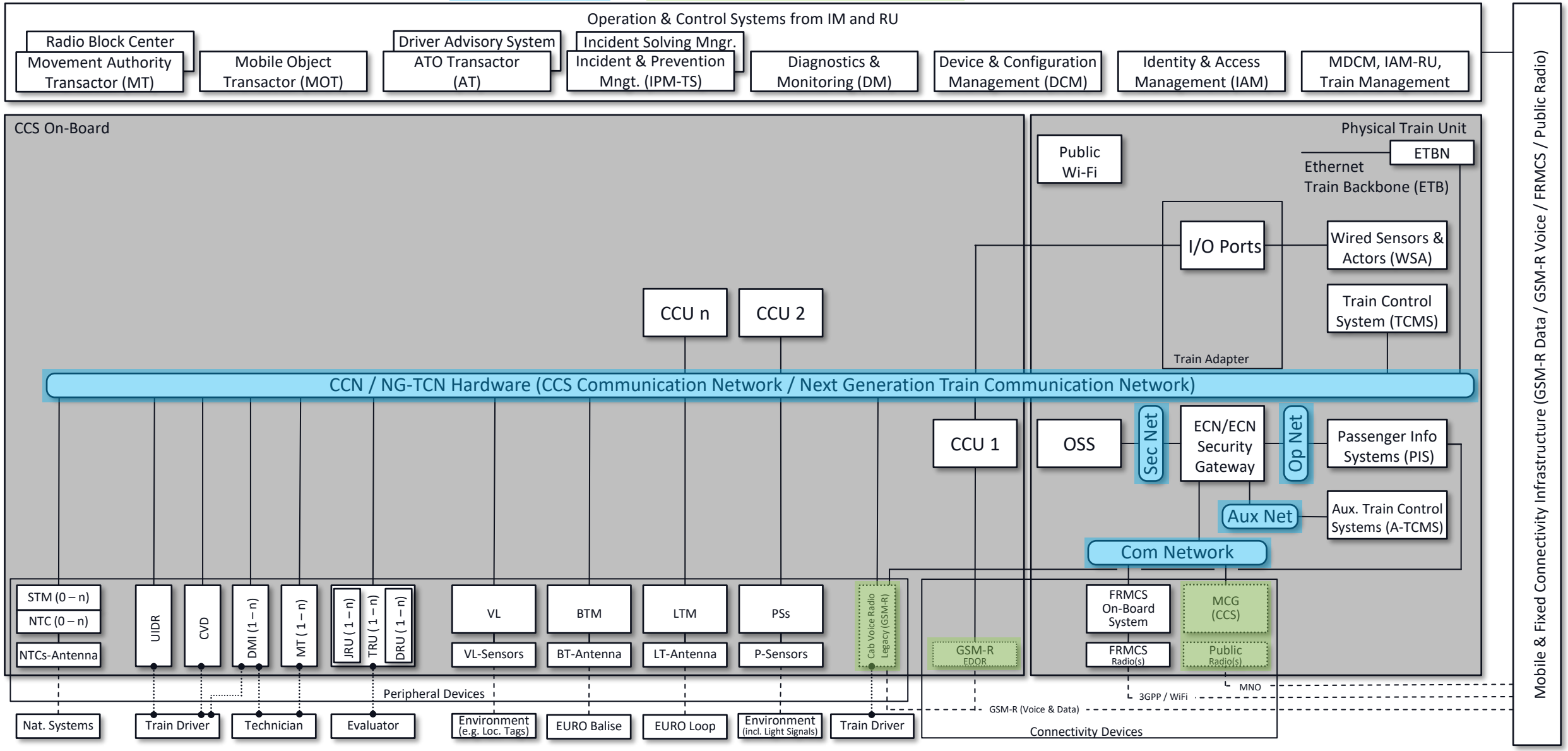
NG-TCN Train – Scenario C

(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)



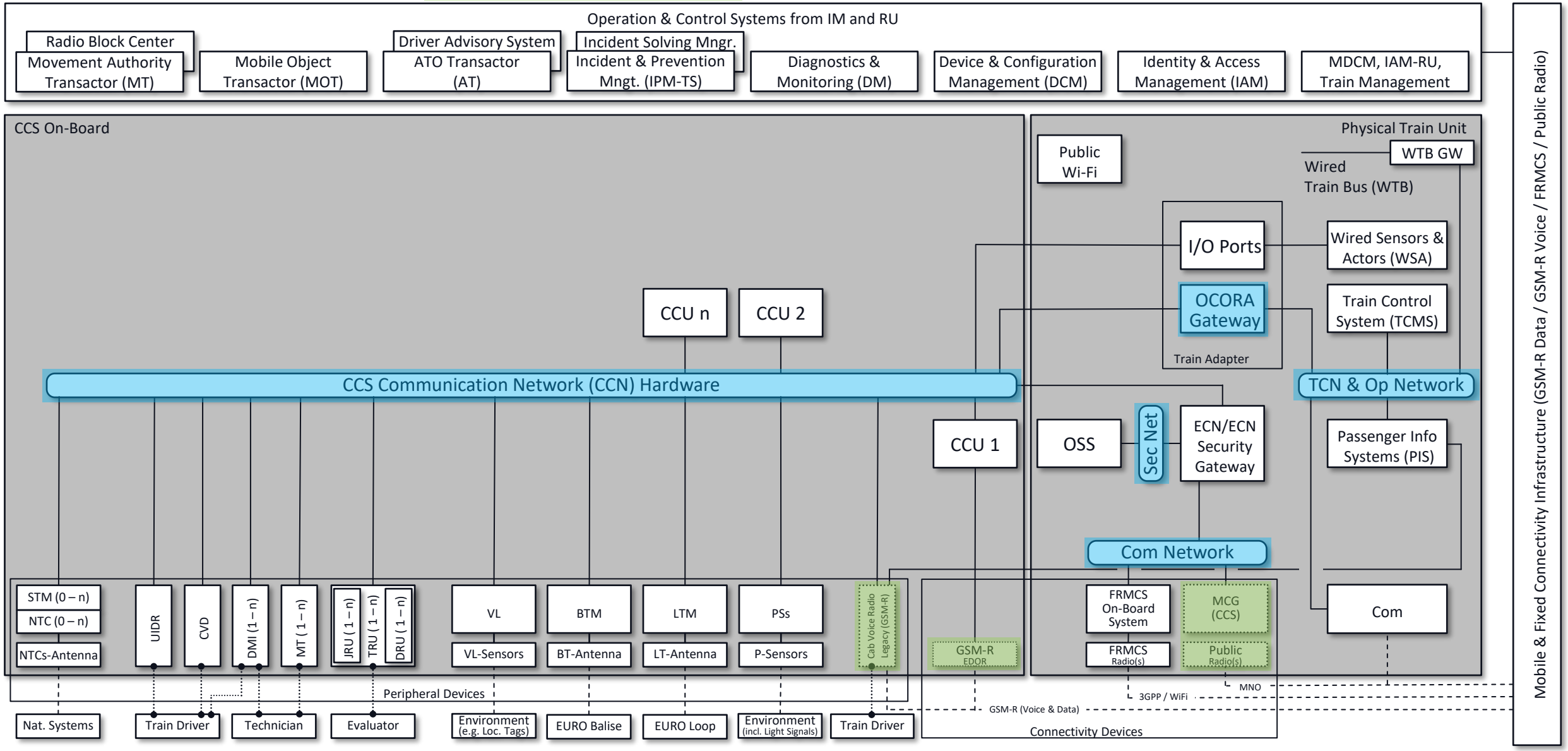
NG-TCN Train – Scenario D

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



Legacy Train

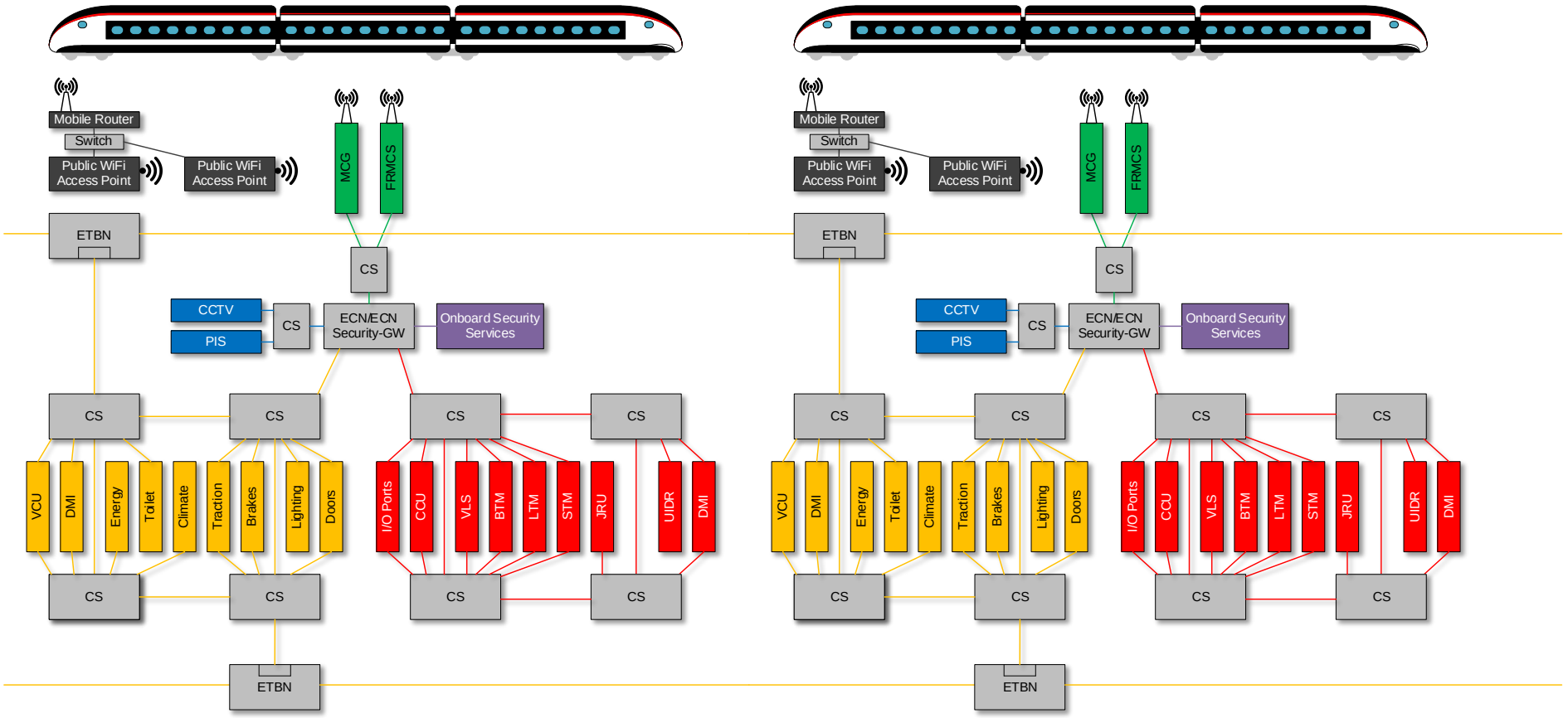
(CCN **physically** separated from Sec Net and Com Net using the OCORA GW connecting to the TCMS / PIS Networks. Support for legacy trackside infrastructure)



Network Topology Scenarios

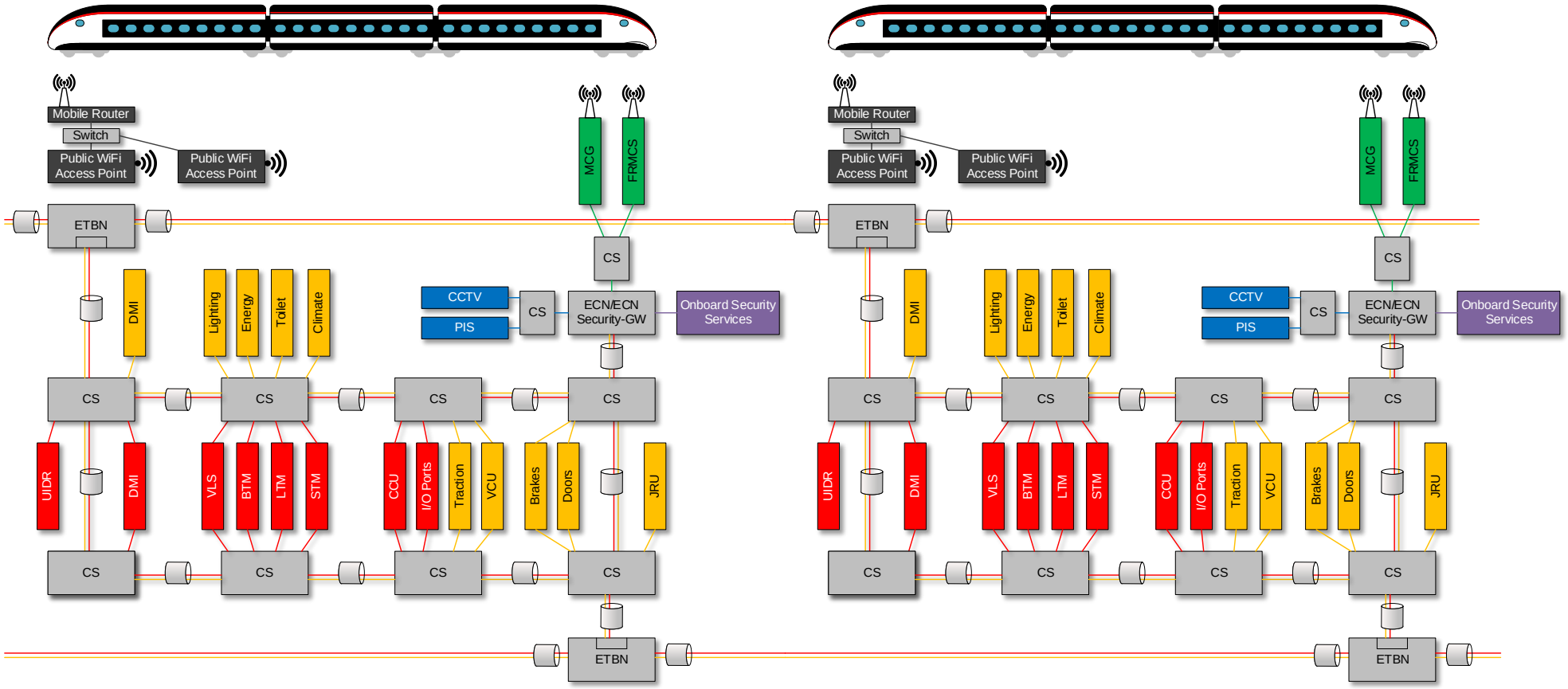
OCORA-BWS02-030 / v2.01 / 03.12.2021 / R1

Scenario A: CCN as **physically** separated network



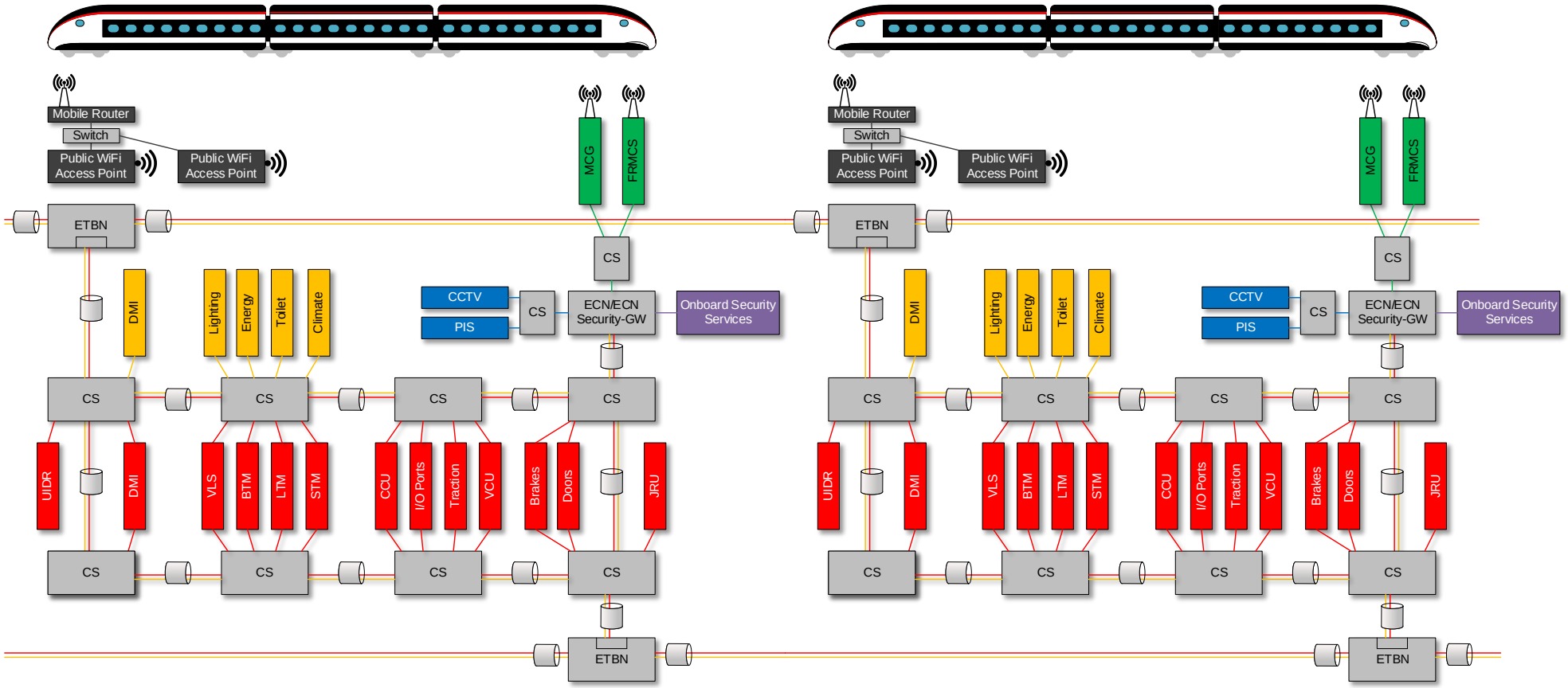
Remark: RAM experts need to assess, what components (if any) need a redundant network connection.

Scenario B: CCN as **logically** separated network



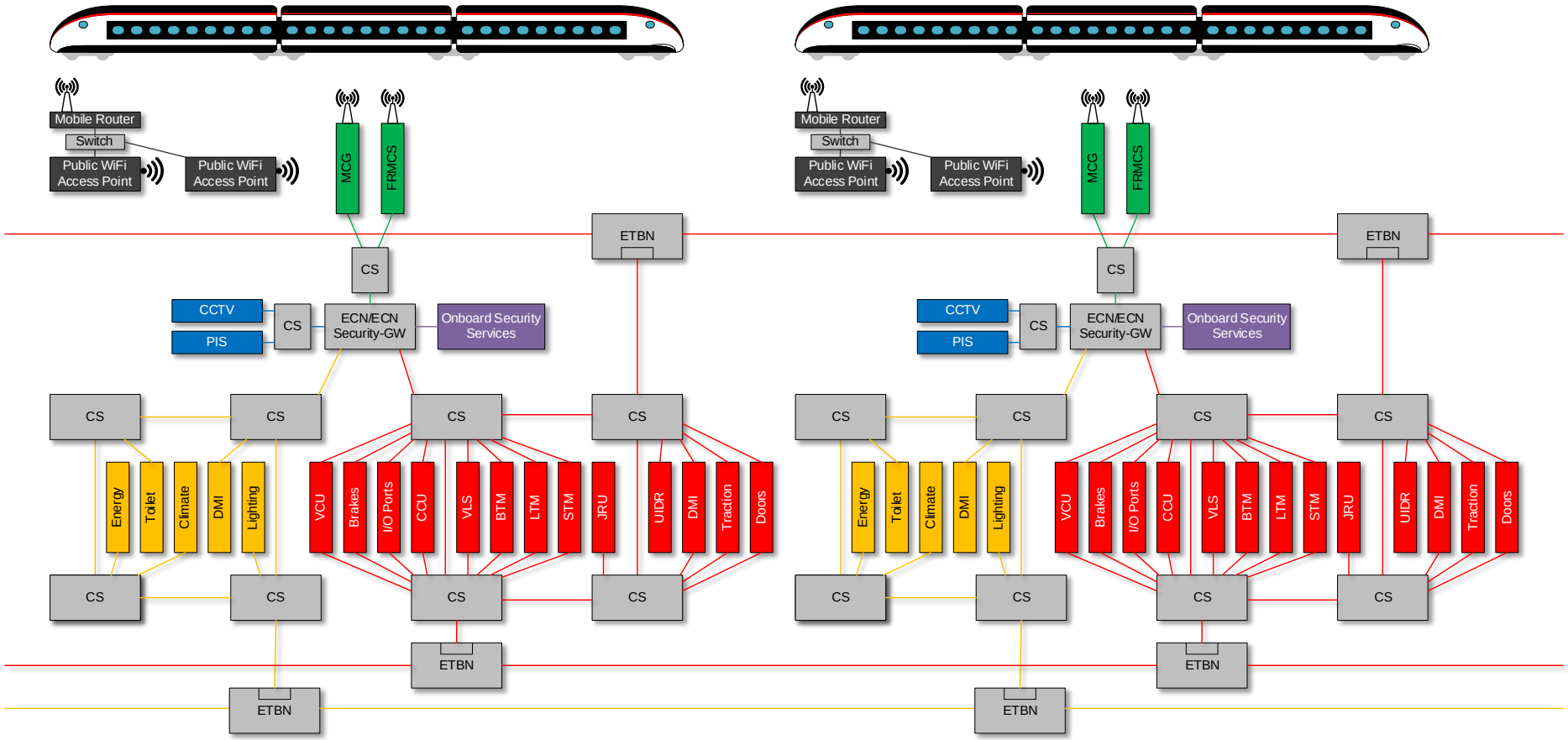
Remark: RAM experts need to assess, what components (if any) need a redundant network connection.

Scenario C: Common critical control network **logically** separated



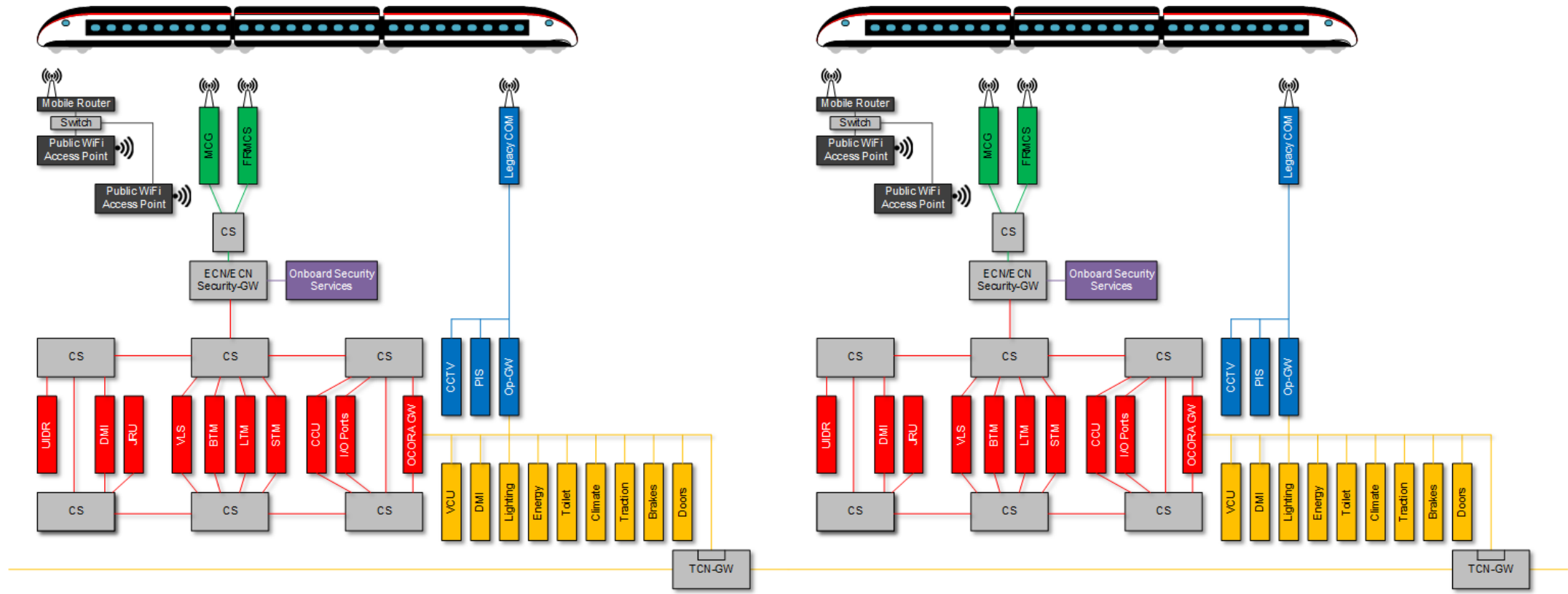
Remark: RAM experts need to assess, what components (if any) need a redundant network connection.

Scenario D: Common critical control network **physically** separated



Remark: RAM experts need to assess, what components (if any) need a redundant network connection.

Legacy Train – Integration with OCORA-GW



COM / Communication Components / Network (LAN, Security Zone)

CCS / CCS Components / Network (VLAN, Security Zone)

TCMS/Auxiliary / TCMS/Auxiliary Components / Network (VLAN, Security Zone)

Operator / Operator Components / Network (LAN, Security Zone)

Security / Security Components / Network (LAN, Security Zone)

Public / Public Components / Network (physically isolated)

Net 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.

Remark: RAM experts need to assess, what components (if any) need a redundant network connection.

Computing Platform

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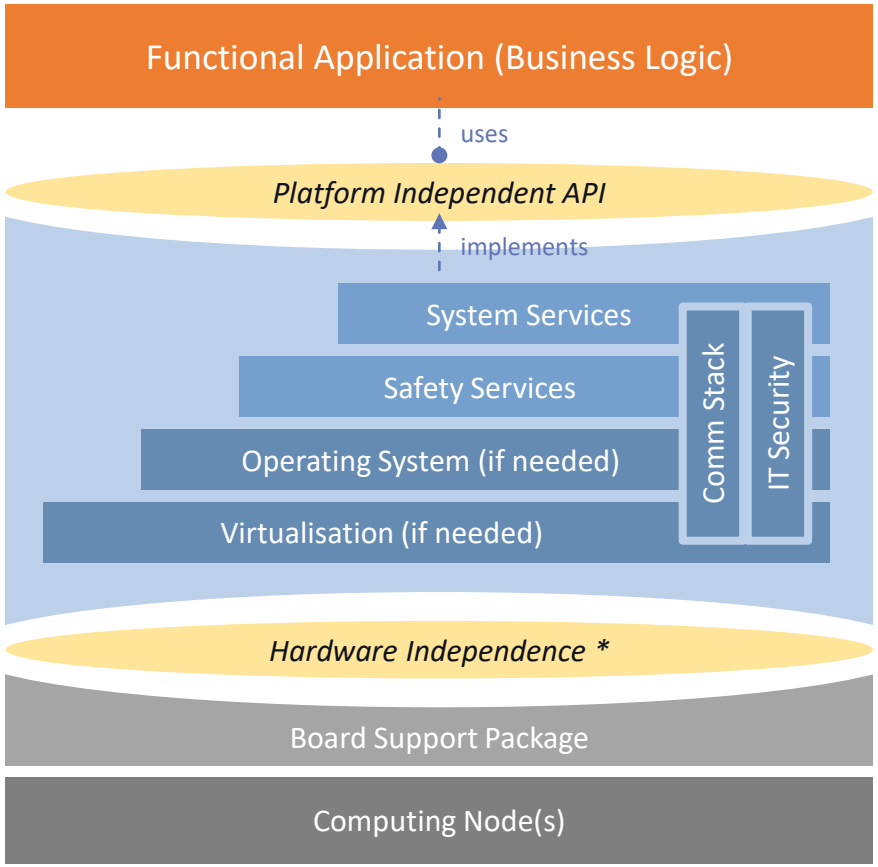
Computing Platform – High Level Architecture

Runtime environment

Hardware

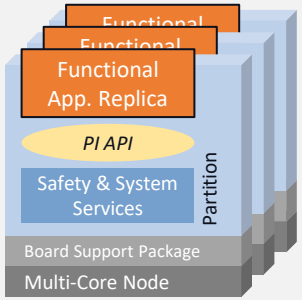


Computing Platform

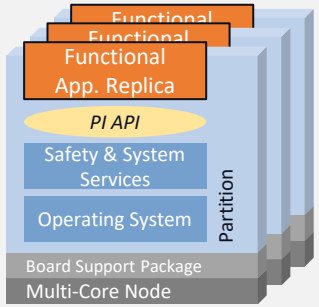
* It is to be discussed to which extent hardware independence can or should be enforced

Computing Platform – Deployment Options

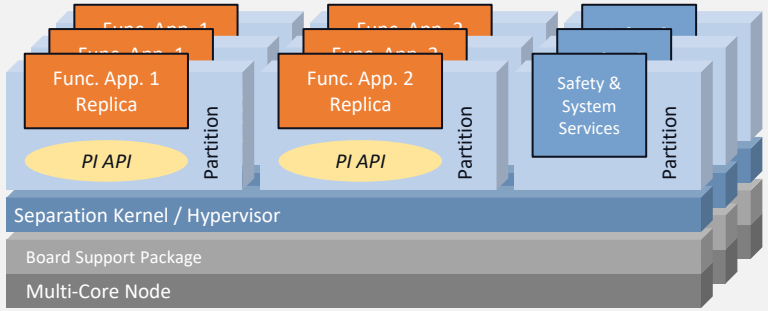
Option A:
Hardware without operating system



Option B:
Hardware with operating system

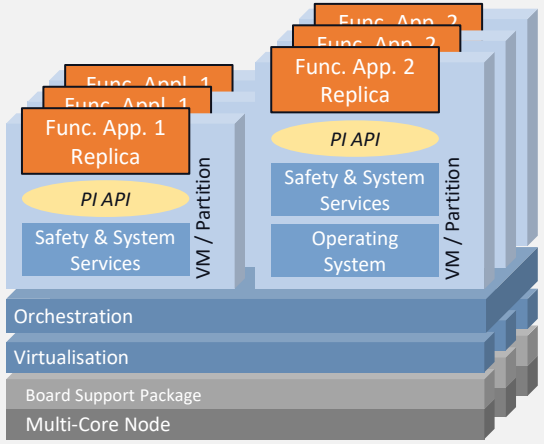


Option C:
Separation kernel / hypervisor based system



Likely options for ***onboard*** deployments

Option D:
Orchestrated virtualisation environment



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.

Functional Vehicle Adapter (FVA)

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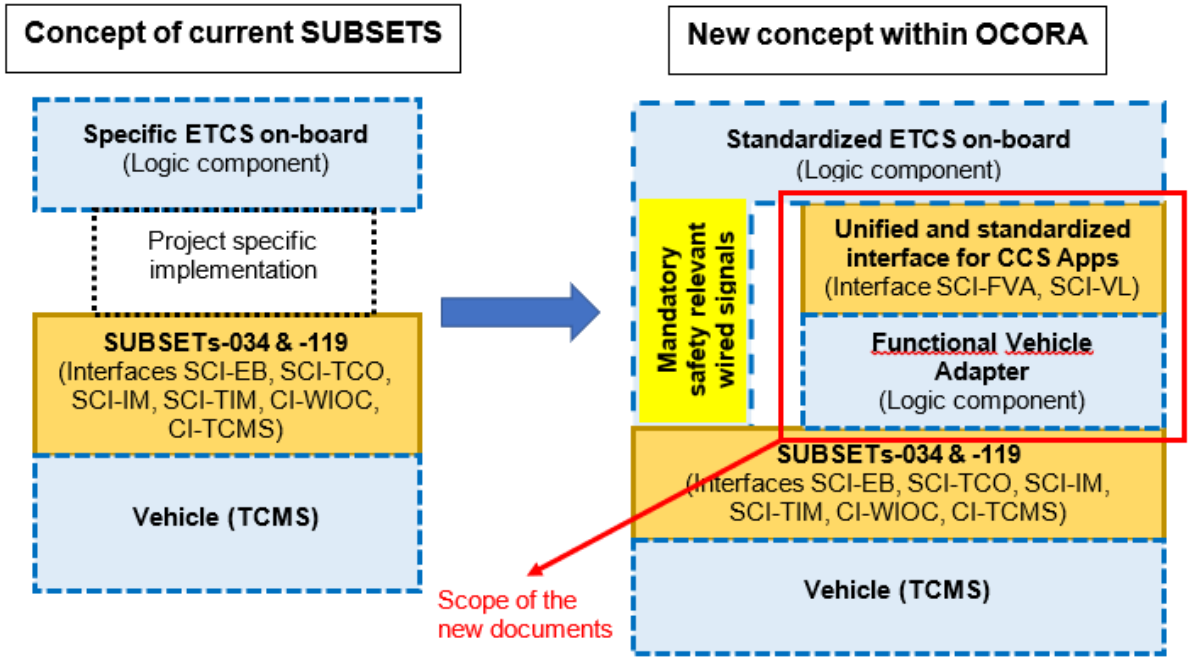
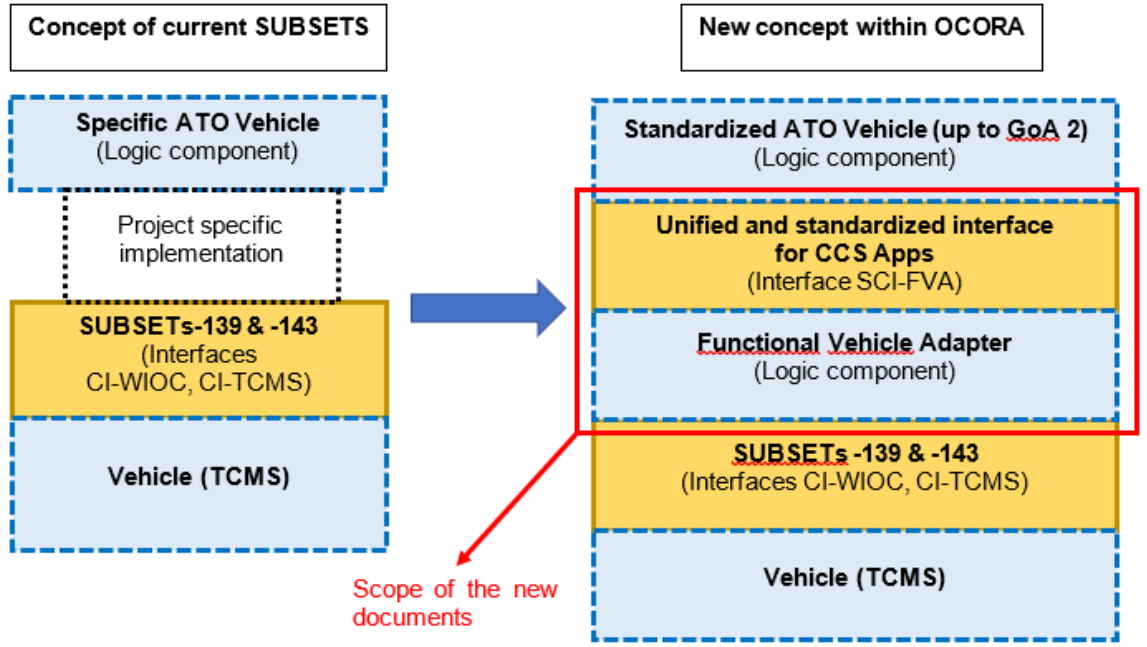
OCORA – Functional Vehicle Adapter

ETCS

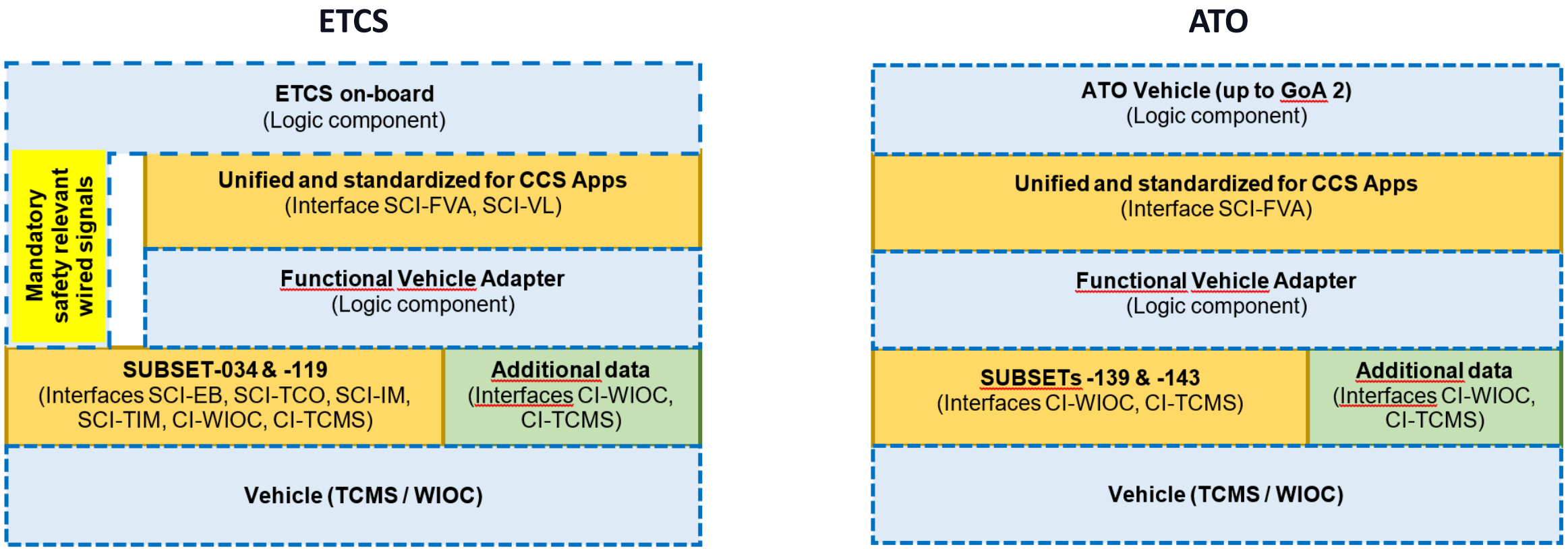


ATO



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

OCORA – Functional Vehicle Adapter: Extensions



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

Modular Safety

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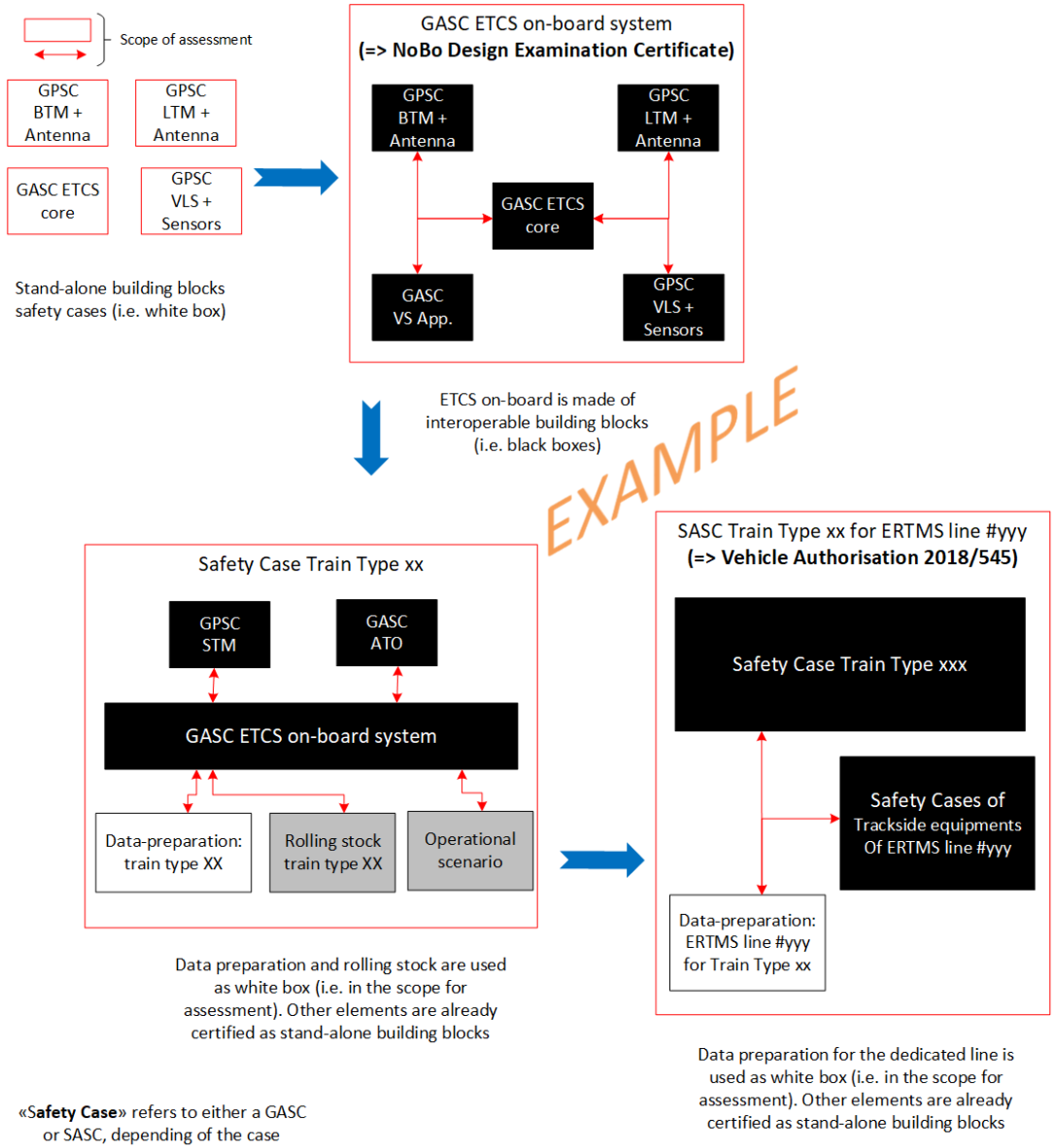
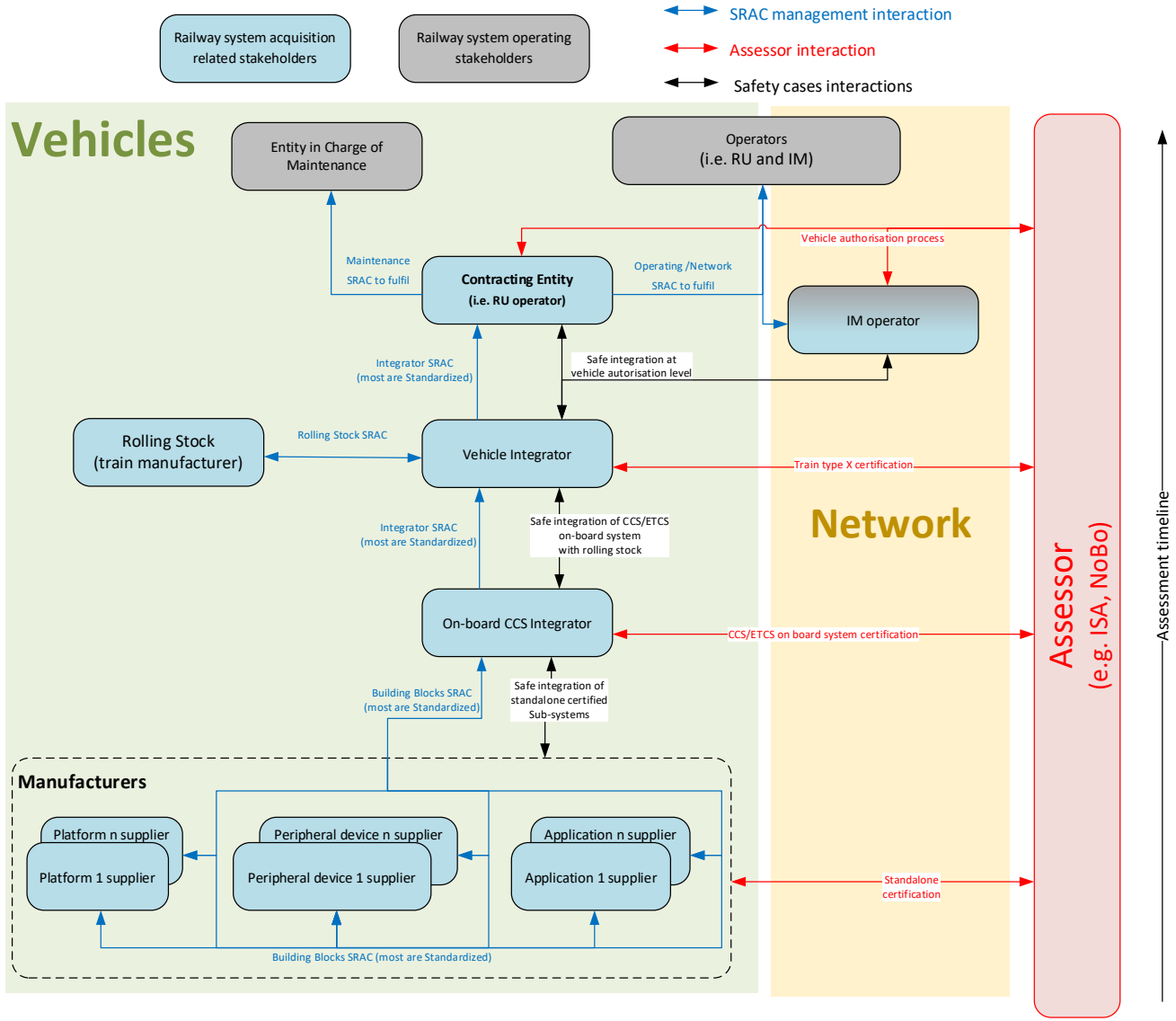
OCORA – Modular Safety

- 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 (initial- and re-certification) at all 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 Delta release
  - Harmonised and generic set of SRAC



OCORA – Modular Safety - Stakeholders



The integrator of the CCS/ETCS on-board system shall **coordinate the activities** of the different suppliers to **integrate** their sub-systems and ensure that finally, ISA and NoBo certificates of the CCS/ETCS on-board system will be delivered by the assessor

➔ Contracting entities (Oprators)

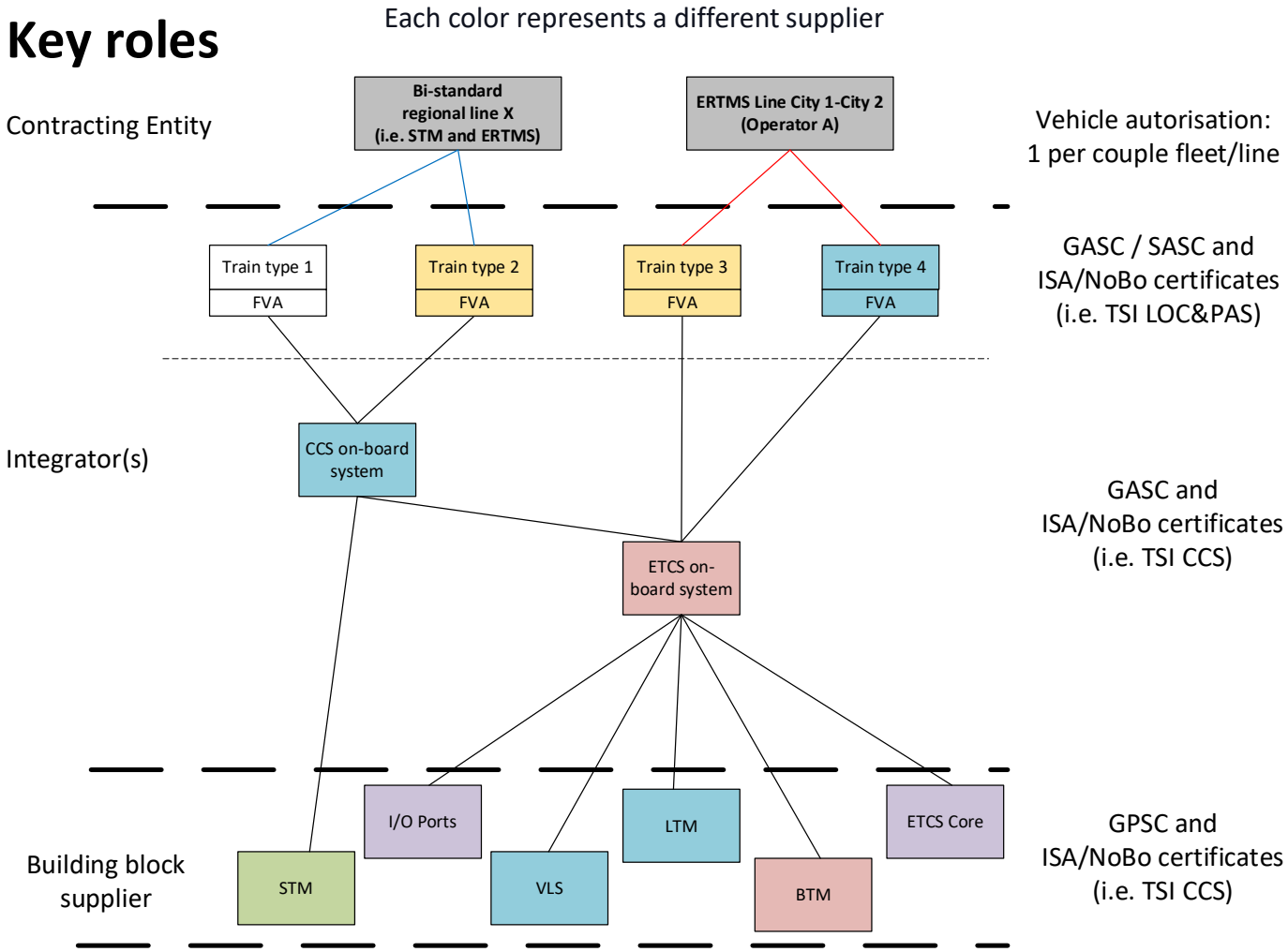
➔ Integrator(s)

➔ Manufacturers (Building Blocks, Application…)

➔ Other (ISA/ NoBo, DeBo..)

OCORA – Modularity & Safety Approval

Key roles



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

- Each building block is delivered to the ETCS on-board integrator with its own ISA/NoBo certificates
- ETCS on-board integrator realise their "safe integration" as defined in era_1209-063 Clarification Note On Safe Integration (I.e. black boxes)
- Based on ETCS on-board ISA/NoBo certificates, CCS on-board integrator realise the safe integration of the STM (I.e. black boxes)
- CCS and ETCS on-board systems are used by the vehicle integrator to get the train type ISA/NoBo certificates (I.e. integration is eased thanks to the FVA)
- The contracting entity can apply for the different vehicle authorisations required
- A generic and systematic approach defined by OCORA, based on CSM-RA will then help any above stakeholder to handle easier (I.e. less delay and costs than today) the evolutions at any level

OCORA – Modularity & Integration Tasks

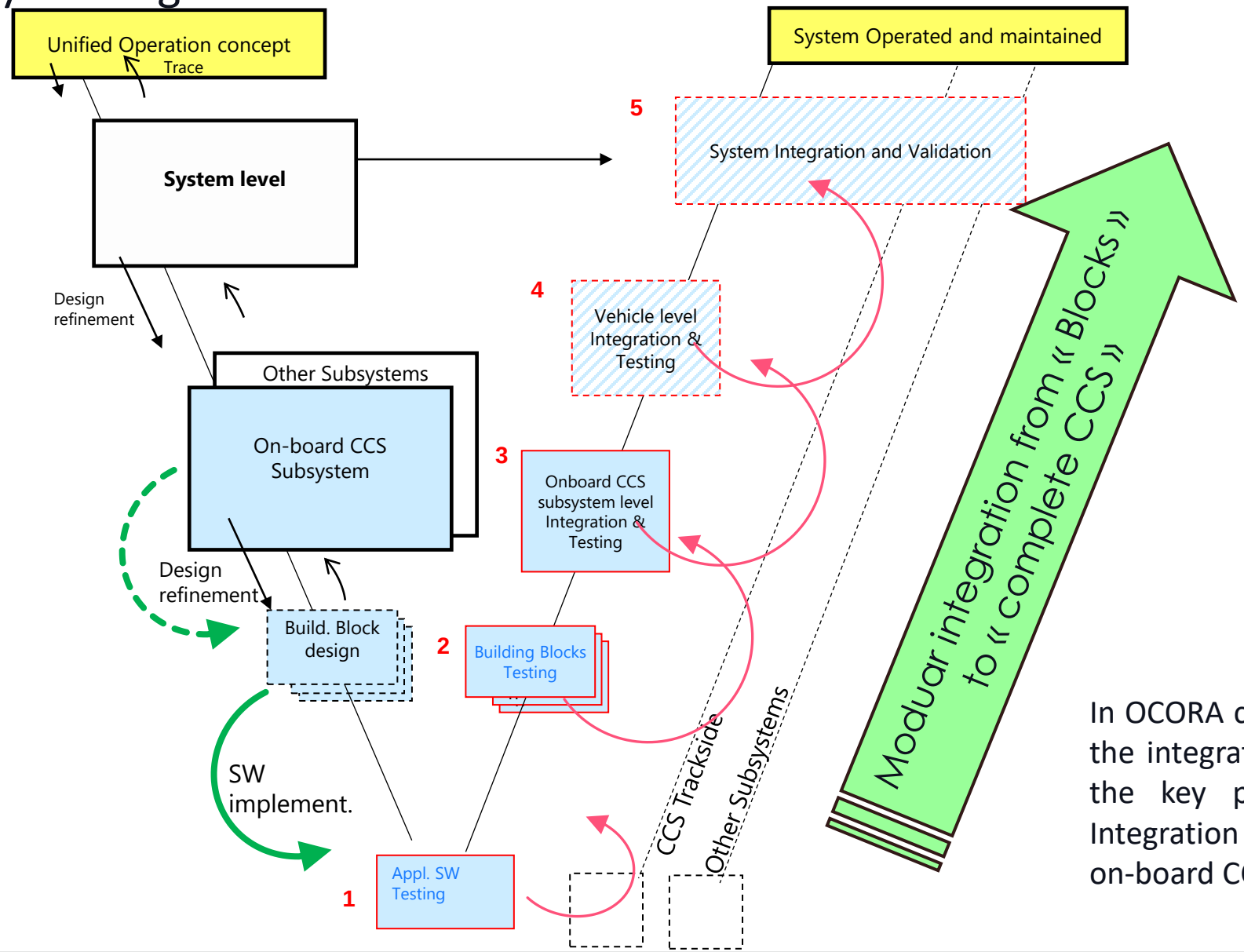
➔ Integrator (System)

➔ Integrator (onboard)

➔ Manufacturers (Building Blocks, Application…)

Scope of OCORA

1, 2..: integration steps



In OCORA compliant projects, the integrator is identified as the key player for Safety, Integration and Testing of the on-board CCS system.

Modular CCS Stakeholders

- ➔ Contracting entities (RU §IM)
- ➔ **Integrator(s)**
- ➔ Manufacturers (Building Blocks, Application…)
- ➔ Other (ISA/ NoBo, DeBo..)

In OCORA compliant projects, the integrator is identified as the key player for Safety, Integration and Testing of the on-board CCS system

Security

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Asset Classification

Name of data or data group	Description of data or data group	SIL	Confidentiality	Integrity	Availability	Privacy
CCU data	Computing data	SIL4	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous
Location data	Vehicle location data	SIL4	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous
BTM data	Balise data, location data	SIL4	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous
LTM data	EURO Loop data	SIL4	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous
NTC data	National Train Control data	SIL4	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous
JRU/TRU/DRU data	Speed, position, communication, audio, video signals	noSIL	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P1 - Personal
I/O Module (EB/TCO) data	Command and monitor data	SIL4	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous
DMI data	Supervised Distance Info (active braking curve), speed info (braking curve, speed monitoring), Supplementary Driving Info (ETCS L or NTC), Planning info (train speed profile crossing station), Monitoring (technical systems), driver input	SIL2	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P1 - Personal
Cab Voice data	Driver communication, audio data	noSIL	C1 - Internal	I1 - Basic Integrity	A2 - High availability	P0 - Anonymous
Radio data GSM-R	RBC communication	SIL0**	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous
Radio data FRMCS	RBC communication	SIL0*	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous
Vehicle Control data	Command and monitor data	SIL2	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous
Passenger data	Audio and video data for the passengers	noSIL	C1 - Internal	I1 - Basic Integrity	A1 - Business hours	P0 - Anonymous
Gateway data	Communication between networks	noSIL	C2 - Confidential	I2 - Special Integrity	A2 - High availability	P0 - Anonymous

x0 = no requirements
x1 = standard requirements
x2 = enhanced requirements

* The functions and SIL for the FRMCS radio are not yet defined.
** SIL for GSM-R radio depends on the view. In the integration phase 'basic integrity' is needed.
Indication 'SIL0' is equivalent to 'Basic Integrity'
Indication 'noSIL' notes a function that has no functional safety requirements

Methodology & Tooling

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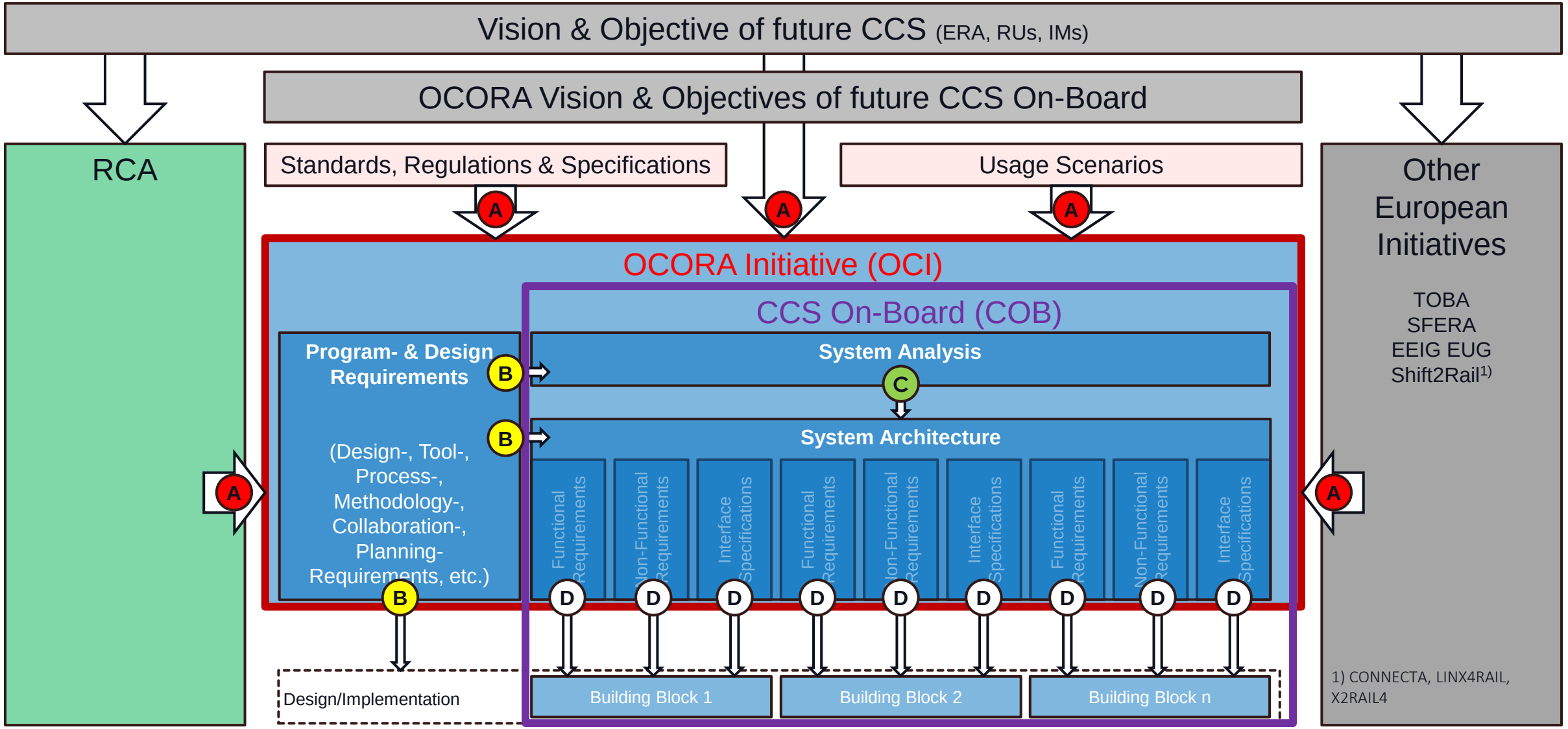
OCORA Requirements Engineering

Structuring the Requirements



OCORA Requirements Engineering

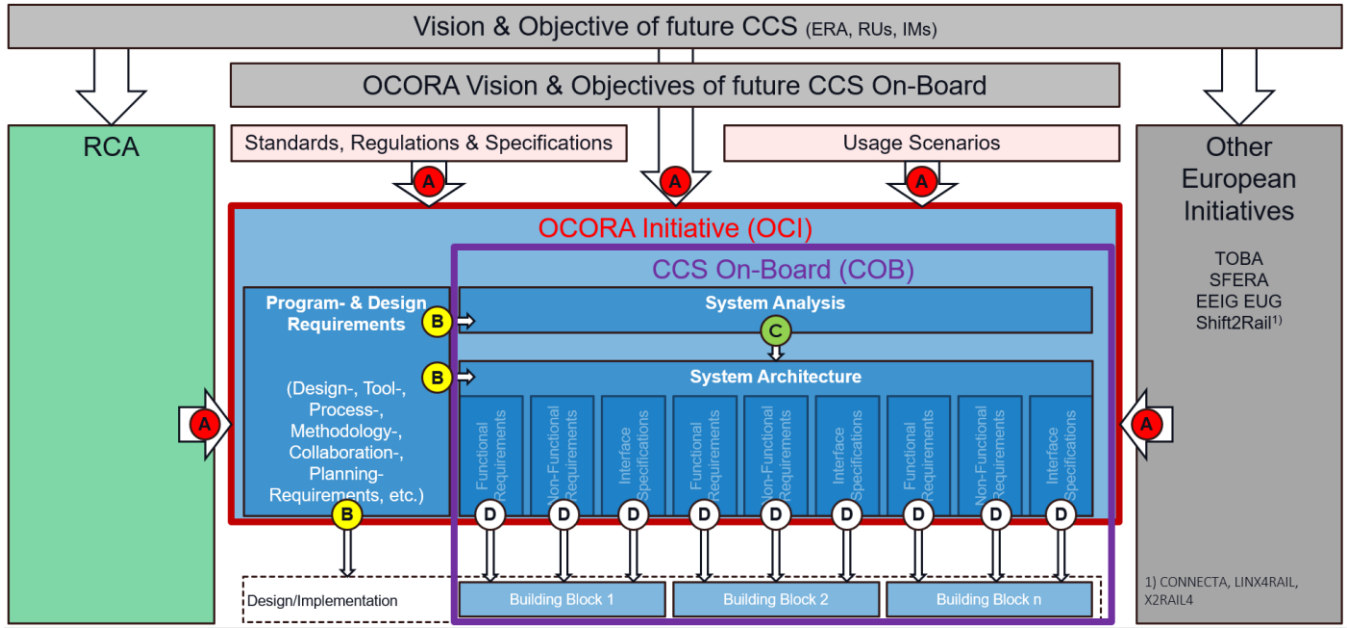
Requirement Definitions

A **Stakeholder Requirements:** OCORA has to manage many different requirements, coming from many different stakeholders.

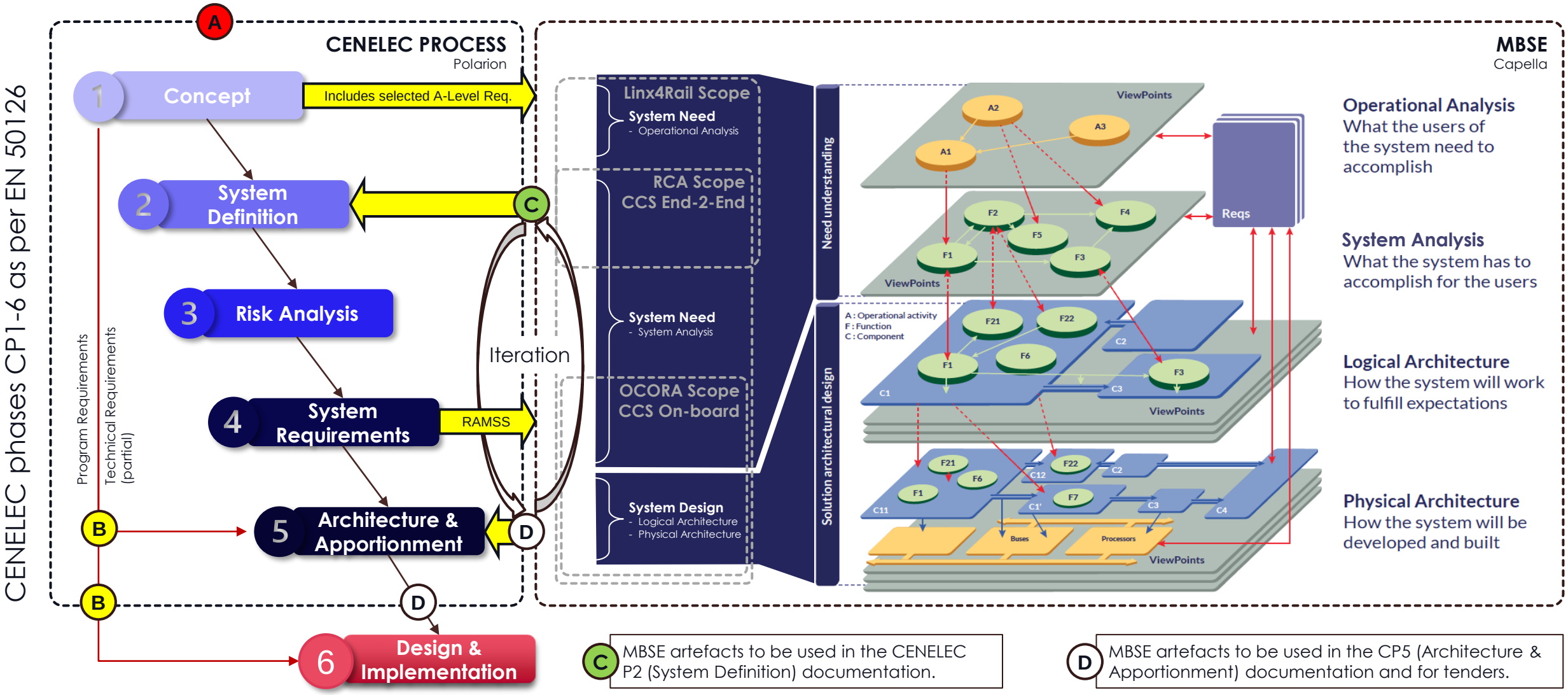
B **Program- & Design Requirements:** The OCORA program defines tools, processes, methodologies and design rules to be used within the program and to be considered during the system analysis and the system design/architecture work.

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.



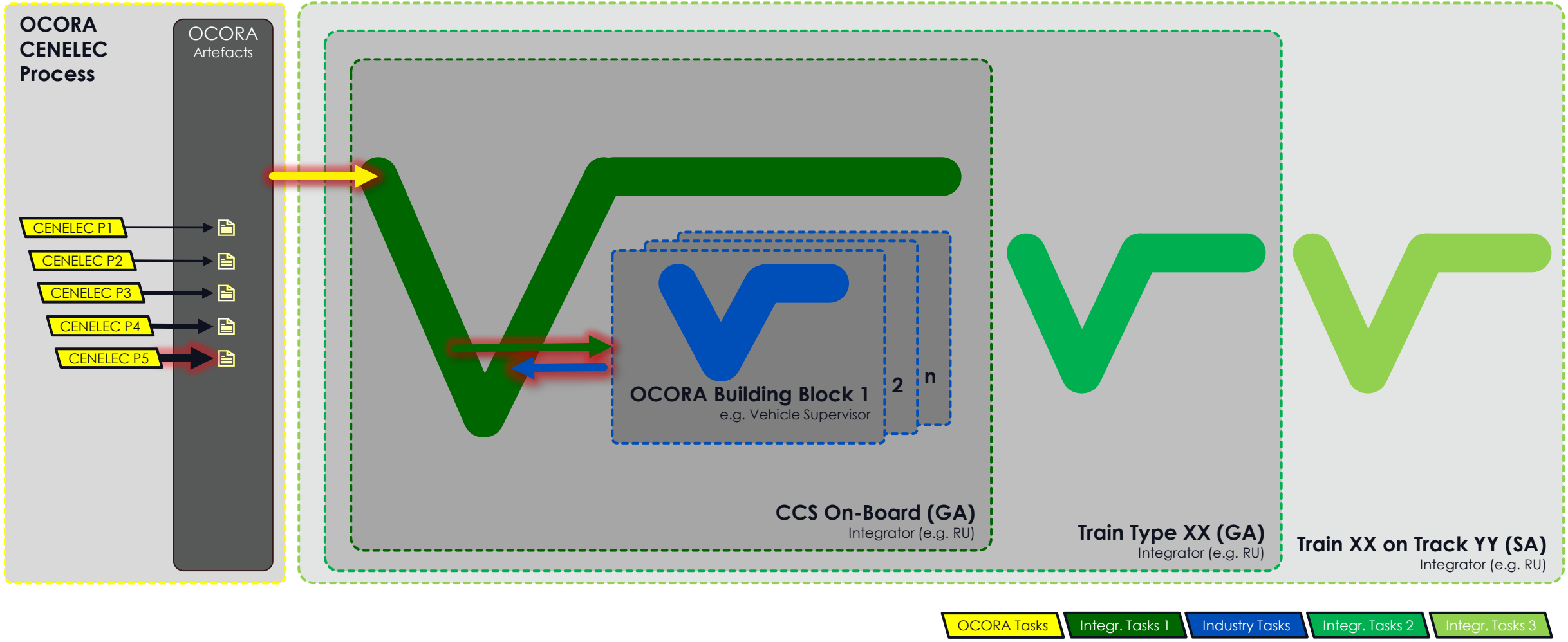
Interaction between CENELEC Process and MBSE



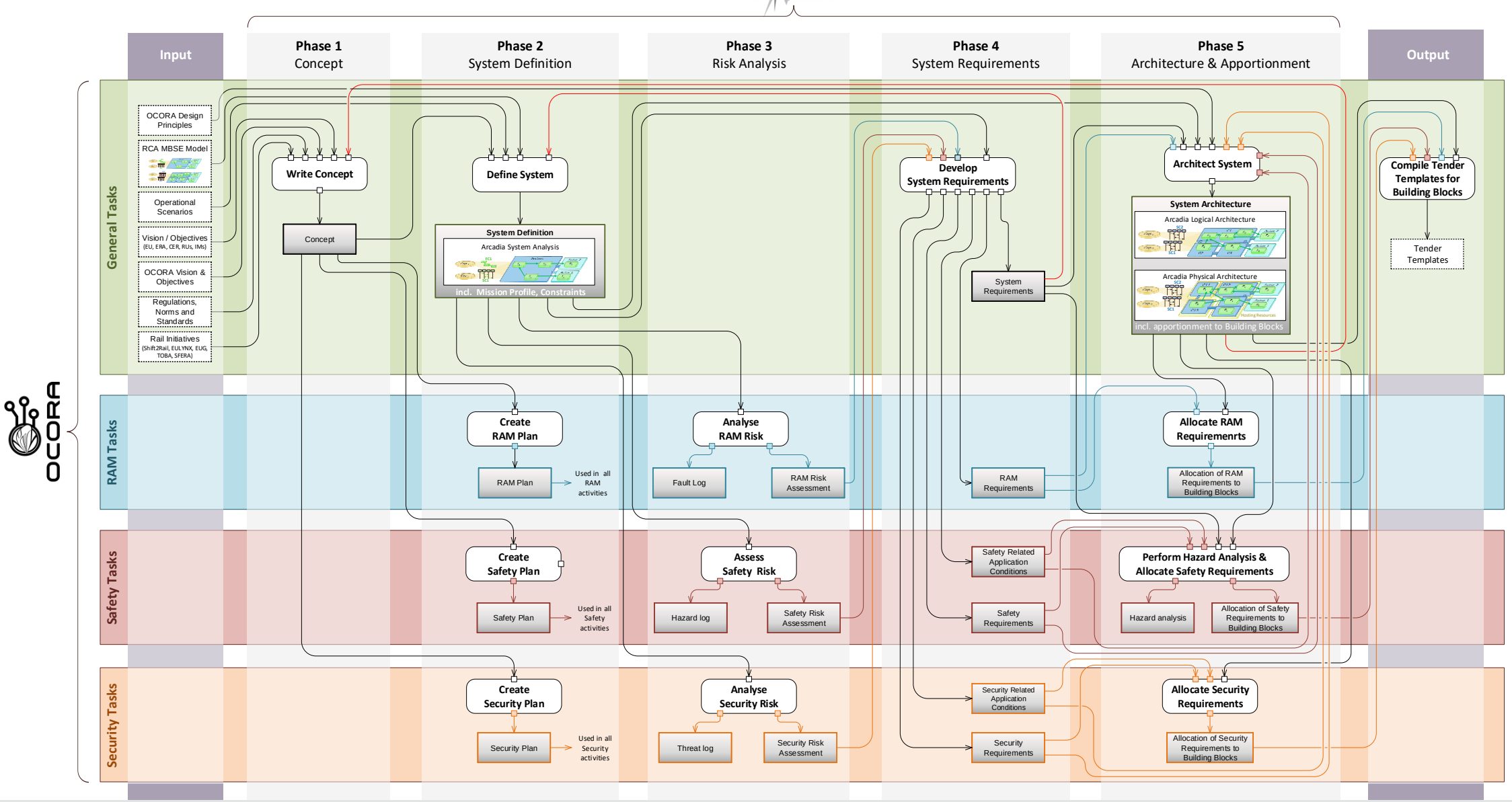
C MBSE artefacts to be used in the CENELEC P2 (System Definition) documentation.

D MBSE artefacts to be used in the CP5 (Architecture & Apportionment) documentation and for tenders.

OCORA in Context of the relevant CENELEC Projects



OCORA CENELEC Process



Operational Concept

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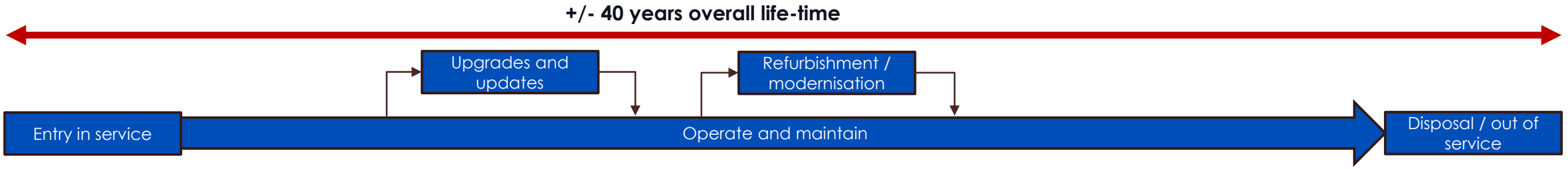
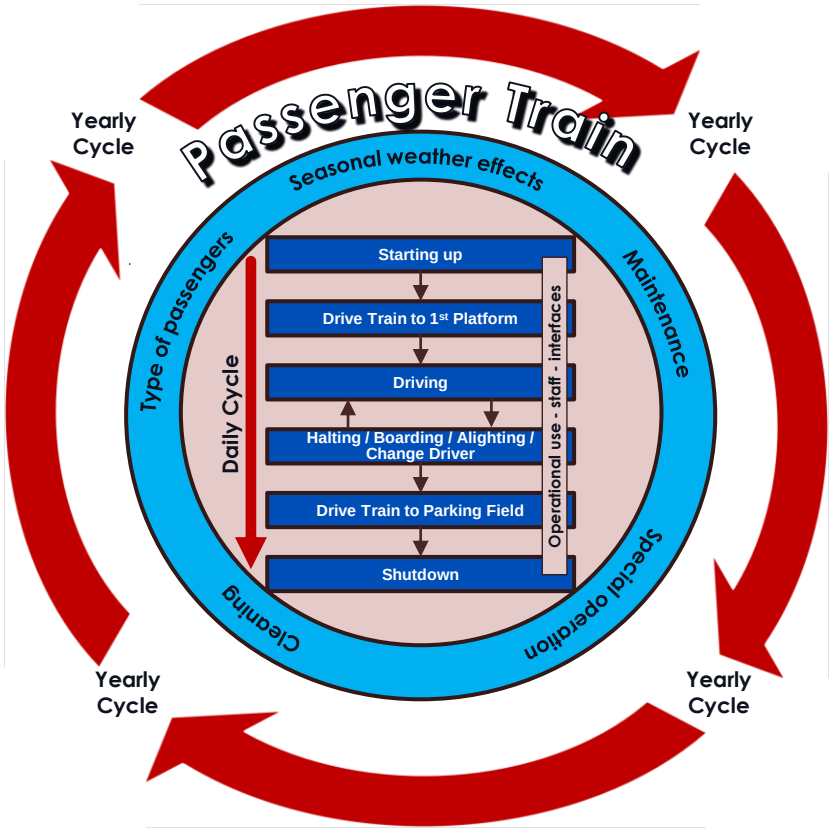
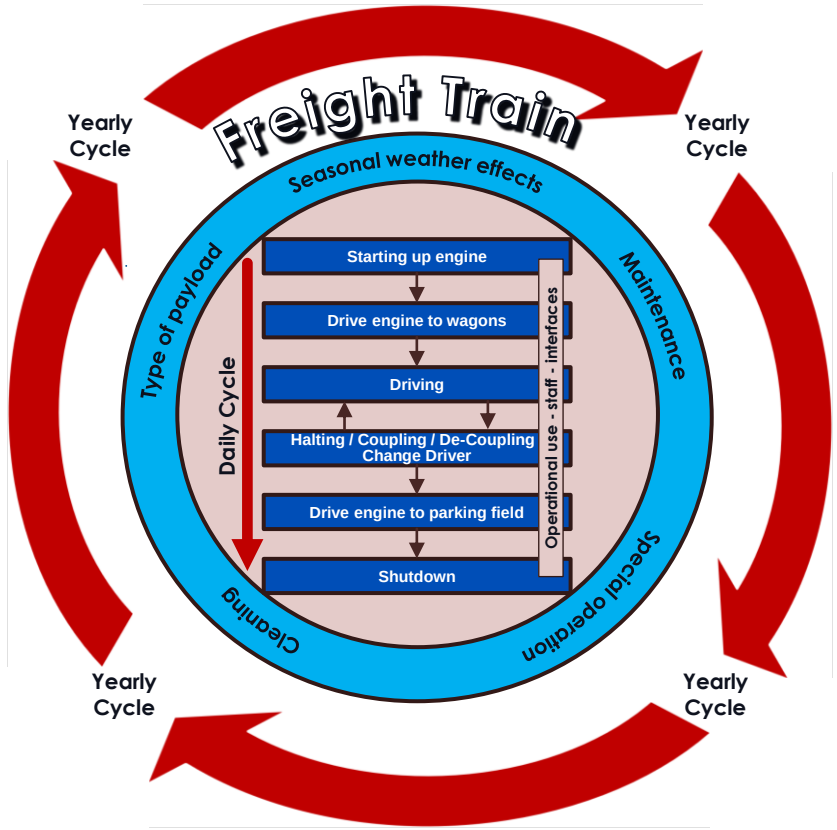
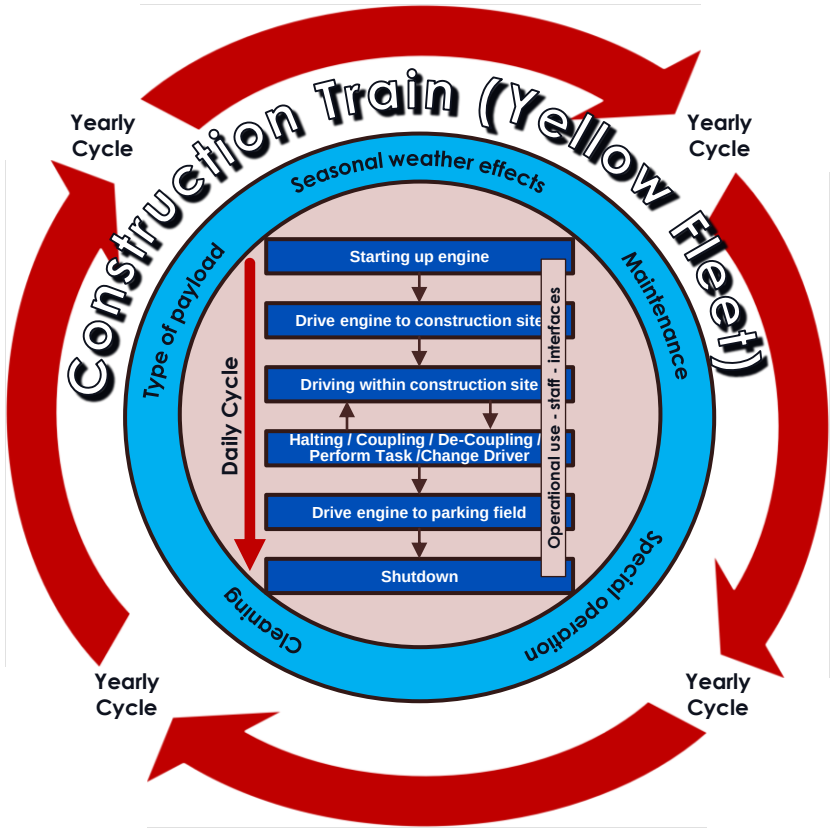
Operational Concept Overview

Live Cycle of Passenger & Freight Trains









Supporting Slides

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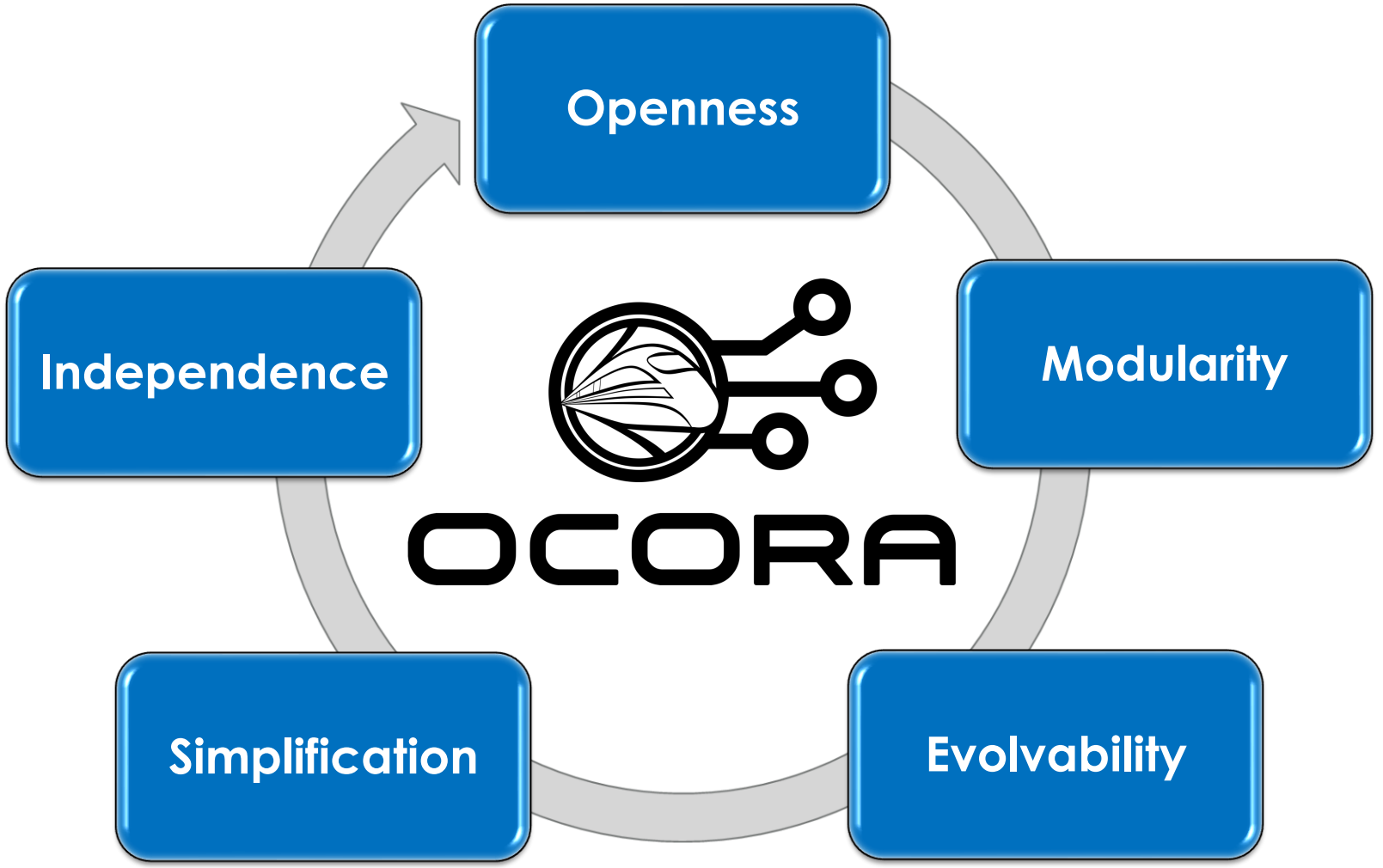
OCORA Key Principles



OCORA Workstreams & Work Packages

Business Workstreams

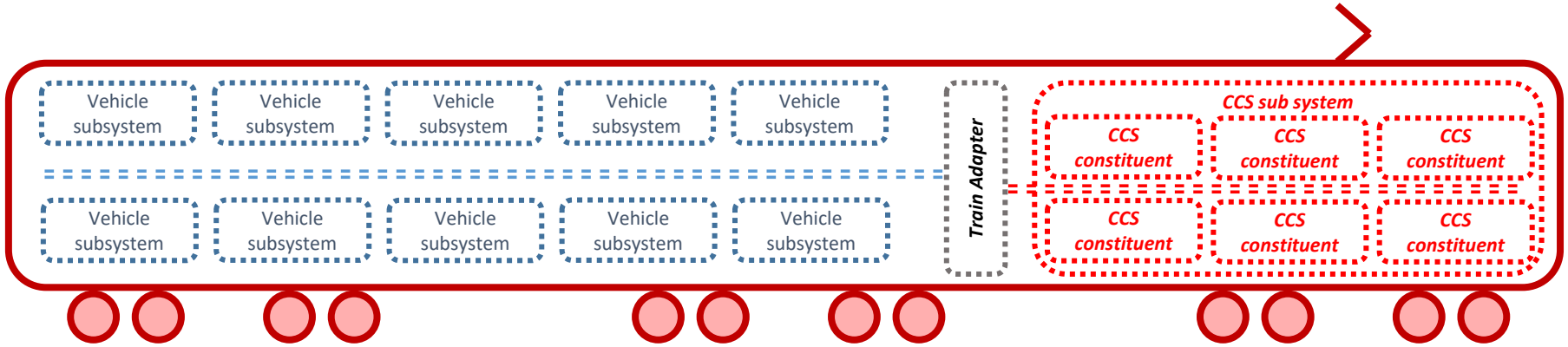
BWS01	Core Team
BWS02	Program & Technical Slides & Posters
BWS03	Introduction to OCORA
BWS04	Problem Statements
BWS05	Roadmap & Planning
BWS06	Business Model
BWS07	Alliances
BWS08	High Level Methodology & Tooling
BWS09	Acceptance of Global Standards

Technical Workstreams

TWS01	System Architecture
TWS02	CCS Communication Network (CCN)
TWS03	Computing Platform
TWS04	Functional Vehicle Adapter
TWS05	Requirements
TWS06	(Cyber-) Security
TWS07	Modular Safety
TWS08	Diagnostic, Configuration, Monitoring
TWS09	Testing

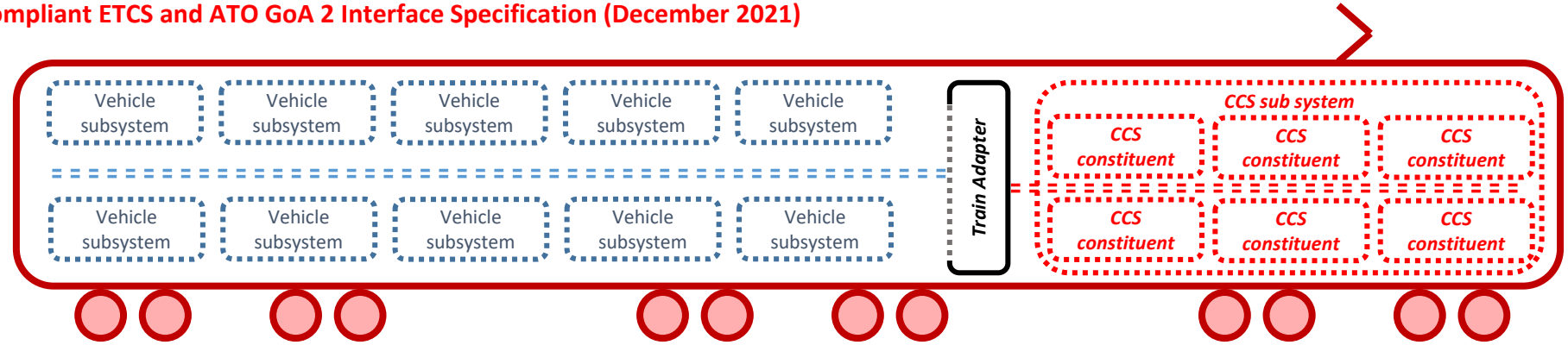
WP01	Open Points from Gamma Release
WP02	MBSE Preparation
WP03	Synchronisation with RCA & S2R
WP04	Localisation
WP05	ATO
WP06	ETCS
WP07	Connectivity
WP08	System Capabilities
WP09	CENELEC Documentation

Level of Modularity 0 (current situation): the integrated proprietary CCS system is (again) fully integrated in the proprietary vehicle environment, driving costs and risks and complicating obsolescence issue



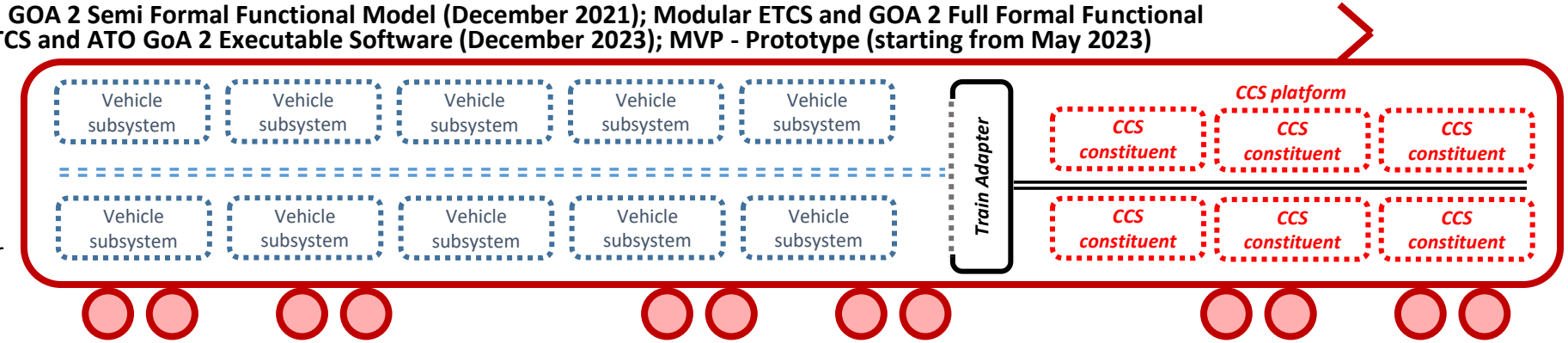
Project proposal: SS119 and SS139 Compliant ETCS and ATO GoA 2 Interface Specification (December 2021)

Level of Modularity 1 (imminent retrofit projects): the interface between the proprietary CCS system is isolated from the fully integrated proprietary vehicle environment, enabling exchange of the CCS environment without affecting the vehicle and vice versa, simplifying obsolescence issues



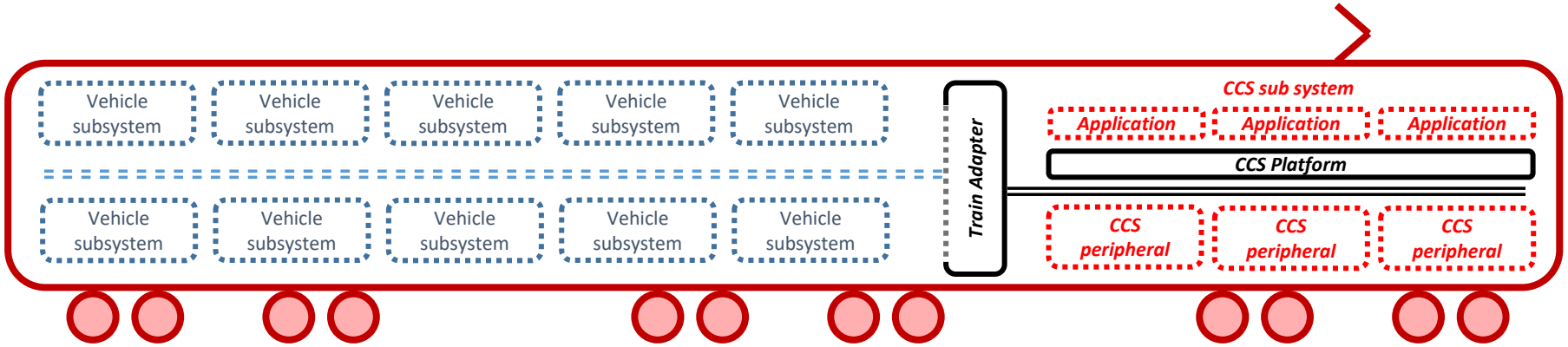
Project proposals: Modular ETCS and GOA 2 Semi Formal Functional Model (December 2021); Modular ETCS and GOA 2 Full Formal Functional Model (December 2022); Modular ETCS and ATO GoA 2 Executable Software (December 2023); MVP - Prototype (starting from May 2023)

Level of Modularity 2 (short term OCORA objective): the interface between proprietary constituents of the CCS system are isolated, enabling exchange of those constituents without affecting either the vehicle or other CCS constituents, simplifying obsolescence and migration issues

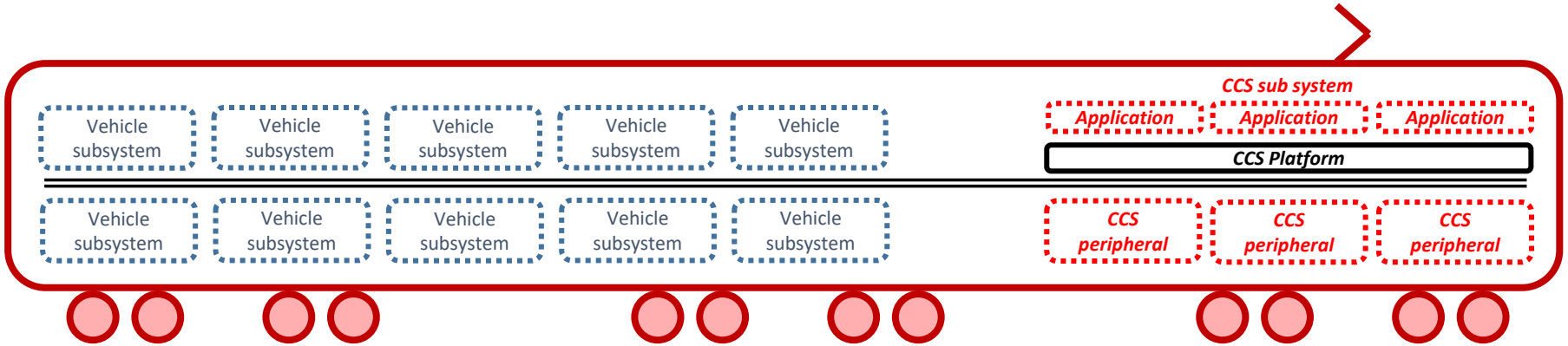


Urgent project proposal **Next project proposals** Integrated, proprietary subsystem or constituent Open, universal subsystem or constituent – MVP

Level of Modularity 5 (full OCORA on-board): the CCS system is composed of a platform, hosting independent application and connected to peri-pheral through a CCS standardized communication network. This open CCS environment is isolated from the fully integrated proprietary vehicle environment



Level of Modularity *n* (long term perspective): the standardised CCS communication network interface any vehicle constituents, simplifying obsolescence and migration issues



Urgent project proposal **Next project proposals** Integrated, proprietary subsystem or constituent Open, universal subsystem or constituent – MVP

OCORA – CCS Communication Network (CCN)

OSI Layer		Protocol	
		Protocol for hard-real-time data	*Protocol for soft- or non-real-time data*
	(Safety*)	**(SDTv2 / SDTv4)**	
5	Session	TRDP - OPC-UA Pub/Sub - DDS-RTPS	
4	Transport	UDP (for process and message data) TCP (for message data)	
3	Network	IPv4	
2	Data Link	**Time-Sensitive Networking (TSN) IEEE 802.1**	**Standard Ethernet IEEE 802.3**
1	Physical	**100BASE-TX or 1000BASE-T**	

*Safety layer is only applicable for safety function related data traffic

Details im Document: OCORA-TWS02-010 - CCN Evaluation