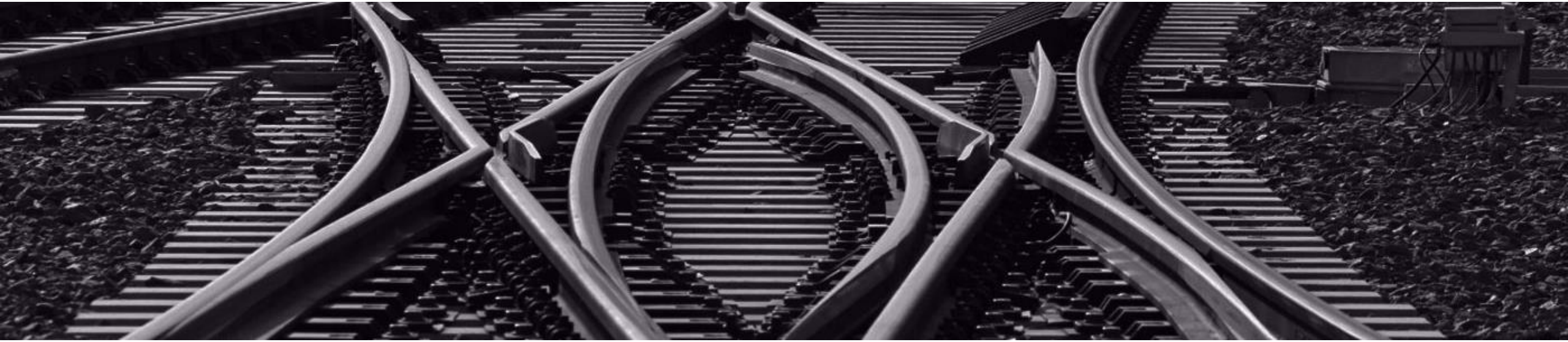


RCA in a nutshell

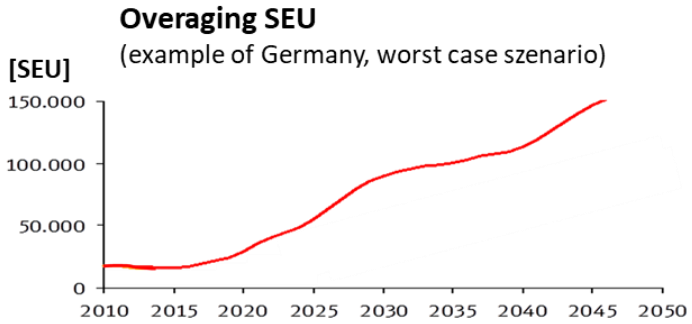
need for RCA – how we do it – what it is all about

Agenda

1. **Need for a Reference CCS Architecture (RCA)**
2. RCA is a joint effort of existing initiatives
3. What RCA is about
4. Relation to IM programs/ plans
5. Tangible results

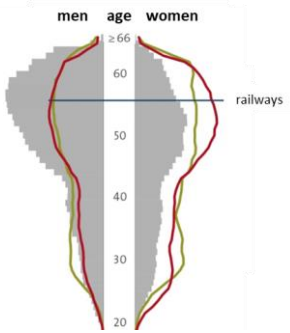
Common problem statement of industry and railways

No.1: Aging Infrastructure



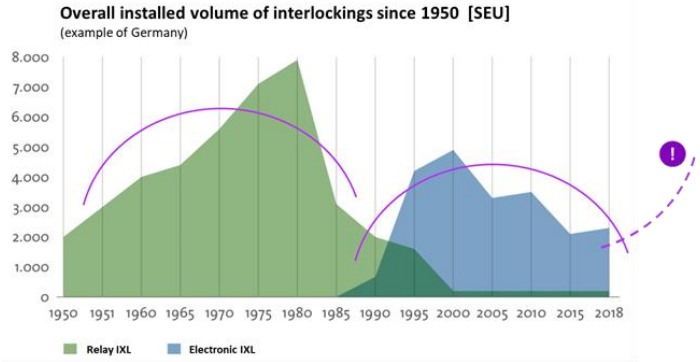
- Shorter life cycles
- Life cycle cost above affordability
- Missing long term compatibility
- Unsolved harmonisation

No.2: Aging Human Ressources



- Problematic skill shift
- Skilled labour shortage

No.3: Continuous Underspending

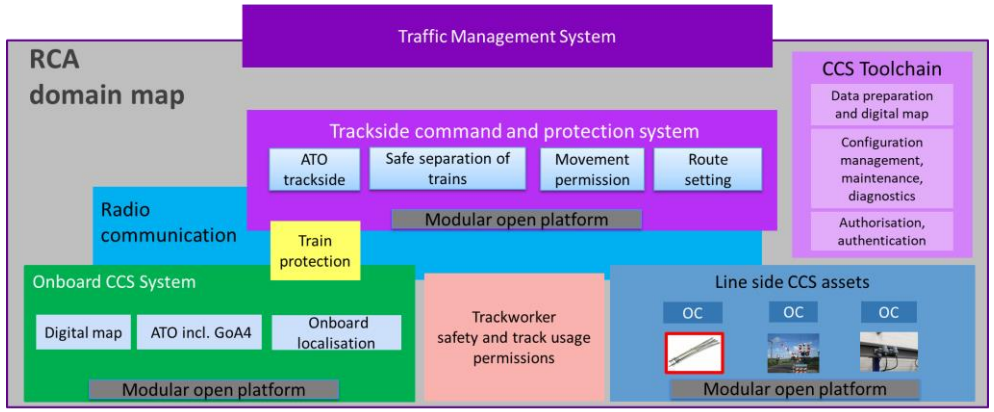


- Risky investments
- Unstable migration programs

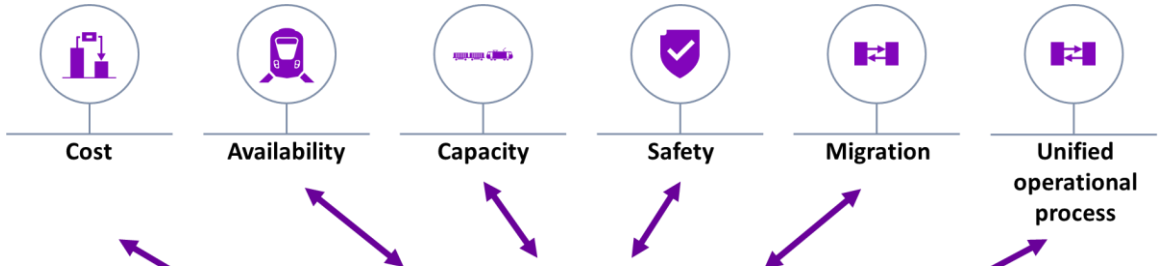
A standardised CCS with game changers that foster digitisation will help solving major problems of the railway sector

Business needs are the drivers for RCA, not technology

Cost | **Availability** | **Capacity** | **Safety** | **Migration** | **Unified operational process**



Functional enhancements and technical capabilities will satisfy business needs



Functional Capabilities

- Improved departure process
- Improved shunting process
- Automatic operation (GoA 2 - 4)
- Highly automated incident management
- Continuous speed / position of all trains
- Improved track worker warning systems
- …

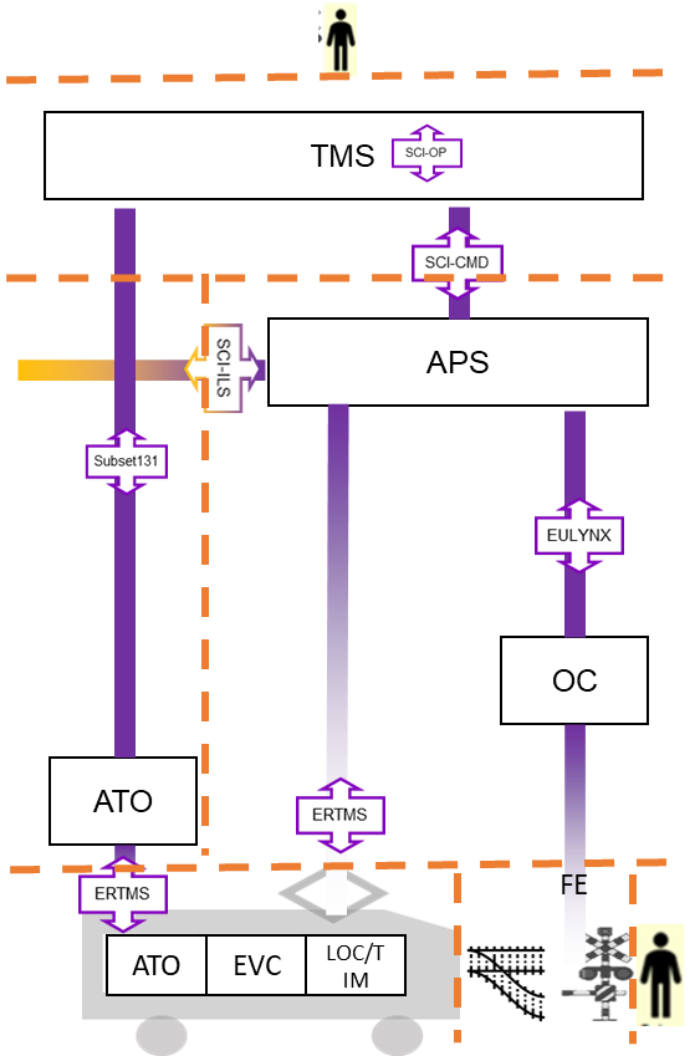
Technical Capabilities

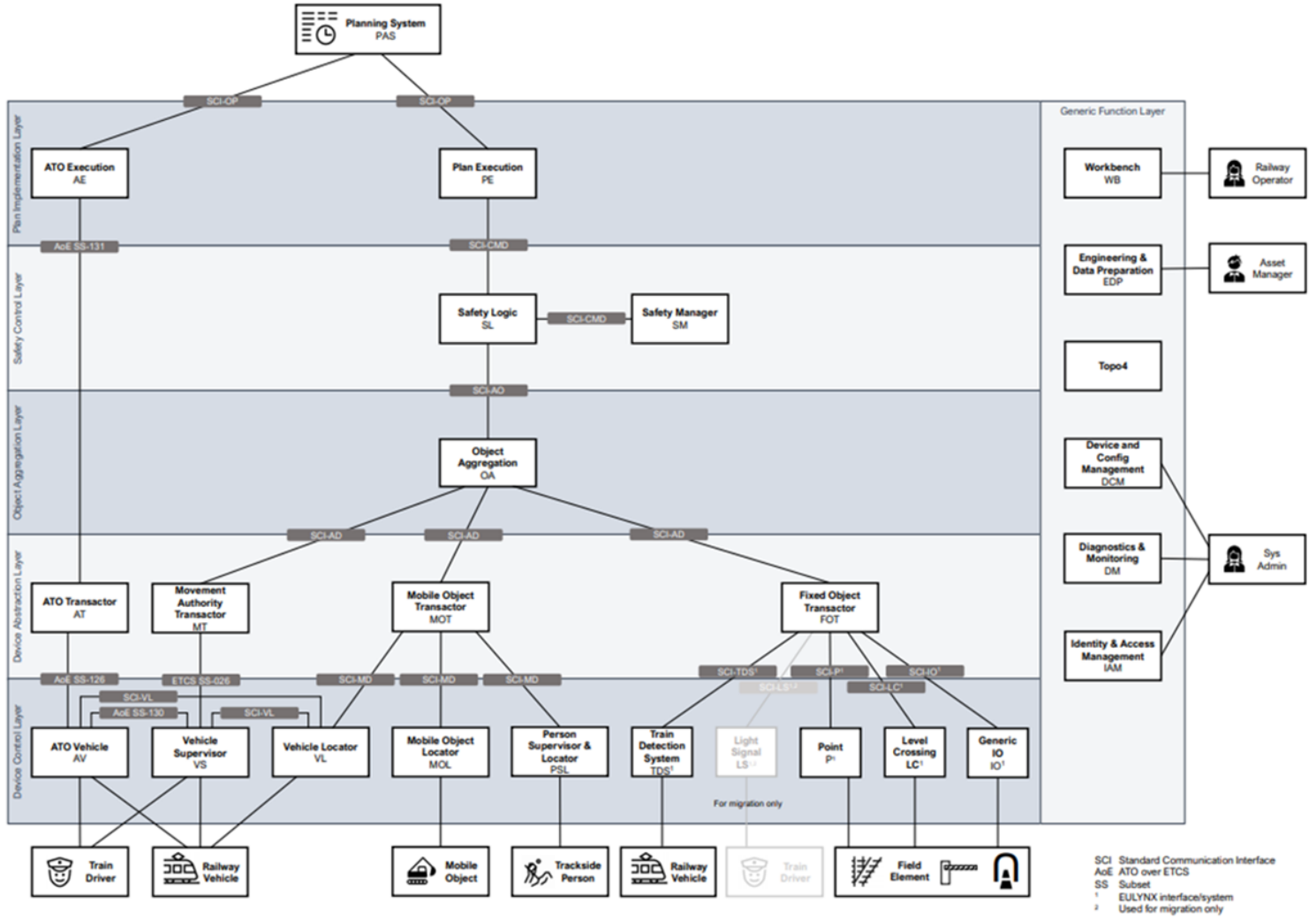
- Full supervision of all movements
- Cab signaling for all movements
- Accurate vehicle localisation
- Continuous detection of position
- Efficient creation of engineering data
- Support for migration in large segments
- …

Architectural Principles

- Rules for separation of functions
- Segregated and self-contained interfaces
- Use of platforms
- …

As a result a Reference CCS Architecture ensures the achievement of the business needs of the railways





Agenda

1. Need for a Reference CCS Architecture (RCA)
2. **RCA is a joint effort of existing initiatives**
3. What RCA is about
4. Relation to IM programs/ plans
5. Tangible results

Three railway-initiated initiatives are driving the harmonization of requirements for a modular CCS architecture.

- ✓ Aligned architecture
- ✓ Close organizational links

EULYNX

Focus: Specs for modular trackside CCS with current functions to reduce TCO.

EULYNX consortium

RCA

Focus: Specs for modular CCS architecture for radio-based ETCS incl. game-changers.

MoU of EULYNX and EUG

OCORA

Focus: Specs for modular on-board CCS architecture to support ETCS rollouts.

MoU of 5 railways

Agenda

1. Need for a Reference CCS Architecture (RCA)
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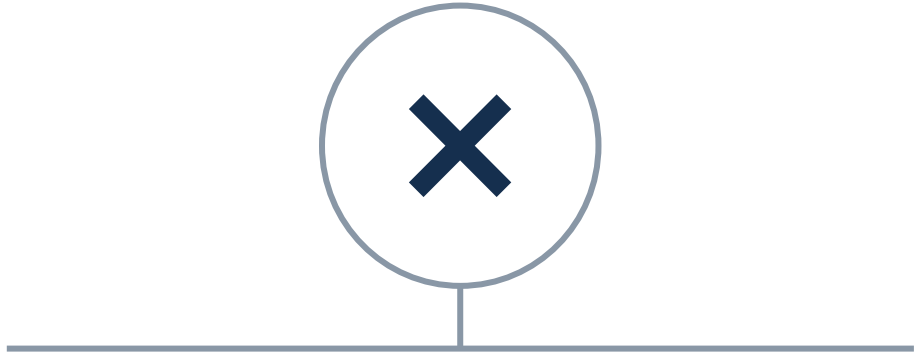
What exactly is RCA?

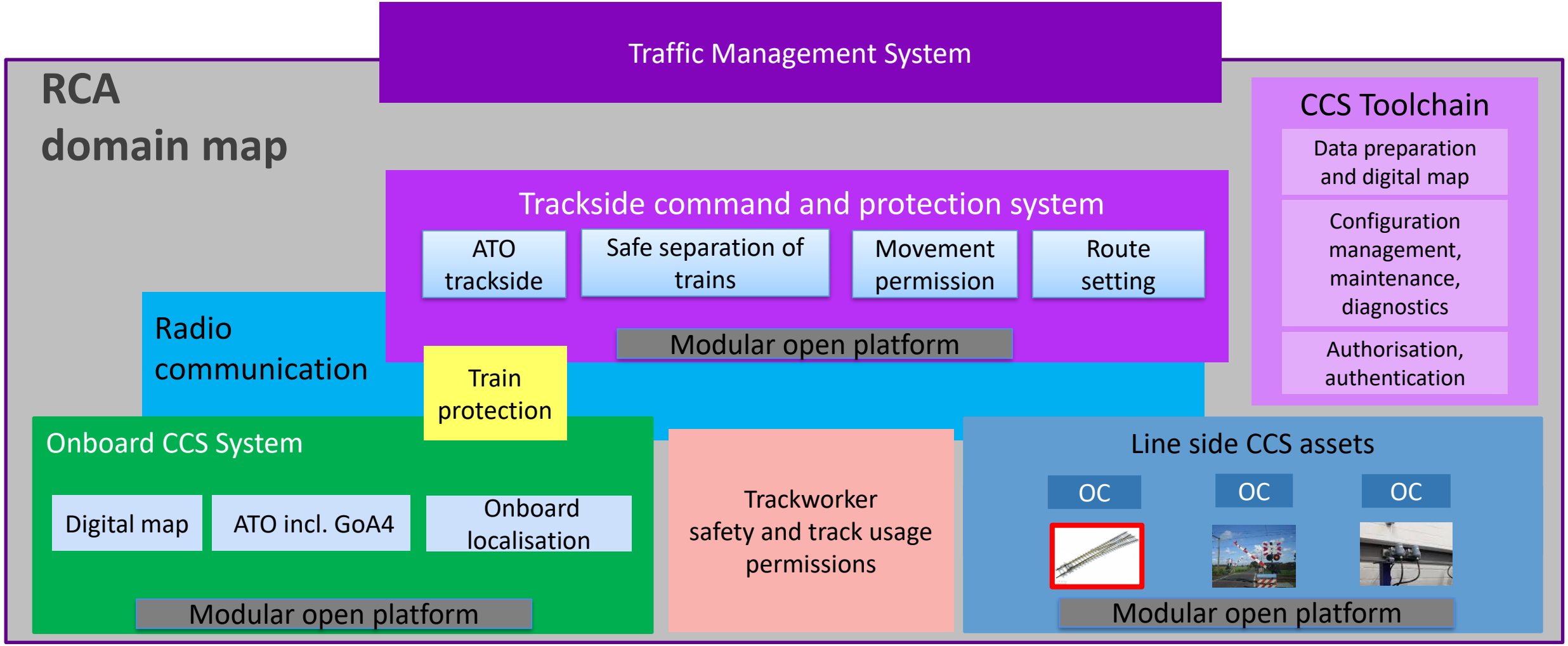
Reference Command and Control Systems Architecture

- Modular Reference Architecture
- Based on ERTMS and ATO
- Includes defined CCS Game Changers
- Evolutionary process
- Interface Specifications (includes EULYNX)
- Harmonized Operations

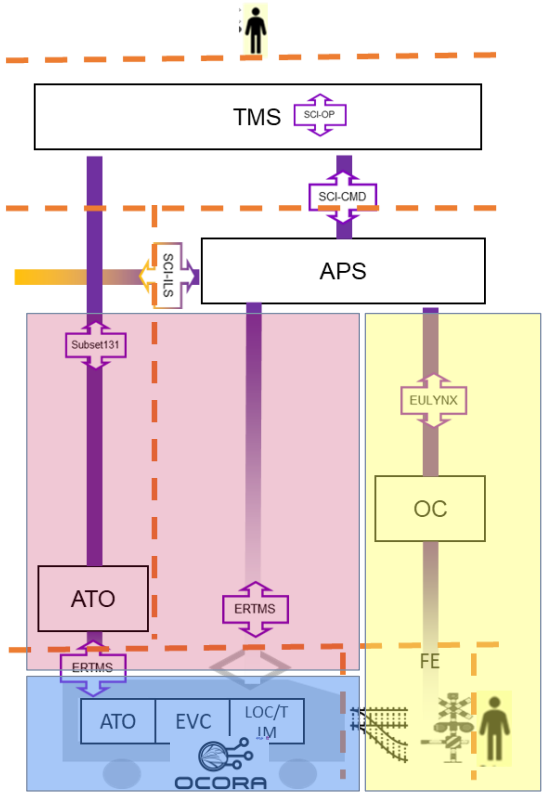


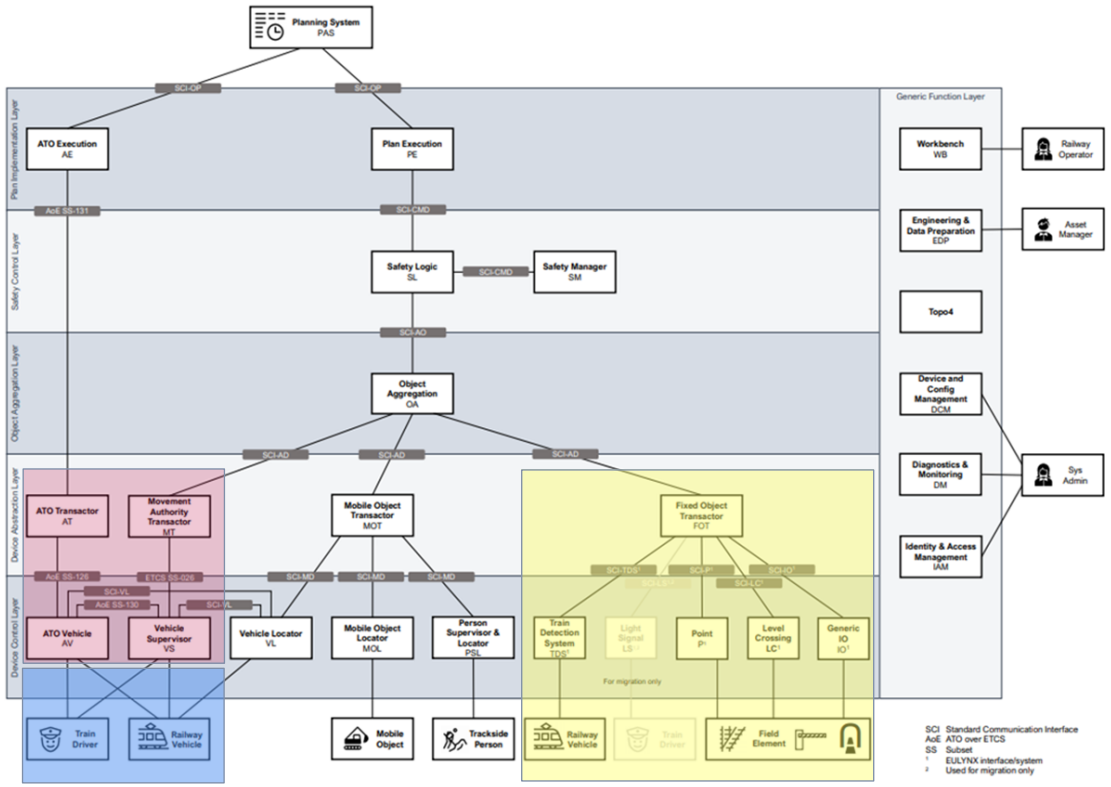
- Product
- Product specifications
- Forced implementation
- End of innovation

System scope and border definition



ERTMS, EULYNX and OCORA are the foundation of RCA





EULYNX

- is an integral part of RCA
- standardizes the interfaces around the Interlocking
- interfaces are a blueprint for further interface standardisation within RCA
- fits perfectly into RCA

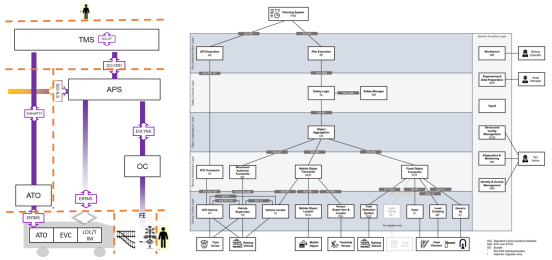
ERTMS

- Important technical game-changers like localisation, FRMCS will be integrated in the TSI

OCORA

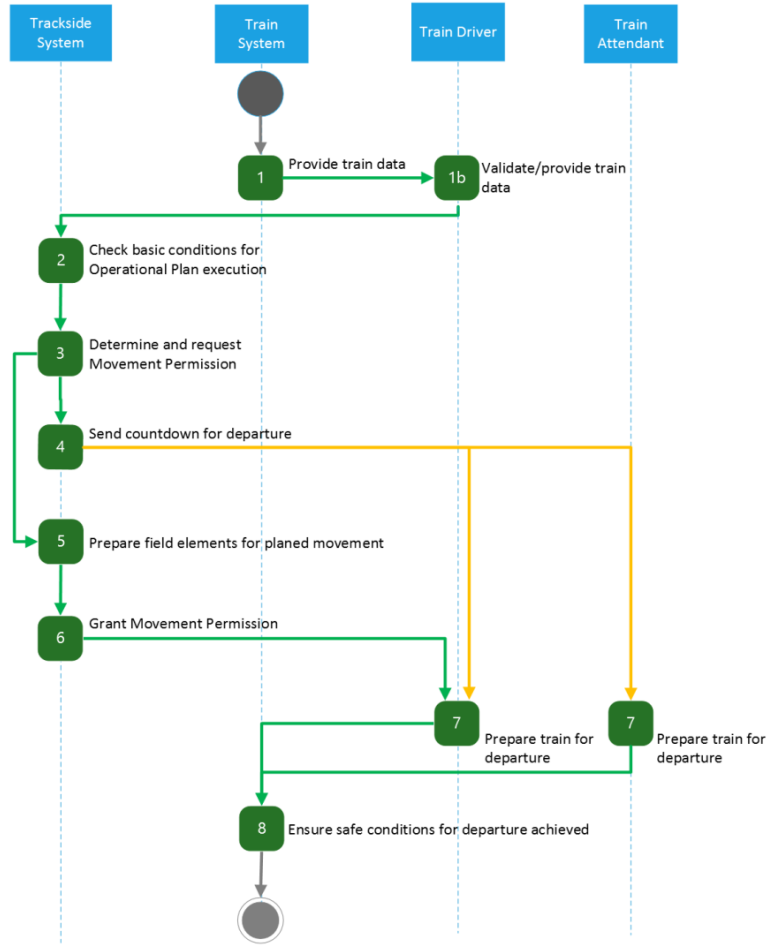
- RCA and OCORA are aligned

With RCA operational harmonisation is feasible



- It is important to not only have a concise technological target picture – simple operational processes for the scope of RCA shall be developed
- Operational processes with the scope of RCA can be aligned
- The game-changers of RCA are an enabler for unified operational processes for CCS
- Without doubt, IMs will in time migrate their infrastructure to the technological and operational target picture of RCA
- On that journey, technologies and operational processes have to be developed hand in hand

Example - Start-of-Mission



Agenda

1. Need for a Reference CCS Architecture (RCA)
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So far there are already tangible results that are mirrored in major IM programs

- Delivered specifications and substantial concepts
- Established System Engineering processes
- Is part of procurement strategies
- EULYNX is part of RCA and provides the development framework
- Established Clusters for RCA

Bane Nor – ERTMS Program
- Renewal program for IXL and ETCS L2

DB Netz AG - DSD
- New projects based on EULYNX >= BL3
- Future migration to RCA under consideration

Network Rail
- Target 190+ shall be based on EULYNX and RCA

ProRail
- Tendering EULYNX

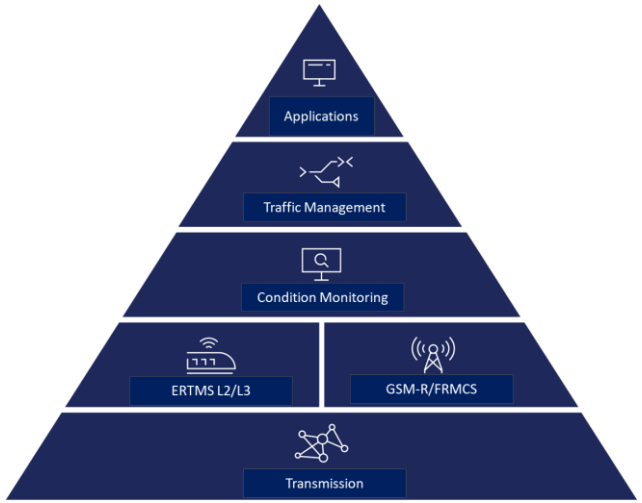
RFI
- Tendering EULYNX

SBB
- ERTMS Strategy is based on RCA

SNCF
- ARGOS – an alternative approach to APS

Bane Nor – ERTMS Program

Vision



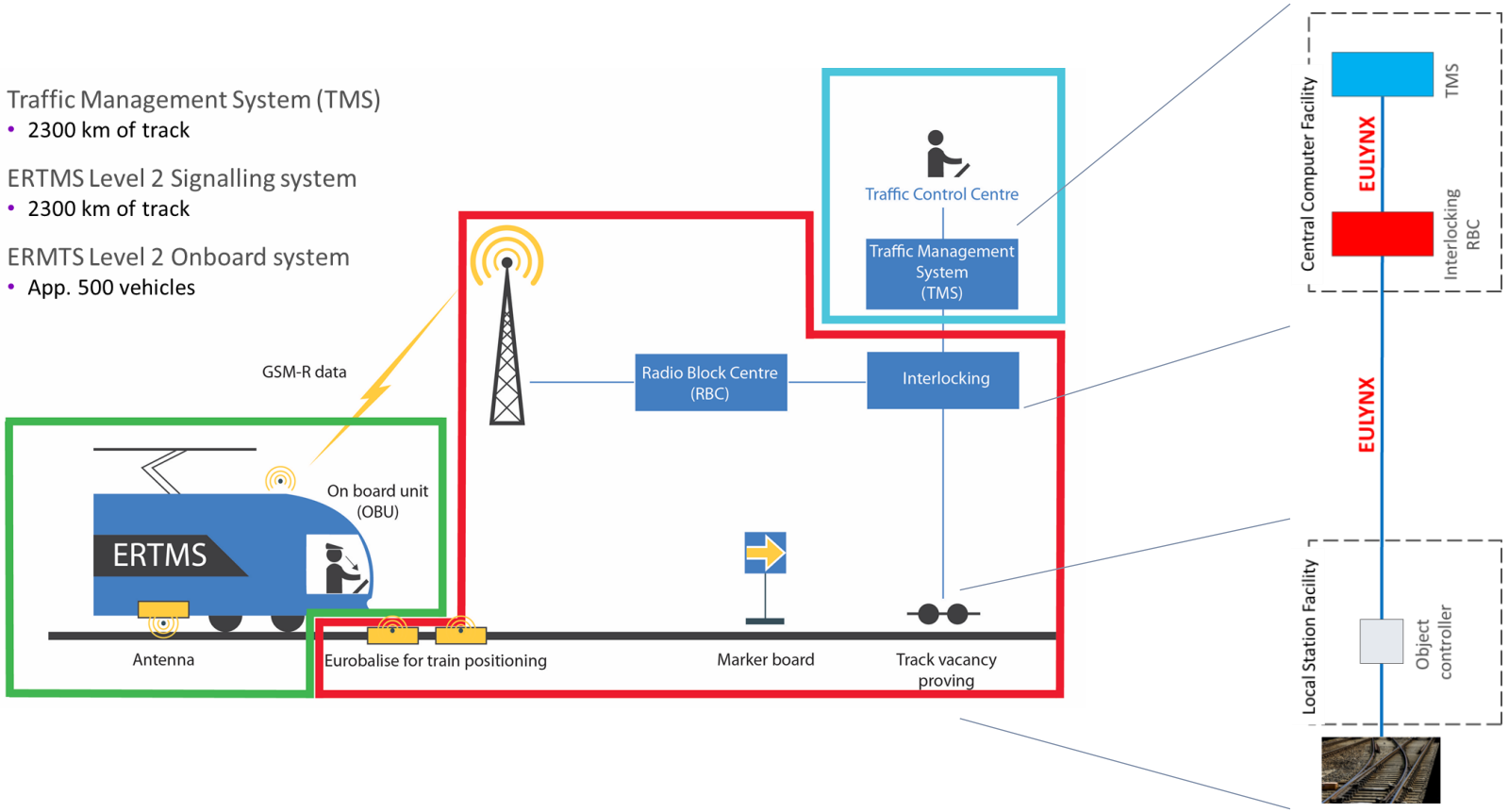
ERTMS Program Scope

Traffic Management System (TMS)
- 2300 km of track

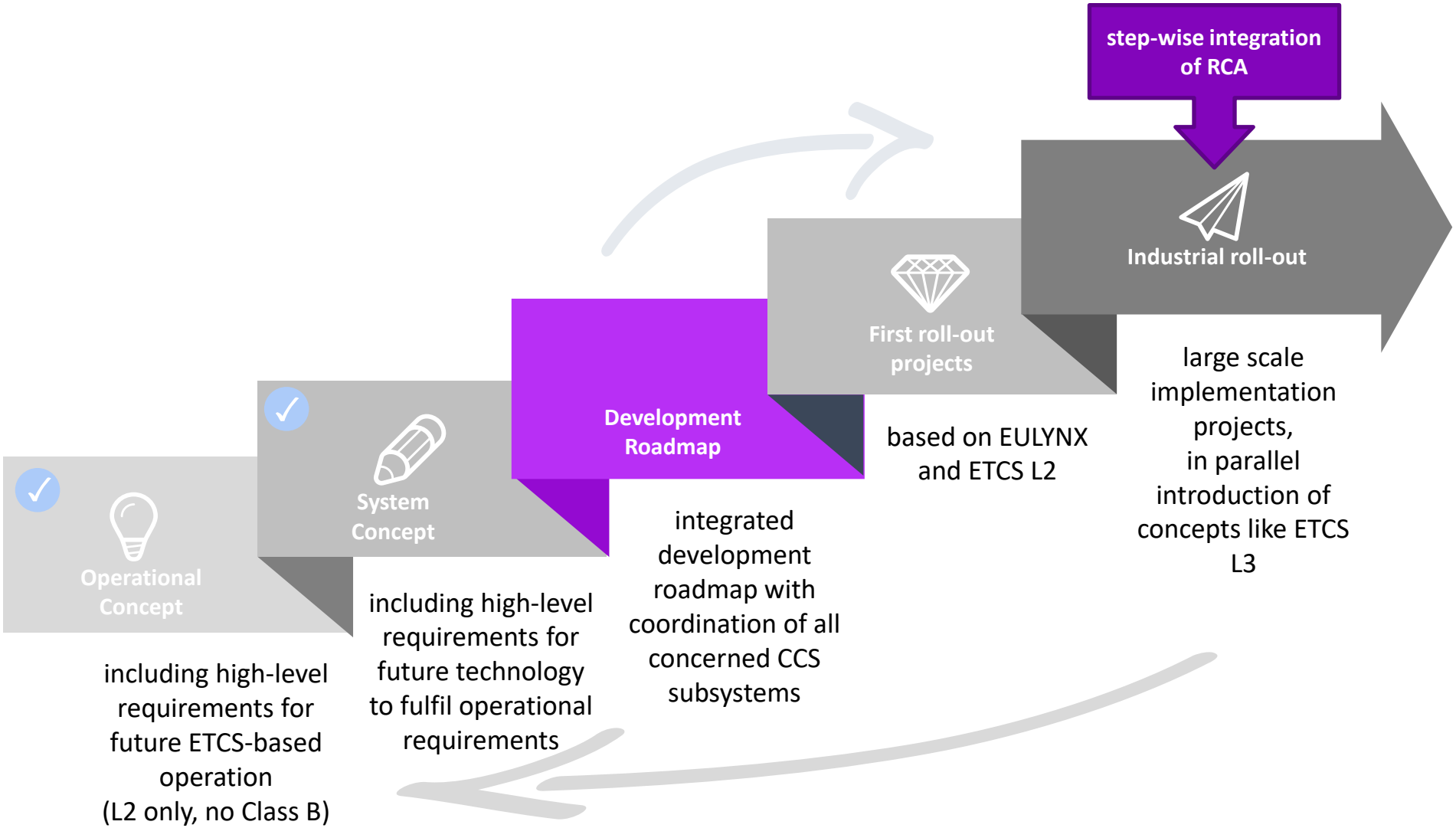
ERTMS Level 2 Signalling system
- 2300 km of track

ERMTS Level 2 Onboard system
- App. 500 vehicles

EULYNX Implementation



DB – „Digitale Schiene Deutschland“ introduces digital rail country-wide with RCA migration in mind

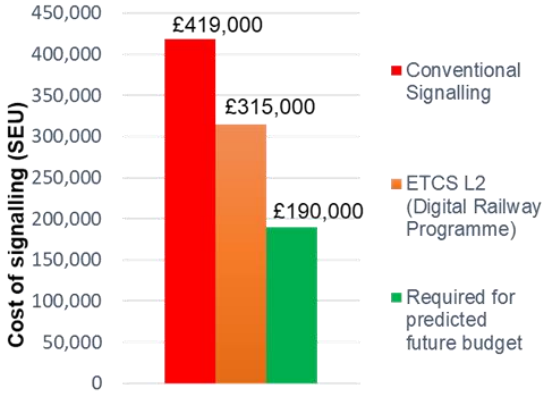


Network Rail reducing cost of signalling to make the GB railway sustainable and affordable for the future T190+

Target 190plus is a **Network Rail Research & Development programme** that looks at the sustainability of the signalling systems on the network and the challenges these bring to the rail industry.

It has the aim to reduce the current whole life cost of signalling from a unit rate (SEU) of **£419,000** to the required **£190,000 by 2029** to enable the ETCS Long Term Deployment Plan to be achieved.

Signalling Cost vs Signalling Options



Architectures of successful cost reduction

Target 190plus tools for change

Automated design approach

We are developing **automated data collection tools** which collect new data in a **more efficient, safer way**, and reuse the data that already exists to reduce duplication. We are also focussing on **optimising how we use and maintain data** across the project lifecycle and day to day operations.

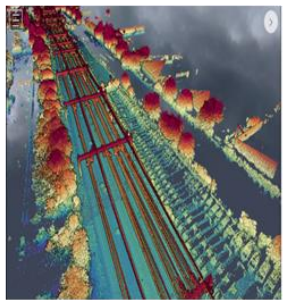
Standardised system architecture

We plan to use **EULYNX specifications and RCA** to standardise interfaces for future CCS technologies and systems including ETCS, to provide common solutions and align interfaces with EU partners, **reducing cost** and **improving performance**.

Automated testing and assurance

Synthetic Environments are one of the opportunities we are looking at that will transform the way signalling is designed, built, and delivered, that will ultimately **reduce train disruptions** for passenger and freight customers, having a **positive impact on the railway** for everyone.

Approach to planning renewal



We are creating the ability **to deliver infrastructure more quickly and efficiently** in the future. The new tools and processes that Target 190plus are developing **will bring efficiencies** in how we plan renewals to support **more sustainable delivery**.

Examples of what Target 190plus are doing

T190+ Target 190plus

Mobility in the Netherlands will increase by 30% in 2030, 40% in 2040; the ambition is to enable more growth

Enormous growth of mobility

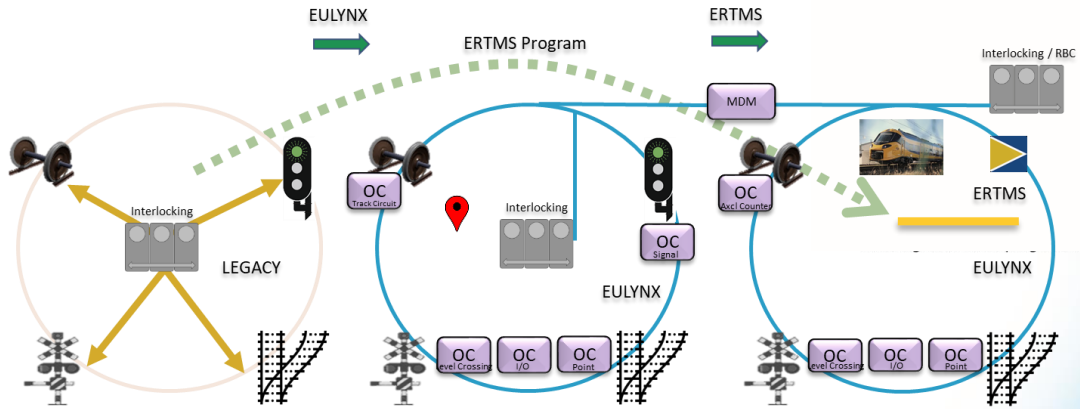
The demand for mobility will increase in the coming years; insufficient capacity can lead to stagnation

Rapid technology development

We have to reverse the trend of the growing number of major disruptions and keep pace with technological developments

System limits reached

We are running into the ceiling of the current system - technological leap forward is inevitable



National ERTMS Program: 7 corridors by **2030**
Tender for CSS ongoing (includes also release steps to EULYNX)
First application EULYNX in Amsterdam by **2026**
Tender for EULYNX ready digital legacy interlockings started
Tender for EULYNX objectcontrollers prepared

Nationwide replacement legacy (with Class B ATB system) by ERTMS **ASAP**, EULYNX architecture is essential in migration path.

ProRail

Signalling

ERTMS in the Netherlands

Already equipped (blue lines)

1. Betuwe Route
2. HSL-South
3. Harbour rail line
4. Amsterdam-Utrecht
5. Hanze Line

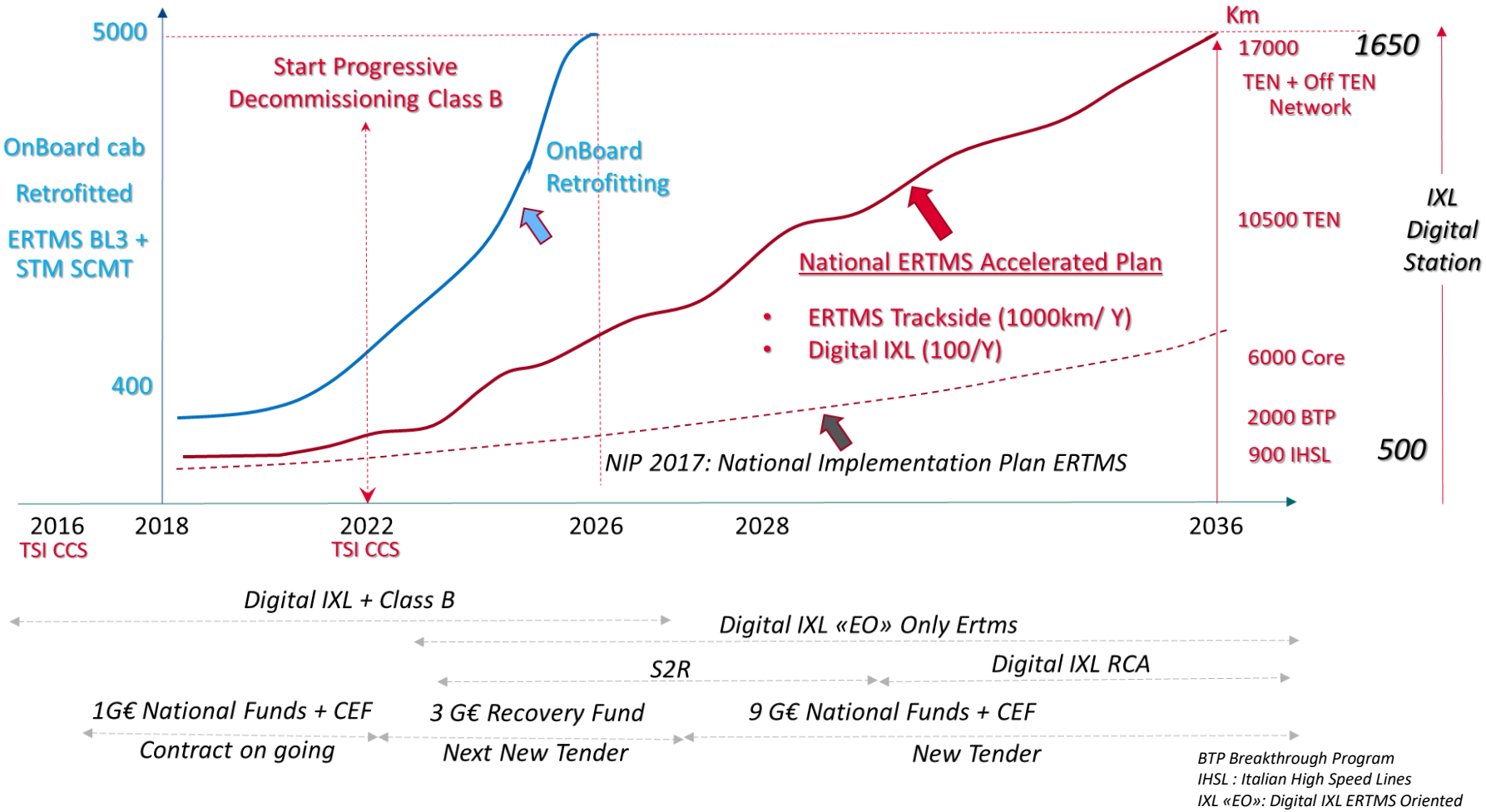
Equipped by 2030 (yellow lines)

6. Kijfhoek – Roosendaal - Belgian border
7. Lelystad – Almere – Schiphol (OV SAAL East)
8. Hoofddorp - Schiphol – Duivendrecht (OV SAAL West)
9. Utrecht – Meteren
10. Roosendaal – Den Bosch ('s Hertogenbosch)
11. Meteren – Eindhoven
12. Eindhoven - Venlo - German border

RFI – ERTMS National Program focuses on future CCS+ scenario

Program & Strategy related to ERTMS ongoing

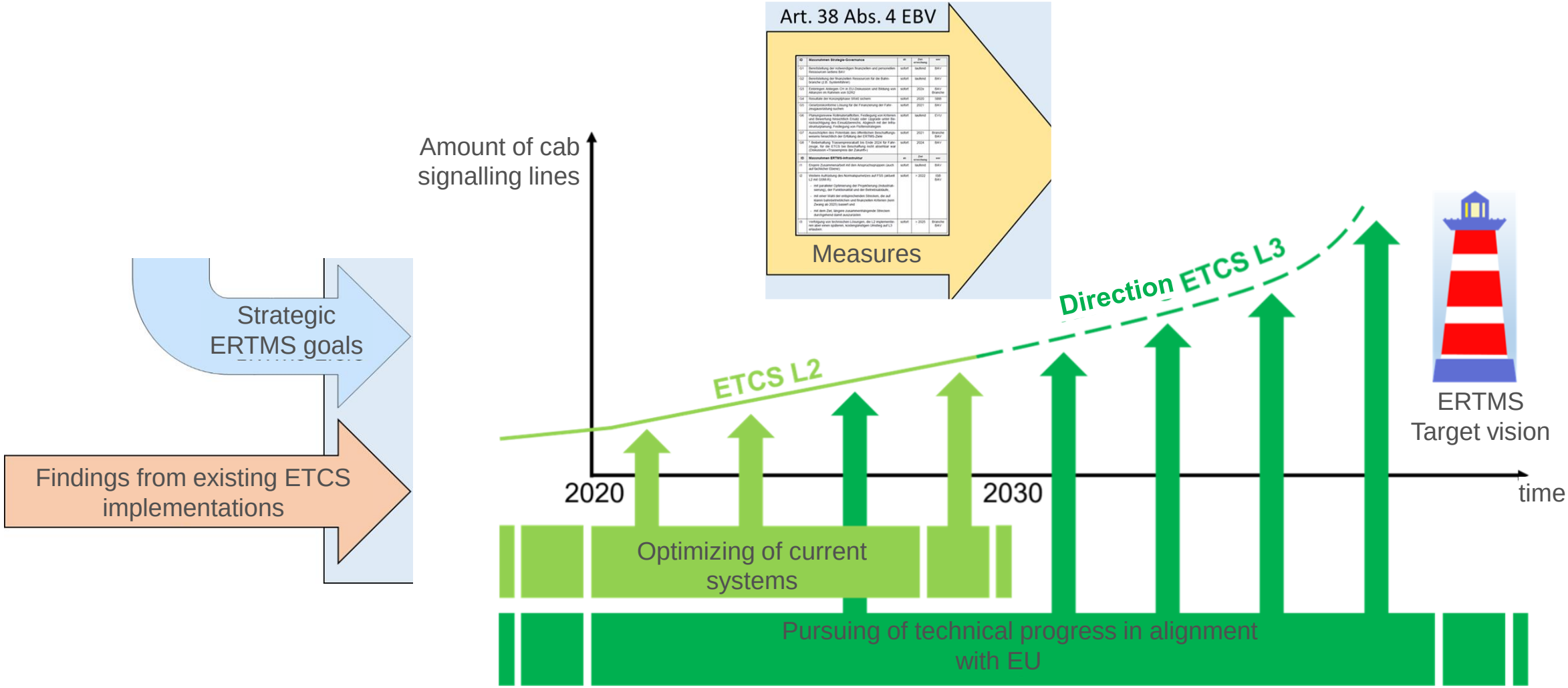
- 2018 start of National ERTMS Accelerated Program
  -> Up to 2022: 1000 km and 100 Digital IXL every year by synchronous decommissioning of Class B
- 2021 Retrofitting Type of vehicles Class B to ERTMS + STM SCMT
- RCA approach will be adopted in Italy after 2030



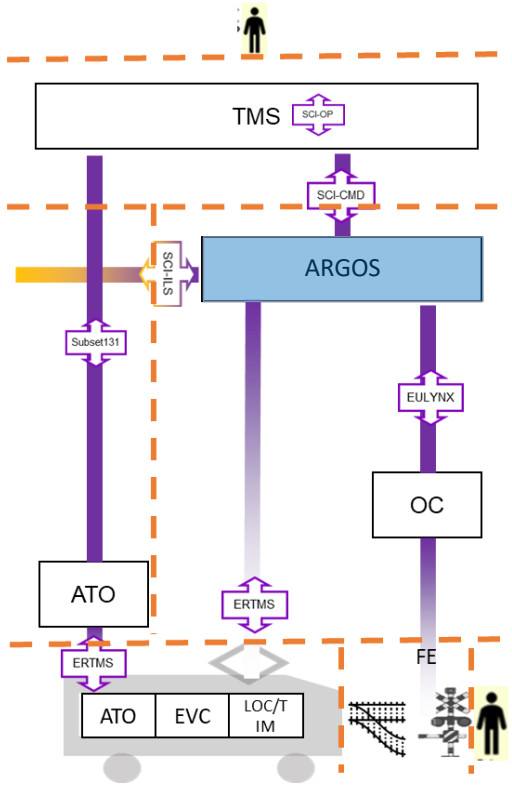
ERTMS Strategy Switzerland

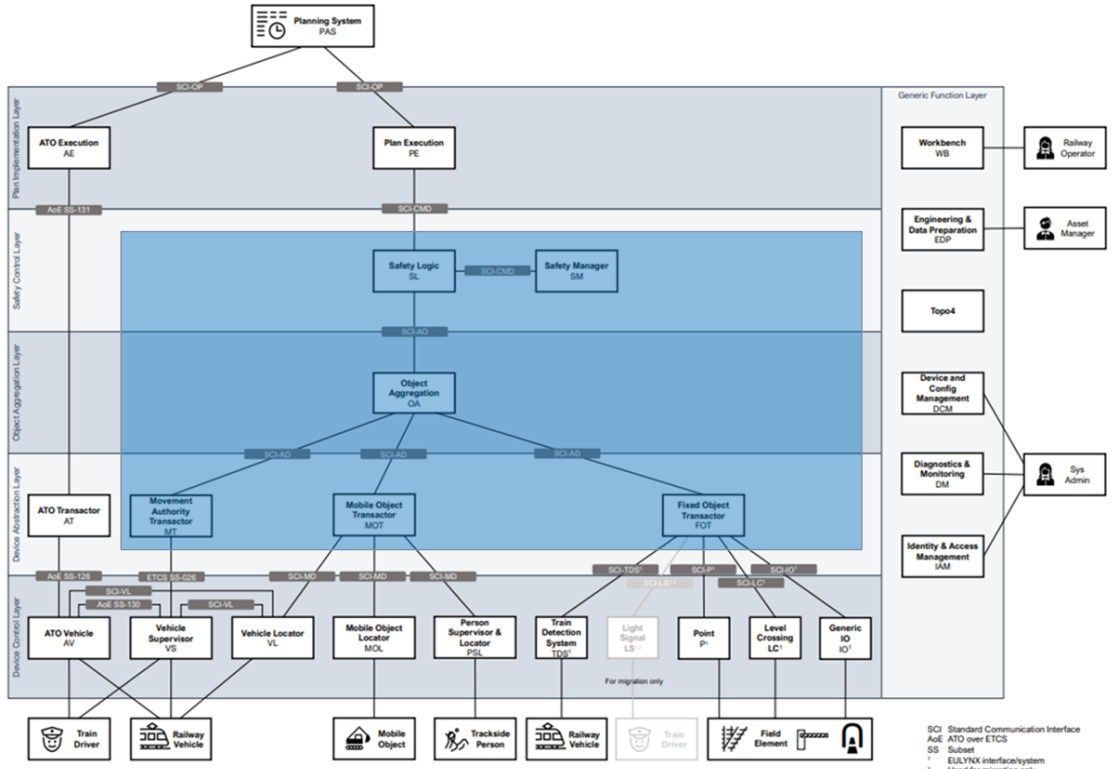
published by BAV (OFT Switzerland)

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



SNCF - RCA and ARGOS are a strategic fit





ARGOS

- is an alternative approach to APS
- can be migrated stepwise towards RCA
- implementing EULYNX interfaces over time, ARGOS can be modular and exchangeable
- supports future upgrades to APS

Agenda

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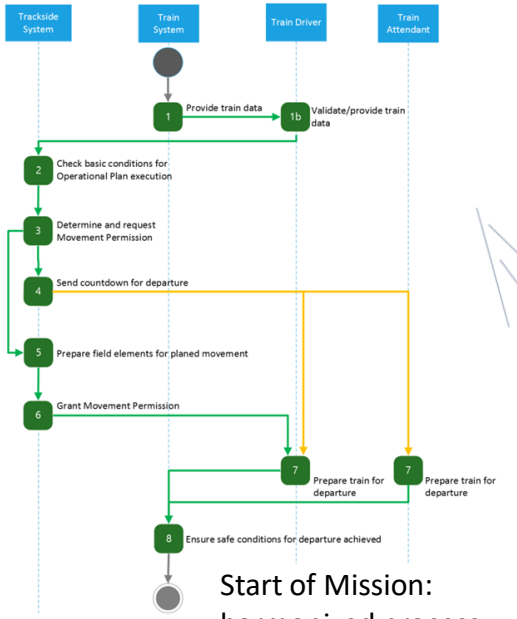
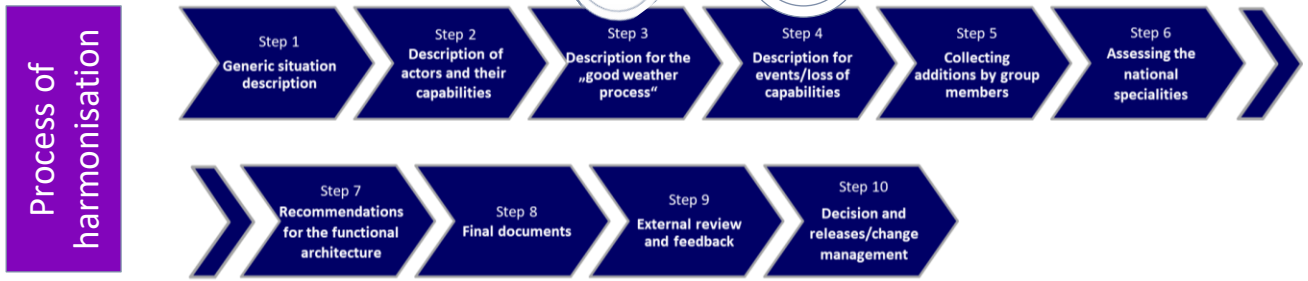
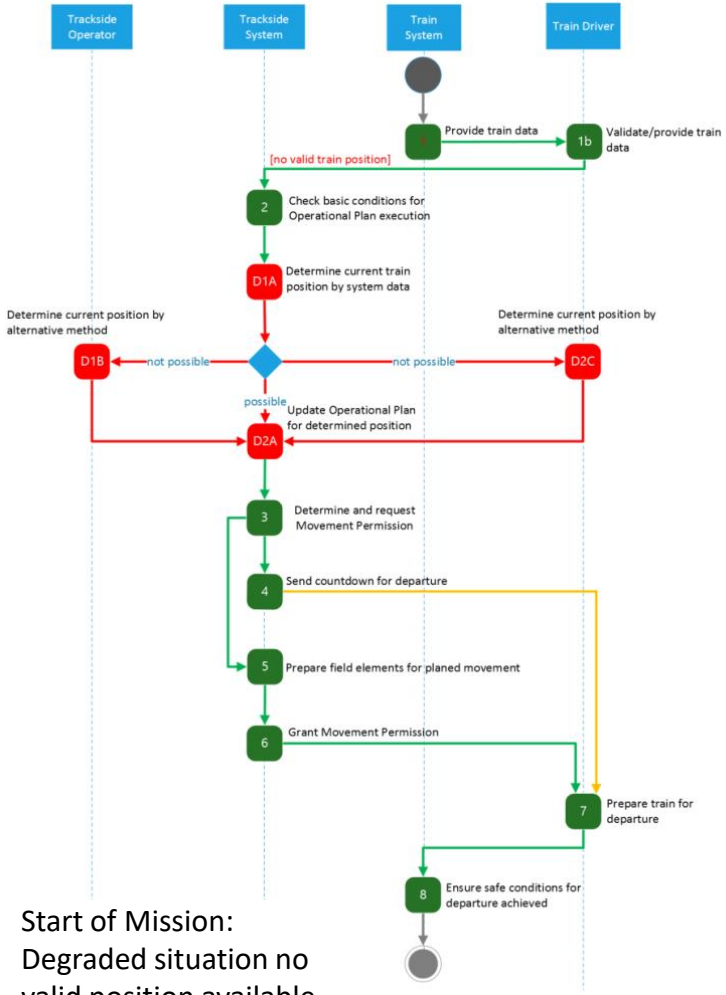
The process of Operational Harmonization is established and feasibility has been demonstrated



Start of Mission:
harmonized process

- In a first step we are looking for a process to handle operational harmonization
- Proof of Concept is about the process not about common operational rules





Start of Mission:
Degraded situation no valid position available

CCS-Migration to Standardisation and Harmonisation – Management Summary

For performance reasons and/or replacement of outdated equipment multiple European Infrastructure Managers (IMs) plan or develop Radio Based Signalling;

Migration to (I) a modular target Reference CCS Architecture is based on interface standardisation, enabling higher performance at lower cost (with different ambition levels within one network);

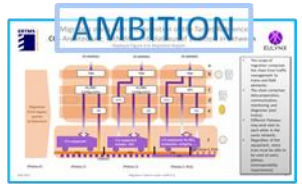
Signalling has been developed in national isolation per network; current developments towards Radio Based Signalling are often based on this. This causes (II) multiple different starting situations; higher performance can only be reached by a business case per IM or per (part of the) network;

Common European results can be achieved by a Plateau migration (number of steps depends per IM) to a combination of (III): ERTMS Game Changers, the EULYNX catalogue of standard interfaces and object controllers, combined with the Advanced Protection System (APS) for higher performance;

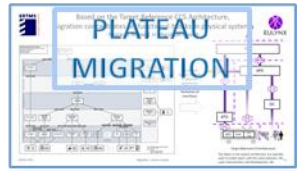
Operational Harmonisation can be developed, starting at migration Plateau 2 with harmonised functionality, combined with standard interfaces in a target RCA system configuration (IV);

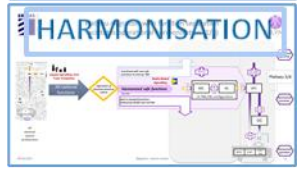
Migration report demonstrates per IM (V) a smooth migration from each typical national situation to the common modular target Reference CCS Architecture based on interface standardisation;

1+1=3: Mutual advantages are reached in the next decade when (VI) proposed developments are part of one common European development approach, see slide 22, e.g. in the ERJU System Pillar initiative.

I 

II 

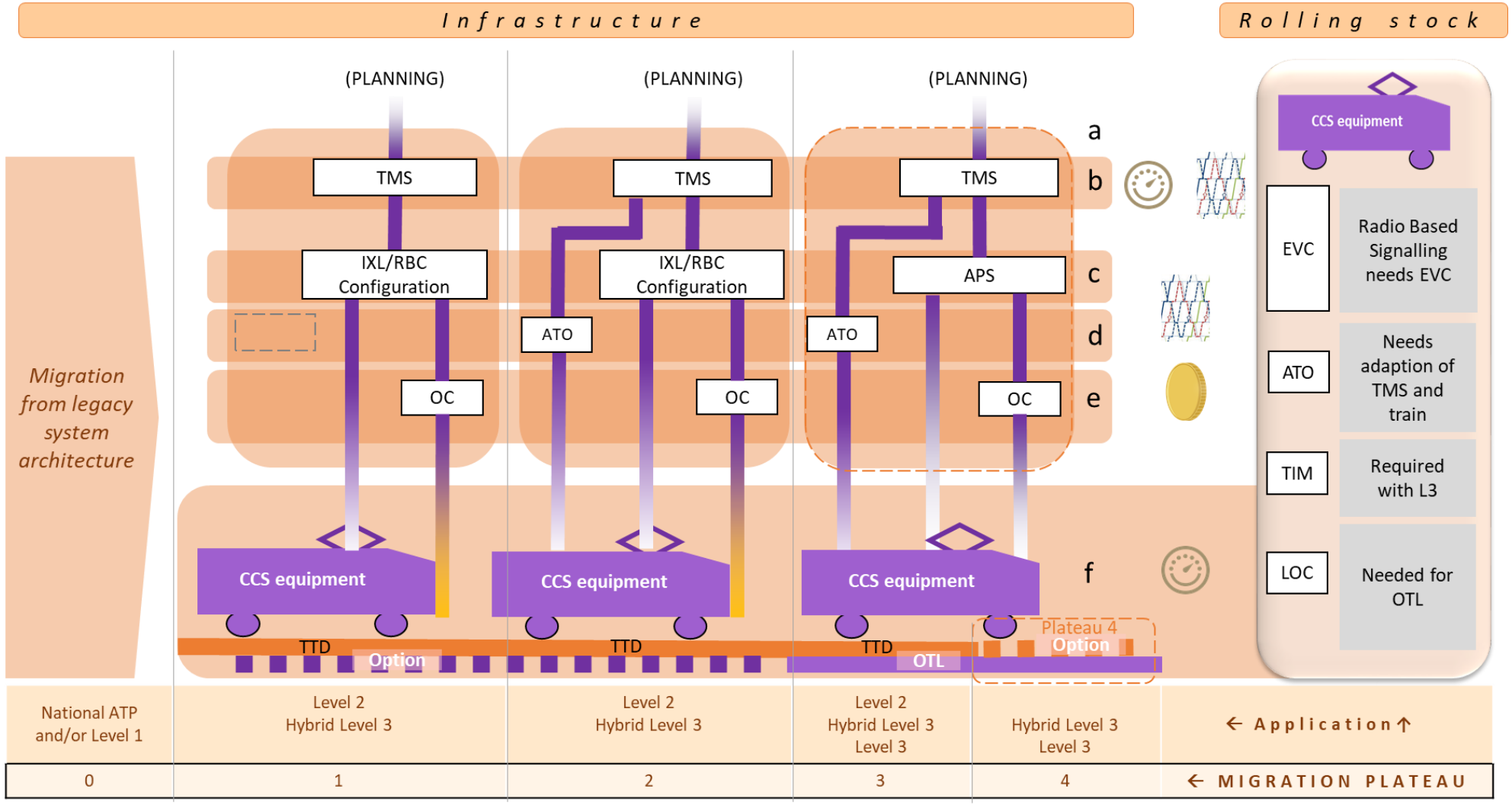
III 

IV 

V 

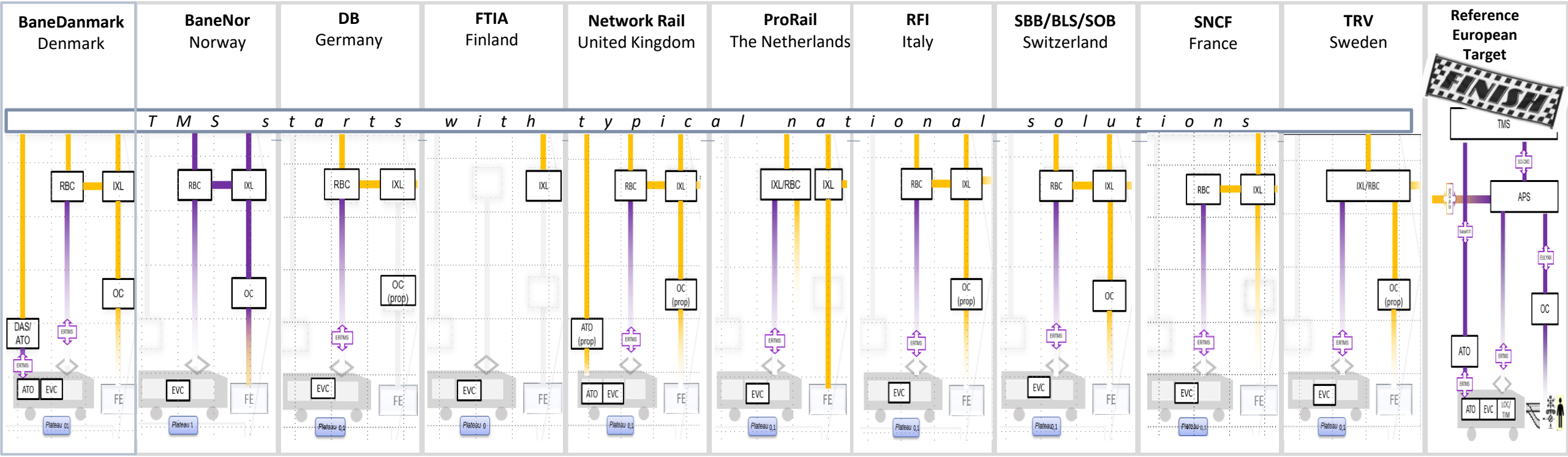
VI 

Migration starts with the definition of the Target Reference CCS Architecture; with different plateaus of ambition in between (I)



- The scope of migration comprises the chain from traffic management to trains and field elements;
- The chain comprises data preparation, communication, monitoring and diagnoses (excl. trains);
- Different Plateaus may exist next to each other in the same network;
- Regardless of the equipment, every train must be able to be used at every plateau (interoperability requirement).

Starting situation of IMs are all different (II)



Legacy, national

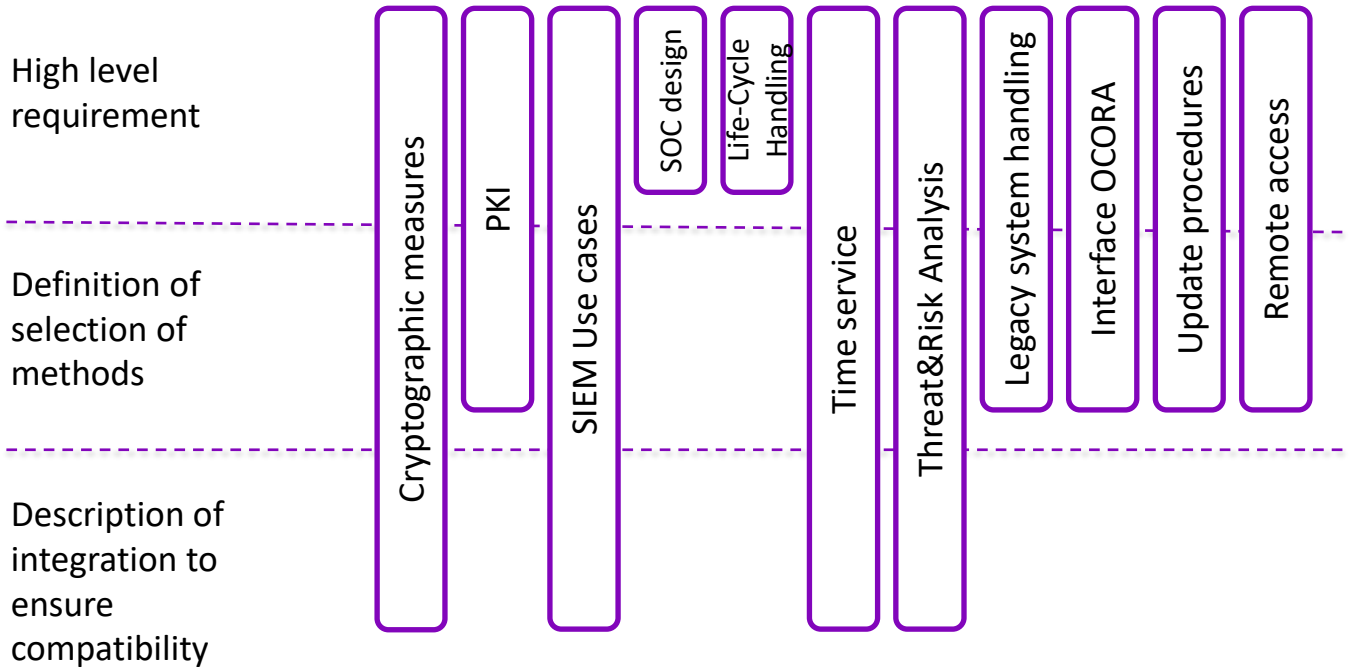
Standardised

P.S. Not all legacy starting variants per IM are shown.

Tangible Cluster Results - IT-Security

The depth of definition depends on the topic. It shall be ensured that the standard (EULYNX, RCA) is not affected by implementing Security. IM-specific solutions shall be possible. Innovations of suppliers shall be supported.

Depth of definition



The Security cluster delivers a catalogue that defines:

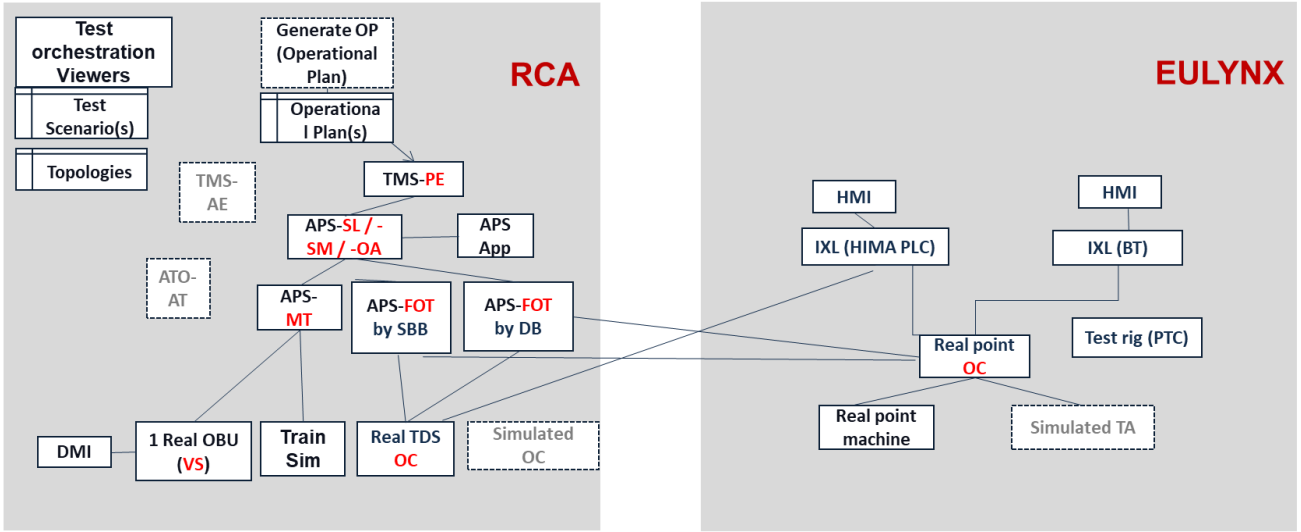
- a method for a common security strategy for EULYNX & RCA that leads to Security Levels for systems and sub-systems
- a roadmap to maintain the defined Security Level in the future
- a mapping of security features to related threats / hazards
- a set of requirements for communication via category 3 networks
- guidelines to avoid interference between EULYNX and legacy & non-EULYNX systems
- ensuring the interfaces, common methods and technologies with the adjacent subsystems like OCORA or TMS

Tangible Cluster Results - Demonstrator

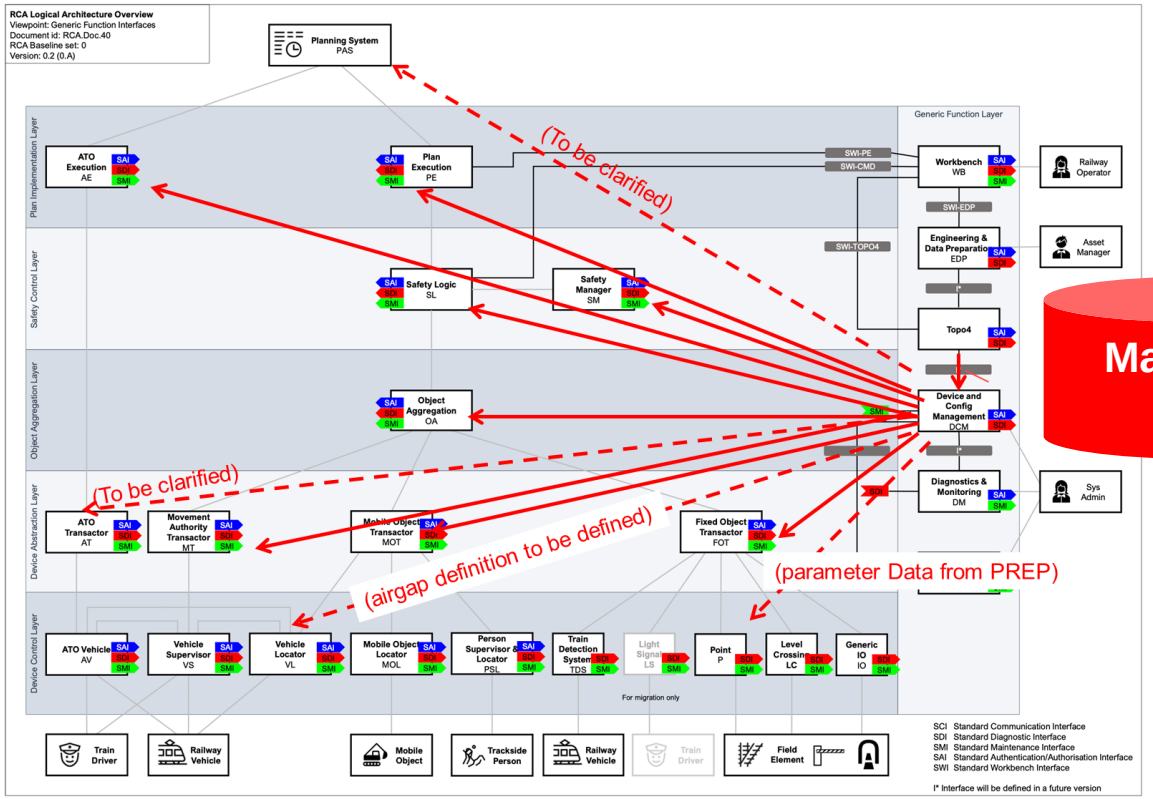
- The demonstrator environment is designed to be shown on fairs like InnoTrans
- Real Hardware, Interfaces and Software
- Place of Engineering: Frankfurt, DB Netz AG

PLACE AND DATE	
7. Railway Forum 2021	Berlin, Germany 07th & 08th September 2021
Signal & Draht Congress	Fulda, Germany, November 2021
Smart Rail Europe	Rome, Italy, 30th November – 2nd December 2021

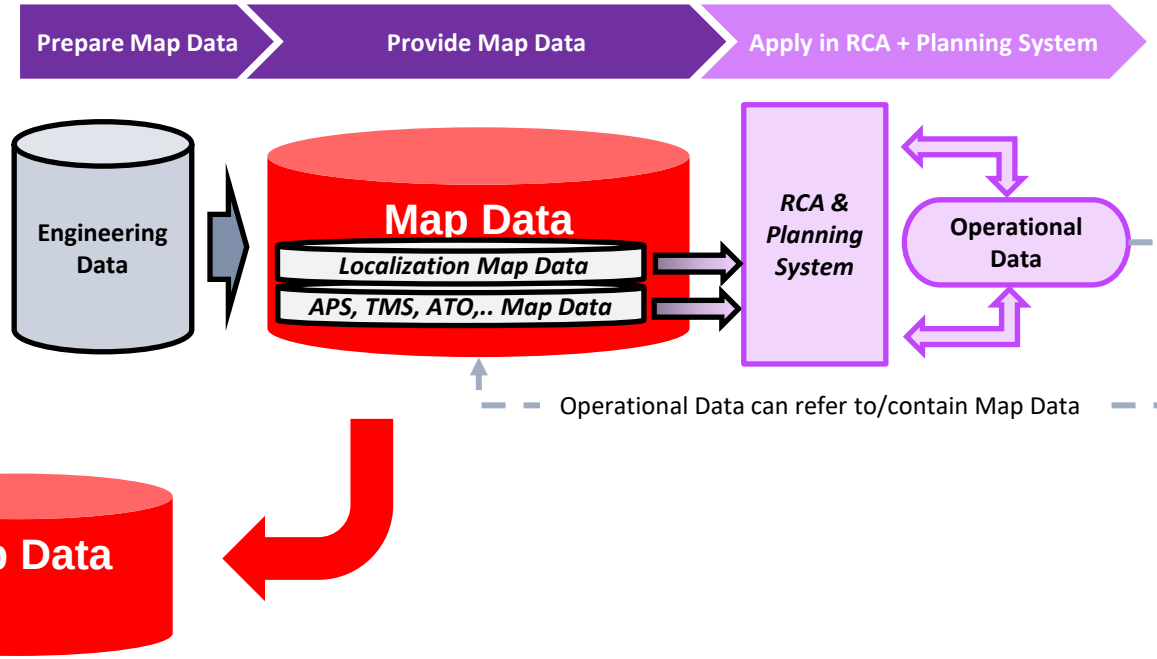
- Interlockings from Movares and Bombardier/Alstom
- Point Machine from Thales
- APS environment from SBB/DB
- RASTA Connections
- EULYNX Interfaces SCI-TDS, SCI-PM and SCI-ILS implementations



Tangible Cluster Results - Digital Map

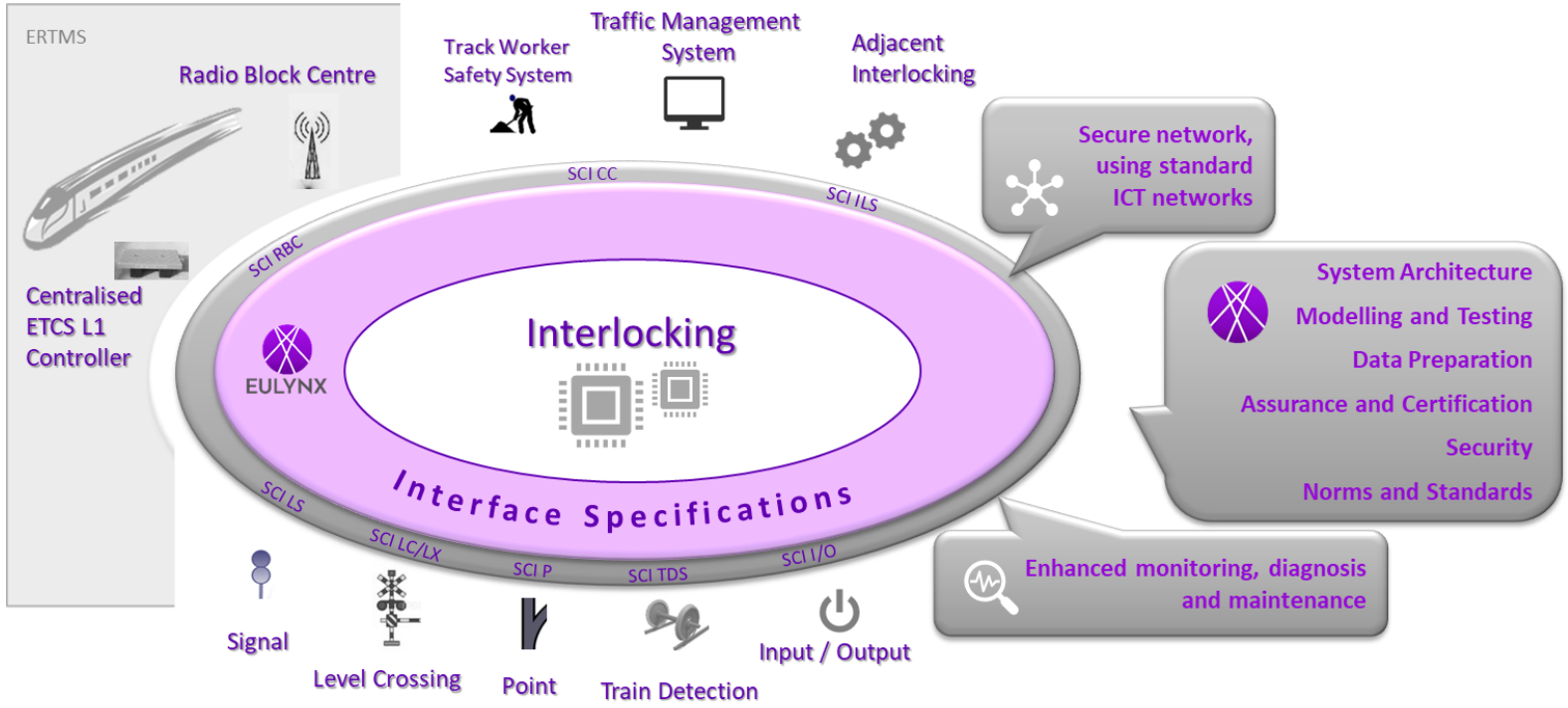


High level process



*"**Digital Map** is a set of functionalities providing track and trackside infrastructure information in the form of structured map data, including quality criteria for the data. In addition, it also ensures map management functionalities like map versioning, and download of map data."*

Tangible results from EULYNX

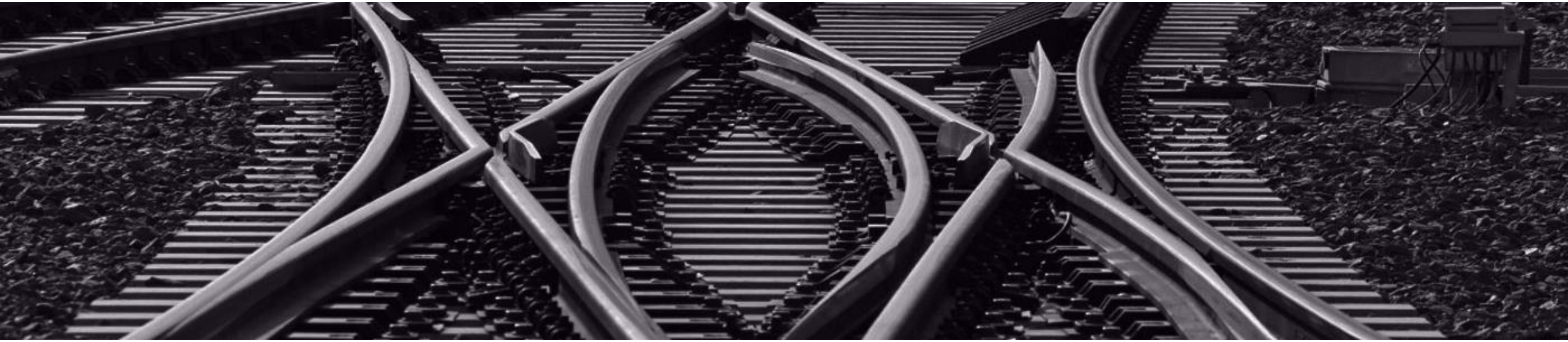


- Baseline set 3 Release 5 and Release 6 completed in 2020
  - Full specifications for functional, diagnostic and maintenance interfaces
- Baseline 4 is in development, first releases planned for Dec. 2021:
  - Enhanced maintenance and diagnostics
  - Multiple object controllers
  - IT security aligned across CCS sector
  - Use of open and wireless networks
  - Full harmonisation for field elements

EULYNX specifications are directly applied in RCA!

Conclusion

- Tangible results can be found in every Cluster and Working Group of RCA and EULYNX
- EULYNX standards are mature and in the latest version reviewed by suppliers
- Orders and tenders are already placed on the basis of EULYNX
- With RCA complexity of signalling across Europe can be diminished



Thank you for your attention

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