



Towards a reliable, efficient, future proof and integrated European railway network



Vision

To deliver a **fully integrated European railway network for citizens and cargo.**

*Rail Research and Innovation
to Make Rail the Everyday
Mobility*

| | |
|--|--|
| High capacity  | Flexible  |
| Interoperable  | Multimodal  |
| Sustainable  | Reliable  |
| Competitive  | Inclusive  |

Europe's Rail Members

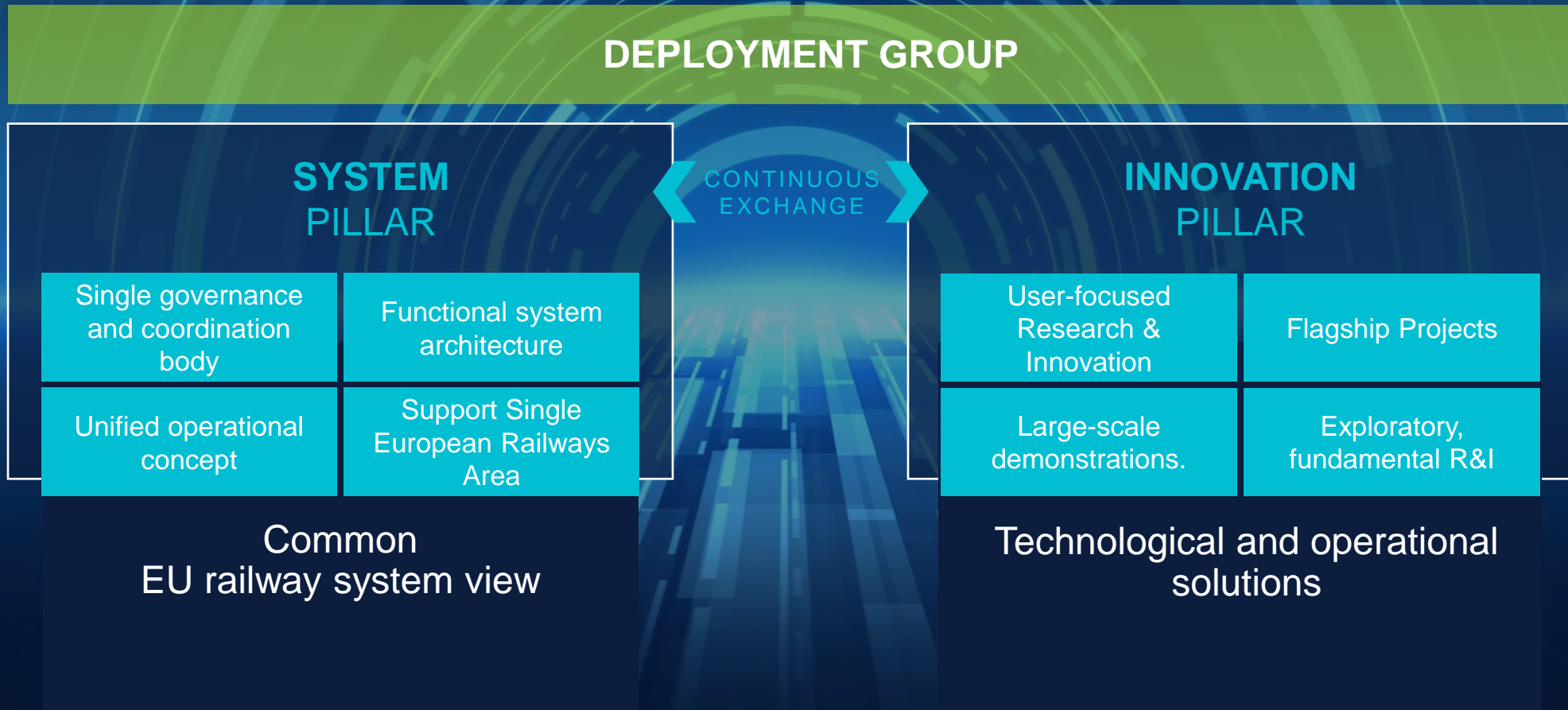




Five Strategic Research & Innovation Priorities

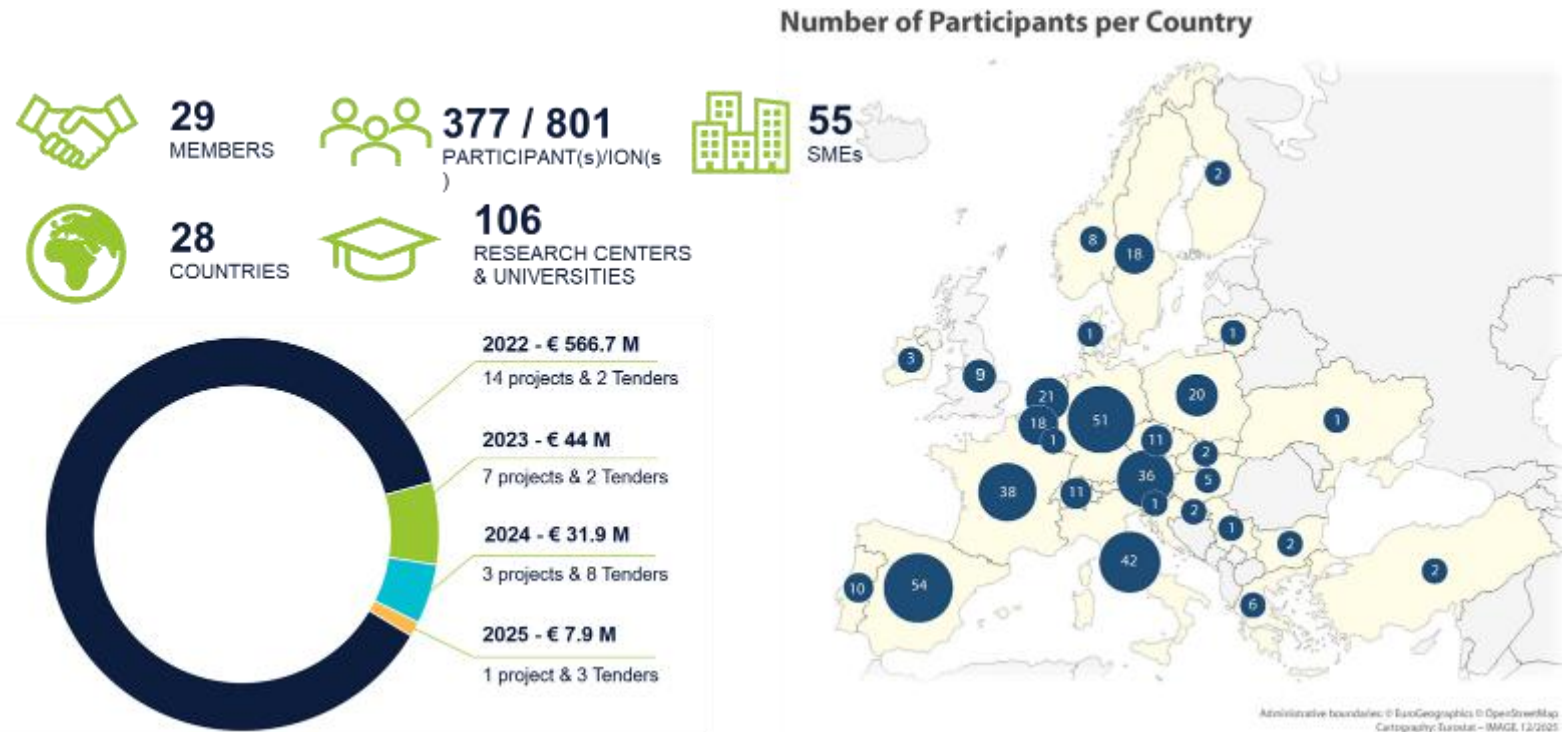
1. European Rail Traffic Management
 - ❖ Integrated traffic management for seamless cross-border operations
2. Digital and Automated Train Operations
 - ❖ Next-generation ATC (ERTMS), progression toward GoA4 fully unattended operations
3. Sustainable and Digital Assets
 - ❖ Lifecycle cost reduction, predictive maintenance, alternative propulsion
4. Competitive Digital Green Rail Freight
 - ❖ Logistic automations with Digital Automatic Coupler (DAC) as key enabling technology
5. Smart Solutions for Low-Density Traffic
 - ❖ Cost-effective regional and rural rail services

Single R&I Programme based on a **system view**



Financial Framework

- Total Programme Budget: €1.23 billion (2021-2031)
 - EU Contribution: €615 million from Horizon Europe (EU framework for R&I)
 - Private Members Contribution: At least €615 million (cash + in-kind)
 - Largest private coordinated sector commitment to a single rail R&I programme
- Co-financing model ensures result-oriented research aligned with EU policy goals



EU-Rail integrated Programme

INNOVATION PILLAR – HIGH-LEVEL OVERVIEW OF ON-GOING PROJECTS

FA1/TT



FA2



FA3



FA4



FA5



FA6



FA7



Exploratory Research (10)



EU-Rail Flagship Projects Demonstration activities (1/2)



- ❑ Ongoing / Under preparation demonstrators: **Over 81**
- ❖ Countries involved: **11**

The demonstrations are taking place in the following member states:



- ❑ Ongoing / Under preparation demonstrators: **7**
- ❖ Countries involved: **9**

The demonstrations are taking place in the following member states:



- ❑ Ongoing / Under preparation demonstrators: **Over 100**
- ❖ Countries involved: **10**

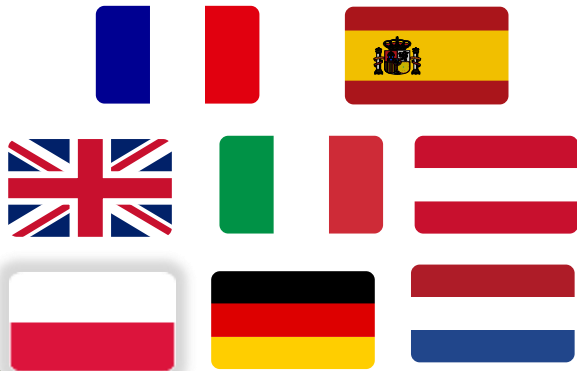
The demonstrations are taking place in the following member states:





- ❑ Ongoing / Under preparation demonstrators: **Over 38**
- ❖ Countries involved: **8**

The demonstrations are taking place in the following member states:



- ❑ Ongoing / Under preparation demonstrators: **13**
- ❖ Countries involved: **8**

The demonstrations are taking place in the following member states:



- ❑ Ongoing / Under preparation demonstrators: **34**
- ❖ Countries involved: **7**

The demonstrations are taking place in the following member states:



Why - The motivation for the System Pillar

Harmonize operations and products with a powerful and modular architecture.

Reduce process effort on all sides (products, assets, production)

Reduced cost

Accelerate product evolution by creating higher market potential per product

Performance, Capacity, Automation, Digitalisation.

Healthy and affordable product and asset lifecycles.
Manage complexity and knowledge availability risks.

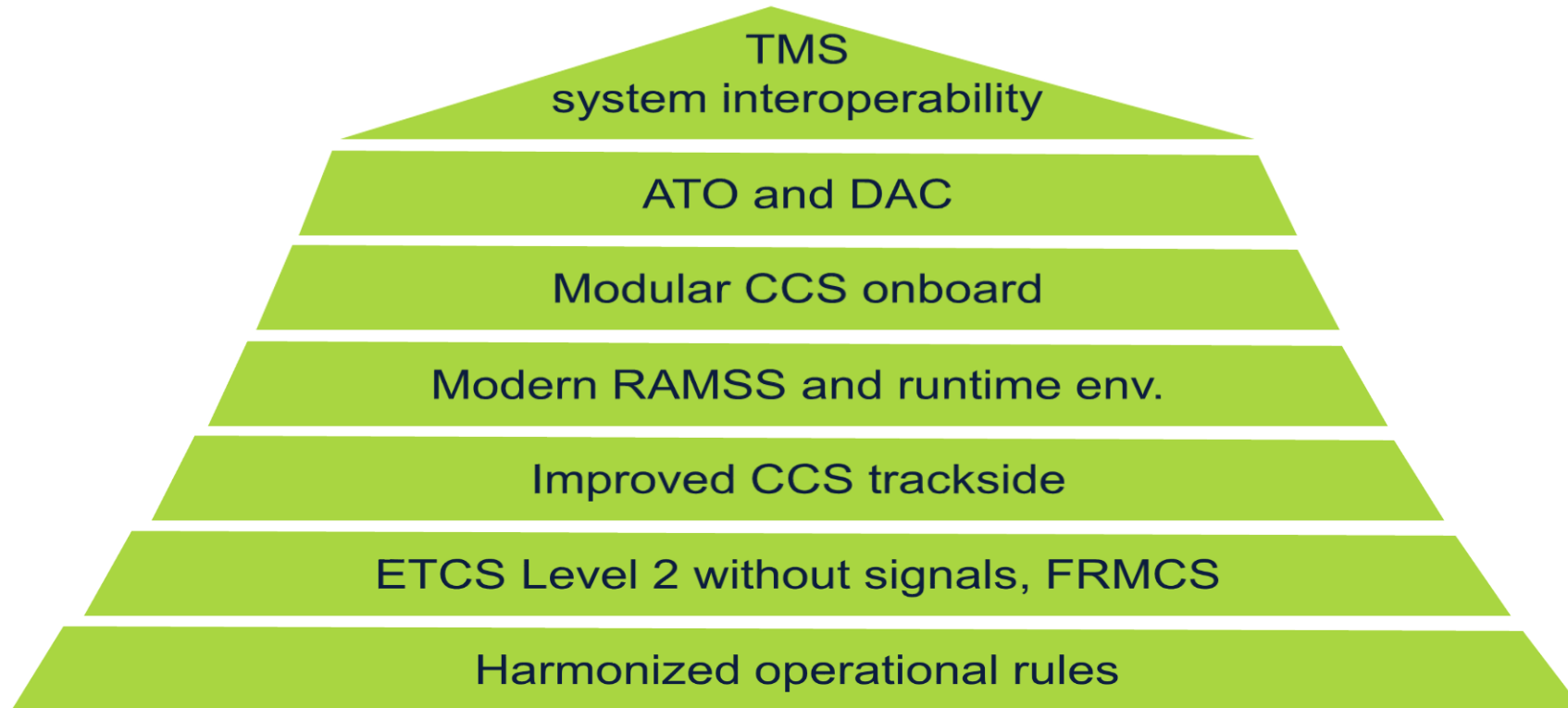
Healthy Business.

Improve interoperability

SERA.

What - System Pillar Scope

Harmonized operational rulebooks, off-the-shelf CCS products



Outcomes of the System Pillar

- ✓ Specifications for cybersecurity and trackside assets approved
- ✓ Integrated production of harmonised operational rules and associated traffic CS specifications based on an agreed design
- ✓ CCS/TMS data model part of extended ERA ontology
- ✓ FRMCS V2 report approved

General

- ✓ The second version of the Standardisation and TSI Input Plan (STIP) was published
- ✓ TSI change request bundles submitted
- ✓ FRMCS V2 report approved

PRAMS and Security

- ✓ Modular safety case structure and EU hazard database
- ✓ Cybersecurity requirements and specifications

Task 1, Rail system

- ✓ To-be architecture for 1 capability

Task 2, Train CS

- ✓ Onboard modular architecture including Ethernet consist network, enhanced train interfaces, modularity, basic ASTP, multi display concept

Task 2, Traffic CS

- ✓ Trackside CS architecture design
- ✓ System specifications and interface of TPS, AEL and ATO trackside (Year 1 of 3)

Task 2, Operational harmonisation

- ✓ European harmonised operational rulebook (Year 1 of 3)

Task 2, Transversal CCS

- ✓ CCS/TMS data model based on extended ERA ontology
- ✓ Digital register and Diagnostics Data Model Specification
- ✓ Configuration and Maintenance management

Task 3, TMS/CMS

- ✓ Interface TMS/Traffic CS (update)
- ✓ Integration TTR messages
- ✓ Cross border variants analysis CMS/TMS

Task 4, DAC/FDFTO

- ✓ Operational standards
- ✓ Central instance for data and software management

Task 5, HERD

- ✓ Demonstrator specification for pilot implementation
- ✓ 2 use cases for harmonised diagnostics were analysed



SYSTEM PILLAR

Change Request submission:

- ✓ 45 Change Requests were approved to be submitted to amend future Technical Specifications for Interoperability.

These are across several important domains, including:

- ❖ Cybersecurity,
- ❖ Control Command and Signalling onboard modularity,
- ❖ Odometry enhancements,
- ❖ Train interface enhancements,
- ❖ Operational harmonisation,
- ❖ Automated Train Operation,
- ❖ Stepwise evolution.



EU-Rail integrated Programme

SYSTEM PILLAR

- ❖ **Cybersecurity Specifications v1.1** – The aim is to have cybersecurity embedded in products. This will imply benefits both for suppliers and operators. One product will be valid for all Europe. The package includes four main specifications and ten supporting documents. Decision approved. Main concepts are:
 - Define an agreed set of Methods, Protocols, Algorithms (e.g. ciphers) to assure the interoperability (e.g. On Board – Trackside communication)
 - Provide compliance with international standards (like 62443) and European laws (like the CRA) with full traceability
 - Implement “Security by Design” for the sector, embedding necessary measures in all components composing the railway system. Making Cyber Security intrinsic to the sectors’ products.
 - Design an “Open” Cyber architecture easy to evolve to counter future threats (like providing post-quantum security measures)

- ❖ **FRMCS** – The 2nd Stakeholder Alignment Meeting was held on 17 December 2025.
 - UIC delivered new specifications FRS and SRS (V2.2). The MORANE2 project is preparing lab tests.
 - ETSI has published 8 FRMCS technical specifications (TS) in January 2026. ERA / EECT V2.2 review process ongoing. UNITEL indicate market time for FRMCS products 6-12 months after stable specifications.
 - The EU-Rail FRMCS Deployment Group delivered some new papers and analyses, including 5 deployment scenarios. A first edition of the new CCS TSI is planned in 2028, while phase-out of GSM-R is expected to start in 2034.
 - Collaboration with FP2 Cluster 3

- ❖ **Specification of CCS on-board modularity** – The aim is to define the onboard communication between the main CCS constituents, in order to support interchangeability.
 - The proposed solution is based on ECN (Ethernet Consist Network) completed with TRDP (middleware) and a safety/real-time layer (also supporting time of delivery). Other standard protocols as MVB and CAN will no more be allowed in new products. Decision approved.

INNOVATION PILLAR

Digital Twins – Several projects take advantage of the digital twins technology:

- ❖ **FP1** aims to create a "Digital Foundation" by integrating digital twins, predictive maintenance, federated data sharing and simulation tools.
 - **Digital enablers:** develops digital twin applications to support traffic management, multimodal mobility and disruption management.
 - **Digital Asset Engineering:** Extension of the BIM standard with railway components and construction of a digital twin of the station.

- ❖ **FP2** develops next-generation braking systems and automated train operations (GoA4).
 - **Digital Twin Validation:** uses digital twins for braking improvements and to validate automation technologies in a virtual environment.
 - **Simulation Modelling:** develops digital replicas to test train integrity and remote-controlled operation in urban setting

- ❖ **FP3** aims to build digital replicas of physical assets (wayside and rolling stock) to enable predictive maintenance and minimize lifecycle costs
 - **Cluster E (Railway Digital Twins):** Dedicated to implementing digital twins to optimize maintenance planning and logistics for railway assets.
 - **Data Integration:** Integrates Digital Twin technologies with BIM (Building Information Modeling), GIS tools, and Artificial Intelligence (AI) to create high-TRL (Technology Readiness Level) solutions for asset monitoring.
 - **Virtual Certification:** Uses digital twins for the virtual certification of railway assets.
 - **Robotics & Maintenance:** Integrates augmented reality (AR) and digital twin data to support maintenance activities, such as train underbody inspections

DEPLOYMENT GROUP

From Talking to Testing to implementing

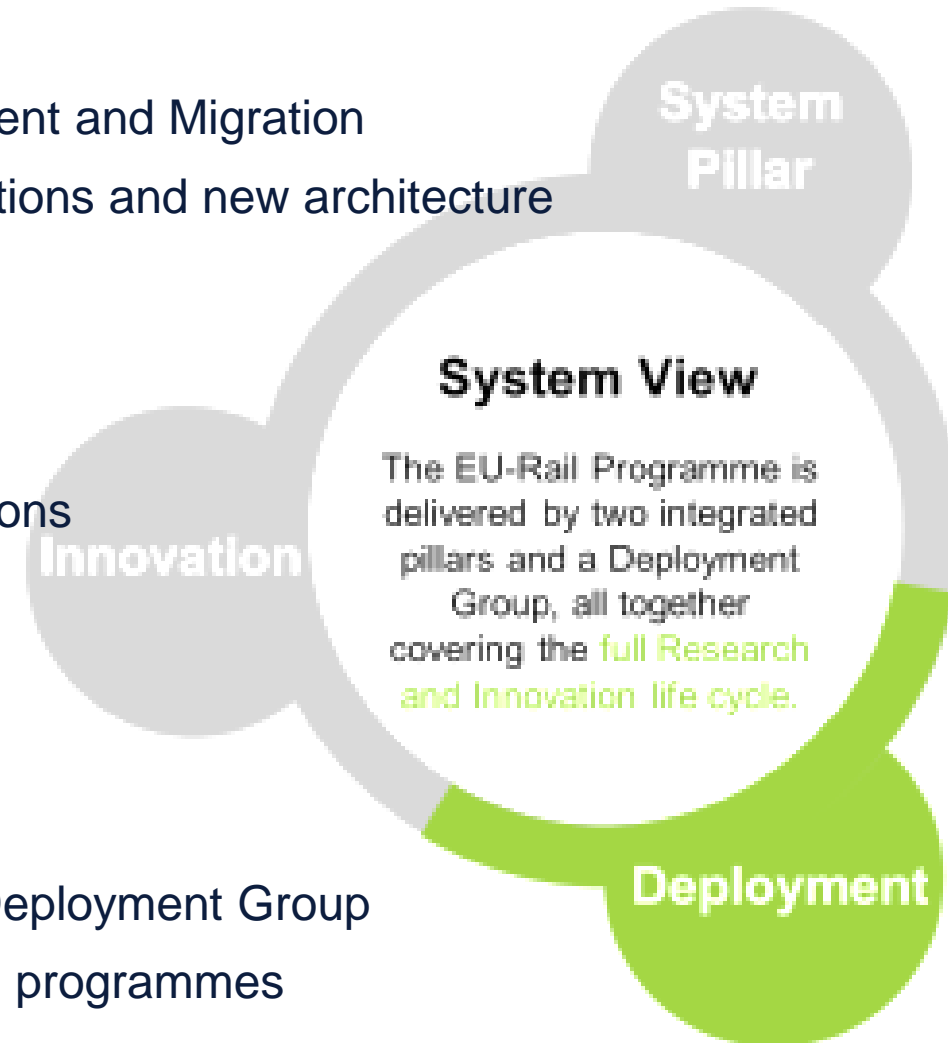
- Objective is to close gap between R&I activities and Deployment and Migration
- Support smooth, fast and cost effective introduction of Innovations and new architecture
- Open group, contributing to whole railway sector and industry

Examines and provides recommendations on:

- Scenarios and analyses for the fast rollout of innovative solutions
- authorisation, cost-drivers, capacity and migration risks

Main sub programme's:

- European DAC Delivery Programme (EDDP)
- European FRMCS (next European Communication system) Deployment Group
- Coordination in deploying different big (digital) Transformation programmes





**The next chapter after EU-Rail:
Introduction of the EU-Rail high
level paper (ideas from
Members)**



Future Policy-Based Public-Private Partnership for Rail

- ✓ ADOPTED BY GB DECISION N° 06/2025 ON 24 JUNE 2025: High-Level Paper on “A Future Policy-Based Public-Private Partnership for Rail” approved by the EU-Rail GB

A mission that centres on **simplifying the rail systems and operations while enhancing its fundamental capabilities.**

Aiming to strengthen the Single Market and deliver a harmonised Single European Rail Area (SERA)

Coordinated EU-level partnership

- **€3 billion in R&I innovation** addressing the need for costly yet essential one-time developments of innovative solutions aiming to transition the diverse existing legacy systems into a new, simplified European rail system.
- **€15 billion in pre-deployment** from the participation of diverse stakeholders across different countries to upgrade their systems and make investments in their network. Procurement activities to enable a first implementation at system level.


- ✓ ADOPTED BY GB DECISION N° 10/2025 ON 02 DECEMBER 2025: High-Level Paper Annex – Flagship Initiatives(FI) approved by the EU-Rail GB

FI1: European Simplified and Integrated Railway System

FI2: The Next-Generation Rail Freight Operations with European Digital solutions

FI3: Resilient and Recoverable Railway System

FI4: Innovative EU High-Speed Rail Corridors

- Traditional Fragmented Approach:
 - ✓ Research delivers technical solutions (TRL 6-7/8 achieved)
 - ✗ But implementation fails due to misaligned actors and processes
 - ✗ "Valley of Death": alignment R&I, standardisation, regulation, and pre-deployment
- A possible future Rail JU as Integrated Solution
 -  **R&I** →  **Standardisation & Regulation** →  **Pre-Deployment** →  **R&I** →  **Standardisation & Regulation** →  **Market Deployment**
 - Not sequential handoffs, but parallel, loop processes from design
 - Unique governance structure ensuring all stakeholders work toward common multi-annual Programme implementation goals



A model that can be built upon

- EU-Rail (and Shift2Rail before):
 - Proven PPP model
 - Effective approach to complex European rail challenges
- Integrated programme: Innovation + System + Deployment
- Addressing historical fragmentation and market failures through coordinated action
- Facilitate cross-sectorial and international cooperation
- Foundation for achieving a Single European Railway Area (SERA)
- Demonstrates that innovation benefit stakeholders and society
- Deliver upon EU policies



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