ANNEX to GB decision n°02/2025

AMENDMENT N° 1
WORK PROGRAMME 2025-2026

adopted by the EU-Rail Governing Board on 24 June 2025

22-09-2025: Editorial corrections have been applied on the version adopted by the EU-Rail JU Governing Board on 24 June 2025

In accordance with Council Regulation (EU) 2021/2085 and with Article 33 of the Europe's Rail Financial Rules from S2R GB Decision n° 11/2019 adopted by the GB decision n° 02/2021.

The Work Programme is made publicly available after its adoption by the Governing Board.

NOTICE RELATED TO S2R JU SUCESSOR

On 30 November 2021, Council Regulation (EU) 2021/2085 of 19 November 2021, establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014, entered into force. In accordance with this Regulation, the Europe's Rail Joint Undertaking (EU-Rail) became the legal and universal successor in respect of all contracts, including employment contracts, procurement contracts and grant agreements, liabilities and acquired property of the Shift2Rail Joint Undertaking (S2R JU). Therefore, if reference is made to S2R JU's contracts/agreements/assets/liabilities in this Work Programme, they should be understood as those of EU-Rail's. In addition, in accordance with Article 174(12), at its first meeting on 21 December 2021, the Governing Board adopted Decision n° 2/2021 listing the decisions adopted by the Governing Board of the S2R JU that shall continue to apply for EU-Rail.

LIST OF ACRONYMS AND ABBREVIATIONS **4**

1. INTRODUCTION **8**

1.1 THE EUROPE'S RAIL JOINT UNDERTAKING (EU-RAIL) 9
1.2 MISSION STATEMENT OF EU-RAIL 11
1.3 BACKGROUND AND LINK WITH THE MASTER PLAN 11
1.4 STRATEGY FOR THE IMPLEMENTATION OF THE PROGRAMME 13

2. WORK PROGRAMME 2025-2026 ..... **15**

2.1 MESSAGE FROM THE EXECUTIVE DIRECTOR 15
2.2 EXECUTIVE SUMMARY 2025-2026 16
2.3 OPERATIONAL ACTIVITIES OF EU-RAIL IN 2025-2026 19
2.3.1 Objectives, indicators and risks 19
2.3.2 The System Pillar 23
2.3.3 The Innovation Pillar 41
2.3.4 The Deployment Group 55
2.3.5 S2R R&I Programme 56
2.3.6 Other risks 56
2.3.7 Scientific priorities, challenges and expected impacts 59
2.3.8 Calls for proposals 61
2.3.9 Calls for tenders and other actions 64
2.3.10 Follow-up activities linked to past calls: monitoring, evaluation and impact assessment 70
2.3.11 Cooperation, synergies and cross-cutting themes and activities 70
2.4 SUPPORT TO OPERATIONS OF EU-RAIL IN 2025-2026 72
2.4.1 Communication, dissemination and exploitation 72
2.4.2 Procurement and contracts 76
2.4.3 Other supporting operations 78
2.4.4 Human resources 80
2.5 GOVERNANCE ACTIVITIES 83
2.5.1 Governing Board 83
2.5.2 Executive Director 84
2.5.3 Scientific Steering Group 84
2.5.4 States' Representatives Group 85
2.5.5 The System Pillar steering group 86
2.5.6 The Deployment Group 87
2.6 STRATEGY AND PLANS FOR THE ORGANISATIONAL MANAGEMENT AND INTERNAL CONTROL SYSTEMS 87
2.6.1 EU-Rail organization 87
2.6.2 Internal Control Framework 88
2.6.3 Financial procedures 89
2.6.4 Ex-ante and ex-post controls 90
2.6.5 Audits 91
2.6.6 Risk Management 92
2.6.7 Anti-fraud strategy 93

3. BUDGET 2025-2026 ..... **95**

ANNEXES **102**

ANNEX I - IKAA PLAN 102
ANNEX II - ORGANISATIONAL STRUCTURE OF THE PROGRAMME OFFICE OF EU-RAIL 110

ANNEX III – KEY PERFORMANCE INDICATORS FOR EUROPE'S RAIL JOINT UNDERTAKING 111
TABLE I - Horizon Europe Common Key Impact Pathway Indicators *111*
TABLE II - Horizon Europe Partnership Common Indicators *113*
TABLE III - Key Performance Indicators specific for EU-Rail *118*
ANNEX IV – SYSTEM PILLAR WORKING METHOD AND SYSTEM ENGINEERING MANAGEMENT PLAN 123
ANNEX V – SYSTEM PILLAR DELIVERABLES AND MILESTONES 124
Engineering Environment Team *124*
PRAMS 125
Security 128
Task 1 Railway System *129*
Task 2 CCS Domain Architecture and Release Coordination *130*
Task 2 CCS: Domain Operational Harmonisation *132*
Task 2 CCS: Domain Traffic Control and supervision *133*
Task 2 CCS: Domain Train Control and supervision *135*
Task 2 CCS: Domain Computing Environment *138*
Task 2 CCS: Domain Trackside Assets Control & Supervision *139*
Task 2 CCS: Domain Transversal Systems *140*
Task 3: TMS & CMS *142*
Task 4: DAC/FDFTO *144*
Task 5: Harmonised Diagnostics *145*
ANNEX VI – CALL(S) FOR PROPOSALS 2025 147
1. CALL: HORIZON-ER-JU-2025-01 149
Conditions for the Call *149*
DESTINATION 7 Innovation on new approaches for guided transport modes *150*
2. CALL: HORIZON-JU-ER-2025-02 154
Conditions for the Call *154*
DESTINATION 1 – Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers *158*
DESTINATION 2 – Digital & Automated up to Autonomous Train Operations *172*
DESTINATION 3 – Intelligent & Integrated asset management *184*
DESTINATION 4 – A sustainable and green rail system *194*
DESTINATION 5 – Sustainable Competitive Digital Green Rail Freight Services *204*
DESTINATION 6 – Regional rail services / Innovative rail services to revitalise capillary lines *216*
DESTINATION 8 – Exploratory Research and other activities *226*
3. CALL: HORIZON- JU-ER-2026-01 (INDICATIVE) 238
ANNEX VII – LIST OF PRIVATE FOUNDING MEMBERS OF THE EUROPE'S RAIL JOINT UNDERTAKING 240
ANNEX VIII – 2025 CALL FOR PROPOSALS – EVALUATION CRITERIA 242
ANNEX IX – LIST OF ASSOCIATED MEMBERS OF THE EUROPE'S RAIL JOINT UNDERTAKING 244

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym/ Abbreviation	Full Title
ABAC	Accrual Based Accounting
AI	Artificial Intelligence
ALM	Application Lifecycle Management
ATO	Automatic Train Operation
ATP	Automatic Train Protection
A&V	Auralisation and Visualisation
BEMU	Battery Electric Multiple Unit
BIM	Building Information Modelling
CA	Commitment Appropriation
CAAR	Consolidated Annual Activity Report
CAPEX	Capital Expenditure
CAS	Common Audit Service of DG RTD
CBA	Cost Benefit Analysis
CBM	Condition-Based Maintenance
CBO	Common Back Office
CCA	Cross Cutting Activities
CCRCC	Control Command and Railway Communication Conference
CDM	Conceptual Data Model
CEI	Call for Expression of Interest
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CERT	Computer Emergency Response Team
CFM	Call for Members
(C)COLA	(Common) Collaboration Agreement
CSA	Coordination and support action
CSIRT	Computer Security Incident Response Team
DAC	Digital Automatic Coupler
D&E-Net	Dissemination and Exploitation Network
DG RTD	Directorate-General of the European Commission for Research and Innovation
DMI	Driver Machine Interface
DOI	Digital Object Identifier
DRIMS	Dynamic Railway Information Management System
DSS	Decision Support System
EC	European Commission
ED	Executive Director
EN	European Norm
ERA	European Union Agency for Railways (formerly European Railway Agency)
ERRAC	European Rail Research Advisory Council
ERTMS	European Rail Traffic Management System
ETCS	European Train Controlling System

Acronym/ Abbreviation	Full Title
EU	European Union
EU-Rail	Europe's Rail Joint Undertaking
EUSPA	European Agency for the Space Programme
FACTs	Flexible AC Transmission Systems
FDFTO	Full Digital Freight Train Operations
FFFIS	Form Fit Functional Interface Specifications
FIS	Functional Interface Specifications
FRMCS	Future Railway Mobile Communication System
FWC	Framework Contract
GA	Grant Agreement
GB	Governing Board
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GoA	Grade of Automation
H2020	Horizon 2020, EU Framework Programme for Research and Innovation
HMU	Hydrogen Multiple Unit
HST	High Speed Train
HVAC	Heating, Ventilation and Air-Conditioning
IA	Innovation Action
IAMS	Intelligent Asset Management System
IAS	Internal Audit Service of the European Commission
IC	Innovation Capabilities
ICT	Information and Communications Technology
IEC	International Electrotechnical Commission
IKAA	In-kind contributions to additional activities
IM	Infrastructure Manager
IMU	Inertial Measurement Unit
IP	Innovation Programme
IPR	Intellectual Property Rights
ISO	International Standardisation Organisation
IT	Information Technology
ITD	Integrated Technology Demonstrator
JTI	Joint Technology Initiative
JU	Joint Undertaking
KPI	Key Performance Indicator
LCC	Life-Cycle Cost
LIDAR	Light Detection and Ranging
LTE	Long-Term Evolution (standard for wireless communication)
MAAP	Multi-Annual Action Plan
MaaS	Mobility as a Service
MAWP	Multi-Annual Work Programme
MB	Moving block

Acronym/ Abbreviation	Full Title
MBSE	Model-Based System Engineering
MFF	Multiannual Financial Framework
MoU	Memorandum of Understanding
MP	Master Plan
N&V	Noise and Vibration
NLOS	Non-line-of-sight
NTP	Network Time Protocol
OC	Open Call
OCORA	Open CCS On-board Reference Architecture
ODM	Operational Data Management
OPEX	Operational Expenditure
OTM	On Track Machine
PA	Payment Appropriation
PPP	Public-Private Partnership
PRM	Persons with Reduced Mobility
PTC	Positive Train Control
PTI	Platform Train Interface
PTO	Public Transport Operator
RAIM	Receiver Autonomous Integrity Monitoring
RAL	Unpaid amount
RAMS	Reliability and Maintainability System
RBC	Radio Block Centre
RCA	Reference Command Control and Signalling Architecture
R-CSIRT	Railway Computer Secutiry Incident Response Team
RFID	Radio Frequency Identification
R&D	Research and Development
R&I	Research and Innovation
RIA	Research and Innovation Action
RoI	Return of Investment
RU	Railway Undertaking
S2R (JU)	Shift2Rail (Joint Undertaking)
SaaS	Software as a Service
SBA	Single Basic Act (Council Regulation No 2021/2085 establishing the Joint Undertakings under Horizon Europe)
SC	Scientific Committee
SEMP	System Engineering Management Plan
SERA	Single European Railway Area
S&C	Switches and Crossings
SiC	Silicon Carbide
SIL	Software in the Loop
SIWG	System Implementation Working Group
SME	Small and Medium Enterprise
SNE	Seconded National Expert

Acronym/ Abbreviation	Full Title
SP	System Pillar
SPD	System Platform Demonstration
SPSG	System Pillar steering group
SRG	States Representatives Group
SRIA	Strategic Research and Innovation Agenda (for EU-Rail SRIA=MP)
SSG	Scientific Steering Group
SWL	Single Wagon Load
SteCo	Steering Committee
TAF	Telematic Application for Freight
TAP	Telematic Application for Passengers
TCMS	Train Control and Monitoring System
TC	Tender Call
TD	Technology Demonstrator
TL	Train Load
TMS	Traffic Management System
TRA	Transport Research Arena
TRL	Technology Readiness Level
TSI	Technical Specifications for Interoperability
TSN	Time Sensitive Networking
TSP	Travel Service Providers
UAV	Unmanned Aerial Vehicle
URID	User Requirements Working Group
V&V	Verification & Validation
WA	Work Area
WCRR	World Congress on Railway Research
WP	Work Programme

1. INTRODUCTION

The Work Programme 2025-2026 (hereinafter "the Work Programme" or "the WP") of the Europe's Rail Joint Undertaking (hereinafter also "EU-Rail" or "the JU") outlines the scope of the activities that will be performed in 2024 related to its integrated Research and Innovation (R&I) Programme. The main focus will be on:

- the Innovation Pillar:
  - the monitoring and performance analysis of the results of the 2022 Flagship Projects, including the achievement of the planned milestones, towards their conclusion in 2026,
  - the ramp-up, following the conclusion of the grant agreements in 2024, of the projects resulting from the Call 2023-1 as well as from the Call 2024-1 that as part of the Integrated Programme complement the Flagship Projects with additional Exploratory research activities and anticipate as well some Flagship Area activities,
  - the launch of the Flagship Project Call 2025-2 during Q4 2025, followed by the conclusion of the grant agreements in 2026, to implement the second phase of all Flagship Areas described in the updated Multi-Annual Work Programme
  - the launch of the Call 2025-01 and 02 respectively during Q1 and Q4 2025, with additional FA7 and Exploratory research activities,
- the System Pillar:
  - delivering, building upon the second-year results of the System Pillar Tasks and Domains and the updated Standardisation and TSI Input plan to the European Commission,
  - launching the activities to be undertaken in the second half of 2025, as well as preparing the outline of the activities to be performed in 2026,
- the Deployment Group:
  - delivering, building upon the first recommendations of the high-level and topical working group(s), aiming at closing the innovation gap towards deployment with addressing European migration and implementation plans,
  - supporting the activities of the European DAC Delivery Programme, in particular working with the European Commission on developing a comprehensive migration strategy to coordinate deployment, in accordance with the Commission communication on "Greening Freight Transport" COM(2023) 440,
- the Membership:
  - the full integration of the new Associated Members in the JU governance and the follow-up of the R&I activities and in-kind contribution commitment that they will be delivering in response of the open call for proposals from EU-Rail.

The EU-Rail Programme aims at contributing to the ambitious targets of the "Sustainable and Smart Mobility Strategy" of the European Commission[1], building upon the many results already achieved and those inherited from the S2R Programme. To highlight the most relevant of these targets, digitalization and automation of railway systems should be mentioned, being a key path towards sustainable (climate neutral, life cycle cost efficient, connected, integrated through a system approach) mobility for passengers and logistic for goods supply.

[1] COM(2020) 789 Final of 9 December 2020, https://eur-lex.europa.eu/resource.html?uri=cellar:5e601657-3b06-11eb-b27b-01aa75ed71a1.0001.02/DOC_1&format=PDF

The WP also provides details on the corporate and supporting activities for the period to come, on the internal control system, and explains the governance structure of EU-Rail, including the tasks of individual bodies of the JU. Finally, the document presents information on the 2025-2026 Budget.

This Work Programme shall be read in conjunction with the EU-Rail's Master Plan (MP)[2] and Multi-Annual Work Plan (MAWP)[3], both adopted on 1 March 2022 by the Governing Board (hereinafter also "the GB").

In the introductory part (Section 1), EU-Rail background, mission and the strategy for the implementation of the Programme are described.

Section 2 outlines the operational activities planned for 2025-2026, the corporate and supporting activities, the EU-Rail governance, as well as it provides information on the organisational and internal management and control framework.

Section 3 details the EU-Rail's 2025-2026 Budget.

Further information regarding IKAA, organisational chart, KPIs, demonstrators, EU-Rail's Founding Members, regarding the System Pillar deliverables and milestones, as well as the topics of the Call for proposals and its evaluation criteria is provided in Section 4.

1.1 The Europe's Rail Joint Undertaking (EU-Rail)

EU-Rail was established by the Council Regulation (EU) No 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014 (hereinafter "the Single Basic Act" or "the SBA")[4] which entered in force on 30 November 2021.

In accordance with Article 174(6) of the SBA, EU-Rail is the legal and universal successor in respect of all contracts, including employment contracts and grant agreements, liabilities and acquired property of the S2R JU which it replaced and succeeded.

EU-Rail is a public-private partnership in the rail sector established under Article 187 of the Treaty on the Functioning of the European Union.

The objective of EU-Rail is to deliver a high capacity integrated European railway network by eliminating barriers to interoperability and providing solutions for full integration, covering traffic management, vehicles, infrastructure and services, aiming to achieve faster uptake and deployment of projects and innovations. That should exploit the huge potential for digitalisation and automation to reduce rail's costs, increase its capacity and enhance its flexibility and reliability, and should be based upon a solid reference functional system architecture shared by the sector, in coordination with the European Union Agency for Railways.

Building on advances in automation and digitalization, EU-Rail aims at speeding up researching, developing and deploying operational and technological innovative solutions to achieve the radical

[2] Adopted by Governing Board Decision n° 01/2022 and available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

[3] Adopted by Governing Board Decision n° 02/2022 and available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

[4] OJ L 427, 30.11.2021, p. 17–119

transformation of the rail system and deliver on European Green Deal objectives. These objectives include,

- a shift of a substantial part of the 75% of inland freight carried by road towards transport by rail and inland waterways.
- scheduled collective travel under 500 km should be carbon-neutral by 2030 within the EU.
- traffic on high-speed rail will double by 2030 and triple by 2050.
- rail freight traffic will increase by 50% by 2030 and double by 2050.
- a fully operational, multimodal Trans-European Transport Network (TEN-T) for sustainable and smart transport with high speed connectivity by 2050.
- improving the competitiveness of rail and supporting the European technological leadership in rail.

In addition to the General and Specific Objectives established in Chapter 1 of the SBA, EU-Rail is entrusted with the following:

General Objectives

(a) contribute towards the achievement of the Single European Railway Area;
(b) ensure a fast transition to more attractive, user-friendly, competitive, affordable, easy to maintain, efficient and sustainable European rail system, integrated into the wider mobility system;
(c) support the development of a strong and globally competitive European rail industry.

Specific objectives

(a) facilitate research and innovation activities to deliver an integrated European railway network by design, eliminating barriers to interoperability and providing solutions for full integration, covering traffic management, vehicles, infrastructure also including integration with non-standard national gauges, such as 1520, 1000 or 1668 mm railway, and services, and providing the best answer to the needs of passengers and businesses, accelerating uptake of innovative solutions to support the Single European Railway Area, while increasing capacity and reliability and decreasing costs of railway transport;
(b) deliver a sustainable and resilient rail system: by developing a zero-emission, silent rail system and climate resilient infrastructure, applying circular economy to the rail sector, piloting the use of innovative processes, technologies, designs and materials in the full life-cycle of rail systems and developing other innovative solutions to guided surface transport;
(c) develop through its System Pillar a unified operational concept and a functional, safe and secure system architecture, with due consideration of cyber-security aspects, focused on the European railway network to which Directive 2016/797 applies, for integrated European rail traffic management, command, control and signalling systems, including automated train operation which will ensure that research and innovation is targeted on commonly agreed and shared customer requirements and operational needs, and is open to evolution;
(d) facilitate research and innovation activities related to rail freight and intermodal transport services to deliver a competitive green rail freight fully integrated into the logistic value chain, with automation and digitalisation of freight rail at the core;
(e) develop demonstration projects in interested member states;
(f) contribute to the development of a strong and globally competitive European rail industry;
(g) enable, promote and exploit synergies with other Union policies, programmes, initiatives, instruments or funds in order to maximise its impact and added value.

In carrying out its activities, the Europe's Rail Joint Undertaking shall seek a geographically balanced involvement of members and partners in its activities. It shall also establish the necessary international connections in relation to rail research and innovation, in line with the Commission priorities.

In addition to the tasks set out in SBA Article 5, EU-Rail together with the Commission had to prepare and, after consultation with the states' representative group, submit for adoption by the Governing Board the Master Plan, developed in consultation with all relevant stakeholders in the railway system and rail supply industry.

In accordance with article 87(1) of the SBA, the members of EU-Rail are the Union, represented by the Commission, and 25 Founding Members listed in Annex II of the SBA[5]. As stated in article 6 of the SBA, in order to become members of EU-Rail, the Founding Members signed a letter of commitment detailing the scope of the membership in terms of content, activities and its duration, as well as the Founding Members' contributions to the joint undertaking, including an indication of the envisaged additional activities.

EU-Rail, after having performed an in-depth review of the areas where such type of membership would bring added value to the R&I Programme, and after having launched a call for expression of interest in 2024, will incorporate new members – the Associated members - in accordance with Article 7 of the SBA.

1.2 Mission statement of EU-Rail

Taking into consideration the objectives to be achieved the following vision and mission are established.

The vision of EU-Rail is

To deliver, via an integrated system approach, a high capacity, flexible, multi-modal, sustainable and reliable integrated European railway network by eliminating barriers to interoperability and providing solutions for full integration, for European citizens and cargo.

The Mission Statement of EU-Rail is

Rail Research and Innovation to make rail the everyday mobility

1.3 Background and link with the Master Plan

As defined in the SBA, the "Strategic Research and Innovation Agenda" (SRIA) represents the document covering the duration of Horizon Europe that identifies the key priorities and the essential technologies and innovations required to achieve the objectives of the JU.

In accordance with Article 86(5) SBA, the Master Plan shall constitute the EU-Rail Strategic Research and Innovation Agenda within the meaning of SBA Article 2(12).

[5] Please see Annex V of this Work Programme for full list of members other than the Union.

The Master Plan (hereinafter also "the MP") was developed in consultation with railway stakeholders. The draft was open for feedback to the general public via the JU's website for 4 weeks and a webinar was organized on 19 November 2021. The Master Plan was sent in consultation to the Scientific Committee and the States Representatives Group, it has been presented to the Transport Working Party of the Council and the TRAN Committee of the European Parliament. Comments and suggestions received have been incorporated, when relevant, in the final version adopted by the EU-Rail Governing Board on 1 March 2022.

The EU-Rail's Master Plan builds also upon the "Rail Strategic Research and Innovation Agenda"[6] of the European Rail Research Advisory Council (ERRAC). ERRAC is a research platform composed of representatives from most of the major European railway research stakeholders: manufacturers, operators, infrastructure managers, the European Commission, EU Member States, academics and users' groups. Its mission is to deliver a vision of the railway's future enabled by Research and Innovation activities.

The Master Plan provides guidance for the Europe's Rail Joint Undertaking's more specific tasks, namely

- develop in its System Pillar a system view that reflects the needs of the rail manufacturing industry, the rail operating community, Member States and other rail private and public stakeholders, including bodies representing customers, such as passengers and freight and staff, as well as relevant actors outside the traditional rail sector.
  The 'system view' shall encompass:
  - the development of the operational concept and system architecture, including the definition of the services, functional blocks, and interfaces which form the basis of rail system operations;
  - the development of associated specifications including interfaces, functional requirement specifications and system requirement specifications to feed into Technical Specifications for Interoperability (TSI) established pursuant to Directive (EU) 2016/797 or standardisation processes to lead to higher levels of digitalisation and automation;
  - ensuring the system is maintained, error-corrected and able to adapt over time and ensure migration considerations from current architectures;
  - ensuring that the necessary interfaces with other modes, as well as with metro and trams or light rail systems, are assessed and demonstrated, in particular for freight and passenger flows;

- facilitate the research and innovation activities necessary to achieve the objectives of EU-Rail, including low TRLs rail-focused research and innovation activities. In that respect, EU-Rail shall:
  - define and organise the research, innovation, demonstration, validation and study activities to be carried out under its authority, while avoiding fragmentation of such activities;
  - exploit standardisation and modularity opportunities, and facilitate the interfaces with other modes and systems;
  - develop demonstration projects;
  - develop close cooperation and ensure coordination with related European, national and international research and innovation activities in the rail sector and beyond as necessary, in particular under Horizon Europe, thereby enabling the Europe's Rail

[6] https://rail-research.europa.eu/wp-content/uploads/2020/12/RAIL-Strategic-Research-and-Innovation-Agenda-2020-_FINAL_dec2020.pdf

Joint Undertaking to play a major role in rail-related research and innovation while also benefiting from scientific and technological advances reached in other sectors;
- ensure, through the cooperation referred here above, the translation of research into effective development effort and development of pioneering innovations and ultimately into market focused innovation through demonstration and deployment;
- perform any tasks necessary to achieve the objectives set out in SBA Articles 4 and 85.

Five areas of priority for EU-Rail have been determined in its MP:

1) European rail traffic management and supporting rail's key role in a multimodal transport system
2) Digital and automated train operations
3) Sustainable and digital assets
4) Competitive digital green rail freight
5) Smart solutions for low density traffic lines (cost-efficient regional lines)

These priorities are underpinned by a system view to ensure a harmonised approach to the evolution of the Single European Rail Area.

EU-Rail also works on forward-looking activities, tackling disruptive technologies and thinking, through performing exploratory research and other complementary activities.

The JU fosters a close cooperation and ensures coordination with related European, national and international research and innovation activities in the rail sector and beyond as necessary, in particular under Horizon Europe, Connecting Europe, and the Digital Agenda. The regional dimension is a priority to ensure that EU-Rail will deliver services to connect European regions in an integrated network approach.

EU-RAIL has put in place measures to maximise its impact using synergies with other European, national and regional programmes and activities beyond the involvement in the overall coordination of Horizon Europe.

This Work Programme results from extracting the priority research and innovation activities identified in the MP and detailed in the MAWP to be delivered by the end of 2026 for the running Flagship Projects and System Pillar activities, while preparing the work for launching new Exploratory Research and other activities, considering the available budgetary resources, including under the multi-annuality by instalment principle and the SBA conditions.

1.4 Strategy for the implementation of the programme

The overall Strategy of EU-Rail is anchored in its Master Plan and is further elaborated in its Multi-Annual Work Plan.

In order to deliver its objectives and strategy, EU-Rail will be set-up around one single Research and Innovation Programme based on a system view. The Programme will be delivered by two integrated pillars - the System Pillar and the Innovation Pillar - and complemented by a Deployment Group, all together covering the full life cycle of R&I from blue sky to pre-deployment and pre-industrialisation processes.

<u>The System Pillar activities</u>

The purpose of the System Pillar is to introduce common EU railway system view so that the evolution of the rail system is based on common operational visions and a layered functional architecture. The

idea of the System Pillar is integrating new scientific knowledge and other industry best practices in order to accelerate and better organise its evolution. The System Pillar is the 'generic system integrator' for the EU-Rail and performs the role of architect of the future railway system. This means that the System Pillar prepares and proposes the concept of operations, the system architecture, the associated standards and specifications, and migration strategies.

The task is to develop the operational concept(s) and functional system architecture for a genuine integrated European system, supported by a model-based systems architecting and engineering approach, beyond the current specifications, with much greater standardisation and much less variation than at present. Its activities are organised in four Tasks, which are presented in Section 2.3.2.

The Innovation Pillar activities

The Innovation Pillar is set up to deliver user-focused research, innovation and large-scale demonstrations. It is tasked to deliver the operational and technological solutions which provide the necessary capabilities to make the European rail system more efficient, flexible and able to answer to the customer needs, maintaining its safety and environment sustainability factors. Its activities are organised in seven Flagship Areas and the Transversal Topic, more details of which are presented in Section 2.3.3.

Continuous exchanges exist between the System Pillar and Innovation Pillar activities as part of the Integrated R&I Programme, with a bi-directional flow: both pillars should provide input and output to each other against a clearly defined series of priorities and objectives to be achieved.

The Deployment Group Activities

The Deployment Group should deliver recommendations to the Governing Board of EU-Rail on the consideration and needs in relation to the deployment of solutions proposed by the JU. These recommendations may include:

- considerations on whether deployment should be mandatory or voluntary;
- technical and operational migration considerations;
- considerations on timing and need for synchronization at the European level;
- economic and business case analyses for the relevant stakeholders and for the European Union;
- purchasing strategies;
- industrial capacity;
- finance and funding plans.

The EU-Rail Deployment Group mainly consists in a High-Level Core Group which could be assisted on an ad-hoc basis by dedicated groups on specific topics requiring additional expertise. Such dedicated groups shall be selected upon recommendation of the High-Level Core Group and in agreement of the Governing Board.

2. WORK PROGRAMME 2025-2026

2.1 Message from the Executive Director

Following the administrative closure of the S2R projects in 2024, the Europe's Rail JU, its Programme office, and its Members will continue the implementation of the integrated Programme with synergetic R&I activities, the integration of new Members, updated proposals for standard items and common approaches, and with a fully operational Deployment Group.

2025 is the year that will earmark the enlargement of the Joint Undertaking Membership, as well as the launch of the second wave of Flagship Projects' call for proposal. The period 2025-2026 is expected to include also some contribution work in view of the preparation of rail research and innovation activities post-2027, under the new Multi-Annual Financial Framework Programme 2028 – 2034, and taking into account the phasing out plan of EU-Rail.

Additionally, in the Greening Freight Transport communication[7] of the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, the deployment of digital automatic couplings (DAC) technology, supported by the R&I of EU-Rail, is highlighted as a game-changer for European rail freight. The Commission is looking forward to developing a comprehensive migration strategy to coordinate deployment, with the help of EU-Rail.
In the same package, the Commission also published a proposal for a Regulation on the use of railway infrastructure capacity in the Single European Railway Area[8], where the rail Infrastructure Managers are called on ensuring alignment, in particular regarding digitalisation of capacity and traffic management, with the work of the Europe's Rail Joint Undertaking as well as they shall contribute to the EU-Rail works in this regard.

EU-Rail will have to work on those strategic items also in 2025 and 2026, together with the Commission, its private Members and its Advisory Bodies, for a coordinated R&I implementation or pre-deployment activities.

The EU-Rail Research and Innovation activities are designed to deliver concrete solutions addressing the climate change crisis the world is facing, addressing climate mitigation and adaptation – the JU Programme Office and its Members are well aware of this urgency and the importance that the work of our integrated Programme, covering innovative solutions' lifecycle, from exploratory research to pre-implementation and deployment, has.

The target remains that by the end of this decade, Europe's Rail should *deliver a high capacity integrated European railway network by eliminating barriers to interoperability and providing solutions for full integration, covering traffic management, vehicles, infrastructure and services, aiming to achieve faster uptake and deployment of projects and innovations. That should exploit the huge potential for digitalisation and automation to reduce rail's costs, increase its capacity and enhance its flexibility and reliability, and should be based upon a solid reference functional system architecture shared by the sector, in coordination with the European Union Agency for Railways*.

EU-Rail has closely follow-up and actively contribute to the discussions among the relevant stakeholders regarding the future of the EU partnerships in the area of Research and Innovation and their possible extension for the next EU multiannual financial framework, leading to the publication of the high-level paper and will continue this reflection in 2025.

[7] https://transport.ec.europa.eu/system/files/2023-07/COM_2023_440.pdf
[8] https://transport.ec.europa.eu/system/files/2023-07/COM_2023_443_0.pdf

The launch of the Research and Innovation activities of this Work Programme shapes the mission-oriented nature of the JU, building on openness and inclusiveness, answering the call of the Member States and Parliament to deliver impact and added value to European citizens. Synergies with other Union – as well as national and regional – programmes and partnerships provide opportunities to complement the series of actions expected from the rail sector, including interacting with ERRAC on complementary activities. Stakeholder relations and dissemination of results ensure the visibility of the progress achieved. Sound financial and risk management and compliance will underpin the implementation of the Programme along its lifecycle.

2.2 Executive Summary 2025-2026

The European Green Deal[9] and the related Roadmap[10], published in December 2019, form an integral part of the European Commission's strategy to implement the United Nation's 2030 Agenda and associated Sustainable Development Goals[11]. EU-Rail, positioned within Horizon Europe under Cluster 5: Climate, energy and mobility, aims to address these particular Sustainable Development Goals:

The European Green Deal sets out a clear vision of how to achieve climate neutrality in Europe by 2050 and presents the EU's new growth strategy. To achieve climate neutrality, a 90% reduction in transport greenhouse gas emissions is needed by 2050. The transformation of the railway system will be pivotal to achieve the environmental and economic objectives by offering both decarbonised and time/cost-competitive transport solutions for passengers as well as for freight.

In December 2020, the "Sustainable and Smart Mobility Strategy – putting European transport on track for the future"[12] was adopted by the Commission. It fosters, besides other concepts, the idea of using the potential of digital technologies to revolutionise the way we move, making our mobility smarter, more efficient, and also greener. The Strategy identifies concrete milestones, and, in order to meet them, particular goals to be achieved by means of rail research and innovation are set as well, such as:

- a shift of a substantial part of the 75% of inland freight carried by road towards transport by rail and inland waterways,
- scheduled collective travel under 500 km should be carbon-neutral by 2030 within the EU,
- traffic on high-speed rail will double by 2030 and triple by 2050,
- rail freight traffic will increase by 50% by 2030 and double by 2050,
- a fully operational, multimodal Trans-European Transport Network (TEN-T) for sustainable and smart transport with high-speed connectivity by 2050,
- improving the competitiveness of rail and supporting the European technological leadership in rail.

9 https://commission.europa.eu/publications/communication-european-green-deal_en
10 https://commission.europa.eu/publications/communication-european-green-deal_en
11 https://sdgs.un.org/goals
12 https://eur-lex.europa.eu/resource.html?uri=cellar:5e601657-3b06-11eb-b27b-01aa75ed71a1.0001.02/DOC_1&format=PDF

EU-Rail also aims, especially within the context of the European DAC Delivery Programme, to contribute in collaboration with the European Commission to the measures presented in July 2023 in the Communication titled "Greening Freight Transport"[13].

Further to the topic of "Digital Decade", the Commission indicated in its Communication of March 2021[14] how digital transformation can improve the ecosystems related to mobility and transport. Digitalisation can improve environmental and cost performance and simultaneously increase safety levels contributing to a higher quality of life. It will be achieved through more advanced levels of automation, faster and more reliable connectivity, and IT enabled profound transformation of the management of mobility services. The public could also benefit from fast internet connectivity for passengers on most stations and lines, user oriented telematics and facilitated multi-modality.

In this context, EU-Rail and its Programme will strive for speeding up the development and deployment of innovative technologies in railway transport in order to contribute to achievement of the above-mentioned milestones. This will require a significant transformation of the railway sector, addressing long overdue changes in legacy operational processes, systems and governance models, as well as integrating with other transport and mobility solutions for passenger services and cargo logistics. The ongoing energy crises, which has major impacts also on rail, requires accelerating research and innovation towards deployment of innovative technological and operational solutions that would contribute to operational efficiencies and energy performance.

The strategic framework for EU-Rail's endeavours is provided in its Master Plan identifying the ambitions and the objectives of this partnership and defining a systemic, long-term and result-oriented delivery strategy for research & innovation in the railway sector.

More specifically, the JU's 2025-2026 priorities in this respect will be on:

1. the R&I activities related to the EU-Rail integrated Research and Innovation (R&I) Programme:
    a. the Innovation Pillar:
        i. the monitoring and performance analysis of the results of the 2022 Flagship Projects, including the achievement of the planned milestones, towards their conclusion in 2026,
        ii. the ramp-up, following the conclusion of the grant agreements in 2024, of the projects resulting from the Call 2023-1 as well as from the Call 2024-1 that as part of the Integrated Programme complement the Flagship Projects with additional Exploratory research activities and anticipate as well some Flagship Area activities,
        iii. the launch of the Flagship Project Call 2025-2 during Q4 2025, followed by the conclusion of the grant agreements in 2026, to implement the second phase of all Flagship Areas described in the updated Multi-Annual Work Programme
        iv. the launch of the Call 2025-01 and 02 respectively during Q1 and Q4 2025, with additional Exploratory research activities,
    b. the System Pillar:
        i. delivering, building upon the second-year results of the System Pillar Tasks and Domains and the updated Standardisation and TSI Input plan to the European Commission,
        ii. launching the activities to be undertaken in the second half of 2025, as well as preparing the outline of the activities to be performed in 2026,
    c. the Deployment Group:

[13] https://transport.ec.europa.eu/system/files/2023-07/COM_2023_440.pdf
[14] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52021DC0118

i. delivering, building upon the first recommendations of the high-level and topical working group(s), aiming at closing the innovation gap towards deployment with addressing European migration and implementation plans,
ii. supporting the activities of the European DAC Delivery Programme, in particular working with the European Commission on developing a comprehensive migration strategy to coordinate deployment, in accordance with the Commission communication on "Greening Freight Transport" COM(2023) 440,

d. the Membership:
   i. the full integration of the new Associated Members in the JU governance and the follow-up of the R&I activities and in-kind contribution commitment that they will be delivering in response of the open call for proposals from EU-Rail.

The Communication activities for 2025-2026 will continue ensuring that the JU's mission, vision and objectives, including the Innovation and System Pillars, and the Deployment Group, are communicated and understood widely. It is expected that the first major results of the six Flagship Projects will be made available in 2025 and 2026. A large part of the communication and dissemination activities will focus on ensuring the results are communicated effectively to the relevant target audiences, in particular with additional focus on the dissemination of Flagship Projects results. To ensure the involvement of stakeholders from the entire rail value chain, including actors from outside of the traditional rail sector, EU-Rail will organise and participate to a number of events and conduct other communication and dissemination activities and campaigns.

During 2025-2026 the JU will seek the continuation of the close collaboration established with:

- the European Railway Research Advisory Council (ERRAC),
- the European Union Agency for Railways (ERA),
- the European Union Agency for the Space Programme (EUSPA),
- national and regional research and innovation programmes as brought forward by the States' Representative Group,
- other programmes, partnerships and EU bodies, with the objective to establish synergies that will result in coordinated activities or joint R&I projects or administrative synergies, such as for example under the back office arrangements with other JUs,
- different associations representing the key stakeholders of the rail sector and beyond,
- third countries programmes, in line with the policy priorities of the Commission and considering the key objective of the competitiveness of the European rail industry.

The main events, where EU-Rail will showcase its results in 2025 and in 2026, are Call Info Days, the Europe's Rail General Assembly (December 2025 and 2026), Women in Rail Awards contributions, events with ERA and the Danish Presidency (2025). Participation of the JU will be ensured at the following external events: European Start-up Prize, the joint JU European Parliament event (April 2025), ITF Summit (May 2025), UITP Global Public Transport Summit 2025 (June 2025), Transport Research Arena (2026), Connecting Europe Days (2026), InnoTrans (2026). Potential other events attendance relevant to the ongoing work of EU-RAIL.. Potential other events relevant to the ongoing work of EU-RAIL will be attended.

Improvements in the JU's internal communication will continue in 2025 and 2026, leveraging on the available IT tools, to boost the flow of information among the staff. Ad hoc campaigns, such as the informative brown Bag Lunches following the feedback from 2024 could continue, as well as team building activities in close collaboration with the Human Resources department.

At the corporate level, EU-Rail will strive for appropriate workload distribution, as well as for costing and staffing levels needed to ensure successful delivery of the Programme. In addition to supporting continuous learning and qualification raising of the staff, activities improving the well-being and team cohesion will be conducted throughout 2025 and 2026. In the upcoming period, the JU's priorities in the HR area will also include developing a fit-to-purpose competency framework and a talent development plan.

The SBA Article 13 requires the Joint Undertakings to establish back-office arrangements between themselves in relation to a list of services. While such back-office arrangements were firstly put in place for accounting services and followed later by the procurement services, others became operational in 2024 or will follow in the upcoming period and will take form of Service Level Agreements (SLAs) concluded between the respective JUs. The costs and benefits of such SLAs will be assessed during the future years while possibly new services will be considered for synergies.

In the area of internal control and assurance, EU-Rail intends in 2025 to further test and fine-tune by means of additional pilot reviews of H2020 lump sum grants the ex-post part of its Horizon Europe risk-based Control Strategy for grants that was endorsed at the end of 2023, while in 2026, the work packages pertaining to the projects of the current HE Programme will start to be reviewed ex-post. The ex-ante part of the above-mentioned Strategy will be continuously applied throughout the period 2025-2026. Implementation of this Strategy represents even greater shift from quantitative (financial) checks towards the qualitative (technical) controls logically following from the exclusive application of the lump sum form of funding under Horizon Europe.

In the last years, the Joint Undertaking has demonstrated the progress achieved through the commitment of its members and stakeholders. The system transformation, to which the JU was expected to substantially contribute, did not end with S2R, as it will still require a major effort in the years to come, connecting fundamental research – applied research – large scale demonstrations/deployment. The system approach brought forward by an institutional partnership such as the Joint Undertaking has proved to be capable of delivering such major transformation, involving legislator, regulator, standardisation bodies and stakeholders.

2.3 Operational activities of EU-Rail in 2025-2026

2.3.1 Objectives, indicators and risks

As mentioned in Section 1.4, the R&I activities of the EU-Rail Programme are based on two Pillars, the System Pillar, which is structured in five main tasks, and the Innovation Pillar that is organised in seven Flagship Areas (FA) and the Transversal Topic (TT). Their objectives and the main high-level risks associated to them are presented below.

The results of the JU will be measured via a series of key performance indicators (KPIs) addressing, on the one hand, the technological and operational outcomes and, on the other hand, the impact that they are expected to realise once deployed. The KPIs will cover the full lifecycle of R&I, from exploratory research to deployment coordination. The KPI model will be based on input delivered by each of the JU projects and reported on a yearly basis, through the Consolidated Annual Activity Report. Each project will be required to ensure that relevant quantitative and qualitative metrics are provided that contribute to the JU's overall KPIs. The current version of the KPIs at the level of the Flagship Areas and the Transversal Topic is provided in Annex III in Section 4 of this WP.

The System Pillar tasks will use the toolset provided by the JU in 2023. The Flagship Projects will have access to the System Pillar platform in order to facilitate information exchange. The process of

exchange of information, of work on common tasks and of collaboration in general as one integrated programme will also continue to be analysed in 2025, based on the R&I outputs produced in 2023 and 2024.

The System Pillar contributes defining the concept of Operations for Rail and a functional rail system architecture for the future, taking into account interfaces within different rail segments and other modes. These activities should ensure a common approach and efficient use of resources; EU-Rail is the platform to enable sector convergence on common solutions at European level and provides the needed coordination and resources . EU-Rail will therefore in particular coordinate and consolidate all relevant sector initiatives, noting the importance of unified requirements from the Railways.

The activities of the System Pillar focus on key priorities but addressing the part of the rail system where relevant and cost-effective, standardisation or commonly agreed harmonised specifications needed to deliver them. This would allow setting the right conditions towards modular (standard interfaces) and scalable solutions in view of large-scale market introduction and their evolution.

The R&I activities that will provide technical solution to fit in the functional rail system architecture, addressing specific technical subsystems, are structured within the Innovation Pillar and established around the full lifecycle of research and innovation, from exploratory research, via applied research to large scale demonstrations.

R&I Large Scale Operational Demos will be one of the major game changers in the impact to be achieved by EU-Rail. It is not about coordinating the funding, it is about Integrated R&I Large Scale Demonstration activities, i.e. moving from small-scale demonstrators[prototypes] in one specific network or lab, to European wide live, operational network-scale demonstration of solutions in a different environment, reaching TRL 7/8/9 level, and to show the benefits from the European deployment of new solutions. This will also be a key component for the inclusiveness of these areas of Europe, and consequently, Member States, under-represented in the current rail research and innovation activities. As they will be capable to contribute to demonstrate the benefits of the proposed partnership, or ongoing Programmes, solutions in their operational network and services offered to their customers.

This activity will also support the necessary steps for the regulatory changes or standards' changes needed to bring solutions to the market, closing the virtuous circle started in the definition of concepts within the System Pillar, before industrialisation and deployment.

The "Deployment Group", which became operational in 2024, will tackle the transition from R&I to coordinated and consistent deployment at European level, to avoid creating new barriers or proposing ways to solve existing one and supporting the creation of the single European area.

The tables below present a summary of the main activities for the years 2025 and 2026:

Year 2025	**Type of call**	**Value of the actions (million EUR)**	**Maximum EU-Rail co-funding (million EUR)**	**Non-funded activities (million EUR)**	**Target contributions from Members in case of award (million EUR)**	**Indicative publication date**
Multi-annual Call for	Open *2025*	245,5	148,2	97,3	325,9	Q4 2025

Year 2025	Type of call	Value of the actions (million EUR)	Maximum EU-Rail co-funding (million EUR)	Non-funded activities (million EUR)	Target contributions from Members in case of award (million EUR)	Indicative publication date
proposal 2025-02(*) (instalment)	*values*	*199,7*	*119,8*	*79,9*	*263,4*	
Call for Proposals – 2025-01	Open	5,2	3,0	2,2	0,0	Q1 2025
	2025 values for Call 2025-01	*5,2*	*3,0*	*2.2*	0,0	
Call for Tenders	Open	14,4	14,4	0,0	0,0	Q1 – Q4 2025 & implementation of new and ongoing contracts/framework contracts
Operational Experts	Open, including through REA, including SSG	0,4	0,4	0,0	0,0	Q1 – Q4 2025
Total		**219,7**	**137,6**	**82,1**	**263,4**	

Year 2026	Type of call	Value of the actions (million EUR)	Maximum EU-Rail co-funding (million EUR)	Non-funded activities (million EUR)	Target contributions from Members in case of award (million EUR)	Indicative publication date
Multi-annual Call for proposals 2025-02(*) (instalment)	Open *2026 values*	0,0 *47,3*	0,0 *28,4*	0,0 *18,9*	0,0 *62,4*	

Year 2026	Type of call	Value of the actions (million EUR)	Maximum EU-Rail co-funding (million EUR)	Non-funded activities (million EUR)	Target contributions from Members in case of award (million EUR)	Indicative publication date
Call for Tenders	Open	8,46	8,46	0	0,0	Q1 – Q4 2026 & implementation of new and ongoing contracts/framework contracts
Operational Experts	Open, including through REA, including the SSG	0,4	0,4	0,0	0,0	Q1 – Q4 2026
Total		**56,2**	**37,3**	**18,9**	**62,4**	

(*) This call for proposals is launched in 2025 with budget commitments divided into annual instalments, meaning that the amount committed by the JU will be confirmed yearly based on the annual budget of the JU. For more information about the annual instalments, please refer to the "Table of Financial programming per year until 2027" in Chapter 3 "Budget 2025-2026" of the present document.

In addition to the specific research and innovation calls and their implementation, in 2025 it is expected that, after the realization of the call for expression of interest, the Associated Members will be selected and become part of the JU.

In line with Regulation (EU) 2021/695 establishing Horizon Europe (hereinafter also "Horizon Europe Regulation"), in particular with regard to Article 52 thereof as well as with Article 171(1) SBA, EU-Rail is bound to contribute to an interim Programme evaluation to feed into the decision-making process of the HE Programme, the next framework programme and other initiatives relevant to R&I. Such interim evaluation of the Programme shall be carried out with the assistance of independent experts selected on the basis of a transparent process once there is sufficient information available about the implementation of the Programme, but no later than four years after the start of that implementation. In 2024, the JU contributed to this activity steered by the European Commission, so that its intended purpose – namely the assessment of the Programme's effectiveness, efficiency, relevance, coherence, and Union added value – could have been effectively achieved.

Furthermore, EU-Rail will continue in 2025 and 2026, as needed, to provide support and inputs to the EC for the purposes of reporting on the performance of partnerships under Horizon Europe, such as by means of the respective Biennial Monitoring Reports (BMR). The various editions of the BMR aim at providing a strong evidence base to guide the implementation of partnerships and to inform strategic discussions on the effectiveness of the new policy approach to European Partnerships and, where

relevant, how it should evolve. The reports further aim to shed light on the progress of partnerships in achieving the EU objectives and targeted impacts both individually and collectively, at EU and national level.

Finally, in line with Article 19(4)(v) SBA, EU-Rail will, as necessary, continue working on its plan for phasing out from Horizon Europe funding, which was based on an assumption of non-renewal of the JUs after the 31 December 2031, also reflecting on the potential scenario of new activities to be performed after the current Europe's Rail integrated Programme and under suitable framework conditions.

2.3.2 The System Pillar

The System Pillar aims to define the concept of operations for Rail and a functional rail system architecture for the future, considering interfaces within different rail segments and other modes.

To achieve an architecture that offers the demanded functional improvements concerning production performance, reliability, quality, and cost as well as the needed architecture quality, the System Pillar (SP) follows the defined process, based on the principles of Model-Based System Engineering (MBSE):

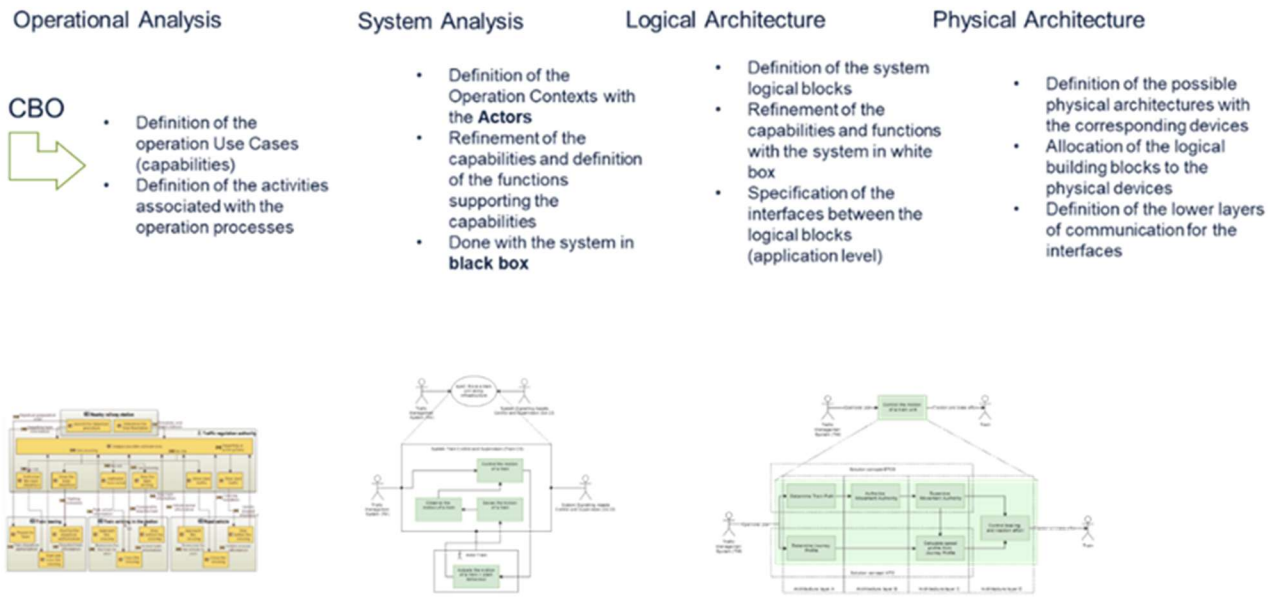


Figure 1: MBSE process used by the System Pillar to develop the overall architecture.

The System Pillar is managed and led by the System Pillar Unit of EU-Rail, under the responsibility of the Executive Director, within the governance established by the Single Basic Act (Council Regulation (EU) No 2021/2085 of 19 November 2021).

The System Pillar (SP) has the responsibility to support a consistent and coordinated approach to the evolution of the rail system according to the EU policy goals. The outputs of the System Pillar are:

- Specifications, and standards, related to among others, to cyber-security, command, control, and signalling systems (CCS), Traffic Management (TMS) and Digital Automated Coupling (DAC) to support European deployment of digital systems.

- Through the Standardisation and TSI Input plan, a coordinated and transparent view of all the harmonisation elements from EU-RAIL in order to define a clear and agreed plan for the evolution of the Command Control and Signalling (CCS)/Traffic Management System (TMS), the TSI enhancements, and standards, which will support interoperability, modular

interchange ability, system integration ability, robustness, harmonisation and implementation of the SERA, and the role of EU-RAIL (both System Pillar and Innovation Pillar) in delivery.

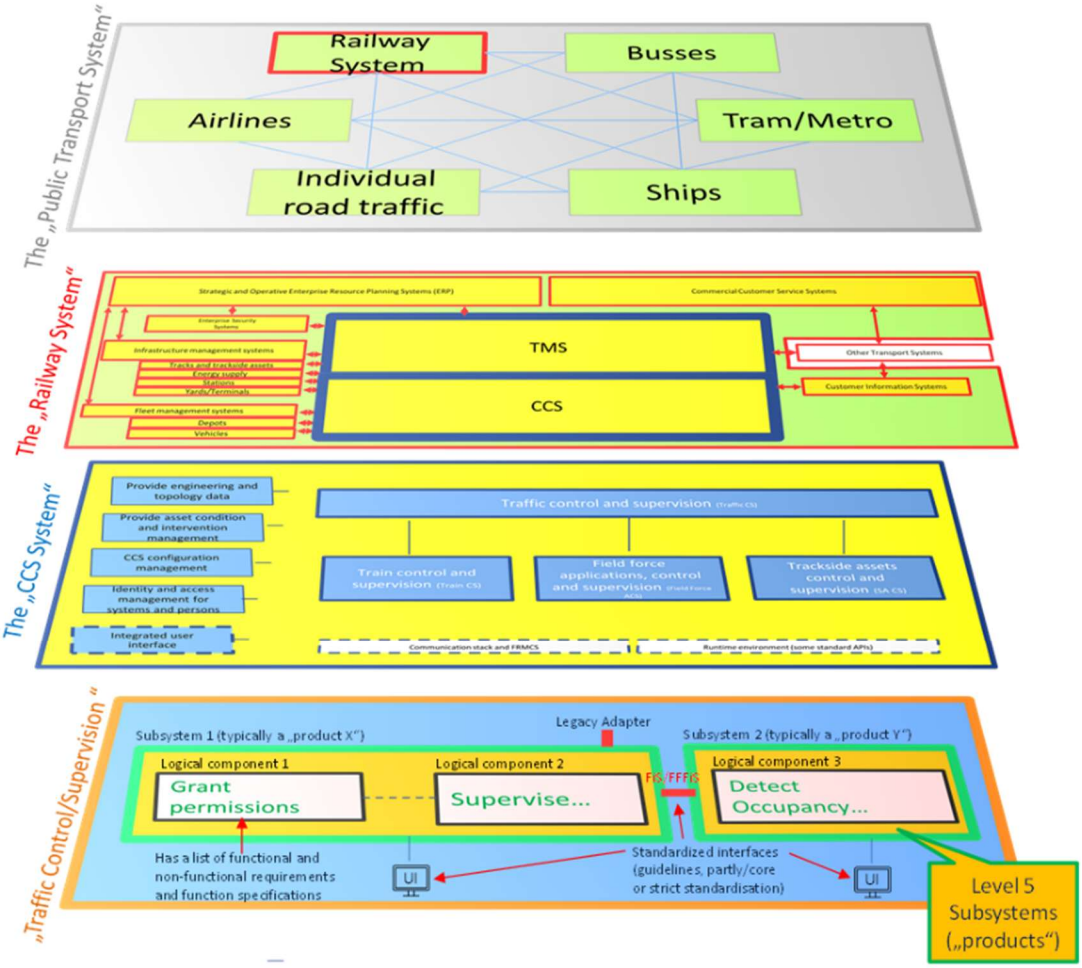


Figure 2: System Level 1-5 view, the content is based on indicative CCS/TMS

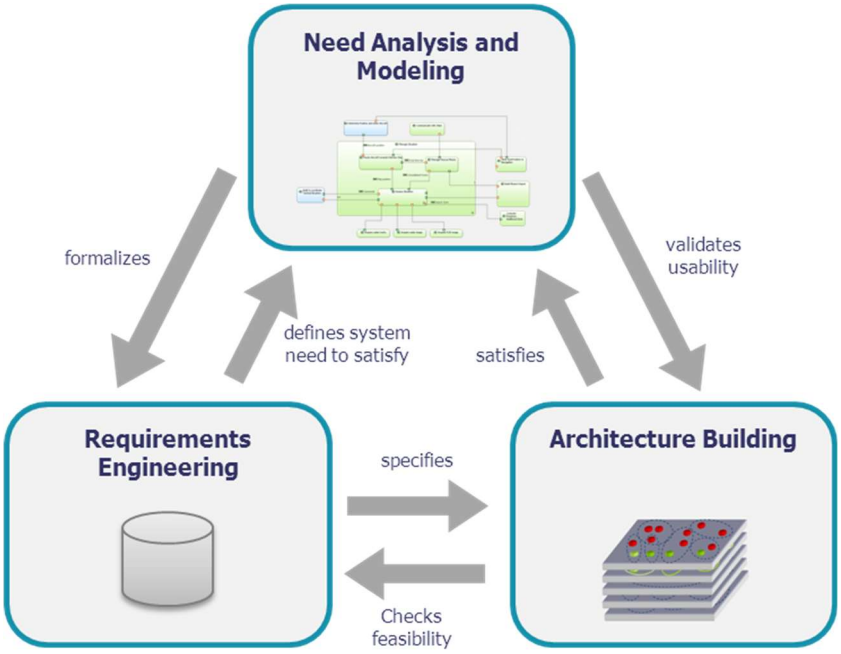


Figure 3: Viewpoint driven approach [Augmenting requirements with models to improve the articulation between system engineering levels and optimize V&V practices', INCOSE International Symposium, 29: 1018-1033]

Through the Ramp-up phase for the SP (2022) a draft high-level architecture has been drafted and reviewed with the sector. The full resource for the System Pillar has been in place since October 2022.

During the first year of the System Pillar (Q4 2022-Q3 2023), the workflows supporting the described model-based system engineering approach for developing the railway system architecture have been launched. The performed work comprises both the top-down system engineering approach, starting from the CBOs and operation use cases, as well as the bottom-up integration of the existing outcomes of previous S2R works or other sector initiatives (as OCORA, EULYNX etc.) The process steps of the implemented model-based system engineering approach have been elaborated in the System Engineering Management Plan (SEMP) and applied to a first set of operational capabilities.

During the second year of the System Pillar (Q4 2023-Q3 2024), the above-described approach has been pursued. Additionally, the System Pillar is coordinating the harmonisation outputs and needs from the EU-RAIL programme in the Standardisation and TSI Input Plan (STIP) and supporting the interaction of the related activities of EU-RAIL with ERA and the standardisation bodies (incl. the Sector Forum Rail (SFR) and RASCOP). The specific harmonisation topics for EU-RAIL as a whole are being integrated and delivered in the Standardisation and TSI Input Plan.

During the third year of the System Pillar (Q4 2024 – Q3 2025), the first outputs of Technical Specifications for Interoperability (TSI) and their associated documents (subsets, applications guides, etc.), EU Standards and other SP documents are expected to be published.

2.3.2.1 SP organisational structure of the activities

Given that it is necessary to define the whole rail system in order to determine the areas of priority and focus. For this, there are two different structures co-existing within the System Pillar organisation of the activities:

- The content structure: Describes the work items that need to be built in a certain sequence to create the deliverables. Content structures have many levels of details and are connected in all directions by the "flow of requirements".

- The organisational structure: Defines the team structure and the control flow, aimed to be as simple (top-down), efficient, and effective as possible.

Regarding the difference between the content structure and the organisational structure, a "design team" for the business architecture of the railway system cannot be the "leading" team for all System Pillar projects. Design work and program management is not the same. The Task 1 analysis and design team contributes important requirements to the SP projects, but the progress management of the SP is done by the SP Core Group/the JU.

The figure below, includes the first and second level operational break down structure of the System Pilar, as of 2024. Additional specific projects and/or may be added in the upcoming years, as the development identifies new lines of work to fulfil the CBOs.

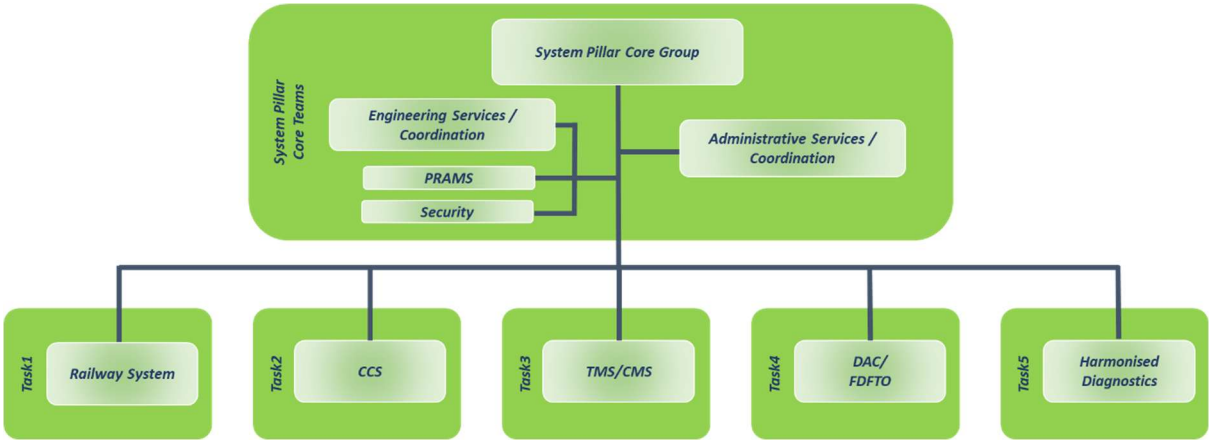


Figure 4: first level operational breakdown structure of the System

The roles and responsibilities of the following SP groups are depicted in the EU-Rail's Governance and Process Handbook15:

- SP Steering Group, Core Group, Engineering Services / Coordination (comprising Engineering Environment Team, Standardisation and TSI input planning, External Architectural support, PRAMMS Management and Assurance), Administrative Services (comprising Programme Office, Economic Analysis),
- Task 1: Railway System,
- Task 2: (Advanced) CCS system design,
    - The cross-cutting domain teams (comprising Operational Design, Architecture and release coordination and Migration and roadmap),
    - The CCS System Design Teams (comprising Traffic control and supervision, Trackside assets control & supervision, Train control and supervision, Transversal CCS component, Field force CCS application, Communication team, Computing environment),
- Task 3: TMS system design,
- Task 4: DAC/FDFTO16 System design.
- Task 5: Harmonised diagnostics

System Pillar Core Teams

System Pillar Core Group

The System Pillar Core Group provides the competent leadership and expertise of the development of the functional layered railway system architecture, specification models and Operational Concepts that enable safe, secure and efficient delivery of the new systems. Moreover, the SPCG manages the common business objectives and deliverables from the different SP Tasks.

Engineering Environment Team

The Engineering Environment team (previously Central Modelling Services) includes methods definition (System Engineering Management Plan (SEMP)) and tools provision and training (Polarion, Capella, SysML specification environment) for the whole System Pillar. The Engineering Environment team monitors the formal quality of the work items, their correct allocation to the tasks and domains, and the consistency, traceability and integrity of the specification.

15 https://rail-research.europa.eu/wp-content/uploads/2023/01/EU-Rail-Governance-and-Process-Handbook.pdf

16 DAC = Digital Automatic Coupler / FDFTO = Full Digital Freight Train Operations (part of FA 5 project)

PRAMS Team

The PRAMS team is in charge to define the strategy, policies, methods, and principles to be followed by the other Tasks and Domains during the design activities as well as to coach and support implementation. PRAMS team do not produce PRAMS Analysis, Hazard and Risk Analysis, for system components or system parts; these activities are delegated to the related Domain that have to include members with PRAMS skills. The PRAMS Functional team is in place to have a proper coordination and synchronization.

Security Team

Security requirements are coordinated centrally this includes top-level design and assurance of the security strategies and requirement implementation in the System Pillar Tasks and the specification of the subsystems for monitoring and the system control access.

System Pillar Task 1: EU Rail System

The System Pillar Task 1 will be focused on the European railway network to which Directive 2016/797 applies. The vision of the European railway system is:

- Open access to SERA, i.e. no technical and operational boundaries for trains, standardisation (economies of scale), safety (including learning from information sharing) and resilience.

- Performant and competitive.

- Synchronised deployment, and

- Full alignment with the future system

The system architecture used by the System Pillar needs to be structurally and logically consistent, and reflect the structural reality that, currently, there is no single European railway system.

The high-level target architecture(s) will input to the considerations of the optimal level of technical and safety harmonisation building on cutting-edge technologies, making it possible to facilitate, improve and develop railway services within the Union, and with third countries, and to contribute to the completion of the SERA and the progressive achievement of the internal market. Interoperability must be achieved and maintained.

The scope of Task 1 should not be time-bound and can consider several iterations of development i.e. it should be ambitious and flexible to consider the impact of new technologies and processes with regards to rail (e.g. from the innovation pillar) which may require a substantial revision of, inter alia, safety concepts and the regulatory framework underpinning operations both with the clear goal to harmonise across Europe.

To achieve the overall evolution and target architectures defined in Task 1 will be a complex challenge. Best practice from other industries shows that successful integration of system architecture approaches, especially when moving from current engrained systems like in rail, is to take the opportunity when systems are in any case evolving to put in place the correct system architecture processes and principles.

System Pillar Task 2: CCS

The regulation and implementation of European rail control-command and signalling (CCS) is of central importance in the running of a safe, efficient, interoperable, robust cost-efficient and reliable rail service in Europe. CCS deals with all the on-board and trackside equipment required to ensure safety and to plan, command and control movements of trains authorised to travel on the network as well as the efficient integration of maintenance processes that occupy tracks.

Historically the automatic systems developed over time to monitor drivers' operation (continuous speed monitoring and avoidance of signals passed at red) have been developed to be different and they are still substantially different in each national railway network, and thus a major barrier to operate one European network.

A central focus at European level has been the implementation of ERTMS (European Railway Traffic Management System), a major industrial programme to harmonise the automatic train control and communication system and underpin interoperability throughout the rail system in Europe. Deployment of ERTMS provides the backbone for a digital, connected Single European Rail Area.

The current harmonisation at European level, through the CCS TSI, addresses the safety and interoperability requirements, the on-board functions and the interfaces between trackside and on-board related to train protection, signalling the permission to move the train and radio communication. Hence, not the full CCS system.

For trackside CCS beyond that specified in the CCS TSI, there are currently network or deployment specific approaches of trackside engineering, operational concept, signalling rules and their interfaces.

The current typical CCS on-board configuration includes multiple proprietary TCMS (train control management systems) and Class B driven interfaces between the main train on-board building blocks, which are currently not harmonised.

As a result, even if ERTMS as it stands is implemented in full across the EU, national systems for significant parts of the CCS system would continue, along with national operational rules driving customisation, and a continued overall fragmented CCS market of signalling configurations and rail business models.

This situation significantly increases CCS complexity and reduces the opportunity for more open and competitive markets across Europe. It also creates a system that is not conducive to harmonised evolution and innovation and induces errors and incompatibilities in implementation of the TSI regulated interfaces. Finally, it undermines the performance of the rail system in favour of clients opting for other mobility and transport solutions.

Hence the CCS task is to develop a harmonised operational concept and functional system architecture for a genuine integrated European CCS system, supported by a model-based systems architecting & engineering approach, beyond the current specifications in the CCS TSI, with much greater standardisation and much less variation than at present. Differences in operation are one of the key root causes for complexity as well as product diversity and therefore are a major cost driver. The harmonization of operational principles where economically possible – in particular under cab signalling and radio-based ETCS is key to achieve generic CCS solutions, minimize national requirements, reduce life cycle cost and achieve operational interoperability. This integrated CCS system will on the one hand deliver unrestricted movement of trains, on the other hand, it will create a single market for rail components.

CCS – both on-board and trackside - will be based on a standardised modular system architecture using standardised interfaces. In order to preserve investment made, the System pillar should not only create adequate interface but care about migration feasibility (i.e. clear and affordable transition steps) and find paths for moving beyond the current system with proprietary interfaces and allowing modularity of components.

The need for the CCS task is because digitalisation technologies are ready for use in rail with huge potential to improve passenger and freight services. Digitalisation coupled with automation is one effective way to increase performance and capacity with less new infrastructure investments. Without

high quality architecture, adding such new technologies and maintaining compatibility will not be possible.

The purpose of the focus on CCS is therefore to take advantage that as networks and Member States migrate to CCS systems of ERTMS L2 or above – the opportunity is taken to do this in a harmonised manner following functional layered architecture principles: this will set a common baseline that will allow to evolve systems at the technological evolution pace. It will be a major change from "black boxes" to "software solutions" computing environments.

Operational interoperability is an equally important goal of the Single European Rail Area. A further major opportunity is thus to create harmonized operational rules.

On this basis, a converging shared vision on future rail operations based on ERTMS-alone Level 2 and Level 3 networks will set up the baseline for the operational and technological solutions to ensure and continue evolutions of rail.

System Pillar Task 3: TMS/CMS

TM/CM means to create a long-term to short-term operational plan (production plan) that fulfils customer needs in an optimized way, to prepare and let execute the plan, and to predict and react on deviations and events with adapted planning or initiated interventions to solve production problems. The operational plan describes in very detail all types of track usage (train movements, stabling, construction sites, usage restriction areas, etc.).

Task 3 aim for Traffic Management is to reach a high, smart and flexible automation and cooperation levels for its long- or short-term simulation, planning, forecasting and coordination processes (cross-company, cross-country) in a way that allows to work with an integrated and rolling high-quality plan in near-real-time, based on automated information exchange between all involved planning partners.

The harmonization of operational processes is a key driver towards a deep and seamless integration of the new services and capabilities, with a specific focus on national borders; this is fundamental for the evolution of the Traffic and Capacity Management System to get an effective Single European Railway Area (SERA).

The basic vision will also include a highly digitalized tactical short-term planning with the relevant cost-efficient approach to address risks and opportunities.

This will allow task 3 of SP to achieve the objectives to:

- Strengthen the ability to sustain a given service quality, punctuality, and safe operation, by completeness of planning, adequate level of information, rapid responses to capacity requests and planning changes and reducing the impact of disturbances,

- Leverage on real-time information and data sharing to provide accurate status in order to provide to customer rapid alerts of traffic congestion and in general provide valuable data and information,

- Enable more efficient infrastructure usage and better predict capacity needs of infrastructure.

System Pillar Task 4: DAC/FDFTO

Coupling is done manually by a worker who must climb between wagons to hook and un-hook them, requiring physically exhausting manual operation in a hazardous environment. A more efficient, sustainable and competitive rail freight system is essential to meet the needs of both climate protection and rising transport volumes. Digital automatic coupler is an enabler to create a modern

and digital European railway freight transport. It will not only increase efficiency thanks to automation processes, but it will also ensure sufficient energy supply for telematics applications, as well as safe data communication throughout the entire train.

Through the work in task 4, mainly regarding the high-level specifications and providing the system view, System Pillar will be supporting the improvement of freight train composition, operation and capacity allocations of paths, stabling tracks (e.g. waiting for terminal slots) and shunting (yard) work.

System Pillar Task 5: Harmonised Diagnostics

The ambitious plans of the European Union and railway undertakings are targeting a significant increase in rail usage. This increase requests a higher availability of railway infrastructure and rolling stock but also shortens the time for maintenance for both infrastructure and rolling stock. Thus, fast, and accurate data sharing among different stakeholders is key for better maintenance.

Previous and on-going projects have already developed approaches and concepts for standardized data exchange. However, a harmonized European approach for exchanging maintenance data has not yet been established and data which is currently produced by different technologies (e.g. checkpoints) cannot be exchanged across Europe, which hinders development of the railway sector and blocks business cases.

The initial remit is to select a limited number of examples to demonstrate “proof of concept” European harmonization on the approach, based on the SP Data Model. The procedure methodology and proposed solution should be worked out using simple, non-critical and useful examples, keeping the complexity of the task within manageable limits. Therefore, existing and proven systems should be considered as far as possible, and feasibility demonstrated using a non-critical, useful applications and applying a system wide view.

2.3.2.2 SP DELIVERABLES, MILESTONES AND HARMONISATION PLANNING

The work of the System Pillar is structured along the different tasks described in previous section SP organisational structure of the activities. In the following section the deliverables and milestones are summarized per task and domain.

Detailed information can be found in Annex V.

Other outputs, such as the Standardisation and TSI Input Plan are also described, and the work to support the maintenance and update of the CCS TSI are also described.

Task 1 Railway System

The main ambition for the Task 1 System Levels is to get a list of the needed and important improvements in selected interaction processes (for a better “to be” architecture). A preliminary analysis should highlight differences in the selected interaction processes between countries represented in Task 1 to assess migration issues. For prioritized capabilities, full operational analysis and system analysis should be finalized using the SEMP.

The system view will allow a common understanding in the space of European railway systems the stakeholders’ needs, resources, and capability to deliver beyond the existing implementation of railway sub-system or products. It will support tackling harmonisation, enable innovation, and build the capability in the railway system.

These improved business and technical process solutions will, to the extent needed, describe the rationale behind the requirements of the to-be target Business Process Architecture and Operational Design. The design work for Task 1 is not intended to describe all process and improvement aspects of the full railway system in full detail, especially when no need for harmonisation inside of the System Pillar is identified.

The deliverables for the period of the Work Programme are:

- Development of the to be architecture for “maintain and monitor rolling stock” and “maintain and monitor infrastructure” capabilities with operational process and scenarios, highlighting divergencies between members states.

- Operational analysis of the to-be architecture, based on “maintain and monitor rolling stock” and “maintain and monitor infrastructure”, including the provision of a draft of performances which could be reached by the To-Be Architecture and derived requirements. Additionally, Task 1 will continue with the Operational Analysis of the to-be architecture for the Operate Train and Manage Energy capabilities.

- Identification and mapping of pain points in the operational architecture, in order to highlight activities and interactions where there are opportunities for harmonization

Task 2 CCS

The activity of task 2 on CCS represents the main focus of the System Pillar activities and is divided in several domains.

Task 2 CCS: Domain Architecture and Release Coordination

T2 ARC domain is responsible for the following “coordination areas”. Each coordination issue is not a design task per se, but fulfils a cross-domain, cross-task and SP-IP oriented roles and supports by this the management task of the Coregroup for a specific content area. Each coordination issue shall be handled by one coordinator who is responsible for it.

The deliverables for the period of the Work Programme are:

- CCS TSI CR Overview including a compilation of the following: SP analysis for the backlog CR enhancements in the ERA CCM DDBB; Preassessment content of the bundles of CR to the different TSI, related to CCS outcomes in EURail; other content work related to alignment with the CCS CR authors from other domains or IP; plan and status of the work according to the plan shared with ERA.

- High level logical architecture on system level 3, including Logical architecture (on System Level 3) of the CCS Reference, coherent overview on the CCS reference architecture identifying the TSI relevant parts and specification of the common CCS architecture including all relevant interfaces.

- System Pillar Document and Release Plan (“DRP”) to show all existing or future result documents, their current status, the release planning and packages, the publication dates for drafts and final versions, the links to the documents, dependency analysis between the different topics and analysis on how other harmonization topics are affected. Its expected to include consistency check with the released STIP.

Task 2 CCS: Domain Operational Harmonisation

It is the task of the domain to integrate the stakeholder needs of RU and IM into the operational design in a way that allows to harmonize CCS procedures in the interoperable interactions and to harmonize

CCS products according to the harmonization scope of the System Pillar. The target of the domain is to deliver until October 2025 the rulebook chapters for the topic package 1 for drivers, signallers, trackworkers and shunting workers.

The deliverables for the period of the Work Programme are:

- Guideline for harmonized CCS related operational processes for ETCS L2 and ATO GoA ½: The target of the domain is to deliver until October 2025 the rulebook chapters for the topic package 1 for drivers, signallers, trackworkers and shunting workers. Additionally, the domain will support the CCS CR process for update, drafting and reviewing existing ERTMS EUG engineering guidelines participating also in any related workgroup with ERA

Task 2 CCS: Domain Traffic Control and Supervision
The domain Traffic CS is a core element of the overall CCS functionality. Therefore, the progress with regards to the description of the functionality, the final alignment about interfaces and the interior architecture is key for the coming period until October 2025. The domain now goes into the phase of concrete specification of system and interfaces, which also increases the workload and need a tight collaboration with Task 2 OD.

The deliverables for the period of the Work Programme are:

- System specification and interfaces for ATO Trackside function (GoA2), System specification and interfaces of the trackside protection system and System specification and interfaces of the execution and adaption layer. The requirements are to be described and approved as SRS and for all harmonized system and user interfaces as FiS/FFFiS. Impact to existing interoperability specifications (in CCS TSI) is to be identified including harmonization of functional/engineering rules and proposed changes to existing requirements.

- CCS Trackside migration analysis considering the economic assessment results. Providing answers to key migration questions such as the basic integration strategy to interconnect existing (national legacy) and SPRA compliant (existing and SPRA) products; functional packages (CCS trackside) mandatory for SPRA to simplify migration; decision criteria for national migration steps that help to decide an optimal migration plan; interfaces that can realistically and economically be rolled out before 2030.

- Preparation of major design decisions for management level and steering group, including a clear but compressed view on major design decisions and their rationales, for experts and for management level. The system concept is approved by domain and SPCG and lists concrete decision questions which are assessed by their major impacts.

- Additionally, members of the Traffic CS team are involved in the following working groups System analysis group and system specification subgroups; UI design group; CCS trackside risk management group; CCS trackside migration group; Technical specialists and advisors' group.

Task 2 CCS: Domain Train Control & Supervision
The Train CS domain is responsible for the onboard CCS system. This includes beside the ETCS vehicle equipment also the additional components and functions like ATO (GoA 2 -4), RTO (Remote train operation), C-DAS and others from the on-board perspective. Close alignment with the communication domain (now Lot 3) required to define the interface between FRMCS and the Train CS system.

The deliverables for the period of the Work Programme are:

- Ethernet CCS consistent network (full stack), complete harmonization onboard CCS communication layer full stack (OSI layers 3-6 and safety layer) based on the deliverables agreed with FP2.

- Train interfaces enhancement, functional enhancement for the train interface to allow for CCS onboard systems to be deployed on vehicles as a product from different vehicle suppliers. (ensure CCS onboard exchangeability).

- Train Display System – Multiple display system concept and definition of Multiple DMI concept based on existing documents / information and specific topics.

- Train interface adaption for integrity handling and train length / overall consist length, following the CCS CR ERA process.

- Definition of Computing Platform for safe applications up to SIL4 (relating to CCS applications or other on-board applications e.g. passenger information). Decoupling software, hardware and computing platform lifecycles.

- Basic ASTP: Odometry performance and robustness enhancement. Enhance the specified performance of accuracy of distances measured on-board and improve its robustness. Consider and may be update the odometry performance targets for new CCS onboards to the state of the art of available and proven technologies (update TSI CCS to existing reality using existing technology).

- Basic advanced safe train positioning: General system requirements and architecture and ASTP interface specification

Task 2 CCS: Domain Computing Environment
The task of the computing environment domain is to find solutions to simplify software installation, hardware configuration and life-cycle processes such as upgrades, updates, or replacements with different software products. These solutions can include standardized API(s) related to the runtime environment and/or hardware on which CCS applications are hosted.

The deliverables for the period of the Work Programme are:

- Computing Environment System capabilities and functions – System Analysis (FRS CONEMP, Functional Requirement specification)

- Standardisation of Computing Environment interfaces I2/3. Usable specification for Hardware Abstraction Interface (I2) and Virtualization Interface (I3) for Computing Platforms for safe applications up to SIL4 (relating to CCS applications or any other applications used in the context of rail operation). Decoupling software, hardware and computing platform lifecycles. Enabling interchangeability between computing platforms, onboard and trackside.

Task 2 CCS: Domain Trackside Assets Control & Supervision
The Trackside CS domain is responsible for the specification of the sub systems controlling the trackside objects like points, track vacancy detection, level crossings and others. With this a unified interface between the Traffic CS system and the object controller should ensure the interchangeability between both components. After the successful release of the second version of the interface specification in June 2024 the work in this period should focus on the remaining topics for a final stable release of the specification for Trackside Assets.

The deliverables for the period of the Work Programme are:

- Finalize TACS specification, according to the STIP.

- Decision proposal for further harmonization of interfaces between object controllers and field devices, following the Granularity Principles method.

- Decision proposal for harmonization of interfaces to power supply and power management, following the Granularity Principles method.

Task 2 CCS: Domain Transversal Systems
The Transversal Systems domain and its three subdomains provide systems, standard protocols, and data structures for functionalities that are needed on network level and for engineering use cases.

The deliverables for the period of the Work Programme are:

- CCS/TMS Data model updated and functional requirements specification for Digital Registry.

- Generic Diagnostics System Specification and Traffic CS Diagnostics Data Model Specification

- Configuration & Maintenance Management and Configuration Management Specification for trackside constituents

Task 3 TMS & CMS
TMS&CMS carries out the coordination and execution of the detailed design work for the lower System Levels 3, 4 and 5 for the Traffic Management System/Capacity Management and defines detailed operational processes and requirements, functional system analysis and technical architecture

The deliverables for the period of the Work Programme are:

- Interface TMS/Traffic CS: Update Function distribution and Interface between TMS/TCS.

- Recommendation of harmonization scope TMS/CMS

- Integration of Timetable Redesign (TTR) Messages. The TTR (Timetable Revision) project and the linked digitalization concept DCM (Digital Capacity Management) define new concepts such as ECM (European Capacity Management), Capacity Broker, TCR (Temporary Capacity Restrictions).

- Cross border variants analysis CMS & TMS, including the preparation of operational, functional, technical, deployment and economic content to support strategic decisions in SPSG regarding TMS and CMS Cross borders.

Task 4 DAC/FDFTO
Task 4 is responsible to manage all cross-cutting activities related to DAC/FDFTO (e.g., regarding operational procedures, architecture and interfaces embedding the onboard system, developed by FP51, into the overall railway system), manage the input to the Standardisation and TSI Input Plan (STIP) for DAC/FTDFTO and supports FP5 regarding authorisation strategy. This implies working in close alignment and cooperation with Innovation Pillar Flagship Project 5 (FP5) and EDDPneo@EU-Rail, including participation in mediation of conflicts with other Innovation Flagship Areas and SP Tasks.

The deliverables for the period of the Work Programme are:

- EU DAC Based Operational Standards and Rule Book based on sector feedback and final mature input from FP5.

- Interfaces between train-internal FDFT and the "outside" world, with focus on Train-Lenth/-Integrity.

- Central Instance for management of Data & Software, including a detailed description of and roadmap for the implementation of a basic functionality of a European Central Instance (incl. connected IT/Cloud architecture) for the pre-deployment phase

Task 5: Harmonised Diagnostics

Harmonised European Railway Diagnostic (HERD) of the System Pillar will generate a set of proven technically and procedurally harmonised diagnostic data use cases and will provide a guideline for a harmonised diagnostic data exchange. The main benefit of HERD is the gain of harmonised condition information for integrated asset management.

The HERD team consists of representatives of the data user as well as of the data provider from supplier industry, infrastructure managers (IM), railway undertakings (RU), and vehicle keepers (VK). Strong alignment with the Innovation Pillar Flagship projects FP1, FP3 and FP5 as well as with the System Pillar Tasks 1, 2 and 4 is ensured by the team members.

The deliverables for the period of the Work Programme are:

- Aligned Use Case 1 demonstrator specification for a Pilot implementation.

- Processing of new Use Cases. There will be a recommendation of how the data exchange between the data users and the data providers should/could be performed.

System Pillar Core Teams

Engineering Environment Team

The Engineering Environment team includes methods definition (System Engineering Management Plan (SEMP)) and tools provision and training (Polarion, Capella, SysML specification environment) for the whole System Pillar. It monitors the formal quality of the work items, their correct allocation to the tasks and domains, and the consistency, traceability and integrity of the specification. The Engineering Environment team has a central and active role in guiding and supporting other teams. Modelling and specification (including integration of external input) is done in the Tasks and domains. The Engineering Environment team is not contributing to the specification or modelling work itself but is actively supporting where needed and taking care that the work of the Tasks and domain can be done in an efficient way and with the needed quality.

The deliverables for the period of the Work Programme are:

- New version of the System Engineering Management Plan (SEMP), describing the processes for quality management, defines the result structure for output documents, adapts the OA/SA processes to the newest workflow version and includes several other smaller updates.

- Consolidated and checked system requirements set V1, including the system requirement set of the SP in its current managed state is accessible via Polarion in a structured way.

- Updated SP Glossary (incl. terms from European legislation) including cleanup and synchronization with ERA ontology.

PRAMS

The PRAMS team is in charge to define the strategy, policies, methods, and principles to be followed by the other Tasks and Domains during the design activities as well as to coach and support implementation. PRAMS team do not produce PRAMS Analysis, Hazard and Risk Analysis, for system components or system parts; these activities are delegated to the related Domain that have to include members with PRAMS skills. The PRAMS Functional team is in place to have a proper coordination and synchronization.

The deliverables for the period of the Work Programme are:

- Establish a "Design Safety Case structure" adequate to the new railway standardised modular architecture of SP and provide the specific process for their application and authorisation (e.g. how to assess them, integrate them, deal with authorisation/approval. This structure will allow to drastically reduce the number of SRAC, support parallel developments between systems and ease integration activities of modular building block.

- Extend the list of accidents and hazards with risk acceptance principles and quantified values (i.e. for top level system hazards having explicit risk estimation as risk acceptance principle) to fasten the realisation of risk assessment and harmonized practices among manufacturers and RUs/IMs. The quantified values to be defined based on an analysis of hazards and contributing conditions leading to the accidents classified within the ERJU. The list of accidents and hazards is based on the future regulation CSM-ASLP but will consider a larger scope with actual lists of accidents and hazards at national level (i.e. SIRF, VDE, EPSF).

- Risk assessment template (i.e. CENELEC Phase3) and a safety guideline presenting all safety activities within SP Domains (up to Phase 5).

- Maintenance of the existing documentation related to Performance Criteria, P-RAM requirements/guidelines and CBM Requirements.

- Integration of Human Factors in the CENELEC V cycle through EET domain. The HOF impact evaluation on Domains design activities (e.g. OD domain) to be completed within EET deliverables.

Security

The Security team is in charge of centrally coordinating the Security requirements, including top-level design and assurance of the requirement implementation in the System Pillar Tasks and the specification of the subsystems for monitoring and the system control access.

It is expected that in Q1 2025 the Security domain provides the outs of the following STIP specifications:

- STIP_75: Shared Security Services Specification

- STIP_76: Secure Communication Specification

- STIP_77: Secure Program Requirements

- STIP_78: Secure Component Specification

In addition to the security specifications foreseen for 20252, the deliverables for the period of the Work Programme are:

- Interface definition to Shared Security Services (TIME, PKI, IAM, BKP, LOG…)

- Security profiles of common security communications protocols (TLS, OPC UA SC, HTTPS…).

- Process security requirements (ISMS, VMS, supply chain security…). Definition of Procedural requirements for Railway Operators (Infra managers and undertakings) and Suppliers to support the technical implementation and life-cycle management of Security for the system under consideration.

- Security requirements for components (not related to interoperability but required for security level and compliance to legal requirements and standards).

- Identification and performance on Gap analysis in other sector areas as was done in SC2.3 for TAF/TAP. Possible investigation areas could be FRMCS, DAC, etc. The requested Gap analysis will result in an evaluation of the gaps, the actions needed and eventually the needed effort.

Standardisation and TSI input plan (STIP)

The System Pillar has developed a strategic Standardisation and TSI Input Plan of the main changes to be introduced within TSIs (mainly CCS and OPE TSIs) and Commission standardisation request. This will include, inter alia, new functionalities and rules. This plan will also be made on the basis of migration considerations and alignment with Innovation Pillar flagship projects. Allowing for an agreed plan and timeline for the evolution of the CCS/TMS system, consistent with the agreed operational concept and system architecture and a clear picture of the role of the EU-RAIL in delivery, including the allocation of those elements that will be delivered by the Innovation Pillar, and the System Pillar.

Topics for harmonisation have been delivered by the members of EU-RAIL via the Task and Domains of the System Pillar as well as the Flagship Projects of the Innovation Pillar. In total, over 200 topics have been proposed, analysed by the System Pillar Core Group and EU-RAIL and classified to allocate the topic to a manageable number of categories. The proposed categories are outlined in the

Category for topic classification		
Category		**Description**
Main section		
C1	Operational harmonisation	Topics related to operational processes and rules
C2	Evolvability and maintainability	Topics aiming at enhanced compatibility between versions and easy maintainability
C3	TMS and CMS	Topics related to enhanced European TMS and CMS
C4	ATO GoA2	Topics related to ATO until GoA2
C5	ATO GoA3/4	Topics related to ATO until GoA3/4
C6	Remote supervision and control	RTO as application independent from ATO Goa3/4 (can come earlier) specific applications, e.g. shunting yards.
C7	ASTP	Topics related to enhanced odometry and localisation systems
C8	FDFTO	Topics related to enhanced freight traffic including DAC
C9	FRMCS	Topics related to new radio system
C10	Onboard	Topics related to CCS onboard systems
C11	Cybersecurity	Topics for cybersecurity in CCS systems
C12	Safety management	Topics related to safety in CCS
C13	PRAM	PRAM topics
C14	Trackside assets	Topics related to CCS trackside assets
C15	Traffic CS	Topics related to enhanced Traffic CS and interfaces to TMS/CMS

C16	Driving control, Adhesion management	Topics related to adhesion management and driving control
C17	Energy management and supply	Topics related to energy management and operational measures
C18	Bridge dynamics	Topics related to vehicle-bridge dynamical interaction
C19	Alternative propulsion, traction energy	Topics related to battery and hydrogen train
C20	TCMS	Topics related to TCMS
C21	Subsystem Components	Topics considering e.g. braking, environmental conditions etc.
C22	Reduction environmental impact	Topics considering noise, air quality and climate change
C23	Composite materials	Use of composite materials for lightweight design
C24	ETCS CR enhancement	ETCS CR enhancements from ERA assessed by the SP
Additional topics		
C25	Digital asset management, data spaces and models	Topics related to data spaces, data models and asset engineering
C26	Digital Twin	Topics related to Digital twin modelling and digital register
C27	Virtual certification	Methods for virtual certification and implementation
C28	Zero-Onsite-Testing	Use of simulations and lab testing procedures
C29	Drones	Topics related to the use of drones in railway applications
C30	Field force applications	Topics related to field forces (maintenance staff and machines)
C31	Diagnosis, monitoring	Topics related to diagnosis, condition-based maintenance in railway applications

Table 1.

Category for topic classification		
Category		**Description**
Main section		
C1	Operational harmonisation	Topics related to operational processes and rules
C2	Evolvability and maintainability	Topics aiming at enhanced compatibility between versions and easy maintainability
C3	TMS and CMS	Topics related to enhanced European TMS and CMS
C4	ATO GoA2	Topics related to ATO until GoA2
C5	ATO GoA3/4	Topics related to ATO until GoA3/4
C6	Remote supervision and control	RTO as application independent from ATO Goa3/4 (can come earlier) specific applications, e.g. shunting yards.
C7	ASTP	Topics related to enhanced odometry and localisation systems
C8	FDFTO	Topics related to enhanced freight traffic including DAC
C9	FRMCS	Topics related to new radio system
C10	Onboard	Topics related to CCS onboard systems
C11	Cybersecurity	Topics for cybersecurity in CCS systems
C12	Safety management	Topics related to safety in CCS
C13	PRAM	PRAM topics

C14	Trackside assets	Topics related to CCS trackside assets
C15	Traffic CS	Topics related to enhanced Traffic CS and interfaces to TMS/CMS
C16	Driving control, Adhesion management	Topics related to adhesion management and driving control
C17	Energy management and supply	Topics related to energy management and operational measures
C18	Bridge dynamics	Topics related to vehicle-bridge dynamical interaction
C19	Alternative propulsion, traction energy	Topics related to battery and hydrogen train
C20	TCMS	Topics related to TCMS
C21	Subsystem Components	Topics considering e.g. braking, environmental conditions etc.
C22	Reduction environmental impact	Topics considering noise, air quality and climate change
C23	Composite materials	Use of composite materials for lightweight design
C24	ETCS CR enhancement	ETCS CR enhancements from ERA assessed by the SP
Additional topics[17]		
C25	Digital asset management, data spaces and models	Topics related to data spaces, data models and asset engineering
C26	Digital Twin	Topics related to Digital twin modelling and digital register
C27	Virtual certification	Methods for virtual certification and implementation
C28	Zero-Onsite-Testing	Use of simulations and lab testing procedures
C29	Drones	Topics related to the use of drones in railway applications
C30	Field force applications	Topics related to field forces (maintenance staff and machines)
C31	Diagnosis, monitoring	Topics related to diagnosis, condition-based maintenance in railway applications

Table 1: Categories for Harmonisation.[18]

Through the Standardisation and TSI Input Plan, the System Pillar has defined a clear and agreed plan for the evolution of the CCS/TMS system, the TSI enhancements, and standards, which will support interoperability, modular interchange ability, system integration ability, robustness, harmonisation and implementation of the SERA, and the role of EU-RAIL (both System Pillar and Innovation Pillar) in delivery.

The STIP does not include an explicit prioritisation of the topics. The implementation of the topics depends on the defined expected timeline, considering harmonisation needs and dependencies with

[17] The section "Additional Topics" includes topics with one or more of the following characteristics:

- Topics which do not yet have a defined time planning due to the early state and uncertainty in the development process.
- Topics which are very innovative and disruptive compared to established technical solutions. Acceptance and uptake by the sector might therefore require additional alignment and coordination.
- Topics for which the state of maturity does not allow a scheduled input to harmonisation channels in the short/medium term. Development and specification work is still ongoing, aiming at a higher maturity and the inclusion in one of the next STIP versions.

[18] Please consider that the list of topics may change/evolve as the project progress.

related specification documents. The STIP key input will be obtained from the different tasks that conform the System Pillar and from the Flagship Projects in the Innovation Pillar, in order to obtain a cohesive multiannual plan.

The STIP document will be reviewed and updated in 2025, in order maintain the critical role supporting the harmonised introduction of improvements into the European rail system, supporting competitiveness interoperability, and safety.

CCS TSI Maintenance Activities
The aim of the activities defined in the Lot 3 CCS TSI Maintenance Activities is

- To resolve errors in the current TSI CCS in order to remove ambiguities in the specifications.
- To transfer results of Lot 2 and any other agreed enhancements into the ERA CCM process for the TSI CCS (with possible impact on TSI OPE).
- To facilitate the inclusion of completed versions of FRMCS specifications in future CCS TSIs
- To help infrastructure managers and vehicle owners with the deployment of ERTMS by solving their (potential) technical problems and by putting into place appropriate processes for testing, validation and certification in view to facilitate the authorisation
- To provide and maintain harmonised engineering guidelines

2.3.2.3 SYSTEM PILLAR AND INNOVATION PILLAR INTERACTIONS

EU-Rail, through the System Pillar (SP) will aim to have a coherent approach to the evolution of the EU rail system through a system architecture approach.

The SP has a discrete work scope to set the system architecture of the rail system (Task 1), and in particular the CCS, TMS/CMS and DAC/FDFTO architecture (Task 2, 3 and 4), as well as coordinating the standardisation and TSI outputs of EU-RAIL. While the main focus will be on these Tasks, the System Pillar will have to integrate and duly consider other key elements, such as interfaces to urban mobility and energy systems.

EU-RAIL will develop the operational concept(s) and functional system architecture with much greater standardisation, a wider scope, aiming at no variation compared to present.

The Innovation Pillar (IP) will deliver, through research and innovation, advances in, inter alia, advanced traffic management, digital and automated train operations, and rail freight.

The description of the interaction is found in the EU-Rail Governance and Programme Handbook19.

The interaction between the IP projects and the SP is both-way. For the specification and development of the demonstrators for innovative technologies, the Flagship Projects of the IP will consider the specifications of the railway target architecture, developed by the System Pillar. Since the complete specification of all levels of the target architecture (including level 5, physical architecture) will not be available in the coming year, higher-level specifications and realistic assumptions will be used.

[19] https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/

In return, the Flagship projects will inform the SP about the technical feasibility and efficiency of different system solutions evaluated in the demonstrators and therefore contribute to the guidance and realignment of the specification of the target railway architecture.

Therefore, the main objective of the IP-SP interaction are:

- Identify the main technical standardisation areas of collaboration between SP and IP,
- build in the projects the necessary details of the continuous process integration to reach together the EU-Rail outcomes that will achieve target system complying with the CBO,
- include necessary provisions to achieve the Standardisation and TSI input plan together with all the necessary mature standards and regulation proposals,

revision that the inputs expected by the Flagship projects from the SP are foreseen to be achievable on time

2.3.3 The Innovation Pillar

The Innovation Pillar is structured in 7 Flagship Areas leading to large scale demonstration as defined in the SBA, complemented by Transversal Topics.

2.3.3.1 FLAGSHIP AREA 1 (FA1): NETWORK MANAGEMENT PLANNING AND CONTROL & MOBILITY MANAGEMENT IN A MULTIMODAL ENVIRONMENT

The main objective of FA1 is to dramatically improve flexibility, efficiency, resilience and capacity adaptation of the European rail network – supporting the development and operation of a Single European Rail Area. The objective is to develop functional requirements, associated specifications, and operational and technological solutions to enable future European Traffic Management. This will include the requirements to make common train operations and ticketing possible and will enable the design of future network management, planning, and control.

To achieve the overall objective, several streams of improvement have been identified:

- Operators need to be able to adapt quickly to unforeseen deviations or disruptions and last minutes changes in demand.
- Increased flexibility paves the way for smarter and tailored door-to-door services and offers, where mobility solutions meet the expectations of passengers and logistics.
- Maintaining the reliability of rail traffic requires all subsystems that influence the traffic to be connected to the Traffic Management System, in order to collect information in real time.
- Enhanced integration of the rail networks should allow to extend capacity planning and operation at European level, enabling capacity optimization and automatic management of cross-border traffic by predicting and controlling routes of cross-border trains in European networks and corridors.

The operational outcomes to be achieved in FA1 will be:

- Improved strategic and tactical planning of the rail network
- Increased resilience of the connected, ‘real time’ rail network

- Integrated rail traffic within door-to-door mobility

The main risk preventing or delaying the delivery of the objectives in this Flagship Area remains the lack of coordination and interactions between the various actors, the organizational framework and not well defined or implemented deployment strategy, and potentially the lack of European regulations to enforce it.

The Grant Agreement of the first EU-Rail Flagship Project 1 implementing this Flagship Area was signed in December 2022 and activities have been ongoing ever since. In 2024, EU-RAIL has signed for the Grant Agreement for FP1-TRAVELWISE, the synergy topic launched together with SESAR JU, which will look at connecting rail traffic management and airports. Activities have started in 2023 and preparation of the enablers continued in 2024. EU-Rail Flagship Project 1 is expected notably to deliver the following **by 2025/26:**

WS1: Network management planning and control & Mobility Management in a multimodal environment
deliver **by 2025/2026** innovative solutions to be demonstrated with:

- **Improving strategic and tactical planning of the rail network**: to overcome the main pain points that the railways are facing and to ensure an enhanced, interoperable planning and management of European-wide railway timetables (**TRL6/7**);
- **Increasing the resilience of a connected 'real time' rail network**: improvement of real-time railway traffic management and operations with the goal to provide a more agile, optimized and automated response to unplanned situations, such as disturbances and dynamic demand especially in cross-border traffic situations(**TRL5-8**);
- **Integrated rail traffic within door-to-door mobility**: Demand-driven predictions to improve operations and service offers, considering information about events across modes. Effect of cross-regional, multimodal travels in combination with demand forecast and disruption handling on improvement of daily operations, benefit on customers (accessibility and attractiveness) (**TRL 5-8**).

In 2024, EU-Rail has awarded a Grant Agreement for Travel Wise, a synergy Flagship project with SESAR JU within the Flagship Area 1 with the following expected outcomes (TRL6):

- **Benchmark on existing solutions** of integrated rail and air traffic;
- **Integration of aviation and railway transport modes**:
    - Definition of single, common and collaboratively-agreed intermodal (airport / railway) operations plan.
    - Definition of the interface between the air traffic management systems (ATMS) (in particular regarding airport-rail connection) and the rail traffic management systems (TMS), both for planning purposes and operations, including disruptions;
    - Real-time information exchange services between aviation and railway
- **ATM-airport-railway collaborative decision-making process:**
    - The evolution of ATM related concepts developed within ATM boundaries e.g. airport operations plan (AOP), airport operations centre (APOC), airport collaborative decision making (A-CDM), total airport management (TAM), network operations plan (NOP), etc.;
    - The integration of data from aviation and railway transport information systems;
    - The development of an integrated capacity management process to ensure modal shift from feeder flights to railway;
    - The development of visualisation and decision support tools.

- **An integrated aviation-railway transport network disruption and crisis management process.**

In 2025, EU-Rail is expecting to launch a topic in its call for proposals for the second set of demonstrators implementing the Flagship Area 1. This is expected to cover activities reaching a higher TRL (up to 8, depending on the technical enabler) implementing and further demonstrating in 2027 developments done in phase 1 of implementation of the Flagship Area in the three main workstreams (capacity planning, traffic management and door to door mobility) with additional capabilities.

2.3.3.2 FLAGSHIP AREA 2 (FA2): DIGITAL & AUTOMATED UP TO AUTONOMOUS TRAIN OPERATIONS

The targeted objective of FA2 is to take the major opportunity offered by digitalization and automation of rail operation and to develop the respective systems. This includes next generation Automatic Train Control (ATC), including Automated Train Operation (ATO) Grade of Automation (GoA) 4, building upon radio-based European Rail Traffic Management System (ERTMS) or above, representing the next evolution of the system, incorporating the latest technological advances, and with functionalities enabling full optimisation of performance in line with the Traffic Management improvements developed in FA1. FA2 will aim at delivering scalable automation in train operations with fully unattended train operations including setting a train in motion, driving and stopping the train, opening and closing the doors, remote train control and recovery operations in the event of disruptions.

The expected outcomes of FA2 are:

- Reduce the cost of capacity, which is a major indirect catalyst for capacity optimisation.
- Allow precise traffic flow management, supporting punctuality, reliability, and productivity improvements.
- Allow the control of much higher train densities with a significantly reduced Life Cycle Cost (LCC) of CCS components compared to today.
- Deliver scalable solutions fitting for high- and low-density lines, supporting the generation of large-scale component markets and standardisable industrial asset management processes as well as to speed up the deployment and ensure long term evolvability of the system.

Potential restraints by the public to travel with automated trains, or the question of acceptance of automated cargo trains loaded with hazardous substances, might represent one of the risks associated with introducing Digital Automated Train Operations (DATO) under FA2.

Another risk is related to the migration to DATO soft- and hardware, where a clear functional separation between subsystems must be achieved. A clear interface with Traffic Management System (TMS) is crucial for implementation as well. The migration risk is also linked to the difficulty of the long lead time of European Train Control System (ETCS) deployment, which shall be mitigated by reducing the cost and by agreeing on an effective EU deployment process, while research and innovation advances.

Furthermore, the risk of not having a 'fit-for-all' legal sector agreement that will allow for sharing and reallocating liabilities, risks, costs, and benefits across the stakeholder groups, might decelerate the implementation of digital and automated train operation technologies. The business risk might be an

issue as well, since the benefits (e.g., capacity increase, mainly for governments) may not be reaped by the same players that will pay for the costs (Infrastructure Managers, Railway Undertakings, and industry), which might lead to postponements, or even avoidance of future investments. The role of the System Pillar to anticipate such risks and to deliver the necessary input to FA1 is important in this respect. Economical, legal, regulatory and organizational implications need to be assessed and jointly agreed upon in the rail sector, which goes beyond the technical scope of FA2.

The Grant Agreement of the first EU-Rail Flagship Project 2 implementing this Flagship Area was signed in December 2022. Activities have started in 2023 and preparation of the enablers continued in 2024.

Activities have started in 2023 and preparation of the main of the enablers continued in 2024. It is expected notably to deliver the following **by 2025/26**:

- Demonstrate technical and functional enablers such as ATO GoA3/4 over mixed radio based ETCS levels (**TRL5**), Hybrid Train Detection, moving block and train integrity (TIMS) (**TRL5/6)**, connectivity (**TRL3-6**), perception (**TRL5**), train positioning (**TRL5**), automated functions and digital register (**TRL5/6**);
- Demonstration of the remote driving and command in depots and yards, including perception systems (**TRL5**);
- A first demonstrator on next generation ATC, with modular onboard and trackside ATC architectures, at proof-of-concept stage, in close collaboration with the EU-Rail System Pillar;
- A proof-of-concepts and/or validation in laboratory and field (i.e., up to **TRL4/5 in Lab and TRL6 on site**) for the following new functions and technical enablers:
    - Virtual Coupling Train Set (**TRL4**)
    - Self-driving wagon (**TRL4**)
    - Autonomous route setting (**TRL4**)
    - Validation and certification (**TRL5**)

In 2024, EU-Rail operationalised with concrete outputs its cooperation with EUSPA, ESA and ERA in a common project (delivered by FP2 within the EU-Rail programme) on the use of a dedicated Rail service of EGNOS (European Geostationary Navigation Overlay Service) for the rail demonstrations on the use of Satellite safe positioning in ERTMS.

In 2024, EU-Rail has awarded a Grant Agreement for FP2-MORANE-2, a synergy Flagship project with SNS JU within the Flagship Area 2 with the following expected outcomes (TRL7):

- **Test design and planning:** Test specifications (performance, interfaces, cybersecurity aspects) and lab and field test plan and test methodology.
- **System component preparation and architectures**:
    - Development of system components (TOBA, controller, dispatcher systems, RMR module with MNO capability, etc…).
- **Lab test preparations and execution:** Three laboratories will be used for this purpose.
- **Execution of 5 field tests:**
    - **Spain:** Conventional line + High speed line
    - **Sweden:** Conventional line (including testing of Multi Operator Core Network - MOCN - scenario with Swedish MNO).
    - **Germany:** Conventional line
    - **The Netherlands**: Conventional line (including MNO test with National operator).

In 2025, EU-Rail is expecting to launch a topic in its call for proposals for the second set of demonstrators implementing the Flagship Area 2. This is expected to cover activities reaching a higher TRL (up to 7, depending on the technical enabler) implementing and further demonstrating in 2027 developments done in phase 1 of implementation of the Flagship Area for all the technical enablers, as foreseen in the EU-Rail MAWP with additional capabilities.

2.3.3.3 FLAGSHIP AREA 3 (FA3): INTELLIGENT & INTEGRATED ASSET MANAGEMENT

This Flagship Area has the objective to provide new innovative technical requirements, methods, solutions and services – including technical requirements and standards for future developments – based on the latest leading-edge technologies to minimise asset life-cycle costs or extend life cycles while meeting the safety and improving the reliability, availability and capacity of the railway system, addressing both infrastructure and rolling stock.

The expected result will be a common European asset management framework composed by a green, digital and safe set of solutions for the rail sector, focusing on three interrelated areas:

- Cost-effective asset management addressing short, mid and long-term interventions widely supported by digital (diagnosis) technologies and data analytics.
- Advanced and high-tech automated execution of construction and interventions supported by robotics and wearables changing the way of working improving health conditions for workers involved and increasing quality and consistency of the results.
- Environmentally friendly production of resilient assets, supported by new design principles, solutions and fabrication techniques.

The risks for FA3 may include extensive cost associated with the market uptake of final solutions due to missing business cases. Siloed proposals for technologies, not considering overall value chain demonstration cases and the integrated approach, might represent another issue.

A different type of risk for this Flagship Area can result from unfit or underdeveloped reference system architecture framework and Conceptual Data Model (CDM), preventing from correct integration of innovations.

Another example of potential risk may lie in the certification processes for new assets, systems, or processes, as well as in reluctance of human factor to accept human-machine interfaces (e.g. augmented reality) in the design and utilisation of innovation.

The Grant Agreement of the first EU-Rail Flagship Project 3 implementing this Flagship Area was signed in December 2022.
Activities have started in 2023 and preparation of the enablers continued in 2024. It is expected notably to deliver the following solutions that can be demonstrated by system approaches of the various developments targeting up to TRL 6 as European common integrated solutions, **by 2025/2026**:

- **Asset Management & TMS.** The main aim of the demonstrator will be to show the integration between the Intelligent Asset Management System (IAMS) and the Traffic Management System (TMS) enabling the share of data and optimising decisions using common metrics – **TRL6**;
- **Asset Management & Rolling Stock.** The main objective of this demonstrator will be to present the monitoring of rolling stock (including on board and wayside technologies) leading to decisions and planning of interventions, and redirecting rolling stock to workshops to

execute the (re)scheduled work both manually as well as by new technologies and solutions to conduct inspection tasks automatically – **TRL6**;

- **Long Term Asset Management.** Development of Life Cycle Cost (LCC) models for infrastructure and rolling stock. This demonstrator will include cross-border infrastructure remaining useful-life analysis and space-time cross-analysis and visualisation – **TRL6**;
- **Asset Management & Infrastructure.** The objective will be to integrate on field and on board systems with central platforms capable of managing Big Data to enable prescriptive interventions, minimising dangerous situations and service disruptions during operation – **TRL6**;
- **Asset Management & Digital Twins.** The focus will be on design, maintenance, upgrade and renewal interventions driven by Digital Twins for the optimisation of processes, maintenance planning and involved logistics. This will enforce the use of BIM to standardise system configuration and AI tools to execute simulations and predictions. The Digital Twin demonstrator will include visualisation, prediction and simulation – **TRL6**;
- **Design & Manufacturing.** This demonstrator will be the showcase of eco-friendly production of resilient assets supported by new fabrication techniques such as additive manufacturing (focused on infrastructure assets) – **TRL5/6**;
- **Robotics & Interventions.** The focus of this demonstrator will be the showcase of high-tech automated execution solutions for construction and interventions supported by robotics and wearables, among other devices, building a safer and more automated railway environment - **TRL5/6**.

In 2025, EU-Rail is expecting to launch a topic in its call for proposals for the second set of demonstrators implementing the Flagship Area 3. This is expected to cover activities reaching a higher TRL (up to 8/9, depending on the technical enabler) implementing and further demonstrating in 2027 developments done in phase 1 of implementation of the Flagship Area for all the technical enablers, as foreseen in the EU-Rail MAWP with additional capabilities.

2.3.3.4 FLAGSHIP AREA 4 (FA4): A SUSTAINABLE AND GREEN RAIL SYSTEM

FA4 pursues the objective of providing new innovative products and services based on leading edge technologies to minimize the overall energy consumption and environmental impact of the railway system, to make this transportation mode healthier, more attractive and to provide resiliency against climate change at a reduced total cost of ownership.

This Flagship Area should provide the following solutions:

- Developments oriented towards a more integrated and standardised Rail Power Smart Grid, integrating greener energies, cutting peak of energy consumption and allowing for a better control and management.
- Developments oriented towards a better energy management at station level (stations as energy hubs) providing more intelligent and integrated control systems and allowing for a larger energy flexibility and resilience of the Electrical Smart Grid.
- Technologies for a more sustainable and extreme hazard resilience design of railway infrastructures and rolling stocks, oriented towards the whole life cycle of the assets and supported by Digital Twin developments.
- Sector tools or platforms for the efficient implementation of circular economy solutions in the railway sector (infrastructure, rolling stock and buildings) and for sharing and communicating of accurate environmental data towards stakeholders.
- Guidelines for the design of modular stations according to size and uses.

One of the main risks associated with FA4 relates to the fact that the relevant technologies for achieving sustainable and green rail system (e.g. hydrogen solutions, batteries, sustainable construction technologies) are primarily developed by other industries and under partnerships other than EU-Rail. This might cause difficulties in transferring these innovations directly to railways for reasons such as the cost of technologies, incompatibilities of standards, or other technical constraints.

Some risks mentioned under FA3 are relevant for FA4 as well. This applies to the risk of having extensive cost associated with the market uptake of final solutions due to missing business cases. Siloed proposals for technologies, not considering overall value chain demonstration cases and the integrated approach, might represent another issue.

Finally, long and costly homologation procedures for new assets, systems or technologies represents another risk to achieving the objectives under this Flagship Area.

The Grant Agreement of the first EU-Rail Flagship Project 4 implementing this Flagship Area was signed in December 2022. Activities have started in 2023 and preparation of the enablers continued in 2024. It is expected notably to deliver the following **by 2025/2026**:

- **Alternative energy solutions for the rolling stock at TRL4/7**, covering:
    - High performances Batteries Electric Multi-Unit (BEMU) train;
    - Hydrogen hybrid trains with test of heavy-duty inspection vehicle and loco for freight-passengers;
    - Sub-urban catenary trains with on board Energy Storage Systems (ESS);
    - Auto adaptive train energy consumption to various services situations.
- A **holistic approach to energy in rail infrastructure (design, production, use and intelligent management) at TRL5/7**, covering:
    - Rail Power Smart Grid in different systems as well as the integration of energy storage solutions;
    - Development of a universal hydrogen refuelling interface as well as digital algorithms to improve refuelling efficiency.
- **Sustainability and resilience of the rail system** in a holistic approach to asset management, delivering more value:
    - Development of solutions and models for the reduction of noise and vibrations from railway infrastructure and rolling stock and to predict the effect of degradation, of maintenance and of noise perception (**TRL5/6**).
- **Improvement of electro-mechanical components and sub-systems for the rolling stock, at TRL6/8**, covering:
    - Technological solutions for the migration to the airless train: Electro-mechanical braking system and novel electro-mechanical pantograph (TRL 6/8) and suspensions;
    - Optimised motors and gearboxes, high performance bogies, suspensions and new materials;
    - Eco-friendly HVAC system technologies;
    - Aerodynamic certification with experimental and numerical methods.
- **Healthier and safer rail system**, covering:
    - Simulation tools for improving the air quality in trains, stations and tunnels (reaching **TRL6/8**).
- **Attractiveness, at TRL4/6**, covering:
    - Modular rolling stock interiors providing easy access (incl. PRM) and new architectures for drivers' cabin.

In 2025, EU-Rail is expecting to launch a topic in its call for proposals for the second set of demonstrators implementing the Flagship Area 4. This is expected to cover activities reaching a higher TRL (up to 7/8/9, depending on the technical enabler) implementing and further demonstrating in

2027 developments done in phase 1 of implementation of the Flagship Area for all the technical enablers, as foreseen in the EU-Rail MAWP with additional capabilities.

2.3.3.5 FLAGSHIP AREA 5 (FA5): SUSTAINABLE COMPETITIVE DIGITAL GREEN RAIL FREIGHT SERVICES

The objective of FA5 is to make rail freight more attractive through increased capacity, e.g. with Digital Automatic Coupler (DAC), which is enabling more functionalities in freight to increase network capacity in a smart way for all types of rail freight transport, as well as significantly improved cross-border operations and multimodal customer services. Increased capacity is the key factor to enable a shift of transport volumes to rail, reducing substantially the related greenhouse gases emissions.

FA5 tackles the challenges by having two clusters which are interlinked but still distinct. The first one is "full digital rail freight operations". It is focused on increasing substantially the productivity, quality and capacity of rail freight by applying digitalization and automation to all possible operational functions and processes including innovative freight assets. The second cluster, "seamless rail freight", is focusing on important aspects to increase the efficiency of the immaterial (information/data) layer of transport and to gain time and save costs by ensuring a seamless environment (between different actors/countries/modes for planning/execution/management) in the long term, but also via short-/medium-term achievements and quick wins.

One of the major risks to the objectives of FA5 is that unclear and changing business cases as well as varying use-cases could lead to unwanted re-iterations in the development of innovations. Such iterations may result in failure to achieve authorisation/certification and could lead to higher investment costs.

In addition, the developments can be hindered by the lack of operational and technical information, or by the unavailability of data from legacy systems being the starting point for European and interoperable solutions. Another obstacle may take form of a delay in ERA's authorisation process or in the preparation of functional requirement specifications in order to meet TRL targets regarding technical enablers.

The number of different systems to be connected and the complexity of the systems can pose a risk to standardising and harmonising of processes, technologies and cross-border systems, which might delay achieving of the objective of European interoperability of systems. High degree of Integration with EU harmonized TMS real time data will be key for delivering expected outputs in rail freight corridors as expected in the "seamless rail freight" workstream.

Finally, the migration from a brownfield environment and underestimation of the complexity of adaptation may be a risk, especially if combined with missing operational rules and technical regulations/standards.

The Grant Agreement of the first EU-Rail Flagship Project 5 implementing this Flagship Area was signed in November 2022 and the project started in December 2022. Activities have started in 2023 and preparation of the enablers continued in 2024. It is expected notably to deliver the following **by 2025/2026**:

WS1 Full digital Freight Train Operations with DAC as enabler for full digital freight train operation deliver **by 2025/2026** the following demonstrators:

- **European full digital freight train operations:** (**TRL 7**) Large-scale demonstrator showing full digital freight train operations based on DAC Type 4 (incl. energy supply &

data/communication solution and Type 5 upgradability, DAC wagon retrofitting and DAC – Hybrid for locomotives) in different regions with several train sets under real operational conditions including technical enablers described in scope section.

- **Demonstration of a fully digitalized and automated yard IV:** (**TRL 5/6 – some functionalities at lower TRL, see enabler section**) Demonstration of Yard automation equipment, wagon identity system allowing automated shunting, video gates and way side check points with visual recognition and AI tools for yard automation.

WS2 Seamless Freight: with easy access and reliable (intermodal) transport service offering digital solutions deliver **by 2025/2026** at least the following:

- **Seamless freight corridor:** (**TRL 4-8**) The comprehensive innovations for planning and operation of cross-border freight trains should be demonstrated on (parts of) two European corridors. Freight specific pilot implementations of key enablers for intermodal predictions, improved cross-border timetable planning, management and path ordering systems taking into account also last mile service, as well as for real-time interaction between various TMS (including yards/terminals). Digital technologies for standardized European Railway checkpoints at borders or other operational stop points. Integrating and connecting the last mile (accession lines/shunting/yards/ terminals) slot planning directly or via interfaces.
- **Seamless customer freight:** (**TRL 4-8**) Seamless planning, management and booking of multimodal rail-based transport integrating multi-actors, should be demonstrated integrating rail in modern supply chains. Improved routing engines more responsive to changing demand, disruptions and customer requirements. This demonstrator will ease end customers to interface with rail.

In 2025, EU-Rail has awarded a Grant Agreement for FP5-DACtiVAte, a Flagship project within the Flagship Area 5, aiming to advance the full digitalization of freight train operations in Europe and to enable the pre-deployment of pilot trains with Digital Automatic Coupling (DAC) by executing required additional tests to the complementary FA5 project, thus establishing confidence before full implementation, while enabling DAC-authorization processes. The project tests the interchangeability of DAC components, expand the number of Wagon Onboard Units in line with FA5 project's system architecture, and enables thorough validation of the pre-deployment trains by additional locomotives able to integrate hybrid couplers. It is expected notably to deliver the following **by 2025/2026**:

Workstream 1: DAC Interface A derailment and propelling safety tests, crash tests, climate chamber tests and initial tests to prove interchangeability of DAC coupler head/shank and draft gear across DAC solutions.

- **Derailment and propelling safety (TRL 6)** :
    - Providing the necessary test results of tests on running safety (safety against derailment) and tolerable longitudinal compressive forces with the DAC interface A (derailment tests);
    - Validating the limit value of compressive forces for DAC interface A of each coupler supplier, based on a specified reference wagon composition as well as for interoperable usage, with running safety validation assessment tool for propelled tests managed under the requirements of international standards and norms;
- **Crash tests considering (TRL 6/7):**
    - Validating figures for DAC interface A couplers according to the crash test requirements based on the requirements of EN 15227 and RID;

- **Climate Chamber Tests (TRL 6/7):**
    - Providing validation of DAC interface A couplers in harsh environment, esp. ice and snow based on T1 standard (-25°C / +40°C) fulfilling the requirements for authorisation.

Workstream 2: Mix and match tests - initial tests to prove interchangeability of DAC interface A coupler head/shank and draft gear across DAC suppliers:

- Managing tests to ensure the interchangeability across all project-involved DAC suppliers;
- Providing bench tests to measure the force transmission at different coupling angles and perform operational tests (TRL 7) on defined test cases.

In 2025, EU-Rail is expecting to launch a topic in its call for proposals for the second set of demonstrators implementing the Flagship Area 5. This is expected to cover activities reaching a higher TRL (up to 8, depending on the technical enabler) implementing and further demonstrating in 2027 developments done in phase 1 of implementation of the Flagship Area for all the technical enablers, as foreseen in the EU-Rail MAWP with additional capabilities.

2.3.3.6 FLAGSHIP AREA 6 (FA6): REGIONAL RAIL SERVICES / INNOVATIVE RAIL SERVICES TO REVITALISE CAPILLARY LINES

The overall objective of FA6 is to ensure long term viability of regional railways by decreasing the total cost of ownership (TCO), in other words, cost per kilometre both in terms of operational expenditure and capital expenditure, while offering a high quality of service and operational safety. In addition, the aspired results aims to increase customer satisfaction and to become an attractive and preferred choice of transport mode.

These goals are expected to be achieved through a concept tailored to regional railways that includes digitalization, automation and utilization of mainstream and emerging technologies for signalling and trackside components, rolling stock and customer information. Cost drivers including infrastructure and energy components, e.g. trackside train detection (axle counters, etc.) and level crossing control systems, should be replaced by less costly wireless and energy self-sufficient components. The foreseen solutions include alignment with System Pillar CCS Reference Architecture, cost efficient infrastructure and energy components, a light, flexible and modular vehicle concept as well as safety and asset management. In addition, a passenger information system should be introduced, allowing to benefit from the solutions available for mainline services while integrating data from regional railways with other modes of transportation and local services, offering added value for customers.

Nevertheless, to enable suppliers to develop technologies at competitive costs and allow an effective implementation and usage by the operators, several risks have to be taken into account, such as the lack of standardization and harmonization, insufficient alignment with TSI-revision cycles, or difficulties with adjusting technologies to specific needs of regional rail, hindering the expected demonstrations and pilots.

In addition, the migration from a brownfield environment and underestimation of the complexity of adaptation may be a risk, especially if combined with missing common operational rules and technical regulations/standards.

The Grant Agreement of the first EU-Rail Flagship Project 6 implementing this Flagship Area was signed in November 2022 and the project was launched in December 2022. In 2024, the development of the technical requirements and use cases for the technical enablers for the next generation of railway

regional lines. The preparation of the demonstration activities of the technical enablers started in June 2024. It is expected notably to deliver the following **by 2025/2026**:

Regional Railway System (CCS & Operations) Demonstration:

- Demonstrate a single integrated Operations Control Center (OCC) covering interlocking, radio blocking and traffic management for regional lines that are not functionally/operationally connected with mainline (**TRL 4/5**);
- Demonstrate simple on-track radio network based on the findings in destination 2 related with cost effective communications, supporting all FRMCS applications, minimizing civil works and energy consumption, to the achievement of cost effective Gigabit Train, the use of public network coverage and compatibility with main lines (**TRL4/5**);
- Demonstrate a specific application for Traffic Management Systems for regional lines improving resilience of a connected rail network, optimizing train operations including disturbing events taking into account high/low-demand situations (disturbance and distraction) (**TRL 4/5**).

Assets Demonstration:

- Demonstrate a systemic approach with the implementation of different railway assets in particular for cost-efficient wireless, energy self-sufficient wayside components in particular CCS track-side components (e.g. switches, level crossings) and if applicable for track vacancy detections and signalling will be evaluated and demonstrated (**TRL4/5**).

Suitable customer services:

- Demonstrate cost-efficient integration of on-board information of multimodal services integrating regional multimodal services (**TRL6**);
- Demonstrate passenger congestion rate monitoring, flow optimization application as well as a low-cost passenger information system for regional services developed within this action (**TRL5**).

In 2025, EU-Rail is expecting to launch a topic in its call for proposals for the second set of demonstrators implementing the Flagship Area 6. This is expected to cover activities reaching a higher TRL (up to 6/7, depending on the technical enabler) implementing and further demonstrating in 2027 developments done in phase 1 of implementation of the Flagship Area for all the technical enablers, as foreseen in the EU-Rail MAWP with additional capabilities.

2.3.3.7 FLAGSHIP AREA 7 (FA7): INNOVATION ON NEW APPROACHES FOR GUIDED TRANSPORT MODES

The objective of FA7 is to explore non-traditional and emerging flexible and/or high-speed guided transport systems, as well as to create opportunities for innovators to bring forward ideas for shaping those future systems via a scientific approach into an existing rail system. This will provide socio-economically efficient and long-term sustainable transport for citizens and businesses throughout Europe. The main aspects for such systems are the reduction of energy consumption, noise and pollutant emissions and land consumption, the use of sustainable raw materials and energy sources and the sustainable use of existing infrastructures whilst ensuring utmost of accessibility and inclusiveness for all user groups.

The vision under FA7 is to develop the next generation of railway transport systems as well as guided transport systems based on a fully automated multi-modal mobility system for passengers and goods which is sustainable, interconnected, digital, on-demand, standardised, scalable and suitable for all transport modes. While FA7 is generally open to all innovation on new approaches for guided

transport modes, the focus will be on solutions which allow higher flexibility through multi-modality such as a transition to intermodal-connected moving infrastructure by centrally coordinated, innovative purpose-built vehicles and on ultra-high-speed energy efficient and environmentally friendly rail systems. The innovation in this Flagship Area are expected to operate on an Open Platform, based on common standards and standardised interfaces, connecting all the transport modes, and be able to provide disruptive Operation and Business Models.

New approaches foreseen under FA7, like moving infrastructures, Pods, magnetic levitation, air levitation, and vacuum tube technique bring a lot of advantages and can be an important and possibly unavoidable component of the mobility of the future. However, several risks are associated with their deployment.

Firstly, a technological maturity is more difficult to be reached for such innovative systems compared to the evolution of existing systems. One of the particular challenges will be the conversion of the existing infrastructure of today's modes and railway mobility to above mentioned future solutions in a more sustainable and non-burdening way for the national economies.

Secondly, a lot of gaps exist related to introduction and consolidation of legislation, as well as standardisation, for FA7 innovative technologies and solutions. A delicate balance needs to be found between having the technologies mature enough to define standards and regulations and setting up a regulatory framework as soon as possible to ensure that the developments fit the required legislation in matter of safety and to obtain the maximum compatibility, interoperability and intermodality.
Finally, risks linked to the sustainable construction of intermodal transportation and/or robust domestic or cross-border transportation lines need to be considered. These include, for example, handling with many different legislative/administrative processes at national and European level, or coping with the emerging climate changes when introducing these new transportation modes.

The POD4Rail project in this Flagship Area started in September 2023. It aims to investigate Pods4Rail to develop a concept for Pods and Pod-Carriers on railway and to identify relevant use cases and business cases. In 2024, the multimodal mobility systems and related use cases were investigated from a social-economical perspective. Business cases were developed for the selected promising use cases. The MaDe4Rail project was concluded in September 2024 and the results were disseminated during InnoTrans 2024. The MaDe4Rail project aimed to explore non-traditional and emerging maglev-derived systems (MDS) and to assess the technical feasibility and effectiveness to introduce MDS in Europe under safety aspects and technical-economic performance.

The Grant Agreement of the Hyper4Rail project in this Flagship Area planned to be signed in November and starts the activities in December 2024.

In 2025, EU-Rail is expecting to continue the implementation of Flagship Area 7.

2.3.3.8 TRANSVERSAL TOPIC: DIGITAL ENABLERS

On the path of becoming fully digital and connected, the rail system will be characterized by a complex landscape comprising multiple heterogeneous enterprise-level mission-critical systems interacting with a very large number of networked stationary and mobile devices and sensors, generating requirements for new mechanisms to be embedded in the digital infrastructure.

Digitalisation is of major importance for all the Flagship Areas, hence it is organised as the Transversal Topic (TT) to have all elements of the system playing together in a coherent and interoperable way.

The digital enablers from this work area – mainly the digital twins[20], innovative processes enabled by interoperable data sharing as including conceptual data model (CDM) will serve various demonstrations in the FAs.

The objective of the transversal topic on digital enablers will support the operational processes and activities of the FAs by three aspects: firstly, the Digital Twins support by composition of reusable, blackbox, compiled, digital interoperable model units of components, subsystems, executing in a federated simulation runtime environment the DT to provide suitable analysis tools (e.g. root-cause analysis). Secondly, the TT will develop and provide a Digital Twins Design toolbox (design-time) to model development tools for design as well as for validation, verification and test; to model registry and discovery services and to model Interoperability validation tools. Thirdly, the TT will provide a Federated dataspace to feed digital twins in order to ensure a common Ontology, Identity and Trust management, Federation Services, Data Assets registry and discovery services, Data Distribution Services, Data stream management, cyber security etc.

There is a number of risks to the objective of enabling the fitting of individual digital twins in a joined environment, such as the potential lack of consensus, alignment, access to data or interoperability of systems. Thus, the risk exists that consolidation with other FAs will not be reached in time or in all needed areas to a sufficient extent.

Additionally, a lack of an agreed framework on rights and obligations as well as governance associated with use of a digital twin and federated data could hinder a proper usage of the developed digital environment.

Another risk associated with digital twin development is finding right complexity as well as granularity level. On one hand, creating a simple digital twin will mainly result in a digital model that cannot accurately represent the real system. On the other hand, creating a too complex digital twin will require substantial amount of work by orders of magnitude and can result in making it difficult to understand, maintain and debug.

Finally, transversality as such is a risk. Requirements and functionalities need to be collected from the FAs as well as the architecture developed in LinX4Rail (2019), and further development in the System Pillar needs to be considered. In addition, requirements from different stakeholders and FAs need to be accommodated and integrated. Besides the content-related challenges, this represents an issue for project management and governance.

Activities have officially started in 2023, following the signature of the Grant Agreement in December 2022. Technical work continued in 2024 and will lead to:

Flagship Project 1, WS2: Digital Enablers
deliver **by 2025/26** the following:

- Connectors for Federated Data Spaces (**TRL6**);
- Common Domain Ontology, building upon S2R works on Conceptual Data Model (CDM) (**TRL6**);
- Digital Twin support, development and execution environment (**TRL5**);
- Common Domain Ontology/ Conceptual Data Model (**TRL6**).

In 2025, EU-Rail is expecting to launch a topic in its call for proposals for the second set of demonstrators implementing the Flagship Area 1 and It will include the continuation of the TT supporting activities.

[20] A digital twin is a virtual representation which is able to imitate the behaviour of a physical system during the span of its lifecycle.

2.3.3.9 EXPLORATORY RESEARCH AND OTHER

Blue sky research, complementary research and other activities allow the integrated Programme to open up its activities to future breakthrough innovation and further R&I activities towards higher TRLs.

Several projects will be supervised, notably:

- The Academics4Rail project aims to build a stable and durable community of railway scientific researchers and academia to share and exchange scientific knowledge with Europe's Rail, as well as to enable a network of 6 PhDs (with the academia teaming up with the industry). Additionally, the project provide the development of an overarching framework and methodology for the qualitative and quantitative assessment of Europe's Rail societal KPIs.
- The above project is complemented by PhDs EU-Rail project that reinforce fostering collaboration and innovation in the European railway sector by consolidating a scientific community and conducting research through 10 PhD positions.
- The InBridge4EU project addresses unresolved issues in current railway infrastructure standards, focusing on improving the dynamic interface between railway bridges and rolling stock.
- The RAIL4CITIES project aims to transform railway stations into promoters of sustainable cities. It focuses on developing a new operational model (SCP model) and deploying it across five European living labs, each targeting different aspects of station transformation.
- ESEP4FREIGHT provides freight customers with an overview of the available rail freight services in Europe via a web platform and support the shift of freight to rail by analysing the current contractual framework, proposing a set of recommendations for its updated and suggesting a set of harmonised and standardised models for transport agreements and contracts.
- LEADER2030 project aims to address the future availability of raw materials and components for EU-Rail innovations by 2030.
- As a support action, DACcord projects coordinates efforts related to the European DAC Delivery programme.
- QuieterRail project aims to introduce a step change in predicting and mapping railway noise and vibration, in the acceptance testing of rolling stock, and in promoting cost-effective noise mitigation.
- Nexus project seeks to establish an innovation benchmark, addressing crucial challenges and guiding European metros toward transformative futures.
- SYMBIOSIS project is a pioneering interdisciplinary initiative in biodiversity. It will build a community of practice between transport infrastructure, energy distribution and production, and biodiversity, while addressing the role of strategic planning in climate change and building resilient rail transport infrastructure.
- XCROSS project will develop a suite of integrated disruptive technologies which combine to provide a technological process for the monitoring, inspection, and maintenance intervention of crossing surface profiles.
- DACFIT project support to the EDDP focusing on both quantitative (numerical) and qualitative (technical capabilities) fleet analysis, retrofit engineering, planning for retrofit capacity, and comprehensive retrofitting implementation plans.

In 2025, EU-Rail is expecting to launch additional topics in its call for proposals on Exploratory Research, following the input and advice from a large consultation process with ERRAC, the Scientific Steering Group, the States' Representatives Group, and also based on possible specific needs identified by the ongoing actions, sector stakeholders or ERA

The JU will also launch specific tenders to ensure effective Programme Management with sector expertise but also involve associations of stakeholders not represented in the JU Governance.

2.3.3.10 INNOVATION PILLAR SPECIFIC OBJECTIVES FOR 2025-2026

In 2025 and 2026, the main objective is to ensure to capitalise on the output of all the R&I activities, and in particular of the first wave of Flagship Projects in view of the launch of the second wave with a call for proposals in Q4 2024. During 2025 Research and innovation will have to continue at the same pace and, especially, any risk and opportunity will be duly managed to avoid jeopardizing the 2025-6 demos. Particular attention will be put on the anticipation of the Flagship Areas 1, 2 and 5 derived from the output of the call for proposals 2023-1 and 2024-1; those projects will need to work in full complementarity with the ongoing Flagship Projects 1, 2 and 5 as well as ensure the proper pace and synchronisation of outputs/deliverables. In 2026 any parallel running period from two Flagship Projects of the same Area should be minimised and closely monitored, but it will also be an opportunity to work for ensuring an appropriate transfer of knowledge.
The exercise conducted in 2024 with the first maturity checkpoints will lead to possible project adjustments in 2025 leading to an analysis of the feasibility of the planned maturity foreseen and possible impact on the MAWP.

Additionally, as part of the Innovation Pillar activities and objectives, the JU will also continue to monitor the implementation of exploratory and other projects (comprising FA7 projects), gathering results that could provide either a direct input or provide the elements for disruptive technologies or basic research, possibly leading to future breakthrough innovation and further R&I activities towards higher TRLs.

The JU, based on the reporting to be provided by the actions, based on the maturity checkpoints outputs (for Flagship Projects) and on the continuous monitoring of the performance of the projects, will decide on their continuation on the basis of agreed performance indicators.

2.3.4 The Deployment Group

To facilitate the smooth deployment of new innovations and architectures, EU-RAIL has established a High-Level Deployment Group. Next to the Innovation Pillar and the System pillar this is the third main EU-RAIL department.

The Deployment Group is expected in 2025 to deliver recommendations to the Governing Board of EU-Rail on the consideration and needs in relation to the deployment of solutions proposed by the JU. These recommendations may include:

- considerations on whether deployment should be mandatory or voluntary;
- technical and operational migration considerations;
- considerations on timing and need for synchronization at the European level;
- economic and business case analyses for the relevant stakeholders and for the European Union;
- purchasing strategies;
- industrial capacity;

- finance and funding plans.

In mid-2024, the High-Level Deployment Group established a dedicated FRMCS Deployment Subgroup to focus specifically on deployment activities.

The current railway telecommunications system, GSM-R, is based on 3GPP 2G technology and is rapidly becoming obsolete. Railway telecommunications manufacturers have indicated that GSM-R networks, components, and technical support will begin to phase out from 2032 onwards. This development is expected to result in increased maintenance costs, greater technical complexity, and heightened operational risks for railway operators.

Following the (still ongoing) development of functional and system requirements, EU-RAIL launched a test and demonstrator programme, FP2-MORANE2, which is dedicated to the execution of both lab and field testing.
Parallel to these developments ERA is working on pre-authorisation works, monitoring and assessing the first results (Version V2).

EU-RAIL System Pillar will produce an updated report, with commitment of the whole Railway sector, including scope of initial First Edition FRMCS, timescale and governance. The report is expected to be approved in Summer 2025.

The European FRMCS deployment subgroup is tasked with addressing broader issues related to future FRMCS deployment and implementation. The urgency stems from the railway sector's view that the future availability of telecommunications presents a high-risk challenge. As a result, the sector strongly prioritizes the timely introduction of new 5G-based technology. This should be achieved within the shortest possible timeframe for upgrading existing equipment, while adhering to a European-level synchronisation strategy and taking into account the individual starting positions of each Member State.

A deployment preparation activity for the transformation of rail (freight) towards an automated and digitised mode of transport is the continued management in 2025 and beyond of the so called European DAC Delivery Programme (EDDP), established and enabled by Shift2Rail in September 2020. For a successful and effective implementation of the Digital Automatic Coupler for European rail freight (DAC), it is of crucial importance for EU-Rail to continue in the already implemented and active open platform through an efficient cooperation between railway undertakings, infrastructure managers and wagon keepers, as well as the rail supply industry, entities in charge of maintenance, concerned sector organisations, logistics operators, rail research centres and national and European political institutions.

2.3.5 S2R R&I Programme

The former S2R Programme was administratively closed during 2024, which was preceded by finalization of all the S2R projects activities in 2023.

2.3.6 Other risks

The risks related to the different components of the EU-Rail Programme, some of which are mentioned in the previous Sections, will be subject to continuous reassessment, taking account of the practical experience with the Flagship Areas, individual projects and tasks. Risk assessment at the level of individual Flagship Projects is carried out within the workflows that are part of the grant management process standardized by the EC at the Research Family level, as well as in the context of

EU-Rail's additional specific control activities, such as e.g. the maturity checkpoints, which form part of the overall JU's HE Control Strategy for Grants. The assessment of various risks related to projects/beneficiaries will also be performed when selecting particular work packages for qualitative (technical) ex-post reviews to be performed in the respective year.

In addition, the table below presents other relevant risks related to the management of projects, as well as to the corporate management of the JU (such risks could also have indirect impact on operational activities), together with the corresponding risk-mitigation actions. These risks were identified as being relevant for 2025 in a risk assessment exercise which was performed in Q4 2024. Within this exercise, current internal and external factors and developments having influence on JU's business were duly considered. Such comprehensive risk assessment exercises complementing the ongoing ad hoc monitoring will be performed also for 2026 and 2027 respectively, and their outcomes will be reflected in the updates to the below table, as necessary.

The table shows specifically those risks which require, due to their criticality, continuous attention and treatment of the Executive Director and, where relevant, of the Governing Board.

Risk identified	**Action plan**
Intrinsic to the EU-Rail Staff limited establishment plan and its actual fulfilment, efficiency of operations is impacted by extensive workload of JU's staff. In combination with the HoRI vacancy, SNE and ICC vacancies, as well as HRO vacancy and the timeframe of the recruitment process for these positions, resulting in high staff turnover, difficulties for the JU to attract new people, while vacant positions might be filled with delays resulting in shortage of resources becoming critical especially during peak periods.	- Continue in conducting recruitments for reaching the actual staffing according to the EU-Rail Staff establishment plan - once accomplished, the envisaged positive effects on workload allocation and back-ups should become visible. - Design/apply a replacement plan (back-ups) where possible. - Within the current budget constraints, a career plan for staff has been prepared and business continuity is ensured. - Enhancing of the overall planning of activities will allow for better personnel risk management. - Recruitment of short-term resources (interim or trainees) has been extended. - Outsourcing of some activities, as applicable, making use of existing Framework contracts or by executing own procurements. - Implementation of back office arrangements among the JUs might decrease the EU-Rail's internal workload in some areas. - Introduction of a multi-annual learning and development policy will be considered. - Flexible arrangements within the bounds of the respective Commission Decision are in place with regard to hybrid working. - Initiatives aimed at ensuring good working environment and team spirit are implemented on a regular basis, such as social events and team building activities. - Provision of career opportunities.
Given the interdependencies of complementary R&I projects, considering as well the start up of a complex and integrated new Programme (including inputs/outputs between System and Innovation Pillars), delays and	- Ensure, through adequate Programme management strengthened monitoring and reporting of projects, including gate reviews, to determine whether specific actions need to be taken with regard to a specific project (re-orientation, early closure, etc.). - Addressing during the GAP any possible alignment issues between ongoing and future R&I activities. - Follow the high-level interactions as detailed in the MAWP.

Risk identified	Action plan
misalignments in the completion of activities may lead to negative project cascading effects impacting Programme outputs.	- Application of maturity checkpoints.
The ambitions of the System Pillar sector/EU are not matched by the outcomes of EU-Rail Programme due to the limitation in terms of available resources to cover the related activities. This might negatively affect the image of the JU.	- Analysis of feasibility of requirements expressed by the sector and appropriate management of expectations. - Application of shorter contractual periods. - Checking of contract deliverables by third parties, for example ERA, and third party experts. - Constant communication on outputs, focusing on concrete results that can be implemented, taking into account the legacy system, migration aspects, business cases, etc. - Request to the contractor evidence allowing matching the foreseen outputs with resources allocation.
Vulnerabilties in IT infrastructure or human failures/omissions enabling unauthorized computer network access or cyber-attacks may lead to compromising of data with potential financial losses and/or reputational damage. Delays might also occur, e.g. if data relevant to day-to-day operations became unavailable e.g. due to a successful ransomware attack.	- Azure VPN connection encryption based on user certificates. - Azure VPN connection encryption based on user certificates. - Two factors authentication for M365 and EU login. - VLANs used for LAN segmentation/ separation minimizing attack/connectivity footprint. - Secured guest Wifi, LAN-independent. - Corporate Wifi secured with user authentication. - Monthly security assessement of both Cooperation Tool and website. - Computers disk encryption in place. - Internet only for non-corporate devices on the wired network. - Lock, change user password remotely; inform the mobile telephony provider; implement intunes security policy for mobile phones. - Implementing the mitigation measures of the DPIA performed for Microsoft Office 365. - Continuous awareness-raising of JU's staff members with regard to cyber security and protection of IT tools and assets. Yearly mandatory cybersecurity sessions. - Sharing of information with the staff about detected actual phishing attempts (also from the EC or other EU bodies) and providing advice on the appropriate way of procedure in such cases. Yearly phishing exercise. - Recurring penetration test of the infrastructure. - Realtime monitoring of our infrastructure logs by CERT.EU to detect early signs of attacks. - Joint ICT strategic plan for all JUs is in place which foresees, i.e. the implementation of the EC authentication method for the JU infrastructure and the implementation of a new regulation for a close cooperation with all EU bodies in terms of cybersecurity and data protection.
Deficiencies in dissemination of results may lead to lack of adequate information to the end-	- The JU provided a series of guidelines to the projects and fostered the use of the HE instrument as the Common Dissemination Booster.

Risk identified	Action plan
user/interested parties and could compromise the intended JU's impact. That can also negatively impact the overall reputation of EU-Rail.	- Proper planning and regular follow up at dedicated JU communication meetings, guidelines, as well as at the Flagship Projects Steering Committees - Point of monitoring and analysis at the maturity checkpoints. - Demos at EU-Rail stand at InnoTrans and other relevant events. - Every time possible, ensuring presence of high-level EU/national (political) representatives in events presenting EU-Rail's results. - Communication via social media channels might be expanded from providing general information about EU-Rail to also reporting on results of individual projects. - Creating an overall dissemination communication plan at JU-level including the coordinated planning from the EU-Rail projects communication and dissemination activities.
Delays or deficiencies in deploying the innovations and new (target) architecture, e.g. due to delayed activities of the Deployment Group, due to administrative reasons or difficulties in mobilising the European rail representatives (Infrastructure Managers and Rail Operators, suppliers, etc.). This might cause that the JU's role and position are negatively affected, as well as the deployment of EU-Rail outcomes in a coordinated and integrated manner, with the potential impact on achievement of the overall Programme objectives.	- Continuous efforts of the JU towards the correct setting up of the Deployment Group, finding appropriated resources such as a Programme manager, including clear communication regarding its role and importance. - Introduction and application of an easy selection process for the candidates to the Deployment Group.

The performed and future risk assessments included/will include considerations with regard to risks of fraud. No qualitatively new potential fraud schemes were identified and the fraud risks described as a result of the thorough assessment carried out in 2022 both at the Research Family level and individually by EU-Rail still apply.

Further details on the JU's risk management are provided in Section 2.6.6.

2.3.7 Scientific priorities, challenges and expected impacts

The focus of EU-Rail's Programme as per particular Tasks, Flagship Areas and the Transversal Topic is presented in Sections 2.3.1, 2.3.2 and 2.3.3. Specific details on the scientific priorities are provided in EU-Rail's MAWP.

The most relevant challenges that the future rail system needs to address are defined in EU-Rail's MP.

They can be grouped in several topics as follows:

- **Changing customer requirements**
  Political, demographic, technological and market trends are changing the needs of passenger and freight rail customers. These shifts, along with disruptive events like the COVID-19 pandemic, require rail to be more flexible than in the past. A customer-centric rail system means offering reliable services that are reactive to demand, adaptable to customer requests, and accessible for all passengers alike.
- **Need for improved performance and capacity**
  In order to deliver an overall more sustainable transport system, rail must be able to accommodate increased demand. New infrastructure will be necessary in certain areas, but the vast bulk of future increased capacity must leverage existing infrastructure, through a systemic digitalization and automation of operations.
- **High cost**
  Rail is currently often more expensive compared to other transport modes, in some cases reflected on the intermediaries or passengers/users. To be more competitive and support future increased usage, rail must deliver more cost-efficient solutions and services when compared to the present day.
- **Climate change adaptation and environmental sustainability**
  Rail is the most sustainable form of motorised transport. Increased use of rail is necessary to fulfil the goal of introducing European climate-neutral mobility and transport. In addition, steps have to be taken to further improve the climate and environmental footprint of rail itself (e.g. reduce the noise). Rail services and networks must also become more resilient against the impacts of climate change. In addition, attention will be focused, including re-prioritization, on areas of the Programme that deal with energy efficiency to answer the ongoing specific crisis risking affecting the overall performance of rail.
- **Legacy systems and obsolescence**
  Rail system assets have very long lifecycles and are based on global and European requirements; additionally, legacy national requirements still survive. The incompatibility of certain national requirements between EU Member States in conjunction with long life cycles results in market fragmentation, greater complexity in introducing new functions in a coordinated way, and in a significant increase in costs. Rail must move to common European network with stronger implementation of the objective of having an increasingly integrated Single European Rail Area, and be more flexible to introduce and scale up new technological and operational solutions to deliver new and improved client oriented services.
- **Interaction with other modes**
  Rail networks, and the services associated to them, to a certain extent link well with other transport modes. But such integration must be improved to better serve the needs of customers, and to make rail a more attractive mode overall so that it can become central to future mobility.
- **Increased competition**
  The European rail supply industry is world leading. However, it faces many challenges at global level. Innovative solutions, conceived, designed, and developed jointly creating new products to be deployed at European level are necessary to strengthen the competitiveness of the European rail supply industry, including its SMEs, providing major opportunities for system integrated solutions to be deployed at global level.

By making efforts in addressing the above-mentioned challenges of rail, and by delivering its set objectives, EU-Rail will strive for the following impacts:

- **More flexibility and punctuality for passengers / freight**
  EU-Rail will support the delivery of much more flexible approaches to planning and traffic management of rail services, allowing rail to better serve customer needs.

- **Improved performance and capacity**
  Through the development of cutting edge technologies designed to be implemented across the whole EU rail network, EU-Rail will help increase capacity and make best use of available assets.
- **Reduced costs**
  EU-Rail outputs are expected to help improve the efficiency of the rail system and reduce overall lifecycle costs, including on the less used lines.
- **More sustainable transport**
  EU-Rail will contribute to a more sustainable transport and mobility system by enabling an increase in the use of rail services, and improving the sustainability of the rail sector itself.
- **Harmonised approach to evolution and greater adaptability**
  EU-Rail will support the sector in coordinating on a common evolution of the system, and a greater harmonisation to support the delivery of the Single European Rail Area and improve the rate of deployment of new technologies.
- **Reinforced role for rail in European transport and mobility**
  EU-Rail work will support smart and cost-efficient rail connectivity, key to future sustainable mobility systems, to deliver better services for passengers and freight.
- **Improved EU rail supply industry competitiveness**
  Increasing the R&I intensity of the European rail supply industry will enhance its capacity to retain its global leadership. By supporting the transformation of the current rail system into a central transport mode of tomorrow's European mobility, EU-Rail will build unique capabilities in the European rail industry, supporting its position in global markets.

2.3.8 Calls for proposals

The below tables summarize the anticipated values of the operational activities planned in 2025 and 2026 under EU-Rail/Horizon Europe, including the different calls

Year 2025	**Type of call**	**Value of the actions (million EUR)**	**Maximum EU-Rail co-funding (million EUR)**	**Non-funded activities (million EUR)**	**Target contributions from Members in case of award (million EUR)**	**Indicative publication date**
Multi-annual Call for proposals 2025-02(*) (instalment)	Open *2025 values*	245,5 *199,7*	148,2 *119,8*	97,3 *79,9*	325,9 *263,4*	Q4 2025
Calls for Proposals 2025-01	Open 2025 *values*	5,2	3,0	2,2	0,0	Q1 2025

Year 2026	Type of call	Value of the actions (million EUR)	Maximum EU-Rail co-funding (million EUR)	Non-funded activities (million EUR)	Target contributions from Members in case of award (million EUR)	Indicative publication date
Multi-annual Call for proposals 2025-02(*) (instalment)	Open	0,0	0,0	0,0	0,0	
	2026 values	*47,3*	*28,4*	*18,9*	*62,4*	

(*) This call for proposals is launched in 2025 with budget commitments divided into annual instalments, meaning that the amount committed by the JU will be confirmed yearly based on the annual budget of the JU. For more information about the annual instalments, please refer to the "Table of Financial programming per year until 2027" in Chapter 3 "Budget 2025-2026" of the present document.

In accordance with the SBA and HE, EU-Rail makes use of calls for tenders to implement the R&I Programme, performing studies, seeking for professional support and expertise to the partnership, and any other relevant activities requested by the Governing Board to complement other R&I activities. For clarity, in line with the respective decisions of the Governing Board, these calls for tenders are not intended to replace functions entrusted to the Programme Office although from the pure accounting point of view, some costs are accounted in administrative lines of the general ledger.

2.3.8.1 CONDITIONS OF THE CALLS AND CALLS MANAGEMENT RULES

The EU-Rail Calls will follow the rules of the European Union's Horizon Europe framework programme and in particular the Horizon Europe rules for participation,[21] as well as the General Annexes to the Horizon Europe Work Programme 2023-2025[22], which apply, unless specified otherwise, to EU-Rail calls for proposals.

Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes apply with the following exception: the technical description Part B of the project proposal should not be longer than 70 pages as described in the application form template for CSA, RIA; and no longer than 120 pages for IA topics.

Part B of the Horizon Europe Work Programme 2023-2025 General Annexes applies for general eligibility conditions.

With regard to financial and operational capacity, part C of the Horizon Europe Work Programme 2023-2025 General Annexes applies.

Part D of the Horizon Europe Work Programme 2023-2025 General Annexes applies regarding the , scores and weighting upon which the proposals will be evaluated, with the following addition:

[21] Regulation (EU) 2021/695 establishing the Horizon Europe programme (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32021R0695)

[22] https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2023-2024/wp-13-general-annexes_horizon-2023-2024_en.pdf

- Under the criteria “Excellence”, “quality of the proposed joint activities to achieve the deliverables”.
- Under the criteria “Impact”, “quality and credibility of the action to contribute achieving the EU-Rail Master Plan objectives and the expected impact of the EU-Rail Multi-Annual Work Programme”.
- Under “quality and efficiency of the implementation”, “Appropriateness of the project management structure and quality of the proposed coordination”.

With regard to the mandatory documents and annexes to be uploaded in the submission system, Part E of the Horizon Europe Work Programme 2023-2025 General Annexes applies.

Part F of the Horizon Europe Work Programme 2023-2025 General Annexes applies with regard to the type of the one-stage evaluation procedure and other aspects such as budget flexibility, joint/coordinated calls, indicative timetables for evaluation and signature of the grant agreement(s) and the evaluation review procedure if a complaint is submitted.

Part G of the Horizon Europe Work Programme 2023-2025 General Annexes applies in regard to legal and financial set-up of the grant agreements, which includes aspects such as starting date, deliverables, form of grant, maximum grant amount and budget categories.

The standard funding rates of Horizon Europe will apply to the CSA or RIA topics as well as for the IA of the call HORIZON-ER-JU-2025-01.

The funding rate for each grant is set at 60% of the total eligible costs for innovation actions (IA) under the call HORIZON-JU-ER-2025-02; each Consortia may decide internally different funding rates in line with the provisions of Article 34 of Horizon Europe Regulation, nevertheless complying with the overall funding rate of 60%.

Where private Founding Members of the EU-Rail would be awarded any activities as a result of the Calls, they shall provide the necessary corresponding contributions in kind (IKOP and/or IKAA) in accordance with their individual letter of commitment.

Considering the lessons learned from the implementation of lump sum pilot since 2018, including evaluation and first reporting periods, EU-Rail Calls for proposals will take the form of lump sums as defined in Commission Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme[23].

In order to facilitate the contribution to the achievement of EU-Rail objectives, the option regarding 'linked actions' of the Horizon Europe Model Grant Agreement and the provisions therein, will be enabled in the corresponding EU-Rail Grant Agreements. Complementarity between particular topics will be specified within their scope in Annex VI of the Work Programme.

Considering the strategic interest of the expected outcomes of actions funded under EU-Rail calls, the JU reserves the right to object to transfers or licensing up to four years after the end of the action, in accordance with the conditions set in the Horizon Europe Model Grant Agreement, Annex 5 ‘Specific rules on IPR’— *Granting authority right to object to transfers or licensing (*Article 16*),* and *Specific rules for carrying out the action (* Article 18).

The outcomes of actions funded under EU-Rail calls are also expected to contribute to European or international standards wherever possible (refer also to Article 16 – *Exploitation of results* – in Annex 5 of the Horizon Europe Model Grant Agreement). In this respect, the actions are also expected to

[23] https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

contribute to the development of EU policies and legislation (including Technical Specifications for Interoperability and Common Safety Methods), System Pillar documents, and in this respect the granting authority, the European Commission, European Union Agency for Railways and the other bodies will require access to the relevant results (i.e. proposals for specifications, requirements, etc.) in accordance with the provision of Annex 5 of the Horizon Europe Model Grant Agreement – Article 16 - *Access rights for the granting authority, EU institutions, bodies, offices or agencies and national authorities to results for policy purposes — Horizon Europe actions.*

Regarding the dissemination obligations of the actions that will be funded under this call, considering that the actions contribute in an integrated manner to the achievement of the EU-Rail objectives established in the SBA and the Master Plan, there is a need to ensure that also the dissemination activities - participation to fairs, mid-term and final events, social media, etc. – are consistent and coherent with the EU-Rail Communication and Dissemination Strategy. Consequently, the actions shall plan, design, coordinate and contribute to the EU-Rail Programme Communication and Dissemination activities, in agreement with the Stakeholder Relations and Dissemination /structure of the JU. This additional exploitation obligation starts from the design of the dissemination and communication activities in the proposal phase; it is established in accordance with Annex 5, Article17 - *Additional dissemination obligations*.

As regards the JU's private members and their constituent or affiliated entities established in third countries, the interests of the Union and the joint undertaking on the grounds of security or public order should be safeguarded. To that end, the JU should be able to request private members to take appropriate measures. Such measures could include the appropriate handling of confidential information or limitation of certain entities in specific operational activities of the private member as stated in recital 16 of the SBA.

2.3.8.2 LIST OF COUNTRIES ENTRUSTING THE JU WITH NATIONAL FUNDS FOR THE CALLS

EU-Rail is not expected to be entrusted by any country with national funds in 2025.

2.3.8.3 COUNTRY SPECIFIC ELIGIBILITY RULES

The conditions described in part B of the General Annexes to the Horizon Europe Work Programme 2023-2025 will be applied by EU-Rail without exceptions.

2.3.9 Calls for tenders and other actions

In 2025, EU-Rail is planning to implement the following call for tenders within the framework of the MAWP:

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)
Implementation framework contracts for services	Europe's Rail System Pillar	Implementation of a 6-year framework contract (3 lots) following an open call for tenders procedure with a total value (3 lots) of EUR 45 million.	Q1-Q4 2025	Specific contracts 2025 (3 lots): 11 700 000 10 000 000 from SP budget. 1 700 000 added to SP budget to cover specific project addressing ERA priority on train detection systems
Other procedures provided for in the EU-Rail Financial Rules	Programme management	The Europe's Rail Joint Undertaking has launched in 2022 and concluded in 2023 a contract, without having recourse to a public procurement procedure as provided in Article 43() of the Financial Rules for one or more contracts to set up a dedicated management structure for projects and foster synergies with other programmes, European, national, regional, etc.	Q4 2025	Contracts renewal 2025: 900 000

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)
Framework contract's implementation	Locomotive fleet retrofit and engineering solutions for DAC (and ERTMS)	Implementation of a 4-year framework contract following an EU-Rail open call for tenders procedure with a total value of 3 000 000	Q1 to Q4 2025	Specific contracts 2025: 500 000
Open Call for Tenders and Framework contract's implementation	Strategic Advice to Europe's Rail Joint Undertaking (support of external providers in the fields of strategy advice and support to EU-RAIL programme management)	Framework contract of 4 year duration with a total budget of EUR 1.200.000/implementation of a 4-year framework contract	Q1 to Q4 2025	Specific contracts 2025: 350 000
Framework contract's implementation	Passenger Perspective in Rail Transformation	Implementation of a 4-year framework contract with a total value of EUR 200.000	Q1 to Q4 2025	Specific contract 2025: 50 000
Implementation through various FWCs	Tool Set	Toolset is an EU-RAIL transversal platform to support the Research and Innovation activities. It includes a model-based engineering system (Capella),	Q1 and Q4 2025	Specific contracts 2025: 644 000

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)
		a process/workflow management tool (Polarion) and a version management tool (Git).		
Open tender-Direct contract	Europe's Rail Multi-Project Collaborative Tool	Collaborative platform for the monitoring of the implementation of Flagship projects and JU programme management	Q3 2025	300 000
Total		**Value of commitments for 2025**		**14 444 000**

In addition, subject to the conclusion of a Contribution Agreement with the European Commission (DG MOVE) the following tender is included:

Open tender-Framework contact for services / Framework contract's implementation	Specialist support on the development of European Harmonised Rulebook	Framework contract for 4 years duration and an estimated budget of EUR 1,000,000 / Implementation FWC Europe's Rail System Pillar	Q4 2025	Specific contract 2025 360 000

In 2026, EU-Rail is planning to implement the following call for tenders within the framework of the MAWP:

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)
Implementation framework contracts for services	Europe's Rail System Pillar	Implementation of a 6-year framework contract (3 lots) following an open call for tenders procedure with a total value (3 lots) of EUR 45 million.	Q1-Q4 2026	Specific contracts 2026 (3 lots): 4 500 000
Other procedures provided for in the EU-Rail Financial Rules	Programme management	The Europe's Rail Joint Undertaking has launched in 2022 and concluded in 2023 a contract, without having recourse to a public procurement procedure as provided in Article 43() of the Financial Rules for one or more contracts to set up a dedicated management structure for projects and foster synergies with other programmes, European, national, regional, etc.	Q4 2026	Contracts renewal 2026: 900 000
Framework contract's implementation	Passenger Perspective in Rail Transformation	Implementation of a 4-year framework contract with a total value of EUR 200.000	Q1 to Q4 2026	Specific contracts 2026: 50.000

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)
Framework contract's implementation	Strategic Advice to Europe's Rail Joint Undertaking (support of external providers in the fields of strategy advice and support to EU-RAIL programme management)	Implementation of a 4-year framework contract with a total value of EUR 1.200.000	Q1 to Q4 2026	Specific contracts 2026 550.000
Implementation through various FWCs	Tool Set	Toolset is an EU-RAIL transversal platform to support the Research and Innovation activities. It includes a model-based engineering system (Capella), a process/workflow management tool (Polarion) and a version management tool (Git).	Q1 and Q4 2026	Specific contracts 2026: 464 000
Framework contract's implementation	Locomotive fleet retrofit and engineering solutions for DAC (and ERTMS)	Implementation of a 4-year framework contract following an EU-Rail open call for tenders procedure with a total value of 3 000 000	Q1 to Q4 2026	Specific contracts 2026: 2 000 000
Total		**Value of commitments for 2026**		**8 464 000**

As already indicated, in accordance with the SBA and HE, EU-Rail makes use of calls for tenders to implement the R&I Programme, performing studies, seeking for professional support and expertise to the partnership, and any other relevant activities requested by the Governing Board to complement other R&I activities. For clarity, in line with respective decisions of the Governing Board, these calls for tenders are not intended to replace functions entrusted to the Programme Office, although from the pure accounting point of view, some of the related costs are accounted in the administrative lines of the general ledger.

Additionally, as part of other operational actions, in 2025 and 2026 it is expected that, after the realization of the call for expression of interest in accordance with Article 7 of the SBA, taking into account in particular the new technological developments or the association of additional countries to Horizon Europe, and following an open and transparent procedure, the Associated Members will be selected and become part of the JU.

2.3.10 Follow-up activities linked to past calls: monitoring, evaluation and impact assessment

The former S2R Programme was administratively closed during 2024, which was preceded by finalization of all the S2R projects activities in 2023.

The ongoing EU-Rail projects are subject to continuous monitoring and evaluation to follow-up on their progress and also allowing to deal with different elements which may influence a demonstration to take place (e.g. necessary authorizations).

To manage the complexity of the EU-Rail Integrated Programme, the Flagship Projects will be subject to a monitoring carried out by the JU, described in the Governance and Process Handbook[24] chapter 7.4 – a control mechanism referred to as the "maturity checkpoints". This will enable a clear status to be reached before proceeding to the next phase and will facilitate consistency across the Flagship Areas and their mutual interaction, as well as the interaction with the System Pillar (which is also expected to undergo a similar process).

In addition, the monitoring and assessment of the EU-Rail projects, especially from the risk and control perspective, will also be subject to the procedures defined in the JU's HE Control Strategy for Grants, which was adopted end of 2023.

As for the link and continuity between the previous and the current JU's programmes, the specific details on how the outputs and achievements of the Shift2Rail projects will be applied for EU-Rail's research and innovation are provided per each Flagship Area and the Transversal Topic in the MAWP.

2.3.11 Cooperation, synergies and cross-cutting themes and activities

EU-Rail will strive for maximising its impact using also synergies with other European, national and regional programmes and activities. Beyond the involvement in the overall coordination of Horizon Europe, the JU will in particular focus on capturing synergies across the following:

[24] https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/

Synergies within the "Climate, Energy and Mobility" cluster: EU-Rail will reach out to other mobility JUs with the aim to build, where possible, consistent projects and demonstrators for climate neutral mobility solutions. This may also address shared areas of intervention such as multi-modal transport, automation in vehicles and other assets, decarbonisation, use of alternative fuels, etc. In particular, specific coordination with the European Partnership Sesar 3, Clean Hydrogen, as well as with the Battery co-programmed partnership appear to be of key relevance. Follow-up will in particular be needed with action to be funded under the first synergy topic call HORIZON-ER-JU-2023-FA1-SESAR: EU-RAIL – SESAR SYNERGY: INTEGRATED AIR AND RAIL NETWORK BACKBONE FOR A SUSTAINABLE AND ENERGY - EFFICIENT MULTIMODAL TRANSPORT SYSTEM.

Synergies with the "Digital, Industry and Space" cluster: Considering the key challenges related to the digital transformation of rail, there are major expectations on how this cluster would be contributing with rail-critical applications. Artificial intelligence, cyber-security and high-performance computing are cross sectoral issues that require deep coordination especially for the development of use cases and the application of European standards. In addition, European space policy appears to be of key relevance, considering the ambition to introduce more and more satellite-based solutions for localization or data transmission. Here also synergies with EUSPA (and ESA) and SNS will be continued building upon the past experience and new ones be created in particular with Chip. Follow-up will in particular be needed with action to be funded under the the first synergy topic call HORIZON-ER-JU-2024-FA2-SNS: EU-RAIL – SNS SYNERGY: DIGITAL & AUTOMATED TESTING AND OPERATIONAL VALIDATION OF THE NEXT EU RAIL COMMUNICATION SYSTEM

Synergies with the Co-Programmed Partnership on AI, Data and Robotics, which could support access to such technologies and relevant industrial partners and developers will be considered in the implementation of this Work Programme. Additionally, inspection and maintenance was one of the 4 priority areas defined under the robotics PPP, so there is knowledge to build on.

Synergies with EU Missions: EU-Rail will explore joint activities with the Climate-Neutral and Smart Cities Mission contributing to comprehensive climate-neutral and smart urban mobility solutions. Single ticketing and smart transport hubs integrating sub-urban and long-distance passenger and freight rail traffic with urban mobility are possible areas of collaboration.

Coherence and synergies in relation to major national (sectoral) policies, programmes and activities: It is estimated that around 15% of the EU stimulus package called Recovery and Resilience Facility - RRF- will be invested in different areas of rail national systems. There is a need to ensure maximum levels of complementarity and impact, including focusing on future-proof investments. This will require to leverage local, regional and national investments to complement the research and innovation activities performed at EU-Rail level and vice versa. In this respect, the States Representatives Group is expected to play a key role. Additionally, thanks to the input provided by the States Representative Group, synergies with national or regional research and innovation programmes are sought, including concrete actions taken or envisaged for the deployment and uptake of relevant technologies and innovative solutions.

In carrying out its activities, EU-Rail seeks to establish the necessary international connections in relation to rail research and innovation, in line with the Commission priorities. In this respect, the JU will cooperate with third countries and/or international organisations, in particular to contribute to the competitiveness of the European rail industry at global level.

EU-Rail will continue the cooperation started by S2R JU with a number of key international partners, such as FRA, APTA, FTA in the US and CUTRIC (CA). In line with the policy priority of the Commission in terms of rail international relations, further exchanges are expected to take place with other third countries.

The collaboration with the EU neighbouring countries, in particular Western Balkans, will continue with the aim to further explore the opportunities for joint activities and large scale demonstrations.

In addition, EU-Rail will ensure the collaboration with sectorial initiatives like (among others) the ongoing UIC project in relation to FRMCS. It will also ensure collaboration with the activities coordinated and carried out by RNE on Capacity allocation and management (link to FA1).

2.4 Support to Operations of EU-Rail in 2025-2026

2.4.1 Communication, dissemination and exploitation

Communication and stakeholder relations

In order to ensure strong engagement from a wide range of stakeholders, communication must be truly *integrated* into the overall framework of the EU-Rail Programme and it is intrinsically related to the level of engagement with the membership, the rail sector and its stakeholders, as well as the broader transport and research sectors.

Reflecting this, the communication objectives defined jointly with the Founding Members, are listed in the JU Stakeholder Relations, Dissemination and Communication Strategy for 2022-2027.

The Communication activities for 2025-2026 will continue to ensure that the JU's mission, vision and objectives, including the Innovation and System Pillars and the Deployment Group, are communicated and understood widely.

Ensuring that the objectives of the current Programme are well understood by the community is fundamental to have the necessary buy-in to cater since the beginning of the Programme for the future deployment of its results. Actions in this area aim to support and demonstrate the added value of the ongoing R&I activities as well as to inform on the new Calls for Proposals and the projects resulting from the Calls, including the results and outcomes of such projects.

A major point of attention in communication activities will be the need to ensure the involvement of stakeholders from the entire rail value chain, including actors from outside the traditional rail sector. We will also focus on addressing decision makers, such as the EU institutions, as well as the private Founding Members and the new Associated Members involving CEOs and CTOs levels to bring coherence of Europe's Rail R&I Programme with future deployment activities. This will be achieved through organisation and participation to a number of Europe-wide and global events, among other communication activities and campaigns.
Stakeholder Relations support the main objectives of the JU. Identified stakeholders will be targeted through direct relations and the identified communication and dissemination activities. At operational level, the challenge for 2025 2026 will be to demonstrate the added value of the JU based on its results. Integration of new Members of the JU will be a key activity.

Communication efforts and dissemination of the EU-Rail R&I outputs in 2025 and 2026 could additionally contribute to the upcoming of the 10th Framework Programme for Research and Innovation (FP10).

EU-Rail communication activities aim to :

- **Continue to raise awareness about the JU** among key stakeholders across Europe from the rail sector , given the ambition of a better integration of rail with other transport modes for both passengers and freight managers, and the need to establish synergies with other thematic areas and sectors as identified in the EU Green Deal and the Sustainable and Smart Mobility Strategy.
- **Support and promote the recognition of the JU's results at global level** with regard to its contribution to the competitiveness of the European railway industry.
- **Promote stakeholder engagement** along and across the value chain in order to facilitate cooperation and knowledge exchange across EU countries and regions, exploiting insofar as possible existing events. This objective will require the organisation of and participation to fora and conferences on specific topics stemming from the current Programme content and key project results and adaptation of key messages to each stakeholder.

Both of the two latter aforementioned objectives will require close work with different stakeholders and their associations.

- **Promote the JU within the EU Institutional arena**. This objective consists of maintaining and further developing political support for EU-Rail from the EU institutions and EU Member States through the promotion of the JU, its objectives and achievements. Target audiences for this objective include the European Parliament and the Council (with particular attention to the rotating presidencies) and policymakers in EU Member States, the Committee of the Regions, the European Economic and Social Committee and other EU bodies, such as the European Union Agency for Railways (ERA), the European Environmental Agency (EEA), the European Agency for the Space Programme (EUSPA) and other Joint Undertakings, especially in the context of building operational and administrative synergies. This objective might require the organisation of events inside the European Parliament, participation in visibility events such as exhibitions, Open Days, and the production of publications, digital and audio-visual content and presentations of key achievements. It is essential to maintain efficient communication channels with DG MOVE and DG RTD and explore all possible collaboration with other DGs, EU Agencies and bodies where appropriate to further increase synergies between EU policy areas and rail transport. EU-Rail will also build synergies with other transport focused Joint Undertakings through joint projects stemming from Calls for Proposals (SNS JU, SESAR3 JU) and initiatives, such as events and digital campaigns, including social media, to further reinforce the collaborative message.
- **Lead a coherent dissemination strategy** regarding projects' activities, achievements, milestones and results notably via coordinating web, documents, audio-visual and digital content and event management of the projects, and their presence on the renew EU-Rail website with the development of an improved dissemination framework, as well as providing information to projects on Horizon Europe dissemination tools. This will include assisting the projects to disseminate their results through the JU's newsletter and social media channels and providing guidelines to the projects on issuing coherent communication products and activities in line with the JU's corporate branding and messages. To this effect, regular meetings and concrete actions will be organised with the Project Coordinators, Flagship Projects Managers and Work Package Leaders for Communication and Dissemination. A dedicated Teams environment and EU Survey Tool for content collection will be further utilised to strengthen information exchange with the projects.
- Pro-actively **publish communication material** with regard to events directly organised by Europe's Rail, participation to external events, as well as meetings related to EU-Rail. A broad dissemination of mostly digital factsheets, leaflets, reports, video content and other digital communication outputs will enhance the visibility of the JU towards other stakeholders, including the general public.
- **Expand the network of press and media contacts** in order to achieve considerable visibility in both specialised and general media. This network could be useful to provide visibility to the publication of press releases and specific articles related to EU-Rail's activities. Furthermore, the communication material produced by the JU will be disseminated through multipliers from the stakeholders base, as listed below.

- **Continue populating website, publishing news, newsletters, mailshots, various publications and animate the social media platforms** in order to stimulate the public interaction on key issues and improve public awareness on the JU's activities. To that effect, bi-annual meetings will be set-up with the Communication Officers of the Founding Members and other key Partners to identify joint communication activities and channels and to elaborate and create synergies on the presence of the JU at major events as well as agree on common practices regarding the dissemination of project results.

Further to the above, EU-Rail relies on key multipliers:

- European Commission Directorate-Generals, with a particular focus on DG MOVE and DG RTD
- JU private Members, including JU project coordinators, corporate Communication managers and project participants, who will communicate the success of the JU to various audiences;
- Presidencies of the European Union;
- Members of the States' Representatives Group (SRG);
- Members of the Scientific Steering Group (SSG);
- ERRAC
- Policy makers and decision-makers;
- Wider stakeholders reached through EU-Rail Information Days and online channels;
- Global stakeholders present at key events, within and outside the Union;
- European railway associations, including those in relation to passengers and staff;
- European Union National Contact Point clusters (for calls info-days);
- Rail trade media;
- Mainstream media;
- EU-Rail staff acting as ambassadors.

The implementation of the communication, dissemination and stakeholder relations activities will continue to be supported through a framework contract established with communication agencies as well as through inter-institutional framework contracts put in place by the European Commission. EU-Rail has established a joint framework contract for communication services together with the SESAR 3 and the Clean Aviation Joint Undertakings running until 16 February 2026. The services include editorial support, events management, digital communication and website support. It is expected that a new framework contract will be put in place for similar services as of March 2026 and EU-Rail will contribute to the preparation of the tender. Europe's Rail will continue using the available services of communication framework contracts of the European Commission.

Dissemination

Dissemination of project results will be at the forefront of communication, dissemination and stakeholder relations activities in both 2025 and 2026. A major focus will be placed on ensuring that the key demonstration activities, milestones and results of the Flagship Projects are efficiently communicated to the relevant target audiences. Connecting relevant national or regional research and innovation programmes identified as potential areas of cooperation by the States' Representative Group. Efforts will also be made to further disseminate the results of the Exploratory Research and Other Activities projects, in complement to the Flagship projects, showcasing synergies and joint activities. Such dissemination efforts will be carried out taking into consideration the link with the projects and the System Pillar, as well as the Deployment Group. The results of the ongoing activities and of projects/tenders are disseminated by EU-Rail via its website, in particular the digital catalogue of Solutions, sections, press releases, newsletters, mailshots, presentations at internal (EC, Governing Board, Scientific Steering Group, States Representatives Group, System and Innovation Programme Board, General Assembly of the JU) and external (conferences, trade fairs, Info days, dedicated Innovation Days etc.) stakeholder events with a focus on InnoTrans 2026, rail, transport, as well as

general mainstream press and through social media. Efforts to manage the projects community for a more efficient information exchange on the Teams platform will be further animated and encouraged. A particular focus will be placed on streamlining dissemination efforts of the Flagship Projects via a new and comprehensive set of guidelines and KPIs. The efforts should result in a series of communication outputs in article and video format available on the EU-Rail website.

EU-Rail will continue to participate to the different working groups established by the European Commission on dissemination and exploitation activities, to ensure that R&I results are integrated with the overall work performed in the rest of Horizon Europe and, where appropriate, in the ERA activities.

Communication on the projects results will be expanded with a shared planning, taking into consideration the best possible way to exploit the innovative solutions developed in EU-Rail. Regular meetings will continue to take place with the Project Coordinators/Flagship Project Managers/Communication Work Package Leaders on Communication to support projects in leading a coherent communication and dissemination campaign at JU corporate level ensuring the project level contribution and optimal dissemination of EU-Rail funded R&I. A cross check of main events at European level and beyond will be undertaken to best advise projects on opportunities for communication and dissemination at relevant events. EU-Rail will monitor the compliance of the Projects with the communication guidelines provided by EU-Rail.

The main events, where EU-Rail will showcase its results in 2025 and in 2026, are Call Info Days, the Europe's Rail General Assembly (December 2025 and 2026), Women in Rail Awards contributions, events with ERA and the Danish Presidency (2025). Participation of the JU will be ensured at the following external events: European Start-up Prize, the joint JU European Parliament event (April 2025), ITF Summit (May 2025), UITP Global Public Transport Summit 2025 (June 2025), Transport Research Arena (2026), Connecting Europe Days (2026), InnoTrans (2026). Potential other events attendance relevant to the ongoing work of EU-RAIL.

In 2026 InnoTrans, Connecting Europe Days and TRA will remain key events where EU-Rail will showcase its main achievements, including the major results coming from the projects. During these events potential synergies with other EU bodies and institutions will be showcased.

In collaboration with the Human Resources, Internal communication will remain a priority. Team building exercises will be organised and regular team meetings will continue to take place, complemented by the bi-monthly Brown Bag Lunches initiative.

Exploitation

Although S2R Programme has already contributed to shortening of the innovation cycle in rail via an integrated research and innovation programme, EU-Rail is expected to accelerate further the introduction of innovative solutions. In order to deploy novel solutions, the sector needs to move towards new ways of working enabling the transformation of rail as one European integrated system. This new way of working will be based on more flexibility and adaptability to user needs, creating solutions much more focused on prototyping and large scale demonstrations, and increased collaboration integrating new entrants, leading to a shorter innovation cycle and delivering impactful results.

There is a clear and shared sector vision that accelerating the market uptake of future proof technological and operational solutions requires for some solutions a coordinated deployment at EU level.

This is also the reason why the SBA foresees an important role of the Deployment Group as an advisory body to the Governing Board. Its tasks are detailed in Section 2.5.6.

Basic considerations regarding exploitation and deployment of results of R&I activities as per each Flagship Area and the Transversal Topic are included in EU-Rail's MAWP and detailed exploitation plans are part of each EU-Rail project grant agreement, with particular attention to the Flagship Projects.

2.4.2 Procurement and contracts

In order to reach its objectives and adequately support its operations and infrastructures, EU-Rail will allocate funds to procure the necessary services and supplies. In order to make procurement and contract management as effective and cost‑efficient as possible, EU-Rail makes use of Service Level Agreements (SLAs) concluded with relevant Commission Services and inter-institutional framework contracts (FWCs) available to them.
In 2025 and 2026, EU-Rail foresees to implement existing Framework contracts (FWCs), where EU-Rail is either the lead contracting authority or a participating contracting authority. When the services needed are not covered by FWCs already in force, EU-Rail will launch procurement procedures for middle or (very) low-value contracts.
In accordance with the SBA (see Section 2.4.3) and the back office arrangements, EU-Rail will continue to develop synergies and efficiencies in procurement related activities with other Joint Undertakings. At this regard, a Service Level Agreement for Procurement Services ("BOA Procurement") has been signed between EU-Rail and other Joint Undertakings, which includes a joint bi-annual procurement plan. For the inter-Joint Undertaking tender external accounting support and annual Accounts and the on-line data protection services, EU-Rail has taken the lead. The below EU-Rail procurement indicative planning and budget is therefore impacted by the joint JU procurement planning 2025-2026 and their successive updates.

Title	Indicative budget (EUR)	Type of procedure	Indicative schedule (Q-quarter)
Refurbishment works at EU-Rail premises	350.000	Use of "Facility Contract management" of the White Atrium with the building owner	Q2-Q3 2025
Communication and event services and supplies	350.000	Specific contracts/order forms implementing a FWC or negotiated procedure for low-value contracts	Q1 to Q4 2025
Subscriptions to journals & periodicals	10.000	Negotiated procedure for low-value contracts	Yearly
Assistance and support of external experts	50.000	Ad-hoc expert contracts based on a Call for expression of interest (CEI) or Specific Contracts/order forms implementing a FWC	Q1 to Q4 2025
Basic Office Furniture	15.000	Specific Contracts/order forms implementing a FWC	Yearly
Catering services (implementation of BOA procurement)	35.000	Specific Contracts/order forms implementing a FWC or negotiated procedure for low-value contracts	Yearly
Water supplies & fontains (implementation of BOA procurement)	5.000	Specific Contracts/order forms implementing a FWC or negotiated procedure for low-value contracts	Yearly
IT support and supplies (implementation of BOA procurement and specific EU-Rail Information System)	245.000	Specific Contracts/order forms implementing a FWC or Negotiated procedure for middle or low value contract	Yearly
Team Building (implementation of BOA procurement) and Training	30.000	Negotiated procedure for low value contract or Specific Contracts/order forms implementing a FWC	Yearly
Implementation of the Back Office Arrangements (BOA) for Accounting services	50,000 / year out of the FwC for all JUs estimated at 440,000 year and with a total value of 3,894, 000 EUR (2 lots)	Implementation of Framework contracts External Support to the Back Office Arrangement for the Joint Undertakings for Statutory Audit Services (Lot 1) and Accounting Services and Other Assurance Engagements (Lot 2) for 10 JUs and for 5 years duration	Q3 to Q4 2025
Inter-JU Data protection on-line register (implementation of BOA procurement)	Frame-work contract for supplies with total amount of EUR 140,000 for 4 years, with a share ("ceiling") of EUR 14,000 per participating Joint Undertaking	Specific Contracts/order forms implementing a FWC	Q3-Q4 2025
Legal and operational support to data protection activities, including externalisation of DPO function (implementation of BOA procurement)	300.000	Specific Contracts/order forms implementing a FWC of 4 years duration	Yearly
Legal assistance services (representation in litigation, legal support services for HR or IPRs etc.) (implementation of BOA procurement)	50.000	Low-value contract, ad-hoc expert contracts based on a Call for expression of interest or Specific Contracts/order forms implementing a FWC	Q1-Q4 2025

This list must not be considered exhaustive and other procurement procedures may need to be launched within the budgetary limits approved by the EU-Rail Governing Board and the budget flexibility clause. The Executive Director shall report to the Governing Board about the procurement procedures put in place as part of the respective CAAR.

2.4.3 Other supporting operations

As indicated in the SBA, potential synergies and efficiencies with other Joint Undertakings could be gained through the set-up of back office arrangements between the European Institutional partnerships in areas such as HR, legal, IT, communication, accounting, audit and anti-fraud strategy and logistics/events/room management. Joint undertakings shall, within one year following the date of entry into force of the SBA, operate back office arrangements by concluding service level agreements, subject to the need to guarantee an equivalent level of protection of the Union's financial interest when entrusting budgetary implementation tasks to Joint Undertakings. Such arrangements are subject to confirmation of viability and following screening of resources.

Taking also account of guidance received from the European Commission, including general and specific principles and generic design options for service provision, the JUs' Executive Directors have already put in place particular back office arrangements for some areas, in accordance with Article 13 of the SBA, and in line with the foreseen solutions endorsed at the JUs GB level at the end of 2022. In particular, EU-Rail took the role of the Lead JU for the back office arrangements for the accounting services of the JUs, with 3 JUs acting as accounting service providers (EU-Rail, CA JU, SESAR JU). While EU-Rail is also supporting other back office arrangements in place, such as procurement services, HR and ICT.

2.4.3.1 IT ACTIVITIES

EU-Rail has implemented common ICT tools designed and offered by the European Commission on the financial management, human resources management and HE call management. These tools are updated and maintained on a regular basis by the EC; they require continuous input from the side of the JU, on the one hand, in terms of future developments to meet the expectations of the partnership and, on the other hand, to correct mistakes.

Since 2018, the JU has implemented ARES (EC document management system) in order to streamline document flow as well as to ensure their proper archiving and registration, then implemented SYSPER for staff administration in 2019 and also implemented SYSTAL to manage the staff recruitment, thereby leveraging on the existing EC infrastructure and processes. EU-Rail makes use of the trainings dedicated to the applications offered by the EC (including the ones used in Programme management, most importantly Compass/SyGMa), to assure their correct usage and implementation by its staff.

EU-Rail shares its ICT infrastructure with other Joint Undertakings located in the White Atrium building. In order to provide an improved security, availability of the systems and staff mobility, the physical infrastructure was virtualized from 2017 to a cloud provider. From 2023, this service is managed by CA JU on behalf of the other JUs under the DIGIT Cloud II framework contract. Another example of collaboration is the tool for the management of the GDPR Register which EU-Rail has procured also on behalf of the other JUs and which has been in use since 2020.

Following a Data Protection Impact Assessment (DPIA) conducted in 2020, EU-RAIL started to migrate to Microsoft cloud services (M365) in 2021, to deliver an improved collaborative environment in combination with an even higher level of ICT security. EU-Rail started an initiative for 2025 to simplify, modernise and digitalise processes and ways of working to increase efficiency, using the newly deployed M365 features.

EU-Rail collaborates with the other JUs in synergy under a joint strategic ICT plan. This plan includes for 2025 the renewal of the FWC for ICT managed services; the upgrade of the common meeting rooms with a videoconference system; the migration of both telephony and internet connections; the creation of a new cybersecurity plan; the renewal of the DPIA on Microsoft products and the migration to Windows 11
In line with the JU 2025 annual work plan based on the implementation of the BOA ICT, every year, one lead JU takes responsibility for the provision of ICT services to all other JUs based on a catalogue of common services agreed in the respective SLA. ICT solutions needed specifically for the EU-Rail Programme implementation, e.g. the system engineering tool, will be acquired and/or developed individually, while the interest of other JUs to join such activities will always be explored.

2.4.3.2 DATA PROTECTION

As regards the processing of personal data, EU-Rail applies Regulation (EU) 2018/1725 of 23 October 2018[25], which entered into force on 11 December 2018.

The role of the Data Protection Officer (DPO) is exercised by the EU-Rail's Chief Legal Officer assisted by an external contractor since early 2021.

EU-Rail, as a controller, maintains a record of processing activities under its responsibility in a central register (GDPR central)[26] and makes this register publicly accessible. In addition, EU-Rail takes appropriate measures to provide transparent information, communication and modalities for the exercise of the rights of the data subject. A collection of privacy notices[27] for each specific processing operation is available in the EU-Rail website. More information is available on the EU-Rail data protection and legal notices pages[28].

In accordance with the SBA (see Section 2.4.3) and the back office arrangements, EU-Rail will continue to develop synergies and efficiencies in data protection related activities with other Joint Undertakings (see implementation of BOA Procurement in Section 2.4.2).

2.4.3.3 ACCOUNTING

The European Commission's Accrual Based Accounting system (ABAC) has been rolled out in the JU in 2016 and is used for accounting purposes.

EU-Rail implements its financial rules[29] which define, inter alia, powers and responsibility of EU-Rail's Accounting Officer. They also make an explicit reference to the possibility that this function could be

[25] Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC.

[26] https://rail-research.europa.eu/dpregister/

[27] https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/

[28] https://rail-research.europa.eu/terms-of-use/

[29] The EU-Rail Governing Board have approved the decisions (GB Decision n° 02/2021) adopted under the former S2R JU that will continue to apply to the EU-Rail (called GB omnibus decision"), which includes, inter alia, the Financial Rules: https://rail-research.europa.eu/wp-content/uploads/2020/01/S2R-JU-Financial-Rules.pdf

attributed to the Accounting Officer of the EC, and such option was effectively utilised by the JU in the past.

However, in October 2021 the European Commission announced the intention to terminate their role of the Accounting Officer of the JU, except for the treasury function, which became effective as of 1 December 2022. The resulting situation was tackled by applying the back office arrangements solution for the accounting function of the JUs. In fact, within this solution, EU-Rail is now performing the role of the Lead JU and is also, being one of the respective three JUs (with the Clean Aviation JU and the SESAR 3 JU), acting in the role of the accounting service provider.

2.4.4 Human resources

2.4.3.4 HR MANAGEMENT

In 2025, EU-Rail will be staffed with 33[30] staff members including 2 Seconded National Experts (SNEs). In line with the Establishment Plan, recruitment procedures are launched as necessary in order to fill the respective posts in case of staff departures. Where needed, the JU will make recourse to Interim Staff while the recruitment processes to hire statutory staff are completed or in case of specific and temporary peaks of activities. In addition to statutory staff members and the SNE's already in place, EU-Rail will also make use of the European Commission's Bluebook to hire trainees and possibly also non-bluebook trainee in the framework of the decision adopted by the Governing Board in 2020 prior to the COVID-19 pandemic. Further details are provided in the Staff Establishment Plan in the following Section.

In the upcoming period, the EU-Rail HR function will continue to ensure ongoing improvement of all HR processes and to develop its internal guidelines, policies and its legal framework, paying particular attention to how the Staff Regulations of Officials of the European Union and the Conditions of Employment of Other Servants of the European Union shall apply to the JU's particularities (in accordance with Article 110 of the EU Staff Regulations).

Annual appraisal and reclassification exercises will be set up by HR within the limits of the Staff Establishment Plan and the EU-Rail Financial Rules.

Further to the adoption of the new decision on working time and hybrid working, EU-Rail will strive on a continuous basis for ensuring a good working environment and team spirit. For this purpose, social events and team building activities will be proposed on regular basis in 2025. Individual coaching sessions will be considered both for staff as well as for the management team.

2.4.3.5 STRATEGY FOR ACHIEVING EFFICIENCY GAINS AND SYNERGIES

From the HR perspective, in 2025, the JU's major challenge will be to continue ensuing smooth implementation of the current EU-Rail Programme.

EU-Rail is committed to ensuring the well-being of staff and that every staff member reaches their full potential. Trainings are strongly encouraged and team building activities are organised on regular basis in order to reinforce the cohesion of the team, the staff engagement and motivation.

[30] An AD7 position as of 2025 was granted to EU-RAIL by the European Commission due to the associated/third countries participation to Horizon Europe Programme.

The JU will continue to implement the HR recommendations made further to the review of its way of working, and in this regard will give priority to the following HR aspects:

- Implement a fit-to-purpose competency framework;
- Run a talent development plan.

In terms of synergies and collaboration with the other Joint Undertakings, in 2025, the JUs will continue sharing the HR-related IT tools (e.g. the e-recruitment tool SYSTAL, SYSPER) and, where necessary, common calls for tenders, selection procedures, training courses for JUs staff and managers as well as a common approach to implementing rules of the EU Staff Regulations. In addition, EU-Rail will continue sharing information and best practices with the other JUs through meetings and working groups such as those among the Executive Directors, Heads of Administration, HR officers, Legal Officers etc. Moreover, in line with the hybrid way of working, further synergies among JUs will also be possible in facility management as several JUs are located in the same building and share joint business continuity planning, managing office spaces and organising procurements of common infrastructure. Finally, in alignment of the SBA and the back office arrangements, close collaboration among the JUs is expected to improve. To this end, a joint analysis on possible synergies and cost-efficiencies among the JUs has been conducted in 2022 with the support of an external consultant, and will continue to be implemented in the upcoming period.

In addition to the above mentioned, the application of lump sum form of grants in the EU-Rail Programme creates further space for increasing efficiency, in particular by enabling in the area of controls to refocus part of the capacities from activities related to costs actually incurred by the beneficiaries to controls aimed more on the qualitative aspects of the projects.

2.4.3.6 STAFF ESTABLISHMENT PLAN[31]

The Authorized Budget indicated in the tables below refers to the staffing of EU-Rail which started its activities on 30 November 2021 and reflects the data in the Legislative Financial Statements that represent part of the SBA legal framework applicable to the JU.

At the time of drafting of this WP, the posts of the Head of Innovation Pillar, Internal Control Coordinator and Human Resources Officer are vacant.
Further to the termination of DG Budget's accounting services to Joint Undertakings and the communication made by the Commission services to take over this function as part of the back office arrangements (BOA) based on SBA Article 13,EU-Rail took over as the lead JU for this part of BOA. The Commission services confirmed that 3 additional contract agents that are already recruited to increase the reinforcement of the BOA, for activities previously performed by DG Budget not linked with the JU operational activities and therefore on top of the 17 contract agents foreseen in the LFS attached to the Commission Proposal for a Council Regulation establishing EU-Rail.

Function group and grade	2024				2025		2026	
	Authorised budget		Filled as of 31/12/2024		Authorised budget		Requested budget	
	Permanent posts	Temporary posts	Permanent posts	Temporary posts	Permanent posts	Temporary posts	Permanent posts	Temporary posts
AD 16								

[31] 2024, 2025 and 2026 staff figures are presented based on the Legislative Financial Statements annexed to the SBA but are subject to the adoption of the EU General Budget for each of the respective years.

AD 15								
AD 14		1		1		1		1
AD 13								
AD 12								
AD 11						2		2
AD 10		2		1		1		1
AD 9		1		1		1		1
AD 8		1		1				
AD 7						5		5
AD 6		4		4		1		1
AD 5		1		1				
AD TOTAL	**0**	**10**	**0**	**9**	**0**	**11**	**0**	**11**
AST 1-11	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
AST TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
AST/SC1-6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
AST + AST/SC TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
GRAND TOTAL	**10**		**9**		**11**		**11**	

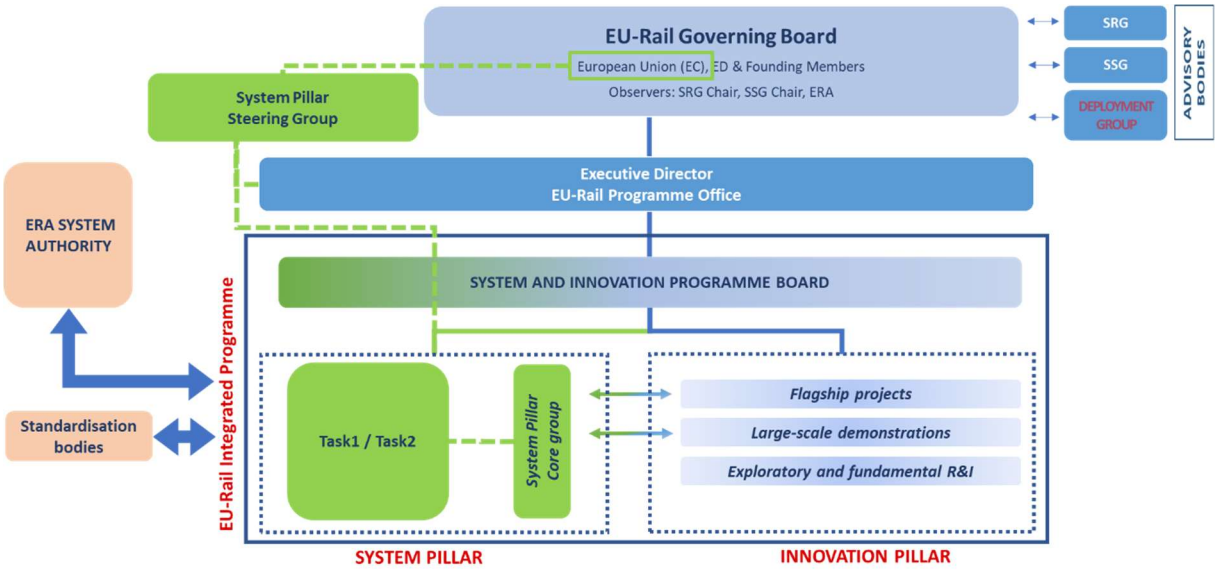
Contract Agents	FTE corresponding to the authorised budget 2024	Headcount as of 31/12/20243	FTE corresponding to the authorised budget 2025	FTE corresponding to the authorised budget 2026
Function Group IV	15	9	15	15
Function Group III	4	7	5	5
Function Group II	1	2		
Function Group I				
TOTAL	**20**	**18**	**20**	**20**

Seconded National Experts	FTE corresponding to the authorised budget 2024	Headcount as of 31/12/2024	FTE corresponding to the authorised budget 2025	FTE corresponding to the authorised budget 20265
TOTAL	**2**	**2**	**2**	**2**

Recruitment forecasts for 2025 following retirement/mobility or new requested posts					
Job title in the JU	**Type of contract (Official, CA, TA)**		**TA/Official**		**CA**
			Function group/grade of recruitment internal (Brackets) and external (single grade)		**Recruitment Function Group (I, II, III and IV)**
	Due to foreseen retirement/ mobility	**New post requested due to additional tasks**	**Internal (brackets)**	**External (brackets)**	
N/A	N/A	N/A	N/A	N/A	N/A

2.5 Governance activities

As follows from the provisions of the SBA, the JU is composed of the following bodies: the Governing Board, the Executive Director, the States' Representatives Group, the System Pillar Steering Group, the Deployment Group and the Scientific Steering Group (the role of the latter was still performed by the Scientific Committee until the first half 2023). In addition to these bodies, the System and Innovation Programme Board (ED-SIPB)[32] supports the Executive Director.



In the field of governance, the JU will continue in the process of the revision and updating of its key internal guiding documents, as necessary, most importantly the Governance and Process Handbook.

2.5.1 Governing Board

The Governing Board (GB) of EU-Rail was established after the Founding Members of EU-Rail other than the Union signed a letter of commitment detailing the scope of the membership in terms of content, activities and duration, as well as their contributions to the joint undertaking, including an indication of the envisaged additional activities referred to in Article 11(1), point (b) SBA.

Concomitantly to the signature of the letters of commitment, the Founding Members of EU-Rail other than the Union nominated their representatives and alternates to the Governing Board. The first Governing Board meeting was held on 21 December 2021 where the GB adopted its Rules of Procedure[33]. In the same meeting, the GB adopted the so-called "omnibus decision"[34], i.e., the list of decisions adopted by the S2R JU that will continue to apply for EU-Rail in accordance with Article 174(12) of the SBA.

The GB of EU-Rail is the decision-making body, having the overall responsibility for the strategic orientation, coherence with relevant Union objectives and policies, and operations of the JU. It shall also supervise the implementation of JU activities.

---

[32] The ED-SIPB provides advice to the Executive Director on resources, schedule, planning and synchronization, implementation, change management and monitoring of the Programme progress, as well as delivers strategic guidance and recommendations with regard to the management of the JU programme.

[33] GB Decision n°01/2021

[34] GB Decision n°02/2021

The body is composed of two representatives from the Commission on behalf of the Union and one representative from each of the Members other than the Union.

Representatives of the European Union Agency for Railways (ERA) and of the European Rail Research Advisory Council (ERRAC) are invited to attend meetings of the Governing Board as observers and take part in its deliberation, but do not have voting rights.

The chairpersons and vice-chairpersons of the States' Representatives Group have observer status in the governing board meetings. The chairpersons of the other bodies of the joint undertaking concerned have the right to attend meetings of the Governing Board as observers whenever issues falling within the scope of their tasks are discussed.

The GB holds ordinary meetings at least twice a year. Extraordinary meetings may be convened at the request of the chairperson, the Executive Director, the Commission or a majority of the representatives of the members other than the Union or of the participating states. In addition, the GB meets once a year in a general assembly and all participants to the research and innovation activities of EU-Rail are invited to attend. The purpose of such assembly is to stimulate reflection on the overall direction of the JU activities, while conducting an open and transparent discussion on the progress of the Master Plan implementation.

In 2025, it is foreseen that the EU-Rail's Governing Board will hold three meetings, the latter to be followed by a General Assembly.

The GB's key planned activities are listed below:

Key activities in 2025 – timetable	
Decision on Associated Members application	Q1
Adoption of the 2024 CAAR and of the Opinion on 2023 Final Annual Accounts, possible amendment adoption of the 2025-2026 Work Programme	Q2
Adoption of the 2026 Work Programme, Potential IKAA plan update, General Assembly to follow after the GB meeting	Q4

2.5.2 Executive Director

The Executive Director (ED) is the chief executive responsible for the day-to-day management of the JU in accordance with the decisions of the Governing Board. The Executive Director is the legal representative of EU-Rail. The ED is accountable to the Governing Board and is supported by the JU staff and advised by the System and Innovation Programme Board (ED-SIPB)[35].

2.5.3 Scientific Steering Group

In November 2023, the role of the JU's scientific advisory body was taken over by the Scientific Steering Group (SSG), formed following the GB Decision 13/2023 of 19 October 2023 on the appointment of the members of the Europe's Rail Scientific Steering Group and on the adoption of the reserve list.

[35] The ED-SIPB provides advice to the Executive Director on resources, schedule, planning and synchronization, implementation, change management and monitoring of the Programme progress, as well as delivers strategic guidance and recommendations with regard to the management of the JU programme.

In 2025, three meetings of the Scientific Steering Group are foreseen.

2.5.4 States' Representatives Group

Members States and countries associated to the Horizon Europe framework programme were asked to nominate their representatives to the States' Representatives Group (SRG).

The SRG shall be consulted, and in particular review information and provide opinions on the matters, such as:

- programme progress of the JU and achievement of its targets and expected impacts as part of Horizon Europe, including the information on calls for proposals and on the proposal evaluation process;
- updating of the Strategic Research and Innovation Agenda in line with the Horizon Europe strategic planning and with other Union and Member States funding instruments;
- links to Horizon Europe and other Union, national and, where relevant, regional initiatives, including cohesion policy funds in line with smart specialisation strategies;
- draft work programmes and consolidated annual activity reports;
- involvement of SMEs, start-ups, higher education institutions and research organisations, and measures taken for promoting participation of newcomers;
- actions taken for dissemination and exploitation of results along the value chain.

In addition, the Member States shall ensure that their respective representatives present a coordinated position that reflects their Member State's views expressed in:

- the committee established by Article 51 of Directive (EU) 2016/797;
- the Programme Committee under Horizon Europe configuration "Climate, Energy and Mobility";
- the Single European Rail Area Committee, established by Article 62 of Directive 2012/34/EU of the European Parliament and of the Council.

One of the key roles of the SRG is to ensure the interface with the JU on integration between the EU-Rail Programme and national, regional and local programmes and initiatives, in relation to R&I as well as dissemination and communications.

Dedicated meetings to cover subjects related to the activities of the System Pillar, the European DAC Delivery Programme and the Deployment groups are foreseen all along 2025.

Further to the above, the SRG may also issue, on its own initiative, opinions, recommendations or proposals to the Governing Board or the Executive Director on technical, managerial and financial matters as well as on work programmes and other documents, in particular when those matters affect national or regional interests.

For the year 2025, three meetings of the SRG are planned (in Q1, Q2 and Q4).

The tentative key activities are listed below:

Key activities in 2025 – timetable	
1st Meeting of the SRG in which it would: – Provide updated information and discuss initiatives on: regional and national research and innovation programmes to allow synergies;	Q1

dissemination and communication activities; deployment activities in relation to EU-Rail.	
2nd Meeting of the SRG (physical insofar as possible at the request of the SRG Chair) in which it would: – Provide opinion on the 2024 Annual Activity Report. – Provide opinion on the Multi Annual Work Programme update. – Provide updated information and discuss initiatives on: regional and national research and innovation programmes to allow synergies; dissemination and communication activities; deployment activities in relation to EU-Rail.	Q2
3rd Meeting of the SRG in which it would: - Provide opinion on the 2026 Work Programme - Provide consolidate report describing national/regional policies in the scope of the JU and identifying specific ways of cooperation with the actions funded by the JU.	Q4

2.5.5 The System Pillar steering group

The System Pillar steering group (SP-STG) shall be an advisory body of the Europe's Rail Joint Undertaking in charge of providing advice on System Pillar issues.

It is composed of representatives of the Commission, representatives of the rail and mobility sector and of relevant organisations, the EU-Rail's Executive Director, the chairperson of the SRG and representatives of the ERA and of the ERRAC. The body is chaired by the Commission.

It is the task of the SP-STG to provide advice to the Executive Director and Governing Board on matters, such as the following:

- the approach to operational harmonisation and the development of system architecture, including on the relevant part of the Master Plan;
- delivering on the specific objective regarding introducing a unified operational concept and a functional, safe and secure system architecture; as well as an integrated European rail traffic management, command, control and signalling systems, including automated train operation;
- carrying out the task related to developing within the System Pillar a system view that reflects the needs of the rail manufacturing industry, the rail operating community, Member States and other rail private and public stakeholders, including bodies representing customers, such as passengers and freight and staff, as well as relevant actors outside the traditional rail sector;
- monitoring the progress of the System Pillar.

Four meetings of the SPSG are foreseen in 2025, one each quarter.

The System Pillar Steering Group is supported by the JU System Pillar Unit and the System Pillar Core Group.

Additionally, the System and Innovation Programme Board, in its advisory role to the Executive Director, supports the activities of the System Pillar steering, committed to advising on the coordination of resources, budgets and timescales, as well as interaction with the Innovation Pillar as well as change management and conflicts.

The EU-Rail Governing Board, as the body responsible for the overall oversight over the EU-Rail's activities, is the final decision body within the System Pillar decision-making process.

2.5.6 The Deployment Group

The role of the Deployment Group shall be to advise the Governing Board on the market uptake of rail innovation developed in the Europe's Rail Joint Undertaking and to support deployment of the innovative solutions.

The EU-Rail Deployment Group mainly consists in a High-Level Core Group which could be assisted on an ad-hoc basis by dedicated groups on specific topics requiring additional expertise. Such dedicated groups will be selected upon recommendation of the High-Level Core Group and in agreement of the Governing Board. The Deployment Group shall be open to all stakeholders. The composition of the Deployment Group shall ensure appropriate thematic focus and representativeness.

Following consultations with the European Commission and private Founding Members of the Europe's Rail Joint Undertaking, as well as the States' Representative Group and Scientific Steering Group (at that time still acting as the Scientific Committee), EU-Rail launched a GB written procedure for establishment of the Deployment Group in June 2023.

At the end of November 2023, the Commission requested support to EU-Rail for the selection process and to propose a number of preselected candidate members (i.e., representatives of EU-Rail Founding Members and of representative bodies), after consulting the System and Innovation Programme Board and considering potential candidates proposed by the States' Representative Group. However, the proposal made by EU-Rail was not binding for the Commission.

The European Commission will took final decision on the composition, structure, and list of candidates to become Members of the Deployment Group in accordance with Articles 22 and 97 of the Single Basic Act, in Commission Decision (C(2024 8368).

The activities of the Deployment Group started informally and in agreement with the Commission in 2024 and it is expected to deliver its first recommendations in 2025.

2.6 Strategy and plans for the organisational management and internal control systems

2.6.1 EU-Rail organization

EU-Rail is organized in Units managed by their Heads, complemented with additional functions reporting directly to the Executive Director. The Programme Unit is further divided into two parts: the Innovation Pillar and the System Pillar. The Head of the System Pillar Unit reports to the Executive Director, but he/she also remains functional reporting to the Head of Programme. EU-Rail organization is depicted in the chart provided in Annex II.

The Programme management falls under the remit of the Head of Programme, who reports to the Executive Director, and has direct responsibility for the Innovation Pillar, while ensuring coordination with the System Pillar as well. During the transition period until the Executive Director is appointed,

the Head of Programme covers also the role of Executive Director a.i., supported in the Programme management by the Head of System Pillar and the three Senior Programme Managers.

The Head of Corporate Services reports to the Executive Director, and is responsible for providing the necessary financial, administrative, legal and compliance support in relation to the activities of the JU.

Other functions of the Programme Office, such as the Assistant of the ED, the Chief Stakeholder Relations and Dissemination, the HR Officer and the Internal Control Coordinator report directly to the Executive Director.

The organization has established its way of working - the "EU-Rail ingredients" - which builds on a series of elements defining the commitment of the staff to strive for a values-based organization.

2.6.2 Internal Control Framework

In 2019, the JU started the process of implementing the new Internal Control Framework (ICF) reflecting also the practices applied in this respect by the Commission, and being based on the COSO[36] Internal Control – Integrated Framework, with five basic components further broken into seventeen principles. Introduction of this new ICF aimed, besides other, at introducing a more pro-active approach in the design and implementation of internal controls, rather than focusing mostly on the compliance aspects. This process resulted in 2020 in the adoption of a revised ICF by means of the Executive Director's Decision ED-20-08. The ICF will continue to be subject to ongoing amendments and fine-tuning, as deemed appropriate, in order to reflect the developments in the internal and external environment of the JU. Further details on the relevant JU's control components are provided in the following Sections.

The EU-Rail's ICF is designed to provide reasonable assurance regarding the achievement of the following objectives:

- Effectiveness, efficiency and economy of operations;
- Reliability of reporting;
- Safeguarding of assets and information;
- Prevention, detection, correction and follow-up of fraud and irregularities;
- Adequate management of the risks relating to the legality and regularity of the underlying transactions, taking into account the multiannual character of programmes as well as the nature of the payments concerned.

The achievement of these ICF objectives are built, besides other elements, on:

- procedures for selecting the best projects through independent evaluation, and for translating them into legal instruments;
- project and contract management throughout the lifetime of every project/contract;
- ex-ante checks and controls[37];
- certification by independent auditors of costs representing the in-kind contributions to additional activities provided by the private members of the JU;

[36] COSO = Committee of Sponsoring Organizations of the Treadway Commission, where the sponsoring organizations are: Amerincan Accounting Association, Association of International Certified Professional Accountants, Financial Executives International, The Association of Accountants and Financial Professionals in Business, The Institute of Internal Auditors.

[37] While for the EU-Rail H2020 grants based on actual costs, such ex-ante controls still include checks of claims, including receipt of audit certificates and ex-ante certification of cost methodologies, for the lump sum grants the focus of the ex-ante controls lies with the qualitative (technical/scientific) apsects of the actions funded by EU-Rail.

- ex-post controls[38];
- qualitative evaluation of project results.

Furthermore, the adherence to ethical and organisational values will continue to be one of the key roles of the Joint Undertaking, subject to monitoring by the Commission. The Executive Director, as the Authorising Officer, will promote a cost-effective system of internal control and management and will be required to report to the GB in this respect. The JU will monitor, with the oversight of its GB, the risk of non-compliance through the developed reporting system[39]. In the application of its control system, the JU will strive for striking a balance between attaining the desired qualitative level of project deliverables on one hand, and a reasonable control burden on the other hand. In other words, the need to manage the budget in an efficient and effective manner, to prevent fraud and to ensure the agreed qualitative level of the projects' work packages delivery will be combined with the effort of avoiding of the Union's Research programme becoming less attractive for the stakeholders from the industry.

In Q1 2025, an annual assessment of the EU-Rail ICF will be conducted both at the level of its individual 17 principles, and from the perspective of the framework as a whole. The assessment will also take into account the available recommendations from the Internal Audit Service of the European Commission, as well as possible recommendations of the European Court of Auditors. The results of the ICF assessment will be presented in the EU-Rail 2025 Consolidated Annual Activity Report.

2.6.3 Financial procedures

EU-Rail shall fully comply with the requirements of Regulation (EU, Euratom) 2018/1046 (the Financial Regulation) as complemented by the EU-Rail Financial Rules. As this regard, on 30 September 2024 Regulation (EU, Euratom) 2024/2509 of the European Parliament and of the Council on the financial rules applicable to the general budget of the Union (recast) entry into force[40]. In accordance with Article 71 of the new Financial Regulation, the Commission is empowered to adopt delegated acts to supplement this Regulation with a model financial regulation for public-private partnership bodies laying down the principles necessary to ensure sound financial management of Union funds[41].

In compliance with Article 71 of Regulation (EU, Euratom) 2018/1046, the Joint Undertaking shall respect the principle of sound financial management. EU-Rail shall also comply with the provisions of the Model Financial Regulation applicable to the Joint Undertaking above referred. As stated in article 71, the EU-Rail Financial Rules shall not depart from the model financial regulation except where their specific needs so require and subject to the Commission's prior consent. Monitoring arrangements, including through the Union representation in the Governing Board, as well as reporting arrangements, will ensure that EU-Rail can meet the accountability requirements both to the College and to the Budgetary Authority.

With regard to ICT tools applied to support its financial procedures, since 2016, the JU has utilized ABAC Workflow. At the time of deployment of this tool, the JU adopted its Manual of Financial

[38] While for the EU-Rail H2020 grants based on actual costs, such ex-post controls still include financial audits on a sample of claims as part of the Horizon 2020 ex-post audit strategy, for the lump sum grants the focus of the ex-post controls lies with the qualitative (technical/scientific) apsects of the actions funded by EU-Rail.

[39] For the EU-Rail H2020 grants based on actual costs, such reporting will still include following up on the results of ex-post financial audits performed by the CAS, including reporting on the cummulative residual error rate of the H2020 Programme.

[40] OJ L, 2024/2509, 26.9.2024.

[41] At the time of publication of this work programme, the Commission has not yet adopted a model financial regulation for public-private partnership bodies. Upon its adoption, the current EU-Rail Financial Rules may be amended or a new Rail Financial Rules may be adopted. Until this date, the current EU-Rail Financial Rules continues to apply.

Procedures including the applicable Financial Circuits. This Manual of Financial Procedures was further revised in a new version in 2017, and amended again later in 2019 and in 2023. The Financial circuits will be further amended in 2025 to take into consideration the updated organigramme of the JU.

The Manual of Financial Procedures has been designed to guarantee a segregation of duties and to apply the four eyes principle in JU's financial transactions. It describes in detail the financial circuits that EU-Rail implements per type of transactions and the roles and responsibilities of each actor involved. To a lesser extent, it also describes the basic principles related to the main processes (grants & procurements).

During the past years, the processes and procedures have been further reinforced with the introduction of the JU Cooperation Tool for the H2020 Programme (including for in-kind contribution declarations and certifications) while for Horizon Europe the integration of IKOP and IKAA is done in the Compass tool, the Governance and Process Handbook, implementation of ICT tool ABAC Assets and different specific procedures that enhance the sound financial management in the implementation of the activities. The functioning of the JU's financial procedures will continue to be subject to regular assessments of the current Internal Control Framework adopted in 2020, and adjustments may be introduced in the future, also taking into account practical experience gained with the implementation of these processes and procedures.

The JU will continue also in the future in reflecting the changes of its financial procedures, as the case may be, in its key internal guiding documents underpinning its day-to-day activities, such as the Governance and Process Handbook.

2.6.4 Ex-ante and ex-post controls

In 2025 and 2026, the focus of ex-ante, and gradually also of the ex-post controls, will shift from the previous S2R Programme, that was finalized, to the EU-Rail's current Programme under Horizon Europe (HE) launched in 2022. In carrying out of these control activities, EU-Rail will follow the procedures for ex-ante and ex-post controls established in its Financial Rules, in the common guidelines applicable to HE introduced by the European Commission, as well as in its relevant internal documents, such as the HE Control Strategy for Grants.

As for the **ex-ante controls** in general, the Article 21(1) of EU-Rail Financial Rules applies, providing that "*each operation shall be subject at least to an ex-ante control relating to the operational and financial aspects of the operation, on the basis of a multiannual control strategy which takes risk into account*". The ex-ante controls are considered essential to prevent errors and to avoid the need for ex-post corrective actions. They take the form of e.g. checking contracts and grant agreements, initiating, checking and verifying invoices and carrying out desk reviews (such as mid-term reviews carried out by external experts on JU's projects), etc. In addition to the controls following from the common guidelines put in place by the Commission as mentioned above, EU-Rail applies some additional control mechanisms defined internally, e.g. the maturity checkpoints for grants.

For the HE grants, EU-Rail has put in place its risk-based Control Strategy to also reflect on the audit recommendations of IAS and ECA. This strategy covers both ex-ante and ex-post controls for grants and fully reflects the fact that under its current Programme, EU-Rail intends to apply solely the lump sum form of funding. The main difference resulting thereof, in comparison to grants based on actual costs, is that the payments will not depend on claiming the costs actually incurred, that beneficiaries will not be obliged to provide the JU with audit certificates and keep/provide financial records, and

that such records may not be requested by the JU during or after the implementation of the action[42]. These differences reflect under the new EU-Rail Control Strategy for Grants in putting emphasis on scientific/technical performance and output of projects, that is in shifting even more from quantitative (financial) type of controls to qualitative (technical) type of controls.

In addition, for its HE Programme, EU-Rail has launched in the second semester of 2023 for all six Flagship Projects application of a new control mechanism for assessing the maturity of the technological developments – the process referred to as the "maturity checkpoints". This mechanism was created to ensure that the technical activities are on track, that they are reaching the desired TRL and that a sectoral alignment of the developed solutions is ensured in the context of other linked Flagship Projects and of the System Pillar. This process will also be supported by independent technical experts.

In accordance with the Article 22 of the EU-Rail Financial Rules, **ex-post controls** are defined as the controls executed to verify financial and operational aspects of finalised budgetary transactions. The main objectives of the ex-post controls are to ensure that the principles of legality, regularity and sound financial management (economy, efficiency and effectiveness) have been respected and to provide the basis for corrective and recovery activities, if necessary.

The ex-post controls of projects from the S2R Programme based on actual costs included financial audits which were covered by the Horizon 2020 Audit Strategy and carried out by the Common Audit Service (CAS) of the Commission. Depending on the timing of the actual finalization of the legacy financial audits performed by the CAS, EU-Rail will still be reporting the outcome of these ex-post audits in its Consolidated Annual Activity Reports for the respective year. This reporting will include the error rates identified and applicable to the JUs population of H2020 projects.

For the lump sum actions intended by EU-Rail to be applied as a sole form of grants under HE, in the absence of any obligations of beneficiaries to report on costs actually incurred, there will not be any financial ex-post audits conducted by the CAS for EU-Rail grants, as well as there will not be any error rate calculation. The JU will be implementing an alternative form of ex-post assurance activities, such as reviews, focused on qualitative/technical assessments of agreed work packages and beneficiaries. These control activities will also be subject to the EU-Rail risk-based Control Strategy for Grants[43], endorsed by the ED end of 2023, and which took into account of the practical experience from the pilot ex-post review of an H2020 lump sum participation conducted in June 2023.

Further to the above-mentioned types of controls, the JU has been applying since 2018 an internal mechanism of ex-post controls on financial transactions related to administrative expenditure as another element in the control framework to complement the overall assurance on the effective implementation of the financial procedures. In 2025 and 2026, the ex-post review on administrative expenditure will continue to be organised as an annual exercise.

2.6.5 Audits

In accordance with *Article 28* of the EU-Rail Financial Rules, the internal audit function shall be performed by the European Commission's Internal Audit Service (IAS).

---

[42] As follows from the decision authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025)

[43] EU-Rail HE Control Strategy revised in December 2024 and adapted with the new guidance from RTD on ex-post technical reviews for lump sum grants.

The internal auditor shall advise EU-Rail on dealing with risks, by issuing independent opinions on the quality of management and control systems, and by issuing recommendations for improving the implementation of operations and promoting sound financial management. Following their in-depth risk assessment of EU-Rail performed in Q4 2023, IAS introduced their Strategic Internal Audit Plan for the period 2024-2026 which includes the pre-selected prospective audit topics and reserve audit topics, subject to annual reassessments.

In 2025-2026, EU-Rail will reflect on the outcomes of the IAS' audits by addressing in due time possible recommendations following thereof.

The financial audit of the JU's annual accounts is performed by an external audit firm that has been chosen under the Framework contract of the European Commission, on the basis of the joint tendering of the services by the EC, agencies and other JUs. From 2024 onwards, all the JUs would also have the possibility to make use of the audit and accounting support contract resulting from the respective tender which was awarded in 2023 in the context of the BOA for Accounting Services.

Each year, the European Court of Auditors (ECA) prepares a specific annual report on the JU in line with the requirements of Article 287(1) of the Treaty on the Functioning of the European Union. In preparing the report, the Court considers the audit work performed by the aforementioned independent external auditor and the action taken in response to their findings.

In 2025-2026, EU-Rail will reflect on the outcomes of the ECA's audits and follow-up audits for previously issued recommendations in order to resolve the respective issues in due time. For horizontal ECA's observations common to several or all JUs, EU-Rail will continue to liaise with the concerned peer Joint Undertakings in finding the adequate ways of addressing those points.

With regard to the H2020 actions based on actual cost reporting funded by the JU, those grants may still be subject in 2025-2026 to finalization of the legacy financial ex-post audits based on previous sampling exercises, in line with the Horizon 2020 common Audit Strategy implemented by the CAS (see also Section 2.6.4). Otherwise, the JU's grants under Horizon Europe, which will be solely based on lump sum form of funding, will by definition no longer be subject to CAS' financial audits where checking of costs actually incurred by the beneficiaries would be involved. However, those grants can still be subject to independent audit activities of the respective bodies (ECA, IAS) in line with their mandates, and based on their own methodology as applicable to the lump sum form of financing.

2.6.6 Risk Management

EU-Rail has an established process of risk management reflecting also the practices applied by the Commission, and being based on the COSO Internal Control – Integrated Framework in which risk assessment represents one of the five basic components of the internal control system. It is a continuous process involving clear communication to governance, staff and stakeholders on how EU-Rail positions itself in the management of risks and opportunities that can affect the achievement of its objectives, taking into consideration the assessment of the level of uncertainty that the JU is willing to accept (risk appetite). The Executive Director approves the policy and sets the tone, staff at the different levels implement the policy in the day-to-day operations. The Governing Board acknowledges the most relevant risks embedded in the JU's risk register brought to its attention by means of the Work Programme and of the Consolidated Annual Activity Report.

In the upcoming period, EU-Rail will continue, in addition to the ongoing ad hoc monitoring and in accordance with its Governance and Process Handbook and the EU-Rail risk-based Control Strategy for Grants, with the conduct of comprehensive annual risk assessment exercises to identify risks

relevant for 2025 and 2026. Such exercises will aim at updating the elements related to risks and opportunities already included in the JU's risk register, as well as at identifying potential new ones. Current internal and external factors and developments having influence on JU's business will be taken into account, as well as the views of IAS following from their assessments of the JU's risks. Due attention will be given also to the fraud risks.

In addition, more targeted assessments of risks related to individual projects/beneficiaries will be part of the implementation of the EU-Rail risk-based Control Strategy for Grants, which was introduced end of 2023.

2.6.7 Anti-fraud strategy

In July 2022, EU-Rail adopted its new Anti-Fraud Strategy for 2022-2025[44] which replaced the previous one initially introduced in 2017. The adoption was preceded by a thorough specific fraud risk assessment. Part of this assessment, in particular the one pertaining to the grant management fraud risks, was conducted commonly at the level of the entire Family of the EU Research & Innovation Services, Agencies and Joint Undertakings (Research Family) and steered by DG RTD. This was complemented at EU-Rail level with the assessment of other risks of fraud, such as those related to procurement, recruitment, misuse of internal information, misuse of JU's reimbursement schemes, etc.

By means of its current Anti-Fraud Strategy, similarly to the previous one, EU-Rail will continue to cover, to the applicable extent, all four elements of the anti-fraud cycle, namely: prevention, detection, investigation and correction.

The main anti-fraud objectives of the JU for the period of 2022-2025 are the following:

1) keeping the JU's internal legal framework related to anti-fraud policy up to date,
2) fostering an anti-fraud culture throughout the organisation,
3) maintaining a high level of awareness and knowledge among the staff members on the subject matter,
4) ensuring high level of reactivity towards OLAF/EPPO,
5) preventing the misuse of internal information/data.

These objectives will be pursued by means of particular measures and actions listed in the related action plan. The actions will be followed up and the action plan will be assessed for potential updates regularly, as a minimum, once a year. To assess the actual conduct and quality of performance of individual EU-Rail anti-fraud activities, several indicators will be used and the results presented in the Consolidated Annual Activity Report for the respective year.

In performing the above-mentioned activities, EU-Rail will continue in taking advantage of knowledge and experience gained by participating in the Fraud and Irregularities in Research Committee (FAIR) and its substructures. Developments with regard to the anti-fraud policies of the European Commission, of the Research Family, and of the JU's parent Directorate General - MOVE – will be considered as well.

Since the JU considers conflict of interest a potential prerequisite for possible fraudulent behaviour, various established measures will continue to be applied at EU-Rail to mitigate this inherent risk, such as:

- declarations on non-existence of conflict of interest by the staff members;

[44] https://rail-research.europa.eu/wp-content/uploads/2022/07/ED-DECISION_ED-22-02_Anti-Fraud-Strategy-2022-2025_Annex_AFS.pdf

- utilization of independent experts in selection procedures who will be obliged to declare any potentially conflicting interests;
- annual declaration of interests by the Governing Board members, as well as declaration of confidentiality and conflict of interest by all attendees to each EU-Rail's Governing Board meeting.

3. BUDGET 2025-2026[45]

In accordance with the General Annexes of the Horizon Europe Work Programme 2023-2025, with regard to budget flexibility, the budgets set out in the calls and topics are indicative. Unless otherwise stated, final budgets may change following evaluation. The final figures may change by up to 20% compared to the total budget indicated in each individual part of the Work Programme. Changes within these limits will not be considered substantial within the meaning of Article 110(5) of Regulation (EU, Euratom) No 2018/1046.

Budget 2025

Statement of Revenue, Title IV (Operational EU-Rail Programme):
Increase of commitment and payment appropriations from operational third countries excluding EFTA (R0) by EUR 9.666.667 for 2025, as a result of the association of the United Kingdom to the Horizon Europe Programme, of the EU-Rail GB request as per decision n. 17/2023 on the commitment expressed by the private members to match a possible increase in the Union contribution to the Europe's Rail Joint Undertaking, and of the endorsement of the Horizon Europe Steering Board based on a proposal by the European Commission.
Decrease of commitment appropriations from the Union by EUR 3.000.000 for 2025, as a result of the European Commission's implementation of the Council Regulation 2023/0201 related to the revision of the EU Multi-Annual Financial Framework for 2021-2027, with the redeployment of EUR 2.1 billion from Horizon Europe in favor of other initiatives (notably the establishment of the Ukraine facility and the support to the objectives of the Strategic Technologies for Europe Platform (STEP) and the new instrument for NextGenerationEU interest financing).

Amendment Nr 1- Statement of Revenue

Introduction of **EUR 397.354,89** of unused commitment appropriations (EUR 292.906,8 from the operational part and EUR 104.448,09 from the administrative part of the Budget) stemming from de-commitments made for the years 2022-2024.

Introduction of the Assigned Revenue fund source in the EU-RAIL Budget Structure with a pro-memoria (p.m.) reference.

Amendment Nr 1- Statement of Expenditure

Title I and II:

Adaptation of the commitment and payment appropriations per line is proposed considering the evolution of budget needs identified during the first quarter. The amount of EUR 198.453 of commitment appropriations and EUR 888.012,5 of payment appropriations are transferred from unused administrative appropriations from the Budget Line 520 to various Budget Lines in titles I and II to cover the administrative needs of EU-RAIL for the current year.

Title III:

Transfer of EUR 42.523.485,48 of operational unused commitment appropriations from the Budget Line 530 to the Budget line 400 to cover for the launch of the CALL-2025-02–2nd wave of Flagship area projects.

[45] 2025 and 2026 Budget (Commitment and Payment appropriations) are subject to the adoption of the EU General Budgets for the respective years. All figures may be updated during both of these adoption procedures.

Transfer of EUR 28.712.521,3 of operational payment appropriations from the Budget Line 530 to the Budget line 400 to cover operational needs of the EU-RAIL for the current year.

Budget 2026

Statement of Revenue, Title IV (Operational EU-Rail Programme):

Increase of commitment and payment appropriations from operational third countries excluding EFTA (R0) by EUR 9.666.667, as a result of the association of the United Kingdom to the Horizon Europe Programme, of the EU-Rail GB request as per decision n. 17/2023 on the commitment expressed by the private members to match a possible increase in the Union contribution to the Europe's Rail Joint Undertaking, and of the endorsement of the Horizon Europe Steering Board based on a proposal by the European Commission. Decrease of commitment appropriations by EUR 4.000.000 for 2026, as a result of the European Commission's implementation of the Council Regulation 2023/0201 related to the revision of the EU Multi-Annual Financial Framework for 2021-2027, with the redeployment of EUR 2.1 billion from Horizon Europe in favor of other initiatives (notably the establishment of the Ukraine facility and the support to the objectives of the Strategic Technologies for Europe Platform (STEP) and the new instrument for NextGenerationEU interest financing).

STATEMENT OF REVENUE - AMENDED - VARIANCE A1							
Title Chapter	**Heading**	**Financial Year 2025 - A1**			**Financial Year 2026**		
		Estimate Commitment Appropriations	Estimate Payment Appropriations	In %	Estimate Commitment Appropriations	Estimate Payment Appropriations	In %
EU contribution (excluding EFTA and third countries contribution)[2]		**87.888.739**	**30.905.930**	37%	**73.858.880**	**78.832.117**	81%
of which (fresh C1) Administrative (Title 1&2)		**2.450.261**	**2.450.261**	3%	**2.553.771**	**2.553.771**	3%
of which frontloaded commitments (Title 1 and Title 2)		-	-		-	-	
of which Operational (Title 3)		**85.438.478**	**28.455.669**	34%	**71.305.109**	**76.278.346**	79%
Of which related to additional entrusted tasks		-	-		-	-	
EFTA and third countries contribution		**12.083.607**	**10.516.580**	13%	**11.697.786**	**11.834.550**	12%
of which Administrative EFTA(Title 1&2)		**67.382**	**67.382**	0%	**70.229**	**70.229**	0%
Of which administrative third countries excluding EFTA (Title 1&2)		-	-		-	-	
of which Operational EFTA (Title 3)		**2.349.558**	**782.531**	1%	**1.960.891**	**2.097.655**	2%
Of which operational third countries excluding EFTA (Title 3)		**9.666.667**	**9.666.667**		**9.666.667**	**9.666.667**	
Financial Members other than the Union contribution		**2.537.000**	**2.537.000**	3%	**2.624.000**	**2.624.000**	3%
of which Administrative (Title 1&2)		**2.537.000**	**2.537.000**	3%	**2.624.000**	**2.624.000**	3%
of which Operational (Title 3)		-	-		-	-	
Financial Contributing partners contribution					-	-	
Interest generated		-	-		-	-	
Assigned Revenue		**p.m.**	**p.m.**		**p.m.**	**p.m.**	
Unused appropriations from previous years		**45.587.747**	**38.788.226**	47%	**3.059.813**	**3.532.735**	4%
Of which administrative		**3.164.261**	**3.532.735**	4%	**3.059.813**	**3.532.735**	4%
Of which operational		**42.423.485**	**35.255.491**	43%	-	-	0%
TOTAL ESTIMATE REVENUE		**148.097.092**	**82.747.736**	100%	**91.240.479**	**96.823.402**	100%

STATEMENT OF EXPENDITURE - AMENDED - VARIANCE A1								
Title Chapter	Heading	Financial Year 2025 - A1			Financial Year 2026			
		Estimate Commitment Appropriations	% Ratio [Year N/year N-1]	Estimate Payment Appropriations	Estimate Commitment Appropriations	% Ratio [Year N+1/year N]	Estimate Payment Appropriations	% Ratio [Year N+1/year N]
1- Staff								
Salaries & allowances								
- Of which establishment plan posts	**110**	1.550.000,00	129%	1.431.163,00	1.596.500	103%	1.596.500	103%
- Of which external personnel	**111**	1.875.244,00	89%	1.972.221,00	1.875.630	103%	1.875.630	103%
Expenditure relating to Staff recruitment								
Mission expenses	**130**	120.000,00	100%	120.000,00	120.000	100%	120.000	100%
Socio-medical infrastructure								
Training	**150**	50.000,00	156%	53.332,00	50.000	100%	50.000	100%
External Services								
Receptions, events and representation								
Social welfare								
Other Staff related expenditure	**190**	300.000,00	254%	311.730,00	300.000	100%	300.000	100%
2-Infrastructure and operating								
Rental of buildings and associated costs	**200**	378.000,00	105%	733.240,00	378.000	100%	378.000	100%
Information, communication technology and data processing	**210**	306.154,00	198%	313.220,00	245.000	100%	245.000	100%
Movable property and associated costs	**220**	20.000,00	200%	20.000,00	10.000	100%	10.000	100%
Current administrative expenditure	**230**	15.000,00	100%	15.000,00	15.000	100%	15.000	100%
Postage / Telecommunications	**240**	15.000,00	100%	15.000,00	15.000	100%	15.000	100%
Meeting expenses	**250**	36.000,00	72%	35.524,00				
Running costs in connection with operational activities	**260**	124.700,00	88%	297.793,00	110.000,00	100%	110.000,00	100%
Information and publishing	**270**	452.998,00	65%	408.647,00	550.000	157%	550.000	157%
Studies								
Other infrastructure and operating expenditure	**290**	110.000,00	147%	315.785,00	190.463	100%	210.000	110%
TOTAL ADMINISTRATIVE (1+2)		**5.353.096,00**	106%	**6.042.655,00**	5.455.593	106%	5.475.130	106%
3-Operational								
TOTAL OPERATIONAL (3)		139.878.188	186%	67.517.388,00	82.725.073	85%	87.815.537	226%
Unused Appropriations								
TOTAL Unused		2.865.808,00	8%	9.187.693,00	3.059.813	7%	3.532.735	9%
ESTIMATE TOTAL EXPENDITURE		**148.097.092**	129%	**82.747.736,00**	**91.240.479**	**62%**	**96.823.402**	**117%**

STATEMENT OF REVENUE - AMENDED - VARIANCE A1														
		Financial Year 2025				Financial Year 2025 - A1			VARIANCE			Financial Year 2026		
Title Chapter	Heading	Estimate Commitment Appropriations	In %	Estimate Payment Appropriations	In %	Estimate Commitment Appropriations	Estimate Payment Appropriations	In %	Estimate Commitment Appropriations	Estimate Payment Appropriations	In %	Estimate Commitment Appropriations	Estimate Payment Appropriations	In %
EU contribution (excluding EFTA and third countries contribution)[2]		**87.888.739**	37%	**30.905.930**	37%	**87.888.739**	**30.905.930**	37%	-	-	100%	**73.858.880**	**78.832.117**	81%
of which (fresh C1) Administrative (Title 1&2)		**2.450.261**	3%	**2.450.261**	3%	**2.450.261**	**2.450.261**	3%	-	-	100%	**2.553.771**	**2.553.771**	3%
of which frontloaded commitments (Title 1 and Title 2)		-	0%	-	0%	-	-		-	-		-	-	
of which Operational (Title 3)		**85.438.478**	34%	**28.455.669**	34%	**85.438.478**	**28.455.669**	34%	-	-	100%	**71.305.109**	**76.278.346**	79%
Of which related to additional entrusted tasks		-	0%	-	0%	-	-		-	-		-	-	
EFTA and third countries contribution		**12.083.607**	13%	**10.516.580**	13%	**12.083.607**	**10.516.580**	13%	-	-	100%	**11.697.786**	**11.834.550**	12%
of which Administrative EFTA(Title 1&2)		**67.382**	0%	**67.382**	0%	**67.382**	**67.382**	0%	-	-	100%	**70.229**	**70.229**	0%
Of which administrative third countries excluding EFTA (Title 1&2)		-	0%	-	0%	-	-		-	-		-	-	
of which Operational EFTA (Title 3)		**2.349.558**	1%	**782.531**	1%	**2.349.558**	**782.531**	1%	-	-	100%	**1.960.891**	**2.097.655**	2%
Of which operational third countries excluding EFTA (Title 3)		**9.666.667**	0%	**9.666.667**	0%	**9.666.667**	**9.666.667**		-	-		**9.666.667**	**9.666.667**	
Financial Members other than the Union contribution		**2.537.000**	3%	**2.537.000**	3%	**2.537.000**	**2.537.000**	3%	-	-	100%	**2.624.000**	**2.624.000**	3%
of which Administrative (Title 1&2)		**2.537.000**	3%	**2.537.000**	3%	**2.537.000**	**2.537.000**	3%	-	-	100%	**2.624.000**	**2.624.000**	3%
of which Operational (Title 3)		-	0%	-	0%	-	-		-	-		-	-	
Financial Contributing partners contribution		-	0%	-	0%				-	-		-	-	
Interest generated		-	0%	-	0%	-	-		-	-		-	-	
Assigned Revenue		-		-		**p.m.**	**p.m.**					**p.m.**	**p.m.**	
Unused appropriations from previous years		**45.190.392**	47%	**38.788.226**	47%	**45.587.747**	**38.788.226**	47%	**397.355**	-	100%	**3.059.813**	**3.532.735**	4%
Of which administrative		**3.059.813**	4%	**3.532.735**	4%	**3.164.261**	**3.532.735**	4%	104.448	-	100%	**3.059.813**	**3.532.735**	4%
Of which operational		**42.130.579**	43%	**35.255.491**	43%	**42.423.485**	**35.255.491**	43%	292.907	-	100%	-	-	0%
TOTAL ESTIMATE REVENUE		**147.699.737**	100%	**82.747.736**	100%	**148.097.092**	**82.747.736**	100%	**397.355**	-	100%	**91.240.479**	**96.823.402**	100%

STATEMENT OF EXPENDITURE - AMENDED - VARIANCE A1

Title Chapter	Heading	Financial Year 2025				Financial Year 2025 - A1								Financial Year 2026			
		Estimate Commitment Appropriations	% Ratio [Year N/year N-1]	Estimate Payment Appropriations	% Ratio [Year N/year N-1]	Estimate Commitment Appropriations	% Ratio [Year N/year N-1]	Estimate Payment Appropriations	% Ratio [Year N+1/year N]	Estimate Commitment Appropriations	% Ratio [Year N+1/year N]	Estimate Payment Appropriations	% Ratio [Year N+1/year N]	Estimate Commitment Appropriations	% Ratio [Year N+1/year N]	Estimate Payment Appropriations	% Ratio [Year N+1/year N]
1- Staff																	
Salaries & allowances																	
- Of which establishment plan posts	**110**	1.550.000,00	129%	1.550.000,00	129%	1.550.000,00	129%	1.431.163,00	119%	-	0%	- 118.837,00	-10%	1.596.500	103%	1.596.500	103%
- Of which external personnel	**111**	1.821.000,00	89%	1.821.000,00	89%	1.875.244,00	89%	1.972.221,00	96%	54.244,00	0%	151.221,00	7%	1.875.630	103%	1.875.630	103%
Expenditure relating to Staff recruitment																	
Mission expenses	**130**	120.000,00	100%	120.000,00	120%	120.000,00	100%	120.000,00	120%	-	0%	-	0%	120.000	100%	120.000	100%
Socio-medical infrastructure																	
Training	**150**	50.000,00	156%	50.000,00	200%	50.000,00	156%	53.332,00	213%	-	0%	3.332,00	13%	50.000	100%	50.000	100%
External Services																	
Receptions, events and representation																	
Social welfare																	
Other Staff related expenditure	**190**	300.000,00	254%	300.000,00	75%	300.000,00	254%	311.730,00	78%	-	0%	11.730,00	3%	300.000	100%	300.000	100%
2-Infrastructure and operating																	
Rental of buildings and associated costs	**200**	378.000,00	105%	378.000,00	110%	378.000,00	105%	733.240,00	213%	-	0%	355.240,00	103%	378.000	100%	378.000	100%
Information, communication technology and data processing	**210**	245.000,00	158%	245.000,00	104%	306.154,00	198%	313.220,00	133%	61.154,00	39%	68.220,00	29%	245.000	100%	245.000	100%
Movable property and associated costs	**220**	10.000,00	100%	10.000,00	500%	20.000,00	200%	20.000,00	1000%	10.000,00	100%	10.000,00	500%	10.000	100%	10.000	100%
Current administrative expenditure	**230**	15.000,00	100%	15.000,00	107%	15.000,00	100%	15.000,00	107%	-	0%	-	0%	15.000	100%	15.000	100%
Postage / Telecommunications	**240**	15.000,00	100%	15.000,00	150%	15.000,00	100%	15.000,00	150%	-	0%	-	0%	15.000	100%	15.000	100%
Meeting expenses	**250**	-	0%	-	0%	36.000,00	72%	35.524,00	144%	36.000,00	72%	35.524,00	144%				
Running costs in connection with operational activities	**260**	110.000,00	78%	110.000,00	27%	124.700,00	88%	297.793,00	74%	14.700,00	10%	187.793,00	47%	110.000,00	100%	110.000,00	100%
Information and publishing	**270**	350.000,00	50%	350.000,00	41%	452.998,00	65%	408.647,00	48%	102.998,00	15%	58.647,00	7%	550.000	157%	550.000	157%
Studies																	
Other infrastructure and operating expenditure	**290**	190.643,00	254%	190.643,00	79%	110.000,00	147%	315.785,00	131%	- 80.643,00	-108%	125.142,00	52%	190.463	100%	210.000	110%
TOTAL ADMINISTRATIVE (1+2)		**5.154.643,00**	102%	**5.154.643,00**	87%	**5.353.096,00**	106%	**6.042.655,00**	102%	**198.453,00**	4%	**888.012,00**	15%	5.455.593	106%	5.475.130	106%
3-Operational																	
TOTAL OPERATIONAL (3)		97.354.702,00	130%	38.804.867,00	47%	139.878.188	186%	67.517.388,00	82%	42.523.485,98	57%	28.712.521,00	35%	82.725.073	85%	87.815.537	226%
Unused Appropriations																	
TOTAL Unused		45.190.392,00	131%	38.788.226,00	120%	2.865.808,00	8%	9.187.693,00	28%	- 42.324.584,00	-123%	- 29.600.533,00	-91%	3.059.813	7%	3.532.735	9%
ESTIMATE TOTAL EXPENDITURE		**147.699.737,00**	129%	**82.747.736,00**	68%	**148.097.092**	129%	**82.747.736,00**	68%	**397.354,98**	**0%**	-	**0%**	**91.240.479**	**62%**	**96.823.402**	**117%**

Table of Financial programming per year until 2027 (incl annual instalments)

	2022	2023	2024	Total	Ratio vs maximum Union contribution (art10 SBA) - max 50%	Total 2022-2024
Total amount to be assigned via annual instalments (Calls)	*232.475,2*					
Amount of annual instalments 2022-1	*135.707,2*	*55.936,1*	*40.831,9*	***232.475,2***	***38,9%***	
Amount to be assigned on annual budget (other calls/tenders/expe	*23.736,7*	*32.639,3*	*34.085,4*	*90.461,5*		
Available Commitment appropriations			*42.423,4*			
Total annual budget (operational EU-Rail Programme)	*159.443,9*	*88.575,4*	*117.340,7*			***365.360,1***

	2025	2026	2027	Total	Ratio cumulative budget of the residual years (min 20%)	Gran total 2022-2027
Total amount to be assigned via annual instalments (Calls)	*148.200,0*					
Available Commitment appropriations	42.423,4					
Amount of annual instalments	*79.610,7*	*26.165,9*		***148.200,0***		
Amount to be assigned on annual budget (other calls/tenders/expe	*17.844,0*	*56.766,7*	*51.452,6*	*126.063,3*	***46,0%***	
Total annual budget (operational EU-Rail Programme)	*97.454,7*	*82.932,6*	*51.452,6*			***597.200,0***

.

ANNEXES

Annex I - IKAA plan

The IKAA plan will be provided following the outcomes of the call for proposals 2025 as the additional activities proposed by the Founding Members in their letter of commitment, in addition to the already existing IKAA plan 2022-2024, and which are related to the future EU-Rail Projects.

The Executive Director will submit an amended Work Programme to update the IKAA plan following the award decision of the Governing Board call 2025-01.

Additional Activities can be accounted for as Private Members' In-Kind Contributions for Additional Activities, when they contribute to the objectives of EU-Rail and are directly linked to its activities, including non-eligible costs of indirect actions funded by EU-Rail, where this is provided for in the present annual additional activities' plan. Subject to the compliance with the aforementioned definition as stated in article 90 of the SBA, the adoption of the present annual additional activities' plan and the signature of the respective grants, Additional Activities will be considered eligible as In-Kind Contributions from the 1 March 2022, and up to two years following the end of the action.

SUBMITTEED IKAA PLAN 2025

OVERVIEW ESTIMATED AMOUNT OF IKAA FOR 2025	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project
1. Support to additional R&I	**3.825.910,01**	**45.377.681,18**
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	23.000,00	8.668.183,88
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	23.000,00	8.253.859,58
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	23.000,00	10.190.290,94
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 4 in the context of achieving the objectives and KPIs of the related Flagship Area	40.000,00	4.273.958,91
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 5 in the context of achieving the objectives and KPIs of the related Flagship Area	23.000,00	2.901.317,60
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 6 in the context of achieving the objectives and KPIs of the related Flagship Area	23.000,00	10.518.515,34
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 7 in the context of achieving the objectives and KPIs of the related Flagship Area	10.000,00	85.000,00
Additional activities are part and contribute to the Member's activities performed and described with the Exploratory Research Projects in the context of achieving the objectives and KPIs of the related Flagship Area	-	136.554,94
Asset Management wayside monitoring and decision management tools	-	50.000,00
ATO functions & integration ATO-OB with ETCS-OB | ATO-TS	-	300.000,00
Automation Island	321.426,00	-
DAC / DAK activities outside ERJU projects	400.000,00	-
Data space for railway	192.758,83	-
Digital Twin activities outside ERJU projects	100.000,00	-
Intuitive design of remote control centers	116.715,00	-
Monitoring and Maintenance of vehicle systems	43.440,00	-
Neuromorphic hardware for railways	45.990,55	-
Project ProCo: Non-funded activities	321.460,00	-
Project RoSto: Non-funded activities	300.000,00	-
Projects InTra & TraCo: Non-funded activities	1.189.806,00	-
Projects VMo4Orte, RoSto, ProCo: Non-funded activities	250.000,00	-
Real-time guarantees description language and contracts	179.313,63	-
System Pillar: Non-funded activities	200.000,00	-
2. Scale-up of technologies	**-**	**1.749.218,44**
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	322.655,00
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	552.805,00
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	-	373.758,44
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 6 in the context of achieving the objectives and KPIs of the related Flagship Area	-	120.000,00
Moving Block -TRL 5 to 7	-	380.000,00
3. Demonstrators	**-**	**10.116.087,62**
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	317.148,73

Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	389.598,10
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	-	1.185.169,92
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 4 in the context of achieving the objectives and KPIs of the related Flagship Area	-	5.227.361,15
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 5 in the context of achieving the objectives and KPIs of the related Flagship Area	-	2.411.809,73
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 6 in the context of achieving the objectives and KPIs of the related Flagship Area	-	585.000,00
4. Creating new business opportunities	**-**	**250.000,00**
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 6 in the context of achieving the objectives and KPIs of the related Flagship Area	-	250.000,00
5. Training and skills development	**-**	**36.000,00**
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	8.000,00
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 6 in the context of achieving the objectives and KPIs of the related Flagship Area	-	11.000,00
Additional activities are part and contribute to the Member's activities performed and described with the Exploratory Research Projects in the context of achieving the objectives and KPIs of the related Flagship Area	-	17.000,00
6. Contribution to the development of new standards, regulations and policies	**175.000,00**	**280.976,46**
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	235.976,46
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	-	45.000,00
Project "Querkraftverstärkung bei Brücken mit glatten Stäben": Non-funded activities	80.000,00	-
Project "TDR – Tunnel Drainage Rover": Non-funded activities	80.000,00	-
System Pillar: Non-funded activities	15.000,00	-
7. Supporting ecosystem development	**150.000,00**	**979.004,92**
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	320.000,00
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 4 in the context of achieving the objectives and KPIs of the related Flagship Area	-	179.004,92
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 5 in the context of achieving the objectives and KPIs of the related Flagship Area	-	480.000,00
Participation in national organisations and possible pilots and support of initiatives in the shape of contributions towards new concepts and ideas (Railforum, Energy Roundtable, etc.)	150.000,00	-
8. Communication, dissemination, awareness raising, citizen engagement	**95.000,00**	**31.375,00**
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	20.000,00
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	-	11.375,00
Participation in conferences and/or seminars to communicate and disseminate knowledge	95.000,00	-
9. Other	**193.000,00**	**783.659,00**
Additional activities related to the EU -RAIL program	160.000,00	-
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	240.000,00
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	-	50.000,00
Additional activities are part and contribute to the Member's activities performed and described with the Flagship Projects 5 in the context of achieving the objectives and KPIs of the related Flagship Area	33.000,00	493.659,00
Grand Total	**4.438.910,01**	**59.604.002,61**

Country	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project
Austria	298.000,00	2.699.000,00
Belgium	-	1.120.500,00
Czechia	33.000,00	770.000,00
France	-	20.560.678,20
Germany	3.700.910,01	4.715.000,00
Italy	160.000,00	7.757.991,11
Netherlands	150.000,00	2.085.347,75
Norway	10.000,00	860.000,00
Poland	17.000,00	266.612,89
Spain	70.000,00	12.205.907,71
Sweden	-	5.364.464,96
Switzerland	-	781.250,00
United Kingdom	-	51.250,00
USA	-	366.000,00
Total	**4.438.910,01**	**59.604.002,61**

SUBMITTEED IKAA PLAN 2026

OVERVIEW ESTIMATED AMOUNT OF IKAA FOR 2025	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project
1. Support to additional R&I	**2.647.219,80**	**21.867.916,93**
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	19.333,33	3.710.775,06
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	19.333,33	5.896.100,71
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	19.333,33	3.918.158,23
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 4 in the context of achieving the objectives and KPIs of the related Flagship Area	19.333,33	3.954.206,69
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 5 in the context of achieving the objectives and KPIs of the related Flagship Area	19.333,33	2.460.592,30
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 6 in the context of achieving the objectives and KPIs of the related Flagship Area	19.333,33	1.415.040,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 7 in the context of achieving the objectives and KPIs of the related Flagship Area	10.000,00	28.500,00
Additional activities are part and contribute to the Member's activities performed and described within the Exploratory Research Projects in the context of achieving the objectives and KPIs of the related Flagship Area	-	134.543,94
Asset Management wayside monitoring and decision management tools	-	50.000,00
ATO functions & integration ATO-OB with ETCS-OB | ATO-TS	-	300.000,00
Automation Island	338.439,00	-
DAC / DAK activities outside ERJU projects	400.000,00	-
Data space for railway	176.693,48	-
Digital Twin activities outside ERJU projects	100.000,00	-
Intuitive design of remote control centers	160.277,00	-
Monitoring and Maintenance of vehicle systems	43.440,00	-
Neuromorphic hardware for railways	47.370,32	-
Project ProCo: Non-funded activities	205.000,00	-
Projects InTra & TraCo: Non-funded activities	600.000,00	-
Projects VMo4Orte, RoSto, ProCo: Non-funded activities	250.000,00	-
System Pillar: Non-funded activities	200.000,00	-
2. Scale-up of technologies	**-**	**1.706.413,44**
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	292.655,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	530.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	-	323.758,44
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 6 in the context of achieving the objectives and KPIs of the related Flagship Area	-	120.000,00

Moving Block -TRL 5 to 7	-	440.000,00
3. Demonstrators	**-**	**7.975.240,75**
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	177.148,73
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	370.598,10
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	-	1.109.456,20
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 4 in the context of achieving the objectives and KPIs of the related Flagship Area	-	3.623.228,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 5 in the context of achieving the objectives and KPIs of the related Flagship Area	-	2.374.809,73
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 6 in the context of achieving the objectives and KPIs of the related Flagship Area	-	195.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 7 in the context of achieving the objectives and KPIs of the related Flagship Area	-	125.000,00
5. Training and skills development	**-**	**233.000,00**
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	195.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	8.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 6 in the context of achieving the objectives and KPIs of the related Flagship Area	-	11.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Exploratory Research Projects in the context of achieving the objectives and KPIs of the related Flagship Area	-	19.000,00
6. Contribution to the development of new standards, regulations and policies	**15.000,00**	**383.982,51**
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	383.982,51
System Pillar: Non-funded activities	15.000,00	-
7. Supporting ecosystem development	**150.000,00**	**40.000,00**
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	40.000,00
Participation in national organisations and possible pilots and support of initiatives in the shape of contributions towards new concepts and ideas (Railforum, Energy Roundtable, etc.)	150.000,00	-
8. Communication, dissemination, awareness raising, citizen engagement	**230.671,00**	**32.375,00**
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	20.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	-	12.375,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 4 in the context of achieving the objectives and KPIs of the related Flagship Area	25.671,00	-
Participation in conferences and/or seminars to communicate and disseminate knowledge	205.000,00	-
9. Other	**190.000,00**	**783.659,00**
Additional activities related to the EU -RAIL program	160.000,00	-

Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	240.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 3 in the context of achieving the objectives and KPIs of the related Flagship Area	-	50.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Projects 5 in the context of achieving the objectives and KPIs of the related Flagship Area	30.000,00	493.659,00
Grand Total	**3.232.890,80**	**33.022.587,62**

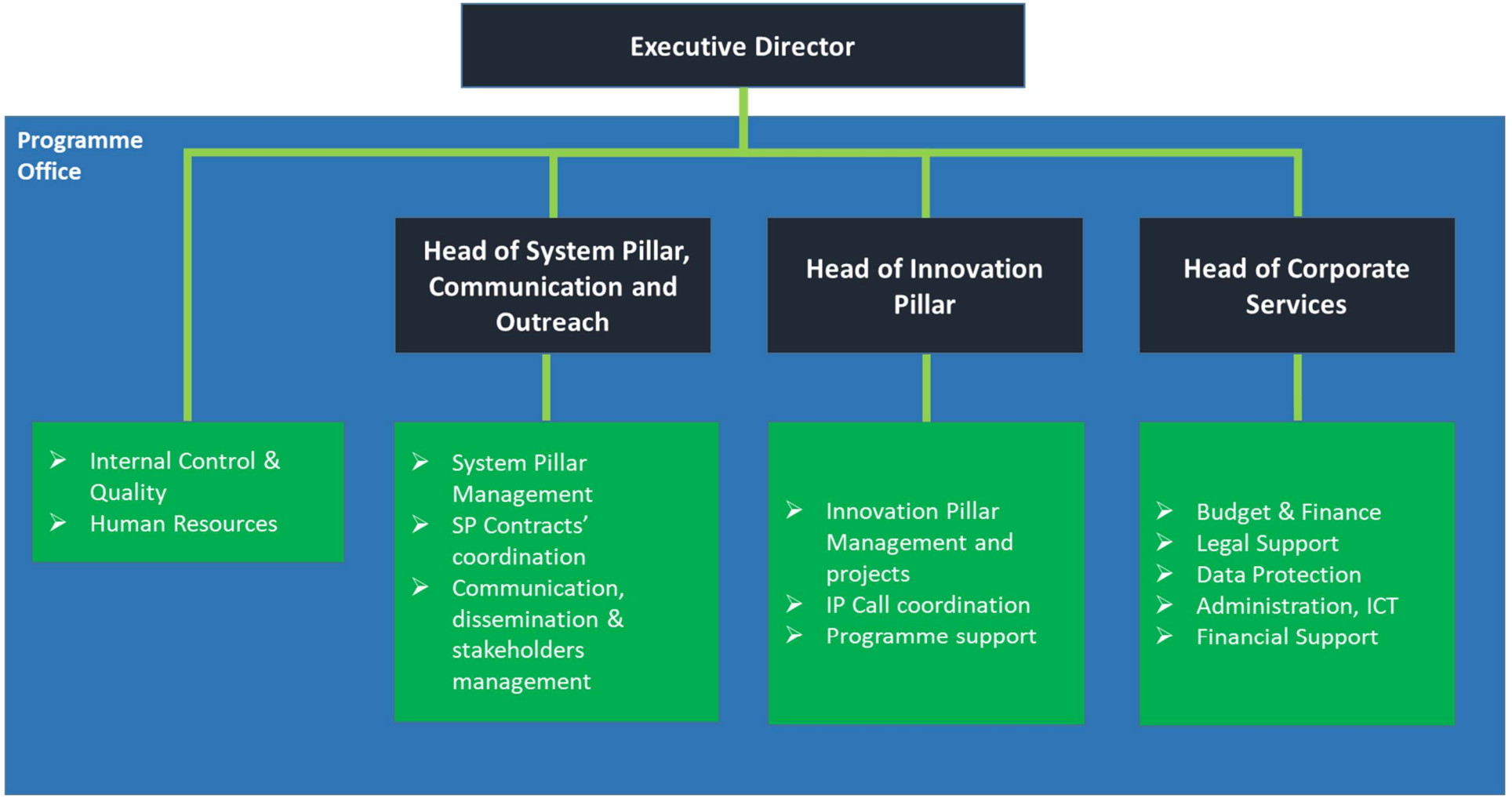
Country	**Estimated annual value (in €) - Link to JU objectives / KPIs**	**Estimated annual value (in €) - Link to JU project**
Austria	116.000,00	2.682.000,00
Belgium	-	347.500,00
Czechia	30.000,00	680.000,00
France	-	6.044.446,50
Germany	2.546.219,80	3.517.000,00
Italy	160.000,00	3.081.094,90
Netherlands	150.000,00	1.495.347,75
Norway	10.000,00	860.000,00
Poland	25.671,00	35.000,00
Spain	195.000,00	10.498.776,61
Sweden	-	3.327.171,86
Switzerland	-	121.250,00
United Kingdom	-	89.500,00
USA	-	243.500,00
Total	**3.232.890,80**	**33.022.587,62**

OVERVIEW CONSOLIDATED IKAA FOR THE PROGRAMME 2022-2026

AA category	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project
1. Support to additional R&I	13.414.675,60	178.869.377,15
2. Scale-up of technologies	2.100.000,00	11.739.245,54
3. Demonstrators	-	40.243.288,53
4. Creating new business opportunities	298.699,00	1.050.000,00
5. Training and skills development	-	2.080.636,51
6. Contribution to the development of new standards, regulations and policies	588.643,35	1.133.279,84
7. Supporting ecosystem development	700.000,00	5.492.425,09
8. Communication, dissemination, awareness raising, citizen engagement	1.020.671,00	141.675,39
9. Other	1.571.000,00	4.427.964,80
Total	**19.693.688,95**	**245.177.892,85**

Country	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project
Austria	718.000,00	15.240.460,00
Belgium	-	3.301.500,00
Czechia	878.699,00	2.965.000,00
France	400.000,00	55.556.701,50
Germany	14.845.275,60	34.290.673,66
Hungary	-	1.754.367,68
India	-	78.000,00
Italy	1.011.000,00	36.395.575,52
Netherlands	700.000,00	14.679.010,56
Norway	40.000,00	3.440.000,00
Poland	224.071,00	3.307.426,35
Portugal	-	30.000,00
Spain	876.643,35	52.022.366,26
Sweden	-	17.435.561,32
Switzerland	-	3.069.750,00
United Kingdom	-	202.000,00
USA	-	1.409.500,00
Total	**19.693.688,95**	**245.177.892,85**

Annex II - Organisational Structure of the Programme Office of EU-Rail



Annex III – Key Performance Indicators for Europe's Rail Joint Undertaking[46]

TABLE I - Horizon Europe Common Key Impact Pathway Indicators[47]

Key Impact Pathway	Short-term	Medium-term	Longer-term
Towards scientific impact			
1-Creating high-quality new knowledge	Publications - Number of peer-reviewed scientific publications resulting from the Programme	Citations - Field-Weighted Citation Index of peer-reviewed Publications resulting from the Programme	World-class science - Number and share of peer-reviewed publications resulting from the projects funded by the Programme that are core contribution to scientific fields
2-Strengthening human capital in R&I	Skills - Number of researchers involved in upskilling (training, mentoring/coaching, mobility and access to R&I infrastructures) activities in projects funded by the Programme	Careers - Number and share of upskilled researchers involved in the Programme with increased individual impact in their R&I field	Working conditions - Number and share of upskilled researchers involved in the Programme with improved working conditions, including researchers' salaries
3-Fostering diffusion of knowledge and open science	Shared knowledge Share of research outputs (open data/publication/software etc.) resulting from the Programme shared through open knowledge infrastructures	Knowledge diffusion -Share of open access research outputs resulting from the Programme actively used/cited	New collaborations - Share of Programme beneficiaries which have developed new transdisciplinary/trans sectoral collaborations with users of their open access research outputs resulting from the Programme
Towards societal impact			
4-Addressing Union policy priorities and global challenges through R&I	Results - Number and share of results aimed at addressing identified Union policy priorities and global challenges (including SDGs) (multidimensional: for each identified priority) Including: Number and share of climate-relevant results aimed at delivering on the Union's commitment under the Paris Agreement	Solutions - Number and share of innovations and research outcomes addressing identified Union policy priorities and global challenges (including SDGs) (multidimensional: for each identified priority) Including: Number and share of climate-relevant innovations and research outcomes delivering on Union's commitment under the Paris Agreement	Benefits - Aggregated estimated effects from use/exploitation of results funded by the Programme on tackling identified Union policy priorities and global challenges (including SDGs), including contribution to the policy and law-making cycle (such as norms and standards) (multidimensional: for each identified priority) Including: Aggregated estimated effects from use/exploitation of climate-relevant results funded

[46] Current insights on how individual partnerships, such as EU-Rail, will contribute to Horizon Europe Key Impact Pathways, and how the partnerships will be monitored using common indicators, can be obtained from the document "Performance of European Partnerships: Biennial Monitoring Report 2022 on partnerships in Horizon Europe" available here: https://op.europa.eu/en/publication-detail/-/publication/a6cbe152-d19e-11ec-a95f-01aa75ed71a1/language-en/format-PDF/source-search
Partial list of common indicators for European Partnerships is provided in the document " A robust and harmonised framework for reporting and monitoring European Partnerships in Horizon Europe", Section 5, available here: https://op.europa.eu/en/publication-detail/-/publication/6b63295f-d305-11eb-ac72-01aa75ed71a1/language-en

[47] Based on Annex V to Regulation 2021/695/EU

			by the Programme on delivering on the Union's commitment under the Paris Agreement including contribution to the policy and law-making cycle (such as norms and standards)
5-Delivering benefits and impact through R&I missions	R&I mission results - Results in specific R&I missions (multidimensional: for each identified mission)	R&I mission outcomes - Outcomes in specific R&I missions (multidimensional: for each identified mission)	R&I mission targets met -Targets achieved in specific R&I missions (multidimensional: for each identified mission)
6-Strengthening the uptake of R&I in society	Co-creation - Number and share of projects funded by the Programme where Union citizens and end-users contribute to the co-creation of R&I content	Engagement - Number and share of participating legal entities which have citizen and end-users engagement mechanisms in place after the end of projects funded by the Programme	Societal R&I uptake - Uptake and outreach of co-created scientific results and innovative solutions generated under the Programme
Towards technological / economic impact			
7-Generating innovation-based growth	Innovative results - Number of innovative products, processes or methods resulting from the Programme (by type of innovation) & Intellectual Property Rights (IPR) applications	Innovations - Number of innovations resulting from the projects funded by the Programme (by type of innovation) including from awarded IPRs	Economic growth - Creation, growth & market shares of companies having developed innovations in the Programme
8-Creating more and better jobs	Supported employment - Number of full time equivalent (FTE) jobs created, and jobs maintained in participating legal entities for the project funded by the Programme (by type of job)	Sustained employment -Increase of FTE jobs in participating legal entities following the project funded by the Programme (by type of job)	Total employment - Number of direct & indirect jobs created or maintained due to diffusion of results from the Programme (by type of job)
9-Leveraging investments in R&I	Co-investment - Amount of public & private investment mobilised with the initial investment from the Programme	Scaling-up - Amount of public & private investment mobilised to exploit or scale-up results from the Programme (including foreign direct investments)	Contribution to '3 % target' - Union progress towards 3 % GDP target due to the Programme

TABLE II - Horizon Europe Partnership Common Indicators

Criterion addressed	Name of the Indicator	Baseline at the start of HE	Results for 2023	Target 2027 (or partial earlier target)
Additionality	Progress towards (financial and in-kind) contributions from partners other than the Union – i.e. committed vs. actual	N/A	EUR 70M IKAA certified for a total 166M signed	Total In kind contribution: EUR 576 million Total financial contribution to the JU running costs: EUR 24 million
Additionality / Synergies	Additional investments triggered by the EU contribution, including qualitative impacts related to additional activities	N/A	Over the course of the programme, EU-Rail members contribute with additional activities, including mobilisation of private investment and national/regional programmes. Expected according to IKAA Plan 2022- 2024: 2024 amended = EUR 73M Estimated 2024 amended value of IKAA linked to JU objectives/KPIs - EUR 5.7M Estimated 2024 amended value of IKAA link to JU projects/topics - EUR 67M	Target 2022-2024: EUR 150,5 million
Directionality	Overall (public and private, in-kind and cash) investments mobilised towards EU priorities	0	EUR 243,9M funding in signed grants linked to the following EU priorities: - European Green Deal - Europe fit for digital age	EUR 600 million

International visibility and positioning	International actors involved	0	28 entities from Associated countries and Third countries are participating in projects as associated partners (8 from Norway, 9 from Switzerland, 8 from UK, 1 from Ukraine, 1 from Serbia and 1 from Turkey) By type: 1 public organization (4%), 12 higher or secondary education establishment (43%), 6 research organizations (21%), 7 private for profit organizations (25%) and 2 other organizations (7%)	N/A
Transparency and openness	Share & type of stakeholders and countries invited/engaged	0	In general the entire rail value chain. In projects: 329 beneficiaries (9 public organizations (3%), 56 higher or secondary education establishments (17%), 45 research organizations (14%), 202 private for profit organizations (61%) and 17 others (5%)) from: 26 countries (20 from EU and 6 associated and third countries) In the EU-Rail States' Representatives Group: 31 member states demonstrating interest (27 from EU and 4 associated countries)	N/A

Transparency and openness	No and types of newcomer members in partnerships and their countries of origin (geographical coverage)	0	Organisation Name	Category		Countr
			Administrador de Infraest	[PRV Other Industrial and/or profit Private organisation]		ES
			Alstom Transport SA	[PRV Other Industrial and/or profit Private organisation]		FR
			ANGELRAIL consortium le	[PRV Other Industrial and/or profit Private organisation]		IT
			AŽD Praha s.r.o	[PRV Other Industrial and/or profit Private organisation]		CZ
			Construcciones y Auxiliar	[PRV Other Industrial and/or profit Private organisation]		ES
			Asociación Centro Tecnol	[RES Public research organisation (including international research organisation as well as private research organisation controlled by a public authority)]		ES
			České dráhy, a.s.	[PRV Other Industrial and/or profit Private organisation]		CZ
			Deutsche Bahn AG	[PRV Other Industrial and/or profit Private organisation]		DE
			Deutsches Zentrum für Lu	[RES Public research organisation (including international research organisation as well as private research organisation controlled by a public		DE
			European Smart Green Ra	[PRV Other Industrial and/or profit Private organisation] + [RES Public research organisation (including international research organisation as well as private research organisation controlled by a public authority)]		ES
			Faiveley Transport SAS	[PRV Other Industrial and/or profit Private organisation]		FR
			Ferrovie dello Stato Italiar	[PRV Other Industrial and/or profit Private organisation]		IT
			Hitachi Rail STS S.p.A.	[PRV Other Industrial and/or profit Private organisation]		IT
			INDRA SISTEMAS S.A & PATEI	[PRV Other Industrial and/or profit Private organisation]		ES
			Jernbanedirektorate (Norv	[PRV Other Industrial and/or profit Private organisation]		NO
			Knorr-Bremse Systems für	[PRV Other Industrial and/or profit Private organisation]		DE
			Österreichische Bundesba	[PRV Other Industrial and/or profit Private organisation]		AT
			Polskie Koleje Państwowe	[PRV Other Industrial and/or profit Private organisation]		PL
			ProRail B.V. & NS Groep N.V.	[PRV Other Industrial and/or profit Private organisation]		NL
			Siemens Mobility GmbH	[PRV Other Industrial and/or profit Private organisation]		DE
			Société nationale SNCF, s	[PRV Other Industrial and/or profit Private organisation]		FR
			Strukton Rail Nederland B	[PRV Other Industrial and/or profit Private organisation]		NL
			THALES SIX GTS France SA	[PRV Other Industrial and/or profit Private organisation]		FR
			Trafikverket	[PRV Other Industrial and/or profit Private organisation]		SE
			voestalpine Railway Syste	[PRV Other Industrial and/or profit Private organisation]		AT

Transparency and openness	No and types of newcomer beneficiaries in funded projects (in terms of types and countries of origin)	N/A	51 newcomers (50 EU & 1 non-EU) of which 9 are SMEs. PRC: 15 PUB: 1 REC: 9 OTH: 3 HES: 23	
Coherence and synergies	Number and type of coordinated and joint activities with other European Partnerships	0	4 back office arrangements (2 of them as leading and lead backup contracting authorising)	7 arrangements among JUs in accordance with Art. 13 of the SBA
Coherence and synergies	Number and type of coordinated and joint activities with other R&I Initiatives at EU /national/regional/sectorial level	0	Coordinated activities at EU level with national / sectorial R&I actions on the Digital Automated Couplers with the European DAC delivery Programme, enabled by EU-Rail. Rail system architecture coordinated in the System Pillar with national and sectorial input notably around signalling activities. Coordination also with Rail Net Europe on infrastructure capacity planning and R&I on traffic management.	N/A

Coherence and synergies	Complementary and cumulative funding from other Union funds (Horizon Europe, National funding, ERDF, RRF, Other cohesion policy funds, CEF, DEP, LIFE, other)	0	Synergies with EU Missions – EUR 0,7M for Smart Cities (Contribution Agreement between the European Union, represented by the European Commission, and EU-Rail, with the objective to provide a financial contribution to finance the implementation of the action “Pilot project - IRS Smart Cities project: new railway station concept for green and socially inclusive smart cities”) EUR 2,5M Joint topic call with SESAR	N/A
International visibility and positioning	Visibility of the partnership in national, European, international policy/industry cycles	0	• Published 10 newsletters • Published 6 press releases • Released 5 publications • Organised 4 events • Participated in 62 industry events • Average number of tweets per month was 28 • 4.910 twitter followers by the end of 2023 • 12.098 LinkedIn followers by the end of 2023 • 2.105 newsletter subscribers by the end of 2023 • 116 members in the general contact list (receiving the newsletter and • mailshots) • 181 members in media list • 85 mentions in press articles • 39 project deliverables highlighted in the news section of the website • 144.645 unique visitors on the website • 26 articles produced by EU-Rail	N/A

TABLE III - Key Performance Indicators specific for EU-Rail

A number of Key Performance Indicators (KPIs) have been identified in the Multi-Annual Work Programme for each Flagship Area. Each JU project will produce consistent quantitative and qualitative metrics during its implementation, so as to determine the actual R&I progress and results achieved.

Starting from this comprehensive list of KPIs that will constitute the basis for the Layer 1, a selection of the most relevant ones by Impact areas is presented in the table below. It is to be noted that further consolidation of KPIs, accompanied by modelling of the rail system/sub-systems impacts, will be performed in the course of the Programme.

This selection, using as a reference baseline the state of the art in 2020 (including results from S2R), will allow a more focused transformation of the operational work delivered with Projects technical and operational results into more tangible Societal Impact qualifications.

The Societal Impact measurement methodology will be developed in the first two years of the functioning of the Joint Undertaking on the basis the technical and operational KPIs provided here. The calculations of the impact will be provided after each round of demonstrators that is in 2025, 2027 and 2031.

#	Impact areas	Key Performance Indicator	Objective	Baseline at the start of EU-Rail Programme	Target at the end of the EU-Rail Programme
1	Customer requirements	Accuracy in total planned travel time of passengers from improved matching between supply and demand, #	Increase availability and predictability of intermodal rail transport offer	State of art in 2020 (including results from S2R)	75%

		Traffic planning certainty, #	Planning certainty, considering the demand forecast, is a key requirement for planning on time, reliable and efficient service delivery	State of art in 2020 (including results from S2R)	Between 65% and 80%[1]
		Handling/response time for intermodal freight offers and regional passenger services, mins	Improve overall customer experience, including growing intermodal freight transport and regional passenger services	State of art in 2020 (including results from S2R)	-50%
2	Improved Capacity	Trains on the line per hour and direction, #	Increased frequency is a key element for improved capacity	State of art in 2020 (including results from S2R)	At least +10%[2]
		Reduction of total freight transport time, mins	Reduced freight transport time leading to better asset utilization and increased capacity	State of art in 2020 (including results from S2R)	-33%
		Increased average freight train length in existing infrastructure limitations or higher loads, meters	Increased length directly leads to more available capacity	State of art in 2020 (including results from S2R)	Up to 1.500m
3	Reduced Costs	Overall OPEX and CAPEX costs of regional lines, incl. maintenance, infrastructure and vehicles	Direct link to lower costs of the regional lines	State of art in 2020 (including results from S2R)	tbc[3]
		Maintenance costs, including thanks to the use of digital twins, €	Direct link to lower costs	State of art in 2020 (including results from S2R)	-10%[4]
		Design and manufacturing costs, €	Leading to reduced investment cost	State of art in 2020 (including results from S2R)	-20%
		Virtual certification tasks that can be conducted in a laboratory, #	Cost of virtual certification activities is much lower than cost of physical certification activities, hence more tasks done virtually leads to lower costs	State of art in 2020 (including results from S2R)	+80%[5]

4	Sustainable and resilient transport	Optimized energy consumption and higher punctuality in regional services, kWh per pax-km or tons-km; mins	More efficient operations, leading to lower energy consumption (with lower CO2 emissions)	State of art in 2020 (including results from S2R)	-10% (energy); +15% (punctuality)
		CO2 equivalent emissions	Further decrease rail carbon intensity	State of art in 2020 (including results from S2R)	Up to 30% for specific use cases (e.g. regional operation and heavy duty inspection vehicles)
		Traffic prediction performance, secs	Improve network resilience through dynamic infrastructure restriction handling, train regulation and automated conflict resolution	State of art in 2020 (including results from S2R)	<120 secs[6]
		Time to respond and resolve a vulnerability (regarding cyber security), mins	Reduced impact of events and increased availability of the rail system	State of art in 2020 (including results from S2R)	tbc[7]
5	Harmonized approach	CCS system CAPEX and OPEX (of main line and regional lines systems (while maintaining or increasing the present safety level	Reducing costs associated with the interoperability of the network will enhance harmonization	State of art in 2020 (including results from S2R)	CAPEX: -25% (regional lines) and -10% (main lines); OPEX -20% (regional and main lines)
		No new national technical rules triggered by innovative solutions coming from the Joint Undertaking and potential reduction of national rules in relation to ERTMS and interlocking	By decreasing the amount of national rules in force, rail transport will evolve towards the Single European Railway Area	State of art in 2020 (including results from S2R)	N/A

		Reduction of answering time between the short-term request of a cross-border train path and the answer with a firm offer, mins	Indicator for more efficient border crossing	State of art in 2020 (including results from S2R)	Down to 5 mins
		Operational dwell time at borders and other handover points relying also on relying on more homogenous system approaches (leading to increase number of trains on given infrastructure), mins	Indicator for more efficient border crossing	State of art in 2020 (including results from S2R)	-50%
6	Reinforced role for rail	Accuracy in total planned travel time of passengers from improved matching between supply and demand, %	The combination of the indicators from Impact Areas 1 and 3 contribute to more effective and cost-efficient rail transport, thereby improving attractiveness of rail compared with other transport modes	State of art in 2020 (including results from S2R)	75%
		Traffic planning certainty, #		State of art in 2020 (including results from S2R)	Between 65% and 80%[1]
		Handling/response time for intermodal freight offers and regional passenger services, mins		State of art in 2020 (including results from S2R)	-50%
		Overall OPEX and CAPEX costs of regional lines, incl. maintenance, infrastructure and vehicles		State of art in 2020 (including results from S2R)	tbc[3]
		Maintenance costs, including thanks to the use of digital twins, €		State of art in 2020 (including results from S2R)	-10%[4]
		Design and manufacturing costs, €		State of art in 2020 (including results from S2R)	-20%
		Virtual certification tasks that can be conducted in a laboratory, #		State of art in 2020 (including results from S2R)	+80%[5]
7	Improved	Maturity of innovative technologies	Innovative technologies will deploy rail capabilities and leverage potential competitive advantages for the EU rail industry	State of art in 2020 (including results from S2R)	TRL 8

Annex IV – System Pillar working method and System Engineering management plan

The System Pillar working method aims at fast and balanced decision making with full sector involvement. Integrated teams within one place - the System Pillar - work on and propose developed positions for sector consideration:

To ensure best results, the System Pillar design process ensures clarification and agreement on objectives and requirements early in the process as a basis for the subsequent decisions on operational design and architecture.

- The aim is to have developed positions put forward by the tasks and associated domain teams based on concentrated resource and a short interaction flow on system design level within the System Pillar teams, enabling speed of development. For this purpose, a detailed working plan, following the concepts of sprints, is established for 2024 for most of the System Pillar Teams. It specifies in detail the process flow and timeline for the development of the target railway system architecture, comprising the conception and modelling of operational capabilities and processes, system capabilities and functional chains as well as logical and physical architecture of the different subsystems (onboard, trackside CCS, etc.). Every design phase of the target architecture (described by the architecture level) is divided into a specification and review phase, aiming at fast and efficient content generation and a reliable, high-quality review.
- To ensure an effective and efficient use of the available resources, the detailed work planning includes the allocation of the resources to specific roles: Specifiers are responsible for developing the architecture concepts and models, requiring a high level of resource commitment to enable the most efficient content generation. The created content is then reviewed and revised by the advisor group, with limited time but a high level of expertise to ensure the high quality of the created content.
- The quality of the System Pillar deliverables is ensured by a review and approval process, defined in the Review and Approval process of the SEMP. Outcomes of a task/domain are first reviewed internally, including the related mirror groups, to ensure the high quality and sector alignment for the performed specification work. Afterwards, the internally approved deliverable is sent to the Core Group for review and approval. Once approved, the deliverable is presented at the Steering Group for decision and final approval before official release.
- Where appropriate, sector organizations are encouraged to support their representatives in the System Pillar teams and the Core Group with input - consolidated positions, early consideration of issues etc.

On all hierarchical levels of the decision-making process a balanced sector representation will ensure that developed and fully considered positions are put forward to the System Pillar Steering Group and Governing Board.

A detailed description of the model-based system engineering process and the related working arrangement including specification work, review and approval can be found in the 2nd version of the System Engineering Management Plan (SEMP). The SEMP is structured along the following content:

- The engineering processes describing the workflow of engineering regarding:
    - System Design Processes: e.g. process steps to get from use cases down to functional design, conception and modelling of the levels of the railway target architecture.
    - Management Processes: e.g. how to collect, decide or allocate requirements or project management processes, or change management processes, how to monitor progress and verify consistency with Common Business Objectives.
    - Review and approval processes: how to ensure a high-quality review by relevant sector stakeholders and a transparent approval of SP deliverables.

    - Publication/Standardisation Processes: e.g. TSI input processes, specification maintenance.
- Definition of design methods:
    - Methods: e.g. how hazards should be linked to risks, and risks be linked to requirements.
    - Ontology, vocabulary: e.g. how to name results of SP or things in the railway landscape.
    - Design and modelling standards, notation: e.g. template structures for documents like “system definition”, or how to describe and draw a function or interface, or how requirements or use cases should be formulated.
- Tools to be used:
    - Design Tools: e.g., to write traceable content, for modelling, approval tools, model proving, etc.
    - Management tools: e.g. project management, issue management, workflow automation, etc.
    - Information flow automation: Carrying, converting and linking files from different tools, manage exchanges between teams.

Annex V – System Pillar deliverables and milestones

Engineering Environment Team

Updated Glossary including cleanup and synchronization with ERA terminology

No	Deliverable	Milestone
01	**Updated Glossary including cleanup and synchronization with ERA ontology**	Q3 2025
	• **Description of Deliverable:** The SP glossary is available and accessible	
	• **Intermediate Milestones:**	
	○ Draft glossary	Q4 2024
	○ Approved glossary V1 covering all imported entries	Q1 2025
	○ Approved glossary V2 covering all existing definitions of system domains	

	• **Definition of Done:** The glossary items are checked and approved, no redundant entries, the synchronization and link to ERA terminology is assured, the glossary is used in the domains. • **Interaction with other Domains/IP:** • **STIP Reference (if applicable):**	

Consolidated and checked system requirements set V1

No	Deliverable	Milestone
02	**Consolidated and checked system requirements set V1**	Q3 2025
	• **Description of Deliverable:** The valid system requirement set of the SP in its current managed state is accessible via Polarion in a structured way	
	• **Intermediate Milestones:**	
	○ The requirement set is consolidated and linked (traceability) for the existing requirements of the domains	Q1 2025
	○ An system integrated requirement set is consolidated and approved	Q1 2025
	○ Q2 2025 Mid-milestone description	Q2 2025
	• **Definition of Done:**	
	• **Interaction with other Domains/IP:**	
	• **STIP Reference (if applicable):**	

SEMP V4

No	Deliverable	Milestone
03	**SEMP V4**	Q3 2025
	• **Description of Deliverable: SEMP Version 4 describes the processes for quality management, defines the result structure for output documents, adapts the OA/SA processes to the newest workflow version and includes several other smaller updates.**	
	• **Intermediate Milestones:**	
	○ List of all elements and chapters to be updated together with work planning	Oct 2024
	○ Draft SEMP V4	Q1 2025
	○ Approved SEMP V4	Q2 2025
	• **Definition of Done:** SEMP is approved in domains and SPCG	
	• **Interaction with other Domains/IP:** All domains	
	• **STIP Reference (if applicable): -**	

PRAMS

Modular Safety Case Structure

No	Deliverable	Milestone
02	**Modular Safety Case Structure**	Q3 2025
	• **Description of Deliverable:** To establish a "Design Safety Case structure" adequate to the new railway standardised modular architecture of SP and provide the specific process for their application and authorisation (e.g. how to assess them, integrate them, deal with authorisation/approval). It is a structure made to benefit from the new railway standardised modular architecture of SP. This structure will allow to drastically reduce the number of SRAC, support parallel developments between systems and ease integration activities of modular building block, In the SC2.3 contract the Modular Safety Case Structure has been developed and ready for review in the Sector in the SC2.4.	
	• **Intermediate Milestones:**	
	○ Start the System Pillar Review Process according to the SEMP (NoBo/AsBo organizations to be involved)	Nov. 2024
	○ Second release updated according to the feedbacks/comments from the sector.	Jan 2025
	• **Definition of Done:** Released to the sector	

	• **Interaction with other Domains/IP:** All Domains and IPs • **STIP Reference (if applicable):** STIP_79	

EU Hazard Database

No	Deliverable	Milestone
03	**EU Hazard Database**	Q3 2025
	Description of Deliverable: To extend the list of accidents and hazards with risk acceptance principles and quantified values (i.e. for top level system hazards having explicit risk estimation as risk acceptance principle) to fasten the realisation of risk assessment and harmonized practices among manufacturers and RUs/IMs. The quantified values to be defined based on an analysis of hazards and contributing conditions leading to the accidents classified within the ERJU. The list of accidents and hazards is based on the future regulation CSM-ASLP but will consider a larger scope with actual lists of accidents and hazards at national level (i.e. SIRF, VDE, EPSF).	
	• **Intermediate Milestones:** o Start the review process for the intermediate release of updated ERHD to be shared for review with other domains and ERA including extended list of accidents and hazards and their connections. o Updated release of ERHD addressing comments from other SP Domains and ERA and updates on list of hazards/accidents and their connections.	Nov. 2024 Jan 2025
	• **Definition of Done:** Released to the sector. • **Interaction with other Domains/IP:** All domains and IPs • **STIP Reference (if applicable):** STIP_80	

Risk assessment template and Safety guideline

No	Deliverable	Milestone
08	**Risk assessment template and safety guideline:**	Q3 2025
	• **Description of Deliverable:** Realisation of a risk assessment template (i.e. CENELEC Phase3) and a safety guideline presenting all safety activities within SP Domains (up to Phase 5)	
	• **Intermediate Milestones:** o Configuration of Nextedy Polarion add-on to create a template for FMEA o Definition of the safety process for system L3, 4 and 5 (up to CENELEC phase 5) o Template for FTA and connection with FMEA outputs	Nov 2024 Feb. 2025 April 2025
	• **Definition of Done:** Document ready for SPCG and STG review • **Interaction with other Domains/IP:** All Domain • **STIP Reference (if applicable):**	

Evolution Management in a Modular Architecture

No	Deliverable	Milestone
04	**Evolution Management in a Modular Architecture**	Q3 2025
	• **Description of Deliverable:** Changes to the existing regulations to improve the management of evolutions of a CCS systems (including cyber-security related and RAM related evolutions in a safety-related system)	
	• **Intermediate Milestones:** o Start the System Pillar Review Process according to the SEMP o Second release updated according to the feedback/comments from the sector.	Nov. 2024 Jan 2025
	• **Definition of Done:** Approved by the domain and ERA • **Interaction with other Domains/IP:** All Domain, ERA • **STIP Reference (if applicable):** STIP_81	

Support EGNOS Project

No	Deliverable	Milestone
05	**Support EGNOS Project** • **Description of Deliverable:** Support EGNOS project (FP2) in the finalization and reviewing of: o Support the completion of the WP 2.1 'Definition of overall certification and authorization process': D2.1.1 and D2.1.2 o Contribute and review the D3.3.2 'E4R Space/Rail System function Hazard Analysis'. • **Intermediate Milestones:** o Review D3.3.2: E4R Space/Rail System functional hazard analysis • **Definition of Done: Review** Report released • **Interaction with other Domains/IP:** ARC and Train CS Domain, FP2 • **STIP Reference (if applicable):**	Q3 2025 Jun2025

Creation of Performance criteria

No	Deliverable	Milestone
06	**Creation of Performance criteria** • **Description of Deliverable:** Only maintenance on existing documentation from SC2.3 • **Intermediate Milestones:** not applicable • **Definition of Done:** Document ready for SPCG and STG review • **Interaction with other Domains/IP:** All Domains • **STIP Reference (if applicable):** STIP_82	Q3 2025

P- RAM requirements/guidelines

No	Deliverable	Milestone
07	**P- RAM requirements/guidelines** • **Description of Deliverable:** Only maintenance on existing documentation from SC2.3 • **Intermediate Milestones:** not applicable o • **Definition of Done:** Document ready for SPCG and STG review • **Interaction with other Domains/IP:** All Domains • **STIP Reference (if applicable):** STIP_83	Q3 2025

CBM requirements

No	Deliverable	Milestone
08	**CBM requirements** • **Description of Deliverable:** Only maintenance on existing documentation from SC2.3 • **Intermediate Milestones:** not applicable o • **Definition of Done:** Document ready for SPCG and STG review • **Interaction with other Domains/IP:** All Domains • **STIP Reference (if applicable):** STIP_84	Q3 2025

Human Organizational Factor

No	Deliverable	Milestone
08	**Human Organizational Factor:** • **Description of Deliverable:** Integration of Human Factors in the CENELEC V cycle through EET domain. The HOF impact evaluation on Domains design	Q3 2025

	activities (e.g. OD domain) started in the SC2.3 to be completed in the SC2.4 within EET deliverables • **Intermediate Milestones:** o Integration and adaptation of SC2.3 draft documentation into EET domain o Start the System Pillar Review Process according to the SEMP o Second release updated according to the feedbacks/comments from the sector. • **Definition of Done:** Document ready for SPCG and STG review • **Interaction with other Domains/IP:** All Domain • **STIP Reference (if applicable):**	Nov 2024 Dec. 2025 Jan 2025

Security

Shared Security Services Specification

No	Deliverable	Milestone
01	**Shared Security Services Specification** • **Description of Deliverable:** Interface definition to Shared Security Services (TIME, PKI, IAM, BKP, LOG,…) • **Intermediate Milestones:** o Document completion according to the comment received o Document release o Document maintenance • **Definition of Done:** Specification Publication • **Interaction with other Domains/IP:** All • **STIP Reference (if applicable):** STIP_75	Q3 2025 Nov. 2024 Jan 2025 Q3 2025

Secure Communication Specification

No	Deliverable	Milestone
02	**Secure Communication Specification** • **Description of Deliverable:** Security profiles of common security communications protocols (TLS, OPC UA SC, HTTPS,…). • **Intermediate Milestones:** o Document completion according to the comment received o Document release o Document maintenance • **Definition of Done:** Specification Publication • **Interaction with other Domains/IP:** All • **STIP Reference (if applicable):** STIP_76	Q3 2025 Nov. 2024 Jan 2025 Q3 2025

Secure Program Requirements

No	Deliverable	Milestone
03	**Secure Program Requirements** • **Description of Deliverable:** Process security requirements (ISMS, VMS, supply chain security,…). Definition of Procedural requirements for Railway Operators (Infra managers and undertakings) and Suppliers to support the technical implementation and life-cycle management of Security for the system under consideration. • **Intermediate Milestones:** o Document completion according to the comment received o Document release o Document maintenance • **Definition of Done:** Specification Publication • **Interaction with other Domains/IP:** All	Q3 2025 Nov. 2024 Jan 2025 Q3 2025

	• **STIP Reference (if applicable):** STIP_77	

Secure Component Specification

No	Deliverable	Milestone
044	**Secure Component Specification** • **Description of Deliverable:** Security requirements for components (not related to interoperability, but required for security level and compliance to legal requirements and standards) • **Intermediate Milestones:** o Document completion according to the comment received o Document release o Document maintenance • **Definition of Done:** Specification Publication • **Interaction with other Domains/IP:** All • **STIP Reference (if applicable):** STIP_78	Q3 2025 Nov. 2024 Jan 2025 Q3 2025

Task 1 Railway System

To be architecture of one new capability

No	Deliverable	Milestone
01	**To be architecture of 1 new capability** • **Description of Deliverable:** The pain points and to be architecture for either "maintain and monitor rolling stock" or "maintain and monitor infrastructure" should be derived. To the extent relevant/necessary for the Level 2 architecture, the inputs from other System Pillar Tasks should be incorporated Compare the to be of both capabilities with the SP harmonized diagnostics (Task 2) and SP Task 5 HERD, also considering the work of FP3, as relevant. • **Intermediate Milestones:** o Identification of Pain point on either "maintain and monitor rolling stock" or "maintain and monitor infrastructure". o To be architecture for either "maintain and monitor rolling stock" or "maintain and monitor infrastructure" • **Definition of Done:** First draft to be architecture for either "maintain and monitor rolling stock" or "maintain and monitor infrastructure" harmonized for SP • **Interaction with other Domains/IP :** Task 2-TRANS and Task 5 HERD, FP3, Task 4 • **STIP reference (if applicable): none**	Q3 2025 Q1 2025 Q3 2025

Continued analysis of "Operate Train" and "Manage Energy"

No	Deliverable	Milestone
02	**Analysis of pain points and outputs from other SP Tasks** **Description of Deliverable:** For the to be architectures as developed in SC 2.3 for Operate Train and Manage Energy, there should be an iteration and refinement including incorporation where needed of existing and ongoing work in other System Pillar domains. o Operate Train to be architecture i. To the extent relevant/necessary for the Level 2 architecture, the inputs from other System Pillar Tasks should be incorporated ii. Compare the to be 'operate train' architecture with the SP Task 3 activities iii. Highlight any issues, if relevant, between Task 2 outputs and the to be architecture for operate train	Q3 2025

	○ Manage Energy to be architecture i. To the extent relevant/necessary for the Level 2 architecture, the inputs from other System Pillar Tasks should be incorporated ii. Compare the to be "manage energy" architecture with the SP Task 3 activities	
	• **Intermediate Milestones:**	
	○ Update To be architecture of Operate Train regarding other task analysis	Q1 2025
	○ Update To be architecture of Manage Energy regarding other task 3 analysis	Q2 2025
	○ Propose recommendation for both capabilities to update architecture on the other task if urgent discrepancies are discovered	Q3 2025
	• **Definition of Done:** Update and harmonized architecture for Operate Train and Manage Energy	
	• **Interaction with other Domains/IP:** Task 4, Task 3, Task 2	
	• **STIP Reference (if applicable**): none	

Task 2 CCS Domain Architecture and Release Coordination

CCS Harmonisation overview

No	Deliverable	Milestone
01	**ATP/ETCS overview**	
	• **Description of Deliverable:** The overview document aims to provide a compressed content summary of the ongoing specification work in task 2 status, interaction and relation with the TSI. It includes technical content overview for all CCS elements (independent of their channel of harmonization), summarizing the main hypothesis in a very compressed way.	Sept 2025
	• **Intermediate Milestones:**	
	○ Structure of the overview document agreed	Nov. 2024
	○ First Draft	Mar 2025
	○ Update document to present to STG	May 2025
	• **Definition of Done:** An implementer of CCS product features gets a complete picture of all existing specification in EURAIL, the main technical content and its maturity status.	
	• **Interaction with other Domains/IP:** Task 2 Traffic CS/Train CS, Task 3, R2DATO demonstrators	

CCS TSI CR Overview

No	Deliverable	Milestone
02	**TSI CR Overview**	
	• **Description of Deliverable:** This deliverable is a compilation of the following: SP analysis for the backlog CR enhancements in the ERA CCM DDBB; Preassessment content of the bundles of CR to the different TSI, related to CCS outcomes in EURail; other content work related to alignment with the CCS CR authors from other domains or IP (e.g. quality check of solution proposals, compatibility assessments, etc); plan and status of the work according to the plan shared with ERA	continuous
	• **Intermediate Milestones:**	
	○ Document structure agreed	Nov 2024

	○ Updated for different CR • **Definition of Done:** EURail can demonstrate to work following the Eurail harmonization document and achieving the objectives included in STIP for CCS related topics with channel of harmonization TSI • **Interaction with other Domains/IP:** All SP Tasks and domains	Quarterly

System level 3 architecture

No	Deliverable	Milestone
03	**High level logical architecture on system level 3** • **Description of Deliverable:** Logical architecture (on System Level 3) of the CCS Reference: Coherent overview on the CCS reference architecture identifying the TSI relevant parts. Specify the common CCS architecture including all interface relevant for: • Interoperability • basic functional allocation • to facilitate integration • overview on Level 3 interface standards and external interfaces • clarification of the scope and the system boundaries of the CCS system • High level control loops including high level hazards and allocation of risk acceptance for the logical components on System Level 3. Support of vertical PRAMS and Security design work. • **Intermediate Milestones:** ○ Produce SP document - Logical architecture (on System Level 3) of the CCS Reference: Architecture including naming its subsystems and interfaces. Document is already reviewed at Domain and mirror group level ○ SP Document is reviewed and published ○ SP Document updated versions • **Definition of Done:** SP Document is published. i.e. document is aproved by domain, mirror group (if applicable), SPCG and STG. • **Interaction with other Domains/IP:** No • **STIP Reference (if applicable**): STIP_5	Q1 2025 Dec. 2024 Mar. 2025 June, Sept. 2025

System Pillar Document and Release Plan

No	Deliverable	Milestone
04	**System Pillar Document and Release Plan ("DRP")** • **Description of Deliverable:** The DRP shows all existing or future result documents, their current status, the release planning and packages, the publication dates for drafts and final versions, the links to the documents, dependency analysis between the different topics and analysis on how other harmonization topics are affected. It includes a check of consistency with the released STIP • **Intermediate Milestones:** ○ Structure agreed, first draft ○ Updated Version • **Definition of Done:** The DRP is complete and the status is correct. • **Interaction with other Domains/IP:** All SP Tasks and domains	Continuous Nov. 2024 Monthly

Support to the EGNOS Project

No	Deliverable	Milestone
06	**Support to the EGNOS Project** • **Description of Deliverable:** the Architecture and Release coordination (SP-ARC) domain, to provide the SP architecture vision and planning (as well as the TSI CCS input	*See mid-milestones*

	plan) EGNOS roadmap needs to comply with, to facilitate the involvement of sector organisations (CER, EIM, UNIFE …)
	• **Intermediate Milestones:**
	  ○ Support and validation of EGNOS WP1.2: Preliminary roadmap and strategic plan.
	  ○ Support of EGNOS WP2.1 "Definition of overall certification and authorisation approach", including
	  i. Contribute to Deliverable D2.1.2 "Overall certification and authorisation approach for introduction of EGNOS ", v2
	• **Definition of Done:** *Please see 23E101_EGNOS WBS*
	• **Interaction with other Domains/IP:** EGNOS project, Train CS, PRAMSS, SPCG
		
		Jun 2025
		
		Dec. 2025

Task 2 CCS: *Domain Operational Harmonisation*

Guideline for harmonized CCS related operational processes for ETCS L2 and ATO GoA 1,2

No	Deliverable	Milestone
01	**Guideline for harmonized CCS related operational processes for ETCS L2 and ATO GoA 1/2** • **Description of Deliverable:** TSI OPE 2026 - Guideline for harmonized CCS related operational processes for ETCS L2 and ATO GoA 1/2 (based on the entity/actor analysis and the analysed operational use cases of SC2.3). For the case of radio-based ETCS alone operation, operational rules described as detailed situation and configuration specific processes for all actors (incl. signaller), for degraded modes, and with a binding time-ordered sequence of actor and system actions with defined input and output. The operational design is based on specific system and engineering requirements which define a more restricted trackside implementation for radio based ETCS alone operation. The recommended amendment for TSI OPE in the form of actor specific Rulebooks. Includes operational rules now also described as detailed situation and configuration specific processes for all actors (incl. signaller), for all degraded modes, and with a binding time-ordered sequence of actor and system actions with defined input and output. The result shall be introduced in 3 steps: As a TSI guideline for 2027 for using ETCS L2 in a specific harmonized way with ATO GoA1/2 and linked to a specific technical implementation**;** • **Intermediate Milestones: See chapter 6.5** • Definition of Done: Rulebooks with filled chapters for the topics of SC2.4, aligned with existing TSI or running TSI CR (e.g. EUG guidelines), approved on domain level and by the Coregroup. Major harmonization impacts are prepared as a compressed harmonization decision list, ready for the Steering Group. • **Interaction with other Domains/IP:** Traffic CS, Task 3, TrainCS • **STIP Reference (if applicable):** STIP_1	Q3 2025

Support to the EGNOS Project

No	Deliverable	Milestone

02	**Support to the EGNOS Project**
	• **Description of Deliverable:** The Operational Harmonisation (SP-OH) domain contributes/reviews to the definition of rail (train positioning) operational requirements
	• **Intermediate Milestones:**
	  ○ Support EGNOS WP3.1 "Rail Operational needs and EGNOS system definition ", including:
	  i. The review of D3.1.1: Operational needs and system capabilities of an ASTP system.
	• **Definition of Done:** *Please see 23E101_EGNOS WBS*
	• **Interaction with other Domains/IP:** EGNOS project, Train CS, PRAMSS, SPCG, ARC
		See mid-milestones
		
		Dec 2024

Task 2 CCS: Domain Traffic Control and supervision

System specification and interfaces ATO Trackside function (perh. incl. interface to EAL)

No	Deliverable	Milestone
01	**System specification and interfaces ATO Trackside *function***	Q3 2025
	• **Description of Deliverable:** The result document structure (along EN50126, phase 1-5, and for the design safety case) is completed concerning topics package 1 and concerning the ATO trackside function	
	• **Intermediate Milestones: General intermediate milestones see chapter 6.5**	
	○ Identification and allocation of ATO-TS functions for GoA2	Dec. 2024
	○ Document structure and properties in Polarion (SEMP P1.8), identified task associated and detailed scope added.	Dec. 2024
	• **Definition of Done:** The topic workitem traces are complete, aligned with existing TSI documents or running CR, and reviewed by SPCG. Major design decisions are described ready for decision in STG. The topic requirements are described and approved as SRS and for all harmonized system and user interfaces as FiS/FFFiS. Impact to existing interoperability specifications (in CCS TSI) is identified including harmonization of functional/engineering rules and proposed changes to existing requirements.	
	• **Interaction with other Domains/IP:** OD, Train CS, Task 3	
	• **STIP Reference (if applicable):** STIP_19, STIP_104	

System specification Trackside Protection System (TPS) incl. interface to adjacent CCS area

No	Deliverable	Milestone
02	**System specification and interfaces of the trackside protection system**	Q3 2025
	• **Description of Deliverable:** The result document structure (along EN50126, phase 1-5, and for the design safety case) is completed concerning topics package 1 and concerning the trackside protection system	
	• **Intermediate Milestones: General intermediate milestones see chapter 6.5**	
	○ Identification and functional allocation of the Trackside Protection System	Dec. 2024
	○ Document structure and properties in Polarion (SEMP P1.8), identified task associated and detailed scope added.	Dec. 2024
	• **Definition of Done:** The topic workitem traces are complete, aligned with existing TSI documents or running CR, and reviewed by SPCG. Major design decisions are described ready for decision in STG. The topic requirements are described and approved for all harmonized system and user interfaces as FiS/FFFiS. Impact to existing interoperability specifications (in CCS TSI) is identified including harmonization of functional/engineering rules and proposed changes to existing requirements.	
	• **Interaction with other Domains/IP:** OD, Train CS, Task 3, Lot 3	
	• **STIP Reference (if applicable):** STIP_102, STIP_101	

System specification and interfaces of the Execution and Adaption Layer

No	Deliverable	Milestone
03	**System specification and interfaces of the execution and adaption layer**	Q3 2025
	• **Description of Deliverable:** The result document structure (along EN50126, phase 1-5, and for the design safety case) is completed concerning topics package 1 and concerning the execution and adaption layer system	
	• **Intermediate Milestones: General intermediate milestones see chapter 6.5**	
	○ Identification and functional allocation of the Execution and Adaption Layer	Dec. 2024
	○ Document structure and properties in Polarion (SEMP P1.8), identified task associated and detailed scope added.	Dec. 2024
	• **Definition of Done:** The topic workitem traces are complete, aligned with existing TSI documents (like EUG guidelines) or running CR, and reviewed by SPCG. Major design decisions are described ready for decision in STG. The topic requirements are described and approved for all harmonized system and user interfaces as FiS/FFFiS. Impact to existing interoperability specifications (in CCS TSI) is identified including harmonization of functional/engineering rules and proposed changes to existing requirements.	

	• **Interaction with other Domains/IP:** OD, Train CS, Task 3 • **STIP Reference (if applicable):** STIP_103	

Trackside migration analysis

No	Deliverable	Milestone
04	**CCS Trackside migration analysis** • **Description of Deliverable:** The deliverable will take the economic assessment results as a basis. The analysis answers the following questions: **a.** What is the basic integration strategy to interconnect existing (national legacy) and SPRA compliant (existing and SPRA) products. What is the typical effort to adapt legacy systems to the new harmonized interfaces? Are "standard adapters" possible and do they make sense? Which harmonized interfaces shall include additional features to connect to the legacy (normally to be avoided)? b. What functional packages (CCS trackside) shall be mandatory for SPRA to simplify migration (e.g. just TPS, or always TPS+EAL together, or even TPS+EAL+ATO GoA2 functions together)? i. Each deployment of mandatory functional packages (subsystems) needs to be self-sufficient concerning functions and user interfaces (e.g. TMS does perhaps not exist). ii. Each deployment of mandatory functional packages (subsystems) needs to be integrateable – offer interconnection possibilities for adjacent legacy systems iii. How do i. and ii. influence the optimal functional allocation for CCS/TMS c. What are recommended decision criteria for national migration steps that help to decide an optimal migration plan. **d.** Which interfaces can be integrated already in existing rollouts before 2030 – what is realistic and economically viable? (e.g. EULYNX TA SCI, T2CE I2/I3, OP, SDI/SMI ?) The deliverable will take the economic assessment results available at October and address additional questions that might be raised in the work realized before the start of this remit • **Intermediate Milestones:** o A. Clarification document for task understanding and result structure o B. Comparison and assessment from migration perspective for mandatory depl. packages o C. CCS trackside migration integration strategy o D. Assessment of pros and cons, and economic assessment examples, for integration of harmonized interfaces already into the rollouts of current systems. • **Definition of Done:** The analysis is approved on domain level, in task 3, in SPCG and ready for presentation on expert level and with a strategic summary also on management level and in the STG • **Interaction with other Domains/IP:** OD, Train CS, Task 3 • **STIP Reference (if applicable):** -	Q3 2025 Nov. 2024 May 2025 Sept. 2025 Mar 2025

Preparation of major design decisions for management level and Steering Group

No	Deliverable	Milestone
05	**Preparation of major design decisions for management level and steering group** • **Description of Deliverable:** The current status of the Traffic CS design shall be described concerning its major design aspects ("Traffic CS system concept"), which shall be decided in SP STG as a basis for further detailed designs. The concept shall include and assess concerns coming from the sector, which are collected upfront), and give the rationales for its recommendations. The system concept shall cover aspects like reduction of the SIL functionality, hybrid train detection and sensor fusion, train-centric safety logic, free placement of movement authorities (moving block), optimized ETCS version management, efficient change of topology data, and functional scopes of TPS and EAL (perhaps ATO TS, if it is a separate subsystem).	Q3 2025

	• **Intermediate Milestones:**
	  o A. Clarification document for task understanding and result structure
	  o B. results from sector consultation
	  o C. Traffic CS system concept ready for decision
	• **Definition of Done:** The document gives a clear but compressed view on major design decisions and their rationals, for experts and for management level. The system concept is approved by domain and SPCG and lists concrete decision questions which are assessed by their major impacts.
	• **Interaction with other Domains/IP:** OD, Train CS, Task 3
	• **STIP Reference (if applicable): -**
		
		Nov. 2024
		Dec. 2024
		Feb. 2025

Task 2 *CCS: Domain Train Control and supervision*

Ethernet CCS consist network (full stack)

No	Deliverable	Milestone

01	**Ethernet CCS consist network (full stack)**
	• **Description of Deliverable:** Complete harmonized onboard CCS communication layer full stack (OSI layers 3-6 and safety layer) based on the deliverables agreed with FP 2.
	• **Intermediate Milestones:**
	  o CR solution proposal in Polarion, identifying associated tasks and detailed scope.
	  o Continuation of Task 2010 from SC2.3. contract: pre assessment CR launched phase 1
	  o Review of the solution proposal for the update of Subset-147 (Proposal expected by FP 2 WP 23: Oct. 2024).
	  o Adaptation of the application layer Subsets (eg. SS 119, 139 etc.) to take the new version of SS 147 into account. (Support by mirror group for specification work expected. Due date depending on scope of SS-147).
	• **Definition of Done:** CR and solution proposal are submitted to ERA.
	• **Interaction with other Domains/IP:** FP2
	• **STIP Reference (if applicable):** STIP_68
		Q3 2025
		
		Dec. 2024
		Dec. 2024
		Feb. 2025
		Sep. 2025

Train interfaces enhancement

No	Deliverable	Milestone

02	**Train interfaces enhancement**
	• **Description of Deliverable:** Functional enhancement for the train interface to allow for CCS onboard systems to be deployed on vehicles as a product from different vehicle suppliers. (ensure CCS onboard exchangeability)
	• **Intermediate Milestones:**
	  o CRs and solution proposal in Polarion, identified task associated and detailed scope added.
	  o Continuation of Task 1050 ad 2060 from SC2.3. contract. Pre assessment CR launched phase 1 and take into account diagnostics, configuration and monitoring requirements / specification of TCCS-domain and requirements from OD-Domain as well as corresponding CRs
	  o Definition of requirement to allow for CCS onboard systems to be deployed and exchanges without vehicle side adaptation on vehicles as a product from different vehicle suppliers.
	  o Collect the demands and prioritize the harmonization demands. Alignment with SS-147, Layers 1 to 6.
	  o Additional CCS internal signals will be made available to be used in the vehicle.
	• **Definition of Done:** CRs and solution proposals for the existing documents S-139, S-119, S-034 and maybe S-125, S-026 are submitted to ERA
	• **Interaction with other Domains/IP:** No, partial by corresponding CRs
	• **STIP Reference (if applicable):** STIP_71
		Q3 2025
		
		Q1 2025
		Dec. 2024
		Q1 2025
		Q2 2025

Multiple Display Concept

No	Deliverable	Milestone

03	**Multiple Display Concept** • **Description of Deliverable:** Train Display System – Multiple display system concept. Define Multiple DMI concept based on existing documents / information and specific topics. • **Intermediate Milestones:** o Document structure and properties in Polarion (SEMP P1.8), identified task associated and detailed scope added. o Continuation of Train CS Task 2100 from SC2.3. contract o Basic concept of apportionment of the logic of applications for the "Multi Display System" (Option 1: the logic in the DMI, Option 2: the logic in the central unit of an application (like EVC for ETCS on-board), Option 3: Option 1 and 2 can be individually decided for each application). o After that a decision can be taken for the logic apportionment (based on the multiple display system concept) for the ETCS application in Subset-121. • **Definition of Done:** Document is approved at domain level and reviewed by SPCG • **Interaction with other Domains/IP:** TCCS • **STIP Reference (if applicable):** STIP_69	Q3 2025 Nov. 2024 Dec.2025 Q1 2025 Q2 2025

Train interface adaption for integrity handling and train length / overall consist length

No	Deliverable	Milestone
04	**Train interface adaption for integrity handling and train length / overall consist length** • **Description of Deliverable:** One or more CRs proposal in order to **a**dapt train interface for train integrity handling and train length / overall consist length automation of freight and passenger trains currently defined in Ss-119, Ss-120, Ss-34, using also new technologies (e.g. the digital automatic coupling (DAC). • **Intermediate Milestones:** o Analyze and review the working document delivered in Polarion (SEMP P1.8) during the Phase 2.3 . o Definition of CRs and solution proposals . o In case of the DAC TI / TL interface this will include the so called "merging function", generating out of two independent SIL 2 Train Length information channels one SIL 4 train length / overall consist length. • **Definition of Done:** One of more CRs submitted to ERA • **Interaction with other Domains/IP:** Task 4, FP2, FP5 • **STIP Reference (if applicable):** STIP_73	Q3 2025 Q1 2025 Q3 2025 Q3 2025

On board modularity and upgradability

No	Deliverable	Milestone
05	**On board modularity and upgradability** • • Definition of Computing Platform for safe applications up to SIL4 (relating to CCS applications or other on board applications e.g. passenger information). Decoupling software, hardware and computing platform lifecycles. The work should be based on the results from Task 2 CE and also include the results from the SC 2.3 works in the PRAMS domain on modular safety case incl. a continuation if required to achieve a modular on board upgrade without re authorization of the complete vehicle. Also the work of TCCS regarding on board configurability should taken into consideration to improve the upgrade process. Needs of railways on upgradeability as well as supplier capabilities (granularity, business cases) to be considered. • • **Intermediate Milestones:** o Analysis of the Task 2 CE results and other relevant input (e.g. FP 2 on board demonstrator)	Q3 2025 Dec. 2024

	○ Time plan for deliverable STIP 72 (currently STIP indicates tbd) ○ Delivery Cost Benefit Analysis on Modularity, shared Computing Platform(s) and upgradeability concept ○ CCS onboard System Logical Architecture and requirements Management/Maintenance ○ CCS onboard System Physical Architecture and requirements Management/Maintenance ○ CCS onboard migration strategy ○ • **Definition of Done:** • **Interaction with other Domains/IP: FP2 / CE / PRAMS /TCCS** • **STIP Reference (if applicable): STIP 72**	Q1 2025 Q2 2025 Q3 2025 Q3 2025 Q3 2025

Basic advanced safe train positioning: Odometry performance and robustness enhancement

No	Deliverable	Milestone
06	**Basic advanced safe train positioning: Odometry performance and robustness enhancement**	Q3 2025
	• **Description of Deliverable:** Basic ASTP: Odometry performance and robustness enhancement Enhance the specified performance of accuracy of distances measured on-board and improve it's robustness . Consider and may be update the odometry performance targets for new CCS onboards to the state of the art of available and proven technologies (update TSI CCS to existing reality using existing technology).	
	• **Intermediate Milestones:**	
	○ CRs preassessment 1 stage achieved.	Q4 2024
	○ Writing the questionnaire on current odometry performance achieved and sending it to the Railway stakeholder	Q4 2024
	○ Deliver the solution proposal for the Robustness CR	Q1 2025
	○ Analysis of the answers to the questionnaire on current odometry performance achieved.	Q2 2025
	○ Deliver the solution proposal for the Odometry performance enhancement	Q3 2025
	• **Definition of Done:** Document incl. pre-assessment stage 1 is approved at domain level and reviewed by SPCG and presented to STG incl ERA • **Interaction with other Domains/IP:** FP 2 and SP Lot 3 • **STIP Reference (if applicable):** STIP_29	

A) Basic advanced safe train positioning: General Architecture Analysis

No	Deliverable	Milestone
07a	**Basic advanced safe train positioning: General system requirements and architecture**	
	Description of Deliverable: Top priority for an ASTP is the increase in accuracy and reliability of the on board localization for ETCS. To reach this target two distinct approaches should be considered. • Definition of the functional requirements, including aspects of application and operation • Physical separation of the localization / odometry functionality into an independent unit providing speed and localization for all users (single source of truth) • Specifying this separate unit to a point where it becomes an independent constituent with a standardized interface to the ETCS onboard system This analysis should include a CBA of both approaches especially considering the integration complexity of two SIL 4 components incl. comparison of other relevant criteria	
	• **Intermediate Milestones:**	
	○ High level functional and operational description of "Enhanced Odometry" and possible, future "Full ASTP"	Q1 2025
	○ CBA (with external support)	Q2 2025

	○ Decision	Q3 2025
	• **Definition of Done:** Decision on architecture presented to STG incl. ERA	
	• **Interaction with other Domains/IP:** FP 2?	
	• **STIP Reference (if applicable):** STIP_29	

B) Basic advanced safe train positioning: ASTP interface specification

No	Deliverable	Milestone
07b	**Basic advanced safe train positioning: ASTP interface specification**	
	Description of Deliverable: Logical and physical analysis for the separation of the localization functionality from the EVC by a harmonized interface. The future ASTP will base on a mix of sensor technologies which will need perhaps additional standard input and output interfaces, which are not in scope in this deliverable. Within this deliverable only the interface between ASTP and EVC (FFFIS) should be defined. In case the existing Eurobalise based relative localization system will be remain, the allocation of the balise reader interface (EVC or ASTP) must be defined based on a model based analysis.	
	• **Intermediate Milestones:**	
	○ Planning of the work incl. intermediate milestones.	Q4 2025
	○ Logical analysis	Q1 2025
	○ Physical analysis	Q2 2025
	○ interface specifications FIS – first structure and first topics	Q3 2025
	• **Definition of Done:** Document incl. pre-assessment stage 1 is approved at domain level and reviewed by SPCG and presented to STG incl. ERA	
	• **Interaction with other Domains/IP:** FP 2	
	• **STIP Reference (if applicable):** STIP_29	

Support to the EGNOS Project

No	Deliverable	Milestone
8	**Support to the EGNOS Project:** EGNOS Interoperability interfaces and dissemination'	*See mid-milestones*
	• **Description of Deliverable:** Lead the activities planned for WP 3.3.1 supported by FP2 resources, Review the deliverables D3.3.2, D3.3.3, D.3.3.4	
	• **Intermediate Milestones:**	
	○ Support EGNOS WP3.1 "Rail Operational needs and EGNOS system definition ", including:	
	i. The review of D3.1.1: Operational needs and system capabilities of an ASTP system.	Dec 2024 Feb 2025
	ii. The review of D3.1.2: SARPs+ for rail SoL applications	
	○ Support EGNOS D3.3.1: Service dissemination and interoperable interfaces.	June2025
	i. Activities Plan	Oct 2024
	ii. Interface Description V1	Apr 2025
	iii. Interface Description final release	Sept 2025
	• **Definition of Done:** *Please see 23E101_EGNOS WBS*	
	• **Interaction with other Domains/IP:** EGNOS project, OD, PRAMSS, SPCG	
	• **STIP Reference (if applicable):** STIP_30	

Task 2 CCS: Domain Computing Environment

CE System Analysis (System Capabilities and functions)

No	Deliverable	Milestone
01	**Computing Environment System capabilities and functions – System Analysis (FRS CONEMP, Functional Requirement specification)**	June 2025
	• **Description of Deliverable:** update/continuation to finalize design for I2/I3 as basis for API specification. Further detailing of design with focus on I1 specific needs for the	

	computing environment (e.g. orchestration, diagnosis, update & configuration management, monitoring), as input to TCCS SD2 and SD3 and R2DATO WP 26 for the detailed specification. • **Intermediate Milestones:** o System Analysis for I2/I3 completed o System Analysis for I1 completed o Input to TCCS SD2/SD3 and R2DATO WP 26 specifications approved • **Definition of Done:** Input to TCCS SD2/SD3 and R2DATO WP 26 specifications delivered and included in TCCS / IP deliverables. • **Interaction with other Domains/IP:** TCCS, R2DATO WP26 • **STIP Reference (if applicable):** No	 Q4 2024 Q1 2025 Q3 2025

Specification for Hardware Abstraction Interface (I2) and Virtualization Interface (I3)

No	Deliverable	Milestone
02	**Specification of concrete APIs in the context of Computing Environments** • **Description of Deliverable:** Standardisation of Computing Environment interfaces I2/3 Usable specification for Hardware Abstraction Interface (I2) and Virtualization Interface (I3) for Computing Platforms for safe applications up to SIL4 (relating to CCS applications or any other applications used in the context of rail operation). Decoupling software, hardware and computing platform lifecycles. Enabling interchangeability between computing platforms, onboard and trackside. • **Intermediate Milestones:** o I2/I3 specification drafted o I2/I3 specification ready for Domain review o I2/I3 specification ready for first discussion in Mirror Group • **Definition of Done:** I2/I3 specification mature enough for JU internal publication, envisaging decision and publication in Q1/2026 • **Interaction with other Domains/IP:** No • **STIP Reference (if applicable):** STIP_4 "Standardisation of Computing Environment"	September 2025 Q4 2024 Q2 2025 Q3 2025

Task 2 CCS: Domain Trackside Assets Control & *Supervision*

Maintaining TACS specification

No	Deliverable	Milestone
01	**Finalize TACS specification** • **Description of Deliverable:** Finalize update of TACS Specification with freeze of all parts of the specification: a. Update the relevant specifications in the System Pillar engineering environment. Assumption: EULYNX tools and methods are used for all System Level 5 specs in SP, so for the model import the effort is small. But explanation and requirements documents need to be maintained in Polarion, linked and integrated. b. Complete backlog topics on specifications (SMI, SDI, SCI) for all documents of SP/EULYNX BL4R3 scope, freeze specifications c. Refine Test Case Specification / Test Catalogue as part of release, targeting to enable interchangeability tests for product implementations d. Publish a release update of frozen specifications • **Intermediate Milestones:** o Pending tickets identified and final actions to be performed before publication identified.	Q3 2025 Oct. 2024

	• **Definition of Done:** SP documents published • **Interaction with other Domains/IP:** TCCS • **STIP Reference (if applicable):** STIP_85, STIP_86, STIP_87, STIP_88, STIP_89, STIP_95, STIP_96, STIP_97, STIP_98, STIP_99, STIP_100, STIP_90, STIP_91, STIP_92, STIP_93, STIP_94	

Interface to field devices

No	Deliverable	Milestone
02	**Interface to field devices**	Feb 2025
	• **Description of Deliverable:** Finalize decision proposal for further harmonization of interfaces between object controllers and field devices, following the Granularity Principles method. Based on SP STG decision continuation of work for specification of selected interfaces. • **Intermediate Milestones:**	
	○ Finalization of the Interface to field devices document. Document ready for SPCG review.	Dec 2024
	• **Definition of Done**: Decision proposal is ready to be decided at December SP STG • **Interaction with other Domains/IP:** No • **STIP Reference (if applicable):**	

Power supply

No	Deliverable	Milestone
03	**Power supply**	Feb 2025
	• **Description of Deliverable:** Finalize decision proposal for harmonization of interfaces to power supply and power management, following the Granularity Principles method. Based on SP STG decision continuation of work for specification. • **Intermediate Milestones:**	
	○ Finalization of the Power supply document. Document ready for SPCG review.	Dec 2024
	• **Definition of Done:** Power supply SP document is ready to be decided at December SP STG • **Interaction with other Domains/IP:** No • **STIP Reference (if applicable):**	

Task 2 CCS: Domain Transversal Systems

SD1 – Data model & Digital Registry

No	Deliverable	Milestone
01	**SD1 – Data model & Digital Registry**	Q3 2025
	Description of Deliverable: Define end-to-end harmonized data processes and model, based on ERA-ontology “single source of truth” approach up to Catalog of Symbols for harmonized user interfaces. Define and implement process for continuous upgrade of ERA-ontology according to the needs of the CCS/TMS Data Model. Consider in the end-to-end process the engineering requirements of System Design domains for CCS assets and include in the CCS/TMS Data Model specification once approved by the other SP Domains. Specify functional allocation for the Digital Registry as a system serving trackside and onboard CCS components based on top-down SEMP process and aligned and approved with the respective SP Domains. • **Intermediate Milestones:**	
	○ OA/SA/LA/PA for Digital Registry drafted	Q4 2024
	○ OA/SA/LA/PA for Digital Registry ready for review	Q1 2025
	○ OA/SA/LA/PA for Digital Registry ready for decision	Q2 2025

	• **Definition of Done:** CCS/TMS Data model updated and released and functional requirements specification for Digital Registry approved by all system design domains • **Interaction with other Domains/IP:** All system design domains, in particular Traffic CS • **STIP Reference (if applicable):** STIP_7, STIP_8, STIP_11	

SD2 – Generic Diagnosis System Specification

No	Deliverable	Milestone
02	**SD2: Generic Diagnostics System Specification**	Q3 2025
	• **Description of Deliverable:** Finalize decision process for harmonized generic diagnostics system concept covering all trackside constituents (trackside assets, trackside protection system, execution and adaption logic, …) and onboard and the relevant diagnostic functional building blocks (e.g. MDM, MDCM). Refine based on decided diagnosis concept, the operational analysis considering distinct business processes of RUs and IMs, complete System Analysis and next steps for logical and physical architecture, including northbound interface of diagnostic system for transmission of collected diagnostic information to adjacent diagnosis systems (SDI-DS). Assumption: The relevant taskforce is employed in the top-down engineering process (including the impacted Domains and the EULYNX toolchain)	
	• **Intermediate Milestones:**	
	○ OA/SA/LA/PA for Diagnosis System drafted	Q4 2024
	○ OA/SA/LA/PA for Diagnosis System ready for review	Q1 2025
	○ OA/SA/LA/PA for Diagnosis System ready for decision	Q2 2025
	• **Definition of Done:** System specification decided	
	• **Interaction with other Domains/IP:** PRAMS and IP (FA1, FA3), Train CS, TACS, Traffic CS	
	• **STIP Reference (if applicable):** STIP_10	

SD2 – Diagnostic Model for Traffic CS

No	Deliverable	Milestone
03	**SD2: Traffic CS Diagnostics Data Model Specification**	Q2 2025
	• **Description of Deliverable:** Specification of core diagnostic data model for Traffic CS (SDI-TPS), including Computing Environment aspects as next steps for SDI and in alignment with Traffic CS.). Assumption: EULYNX tools and methods are used for all System Level 5 specs in SP, and EULYNX toolchain is included through the relevant taskforce in the drafting process.	
	• **Intermediate Milestones:**	
	○ SDI-TPS outline drafted	Feb 2025
	○ SDI-TPS first full iteration for core specification ready for internal review	Apr 2025
	• **Definition of Done:** SDI-TPS (for core diagnostic model) specification as internal draft approved	
	• **Interaction with other Domains/IP:** Traffic CS, Computing Environment	
	• **STIP Reference (if applicable):** STIP_10	

SD3 – Configuration & Maintenance Management

No	Deliverable	Milestone
04	**SD3 – Configuration & Maintenance Management**	Q3 2025
	• **Description of Deliverable:** Finalize decision process for harmonized configuration and maintenance management concept covering all trackside constituents (trackside assets, trackside protection system, execution and adaption logic, …) and on-board together with Train CS and Computing Environment. Refine based on decided configuration and maintenance management concept, the operational analysis considering distinct business processes of RUs and IMs, complete system Analysis and derive logical and physical architecture for the transversal configuration and maintenance management service functions/subsystems. Do and deliver required PRAMS (PRAMS vertical activities) and Cybersecurity risk analysis to deliver design safety case for the overall end-to-end configuration management process.	

	Assumption: The relevant taskforce are employed in the top-down engineering process (including the impacted Domains and the EULYNX toolchain)
	• **Intermediate Milestones:**
	  ○ OA/SA/LA/PA for Configuration Management System drafted
	  ○ OA/SA/LA/PA for Configuration Management System ready for review
	  ○ OA/SA/LA/PA for Configuration Management System ready for decision
	• **Definition of Done:** Operational and system analysis for trackside and onboard CCS configuration management process approved by other SP Domains and decided in SP STG
	• **Interaction with other Domains/IP:** FP2 for test implementation with IP to be aligned, TACS, Traffic CS, Security, PRAMS, Train CS
	• **STIP Reference (if applicable):** STIP_6
		
		Q4 2024
		Q1 2025
		Q2 2025

SD3 – Configuration Management Specification for trackside constituents

No	Deliverable	Milestone

05	**SD3: Configuration Management Specification for trackside constituents**
	• **Description of Deliverable:** Specification of configuration management interfaces for trackside constituents (Trackside assets and Traffic CS (SMI and SCI)) based on decided harmonized configuration management concept, including Computing Environment aspects and in alignment with Traffic CS as next steps for SMI and affected SCI. Consider forward compatibility to enhancement to onboard configuration management process. Assumption: EULYNX tools and methods are used for all System Level 5 specs in SP, and EULYNX toolchain is included through the relevant taskforce in the drafting process.
	• **Intermediate Milestones:**
	  ○ SMI-XX and, if needed, CRs for affected SCIs drafted
	  ○ SMI-XX and, if needed, CRs for affected SCIs ready for approval with mirror groups
	• **Definition of Done:** SMI-XX specification released and, if needed, CRs for affected SCIs submitted
	• **Interaction with other Domains/IP:** TACS, Traffic CS, Computing Environment
	• **STIP Reference (if applicable):** STIP_10
		Q3 2025
		
		Q1 2025
		Q2 2025

Task 3: TMS & CMS

Function distribution and Interface between TMS/TCS

No	Deliverable	Milestone

01	**Interface TMS/Traffic CS: Update Function distribution and Interface between TMS/TCS**
	• **Description of Deliverable:** Consistent splitting of the features of a Supervision system between the two systems (TMS and TCS) which implement the specification of the interface between TMS and TCS, based on SP previous results in task 3 and task 2. Review the Operational Rulebook specification for TMS/TCS related operational concepts and capabilities that require harmonized operational processes with impact on TMS actors (e.g. dispatcher). Update TMS/TCS specification in line with remaining open points to be clarified with Traffic CS.
	• **Intermediate Milestones:**
	  ○ List of operational capabilities that should be harmonized for interface TMS-TCS and added in System Architecture Document. Alignment with the operational concepts and capabilities in OD that include TMS
	  ○ Close remaining open point to update the TMS-TCS interface specification with the precise and complete set of structured information to be exchanged between TMS and TCS, which supports the execution of the apportioned functions to the two systems.
	• **Definition of Done:** TMS/TCS Document is aligned with Traffic CS and other possible Task 2 related domains and in line with related operational capabilities harmonized in Operational Rulebook of OD/Traffic.
	• **Interaction with other Domains/IP:** Traffic CS, OD
		Q3 2025
		
		Q1 2025
		
		Q2. 2025

	• **STIP Reference (if applicable):** STIP_18	

Recommendation of harmonization scope TMS/CMS

No	Deliverable	Milestone
02	**Recommendation of harmonization scope TMS/CMS** • **Description of Deliverable:** Based on the existing system design documents of SC2.3 (e.g. TMS/CMS functional split, TMS/CMS variants analysis) develop recommendation for the functional distribution and interface specification to be harmonized. The deliverable shall analyze the harmonization scope based on operational use cases and considering current pain points and limitations in the European level planning and dispatching process. The analysis shall include rational that demonstrate the benefit of a respective harmonization, following the ARC D2.3 Granularity Concepts and Principles Guideline. • **Intermediate Milestones:** o Identify relevant operational use cases to be analysed o Analysis of operational use cases with pain points and limitations completed o Granularity Concepts and Principles for CMS/TMS split completed, draft recommendation of functional scope to be harmonized • **Definition of Done:** Approved decision proposal for harmonization scope of TMS/CMS interface, ready for SP STG decision • **Interaction with other Domains/IP:** FP1 • **STIP Reference (if applicable):** STIP_17	Q2 2025 Dec. 2024 Feb . 2024 May 2025

Integration of TTR Messages

No	Deliverable	Milestone
03	**Integration of TTR Messages** • **Description of Deliverable:** Include the technical messages defined in the TTR process in the TSI framework. The TTR (Timetable Revision) project and the linked digitalization concept DCM (Digital Capacity Management) define new concepts such as ECM (European Capacity Management), Capacity Broker, TCR (Temporary Capacity Restrictions) to answer the ambitions of Task 3. • **Intermediate Milestones:** o TTR harmonization scope identified and agreed o Draft specification for technical messages o Final specification of technical messages • **Definition of Done:** Specification ready for publication • **Interaction with other Domains/IP:** FP1 • **STIP Reference (if applicable):** STIP_16	Q3 2025 Q4 2024 Q1 2025 Q2 2025

Support content for strategic cross border discussions in STG

No	Deliverable	Milestone
04	**Cross border variants analysis CMS & TMS**	Q3 2025

	• **Description of Deliverable:** Preparation of operational, functional, technical, deployment and economic content to support strategic decisions in SPSG regarding TMS and CMS Cross borders.
	• **Intermediate Milestones:**
	  ○ Update based on SP STG discussion 10/2024
	  ○ Update based on SP STG discussion 03/2025
	  ○ Update based on SP STG discussion 05/2025
	• **Definition of Done:** CMS/TMS variants discussion closed in SP STG
	• **Interaction with other Domains/IP:** FP1
	• **STIP Reference (if applicable):** STIP_16, 12, 13
		
		Dec 2024
		Q2 2025
		Q3 2025

Task 4: DAC/FDFTO

EU DAC Based Operational Standards and RuleBook [WP2]

No	Deliverable	Milestone
01	**EU DAC Based Operational Standards (continuing WP2 from SC2.3)**	Q3 2025
	• **Description of Deliverable:** EU DAC Based Operational Standards and RuleBook	
	• **Intermediate Milestones:**	
	○ From SC2.3: Finalization of Operations Architecture related to FDFTO interfaces: ERTMS use cases, ASO/ATO [WP3.2, WP3.3] – as a side product of the RuleBook discussion	Q3 2024
	○ From SC2.3: General agreement with Task 2-OD on structure and format of the RuleBook	Q3 2024
	○ Continuation from SC2.3: Elaboration of preliminary EU Harmonised Operation Procedures (FDFTO Rule Book) – based on FP5 deliverable D2.1[WP2] Note: RuleBook will still show white spots where FP5 input is not yet available	Q1 2025
	○ Document structure and properties in Polarion (SEMP P1.8), identified task associated and detailed scope added (with support of PMO)	Nov. 2024
	○ Agreement with FP 5 on timetable to fill the white spots	Q4 2024
	○ Filling of the white spots based on input by FP5, based on mentioned timetable deadlines.	Continuous Q3 2025
	○ Review of rulebook by the sector, inclusive alignment with Task2 and via the EDDP operational sounding board.	
	○ Finalization of draft EU Harmonised Operation Procedures (FDFTO Rule Book) including mature final input from FP5, ready for training of staff for pre-deployment trains	Q4 2025
	• **Definition of Done:** FDFTO Operation Procedures and RuleBook are reviewed by the domain and SPCG	
	• **Interaction with other Domains/IP:** OD, FP5	
	• **STIP Reference (if applicable):** STIP_38	

Interfaces between train-internal FDFT and the "outside" world, with focus on Train-Lenth/-Integrity [WP3.1]

No	Deliverable	Milestone
02	**Interfaces to the "outside" world (restarting WP3.1 from SC2.3)**	Q2 2025
	• **Description of Deliverable: Final agreement with FP 5 on concept and implementation of Safe Train Length (SIL 4)**	
	• **Intermediate Milestones:**	
	○ Document structure and properties in Polarion (SEMP P1.8), identified task associated and detailed scope added (with support of PMO)	Nov. 2024
	○ From SC2.3: Agreement with Task 2, FP2 and FP5 on CR for draft concept of “merging function” and interfaces to FDFT	Sept. 2024
	○ Agreement with FP5 on architecture and concept for FDFT-internal function to deliver 2. independent train length information (SIL 2), incl. safety concept	Q1 2025

	○ Definition of FFFIS for both channels to ETCS OBU ○ Agreement with FP5 on a roadmap for implementation (target for implementation: end 2027) • **Definition of Done:** Agreement with FP5 on concept, FFFIS and roadmap for implementation • **Interaction with other Domains/IP:** FP5, FP2, Task 2 Train CS • **STIP Reference (if applicable):** STIP_36 (FDFTO Train Functions), STIP_73 (interface)	Q1 2025 02 2025

Central Instance [WP4]

No	Deliverable	Milestone
03	**Central Instance** for m**anagement of Data & Software** • **Description of Deliverable:** Detailed description of and roadmap for the implementation of a basic functionality of a European Central Instance (incl. connected IT/Cloud architecture) for the pre-deployment phase • **Intermediate Milestones:** ○ Document structure and properties in Polarion (SEMP P1.8), identified task associated and detailed scope added (with support of PMO) ○ From SC2.3: Approved concept for organisation and processes of Central Instance ○ From SC2.3: Approved concept for implementation for the pre-deployment phase (stakeholder analysis, project organisation, budget) ○ Agreement with EDDP (and FP5) on requirements and needs for data upload (mainly for operation of FDFT and monitoring of reliability of the pre-deployment trains) ○ Detailed roadmap for implementation of a basic functionality of the CI for the pre-deployment phase ○ Preparation of a PoC • **Definition of Done:** Definition of Management Organization , Procedures, IT (Cloud) Architecture for FDFT applicative software download, FDFT data upload and dispatching to authorized data owners and data users. • **Interaction with other Domains/IP:** FP5, EDDP • **STIP Reference (if applicable):** STIP_47	Q3 2025 Nov. 2024 Q3 2024 Q3 2024 Nov. 2024 Q1 2025 Q3 2025

Task 5: Harmonised Diagnostics

Aligned UC 1 demonstrator specification for a pilot implementation

No	Deliverable	Milestone
01	Aligned UC 1 demonstrator specification for a Pilot implementation • **Description of Deliverable:** a. Performance definition and measurement specification b. Structure of KPIs c. Time schedule for the implementation of the Pilot application d. Definition of Pilot participants: roles and responsibilities e. Risk assessment and supposed mitigation actions f. CBA structure • **Intermediate Milestones:** ○ Q4 2024 Mid-milestone description i. Completion of the synergies analysis with other SP-domains and IP ii. Plan and action implementation based on the synergies iii. Risk assessment and risk mitigation plan ○ Q1 2025 Mid-milestone description i. Performance definition ii. KPIs-structure iii. Draft of the Harmonised Diagnostic Data Interface (HDDI) iv. Identification of the Pilot participants and their roles ○ Q2 2025 Mid-milestone description	Q2 2025 Q4 2024 Q1 2025 Q2 2025

	i. Time schedule for the implementation of the Pilot application ii. Measurement specification iii. Specification of the HDDI iv. CBA structure for UC1 • **Definition of Done:** The main objectives are the alignment on the implementation of the Use Case demonstrator and the specified time schedule for the pilot project. The HDDI is defined and accorded with the other tasks in the SP and the Flagship projects. • **Interaction with other Domains/IP:** SP/Task 2, FP3, FP1-TT • **STIP Reference (if applicable):** No STIP entrance related to TSI	

Processing of new Harmonisation Use Cases

No	Deliverable	Milestone
02	Processing of new Use Cases • **Description of Deliverable:** a. Evaluation of the results of Phase 2 and alignment on the next Use Cases for harmonisation b. Definition of the HDDI requirements of the selected Use Cases c. Specification of the interaction with the most relevant synergies with the SP-tasks and the IP-projects. d. Preparation of an European Map draft of the existing/planned railway diagnostic systems • **Intermediate Milestones:** ○ Q1 2025 Mid-milestone description i. Table of the next Use Cases with recommendations of the next steps ○ Q2 2025 Mid-milestone description i. Identification and recommendation of how the harmonised diagnostic data can be exchanged in the specific Use Cases ○ Q3 2025 Mid-milestone description i. HDDI requirements of the prioritised Use Cases • **Definition of Done:** The main objectives are the description of the maturity of the next Use Cases and develop a road- map. There will be a recommendation of how the data exchange between the data users and the data providers should/could be performed. • **Interaction with other Domains/IP:** SP/Task 2, FP3, FP1-TT • **STIP Reference (if applicable):** No STIP entrance related to TSI	Q3 2025 Q1 2025 Q2 2025 Q3 2025

Annex VI – Call(s) for proposals 2025

EU-Rail has to deliver a high-capacity integrated European railway network by eliminating barriers to interoperability and providing solutions for full integration, covering traffic management, vehicles, infrastructure and services, aiming to achieve faster uptake and deployment of projects and innovations. That should exploit the huge potential for digitalisation and automation to reduce rail's costs, increase its capacity and enhance its flexibility and reliability, and should be based upon a solid reference functional system architecture shared by the sector, in coordination with the European Union Agency for Railways.

The European Green Deal objective is to reach climate neutrality by 2050, the Fit for 55 package sets medium-term greenhouse gas emissions reduction objectives, and the Digital Decade sets the path to bring Europe to the forefront of digitalisation and automation.

The Sustainable and Smart Mobility Strategy articulates the pathways towards digitalising and greening the transport sector and sets specific milestones for the railway sector.

The railway sector will contribute to those objectives by increasing its capacity for passenger and goods transport, enabling an increase in the use of rail transport, and by reducing further the greenhouse gas emissions of the railway sector itself.

In order to foster the transformation of the railway system, the EU encourages research and innovation with its new EU Framework Programme for Research and Innovation - Horizon Europe.

The objectives of EU-Rail have been set to address the EU policy objectives, rail sector vision, and the challenges inherent to the transformation of the rail system as set in its Master Plan[48] and Multi-Annual Work Programme[49].

The general objectives, as set out in the Single Basic Act are:

(a) contribute towards the achievement of the Single European Railway Area;
(b) ensure a fast transition to more attractive, user-friendly, competitive, affordable, easy to maintain, efficient and sustainable European rail system, integrated into the wider mobility system;
(c) support the development of a strong and globally competitive European rail industry

The Specific objectives to the partnership are to:

(a) facilitate research and innovation activities to deliver an integrated European railway network by design, eliminating barriers to interoperability and providing solutions for full integration, covering traffic management, vehicles, infrastructure also including integration with national gauges, such as 1520, 1000 or 1668 mm railway, and services, and providing the best answer to the needs of passengers and businesses, accelerating uptake of innovative solutions to support the Single European Railway Area, while increasing capacity and reliability and decreasing costs of railway transport;
(b) deliver a sustainable and resilient rail system: by developing a zero-emission, silent rail system and climate resilient infrastructure, applying circular economy to the rail sector, piloting the use of innovative processes, technologies, designs and materials in the full life-cycle of rail systems and developing other innovative solutions to guided surface transport;

[48] Master Plan available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

[49] MAWP available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

(c) develop through its System Pillar a unified operational concept and a functional, safe and secure system architecture, with due consideration of cyber-security aspects, focused on the European railway network to which Directive 2016/797[50] applies, for integrated European rail traffic management, command, control and signalling systems, including automated train operation which shall ensure that research and innovation is targeted on commonly agreed and shared customer requirements and operational needs, and is open to evolution;

(d) facilitate research and innovation activities related to rail freight and intermodal transport services to deliver a competitive green rail freight fully integrated into the logistic value chain, with automation and digitalisation of freight rail at the core;

(e) develop demonstration projects in interested Member States;

(f) contribute to the development of a strong and globally competitive European rail industry;

(g) enable, promote and exploit synergies with other Union policies, programmes, initiatives, instruments or funds in order to maximise its impact and added value.

In order to achieve the aforementioned objectives, EU-Rail performs its activities via calls for proposals and calls for tenders. The 2025 Call for Proposals is structured around one topic for each of the Destinations 1 to 6, as well as 4 topics under Destination 8.

- **Destination 1 – Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers**. The objective is to achieve the Single European Rail Area by researching, developing and delivering a flexible, efficient, resilient and high-capacity European rail network. It also about the implementation of a railway Digital enabler and Digital twin environment, where all digital elements of the system can play together in a coherent and interoperable way.

- **Destination 2 - Digital & Automated up to Autonomous Train Operations**. The objective is to research, develop and deliver the next generation Automated Train Control system and scalable automation in train operations to optimize operations and increase capacity on the network.

- **Destination 3 - Intelligent and integrated asset management**. A holistic and integrated asset management for rail infrastructure and rolling stock contributes to reducing infrastructure and rolling stock life cycle costs and improving reliability and efficiency of construction and maintenance. Technological solutions and methods are to be developed that reduce asset life cycle costs while ensuring safety and safeguarding the reliability and capacity of infrastructure and rolling stock.

- **Destination 4 - A sustainable and green rail system**. Supporting the European Green Deal by promoting rail solutions, reducing greenhouse gas emissions, and enhancing rail sustainability applying circular economy principles in the rail sector is a key priority. Innovative solutions based on leading-edge technologies will contribute to reduce energy consumption and the rail's impact on the environment, making it healthier, more attractive, and more resilient to climate change while reducing costs of ownership.

- **Destination 5 – Sustainable Competitive Digital Green Rail Freight Services.** The final objective is to make rail freight more attractive through digitalization and automation of operational functions and processes, including those at the intersection with other transport modes, as well as increasing the efficiency of the immaterial (information/data) layer of transport via researching, developing and delivering innovative interoperable and scalable solutions

[50] Directive 2016/797 of the European Parliament and of the Council of 11 May 2016 on the interoperability of the rail system within the European Union.

- **Destination 6 – Regional Rail Services / Innovative rail services to revitalise capillary lines**. Regional railways are essential as a link to other transport services but also to serve Europe's regions, its citizen and businesses, which is why their long-term viability should be ensured. To this end, total costs of ownership are to be reduced while maintaining high service quality and operational safety. The concept to be developed will be tailored to the regional railways and will include digitalisation, automation, and the use of new and mainstream technologies.

- **Destination 7 – Innovation on new approaches for guided transport modes**. EU-Rail promote forward looking activities, tackling disruptive technologies and thinking, performing exploratory research to accelerate the pace towards radical system innovations in the guided transport modes and supporting the evolution of the Innovation Programme in scope and targets.

- **Destination 8 – Exploratory Research and other activities**. EU-Rail promote forward looking activities, tackling disruptive technologies and thinking, performing exploratory research to accelerate the pace towards radical system innovations in the guided transport modes and supporting the evolution of the Innovation Programme in scope and targets.

1. Call: HORIZON-ER-JU-2025-01

Conditions for the Call

Indicative budget(s)

Call	Budgets (EUR million)	Deadline
	2025	
HORIZON-ER-JU-2025-01	3,0	7 May 2025
Overall indicative budget	3,0	

By analogy with the Horizon Europe Annual Work Porgramme 2023-2025 call conditions, the EU-Rail Executive Director may decide to open the call up to one month prior to or after the envisaged date(s) of opening as well as may decide to delay the deadline(s) by up to two months. This provision applies to all call topics here-in detailed.

Topics	Type of Action	Expected EU contribution per project (EUR million)[51]	Number of projects expected to be funded
	Opening: 26 February 2025 Deadline(s): 7 May 2025		
HORIZON-ER-JU-2025-FA7-01	IA	3,0	1

General conditions relating to this call	
Admissibility conditions	The conditions are described in part A of the General Annexes to the Horizon Europe Work Programme 2023–2025.
Eligibility conditions	The conditions are described in part B of the General Annexes to the Horizon Europe Work Programme 2023–2025.
Financial and operational capacity and exclusion	The criteria are described in part C of the General Annexes to the Horizon Europe Work Programme 2023–2025.
Award criteria	The criteria are described in part D of the General Annexes to the Horizon Europe Work Programme 2023–2025.
Documents	The documents are described in part E of the General Annexes to the Horizon Europe Work Programme 2023–2025.
Procedure	The procedure is described in General Annex F to the Horizon Europe work programme for 2023–2025.
Legal and financial set-up of the Grant Agreements	The rules are described in part G of the General Annexes to the Horizon Europe Work Programme 2023–2025.

DESTINATION 7 Innovation on new approaches for guided transport modes

Based on current trends and forecasts, the number of passengers will significantly increase in the upcoming decades and the existing transport modes may face capacity limitations without infrastructure investments. Emerging technology for guided transport systems could be a

[51] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

complementary solution for the increased demand, increasing also the availability of sustainable transportation solutions. This topic seeks to enhance the existing railway system by exploring the integration of maglev-derived technologies into existing railway infrastructures to reinforce railways as the backbone of the trans-European multimodal transport network by increasing its capacity and performances.

The technical approach to be developed could support the enrichment of the railway system through the integration of maglev-based solution into the existing infrastructure following a principle of overlapping technological layers. This integration aims to implement technological, functional and performance upgrades to existing lines and to ensure interoperability of vehicles with both the magnetic and traditional infrastructure by preserving the flow of traditional trains on the existing railway corridor.

HORIZON-ER-JU-2025-FA7-01: FURTHER TECHNOLOGICAL DEVELOPMENT OF MAGLEV-DERIVED SYSTEMS

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 3 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 3 million. Applicant Private[52] Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.263[53] times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration.
Technology Readiness Level	Activities are expected to be of low TRL, with possible existing concept designs at TRL5/6, higher TRL are possible – see General Annex B for a guide to the TRL definitions and criteria to be used.
Type of Action	Innovation Action

[52] As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

[53] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies, with the following exception: the limit for a full Innovation Action application is set to 120 pages.
Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the topic. The applicants are expected to gather expertise from companies developing Maglev-based technologies and/or rail applications, including SMEs and start-ups.
Funding of only one project per topic	EU-Rail may award up to one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]].
Award criteria additional details	The award criteria included in part D of the General Annexes of the Horizon Europe Work Programme 2023 – 2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.

Expected outcomes:

This call addresses potential solutions which could support solving current transport challenges and make the current rail system more performant by introducing Maglev-Derived transport systems (MDS). Building upon the results of Europe's Rail MaDe4Rail[54] project, this call aims to further assess and propose solutions on the technical open points of maglev derived technologies. In addition, further develop the design concept based on the most promising use cases while tackling the technical issues and analyse the economic viability of the system and propose a full scale fully automated MDS application concept.

The Project stemming from this topic shall address all the following work streams and is expected to provide all the following:

Work stream 1: Configuration design development

[54] https://www.rfi.it/en/Network/in-europe/MaDe4Rail.html

This workstream should assess the technical open points defined by the previous project MaDe4Rail and assess the feasibility of use of MDS on the TEN-T lines equipped with ETCS. This shall encompass further analysis of the CCS, communication and infrastructure components with special attention to the balises, radio communication system, odometry and train detection systems. The installation of MDS has an impact on the maintenance processes, further assessment shall be carried and propose adaptation of the existing processes considering the installation of the linear motor.

Work stream 2: Testing and validation

To run MDS on traditional railways, it is essential that the system is compliant with Technical Specifications for Interoperability (TSI). This workstream shall verify MDS component compliance with TSI specifications through compatibility tests and simulations, also evaluating the potential impact of MDS systems on standards and TSI and the potential evolution of the system or the requirements. If MDS is expected to run on the TEN-T network, compatibility with Eurobalises and the track geometry are prerequisites. Based on the outcome of WS1 and from the testing, the technical and economical variability of the system shall be analysed. At the end of this workstream, a detailed concept architecture (TRL5) for a 1:1 scale MDS demonstrator is expected to be delivered.

Scope:

The project shall contribute to deliver the expected outcomes and the work of the project should foresee:

Work stream 1: Configuration design development

- Advanced design concept of technical enablers and basic technologies supporting maglev-derived systems (TRL3) to address the following open points. The work should be based on the results coming from MaDe4Rail:
    - Assess the geometric and electromagnetic compatibility for railway infrastructure;
    - Assess the effective max safe, tolerable speed increase in curves, by adjusting cant and cant deficiency through levitation;
    - Assess the track infrastructure adaptation for forces added by new propulsion systems;
    - Assessment of track maintenance procedures to allow the use of linear motors between the rail considering the maintenance regimes, devices to be used and local maintenance regulations.

Work stream 2: Testing and validation

- Based on the results from work-stream 1, test full functionality, performances and safety of an MDS in a laboratory environment up to in relevant environment (TRL5/6). This shall include test related to electromagnetic compatibility test of the balise and the MDS and test of MDS in level-crossing and switches.
- Evaluation the technical and economical feasibility based on the test results;
- Identify the gaps and the potential topics for standardization on safety and security, including impact on existing regulation, in particular on the rail Technical Specification for Interoperability;

- Based on the results of Workstream 1 and 2, propose a detailed architecture concept (TRL5) of a full 1:1 scale fully automated Maglev-derived system including detailed technical, safety, security and performance requirements.

Interactions with other EU-RAIL projects:

The System Pillar will deliver a new functional system architecture for the railway system, which will have an impact on the overall system design, including its interfaces between sub-systems. The action to be funded under this topic should interact with the System Pillar and shall take into consideration the work to be released by the System Pillar and its evolution.

Gender dimension

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

2. Call: HORIZON-JU-ER-2025-02

Conditions for the Call

Indicative budget(s)

Call	Budgets (EUR million)		Deadline
	2025	2026	
HORIZON-JU-ER-2025-02	119,2	28,4	11 February 2026
Minimum overall indicative budget	148,2		

By analogy with the Horizon Europe Annual Work Programme 2023-2024 call conditions, The EU-Rail Executive Director may decide to open the call up to one month prior to or after the envisaged date(s) of opening as well as may decide to delay the deadline(s) by up to two months. This provision applies to all call topics here-in detailed.

DESTINATION 1 – Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers

Topics	Type of Action	Expected EU contribution per	Number of projects expected to be funded

		project (EUR million)[55]	
	Opening: 8 October 2025 Deadline(s): 11 February 2026		
HORIZON-JU-ER-2025-FA1-TT-01	IA	22,4	1
Overall indicative budget		22,4	

DESTINATION 2 – Digital & Automated up to Autonomous Train Operations

Topics	Type of Action	Expected EU contribution per project (EUR million)[56]	Number of projects expected to be funded
	Opening: 8 October 2025 Deadline(s): 11 February 2026		
HORIZON-JU-ER-2025-FA2-01	IA	33,1	1
Overall indicative budget		33.1	

DESTINATION 3 – Intelligent & Integrated asset management

Topics	Type of Action	Expected EU contribution per project (EUR million)[57]	Number of projects expected to be funded
	Opening: 8 October 2025 Deadline(s): 11 February 2026		
HORIZON-JU-ER-2025-FA3-01	IA	32.8	1
Overall indicative budget		32.8	

DESTINATION 4 – A sustainable and green rail system

[55] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
[56] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
[57] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Topics	Type of Action	Expected EU contribution per project (EUR million)[58]	Number of projects expected to be funded
	Opening: 8 October 2025 Deadline(s): 11 February 2026		
HORIZON-JU-ER-2025-FA4-01	IA	26.6	1
Overall indicative budget		26.6	

DESTINATION 5 – Sustainable Competitive Digital Green Rail Freight Services

Topics	Type of Action	Expected EU contribution per project (EUR million)[59]	Number of projects expected to be funded
	Opening: 8 October 2025 Deadline(s): 11 February 2026		
HORIZON-JU-ER-2025-FA5-01	IA	20.4	1
Overall indicative budget		20.4	

DESTINATION 6 – Regional rail services / Innovative rail services to revitalise capillary lines

Topics	Type of Action	Expected EU contribution per project (EUR million)[60]	Number of projects expected to be funded
	Opening: 8 October 2025 Deadline(s): 11 February 2026		
HORIZON-JU-ER-2025-FA6-01	IA	10	1
Overall indicative budget		10	

DESTINATION 8 – Exploratory Research and other activities

[58] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

[59] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

[60] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Topics	Type of Action	Expected EU contribution per project (EUR million)[61]	Number of projects expected to be funded
	Opening: 8 October 2025 Deadline(s): 11 February 2026		
HORIZON-JU-ER-2025-EXPLR-01 : STUDIES ON RAIL 5.0	RIA	0.6	NA
HORIZON-JU-ER-2025-EXPLR-02 : STUDIES ON INNOVATION IN CLIMATE FINANCE FOR RAIL	RIA	0.6	NA
HORIZON-JU-ER-2025-EXPLR-03: EXTENDING THE RAIL NETWORK OF PHDS	RIA	1	NA
HORIZON-JU-ER-2025-EXPLR-04: SUPPORT TO THE EUROPEAN FRMCS DEPLOYMENT GROUP	CSA	0.7	1
Overall indicative budget	2.9		

General conditions relating to this call	
Admissibility conditions	The conditions are described in part A of the General Annexes to the Horizon Europe Work Programme 2023-2025
Eligibility conditions	The conditions are described in part B of the General Annexes to the Horizon Europe Work Programme 2023-2025

[61] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Financial and operational capacity and exclusion	The criteria are described in part C of the General Annexes to the Horizon Europe Work Programme 2023-2025.
Award criteria	The criteria included in part D of the General Annexes to the Horizon Europe Work Programme 2023-2025 are complemented with additional elements as specified in Annex VIII to this Work Programme.
Documents	The documents are described in part E of the General Annexes to the Horizon Europe Work Programme 2023-2025.
Procedure	The procedure is described in part F of the General Annexes to the Horizon Europe Work Programme 2023-2025.
Legal and financial set-up of the Grant Agreements	The rules are described in part G of the General Annexes to the Horizon Europe Work Programme 2023-2025.

DESTINATION 1 – Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers

DESTINATION 1 – description (possibly included in the Expected Outcome in the Funding Portal)

In the context of Network management planning and control & Mobility Management in a multimodal environment, the objective is to research, develop and deliver the functional requirements, associated specifications, and operational and technological solutions to enable a common future European Traffic Management layer. This shall include the requirements to achieve uniform train operations; ticketing services may also be considered part of such endeavour. This will enable the design of future network and capacity management, planning, and control.

In order to accelerate the European approach, research and innovation in the Flagship Project stemming from this topic shall also consider early implementation of common functions and approaches starting from existing national TMS. A dynamic network and traffic management at European scale, built upon a harmonised functional system architecture to ensure agile, borderless and mixed-traffic operations, is the target solution that the various legacy TMS should migrate towards.

This extends the capacity planning at European level and enables the automatic management of cross-border rail traffic. Improved service offers, operations and capacity utilization are reducing the inefficiencies of the door-to door services and enhancing the competitiveness of rail-based mobility chains.

To achieve the overall objective of a dynamic European traffic management, several improvements have been identified and described in the revised Europe's Rail Multi-Annual Work Programme[62].

When the railway system becomes fully digital and connected, the availability of real-time and historical data from across the whole system will unlock a whole range of new possibilities. However, a fully digital connected rail system will be characterized by a complex landscape comprising multiple heterogeneous systems and interactions.

For this reason, Destination 1 has also the objective to ensure the implementation of a railway Digital enabler and twin environment, where all digital elements of the system can play together in a coherent and interoperable way.

Proposals under this Destination should set out a credible pathway (including an exploitation plan) to contributing to all of the following expected impacts as described in the Master Plan.

The selected proposal for funding under this Destination will be a Flagship Project of Europe's Rail with significant expected impacts, which require an integrated sector systemic approach. Proposals should therefore set out a credible pathway (including an exploitation plan) to contributing to all of the following expected impacts as described in the Master Plan.

Meeting evolving customer requirements

Improved EU rail supply industry competitiveness

Reinforced role for rail in European transport and mobility

Harmonised approach to evolution and greater adaptability

More sustainable and resilient transport

In the context of Network management planning and control & Mobility Management in a multimodal environment, proposals under this Destination should deliver the innovative solutions to be demonstrated and monitored to achieve the following levels by 2030:

Improving strategic and tactical planning of the rail network:

- Increased number of possible trains on a given infrastructure on a reference day using improved processes and methods:
  - Baseline 2022, expected increase 5% to 20%, depending on the line or area.
- Reduction of answering time between the short term request of a cross-border train path and the answer with an adequate offer:
  - Down to 5 minutes.
- Improved flexibility of timetables and hence, reduced impact of disturbances and disruptions
  - Baseline 2022, expected decrease 5% to 15% of delay minutes in a reference week depending on the line or area

Increasing resilience for a connected 'real-time' rail network

[62] See MAWP (https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/)

- Prediction Quality as the basis for decision quality in Traffic Management: For a representative set of 100 trains running in a 2h interval ahead of actual time, less than 5 percent of the predicted timing shall not deviate from the actual more than 5 minutes. Note: Train cancellations not considered
- Prediction performance as the basis for in-time decision making in Traffic Management: less than 120 seconds in a typical set of 100 trains running in a 2h interval ahead of actual time. Note: Prediction shall consider dynamic infrastructure constraints (e.g., TSR, track blockages), implemented train control decisions and automated conflict resolution.
- ATO Journey Profile / Segment Profile provision cycle time down to 30 secs

Integrated rail traffic within door –to-door mobility

- Demand forecast for improved service planning:
  - Achieve 65% precision in the average forecast 1 week in advance
  - Achieve 80% precision in the forecast at 1 hour
- Improved matching between demand and supply:
  - Achieve 75% reaching passengers' planned travel time

In the context of Digital enablers and twin, the expected specific impacts of this Destination are:

- Improved EU rail supply industry competitiveness among others by reducing duration and costs for development and certification by several measures of digitalisation e.g. virtual certification tasks that can be conducted in a laboratory by 80%
- Number of Digital Twins able to be integrated, tested and validated in the "Design Environment": achieve minimum 5 Digital Twins developed by Destinations integrated in the "Digital Twin transversal Environment"
- Improve the use of federated Data and CDM: achieve 10% increase of Number of shared entities federated (referred).

HORIZON-JU-ER-2025-FA1-TT-01: NETWORK MANAGEMENT PLANNING AND CONTROL & MOBILITY MANAGEMENT IN A MULTIMODAL ENVIRONMENT AND DIGITAL ENABLERS

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 22.4 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 22.4 million. Applicant Private[63] Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.263[64] times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified.

[63] As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

[64] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

Specific Conditions	
	In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Indicative project duration	30 months.
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve a minimum between TRL 6 and TRL 8, depending on the enabler addressed, or higher by the end of the project – see General Annex B for a guide to the TRL definitions and criteria to be used.
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies with the following exception: the limit for a full Innovation Action application is set to 120 pages.
Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the Destination: • Expertise from rail infrastructure managers and railway undertakings, which should allow – defining main challenges, use cases and functional needs, prioritising a European Corridor approach or European multiple-cross-border scenarios (e.g. two borders in few hundreds kilometres) – specifying, prioritizing and clustering demonstrators to ensure that researched innovative processes, operational and technological solutions are covered, – hosting the demonstrations and providing test trains/facilities, – providing data structures and content as well as processes, e.g. certification which can be subject for digitalisation. • Expertise from rail suppliers (system integrators, manufacturers and/or technology providers), which should allow, jointly, – proposing operational and technological innovative solutions to identified use cases and functional needs, – identifying the technical requirements and interface specifications, aligned with the System Pillar architecture, – designing, developing, prototyping and delivering innovative operational & technological solutions and systems to be integrated within the demonstrations, depending on the specific target TRL level. • Expertise from research institutes and academia, which should allow – planning, developing, studying, testing and evaluating solutions, systems and demonstrators together with the previous categories of expertise, – supporting any possible scientific or methodological issues that may arise during the performance of the action – contributing to other aspects of the innovation cycle, as well as to the procedural aspects for validation, certification, etc.

Specific Conditions	
	• Complementary expertise from other sectors and parties, with particular attention to SMEs and Start-ups, which may contribute to enhance the actions' outcome.
Contribution to the monitoring and implementation, standardisation, of the EU-Rail Programme	The action resulting from this topic is identified as a "flagship project" expected to perform, by the completion of the research and innovation lifecycle, "large scale demonstrations", in the meaning of Council Regulation (EU) 2021/2085. Hence, the action is a key contributor to the achievement of the objectives identified in the Master Plan [65] as further detailed in the revised Multi-Annual Work Programme[66]. In this respect, applicants are expected to deliver relevant information (data, results, etc.) as mutually agreed, to the JU and the Linked Project[s] to contribute to the advancement of the Innovation and System Pillars[67] activities, as well as in view of the development and implementation of EU policy and legislation (including Technical Specifications for Interoperability and Common Safety Methods) and the development of European standards. As specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to European or international standards, the EU-Rail grant agreements will include an additional information obligation related to standards. Beneficiaries must inform EU-Rail (up to four years after the end of the action) if the results can be reasonably expected to contribute to European or international standards. As part of its internal control and management framework, the JU will perform series of reviews and maturity checkpoints to assess the overall progress against the project plan and against the performance and TRL targets. Depending on the outcome of these reviews and maturity checkpoints(s), the scope of the project may be revised and/or funding reduced in accordance with the provisions of the relevant grant agreement. Mitigation actions may be requested by the JU as condition for continued funding. The proposal shall consider the necessary resources – FTE and/or other – to ensure the monitoring of the "Flagship Project" via regular reporting, reporting of data for the Programme KPIs, etc. A EU-Rail Governance and Process Handbook is available here : https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/
Linked Projects	As specified in section 2.3.8.1 of the Work Programme, in order to facilitate the contribution to the achievement of the EU-Rail objectives, the options regarding 'linked actions' of the EU-Rail Model Grant Agreement and the provisions therein, is enabled in the corresponding EU-Rail JU Grant Agreements. The action that is expected to be funded under this topic will be complementary to the following projects: • FP1 - MOTIONAL (GA number: 101101973) • FP2-R2DATO (GA number: 101102001) • FP3 – IAM4RAIL (GA number:101101966) • FP4 – RAIL4EARTH (GA number: 101101917)

[65] Master Plan available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

[66] Revised MAWP available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/ .

[67] Refer to the revised Multi-Annual Work Programme available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

Specific Conditions	
	• FP5-TRANS4M-R (GA number: 101102009) • FP6-FutuRe (GA number: 101101962) • FP7-Pods4Rail (GA number: 101121853) The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics: • HORIZON-JU-ER-2025-FA2-01: Digital & Automatic up to Automated Train Operations • HORIZON-JU-ER-2025-FA3-01: Intelligent & Integrated asset management • HORIZON-JU-ER-2025-FA4-01: A sustainable and green rail system • HORIZON-JU-ER-2025-FA5-01: Sustainable Competitive Digital Green Rail Freight Services • HORIZON-JU-ER-2025-FA6-01: Regional rail services / Innovative rail services to revitalise capillary lines Please note that the list is non-exhaustive as additional Linked Projects may follow at a later stage of the programme implementation to complement the activity.
Funding of only one project per topic	EU-Rail may award up to one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]].
Lower funding rate	The funding rate of the action is 60% of the eligible costs to achieve the leverage effect established in the SBA. Each Consortia may decide internally different funding rates in line with the provisions of Article 34 of Horizon Europe nevertheless complying with the overall funding rate of 60%.
Award criteria additional details	The award criteria included in the General Annexes of the Horizon Europe Work Programme 2023-2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.
Additional dissemination obligations	In addition, as specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to considering the key contributing role of this topic, in designing the dissemination and communication activities, the proposal shall consider that the "Flagship Project" will be part of the overall EU-Rail Programme and the planning of key events – demonstrations, participations to fair, etc. – will be coordinated at Programme level and by the "Stakeholder Relations and Dissemination" structure of the JU. The proposal shall consider the KPIs metrics on dissemination and communication included in the EU-Rail Governance and Process Handbook available here : https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/

Expected Outcome

The action to be funded under this Destination shall address two work streams (WS):

WS1: Network management planning and control & Mobility Management in a multimodal environment

The developed solutions shall enhance capabilities and allow to achieve the following outcomes:

Improving strategic and tactical planning of the rail network:

The innovative functionalities of planning & simulation shall cover activities related to the strategic and short term rail services planning considering the impact of the evolution of ERTMS and ATO with the aim of boosting the efficiency of the rail network and its operations, considering as well international strategic planning initiatives by the sector. Coherence with external services and operational technologies for future planning processes shall be ensured by taking into account for example the related driving modes and onboard technologies such as C-DAS and/or ATO already at the planning stage. This specifically should address the areas of cross-border planning, yard and station processes, traffic management and ETCS or ATO modelling. The innovations shall be integrated/connected and used with state-of-the-art systems, to demonstrate the intended functionalities and the capability to be implemented for production use.

The proposals shall foresee the delivery of an architecture showing how the different enablers and elements interface with each other and with legacy systems. This is expected by M6.

Increasing the resilience of a connected 'real time' rail network:

Another output of the activities carried out in this Destination shall be the European real-time railway traffic management and operations with the goal to provide a more agile, optimized and automated response to unplanned situations, such as disturbances and responses to dynamic demand especially in cross-border traffic situations, also enabling an automation-human teamwork when requested. Such significantly enhance TMS shall be capable to support interoperable traffic management on a European dimension, which shall increase the resilience of a connected "real-time" rail network in Europe. The solution should ensure optimisation of the quality of cross-border train paths in the scheduling process (e.g. resource negotiation with subsystems), as well as the corresponding real-time deviation management, and be able to adapt to different constraints and human/automation indications pertaining to the decision-making level. An optimized overall system architecture and operational workflows have to be developed together with the System Pillar.

The proposals shall foresee the delivery of an architecture showing how the different enablers and elements interface with each other and with legacy systems. This is expected by M6.

Integrated rail traffic within door-to-door mobility

The solution should develop and integrate a number of enablers for an improved real-time door-to-door offer planning and management. It includes better information exchange between operators (for operational issues), long-term and short-term demand predictions for all parts and stretches of the chain, and systems for dynamic best offers (incl. real-time availability of resources and network constraints). To enable the developed technologies to be put in effective use, in parallel to technological developments, there shall be a process defined between European IMs, RUs and other relevant actors to agree on necessary data management and data exchange. Additional enablers are improved accessibility and attractiveness at the interconnection, specifically for Persons with Reduced Mobility (PRM).

The Flagship Project stemming from this topic shall deliver by 2028 innovative solutions to be demonstrated with:

- **Improving strategic and tactical planning of the rail network [TRL 7]**:
    - Functional system for strategic, tactical and short-term planning considering ERTMS and ATO evolvement and their related effects on capacity; planning using integrated feedback loops from operations, including TMS and C-DAS/ATO; using ATO journey profiles for timetabling
- **Increasing the resilience of a connected 'real-time' rail network [TRL 6/7]** :
    - TMS at regional area with decision support and interaction between actors, including integration with incident management and handling of maintenance, co-operative planning for improved interaction between nodes (important yards and stations) and rail network as well as cross-border operations and asset conditions for rolling stock and infrastructure in real-time
    - TMS at global area: decision support and automation and overall real-time traffic plan, with feedback loops from operation to planning, showcasing the capabilities:
        - Real-time connection of the networks
        - Improved modelling for cross-border
        - Integration of energy management (Electric Traction System)
        - Real-time crew / rolling stock dispatching
        - Cooperative planning multi-actors
        - Dispatching, incident management and customer information
        - Disruption management
        - Increased automation in decision support
        - Conflict detection & resolution
- **Integrated rail traffic within door-to-door mobility [TRL 7/8]**:
    - Improved long-term demand driven predictions considering short term demand forecast and disruption management and using additional data sources and external data (e.g., public events, seat availabilities); Use of Digital Twins for the visualisations and modelling of movements at train stations
    - Cross-border travel within Europe and the connection of rural areas to create an inclusive mobility network, with focus on PRM guidance based on real-time data

In addition to the above, the proposal shall cover important preparatory works needed to be launched for the future set of demonstration foreseen in the Multi-annual Work programme in view of the evolutions of the solutions:

- Automated solutions for improved strategic and tactical planning supporting cross-border scheduling and TTR planning process, based on harmonised methods for capacity planning with intelligent functions with optimization and simulation support showcasing the following capabilities:
    - Improved capacity allocation using Rolling planning and TTR
    - Optimization methods for timetabling and railway planning
    - Improvement of rail simulation models for selected Use Cases
- TMS including real-time effect of ATO and the resulting service quality, as well as feedback loops with planning process effects of feeding operational observations into improved train timetables and decision support for improved control of nodes, yards and stations, and improved connection to industry sidings and ports, as well as interaction with other rail networks showcasing the following capabilities:
    - Real-time convergence between planning & operations
    - Connection TMS & CTC, and automated yards
    - Integration with yard and station management

    - Speed regulation, precise routes and target times for ATO and dynamic timetables
- Using the output from disruption management and demand-driven predictions (short-term) and further integrating and adjusting long-term predictions and the digital twin approach to improve rail capacities by applying AI-based and machine-learning techniques and providing a B2B service platform on a pan-European level to move towards an inclusive mobility network showcasing the following capabilities:
    - AI-based optimization of rail capacity.
    - Pan European B2B service platform.
    - General approach to platform based guidance.
    - Digital Twin usage for predictive support of operators (incl. short & long term demand) and if possible to provide indications on the infrastructure limits (bottlenecks) and infrastructure investments' needs (especially in the coordination of the investments across different countries).

The action to be funded under this Destination also needs to provide the following necessary element for the demonstrations under the action to be funded under *Digital and Automated, up-to Autonomous train operations* (Destination 2) to be delivered for 2028 demonstrations: TMS functionality for serving autonomous path allocation [TRL6]

The action to be funded under this Destination also needs to provide the following necessary elements for the demonstrations under the action to be funded under the Destination *Sustainable Competitive Digital Green Rail Freight Services* (Destination 5) to be delivered for 2028 demonstrations: indicative list of enablers (1, 2, 3, 4, 6, 9, 10) as described under the Scope section of this Destination. In addition to the above, the proposal shall cover important preparatory works needed to be launched for the future set of FA5 demonstration foreseen in the Multi-annual Work programme in view of the evolutions of the solutions, linked with those same enablers at higher TRL.

The action to be funded under this Destination also needs to provide the following necessary elements for the demonstrations under the action to be funded under the Destination 6 *Regional rail services / Innovative rail services to revitalise capillary lines* to be delivered for 2028 demonstrations: indicative list of enablers (1, 2, 3, 4, 6, 11, 12, 13, 16, 17, 19, 20, 21 and 23) as described under the Scope section of this Destination. In addition of the above, the proposal shall cover important preparatory works that needs to be launched for the future set of FA6 demonstrations foreseen in the Multi- annual Work programme in view of the evolutions of the solutions, linked with those same enablers at higher TRL.

WS2: Digital Enablers

By definition a Digital Twin is a virtual representation able to imitate the behaviour of a physical system during the spans of its lifecycle. Within the railway, a Digital Twin encompasses at least two levels, a Unit level (Functional Mock-up Units- FMU) where specialized "domain-knowledge" is located and a Interface level (Functional Mock-up Interfaces - FMI) where I/O requirements as well as the interactions among FMU are implemented.

The work stream on digitalisation should support operational processes and activities of all Destinations and especially the implementation of the related use cases. It will take into account the System Pillar (SP) CONOPS (Concept of Operation) of the rail system as well as definitions of SP-architectures and SP-interfaces. The action to be funded under this Destination shall analyse and assess available requirements for the interlinking layers of common European Mobility Data Spaces (EMDS) against the architecture delivered by FP1-MOTIONAL[68] and ensure their implementation. Requirements, implementation and data for the Digital Twins are responsibility of this Destination.

This work stream will support this by three aspects:

[68] Reference to D31.1 Federated Data space "sandbox environment description": https://rail-research.europa.eu/pages/fp1-motional/deliverables

- "Digital Twin Support Environment" for operational processes of the Destinations by composition of reusable, black-boxed, compiled, digital interoperable model units (FMU) of components, subsystems and super-systems.
- "Digital Twins Design Environment" to facilitate the integration at interface level (FMI) as well as validation, verification, and test, including model registry and discovery services and interoperability validation tools
- A "Run-Time Environment" based on a Federated dataspace to feed an execute Digital Twins to ensure a common Ontology and associated Federation Services such as: Identity and Trust management, Data Assets registry and discovery services, Data Distribution Services, Data stream management, Cyber security etc.

Digital Enablers' Architecture and related interfaces need to be wider than the Architecture provided e.g. for the CCS+ to enable the Digital Twin environment to work properly. Hence the results and definition of the SP need to be taken into account and represented.

Rapid development of digital technologies offers numerous opportunities for creating new value-added services in the railway industry. To seize these opportunities, the following outcomes must be achieved by this WS:

1) Develop data federation, access and processing services through standardized interfaces
2) Based on the outputs and toolset developed within EU-RAIL, a common machine-readable domain ontology must be developed to structure the data unambiguously across all systems participating in data sharing
3) Ensure a powerful, secure and reliable data and communication infrastructure.

The railway digital enabler is meant to be considered as a set of concepts, models, technologies and methods addressing the three levels of actions - data, services and digital infrastructure. The railway digital enabler is therefore a framework that needs to be filled with real technology and architectures in specific Destinations applications. Related to this concept, it should be emphasized that in addition to a common standardized / well-documented data space, a common standardized / well-documented semantics and standardized / well-documented protocols are also needed and shall be worked out in detail.

All the expected output of the action to be funded under this WS shall be exploited by all Destinations in building and executing Digital Twins.

In addition, this WS shall include preparation work:
- for modular built-up of Digital Twin within the development environment
- use of artificial intelligence to collect and analyse data patterns and support decision making process
- Digital Twins using real-time algorithms

Scope

Action to be funded under this topic should research, develop, and deliver the following capabilities and/or any other relevant capability to achieve the aforementioned expected outcome, on the basis of the public deliveries of FP1-MOTIONAL (GA: 101101973)[69]:

WS1

To improve strategic and tactical planning of the rail network developing solutions that enable by 2028:

[69] https://projects.rail-research.europa.eu/eurail-fp1/deliverables/

- **Enabler 1**: European cross-border scheduling with international train path planning and Improved capacity allocation using rolling planning and TTR [TRL7]
- **Enabler 2**: Decision support for short term planning [TRL7]
  Enabler 3: Optimization methods for timetabling and railway planning (incl. capacity efficiency and energy saving) [TRL7]
- **Enabler 4**: Improved rail traffic simulation models for selected Use Cases to forecast punctuality in the network (e.g. simulating proportion primary and secondary delays, simulations drivers vs. ATO over ETCS …). [TRL7]
- **Enabler 5**: Integration of TMS with a) yard capacity planning and b) station capacity planning [TRL7]
- **Enabler 6**: New planning and operational processes using feedback loops from ERTMS ATO and C-DAS [TRL7]

Developments on all those enablers should also cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions.

To increase resilience of a connected 'real time' rail network developing solutions that enable by 2028:

- **Enabler 7**: Real-time connection of rail networks as managed by TMSs and involved actors and Modelling and decision support for cross-border traffic management [TRL7]
- **Enabler 8**: Integration of TMS with a) yard management system and processes; b) station management system and processes; c) energy management (Electric Traction System); d) real-time crew / rolling stock dispatching [TRL7]
- **Enabler 10:** Real-time convergence between planning & feedback loop from operations [TRL6]
- **Enabler 11:** Cooperative planning multi-actors within rail [TRL6]
- **Enabler 12**: Integration of incident management and customer information, with IM and RU interaction and Decision Support for Disruption management [TRL7]
- **Enabler 13**: TMS speed regulation of trains, precise routes and target times for ATO and dynamic timetables [TRL7]
- **Enabler 14**: Automation of very short term train control decisions and Real-time conflict detection & resolution for main line and optimisation [TRL7]

Developments on all those enablers should also cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions.

To integrate rail traffic within door-to-door mobility developing solutions that enable by 2028:

- **Enabler 15**: Improved rail integration using B2B intermodal services leveraging existing European standards: cross-operator information sharing on e.g. sales and distribution, traffic information, end-user experience, … [TRL8]
- **Enabler 16**: This enabler focuses on delivering a smooth, hands-free, and accessible journey for all passengers by integrating smart, user-centric services across the rail network and with other modes of transport. It aims to enhance comfort, autonomy, and inclusivity throughout the entire travel chain. [TRL7]
- **Enabler 18**: Innovative platform-based passenger guidance solution, measurement and guidance of customer flows to and on the platform [TRL7]
- **Enabler 19**: Short term demand forecast calculation using run time data (e.g. ticketing data, short term weather forecast, passenger density, ….) [TRL8]
- **Enabler 20**: Long term demand forecast with focus on data analytics based on a variety of sources (e.g., public events, holiday calendar) and operators' data (e.g., fare, passenger density data) and historical information for predictive models related to passenger clustering [TRL7]

- **Enabler 21**: Integrated traffic simulation and demand forecast in a Digital Twin to optimize offer, passenger occupancy, connection time and other service-related elements [TRL7]
- **Enabler 22**: Disruption management across different mobility modes enabling operators to collaboratively solve the disruption and properly inform passengers [TRL8]

Developments on all those enablers should also cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions.

It is expected that the work stream 1 will use the EU-RAIL System Pillar Cybersecurity specifications [70], provide feedback to the work stream 2 and foresee adequate structure and resources for these activities.

WS2

Connectors for Federated Data Spaces, TRL7 by 2028

A need for *federated data spaces* to make all heterogeneous data available to specialized digital applications in multiple domains while a) allowing incremental extensions and avoiding the rigidity of synchronized and centralized deployment timelines and b) providing data owners with the ability to retain control of their assets.

A federated data space is a distributed secure and reliable data sharing and communication infrastructure enabling data federation, access and processing services through standardized interfaces. Incremental extensions of the federated data space are achieved by new devices and systems using the exposed services to add themselves to the federation as they become available, while data asset protection by their owners is achieved by each participant implementing their own data access policies at the interface between their system and the federated dataspace. Connectors using these interfaces must be developed for existing or legacy/proprietary systems to participate in the federation. The sequence of successive federations must take into account the dependencies identified in Annex B between Destinations.

Common Domain Ontology, building upon S2R works on Conceptual Data Model (CDM) and ERA Ontology, TRL 7 by 2028

For Research & innovation and demonstrations activities (within the action) making use of data models related to the interoperability or safety of the rail system, those data models should be aligned with the ERA Ontology[71]. This ontology defines the conceptual framework and the specific terms and relationships for the interoperability or safety of the rail system in the EU that shall be used or where relevant extended. This includes the reuse of the ERA ontology with its semantic artifacts (shacl rules, skos ..) and in cases where it is not sufficient, extensions should be proposed to maintain semantic consistency and interoperability across systems. Those extensions proposals should cover the processes to validate extension to the ERA Ontology with compliant datasets and related competency questions and linked SPARQL queries based on interoperability testbed validation tools (Interoperability Test Bed Guides — ITB Guides[72]). Corresponding documentation should also include any mappings or transformations considered in the Research & Innovation activities and any assumptions made.

High quality data and its accessibility is key to the success of the next generation of railway application and services. Therefore, data does not only need to be of high semantic quality, but also has to be specified by a standardized high-quality syntax.

[70] https://rail-research.europa.eu/horizontal-tasks/

[71] https://github.com/Interoperable-data/ERA-Ontology-3.1.0

[72] https://www.itb.ec.europa.eu/docs/guides/latest/overview/index.html

Digital Twin support, development and execution environment, TRL6 by 2028

As a virtual representation able to imitate the behaviour of a physical system, a Digital Twin is a software implementation of a structural and behavioural model of the represented system. A development environment for Digital Twins shall be composed of standard modelling tools, editors, compilers and debuggers used by specialists to create self-contained, compiled functional mock-up units (FMUs). Searchable libraries of FMUs are also part of the Digital Twin development environment, used to implement higher level FMUs as compositions of submodels through standardized interfaces. Compiled FMUs are deployed to an interoperable Digital Twin execution environment in which models are initialized with data obtained from the federated dataspace through the dataspace services, and simulations runs are performed to generate the projected behaviour of the imitated physical system.

Cybersecurity, TRL 6 by 2028

Demonstrate Shared Cybersecurity Services for the Rail System allowing stakeholders in all EU-RAIL Destinations to apply Cybersecurity applications to secure their digital assets, data and communication. Added to the Digital Assets and Engineering toolbox and shareable as a service in a cloud environment, the Shared Cybersecurity Services will provide state-of-the-art cybersecurity procedures, methods and applications.

- Coordination with EU-RAIL System Pillar and other Destinations:
    - Align with EU-RAIL System Pillar Cybersecurity specification
    - Feedback to EU-RAIL System Pillar from demonstrator findings (after demonstration)
    - Coordination with relevant other Destinations (presentation, feasibility check, collecting conditions and requirements for use of Shared Cybersecurity Services).

- Creation and set up of the Shared Cybersecurity Services (SCS) demonstrator (TRL 6):
    - Setting up the Shared Cybersecurity Services demonstrator in a cloud environment such as the Rail Data Space based on the EU-RAIL System Pillar Cybersecurity specifications.
    - Testing and demonstrating the SCS demonstrator in combination with data connectors and/or digital twin supplementing with additional applicable standards.
    - Test interfaces, interoperability and operational procedures of the Shared Cybersecurity Services with selected and interested Destinations.

Key Performance Indicators

The action shall actively contribute to measure and monitor the specific quantitative KPIs defined in the Destination description above, including its contribution to the Europe's Rail Master Plan impacts. Outcomes are to be delivered at a calendar annual basis by each year end.

Collaboration work required with other Destinations

The required collaboration work, including the resources required, with other Destinations included in this call should be foreseen by the action to be funded under Destination 1:

- Common activities/tasks related to the review of system specifications to be developed by the action to be funded under Destination 2, Destination 3, Destination 4, Destination 5 and Destination 6.
- For WS1 only, a common activity/task related to the integration and pilot test(s) of the technical enablers to be provided by the actions to be funded under Destination 2, Destination 3 and Destination 4 and Destination 5 for the demonstration to be carried out in the action to be funded by Destination 1, Destination 2, Destination 3, Destination 4, Destination 5 and Destination 6.

Interaction with the System Pillar

The System Pillar aims to guide, support and secure the work of the Innovation Pillar (i.e. to ensure that research is targeted on commonly agreed and shared customer requirements and operational needs, compatible and aligned to the system architecture), and the Innovation Pillar will impact the scope of the System Pillar where new technologies or processes mean that innovations can drive a change in approach, as well as delivering detailed specifications and requirements.
In this respect, the proposal should allocate necessary resources that would be dedicated to areas linked to the System Pillar conceptual and architecture works – particularly addressing specification development and demonstration activities following architectural aspects, stemming from the work of System Pillar:

- Definition of functional enhancements for capacity management for the Telematics TSI including harmonized processes, messages and data sources (STIP_16), e.g for Integration of planning systems and processes including cross-border planning.
- Traffic Management based upon the federated model and "European Network Concept Principles" (new STIP item), to demonstrate requirements that go beyond current regulation.
- Function distribution and interface between TMS/CMS (STIP_17), for functional enhancements, e.g. to improve operational performance on cross border traffic
- Function distribution and interface between TMS/Traffic CS (STIP_18).
- the ERA-ontology derived from the SP CCS/TMS Data Model (see also STIP_8 and STIP_11: CCS/TMS Data Model) shall be taken up for data preparation, validation, processing and interface communication purpose related with CCS and TMS.
- Specification of requirements for the Service Function Configuration and the interface to the CCS/TMS subsystems (STIP_8)
- EU-RAIL Cybersecurity Specification based demonstration of Shared Cybersecurity Services (STIP_75)

The EU-RAIL System Pillar is producing specifications and other relevant documents [73]. In general the documents applicable to the Destination 1 should be used. If it is considered documents are not applicable, the proposals shall explain the reason(s) for not using them (to note the application of the documents may still be required by EU-RAIL). During the action to be funded under this Destination, there may be updating of the documents, including based on feedback from application in technical enablers and demonstrators. Relevant feedback should be provided on a regular basis to EU-RAIL and the System Pillar.

In consideration of the timing of the activities, the planning as per the STIP should be taken into account and referred to. The proposal shall foresee feedback to the SP harmonization specification as part of the relevant deliverables, as well as capacity for joint workgroups to justify SP requirements, on the basis of the demonstrations, as mature for harmonization output.

The alignment of the activities will primarily take place during the Grant Preparation Phase and ramp up phase of the awarded proposal, and there will be continued, structured and regular interaction through the life of the project.

The action shall actively contribute to the update of the EU-Rail Standardisation and TSIs input plan (STIP) wherever relevant. Similarly, the action shall contribute to the development and implementation of EU policy and legislation including Technical Specifications for Interoperability and Common Safety Methods, as well as to publications of the System Pillar.

Gender dimension
In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

[73] https://rail-research.europa.eu/v1-release/

Other

It is expected that the Flagship Project stemming from this topic:

- will involve sufficient European geographical representation of academia, and ensure that all needed expertise for the described activities reflects the Special skills and/or capabilities expected from the Applicant(s) as described in the specific topic conditions.
- will be compliant with the EU Data Policy 2020 and associated legal instruments. This requires adherence to EU framework, including but not limited to the Open Data Directive (EU) 2019/1024 and associated implementing Regulation (EU) 2023/138 on high-value data sets, the Data Governance Act (Regulation (EU) 2022/868), the Data Act (Regulation (EU) 2023/2854), and the Interoperable Europe Act (Regulation (EU) 2024/903). Ensuring compliance involves verifying that data management, processing and sharing comply with applicable EU framework.

DESTINATION 2 – Digital & Automated up to Autonomous Train Operations

DESTINATION 2 – description (possibly included in the Expected Outcome in the Funding Portal)

Solving rail capacity problems remains a key challenge on main lines of the European networks. A major opportunity is offered by digitalization and automation of rail operation, where DATO (Digital "Automated" Train Operations) represents the most visible result of a major transformation of rail operations in an environment where the building of new infrastructure is not a viable option. This innovation relies on a next generation of Automatic Train Control (ATC), in addition to enhancements on the Train Control and Monitoring System (TCMS). ATC[74] is the combination of Automatic Train Protection (ATP) systems, Automatic Train Supervision (ATS), and Automated Train Operation (ATO) – together representing an evolution of the current Control, Command and Signalling (CCS) subsystem.

The aim of this Destination is to take the major opportunity offered by digitalization and automation of rail operation and to develop the Next Generation ATC and deliver scalable automation in train operations.

The selected proposal for funding under this Destination will be a Flagship Project of Europe's Rail with significant expected impacts, which require an integrated sector systemic approach. Proposals should therefore set out a credible pathway (including an exploitation plan) to contributing to all of the following expected impacts as described in the Master Plan.

[74] The ATS is responsible for "[the] supervision of [the] train status, automatic routing selection, automatic schedule creation, automatic operations logging, statistics and report generation, and automatic system status monitoring". The ATP system is designed as a fail-safe system, intended to keep a safe distance between trains and to make each individual train comply with the track speed limits. If the speed limit is exceeded, ATP will automatically slow down the train or even bring it to a complete stop. ATO is responsible for the train operation part, so the traction and braking controls, but also creating the trains speed profile, the communication with the wayside equipment, the opening and closing of the train doors, and automatic train reversal.

Meeting evolving customer requirements	Reduced costs	Harmonised approach to evolution and greater adaptability	Improved EU rail supply industry competitive-ness	Improved performance and capacity	Reinforced role for rail in European transport and mobility

These can be further detailed with specific impacts of this destination, as:

- Lowering expenses of railway undertakings and infrastructure managers,
- Decreasing travelling times for passengers and freight,
- Increasing the overall capacity of the rail operation,
- Increasing the punctuality,
- Improving the quality of operation,
- Increasing operational reliability,
- Improving recovery time after any interruption or intervention,
- Improving reaction time,
- Increasing flexibility in planning on existing infrastructure,
- Reducing energy consumption.

Proposals under this Destination should set appropriate monitoring and demonstration activities to measure the following KPIs:

Type of impact	KPI	Expected Improvements
A first technical KPI which can show the improved flexibility in the responsiveness is the system response time which could be given based on the reaction requested from FA1.	Responsiveness is understood as the time to react to a request from FA1 in a shorter time than today. Responsiveness provided by FA2 is the enabler for improved flexibility and can be measured as time.	Reduction from 2h to 2Min.
The accidentology indicator will show the improvement of the operational safety for mixed traffic in urban environment with trams while reducing the human factor in the normal operation.	No. of collisions with third-parties per 10.000 km travelled	Decrease by 50% (ca. from 0.2 to 0.1)
As operational KPI the improvement of the capacity can be used, as the increase as well indirectly improves travelling times, punctuality, quality of operation and reliability.	No. of trains on line per hour and direction	Increase of 10%
The cost-related operational KPI is the reduction of the Life-Cycle Cost (LCC) where especially the cost of operation includes energy consumption and productivity. CAPEX are assumed not to increase compared to today's, while including additional functionalities. OPEX-relevant factors reduced by different measures as e.g. productivity increased by higher automation in	Energy consumption in kWh reduction measured as energy per passenger-km	Reduction by 10% compared to driver's average,

Type of impact	KPI	Expected Improvements
train operations, energy consumption reduction and improved punctuality by automation.		
	Increased Staff productivity is understood as raising the productive hours, which are understood as worked hours from staff minus waiting times, commuting/shuttling times, etc.	Increase by 30%
	Punctuality is understood here as reduction in cumulated delay time and measured as delay/service in time	Reduction by 20%

HORIZON-JU-ER-2025-FA2-01: DIGITAL & AUTOMATIC UP TO AUTOMATED TRAIN OPERATIONS

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 33.1 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 33.1 million. Applicant Private[75] Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.263[76] times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Indicative project duration	30 months.
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve a minimum between TRL 5 and TRL 7, depending on the enabler addressed, or higher by the end of the project – see General Annex B for a guide to the TRL definitions and criteria to be used.
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies with the following exception: the limit for a full Innovation Action application is set to 120 pages.

[75] As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

[76] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the Destination: • Expertise from rail infrastructure managers, railway undertakings, and urban light rail operators, which should allow – defining main challenges, use cases and functional needs, – specifying, prioritizing and clustering demonstrators to ensure that researched innovative processes, operational and technological solutions are covered, – hosting the demonstrations and providing test trains/facilities, – providing data structures and content as well as processes, e.g. certification which can be subject for digitalisation. • Expertise from rail suppliers (system integrators, manufacturers and/or technology providers), which should allow, jointly, – proposing operational and technological innovative solutions to identified use cases and functional needs, – identifying the technical requirements and interface specifications, aligned with the System Pillar architecture, – designing, developing, prototyping and delivering innovative operational & technological solutions and systems to be integrated within the demonstrations, depending on the specific target TRL level. • Expertise from research institutes and academia, which should allow – planning, developing, studying, testing and evaluating solutions, systems and demonstrators together with the previous categories of expertise, – supporting any possible scientific or methodological issues that may arise during the performance of the action – contributing to other aspects of the innovation cycle, as well as to the procedural aspects for validation, certification, etc. • Complementary expertise from other sectors and parties, with particular attention to SMEs and Start-ups, which may contribute to enhance the actions' outcome.
Contribution to the monitoring and implementation, standardisation of the EU-Rail Programme	The action resulting from this topic is identified as a "flagship project" expected to perform, by the completion of the research and innovation lifecycle, "large scale demonstrations", in the meaning of Council Regulation (EU) 2021/2085. Hence, the action is a key contributor to the achievement of the objectives identified in the Master Plan [77] as further detailed in the revised Multi-Annual Work Programme[78]. In this respect, applicants are expected to deliver relevant information (data, results, etc.) as mutually agreed, to the JU and the Linked Project[s] to contribute to the advancement of the Innovation and System Pillars[79] activities, as well as in view of the development and implementation of EU policy and legislation (including Technical Specifications for Interoperability and Common Safety Methods) and the development of European standards. As specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to European or international standards, the EU-Rail grant agreements will include an additional

[77] Master Plan available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

[78] Revised MAWP available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

[79] Refer to the revised Multi-Annual Work Programme available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

	information obligation related to standards. Beneficiaries must inform EU-Rail (up to four years after the end of the action) if the results can be reasonably expected to contribute to European or international standards. As part of its internal control and management framework, the JU will perform series of reviews and maturity checkpoints to assess the overall progress against the project plan and against the performance and TRL targets. Depending on the outcome of these reviews and maturity checkpoints(s), the scope of the project may be revised and/or funding reduced in accordance with the provisions of the relevant grant agreement. Mitigation actions may be requested by the JU as condition for continued funding. The proposal shall consider the necessary resources – FTE and/or other – to ensure the monitoring of the "Flagship Project" via regular reporting, reporting of data for the Programme KPIs, etc. The EU-Rail Governance and Process Handbook is available here: https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/
Linked Projects	As specified in section 2.3.8.1 of the Work Programme, in order to facilitate the contribution to the achievement of the EU-Rail objectives, the options regarding 'linked actions' of the EU-Rail Model Grant Agreement and the provisions therein, is enabled in the corresponding EU-Rail Grant Agreements. The action that is expected to be funded under this topic will be complementary to the following projects: FP1 - MOTIONAL (GA number: 101101973) FP2-R2DATO (GA number: 101102001) FP2-MORANE 2 (GA number: 101196125) FP3 – IAM4RAIL (GA number:101101966) FP4 – RAIL4EARTH (GA number: 101101917) FP5-TRANS4M-R (GA number: 101102009) FP6-FutuRe (GA number: 101101962) The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics: • HORIZON-JU-ER-2025-FA1-TT-01: Network management planning and control & Mobility Management in a multimodal environment • HORIZON-JU-ER-2025-FA3-01: Intelligent & Integrated asset management • HORIZON-JU-ER-2025-FA4-01: A sustainable and green rail system • HORIZON-JU-ER-2025-FA5-01: Sustainable Competitive Digital Green Rail Freight Services • HORIZON-JU-ER-2025-FA6-01: Regional rail services / Innovative rail services to revitalise capillary lines Please note that the list is non-exhaustive as additional Linked Projects may follow at a later stage of the programme implementation to complement the activity.
Funding of only one project per topic	EU-Rail may award up to one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting

	date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]].
Lower funding rate	The funding rate of the action is 60% of the eligible costs to achieve the leverage effect established in the SBA. Each Consortia may decide internally different funding rates in line with the provisions of Article 34 of Horizon Europe nevertheless complying with the overall funding rate of 60%.
Award criteria additional details	The award criteria included in the General Annexes of the Horizon Europe Work Programme 2023 – 2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.
Additional dissemination obligations	In addition, as specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to considering the key contributing role of this topic, in designing the dissemination and communication activities, the proposal shall consider that the "Flagship Project" will be part of the overall EU-Rail Programme and the planning of key events – demonstrations, participations to fair, etc. – will be coordinated at Programme level and by the "Stakeholder Relations and Dissemination" structure of the JU. The proposal shall consider the KPIs metrics on dissemination and communication included in the EU-Rail Governance and Process Handbook available here : https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/

Expected Outcome

The solutions to be delivered by this action are expected to cover a wide range of applications for the next generation Automatic Train Control (ATC) technologies, such as passenger trains for high speed, light rail urban lines, suburban lines, freight trains and regional lines including low density lines as well as including application in more complex situations, such as mixed traffic, power supply transitions and ATP transitions (e.g. ETCS to undefined tracks).

The Flagship Project stemming from this topic is expected to contribute to Europe's Rail Programme with the following outcomes, to be delivered on the basis of results stemming from Phase 1 of Europe's Rail programme (FP2-R2DATO – GA number 101102001[80]) and appropriately developed further in close coordination with the EU-RAIL System Pillar:

- Implementation of operational solutions to be demonstrated in specific use cases through demonstrators and technical enablers up to TRL7.

- To secure investments and ensure a clear migration path, the next generation ATC shall support backwards compatibility for all automation levels. Furthermore, the overarching automation process shall also support end-to-end customer solutions independent from the existing infrastructure, to guarantee the automation of the operation over the entire value chain. In addition to the modularisation of the functionality of the ATC systems, the decoupling of software from hardware will pave the way for a modular hardware platform. Upgradeability

[80] On the basis of FP2-R2DATO deliveries: https://projects.rail-research.europa.eu/eurail-fp2/deliverables/

shall be a clear goal. Special attention shall be given to the cost effectiveness of the solutions regarding maintainability and evolvability as well as taking into account retrofitting aspects where relevant.

- The following additional operational scenarios shall be considered in the development of the required technical enablers, services and functions:
  - Mixed operation for radio based ERTMS on lines with/without (mixed situation) Trackside Train Detection (TTD),
  - Train Integrity Monitoring System (TIMS) and localisation capabilities for different target configurations. To pave the way for an improved, faster infrastructure change from Class B to the previously defined scenarios with focus on shortening effort, prerequisites and duration (including simplified safety case effort, e.g., for changes) including integration with the modular ATC systems and the TMS.
  - "Fully mature ERTMS": full supervision (cab signalling) continuously in all normal modes, also for shunting, or for yellow fleet movements.
  - The same architecture shall be used for efficient processes for train stabling, formation and preparation, as well as in marshalling yards, depots or terminals in connection with their specialized technologies for passenger and freight trains.
  - Georedundant ATC deployments for increased resilience in rail operations.
  - Urban light rail automated operations.

The demonstrations of the innovative solutions shall take into consideration interoperability aspects, challenging topology, system resilience and climate situations across Europe to demonstrate and assess the full impact of the next-generation ATC. This Destination shall deliver by 2028 at least the following:

- Demonstration of ATO GoA3/4 – over ETCS and on non-supervised lines in the following scenarios (TRL7) including elements of remote driving (TRL6) and perception (TRL6)[81]:
  - Depot, yards and specific lines (private or segregated)
  - shunting and stabling operations
  - mainline (protected by ETCS) and regional
  - light rail urban transport
  - other type of vehicles (e.g. maintenance)

- Demonstration of Hybrid Train Detection (TRL6), moving block (TRL6) and TIMS (TRL7), Satellite Communication (TRL4), Advanced Safe Train Positionning (TRL6), automated functions (TRL6) and digital register (TRL6).

- Demonstrations (vary from TRL3 up to TRL6 depending on the test case possibly in different laboratories and test sites) on new generations ATC supported by harmonised operational and engineering requirements, when applicable and possible with modular onboard and trackside ATC and platform architectures, in close collaboration with the EU-Rail System Pillar and, if relevant, EU-Rail deployment group. Demonstrations shall concentrate on solutions delivering functional stability and early return on investments.

- Demonstrate ACS/FRMCS adaptation for Wireless Object Controller (linked to FA6) and for monitoring systems (linked to FA3) (TRL6). This can include aspects related to Adaptation for Multi connectivity (FRMCS/ACS) for Object Controller and monitoring system, Wayside communication through perception to onboard.

- Demonstrate the Multiconnectivity Platform (TRL6): improve the concept of the Multiconnectivity Platform (Formerly ACS) to allow for radio bearers such as Gigabit radio or satellite connectivity, and different applications with FRMCS interfaces (TSapp, OBapp...), both critical, business or performance-related, that are not yet considered in the existing FRMCS specifications.

- A demonstration of next generation braking subsystems (TRL6)

- Demonstrations for the following technical enablers:
    - Virtual Coupling Train Set (TRL5)
    - Self-driving wagon (TRL 5)
    - autonomous route setting (TRL5)
    - validation and (virtual) certification (TRL6)

Finally, the action shall cover important preparatory works to be launched for the future set of demonstration foreseen in the MAWP in view of the finalisation of the technical work of Flagship Area 2 (Phase 3):

- Preparation for integrated demonstration of different technical enablers in order to prove the expected performance improvements at system level, in different operational scenarios. In addition, it is expected that the action will also prepare common demonstrations with other Flagship Areas (FA1, FA3, FA5 and the TT) in addition to preparing the next and final maturity increase of the above-mentioned technical enablers.
- Moreover, the Flagship Project to be funded under this topic shall prepare demonstration and validation activities that shall be conducted as part of Flagship Area 2 (Phase 3) and that are related to FRMCS optimizations and enhancements subject to FRMCS V3 specifications, e.g., such as defined in the System Pillar FRMCS report[17] and that are not covered with FRMCS V3 specifications. This work shall build up on FP2-MORANE-2 (GA n°101196125) and requires that timeline and content are strictly aligned and complementary with FP2-MORANE-2. Preparational activities of EU-Flagship Area 2 (Phase 3) can include the creation of test specification documents as well as the staging of test tracks and onboard equipment for validations.

The action to be funded under this Destination also needs to provide the following necessary element for the demonstrations under the action to be funded under Destination 5, Sustainable Competitive Digital Green Rail Freight Services, to be delivered for 2028 demonstration: enablers 1, 3, 4, 7 and as described under the Scope section of this Destination. In addition of the above, the proposal shall cover important preparatory works needs to be launched for the future set of FA5 demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions, linked to these same enablers , at higher TRL.

The action to be funded under this Destination also needs to provide the following necessary element for the demonstrations under the action to be funded under Destination 6, Regional rail services/innovative rail services to revitalise capillary lines, to be delivered for 2028 demonstration: Enablers 2, 3, 4, 5, 6, 7, 9, 10 and 14 as described under the Scope section of this Destination. In addition of the above, the proposal shall cover important preparatory works needs to be launched for the future set of FA6 demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions, linked with those same enablers at higher TRL.

The action to be funded under this Destination also needs to provide the following necessary element for the demonstrations under the action to be funded under Destination 1, Network management planning and control & Mobility Management in a multimodal environment, to be delivered for 2028 demonstration: enablers 1 and 4 as described under the Scope section of this Destination, in addition to providing parameters for planning and simulation tools to calculate the capacity benefits. In

addition of the above, the proposal shall cover important preparatory works needs to be launched for the future set of FA1 demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions, linked with those same enablers at higher TRL.

Scope

The Flagship Project stemming from this topic should develop the following capabilities:

Capability for improving operation performance

Automating functions, such as the wake-up and train preparation capability is needed to start operation, causing the need for development within this Destination of:

- **Enabler 1: Automating functions**, such as **train preparation** for both passenger and freight trains. Incident handling, vehicle self-healing and self-managing, cooperative awareness at TRL6 in 2028. The work shall also cover auto-diagnostics, operational tests and reset capability of DATO and next generation ATC operated trains.

Trains must be continuously traceable for traffic control and train operators in automated operation. For this purpose, this Destination should develop:

- **Enabler 2: Absolute safe train positioning** at TRL6 in 2028
- **Enabler 3: Train integrity** highly accurate and safe, incorporating new sensors at TRL7 in 2028. Train Safe Length Determination at TRL6 (SIL4) in 2028. For this specific enabler, close coordination with the action to be funded under Destination 5 is to be performed, including an action plan for joint testing activities to be delivered within Month 3 of the project.
- **Enabler 4:** new **ATO technology** solutions for the automated driving and decision-making, interoperable, and for all application and segments (including freight and regional) for commercial run at TRL 6/7 in 2028. It should include the already available integration of C-DAS and should include appropriate interfaces with TMS for energy network management;
- **Enabler 5: Connectivity solutions**: train to ground communication (FRMCS) at TRL7, Multiconnectivity Platform (formerly ACS) at TRL6, Satellite Communications (TRL4) and V2X (TRL6) in 2028.

Safe unattended operation must be ensured by **comprehensive, modular, and scalable perception systems (on-board and trackside) for both outdoor and indoor environments**. Systems shall be developed under this Demonstration for:

- **Enabler 6: Safe environment perception**, including signal reading (when applicable) and obstacle detection (including for level crossing), supporting cooperative awareness, supported by virtual certification at TRL6 in 2028. In addition, such systems shall support the monitoring and diagnosis of assets, beyond the incident prevention functionalities.

In transition (either technical or operational) or shunting mode, automated train operation requires the development in this Destination of:

- **Enabler 7: Remote driving and command**, for depots, for lines with low traffic, and for fall-back operations as well as for shunting at TRL6 in 2028.

Additionally, the Destination should develop:

- **Enabler 8: Autonomous route setting**, on low traffic/regional networks, in terminals, in depots and in urban environment at TRL5 in 2028.
- **Enabler 9:** a **Digital Register,** acting as a central data source for, e.g., safe train positioning, ATP, TMS and DATO at TRL6 in 2028.

Capability for offering more capacity to customers

- **Enabler 10:** The combination of radio based ETCS with ATO is key to increase the capacity of railway lines. The development of the following enablers is therefore essential: **ETCS Hybrid Train Detection and Moving block systems**, taking into account aspects related to **relative braking distance.** Activities shall reach TRL6 for 2028 demonstration.

- **Enabler 11:** A **fully fledged Virtual coupling,** another key element to achieve shorter headways and operational flexibility, supported by enhanced connectivity and localisation, shall also be developed at TRL5, taking into account the outputs from the EU-Rail System Pillar.

- **Enabler 12**: This development shall also include **self-driving freight wagons** (supporting cooperative awareness). Activities shall reach TRL5 for the 2028 demonstration.

- **Enabler 13:** To maximise next generation ATC performance, a **new generation of brake systems** is needed to bring adjustable/configurable emergency brake control, the holding brake function and integrated adhesion management among other enhanced functionalities. This destination is expected to reach TRL6 for the 2028 demonstration.

Capability for supporting cost-effective deployment

- **Enabler 14**: Technology as well and the operational procedures need to be validated and tested to ensure fast and safe deployment. To this end, this destination is expected to develop novel **platform and facilities for testing, validation and (virtual) certification**. Developments should reach TRL 6 in 2028.

Capabilities enabling operational objectives:

The following enablers shall be developed:

- **Enabler 16:** Modular platform based on next generation ATC architectures, for agreed on-board and trackside modular architecture, reaching TRL6 in 2028.

- **Enabler 17:** Evolved onboard communication networks at TRL7 in 2028.

- **Enabler 18:** stable ETCS onboard supporting further end-to-end digital and automated rail operation. Activities can foresee rationalisation and consolidation of mature and generic ETCS onboard related interfaces (e.g. interface to TCMS, TIMS, localisation, ATO, FRMCS and HMI). This work should be performed in coordination with the EU-RAIL System Pillar. TRL3

- Deployment and migration strategic plans, including training and human factors.

Developments on all those enablers should also cover important preparatory works with higher TRL for the next and final set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions.

For Research & innovation and demonstrations activities (within the action) making use of data models related to the interoperability or safety of the rail system, those data models should be aligned with the ERA Ontology[82]. This ontology defines the conceptual framework and the specific terms and relationships for the interoperability or safety of the rail system in the EU that shall be used or where relevant extended. This includes the reuse of the ERA ontology with its semantic artifacts (shacl rules, skos ..) and in cases where it is not sufficient, extensions should be proposed to maintain semantic consistency and interoperability across systems. Those extensions proposals should cover the

[82] https://github.com/Interoperable-data/ERA-Ontology-3.1.0

processes to validate extension to the ERA Ontology with compliant datasets and related competency questions and linked SPARQL queries based on interoperability testbed validation tools (Interoperability Test Bed Guides — ITB Guides[83]). Corresponding documentation should also include any mappings or transformations considered in the Research & Innovation activities and any assumptions made.

Key Performance Indicators

The action shall actively contribute to measure and monitor the specific quantitative KPIs defined in the Destination description above, including its contribution to the Europe's Rail Master Plan impacts. Outcomes are to be delivered at a calendar annual basis by each year end.

Collaboration work required with other FAs and other R&I

The action to be funded under Destination 2 shall foresee a common activity/task related to capturing specific requirements and review of system specifications relevant to the actions to be funded under Destination 5 and Destination 6.

The action to be funded under Destination 2 shall foresee a common activity/task related to the Preparatory works on the integration and pilot test(s) of the technical enablers to be provided to the actions to be funded under Destination 1, Destination 5 and Destination 6 for the demonstration to be carried out in the action to be funded by Destination 1, Destination 5 and Destination 6.

It is expected that the Flagship Project stemming from this topic will use the EU-RAIL System Pillar Cybersecurity specifications [84], provide feedback to the Destination 1 Workstream 2 covering Cybersecurity and foresee adequate structure and resources for these activities.

Additionally, the project should seek for synergies and take into account the output of the EU-Rail Project NEXUS (GA number: 101177985).

Interaction with the System Pillar

The System Pillar aims to guide, support and secure the work of the Innovation Pillar (i.e. to ensure that research is targeted on commonly agreed and shared customer requirements and operational needs, compatible and aligned to the system architecture), and the Innovation Pillar will impact the scope of the System Pillar where new technologies or processes mean that innovations can drive a change in approach, as well as delivering detailed specifications and requirements.

In general for onboard demonstration work the latest ERTMS system version for the onboards should be used.

The proposal shall include specification (including drafts of new or extended subsets of the CCS TSI) and demonstration activities for the validation of the following architectural aspects, stemming from the work of System Pillar. The specification work in particular shall be closely coordinated with the System Pillar work to ensure consistency.

Architectural aspects to be considered:

- Enhanced train interface, especially for two train length information (STIP_73)
- Characteristic, application services and application communication of an onboard repository (STIP_67)
- Exchangeability of ASTP (STIP_29)
- SS- 147 for harmonized full stack (STIP_68) [perhaps already finished in WP23, phase 1]

[83] https://www.itb.ec.europa.eu/docs/guides/latest/overview/index.html

[84] https://rail-research.europa.eu/horizontal-tasks/

- DMI/Multi-Display (STIP_69/70)
- Full ASTP (to be continued for clarification, if current demonstrators not already lead to an agreed solution selection)(STIP_30)
- Supervised Manoeuvres (STIP 135)
- ATO GoA 3,4 (STIP20-27)
- RTO, remote train supervision and control (STIP 28)
- Continuation of moving block demonstrator / trackside protection system according to TrafficCS requirements (STIP_102) including demonstration of digital register (STIP 8) and configuration management (STIP 7)
- Simulation of operational scenarios along results of SP OD rulebooks (STIP 2)
- Cyber security

The proposal may also include preparatory activities for the validation of those architectural elements in Phase 3 of the EU-RAIL programme. In consideration of the timing of the activities, the planning as per the STIP should be taken into account and referred to.

The proposal should allocate necessary resources that would support the above-mentioned activities.

The alignment of the activities will primarily take place during the Grant Preparation Phase and ramp up phase of the awarded proposal, and there will be continued, structured and regular interaction through the life of the project.

The EU-RAIL System Pillar is producing specifications and other relevant documents [85]. In general the documents applicable to the Destination 2 should be used. If it is considered documents are not applicable, the proposals shall explain the reason(s) for not using them (to note the application of the documents may still be required by EU-RAIL). During the action to be funded under this Destination, there may be updating of the documents, including based on feedback from application in technical enablers and demonstrators. Relevant feedback should be provided on a regular basis to EU-RAIL and the System Pillar.

The action shall actively contribute to the update of the EU-Rail Standardisation and TSIs input plan (STIP) wherever relevant. Similarly, the action shall contribute to the development and implementation of EU policy and legislation including Technical Specifications for Interoperability and Common Safety Methods, as well as to publications of the System Pillar.

Interaction with other relevant actions
Work under this topic should link to relevant actions, when appropriate, financed by the European Space Agency (ESA), the European Union Agency for the Space Programme (EUSPA), the Connecting Europe Facility (CEF2).

Gender dimension
In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Other
It is expected that the Flagship Project stemming from this topic:
- will involve sufficient European geographical representation of academia, and ensure that all needed expertise for the described activities reflects the Special skills and/or capabilities expected from the Applicant(s) as described in the specific topic conditions.
- will be compliant with the EU Data Policy 2020 and associated legal instruments. This requires adherence to EU framework, including but not limited to: the Open Data Directive (EU)

[85] https://rail-research.europa.eu/v1-release/

2019/1024 and associated implementing Regulation (EU) 2023/138 on high-value data sets, the Data Governance Act (Regulation (EU) 2022/868), the Data Act (Regulation (EU) 2023/2854), and the Interoperable Europe Act (Regulation (EU) 2024/903). Ensuring compliance involves verifying that data management, processing and sharing comply with applicable EU framework.

DESTINATION 3 – Intelligent & Integrated asset management

DESTINATION 3 – description (possibly included in the Expected Outcome in the Funding Portal)

The financial and, to a certain extent, environmental costs associated with designing, building, constructing, operating, maintaining, and decommissioning rail drive also its capacity to compete and offer attractive services for the clients, passengers and supply chain. Therefore, rail asset management is a key area for research and innovation.

In the vision of the future rail asset management, assets status evolution information will be integrated with TMS (Traffic Management System) to improve services, reducing unavailability by limiting the impact of in-service failures and/or providing alternative solutions without cost impacts, and increasing safety. Moreover, the available information combined with AI (Artificial Intelligence) and digital twins will introduce intelligence to the management and optimize the overall life cycle and operation of the rail system.

The selected proposal for funding under this Destination will be a Flagship Project of Europe's Rail with significant expected impacts, which require an integrated sector systemic approach. Proposals should therefore set out a credible pathway (including an exploitation plan) to contributing to all of the following expected impacts as described in the Master Plan.

These can be further detailed with specific impacts of this destination, as:

- Increase the volumes of rail transportation on existing lines
- Improve the cost-effectiveness of rail transportation on existing lines
- Reduce the CO_2 emissions from the maintenance of existing lines
- Reduce the construction time and costs of new assets
- Increase in durability and reliability of assets
- Optimise life-cycle costs of assets
- Strengthen European rail industry competitiveness with more qualified products
- Improve Flexibility and punctuality of the railway system

Proposals under this Destination should set appropriate monitoring and demonstration activities to measure the following KPIs:

#	Demonstrator Name	High level theme and result	KPI's
1	Asset Management & TMS	Integration of Intelligent Asset Management System (IAMS) & TMS	I. Qualitative and prompt integration of information, including reducing time to transfer asset condition status to TMS by 50 %, in specific use cases
2	Asset Management & Rolling Stock	Asset Management of Rolling Stock Operation, including specific solutions for freight	II. reduction of maintenance costs up to 10% in specific use case, and/or III. 25% reduction of in-service failures IV. increasing rolling stock availability respective reducing workshop downtime targeting 10% in specific use cases
3	Long Term Asset Management	Infrastructure long-term Asset Management	V. Tools which provide at least 3 possible strategies of long term management with an accuracy (as defined by ISO) improvement of 10%
4	Asset Management & Infrastructure	Asset Management of Infrastructure Operation	VI. reduction of maintenance costs targeting 10% in specific use case, and/or VII. 25% reduction of in-service failures
5	Asset Management & Digital Twins	Digital Twin Asset Management, addressing both Rolling Stock & Infrastructure	VIII. The number of assets managed and monitored by Digital Twins is increased by 25 %
6	Design & Manufacturing	Advanced and Holistic Design	IX. For repair: Extension of remaining life 25% X. 20% time reduction (from design to manufacturing) XI. 20% cost reduction
7	Robotics & Interventions	Remotely controlled and unmanned interventions	XII. Increased accuracy of inspections of 25% with respect to conventional actions and/or XIII. Reproducibility of inspections of 25% with respect to conventional actions XIV. Cost reduction of the interventions by at least 33%

HORIZON-JU-ER-2025-FA3-01: INTELLIGENT & INTEGRATED ASSET MANAGEMENT

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 32.8 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 32.8 million.

	Applicant Private[86] Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.263[87] times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Indicative project duration	30 months.
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve a minimum between TRL 6 and TRL 8, depending on the enabler addressed, or higher by the end of the project – see General Annex B for a guide to the TRL definitions and criteria to be used.
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies with the following exception: the limit for a full Innovation Action application is set to 120 pages.
Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the Destination: • Expertise from rail infrastructure managers and railway undertakings, which should allow – defining main challenges, use cases and functional needs, – specifying, prioritizing and clustering demonstrators to ensure that researched innovative processes, operational and technological solutions are covered, – hosting the demonstrations and providing test trains/facilities, – providing data structures and content as well as processes, e.g. certification which can be subject for digitalisation. • Expertise from rail suppliers (system integrators, manufacturers and/or technology providers), which should allow, jointly, – proposing operational and technological innovative solutions to identified use cases and functional needs, – identifying the technical requirements and interface specifications, aligned with the System Pillar architecture, – designing, developing, prototyping and delivering innovative operational & technological solutions and systems to be integrated within the demonstrations, depending on the specific target TRL level. • Expertise from research institutes and academia, which should allow – planning, developing, studying, testing and evaluating solutions, systems and demonstrators together with the previous categories of expertise,

[86] As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

[87] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

	– supporting any possible scientific or methodological issues that may arise during the performance of the action – contributing to other aspects of the innovation cycle, as well as to the procedural aspects for validation, certification, etc. • Complementary expertise from other sectors and parties, with particular attention to SMEs and Start-ups, which may contribute to enhance the actions' outcome.
Contribution to the monitoring and implementation, standardisation of the EU-Rail Programme	The action resulting from this topic is identified as a "flagship project" expected to perform, by the completion of the research and innovation lifecycle, "large scale demonstrations", in the meaning of Council Regulation (EU) 2021/2085. Hence, the action is a key contributor to the achievement of the objectives identified in the Master Plan [88] as further detailed in the revised Multi-Annual Work Programme[89]. In this respect, applicants are expected to deliver relevant information (data, results, etc.) as mutually agreed, to the JU and the Linked Project[s] to contribute to the advancement of the Innovation and System Pillars[90] activities, as well as in view of the development and implementation of EU policy and legislation (including Technical Specifications for Interoperability and Common Safety Methods) and the development of European standards. As specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to European or international standards, the EU-Rail grant agreements will include an additional information obligation related to standards. Beneficiaries must inform EU-Rail (up to four years after the end of the action) if the results can be reasonably expected to contribute to European or international standards. As part of its internal control and management framework, the JU will perform a series of reviews and maturity checkpoints to assess the overall progress against the project plan and against the performance and TRL targets. Depending on the outcome of these reviews and maturity checkpoints(s), the scope of the project may be revised and/or funding reduced in accordance with the provisions of the relevant grant agreement. Mitigation actions may be requested by the JU as condition for continued funding. The proposal shall consider the necessary resources – FTE and/or other – to ensure the monitoring of the "Flagship Project" via regular reporting, reporting of data for the Programme KPIs, etc. The EU-Rail Governance and Process Handbook is available here: https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/ Proc.Handbook.pdf
Linked Projects	As specified in section 2.3.8.1 of the Work Programme, in order to facilitate the contribution to the achievement of the EU-Rail objectives, the options regarding 'linked actions' of the EU-Rail Model Grant Agreement and the provisions therein, is enabled in the corresponding EU-Rail Grant Agreements. The action that is expected to be funded under this topic will be complementary to the following projects: FP1 - MOTIONAL (GA number: 101101973) FP2-R2DATO (GA number: 101102001)

[88] Master Plan available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

[89] Revised MAWP available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

[90] Refer to the revised Multi-Annual Work Programme available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

	FP3 – IAM4RAIL (GA number:101101966) FP4 – RAIL4EARTH (GA number: 101101917) FP5-TRANS4M-R (GA number: 101102009) FP6-FutuRe (GA number: 101101962) The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics: • HORIZON-JU-ER-2025-FA1-TT-01: Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers • HORIZON-JU-ER-2025-FA2-01: Digital & Automatic up to Automated Train Operations • HORIZON-JU-ER-2025-FA4-01: A sustainable and green rail system • HORIZON-JU-ER-2025-FA5-01: Sustainable Competitive Digital Green Rail Freight Services • HORIZON-JU-ER-2025-FA6-01: Regional rail services / Innovative rail services to revitalise capillary lines Please note that the list is non-exhaustive as additional Linked Projects may follow at a later stage of the programme implementation to complement the activity.
Funding of only one project per topic	EU-Rail may award up to one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2028) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2028/horizon/guidance/ls-decision_he_en.pdf]].
Lower funding rate	The funding rate of the action is 60% of the eligible costs to achieve the leverage effect established in the SBA. Each Consortia may decide internally different funding rates in line with the provisions of Article 34 of Horizon Europe nevertheless complying with the overall funding rate of 60%.
Award criteria additional details	The award criteria included in part D of the General Annexes of the Horizon Europe – Work Programme 2023 – 2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.
Additional dissemination obligations	In addition, as specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to considering the key contributing role of this topic, in designing the dissemination and communication activities, the proposal shall consider that the "Flagship Project" will be part of the overall EU-Rail Programme and the planning of key events – demonstrations, participations to fair, etc. – will be coordinated at Programme level and by the "Stakeholder Relations and Dissemination" structure of the JU.

	The proposal shall consider the KPIs metrics on dissemination and communication included in the EU-Rail Governance and Process Handbook available here : https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/

Expected Outcome

To achieve the overall goal of this destination, five high-level capabilities have been identified, and the expected solutions should integrate the following:

Information sharing across the supply chain and TMS

The focus is on the ability to capture and share information securely across the entire rail system lifecycle, including operation, of rail assets. Furthermore, this area of action includes the secure exchange of information between the existing TMS[91] and the Intelligent Asset Management System[92] (IAMS).

Unmanned and non-invasive monitoring and inspections

Building upon the work delivered by FP3-IAM4RAIL[93] in EU-RAIL and other research and innovation activities, the objective is to enhance the capability for automated and unmanned inspection and monitoring, evolving towards non-invasive and self-diagnostic systems with no or minimal service disruptions.

Advanced and holistic asset decisions

Building upon the work delivered by FP3-IAM4RAIL[94] in EU-RAIL and other research and innovation, the focus is on the capability of making decisions in an advanced, automated, centralised, and holistic manner, considering the different assets, actors, standards, and regulations, especially combining track and rolling stock data. Furthermore, Digital Twins and enhanced visualisation techniques shall be exploited to support decision-making.

Advanced and holistic design and certification of assets (including virtual certification)

Building upon the work delivered by FP3-IAM4RAIL[95] in EU-RAIL and other research and innovation, this outcome has a clear focus on the development of newly deployed components for the rail system with a LCC and system performance approach. Furthermore, in conjunction with the following capability, the use of additive manufacturing techniques shall be addressed, as well as the use of self-healing techniques and materials.

Remotely controlled and unmanned interventions

Building upon the work delivered by FP3-IAM4RAIL[96] in EU-RAIL and other research and innovation, the objective is the development of capabilities for remote, automated, and unmanned intervention actions in rail systems. This shall make use of various technologies, including from other industries, such as robotics and wearable devices benefitting from state-of-the -art AI algorithms to support rail personnel, improve safety and increase the efficiency of intervention tasks.

The Flagship Project stemming from this topic should deliver, by 2028, innovative solutions to be demonstrated under the following **high-level principles**:

---

91 Results from Shift2Rail activities should be taken into account, see public deliverables of S2R TD2.9 (TMS) available here: WP6 deliverables: https://projects.shift2rail.org/s2r_ip2_n.aspx?p=X2RAIL-2

92 Results from Shift2Rail activities should be taken into account, see public deliverable of S2R TD3.6, TD3.7 and TD3.8 (IAMS) available here: https://projects.shift2rail.org/download.aspx?id=1fc574ec-1a28-4199-b77b-402d352d62f0 + EU-RAIL FP3-IAM4RAIL Deliverable 2.7 https://rail-research.europa.eu/wp-content/uploads/2025/09/D2.7.pdf

93 EU-RAIL FP3-IAM4RAIL Deliverable 2.7 https://rail-research.europa.eu/wp-content/uploads/2025/09/D2.7.pdf

94 EU-RAIL FP3-IAM4RAIL Deliverable 2.7 https://rail-research.europa.eu/wp-content/uploads/2025/09/D2.7.pdf

95 EU-RAIL FP3-IAM4RAIL Deliverable 2.7 https://rail-research.europa.eu/wp-content/uploads/2025/09/D2.7.pdf

96 EU-RAIL FP3-IAM4RAIL Deliverable 2.7 https://rail-research.europa.eu/wp-content/uploads/2025/09/D2.7.pdf

a. The integration of the complete value chain.
b. The exploitation of synergies between stakeholders at different levels, for instance, with respect to crossed monitoring.
c. The prioritisation of activities to achieve 2030 European objectives in rail mobility, exploiting EU-RAIL results.

The demonstrators for innovative solutions shall have several **operational differences** to be covered, including:

- **Climate**: The proposed solutions shall have to be able to take into account the wide variety of European climate types. (some cases can address extreme climate events)
- **Line type:** Demonstrators shall address high speed, conventional, regional, suburban and freight lines.
- **Traffic type:** Demonstrators shall cover passenger, freight and mixed lines.
- **Asset type:** Infrastructure and rolling stock shall be addressed jointly whenever possible considering all assets, including track, civil structures, earthworks, signalling, vehicles, track side, stations or power infrastructures.
- **Planning level:** demonstrators shall cover the Strategic Asset Management Plan level (SAMP), the Asset Management Plan level (AMP) and the Implementation of the Asset Management Plan level (IAMP).

The destination shall research, develop and deliver solutions that can be demonstrated by system approaches of the various developments targeting up to TRL 7/8 as European common integrated solutions. Due consideration should be given to certification and validation of the new technologies and processes as part of those demonstrators, that may be supported by several Use Cases:

1. **Asset Management & TMS.** The main aim of the demonstrator shall be to show the integration between the Intelligent Asset Management System (IAMS) and the Traffic Management System (TMS) enabling the sharing of data and optimising decisions using common metrics – TRL7 by 2028.
2. **Asset Management & Rolling Stock.** The main objective of this demonstrator shall be to present the monitoring of rolling stock (including on board and wayside technologies) leading to decisions and planning of interventions, and redirecting rolling stock to workshops to execute the (re)scheduled work both manually as well as by new technologies and solutions to conduct inspection tasks automatically – TRL7 by 2028.
3. **Long Term Asset Management.** Development of Life Cycle Cost (LCC) models for infrastructure. This demonstrator shall include cross-border infrastructure remaining useful-life analysis and space-time cross-analysis and visualisation – TRL7 by 2028.
4. **Asset Management & Infrastructure.** The objective shall be to integrate on field and on board systems with central platforms capable of managing Big Data to enable prescriptive interventions, minimising dangerous situations (as extreme climate events) and service disruptions during operation – TR7 by 2028.
5. **Asset Management & Digital Twins.** The focus shall be on design, maintenance, upgrade and renewal interventions driven by Digital Twins for the optimisation of processes, maintenance planning and involved logistics. This shall enforce the use of BIM to standardise system configuration and AI tools to execute simulations and predictions. The Digital Twin demonstrator shall include visualisation, prediction and simulation – TRL7 by 2028.
6. **Design & Manufacturing.** This demonstrator shall be the showcase of eco-friendly production of resilient assets supported by new fabrication techniques such as additive manufacturing (focussed on infrastructure assets) – TRL6/7 by 2028
7. **Robotics & Interventions.** The focus of this demonstrator shall be the showcase of high-tech automated execution solutions for construction and interventions supported by robotics and wearables, among other devices, building a safer and more automated railway environment – TRL6/7 by 2028

Each of these high-level demonstrators shall be further detailed and filled with specific, tangible and suitable use cases illustrating the impact of the technologies in concrete solutions as well as their reproducibility at EU scale. The choice of these use cases shall be based on sound business cases supported by a wide range of stakeholders possibly covering a wide range of assets proofing the versatility of the technologies, such as:

- Physical infrastructure: track, civil structures, earthworks, signalling, track side, stations or power infrastructures.
- Rolling stock: passenger service, freight and light/urban vehicles.

The business cases shall illustrate that major and widely recognised pain points are addressed ensuring that the wide deployment of the outcomes will contribute to a significant improvement in cost reduction, direct cost or LCC and/or reliability of the system or work conditions.

Where an opportunity would materialize to achieve more aggregated demonstrators, especially linking demonstrators in the area of asset management, in business cases that will link digital twins, TMS and asset management for rolling stock and/or infrastructure, this should be pursued.

At least one of the proposed Use Case shall use the Harmonised Diagnostic Data Interface [97] (specification provided by SP Task 5) and demonstrate its applicability and benefit for asset monitoring.

The action to be funded under this Destination also needs to provide the following necessary elements for the demonstrations under the action to be funded under the **Destination 1 – Network management planning and control & Mobility Management in a multimodal environment** to be delivered for 2028 demonstrations: Technical enabler 1 as described under the Scope section of this Destination. In addition of the above, the proposal shall cover important preparatory works needs to be launched for the future set of FA1 demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions, linked with the same enabler at higher TRL.

Scope

The Flagship Project stemming from this topic shall develop under the following capabilities the enablers and any other which may contribute to deliver the aforementioned expected outcome with the associated maturity level foreseen (up to – depending of the Use Case):

Capability for Information sharing across the supply chain and TMS

Enabler 1: Scalable information platform to integrate and exchange information (e.g., asset health, maintenance planning, fleet operation, etc.) across the supply chain and TMS, requiring necessary management and sharing agreements between the involved actors at TRL7 in 2028, and amongst others:

- secure standardised interfaces, methods, and processes for different data exchange (e.g., inspection devices to Asset Management Platform, etc.) at TRL7 in 2028, and

Capability for Unmanned and non-invasive monitoring and inspections

Enabler 2: Improved (in terms of cost reduction and/or better accuracy) asset diagnostic and inspection systems, as well as advanced, context aware, unmanned automated monitoring and inspections solutions at TRL7 in 2028, and amongst others:

- AI and ML solutions for automated monitoring and inspections, and data fusion algorithms to combine information provided by different inspection techniques to better determine the health status of the assets at TRL7 in 2028;
- Development of context awareness techniques for unmanned interventions at TRL 7 in 2028;

[97] https://rail-research.europa.eu/wp-content/uploads/2024/12/20241218_HERD_Report_SP_Website.pdf

- Development of synchronization algorithms for inspection data stamping in terms of accurate position and time at TRL7 in 2028;

Capability for Advanced and holistic asset decisions

Enabler4: New methodologies and technologies to leverage advanced and holistic asset decisions during the span of their life cycle at TRL7/8 in 2028, based on:

- probabilistic models for component failure to integrate cost of potential hazard risks and cost of potential unavailability in the asset maintenance decision strategy, at TRL7 in 2028
- Harmonisation of railway asset LCC determination, at TRL7 in 2028
- Operational and IoT data with additional rail system information and knowledge as well as technologies to enable cooperative diagnostic between assets at TRL8/9 in 2028
- AI-based hybrid Decision Support based on predictive and prescriptive data analytics and Machine Learning algorithms for anomaly detection and failure prediction with optimised human-AI interactions at TRL7 in 2028

Enabler 5: Digital Twins integrated with BIM, GIS tools, and Virtual and Augmented Reality to enable agile visualization for different stakeholders of asset health status (historical, current, and forecasted) in various use cases at TRL 7 in 2028.

Capability for Advanced and holistic design and certification of assets

Enabler 6: Advanced and holistic design and certification of assets, at TRL 6/8 in 2025, based on:

- New ethical-by-design materials and/or innovative materials and processes for additive manufacturing, with advanced LCC characteristics, at TRL 6 in 2028
- Advanced automated certification techniques (including virtual certification), at TRL7 in 2028
- Energy scavenging approaches for self-supporting monitoring solutions, at TRL 6 in 2028

Capability for Remotely controlled, unmanned and metadata-assisted interventions

Enabler 7: Development of remotely controlled, unmanned and metadata-assisted interventions in construction, maintenance, and renewal operations, based on:

- non-invasive or collaborative unmanned robotic actuators and wearables as well as advanced unmanned robotic vehicles with AI and ML algorithms for automated robotic interventions, at TRL7 in 2028.
- additive manufacturing techniques and validation standards for manufacturing and repairing assets at TRL 6/7 in 2028.

Developments on all those enablers should also cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions.

For Research & innovation and demonstrations activities (within the action) making use of data models related to the interoperability or safety of the rail system, those data models should be aligned with the ERA Ontology[98]. This ontology defines the conceptual framework and the specific terms and relationships for the interoperability or safety of the rail system in the EU that shall be used or where relevant extended. This includes the reuse of the ERA ontology with its semantic artifacts (shacl rules, skos ..) and in cases where it is not sufficient, extensions should be proposed to maintain semantic consistency and interoperability across systems. Those extensions proposals should cover the processes to validate extension to the ERA Ontology with compliant datasets and related competency questions and linked SPARQL queries based on interoperability testbed validation tools (Interoperability Test Bed Guides — ITB Guides[99]). Corresponding documentation should also include

[98] https://github.com/Interoperable-data/ERA-Ontology-3.1.0

[99] https://www.itb.ec.europa.eu/docs/guides/latest/overview/index.html

any mappings or transformations considered in the Research & Innovation activities and any assumptions made.

Key Performance Indicators
The action shall actively contribute to measure and monitor the specific quantitative KPIs defined in the Destination description above, including its contribution to the Europe's Rail Master Plan impacts. Outcomes are to be delivered at a calendar annual basis by each year end

Collaboration work required with other FAs
The action to be funded under Destination 3 shall foresee a common activity/task related to the use case developments relevant to the actions to be funded under Destination 1, 2 and 5 (not limited to).

It is expected that the Flagship Project stemming from this topic will use the EU-RAIL System Pillar Cybersecurity specifications [100], provide feedback to the Destination 1 Workstream 2 covering Cybersecurity and foresee adequate structure and resources for these activities.

Interaction with the System Pillar
The System Pillar aims to guide, support and secure the work of the Innovation Pillar (i.e. to ensure that research is targeted on commonly agreed and shared customer requirements and operational needs, compatible and aligned to the system architecture), and the Innovation Pillar will impact the scope of the System Pillar where new technologies or processes mean that innovations can drive a change in approach, as well as delivering detailed specifications and requirements. The interaction with the System Pillar activities on the Harmonised Diagnostics should receive particular attention.

In this respect, the necessary resources would have to be dedicated to areas linked to System Pillar conceptual and architecture works – particularly addressing specification development (the interaction is illustrated in the System Pillar – Innovation Pillar interaction note (Annex VI of this Work Programme). The alignment of the activities will primarily take place during the Grant Preparation Phase and ramp up phase of the awarded proposal, and there will be continued interaction through the life of the project.

The EU-RAIL System Pillar is producing specifications and other relevant documents [101]. In general the documents applicable to the Destination 3 should be used. If it is considered documents are not applicable, the proposals shall explain the reason(s) for not using them (to note the application of the documents may still be required by EU-RAIL). During the action to be funded under this Destination, there may be updating of the documents, including based on feedback from application in technical enablers and demonstrators. Relevant feedback should be provided on a regular basis to EU-RAIL and the System Pillar.

The action shall actively contribute to the update of the EU-Rail Standardisation and TSIs input plan (STIP) wherever relevant. Similarly, the action shall contribute to the development and implementation of EU policy and legislation including Technical Specifications for Interoperability and Common Safety Methods, as well as to publications of the System Pillar.

Gender dimension
In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Other
It is expected that the Flagship Project stemming from this topic:

[100] https://rail-research.europa.eu/horizontal-tasks/
[101] https://rail-research.europa.eu/v1-release/

- will involve sufficient European geographical representation of academia, and ensure that all needed expertise for the described activities reflects the Special skills and/or capabilities expected from the Applicant(s) as described in the specific topic conditions.
- will be compliant with the EU Data Policy 2020 and associated legal instruments. This requires adherence to EU framework, including but not limited to the Open Data Directive (EU) 2019/1024 and associated implementing Regulation (EU) 2023/138 on high-value data sets, the Data Governance Act (Regulation (EU) 2022/868), the Data Act (Regulation (EU) 2023/2854), and the Interoperable Europe Act (Regulation (EU) 2024/903). Ensuring compliance involves verifying that data management, processing and sharing comply with applicable EU framework.

DESTINATION 4 – A sustainable and green rail system

DESTINATION 4 – description (possibly included in the Expected Outcome in the Funding Portal)

In order to improve the existing sustainability performances of railway systems, new innovative products and services need to be developed, tested and deployed. On the basis of leading-edge technologies to minimize the overall energy and resource consumption and environmental impact of the railway system, the aim of this destination is to accomplish a more attractive and climate resilient mode of transport. With the cooperation of the whole European rail value chain, the target is to optimise performances, stimulate the modal shift and improve passenger experience. Given the level of investments needed towards decarbonation of the overall rail system, the R&I activities will contribute to the objective of a Climate Neutral Europe for 2050. This means:

- Innovative solutions to minimise environmental footprint of the overall rail system., including less resource-intensive materials (infrastructure, rolling stock and operational).
- Holistic approach towards generation, storage and optimal use of energy in the infrastructure connected to the European energy network.
- Innovative approaches to design and use, focused on increased capacity and modularity of solutions (tools, manufacturing processes and efficient use of resources)
- Systems improvement including electro-mechanical components for low consumption, low emissions, low noise and low vibration levels.
- Healthier and safer subsystems such as air-filtration, disinfection systems and eco-friendly HVAC technologies.
- New designs of rolling-stock especially modular interiors for a more adaptative, attractive and economically sustainable railway transport for passengers and supported by industrial standards.

The selected proposal for funding under this Destination will be a Flagship Project of Europe's Rail with significant expected impacts, which require an integrated sector systemic approach. Proposals should therefore set out a credible pathway (including an exploitation plan) to contributing to all of the following expected impacts as described in the Master Plan.

Meeting evolving customer requirements	Improved EU rail supply industry competitiveness	Reduced costs	More sustainable and resilient transport	Improved performance and capacity

These can be further detailed with specific impacts of this destination, as:

- Reducing energy consumption: The continuous technologies evolution leads to significant decrease of energy consumption. Acceleration towards a zero $CO2_e$ emission rail system.
- Bosting alternatives to the use of fossil fuels are unavoidable for the overall European rail system. Every potential solution, mainly energy storage system and hydrogen (H2) have to be considered.
- Defining the industrial standards that will support the need to demonstrate and prove rail as the greenest mode of transport, easing the transformation of the rail system in a circular economy model while ensuring resilience to external risks, such as climate change.
- Regarding the attractiveness of the vehicles, shared concepts and the relevant industrial standards will ease quicker and greener transformation of the European rail vehicles.

Proposals under this Destination should set appropriate monitoring and demonstration activities to measure the following KPIs:

	KPI Title / Type of impact	Dimension / KPI	Baseline / Expected improvement
	Autonomy. Linked to sustainability via CO2 reduction on Diesel regional trains	Extended reach (km)	Baseline 80km and target 200km for regional trains
	Physical energy consumption (train, infrastructure, station)	kWh/passenger.km kg CO2/year.m2 kg H2/vehicle.ton.km	Existing electric railways and up to 30% in specific use cases (linked also to ATO – DAS, HVAC, airless train for energy consumption reduction and innovative traction systems)
	Physical CO2 equivalent emissions (LCA) linked to new propulsion systems, stations and infrastructure	kg CO2/passenger.km kg C02/year.m2	Up to 30% for specific use cases (e.g. different fleets on specific railway lines, reduction to 0% for regional trains on non-electrified lines by substitution of Diesel by battery/H2 and heavy duty inspection vehicles)
	Noise emitted by train, infrastructure at component level	dB(A)	Between 3-8dB for specific use cases on existing electric railways, Diesel, Hydrogen trains, infrastructure, stations. (e.g. brakes (compressor), HVAC subsystems, pre-heating operations, depots facilities)
	Life Cycle Costs reduction	%	Between 5-10% for specific use cases including externalities costs

HORIZON-JU-ER-2025-FA4-01: A SUSTAINABLE AND GREEN RAIL SYSTEM

Specific Conditions

Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 26.6 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 26.6 million. Applicant Private[102] Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.263[103] times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Indicative project duration	30 months.
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve a minimum between TRL 6 and TRL 9, depending on the enabler addressed, or higher by the end of the project – see General Annex B for a guide to the TRL definitions and criteria to be used.
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies with the following exception: the limit for a full Innovation Action application is set to 120 pages.
Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the Destination: • Expertise from rail infrastructure managers and railway undertakings, which should allow – defining main challenges, use cases and functional needs, – specifying, prioritizing and clustering demonstrators to ensure that researched innovative processes, operational and technological solutions are covered, – hosting the demonstrations and providing test trains/facilities, – providing data structures and content as well as processes, e.g. certification which can be subject for digitalisation. • Expertise from rail suppliers (system integrators, manufacturers and/or technology providers), which should allow, jointly, – proposing operational and technological innovative solutions to identified use cases and functional needs, – identifying the technical requirements and interface specifications, aligned with the System Pillar architecture, – designing, developing, prototyping and delivering innovative operational & technological solutions and systems to be integrated within the demonstrations, depending on the specific target TRL level. • Expertise from research institutes and academia, which should allow

[102] As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

[103] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

	– planning, developing, studying, testing and evaluating solutions, systems and demonstrators together with the previous categories of expertise, – supporting any possible scientific or methodological issues that may arise during the performance of the action – contributing to other aspects of the innovation cycle, as well as to the procedural aspects for validation, certification, etc. • Complementary expertise from other sectors and parties, with particular attention to SMEs and Start-ups, which may contribute to enhance the actions' outcome.
Contribution to the monitoring and implementation, standardisation of the EU-Rail Programme	The action resulting from this topic is identified as a "flagship project" expected to perform, by the completion of the research and innovation lifecycle, "large scale demonstrations", in the meaning of Council Regulation (EU) 2021/2085. Hence, the action is a key contributor to the achievement of the objectives identified in the Master Plan [104] as further detailed in the revised Multi-Annual Work Programme[105]. In this respect, applicants are expected to deliver relevant information (data, results, etc.) as mutually agreed, to the JU and the Linked Project[s] to contribute to the advancement of the Innovation and System Pillars[106] activities, as well as in view of the development and implementation of EU policy and legislation (including Technical Specifications for Interoperability and Common Safety Methods) and the development of European standards. As specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to European or international standards, the EU-Rail grant agreements will include an additional information obligation related to standards. Beneficiaries must inform EU-Rail (up to four years after the end of the action) if the results can be reasonably expected to contribute to European or international standards. As part of its internal control and management framework, the JU will perform series of reviews and maturity checkpoints to assess the overall progress against the project plan and against the performance and TRL targets. Depending on the outcome of these reviews and maturity checkpoints(s), the scope of the project may be revised and/or funding reduced in accordance with the provisions of the relevant grant agreement. Mitigation actions may be requested by the JU as condition for continued funding. The proposal shall consider the necessary resources – FTE and/or other – to ensure the monitoring of the "Flagship Project" via regular reporting, reporting of data for the Programme KPIs, etc. The EU-Rail Governance and Process Handbook is available here : https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/
Linked Projects	As specified in section 2.3.8.1 of this Work Programme, in order to facilitate the contribution to the achievement of the EU-Rail objectives, the options regarding 'linked actions' of the EU-Rail Model Grant Agreement and the provisions therein, is enabled in the corresponding EU-Rail Grant Agreements.

[104] Master Plan available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

[105] Revised MAWP available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

[106] Refer to the revised Multi-Annual Work Programme available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

	The action that is expected to be funded under this topic will be complementary to the following projects: • FP1 - MOTIONAL (GA number: 101101973) • FP2-R2DATO (GA number: 101102001) • FP3 – IAM4RAIL (GA number:101101966) • FP4 – RAIL4EARTH (GA number: 101101917) • FP5-TRANS4M-R (GA number: 101102009) • FP6-FutuRe (GA number: 101101962) The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics: • HORIZON-JU-ER-2025-FA1-TT-01: Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers • HORIZON-JU-ER-2025-FA2-01: Digital & Automatic up to Automated Train Operations • HORIZON-JU-ER-2025-FA3-01: Intelligent & Integrated asset management • HORIZON-JU-ER-2025-FA5-01: Sustainable Competitive Digital Green Rail Freight Services • HORIZON-JU-ER-2025-FA6-01: Regional rail services / Innovative rail services to revitalise capillary lines Please note that the list is non-exhaustive as additional Linked Projects may follow at a later stage of the programme implementation to complement the activity.
Funding of only one project per topic	EU-Rail may award up to one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]].
Lower funding rate	The funding rate of the action is 60% of the eligible costs to achieve the leverage effect established in the SBA. Each Consortia may decide internally different funding rates in line with the provisions of Article 34 of Horizon Europe nevertheless complying with the overall funding rate of 60%.
Award criteria additional details	The award criteria included in part D of the General Annexes of the Horizon Europe – Work Programme 2023 – 2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.
Additional dissemination obligations	In addition, as specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to considering the key contributing role of this topic, in designing the dissemination and communication activities, the proposal shall consider that the "Flagship Project" will be part of the overall EU-Rail Programme and the planning of key events – demonstrations, participations to fair, etc. – will be coordinated at

	Programme level and by the "Stakeholder Relations and Dissemination" structure of the JU. The proposal shall consider the KPIs metrics on dissemination and communication included in the EU-Rail Governance and Process Handbook available here : https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/

Expected Outcome

Building upon the work achieved in FP4-Rail4Earth (GA number: 101101917) and other research and innovation, the Flagship Project stemming from this topic should deliver solutions for the holistic approach to:

- Energy and equivalent CO_2 savings in the rail system, covering:
  - Developments oriented towards a more integrated and standardised Rail Power Smart Grid, integrating greener energies[107], cutting peak of energy consumption and allowing for a better control, and management.
  - Developments oriented towards a better energy management not only at station level but also providing more intelligent and integrated control systems and allowing for a larger energy flexibility and resilience of the Electrical Smart Grid.

- Circular, sustainable solutions contributing to a resilient rail, covering:
  - Technologies, systems and materials for a more sustainable, less resource-intensive and extreme hazard resilient by design (including climate change related issues) of railway infrastructure/assets and rolling stocks, oriented towards the whole life cycle of the assets.
  - Guidelines for the design/rehabilitation of modular stations according to size and uses oriented towards the reduction of the carbon footprint for the whole life cycle.

- A healthier, safer and more attractive railway system, covering:
  - HVAC[108] at the vehicle level with improved management of air flow and integration of health management measures in the rolling stock, for a European deployable solution.
  - Passenger flow management integrating health and safety measures.
  - Industrial standards for easing the quick adaptation of interiors by modularity with the integration of bio-sourced materials and circularity of the assets.

The Flagship Project stemming from this topic should deliver, by 2028, innovative and resilient solutions to be demonstrated by:

- Alternative energy solutions for the rolling stock, covering at TRL7/8:
  - High performances Batteries Electric Multi-Unit (BEMU) train;
  - Hydrogen hybrid trains with test of heavy-duty inspection vehicle and/or loco for freight-passengers;
  - Auto adaptive train energy consumption to various services situations;

- A holistic approach to energy in rail infrastructure (design, production, use and intelligent management), at TRL6/8, covering:
  - Rail Power Smart Grid in different systems as well as the integration of energy storage[Error! Bookmark not defined.] solutions;
  - Development of a universal hydrogen refuelling interface, with a specific focus on the development of digital algorithms to improve refuelling efficiency

[107] Study on the use of Fuel Cells and hydrogen in the railway environment, available here: https://rail-research.europa.eu/latest-news/new-study-on-the-use-of-fuel-cells-and-hydrogen-in-the-railway-environment/ + FP4-Rail4earth public relevant deliverables https://rail-research.europa.eu/rail-projects/fp4-rail4earth/

[108] FP4-Rail4earth public relevant deliverables https://rail-research.europa.eu/rail-projects/fp4-rail4earth/

- Sustainability and resilience of the rail system in a holistic approach to asset management, delivering more value at TRL6/7:
    - Development of solutions and models for the reduction of noise and vibrations from railway infrastructure and rolling stock[109] and to predict the effect of degradation, of maintenance and of noise perception as well as ensuring resilience to external risks, such as climate change;

- Improvement of electro-mechanical components and sub-systems for the rolling stock, at TRL7/9, covering:
    - Technological solutions for the migration to the airless train: Electro-mechanical braking system[110] and novel electro-mechanical pantograph;
    - Optimised motors and gearboxes, high performance bogies, suspensions and new materials;
    - Eco-friendly HVAC system technologies;
    - Aerodynamic certification with experimental and numerical methods;

- Healthier and safer rail system at TRL7/9, covering:
    - Solutions for improving the air quality in trains, stations and tunnels;

- Attractiveness, at TRL7/8, covering:
    - Modular rolling stock interiors providing new design and new architectures (including drivers' cabin), respecting PRM requirements and enhancing accessibility with innovative solutions.

In addition of the above, the proposal shall cover important preparatory works needs to be launched for the future set of demonstration foreseen in the Multi- Annual Work Programme in view of the evolutions of the solutions up to TRL 8, and where possible 9:

- integration of technical enablers for high performances BEMU trains to enhance standardised and interoperable batteries charging interfaces and data protocol to ensure cost efficiency;
- scalability of energy storage applications;
- airless train components' evolution and technologies used for the reduction of noise, weight and energy consumption;
- preparation and/or simulation of the integrated demonstration in real environment of modular rolling stock.

The action to be funded under this Destination also needs to provide the following necessary elements for the demonstrations under the action to be funded under the **Destination 1, Network management planning and control & Mobility Management in a multimodal environment** to be delivered for 2028 demonstrations: enablers 4 and 5 as described under the Scope section of this Destination, in addition to providing DAS/C-DAS and energy management experts input for the optimization methods for capacity efficiency and energy saving. In addition of the above, the proposal shall cover important preparatory works needs to be launched for the future set of demonstration foreseen in the Multi-annual Work programme in view of the evolutions of the solutions, linked with the same enablers at higher TRL.

Scope

The Flagship Project stemming from this topic should develop the following capabilities:

<u>Alternative energy solutions for the rolling stock</u>

[109] FP4-Rail4earth public relevant deliverables https://rail-research.europa.eu/rail-projects/fp4-rail4earth/
[110] FP4-Rail4earth public relevant deliverables https://rail-research.europa.eu/rail-projects/fp4-rail4earth/

Development, validation and demonstration of traction system components, including related innovative and standardised functions, to improve technical, environmental, circular economy and LCC KPIs. To demonstrate the feasibility of the results of the innovation, the technical enabler will be applied in static test bench and real demonstrators of:

- **Enabler 1**: Trains with on-board Energy Storage Systems. High performance and high efficient Batteries Electric Multi-Unit (BEMU) trains with long autonomy (80km baseline and over 200 km targeted) (TRL 7/8 to be achieved in 2028)
- **Enabler 2**: Hydrogen hybrid trains: infrastructure inspection/maintenance heavy duty vehicle and/or loco for freight-passengers at TRL7 in 2028 (powered with gas H2 or liquid H2)

Holistic approach to energy management in the railway system

The increased use of renewable energy sources (RES), energy storage devices and the smart energy management will improve the global mobility decarbonization and the energy efficiency of the railway system. Within this Destination, this approach will be done through:

- **Enabler 3**: Development of a universal hydrogen refuelling interface as well as digital algorithms to improve refuelling efficiency at TRL6/7 in 2028.
- **Enabler 4**: Integration of various sources in different systems (e.g. 25kV AC, 1,5/3kV DC), of renewable energy, energy harvesting technologies, breaking energy recovery, etc, as well as the integration of energy storage at TRL6/8 in 2028.
- **Enabler 5**: Solutions for the optimal energy management in the whole power system, covering traction and non-traction demand including stations as energy hubs and integrated in a smart grid under the market rules and targeting at TRL7/8 in 2028.
- **Optional – Enabler 17:** Develop and validate innovative static and dynamic charging solutions for battery trains operating with DC traction at TRL6 in 2028

Sustainability and resilience of the rail system to deliver added value on asset management

This Destination aims to provide solutions to foster environmental advantages of rail, reduce nuisances and addressing resilience on the whole life cycle through:

- **Enabler 6**: Adaptation to climate change with the development of a tool on European climate variables usable for railway assets, considering risk assessment reports and considering the evaluation of existing solutions to accelerate the lowering of environmental footprint targeting TRL6 in 2028 to implement adaptation strategies.
- **Enabler 7**: Development of noise indicators, simulation and measurement tools, mitigation measures and optimised maintenance regimes for noise and vibrations, at TRL6/7 in 2028.
- **Enabler 8**: Research oriented towards smarter and greener railway stations including methodologies and guidelines for the optimal design/rehabilitation of station layout including modularity oriented towards carbon footprint reduction, as well as digital twin technologies for smarter energy management and for the integration of resilience and circularity indicators of railway stations to be validated at TRL7/8 in 2028.
- **Enabler 9**: Development of tools and indicators to promote eco-design, assess environmental performance improvements and ensure standardized reporting of the environmental impacts of the rail sector at TRL6/7 in 2028.

Improvement of electro-mechanical components and sub-systems for the rolling stock

The technological solutions for the migration to the airless train will require high performance bogies, gearboxes, suspensions, and materials. This destination will achieve those improvements by:

- **Enabler 10**: Developing and introduce to the market electro-mechanical braking system and pantograph while targeting energy savings on the involved subsystems and reduce associated maintenance costs at TRL7/9 in 2028 and prepare for later evolutions.
- **Enabler 11**: Introducing optimised motors and gearboxes, high performance bogies, suspensions and new materials following circular economy principles at TRL7 in 2028.

- **Enabler 12**: Delivering alternative technologies to replace hydrofluorocarbon refrigerants by HVAC system using green refrigerants or new cooling technologies with reduced energy consumption at TRL7 in 2028.
- **Enabler 13**: Introducing enhanced experimental and numerical methods at TRL6/7 on aerodynamic certifications in 2028.

Healthier and safer rail system

The demonstration of novel systems and technologies to include enhancing the air quality by air purification and air distribution while addressing the thermal comfort and air quality (virus, bacteria, volatile organic compounds and fine particles) to guarantee a platform independent approach by:

- **Enabler 14**: Specific sub-demonstrators to be set-up, each of them contributing to the overall goal of the demonstration of a healthier environment in the rail vehicle, for both new designs of future trains and refurbishment of existing trains at TRL7/9 in 2028.

Attractiveness

This destination is expected to develop rolling stock interiors designed by modularity, plug and play fixation systems by innovative low-tech, circular design and comfort aspects, as well as to develop new architectures for driver's cabin to reach TRL7/8 in 2028. Within this Destination, the demonstrations will be supported on:

- **Enabler 15**: The facilitation of on-demand/modular comfort for users such as access, lighting, thermal and acoustic conditions as well as with new architectures to increase passenger capacity at TRL8 in 2028.
- **Enabler 16**: The facilitation to adapt rolling stock with refurbishment and innovative concepts to support the increase of capacity of the rolling stock, including accessibility to PRM at TRL7/8 in 2028 and prepare for later evolutions.

Developments on all those 16 enablers (+1 optional) should also cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions.

For Research & innovation and demonstrations activities (within the action) making use of data models related to the interoperability or safety of the rail system, those data models should be aligned with the ERA Ontology[111]. This ontology defines the conceptual framework and the specific terms and relationships for the interoperability or safety of the rail system in the EU that shall be used or where relevant extended. This includes the reuse of the ERA ontology with its semantic artifacts (shacl rules, skos ..) and in cases where it is not sufficient, extensions should be proposed to maintain semantic consistency and interoperability across systems. Those extensions proposals should cover the processes to validate extension to the ERA Ontology with compliant datasets and related competency questions and linked SPARQL queries based on interoperability testbed validation tools (Interoperability Test Bed Guides — ITB Guides[112]). Corresponding documentation should also include any mappings or transformations considered in the Research & Innovation activities and any assumptions made.

Key Performance Indicators

The action shall actively contribute to measure and monitor the specific quantitative KPIs defined in the Destination description above, including its contribution to the Europe's Rail Master Plan impacts. Outcomes are to be delivered at a calendar annual basis by each year end

Collaboration work required with other FAs and R&I

[111] https://github.com/Interoperable-data/ERA-Ontology-3.1.0

[112] https://www.itb.ec.europa.eu/docs/guides/latest/overview/index.html

The action to be funded under Destination 4 shall foresee common activity/task related to the use case developments relevant to the actions to be funded under Destination 1 (not limited to).

It is expected that the Flagship Project stemming from this topic will use the EU-RAIL System Pillar Cybersecurity specifications [113], provide feedback to the Destination 1 Workstream 2 covering Cybersecurity and foresee adequate structure and resources for these activities.
Additionally, the project should seek for synergies with any project stemming from the topic call "HORIZON-CL5-2026-05-D2-03: Integrated Production and Product Development for Next-Generation Lithium-based Batteries for Mobility" that would include a rail application.

Interaction with the System Pillar
The System Pillar aims to guide, support and secure the work of the Innovation Pillar (i.e. to ensure that research is targeted on commonly agreed and shared customer requirements and operational needs, compatible and aligned to the system architecture), and the Innovation Pillar will impact the scope of the System Pillar where new technologies or processes mean that innovations can drive a change in approach, as well as delivering detailed specifications and requirements.

In this respect, the necessary resources would have to be dedicated to areas linked to System Pillar conceptual and architecture works – particularly addressing specification development (the interaction is illustrated in the System Pillar – Innovation Pillar interaction note (Annex VI of this Work Programme). The alignment of the activities will primarily take place during the Grant Preparation Phase and ramp up phase of the awarded proposal, and there will be continued interaction through the life of the project.

The EU-RAIL System Pillar is producing specifications and other relevant documents [114]. In general the documents applicable to the Destination 4 should be used. If it is considered documents are not applicable, the proposals shall explain the reason(s) for not using them (to note the application of the documents may still be required by EU-RAIL). During the action to be funded under this Destination, there may be updating of the documents, including based on feedback from application in technical enablers and demonstrators. Relevant feedback should be provided on a regular basis to EU-RAIL and the System Pillar.

The action shall actively contribute to the update of the EU-Rail Standardisation and TSIs input plan (STIP) wherever relevant. Similarly, the action shall contribute to the development and implementation of EU policy and legislation including Technical Specifications for Interoperability and Common Safety Methods, as well as to publications of the System Pillar.

Gender dimension
In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Other
It is expected that the Flagship Project stemming from this topic:

- will involve sufficient European geographical representation of academia, and ensure that all needed expertise for the described activities reflects the Special skills and/or capabilities expected from the Applicant(s) as described in the specific topic conditions.
- will be compliant with the EU Data Policy 2020 and associated legal instruments. This requires adherence to EU framework, including but not limited to the Open Data Directive (EU) 2019/1024 and associated implementing Regulation (EU) 2023/138 on high-value data sets, the Data Governance Act (Regulation (EU) 2022/868), the Data Act (Regulation (EU)

[113] https://rail-research.europa.eu/horizontal-tasks/
[114] https://rail-research.europa.eu/v1-release/

2023/2854), and the Interoperable Europe Act (Regulation (EU) 2024/903). Ensuring compliance involves verifying that data management, processing and sharing comply with applicable EU framework.

DESTINATION 5 – Sustainable Competitive Digital Green Rail Freight Services

DESTINATION 5 – description (possibly included in the Expected Outcome in the Funding Portal)

The objective of this Destination is to make rail freight more attractive through better services to the European supply chain by the following threefold : Increasing capacity and efficiency (e.g. with Digital Automatic Coupler (DAC) and other technological and operational solutions) in a smart way for all types of rail freight transport, improving cross-border operation (cross border implies an important share of freight traffic and is expected to grow) and finally a better multimodal service offering. In addition to all these, this destination aims to contribute, if necessary, in the delivery of harmonization by means of contributing on the definition of European Standards.

Those objectives should be addressed aiming to deliver solutions in the following areas:

- **Full digital freight train operations** enabled by key technologies for transforming the European Rail Freight sector which will increase productivity (time and cost reduction), efficiency (through process automation) and service quality, all of that leading to an increase of competitiveness. Together with a "smart" increase of capacity, more freight traffic can be shifted to the European rail system, significantly contributing to the EU Green Deal. The development of innovative freight assets (e.g. innovative freight wagons, last mile solutions, terminals) allow to further improve the competitiveness of rail freight by reducing LCC[115], operational costs and also increasing automation.
- A **seamless rail freight** with a significantly reduced average transportation time based on an agile, interoperable and open environment within integrated and harmonized European mobility networks which interacts with other businesses; an environment in which companies can optimize their operations; for railway undertakings and intermodal operators, this results into higher productivity, better capacity utilization, improved planning possibilities and, through the reduction of cross-border barriers and multimodality, faster transport handling, altogether resulting into higher reliability. In addition, comprehensive multimodal and transparent customer information in combination with easy booking and managing functions, lead to an increase in customer satisfaction and easier access to rail-based services. Being based on harmonized European data this leads to higher predictability and planning possibilities.

The selected proposal for funding under this Destination will be a Flagship Project of Europe's Rail JU with significant expected impacts, which require an integrated sector systemic approach. Proposals should therefore set out a credible pathway to contributing to all of the following expected impacts as described in the Europe Rail JU Master Plan.

---

[115] Life Cycle Costs LCC

Improved EU rail supply industry competitiveness | More sustainable and resilient transport | Reinforced role for rail in European transport and mobility | Improved performance and capacity | Reduced costs

---

Proposals under this Destination should set appropriate monitoring and demonstration activities to measure the following KPIs:

In the field of European full digital freight train operations

- Decrease train formation/decomposition (shunting/coupling/uncoupling) time:
  - Expected time reduction targeting 40-50%.
- Decrease train preparation/ departure process time:
  - Expected time reduction targeting 40-70%.
- Demonstrate increased average train length [m] up to maximum length in existing infrastructure limitations or higher loads:
  - Train length increased up to 1.500 m.

In the field of seamless rail freight

- Reduce average transportation time on reference corridor
  - Average transportation lead time reduced targeting towards the MAWP objective 10-20%.
- Reduce operational dwell time at borders and other handover points:
  - Dwell time reduced targeting towards the MAWP objective 50%.
- Reduce the number of additional non-added value operational stops (e.g. cross-border, considering for instance enhanced interoperability of rolling stock and continuous operations) limiting also the energy consumption:
  - Reduced number of operational stops targeting 20%.
- Reduce handling/response time for ad-hoc cross-border path requests
  - Reduced time by targeting towards the MAWP objective 70%.
- Reduce handling/response time for connected comprehensive multimodal offers
  - Reduced response time by at least 30%, targeting the objective 50% as stated in MAWP 50%.
- Reduced energy consumption and reduced footprint through less stops at borders and increased use of multimodal railway transport
  - Reduced energy consumption towards the overall MAWP objective of 10%.

HORIZON-JU-ER-2025-FA5-01: SUSTAINABLE COMPETITIVE DIGITAL GREEN RAIL FREIGHT SERVICES

Specific Conditions

Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 20.4 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.4 million. Applicant Private[116] Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.263[117] times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Indicative project duration	30 months.
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve a minimum between TRL 5 and TRL 8, depending on the enabler addressed, or higher by the end of the project – see General Annex B for a guide to the TRL definitions and criteria to be used.
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies with the following exception: the limit for a full Innovation Action application is set to 120 pages.
Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the Destination: • Expertise from rail infrastructure managers and railway undertakings, which should allow – defining main challenges, use cases and functional needs, – specifying, prioritizing and clustering demonstrators to ensure that researched innovative processes, operational and technological solutions are covered, – hosting the demonstrations and providing test trains/facilities, – providing data structures and content as well as processes, e.g. certification which can be subject for digitalisation. • Expertise from rail suppliers (system integrators, manufacturers and/or technology providers), which should allow jointly, – proposing operational and technological innovative solutions to identified use cases and functional needs, – identifying the technical requirements and interface specifications, aligned with the System Pillar architecture, – designing, developing, prototyping and delivering innovative operational & technological solutions and systems to be integrated within the demonstrations, depending on the specific target TRL level. • Expertise from research institutes and academia, which should allow

[116] As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

[117] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

	– planning, developing, studying, testing and evaluating solutions, systems and demonstrators together with the previous categories of expertise, – supporting any possible scientific or methodological issues that may arise during the performance of the action – contributing to other aspects of the innovation cycle, as well as to the procedural aspects for validation, certification, etc. • Complementary expertise from other sectors and parties, with particular attention to SMEs and Start-ups, which may contribute to enhance the actions' outcome.
Contribution to the monitoring and implementation, standardisation of the EU-Rail Programme	The action resulting from this topic is identified as a "flagship project" expected to perform, by the completion of the research and innovation lifecycle, "large scale demonstrations", in the meaning of Council Regulation (EU) 2021/2085. Hence, the action is a key contributor to the achievement of the objectives identified in the Master Plan [118] as further detailed in the revised Multi-Annual Work Programme[119]. In this respect, applicants are expected to deliver relevant information (data, results, etc.) as mutually agreed, to the JU and the Linked Project[s] to contribute to the advancement of the Innovation and System Pillars[120] activities, as well as in view of the development and implementation of EU policy and legislation (including Technical Specifications for Interoperability and Common Safety Methods) and the development of European standards. As specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to European or international standards, the EU-Rail grant agreements will include an additional information obligation related to standards. Beneficiaries must inform EU-Rail (up to four years after the end of the action) if the results can be reasonably expected to contribute to European or international standards. As part of its internal control and management framework, the JU will perform series of reviews and maturity checkpoints to assess the overall progress against the project plan and against the performance and TRL targets. Depending on the outcome of these reviews and maturity checkpoints(s), the scope of the project may be revised and/or funding reduced in accordance with the provisions of the relevant grant agreement. Mitigation actions may be requested by the JU as condition for continued funding. The proposal shall consider the necessary resources – FTE and/or other – to ensure the monitoring of the "Flagship Project" via regular reporting, reporting of data for the Programme KPIs, etc. The EU-Rail Governance and Process Handbook is available here: https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/
Linked Projects	As specified in section 2.3.8.1 of the Work Programme, in order to facilitate the contribution to the achievement of the EU-Rail objectives, the options regarding 'linked actions' of the EU-Rail Model Grant Agreement and the provisions therein, is enabled in the corresponding EU-Rail Grant Agreements.

[118] Master Plan available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

[119] Revised MAWP available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

[120] Refer to the revised Multi-Annual Work Programme available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

	The action that is expected to be funded under this topic will be complementary to the following projects: • FP1 - MOTIONAL (GA number: 101101973) • FP2-R2DATO (GA number: 101102001) • FP3 – IAM4RAIL (GA number:101101966) • FP4 – RAIL4EARTH (GA number: 101101917) • FP5-TRANS4M-R (GA number: 101102009) • FP5-DACtiVate (GA number: 101195671) The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics: • HORIZON-JU-ER-2025-FA1-01: Network management planning and control & Mobility Management in a multimodal environment • HORIZON-JU-ER-2025-FA2-01: Digital & Automatic up to Automated Train Operations • HORIZON-JU-ER-2025-FA3-01: Intelligent & Integrated asset management • HORIZON-JU-ER-2025-FA4-01: A sustainable and green rail system Please note that the list is non-exhaustive as additional Linked Projects may follow at a later stage of the programme implementation to complement the activity.
Funding of only one project per topic	EU-Rail may award up to one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]].
Lower funding rate	The funding rate of the action is 60% of the eligible costs to achieve the leverage effect established in the SBA. Each Consortia may decide internally different funding rates in line with the provisions of Article 34 of Horizon Europe nevertheless complying with the overall funding rate of 60%.
Award criteria additional details	The award criteria included in part D of the General Annexes of the Horizon Europe – Work Programme 2023 – 2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.
Additional dissemination obligations	In addition, as specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to considering the key contributing role of this topic, in designing the dissemination and communication activities, the proposal shall consider that the "Flagship Project" will be part of the overall EU-Rail Programme and the planning of key events – demonstrations, participations to fair, etc. – will be coordinated at Programme level and by the "Stakeholder Relations and Dissemination" structure of the JU.

	The proposal shall consider the KPIs metrics on dissemination and communication included in the EU-Rail Governance and Process Handbook available here : https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/

Expected Outcome

Building upon the results of S2R IP5[121], EU-Rail FP5-TRANS4M-R[122] and European DAC Delivery Programme (EDDP)[123] in particular, and other rail research and innovation activities, the Flagship Project stemming from this topic is expected to contribute to Europe's Rail Programme addressing the two areas described in the previous Destination 5 section, more in particular addressing two workstreams:

1. Work Stream WS1 Full digital Freight Train Operations with DAC as enabler for full digital freight train operation;

2. Work Stream WS2 Seamless Freight: with easy access and reliable (intermodal) transport service offering digital solutions.

Based on the two workstreams to be addressed, the Action is also expected to tackle specific activities/actions in relation to:

- FDFTO backend concept and its development in close alignment with rail freight stakeholders and System Pillar
- Contribute actively to the DAC specification, including power and data transmission
- Define concrete reliability targets in collaboration with ERA
- Address identified open points and actively contribute to specific technical solutions and risk identified (crashworthiness, specific requirements for ATEX environments, running dynamic behaviour in locomotives with hybrid coupling systems, longitudinal compressive forces in track gauges other than 1435 mm if possible)
-
- DAC migration requirements and specifications and how the assessment/definition of those specific requirements is linked to the DAC state of the art
- Support the pioneer DAC train activities and the links to testing and authorisation activities
- Explore the use of the web platform developed in Wave 1 [124] in the relevant demonstrators related to the seamless freight corridor and seamless customer freight solutions to be delivered. Consider further development for this web platform, including the integration of real time data for freight services within the scope of work.
- Specific demonstration activity to be considered in Central/Eastern Europe.

For **WS1** this destination should deliver by 2028 the following demonstrators:

[121] Results from Shift2Rail activities should be taken into account, please see FR8RAIL II D1.2-FR82 Automatic coupling and wagon design spec: https://projects.shift2rail.org/download.aspx?id=6bcc5d84-2b74-48f2-a24d-f52351c9904a

[122] Results from FP5-TRANS4M-R (https://projects.rail-research.europa.eu/eurail-fp5/deliverables/)

[123] Results from European DAC Delivery Programme (EDDP) enabled by Europe's Rail should be taken into account, please see https://rail-research.europa.eu/european-dac-delivery-programme/

[124] Results from ESEP4Freight (https://www.esep4freight.eu/deliverables/)

European full digital freight train operations: (TRL 7-8)

- Proposals are expected to deliver a follow-up large-scale demonstrator from EU-Rail FP5-TRANS4M-R[125] and extend the outcomes and results from TRL 7 to TRL 8. This includes the full digital freight train operations based on DAC Type 4 and Type 5 (including energy supply and data/communication solution) (TRL 8), train composition detection/management system, automated/automatic brake test system (TRL 8), and train integrity / train length determination (TRL 7). For this specific enabler, close coordination with the action to be funded under Destination 2 is to be performed, including an action plan for joint testing activities to be delivered within Month 3 of the project.

European full digital freight train operations: (TRL 5-7)

Proposals are expected to deliver a second demonstrator with a lower TRL level for technical solutions upgrading available functionality but at TRL 6-7 for automated parking brake system, digital wagon inspection (including RST+INF assets) concepts and solutions, and distributed power concepts and solutions (TRL 5-6) and electro-pneumatic brake (TRL 6-7), with specific focus on proving full functionality (added value for the sector respecting/meeting customer needs), safe system integration, interoperability and harmonised (cross-border) operation. Demonstration of innovative concepts for efficient, high-performing freight assets and self-propelled wagons (TRL 5-6) and automated/autonomous loading/unloading technologies (TRL 7-8) for last mile distribution are also expected to be addressed.

Demonstration of Yard automation: (TRL 7)

Demonstration of fully automated shunting loco(and wagons) movements, yard digitalization and full automated train composition and dispatching, as well as yard automation equipment and data exchange on wagon condition are expected to be addressed. Demonstrators shall focus on full functionality (added value for the sector respecting/meeting customer needs), safe system integration, interoperability, harmonized (cross-border) operation.

The return on experience of the demonstrators shall pave the way for preparing an European-wide DAC roll-out and finalization of the DAC standardisation and contribute to build up robustness of various TSI revisions. This will enable necessary safety analysis or safe system integration followed by authorisation prerequisite for deployment.

- In addition of the above, the proposal shall cover important preparatory works to be launched for the future set of demonstration foreseen in the Multi- Annual Work Programme in view of the evolutions of the solutions.:

For **WS2** this destination should deliver by 2028 at least the following:

Seamless freight corridor TRL 5-8

The cross-border freight trains demonstrator should be demonstrated on (parts of) two European corridors. It should demonstrate: integrated cross-border timetable planning, management and path ordering systems taking into account planning horizons (Digital Capacity Management) and especially the specific needs of short-term path requests for (international) freight services also last mile service, as well as for real-time interaction between various TMS (including yards/terminals) coming from destination. It should also demonstrate Dynamic yard/terminal management systems with optimization functions using and providing real-time information from/to the dynamic TMS systems, Dynamic freight specific real time functions for the interaction of TMS and other management systems, Real-time gathering and processing of

[125] Results from FP5-TRANS4M-R (https://projects.rail-research.europa.eu/eurail-fp5/deliverables/)

influencing data. Connection with rail TMS systems and other resource management systems, AI based prediction models. Accuracy and computational learning functions

This demonstrator should include technologies for standardized European Railway checkpoints at borders or other operational stop points, replacing manual process by digitalization and automation, using innovative technologies and processes. The demonstrator will include Integrating and connecting the last mile (accession lines/shunting/yards/ terminals) slot planning directly or via interfaces. This will have to be connected with other supporting implementations like certified translation tools or harmonized processes.

Seamless customer freight TRL6-8

The seamless planning management and booking of multimodal rail-based transport integrating multi-actors, should be demonstrated by combining the key enablers to an innovative open system, which will simplify the way of organizing transport and integrating rail in modern supply chains. Based on increased data quality and availability on one side and improved routing engines on the other side it should be demonstrated how transport planning[126] will get more responsive to changing demand, disruptions and customer requirements. This demonstrator will ease end customers to interface with rail. In addition dynamic TMS stemming from call the flagship project from Destination 1 shall be incorporated in connection with dynamic dispatching tools which shall be key for the optimal automation of yards and last mile operations[127].

In addition of the above, the proposal shall cover important preparatory works needs to be launched for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions mentioned above, which then shall be extended by additional functions, extended scope and higher TRL levels.

The action to be funded under this Destination also needs to provide the following necessary element for the demonstrations under the action to be funded under **Destination 1** to be delivered for 2028 demonstration: For FA5 WS1 enablers to be identified under the Scope section of Destination 1. For FA5 WS2 enablers to be identified under the Scope section of Destination 1

The action to be funded under this Destination also needs to provide the following necessary element for the demonstrations under the action to be funded under **Destination 2** to be delivered for 2028 demonstration: Enablers to be identified under the Scope section of Destination 2.

The action to be funded under this Destination also needs to provide the following necessary element for the demonstrations under the action to be funded under **Destination 3** to be delivered for 2028 demonstration: Enablers to be identified under the Scope section of Destination 3.

Scope

The Flagship Project stemming from this topic should develop the following capabilities:

Capabilities for improving European full digital freight train operations

- **Enabler 1:** Development of an EU-harmonized DAC, plus the necessary freight consist backbone system including a solution for both the energy supply as well as data/communication (setting the right conditions towards modular -standard interfaces-

[126] Results from Shift2Rail activities should be taken into account, see S2R IP5 ARCC D3.1 – Improved methodology for timetable planning https://projects.shift2rail.org/download.aspx?id=c32f4173-14db-431f-b31c-40aee080a437

[127] Results from Shift2Rail activities should be taken into account, see S2R IPC OPTIYARD D5.2 D5.2 Yard optimization algorithm_network decision-support tool https://projects.shift2rail.org/download.aspx?id=f0a32c8c-e23e-4488-bc4e-45e53c527788

expected to be scalable, of plug & play integration, etc. solution). As needed by the demonstrator the enabler must be able to drive complete train sets. Apart from the development of a coupler solution for locomotives, this DAC shall be upgradable to Type 5. **(TRL 8 by 2028**). There is also the identified need for the development of the FDFT backend concept (TRL5) as the enabler to ensure communication to and from the vehicles.

- **Enabler 2:** Developing a train composition detection/management system, automated/automatic brake test system, on asset side DAC wagon retrofitting solutions. **(TRL 8 by 2028)**

- **Enabler 3:** Automated parking brake system, digital wagon inspection, distributed power system, electro-pneumatic brake **(TRL 6-7 by 2028)** and cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions.

Capabilities for increasing automation in shunting operations

- **Enabler 4** Development of systems and solutions for basic autonomous shunting operations. Development of solutions for yard automation including digitalization that enable automated train composition and dispatching (Automated Shunting Operations), including data exchange on wagon condition (visual recognition methodologies and AI-tools for yard automation) **(TRL7 by 2028)** and cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions.

- **Enabler 5** Achieving expected consolidation of the expected new freight capabilities, providing requirements and giving feedback to Destination 2 for new automation technology solutions for the automated driving and decision-making as well as automating functions, such as train preparation and basic automatic yard shunting **(TRL8 by 2028)**.

Capabilities for DAC based wagon concepts incl. multi-modal transport applications

- **Enabler 6** Developing DAC based wagon concepts incl. multi-modal transport applications (retrofitting needs for combined traffic T3000 kind of wagons) **(TRL 7-8 by 2028)**. This also includes the development of innovative concepts for efficient high performing freight assets and self-propelled wagons **(TRL 6 by 2028)** and cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions

Capabilities for Seamless Freight Corridor

- **Enabler 7** Setting up the respective models and systems to test and demonstrate the destination 1 developments for integrated timetable planning on selected part of a European corridor **(TRL7-8 by 2028)** and cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions

- **Enabler 8** Develop dynamic yard/terminal management systems and test their integration with dynamic TMS based on agreed interfaces– that will be specified among destination 1 and the TMS development that will come from destination 1 **(TRL 6-8 by 2028)** and cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions

- **Enabler 9** Specify and develop intermodal monitoring and prediction systems, which shall work in combination with dynamic TMS and other resource management systems using AI based models, accuracy and computational learning functions **(TRL6-8 by 2028)** and cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions

- **Enabler 10** Specify and develop Railway Checkpoints that will automate Freight Train Transfer Inspections at borders, yards or other operational stop points, digitalising and automating processes through innovative sensors, specialised adapted video gates and handheld devices. Integrative deployment of video gates, way side check points, visual recognition methodologies and AI-Tools for yard automation **(TRL 8 by 2028**) in connection with Destination 3 and cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions

Capabilities for Seamless Freight Multimodal and Customer

- **Enabler 11** Specifications for the development of integrated multimodal transport planning, management and operational systems enabling easy access to rail-base (intermodal) services and dynamic demand responsive service offering, network planning and capacity management based on agreed interfaces with TMS – with Destination 1 - and the specific freight development to support this functionality **(TRL5-8 by 2028)**. and cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi-annual Work programme in view of the evolutions of the solutions

- **Enabler 12** Analysis and coordination of requirements for seamless data exchange / data availability for the various Destination 5 developments and planned demonstrations, taking into account existing/proposed data standards (if applicable) and regulations e.g. TAF TSI. Specification and development of required processes/tools (e.g. interfaces/ converters.) **(TRL 7-8 by 2028)** and cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work programme in view of the evolutions of the solutions

- **Enabler 13** Analysis and coordination of required technology upgrades of legacy/national systems to be able to provide/consume/process harmonised data from/for international (European) applications/innovations. Development of an implementation plan. **(TRL 7-8 by 2028)**

For Research & innovation and demonstrations activities (within the action) making use of data models related to the interoperability or safety of the rail system, those data models should be aligned with the ERA Ontology[128]. This ontology defines the conceptual framework and the specific terms and relationships for the interoperability or safety of the rail system in the EU that shall be used or where relevant extended. This includes the reuse of the ERA ontology with its semantic artifacts (shacl rules, skos ..) and in cases where it is not sufficient, extensions should be proposed to maintain semantic consistency and interoperability across systems. Those extensions proposals should cover the processes to validate extension to the ERA Ontology with compliant datasets and related competency questions and linked SPARQL queries based on interoperability testbed validation tools

[128] https://github.com/Interoperable-data/ERA-Ontology-3.1.0

(Interoperability Test Bed Guides — ITB Guides[129]). Corresponding documentation should also include any mappings or transformations considered in the Research & Innovation activities and any assumptions made.

Collaboration work required with other FAs, SP and CEF projects

The action to be funded under Destination 5 should foresee developing a deliverable capturing specific requirements described in the Expected scope and relevant for the action to be funded under Destination 1, Destination 2, and Destination 3, suggested to be delivered indicatively by M6.

The action to be funded under Destination 5 shall foresees a common activity/task related to the review of system specifications to be developed by the action to be funded under Destination 1, Destination 2, Destination 3.

The action to be funded under Destination 5 shall foresee a common activity/task related to the Preparatory works on the integration and pilot test(s) of the technical enablers to be provided by the action to be funded under Destination 1, Destination 2, Destination 3 for the demonstration to be carried out in the action to be funded by Destination 1, Destination 2, Destination 3.

It is expected that the Flagship Project stemming from this topic will use the EU-RAIL System Pillar Cybersecurity specifications [130], provide feedback to the Destination 1 Workstream 2 covering Cybersecurity and foresee adequate structure and resources for these activities.

Additionally, the project should seek for synergies with any project stemming from the topic call "CEF-T-2024-SIMOBGEN-REMIB-WORKS : Removing rail interoperability barriers - studies, works or mixed" that would include a rail DAC related application.

The project should also seek for synergies and take into account the output of the EU-Rail Projects DACtivate and DACFit.

Key Performance Indicators

The action shall actively contribute to measure and monitor the specific quantitative KPIs defined in the Destination description above, including its contribution to the Europe's Rail Master Plan impacts. Outcomes are to be delivered at a calendar annual basis by each year end

Interaction with the System Pillar

The System Pillar aims to guide, support and secure the work of the Innovation Pillar (i.e. to ensure that research is targeted on commonly agreed and shared customer requirements and operational needs, compatible and aligned to the system architecture), and the Innovation Pillar will impact the scope of the System Pillar where new technologies or processes mean that innovations can drive a change in approach, as well as delivering detailed specifications and requirements.

All necessary documents will be exchanged with the System Pillar regardless of the confidentiality status.

[129] https://www.itb.ec.europa.eu/docs/guides/latest/overview/index.html

[130] https://rail-research.europa.eu/horizontal-tasks/

For the harmonisation and finalisation of operational procedures, concurrent development and harmonisation in the context of the migration scenarios will be carried out with the system pillar team with the aim to determine their impact on the definition of the procedures

For freight system architecture, there should be collaboration and regular interactions with the System Pillar experts.

In this respect, the proposal should allocate necessary resources that would be dedicated to areas linked to the System Pillar conceptual and architecture works – particularly addressing specification development (the interaction is illustrated in the System Pillar – Innovation Pillar interaction note (Annex VI of this Work Programme)). The alignment of the activities will primarily take place during the Grant Preparation Phase and ramp up phase of the awarded proposal, and there will be continued, structured and regular interaction through the life of the project.

System Pillar interaction will mainly regard system architecture incl. logic for authorisation responsibility for each component, authorisation strategy/preparation/planning and safety management, standardisation management, and on top on migration planning and CBA which is in the scope of EDDP.

The EU-RAIL System Pillar is producing specifications and other relevant documents [131]. In general the documents applicable to the Destination 5 should be used. If it is considered documents are not applicable, the proposals shall explain the reason(s) for not using them (to note the application of the documents may still be required by EU-RAIL). During the action to be funded under this Destination, there may be updating of the documents, including based on feedback from application in technical enablers and demonstrators. Relevant feedback should be provided on a regular basis to EU-RAIL and the System Pillar.

The action shall actively contribute to the update of the EU-Rail Standardisation and TSIs input plan (STIP) wherever relevant. Similarly, the action shall contribute to the development and implementation of EU policy and legislation including Technical Specifications for Interoperability and Common Safety Methods, as well as to publications of the System Pillar.

Gender dimension
In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Other
It is expected that the Flagship Project stemming from this topic:

- will involve sufficient European geographical representation of academia, and ensure that all needed expertise for the described activities reflects the Special skills and/or capabilities expected from the Applicant(s) as described in the specific topic conditions.
- will be compliant with the EU Data Policy 2020 and associated legal instruments. This requires adherence to EU framework, including but not limited to the Open Data Directive (EU) 2019/1024 and associated implementing Regulation (EU) 2023/138 on high-value data sets, the Data Governance Act (Regulation (EU) 2022/868), the Data Act (Regulation (EU) 2023/2854), and the Interoperable Europe Act (Regulation (EU) 2024/903). Ensuring compliance involves verifying that data management, processing and sharing comply with applicable EU framework.

[131] https://rail-research.europa.eu/v1-release/

DESTINATION 6 – Regional rail services / Innovative rail services to revitalise capillary lines

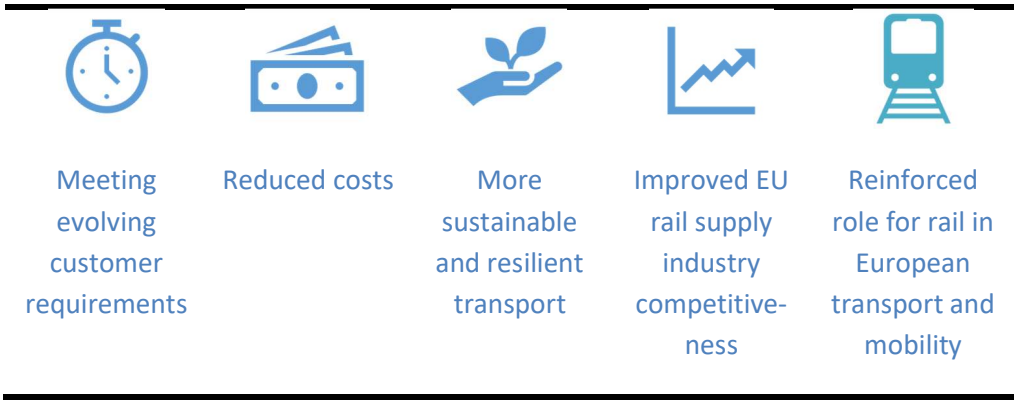
DESTINATION 6 – description (possibly included in the Expected Outcome in the Funding Portal)

Regional railway (lower usage lines or secondary network) plays a crucial role not only in serving Europe´s regions but also as feeder lines for passenger and freight traffic for the main/core network. Hence, having an essential function as green transport and connecting other public transport services (e.g. bus) as well as first & last mile services such as car, bike sharing, cycling, walking from railway stations to remote locations. However, these railway lines need to be revitalized or even regenerated to make them economically, socially and environmentally sustainable and meet the current customer needs. The overall objective is to ensure long term viability of regional railways by decreasing the total cost of ownership, in other words, cost per kilometre both in terms of OPEX and CAPEX, while offering a high quality of service and operational safety as well as better customer satisfaction.

These goals are expected to be achieved through a concept tailored to regional railways that includes digitalisation, automation and utilisation of mainstream and emerging technologies for signalling and trackside components and customer information.

The outcome and demonstrated solutions shall not only be applicable for specific lines or regions but be adequately scalable and interoperable to become a European solution. Furthermore, proposed solutions and technologies could be applied to provide a more cost-efficient infrastructure in other settings. In addition standardised solutions for specific regional railways that are not functionally / operationally connected with mainline network might apply or for the purpose of pilot applications with the perspective of a further development for global application.

The selected proposal for funding under this Destination will be a Flagship Project of Europe's Rail with significant expected impacts, which require an integrated sector systemic approach. Proposals, should therefore set out a credible pathway (including an exploitation plan) to contributing to the following expected impacts as described in the Master Plan.



Proposals under this Destination should set appropriate monitoring and demonstration activities to measure the following KPIs:

Customer Services, Regional System Solutions, CCS & Operations and Regional Railway Assets

- Reduced CAPEX of the CCS system, while maintaining or increasing the present safety level:
  - Expected decrease by targeting 25%.
- Reduced the CAPEX of radio network and allowing for higher savings due to the utilization of public radio network in low density lines:
  - Expected decrease by targeting 15%.

- Increased system availability due to reduced trackside asset failure and more reliable CCS (Average delay minutes per assets and signalling failures):
    - Expected increase by targeting 10%.
- Reliable cost-effective fail safe on board train integrity, train length detection and train positioning:
    - Increased reliability by targeting 15%,
    - Reduced OPEX and CAPEX by targeting 15%.
- Optimized energy consumption and higher punctuality through ATO over ERTMS targeting GoA4:
    - Expected decrease of energy consumption targeting 10%,
    - Increased punctuality targeting 15%.
- Reduced OPEX costs/km (reduction expected due to trackside asset decrease) for trackside railway assets:
    - Expected reduction of targeting 30%.
- Reduced OPEX costs/km (reduction expected due to trackside asset decrease) for trackside railway assets:
    - Expected reduction of targeting 30%.
- Increased energy efficiency for trackside railway assets (as part of the OPEX saving above, not to be added on top):
    - Expected increase by targeting 15%.

.

HORIZON-JU-ER-2025-FA6-01: REGIONAL RAIL SERVICES / INNOVATIVE RAIL SERVICES TO REVITALISE CAPILLARY LINES

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 10 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10 million. Applicant Private[132] Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.263[133] times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as

[132] As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

[133] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

	mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Indicative project duration	30 months.
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve a minimum between TRL 5 and TRL 7, depending on the enabler addressed, or higher by the end of the project – see General Annex B for a guide to the TRL definitions and criteria to be used.
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies with the following exception: the limit for a full Innovation Action application is set to 120 pages.
Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the Destination: • Expertise from rail infrastructure managers and railway undertakings, which should allow – defining main challenges, use cases and functional needs, – specifying, prioritizing and clustering demonstrators to ensure that researched innovative processes, operational and technological solutions are covered, – hosting the demonstrations and providing test trains/facilities, – providing data structures and content as well as processes, e.g. certification which can be subject for digitalisation. • Expertise from rail suppliers (system integrators, manufacturers and/or technology providers), which should allow, jointly, – proposing operational and technological innovative solutions to identified use cases and functional needs, – identifying the technical requirements and interface specifications, aligned with the System Pillar architecture, – designing, developing, prototyping and delivering innovative operational & technological solutions and systems to be integrated within the demonstrations, depending on the specific target TRL level with the possibility of carry out integrated demonstrators. • Expertise from research institutes and academia, which should allow – planning, developing, studying, testing and evaluating solutions, systems and demonstrators together with the previous categories of expertise, – supporting any possible scientific or methodological issues that may arise during the performance of the action – contributing to other aspects of the innovation cycle, as well as to the procedural aspects for validation, certification, etc. • Complementary expertise from other sectors and parties, with particular attention to SMEs and Start-ups, which may contribute to enhance the actions' outcome.
Contribution to the monitoring and implementation, standardisation	The action resulting from this topic is identified as a "flagship project" expected to perform, by the completion of the research and innovation lifecycle, "large scale demonstrations", in the meaning of Council Regulation (EU) 2021/2085. Hence, the action is a key contributor to the achievement of the objectives identified in

of the EU-Rail Programme	the Master Plan [134] as further detailed in the revised Multi-Annual Work Programme[135]. In this respect, applicants are expected to deliver relevant information (data, results, etc.) as mutually agreed, to the JU and the Linked Project[s] to contribute to the advancement of the Innovation and System Pillars[136] activities, as well as in view of the development and implementation of EU policy and legislation (including Technical Specifications for Interoperability and Common Safety Methods) and the development of European standards. As specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to European or international standards, the EU-Rail grant agreements will include an additional information obligation related to standards. Beneficiaries must inform EU-Rail (up to four years after the end of the action) if the results can be reasonably expected to contribute to European or international standards. As part of its internal control and management framework, the JU will perform series of reviews and maturity checkpoints to assess the overall progress against the project plan and against the performance and TRL targets. Depending on the outcome of these reviews and maturity checkpoints(s), the scope of the project may be revised and/or funding reduced in accordance with the provisions of the relevant grant agreement. Mitigation actions may be requested by the JU as condition for continued funding. The proposal shall consider the necessary resources – FTE and/or other – to ensure the monitoring of the "Flagship Project" via regular reporting, reporting of data for the Programme KPIs, etc. The EU-Rail Governance and Process Handbook is available here : https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/ /
Linked Projects	As specified in section 2.3.8.1 of the Work Programme, in order to facilitate the contribution to the achievement of the EU-Rail objectives, the options regarding 'linked actions' of the EU-Rail Model Grant Agreement and the provisions therein, is enabled in the corresponding EU-Rail Grant Agreements. The action that is expected to be funded under this topic will be complementary to the following projects: • FP1 - MOTIONAL (GA number: 101101973) • FP2-R2DATO (GA number: 101102001) • FP2-MORANE 2 (GA number: 101196125) • FP3 – IAM4RAIL (GA number:101101966) • FP4 – RAIL4EARTH (GA number: 101101917) • FP5-TRANS4M-R (GA number: 101102009) • FP6-FutuRe (GA number: 101101962) • FP7-Pods4Rail (GA number: 101121853) The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

[134] Master Plan available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

[135] Revised MAWP available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

[136] Refer to the revised Multi-Annual Work Programme available at https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

	• HORIZON-JU-ER-2025-FA1-01: Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers • HORIZON-JU-ER-2025-FA2-01: Digital & Automatic up to Automated Train Operations • HORIZON-JU-ER-2025-FA3-01: Intelligent & Integrated asset management • HORIZON-JU-ER-2025-FA4-01: A sustainable and green rail system • HORIZON-JU-ER-2025-FA5-01: Sustainable Competitive Digital Green Rail Freight Services Please note that the list is non-exhaustive as additional Linked Projects may follow at a later stage of the programme implementation to complement the activity.
Funding of only one project per topic	EU-Rail may award up to one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]].
Lower funding rate	The funding rate of the action is 60% of the eligible costs to achieve the leverage effect established in the SBA. Each Consortia may decide internally different funding rates in line with the provisions of Article 34 of Horizon Europe nevertheless complying with the overall funding rate of 60%.
Award criteria additional details	The award criteria included in part D of the General Annexes of the Horizon Europe – Work Programme 2023 – 2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.
Additional dissemination obligations	In addition, as specified in section 2.3.8.1 of the Work Programme, and to facilitate contributions to considering the key contributing role of this topic, in designing the dissemination and communication activities, the proposal shall consider that the "Flagship Project" will be part of the overall EU-Rail Programme and the planning of key events – demonstrations, participations to fair, etc. – will be coordinated at Programme level and by the "Stakeholder Relations and Dissemination" structure of the JU. The proposal shall consider the KPIs metrics on dissemination and communication included in the EU-Rail Governance and Process Handbook available here : https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/functioning-of-the-europes-rail-ju/

Expected Outcome

Building upon the results of S2R and of Europe's rail first wave Flagship projects as well as EU-member states rail research and innovation activities, the Flagship Project stemming from this topic is expected to contribute specifically in regional solution linked to system architecture approaches, CCS & Operations, rail infrastructure assets as well as Customer Services.

Solutions should demonstrate that costs for these areas can be lowered and that solutions can be subsequently deployed under operational conditions. Thus, the main focus of this project is to develop in all areas solutions which can be demonstrated mainly in an intended environment and deployed in integrated demonstrators in operational environment in a subsequent project.

The Flagship Project stemming from this topic is expected to contribute to Europe's Rail Programme with the following outcomes:

- possible adaptation of the proposed solution to meet the specific requirements of low density lines,
- demonstration of the possibility of scaling up as a European solution,
- adapt and demonstrate solutions up to TRL7,
- demonstration of the feasibility of proposed technical solutions and preparatory work for integrated demonstrator under operational conditions (TRL7) set for the future.

System, CCS & Operations

Building upon the work developed within S2R, FP2-R2DATO[137], FP6-FUTURE[138] as well as in other research and innovation activities, the actions stemming from this destination shall review and amend if necessary the system requirements (technical and operational) which will be integrated and used by the other FAs in their relevant developments on TMS, CCS and vehicles as well as a data sharing and analysis platform. In addition, this destination shall demonstrate the technical enablers in a cost efficient and customer centric manner. Hence, a strong involvement of actions from the relevant destinations is required and needs to be secured.
The action stemming from this destination shall also provide relevant input in the area of regional lines to the System Pillar activities.

Assets

Building upon the work developed within FP4-Rail4EARTH[139], FP6-FUTURE as well as in other research and innovation activities, this destination shall focus on demonstrating cost-efficient components including wireless and energy self-sufficient infrastructure components and trackside wireless communications to decrease the operational and overhead cost.
Assessment of using multimodal (rail/road) fuelling stations for regional services shall be addressed taken into consideration input from Destination 4.

Customer Service

In addition, building upon the work developed within FP1-MOTIONAL[140] and FP6-FUTURE as well as in other research and innovation activities, the action stemming from this destination shall contribute to demonstrate highly accurate multimodal passenger service information, at railway stations and/or personal devices (including people and goods management) to allow for a smooth journey from railway to other modes and vice versa and to bridge the challenging last-mile issue in regional areas.

Building on the result of the Europe's Rail, the Flagship Project stemming from this topic shall deliver, by 2028, individual and integrated demonstrations if technically and geographically feasible based on the two clusters defined in the MAWP:

- Demonstrator cluster 1: regional lines with significant connection with mainline (Group 1)
- Demonstrator cluster 2: regional lines with no or limited connection with mainline (Group 2)

[137] https://rail-research.europa.eu/rail-projects/fp2-r2dato/
[138] https://rail-research.europa.eu/rail-projects/fp6-future//
[139] https://rail-research.europa.eu/rail-projects/fp4-rail4earth/
[140] https://rail-research.europa.eu/rail-projects/fp1-motional/

The demonstrators shall consider the following scenarios:

Demonstrators linked to technical enablers developed within **Destination 6**:

- Demonstrate for Group 2 a single integrated Operations Control Center (OCC) covering interlocking, radio blocking and traffic management for regional lines that are not functionally/operationally connected to mainline (TRL 6).
- Demonstrate for Group 2, the suitable application of cost-efficient COTS based radio communications considering 4G, 5G or later and satellite exploiting cloud data management technologies over standard IP protocol while considering the economic viability for regional lines (TRL6/7)

Demonstrator linked to technical enablers developed within **Destination 1:**

- Demonstrate a specific application for Traffic Management Systems for regional lines improving resilience of a connected rail network, optimizing train operations including disturbing events taking into account high/low-demand situations (disturbance and distraction) (TRL 6).

Demonstrators linked to technical enablers developed within **Destination 2:**

- Demonstrate ATO over ETCS up to GoA3/4 adapted to regional operations a specific application for safe environment perception solutions, including signal reading and obstacle detection, energy saving and optimisation of driving schedule and remotely controlled trains (TRL6)
- Demonstrate hybrid train detection and moving block for regional services (TRL6)
- Demonstrate the suitable application of cost-efficient communications (Train to Train, Train to Trackside – wayside assets, Trackside to Trackside) with the use of mobile networks or communication infrastructure from third parties (e.g. 4G, 5G, satellite comms) while considering the economic viability for regional lines (TRL6/7)
- Demonstrate a specific application of safe absolute train positioning, based on among others hybrid, multi sensor technologies, digital maps, onboard database (TRL6)
- Demonstrate the use of public and private radio networks based on the findings from FP6-FUTURE and Destination 2 related to cost effective communications such as Gigabit radio, supporting the application of FRMCS[118] e.g. multi-connectivity, minimizing civil works and energy consumption, to the achievement of cost effective digital operations and Gigabit Train applications, the use of public network coverage and compatibility with main lines (TRL6/7)
- Demonstrate a specific application for fail-safe train integrity for regional trains (TRL7)
- Demonstrate a specific application for Train length detection for regional trains (TRL6)
- Demonstrate the suitability of a digital platform for CCS validation & TSI certification and authorization for Regional Lines (TRL5).

This requires a strong involvement of and interaction between actions from relevant other destinations but also provides relevant input in the area of Regional Lines (e.g. characterization of existing regional lines across Europe and future expectations and high-level requirements) to the System Pillar activities.

Assets Demonstration

- Demonstrate a systemic approach with the implementation of different railway assets in particular for cost-efficient wireless, energy self-sufficient wayside components in particular CCS track-side components (e.g. switches, level crossings) and if applicable for track vacancy detections and signalling shall be evaluated and demonstrated (TRL6) and/or demonstrate the concept of Smart Wayside Object Controller (TRL5/6).

Suitable customer services

- Demonstrate cost-efficient integration of on-board and/or personal devices information of multimodal services integrating regional multimodal services based on demand-responsive transport (TRL7)
- Demonstrate passenger congestion rate monitoring, flow optimization application as well as a low-cost passenger information system for regional services developed within this action (TRL6)

The action to be funded under this Destination shall also provide an updated technical and operational requirements (and all necessary elements) for the adaptation of "Destination 1" enablers 1, 2, 3, 4, 6, 11, 12, 13, 16, 17, 19, 20, 21 and 23 to be developed under the action to be funded under **Destination 1 - Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers.**

The action to be funded under this Destination shall also provide an updated technical and operational requirements (and all necessary elements) for the for the adaptation of "Destination 2" enablers 2, 3, 4, 5, 6, 7, 9, 10 and 14 to be developed under the action to be funded under **Destination 2 – Digital & Automated up to Autonomous Train Operations.**

Scope:

The Flagship Project stemming from this topic shall develop under the following capabilities the enablers and any other which may contribute to deliver the afore-mentioned expected outcome:

CCS & Operations

1. Develop based on the work of FP6-FUTURE[141], develop a Destination 6 specific application based on respectively improving generic application developed in Destinations 1 and 2 of several technical enablers and components for a cost-efficient performant control command and signalling system adapted to Regional Lines (TRL5-7 in 2028).
2. Develop based on the work of FP6-FUTURE[142], develop a single integrated Operations Control Centre (OCC) covering interlocking, radio blocking and traffic management for regional lines that are not functionally/operationally connected with mainline. This integrated OCC will reduce the software and hardware compare to traditional non integrated architecture while ensuring the same safety level (TRL6 in 2028).

Asset

3. Develop based on the work of FP6-FUTURE[143], Smart Wayside Object Controller (TRL5/6) and/or infrastructure components and wayside elements focused on Regional Railway cost drivers (e.g. level crossings, switches) which are energy self-sufficient and/or wireless enabled (by using the simplified communication system developed in CCS and Operations; enable remote control or full or partial automation and/or autonomous operation (TRL6 in 2028).
4. Develop based on the work developed in FP6-FUTURE[144], a concept for alternative fueling/charging stations for regional railway being interoperable with other road/rail vehicles (TRL3 in 2028)

141 https://rail-research.europa.eu/pages/fp6-future/deliverables
142 https://rail-research.europa.eu/pages/fp6-future/deliverables
143 https://rail-research.europa.eu/pages/fp6-future/deliverables
144 https://rail-research.europa.eu/pages/fp6-future/deliverables

Customer service

5. Based on the work developed in FP6-FUTURE[145], develop cost-efficient integration of on-board and or personal device information of multimodal services integrating regional multimodal services based on demand-responsive transport (TRL7 by 2028). Developments need to take into account solutions stemming and related to work on the ontology networks that have been produced in previous FP-FUTURE[146] to align with CEN standards such as Transmodel as well as with the connections to National Access Point.
6. Based on the work developed in FP6-FUTURE[147], develop passenger congestion rate monitoring, flow optimization application as well as a low-cost passenger information system (by e.g. also using train positioning, FRMCS) for regional services while integrating multimodal services at railway stations. Such an application will be using the developments done in Destination 1 in the context of multimodal timetable integration. (TRL6 by 2028)

Developments on all those enablers should also cover important preparatory works with higher TRL for the future set of demonstration foreseen in the Multi- annual Work Programme in view of the evolutions of the solutions.

For Research & innovation and demonstrations activities (within the action) making use of data models related to the interoperability or safety of the rail system, those data models should be aligned with the ERA Ontology[148]. This ontology defines the conceptual framework and the specific terms and relationships for the interoperability or safety of the rail system in the EU that shall be used or where relevant extended. This includes the reuse of the ERA ontology with its semantic artifacts (shacl rules, skos ..) and in cases where it is not sufficient, extensions should be proposed to maintain semantic consistency and interoperability across systems. Those extensions proposals should cover the processes to validate extension to the ERA Ontology with compliant datasets and related competency questions and linked SPARQL queries based on interoperability testbed validation tools (Interoperability Test Bed Guides — ITB Guides[149]). Corresponding documentation should also include any mappings or transformations considered in the Research & Innovation activities and any assumptions made.

Integrated demonstrator preparatory work

Validated the list of requirements and an implementation plan of the integrated demonstrators in preparation for Wave 3 based on the results of FP6-FUTURE[150], which will showcase the demonstration of solutions in operational environment (TRL7). Outcomes under this activity are expected by M12.

Key Performance Indicators

The action shall actively contribute to measure and monitor the specific quantitative KPIs defined in the Destination description above, including its contribution to the Europe's Rail Master Plan impacts. Outcomes are to be delivered at a calendar annual basis by each year end.

Collaboration work required with other FAs

The action to be funded under Destination 6 shall foresee developing a deliverable capturing updated or additional specific requirements coming from the specific regional rail applications and relevant for the action to be funded under Destination 1 and Destination 2, suggested to be delivered indicatively by M6.

---

145 https://rail-research.europa.eu/pages/fp6-future/deliverables
146 https://rail-research.europa.eu/pages/fp6-future/deliverables
147 https://rail-research.europa.eu/pages/fp6-future/deliverables
148 https://github.com/Interoperable-data/ERA-Ontology-3.1.0
149 https://www.itb.ec.europa.eu/docs/guides/latest/overview/index.html
150 https://rail-research.europa.eu/pages/fp6-future/deliverables

The action to be funded under Destination 6 shall foresee a common activity/task related to the review of system specifications to be developed by the action to be funded under Destination 1 and Destination 2.

The action to be funded under Destination 6 shall foresee a common activity/task related to the Preparatory works on the integration and pilot test(s) of the technical enablers to be provided by the action to be funded under Destination 1 and Destination 2 for the demonstration to be carried out in the action to be funded by Destination 1 and Destination 2.

It is expected that the Flagship Project stemming from this topic will use the EU-RAIL System Pillar Cybersecurity specifications [151], provide feedback to the Destination 1 Workstream 2 covering Cybersecurity and foresee adequate structure and resources for these activities.

Interaction with the System Pillar
The System Pillar aims to guide, support and secure the work of the Innovation Pillar (i.e. to ensure that research is targeted on commonly agreed and shared customer requirements and operational needs, compatible and aligned to the system architecture), and the Innovation Pillar will impact the scope of the System Pillar where new technologies or processes mean that innovations can drive a change in approach, as well as delivering detailed specifications and requirements.

In this respect, the proposal should allocate necessary resources that would be dedicated to areas linked to the System Pillar conceptual and architecture works – particularly addressing specification development (the interaction is illustrated in the System Pillar – Innovation Pillar interaction note (Annex VI of this Work Programme)). The alignment of the activities will primarily take place during the Grant Preparation Phase and ramp up phase of the awarded proposal, and there will be continued, structured and regular interaction through the life of the project.

The EU-RAIL System Pillar is producing specifications and other relevant documents [152]. In general the documents applicable to the Destination 6 should be used. If it is considered documents are not applicable, the proposals shall explain the reason(s) for not using them (to note the application of the documents may still be required by EU-RAIL). During the action to be funded under this Destination, there may be updating of the documents, including based on feedback from application in technical enablers and demonstrators. Relevant feedback should be provided on a regular basis to EU-RAIL and the System Pillar.

The action shall actively contribute to the update of the EU-Rail Standardisation and TSIs input plan (STIP) wherever relevant. Similarly, the action shall contribute to the development and implementation of EU policy and legislation including Technical Specifications for Interoperability and Common Safety Methods, as well as to publications of the System Pillar.

Gender dimension
In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Other
It is expected that the Flagship Project stemming from this topic:

- will involve sufficient European geographical representation of academia, and ensure that all needed expertise for the described activities reflects the Special skills and/or capabilities expected from the Applicant(s) as described in the specific topic conditions.

[151] https://rail-research.europa.eu/horizontal-tasks/
[152] https://rail-research.europa.eu/v1-release/

- will be compliant with the EU Data Policy 2020 and associated legal instruments. This requires adherence to EU framework, including but not limited to the Open Data Directive (EU) 2019/1024 and associated implementing Regulation (EU) 2023/138 on high-value data sets, the Data Governance Act (Regulation (EU) 2022/868), the Data Act (Regulation (EU) 2023/2854), and the Interoperable Europe Act (Regulation (EU) 2024/903). Ensuring compliance involves verifying that data management, processing and sharing comply with applicable EU framework.

DESTINATION 8 – Exploratory Research and other activities

HORIZON-JU-ER-2025-EXPLR-01 : STUDIES ON RAIL INDUSTRY 5.0

Expected EU contribution	EU-Rail estimates that an EU contribution 0.6 million EUR would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amount
Indicative budget	The total indicative budget for the topic will be 0.6 million EUR. Applicant Private[153] Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.26352 times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Technology Readiness Level	Activities are expected to be of low TRL1, with possible technology concept formulated at TRL2, higher TRL are also possible – see General Annex B for a guide to the TRL definitions and criteria to be used.
Indicative project duration	30 months. This does not preclude submission and selection of a proposal with a different project duration
Type of Action	RIA (Research and Innovation Action)
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies, with the following exception: the limit for a full Research and Innovation Action application is set to 70 pages.
Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the topic. The applicants are expected to gather expertise leveraging from the knowledge of Academia and of the rail supply industry, SMEs and start-ups. In addition, applicants should leverage from the expectations of the end users, in the horizon 2030, considering the R&I contribution and vision from the EU-Rail Master Plan and Multi-Annual Work Plan.
Retroactive starting date of the	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting

[153] As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

grant	date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025) [https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]
Award criteria additional details	The award criteria included in part D of the General Annexes of the Horizon Europe Work Programme 2023-2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.

Expected Outcome

European Commission's Industry 5.0 Award provides a vision of the future of European industry taking into consideration the achievement of 'societal goals beyond jobs and growth. Industry 5.0 is seen "as transition to a sustainable, people-centric and resilient European industry"[154].

The expected outcome of this Research and Innovation Action is a study that identifies the key challenges, drivers, and expected measurable outcomes/benefits related to the application of the new concepts introduced by the 5.0 Industry principles to the rail sector.

The study shall provide recommendations for the implementation of Industry 5.0 vision that will lead to a significant improvement of safety, reliability, and efficiency in rail operations.

Scope

The scope of the activities to be performed under this research and innovation action can address the following:

- Identification of practices and drivers required for the implementation of the Industry 5.0 principles in the European rail sector:
    - Identification of the impacted stakeholders (i.e. Infrastructure Managers (IM), operators, suppliers, academia, etc.)
    - Investigation and identification of possible implementation solutions
    - Definition of implementation drivers, challenges and risks. The study shall also focus on the scope and role of public policies and regulations in the successful implementation of Industry 5.0).
- Definition of success factors for the implementation of the Industry 5.0 principles in the rail sector, including: stimulating competitiveness, reputation, talent attraction, job creation, meeting climate goals, etc.
- Identification of internal and external factors with the potential to impact (positively or negatively) the implementation of Industry 5.0 in rail industry. Such factors may include:

[154] https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/industry-50_en

worker acceptance of advanced technology, community engagement, and the potential for inequalities.

- Progress and benefits measurement: develop a framework for the measurement of progress towards the implementation of the Industry 5.0 in the rail sector within its three main dimensions: safety, reliability and efficiency.

- Recommendations for pilot projects showcasing the implementation of Industry 5.0 principles and leading towards a human centric rail system.

Interactions with other EU-RAIL projects:

The action to be funded under this topic shall:

- Take into account the outputs from EU-RAIL Flagship areas 1,2,3,4,5 and 6 if relevant to the studies.

HORIZON-JU-ER-2025-EXPLR-02 : STUDIES ON INNOVATION IN CLIMATE FINANCE FOR RAIL

Expected EU contribution	EU-Rail estimates that an EU contribution 0.6 million EUR would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amount
Indicative budget	The total indicative budget for the topic will be 0.6 million EUR. Applicant Private[155] Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.26352 times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Technology Readiness Level	Activities are expected to be of low TRL1, with possible technology concept formulated at TRL2, higher TRL are also possible – see General Annex B for a guide to the TRL definitions and criteria to be used.
Indicative project duration	30 months. This does not preclude submission and selection of a proposal with a different project duration
Type of Action	RIA (Research and Innovation Action)
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies, with the following exception: the limit for a full Research and Innovation Action application is set to 70 pages.
Special skills	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the topic.

[155] As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

and/or capabilities expected from the Applicant(s)	The applicants are expected to gather expertise leveraging from the knowledge of Academia and of the rail supply industry, SMEs and start-ups. In addition, applicants should leverage from the expectations of the end users, in the horizon 2030, considering the R&I contribution and vision from the EU-Rail Master Plan and Multi-Annual Work Plan.
Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025) [https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]
Award criteria additional details	The award criteria included in part D of the General Annexes of the Horizon Europe Work Programme 2023-2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.

Expected Outcome

The EU's goal set by the European Green Deal is to achieve net-zero emissions by 2050. Railways are an essential component for transport decarbonisation and while technological developments would help rail to become more competitive and attractive, significant investment would be needed in the coming years to implement the successful outcome of EU-Rail innovations. In order to achieve this ambitious goal, exploring ways to unlock new financing sources and mechanisms to support sustainable railway development is of key importance.

Key expected outcomes of this Research and Innovation Actions shall include the development of new knowledge with the identification of the key challenges, drivers, and expected measurable outcomes/benefits of implementing the new concepts of environmental economy. More specifically, the studies can include:

- Identifying strategies to leverage green bonds and sustainability-linked financing instruments for railway projects. This includes investigating solutions for an increased use of "carbon credits" by rail companies as a means to generate revenue and contribute to meeting climate targets in Europe.
- Researching and provide recommendations for standardised methodologies for measuring and verifying greenhouse gas emission reductions from rail investments to facilitate access to carbon markets and results-based climate finance. Consideration of EU Taxonomy, as well as in-depth clarification of avoided emissions from modal shift should be part of the research.
- Develop reporting guidelines enabling the alignment with Corporate Sustainability Reporting Directives (CSRD) regarding the climate finance instruments.
- Analysis of current climate financing criteria and provide recommendations for bridging the gaps and better accommodate rail projects in order to encourage the investment and use of low-carbon transport modes. Provide where relevant policy recommendations.

Scope

The study should aim to provide actionable recommendations to help railways to access the growing pool of climate finance to support their transition to low-carbon, climate-resilient transport system , and can include the following:

- Conducting a comprehensive review of existing green financing instruments and their applicability to the rail sector, identifying key barriers and opportunities for increased uptake.
- Analysing the investment criteria and processes, and identifying strategies for an increased utilization of carbon credits by rail companies, as means to offset emissions, generate revenue, etc. This includes the investigation of innovative approaches to aggregate and scale up smaller rail initiatives, to meet minimum investment thresholds for climate finance. Explore the possibility of innovative financing structures as well that blend public, private and climate-specific funding sources to maximize investment in low-carbon rail infrastructure and operations. The study shall provide actionable and data-driven recommendations for the rail industry, to assist them in their decision making towards identification and implementation of decarbonization strategies capturing sustainable finance opportunities.
- Providing guidelines/recommendations for harmonising processes for monitoring, reporting and evaluation across European rail companies of accurate gas emissions measurements. The aim of these is to enable the progress towards achieving the decarbonization goals, while providing clear, easy to follow instructions regarding: regulatory requirements; access to financing channels; integration of climate-related considerations into corporate strategy and operations.
- Investigating the contribution and opportunities of climate finance instruments in enabling the transition towards rail passenger and freight transport from other less green transport modes, as a key step in achieving the EU green deal objectives. Provide recommendation for bridging the gaps in terms of policies, regulations, and incentives fostering the investments and use of low-carbon transport modes and in particular for rail fostering the market take-up of novel technologies and solutions into the existing European rail network and systems.

Gender dimension

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-JU-ER-2025-EXPLR-03: EXTENDING THE RAIL NETWORK OF PHDS

Expected EU contribution	The Europe´s Rail Joint Undertaking estimates that an EU contribution of EUR 1 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic will be 1 million EUR Applicant Private Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.26352 times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Indicative project	No indication given, applicants should indicate the most appropriate period for the

duration	action, in particular in relation to the PhD works
Technology Readiness Level	Activities are expected to be of low TRL1, with possible technology concept formulated at TRL2, higher TRL are also possible – see General Annex B for a guide to the TRL definitions and criteria to be used.
Type of Action	RIA (Research and Innovation Action)
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies, with the following exception: the limit for a full Research and Innovation Action application is set to 70 pages.
Special skills and/or capabilities expected from the Applicant(s)	EU-Rail expects proposals to be submitted by consortia that consider PhD researchers/doctorships in the area of works of the topics presented in the Call text or in other scientifically relevant areas. Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the topic. The applicants are expected to gather expertise leveraging from the knowledge of Academia and of the rail supply industry, SMEs and start-ups. In addition, applicants should leverage from the expectations of the clients, in the horizon 2030, considering the R&I contribution and vision from the EU-Rail Master Plan and Multi-Annual Work Plan.
Linked Projects	As specified in section 2.3.8.1 of the Work Programme, to facilitate the contribution to the achievement of the EU-Rail objectives, the options regarding 'linked actions' of the EU-Rail Model Grant Agreement and the provisions therein, is enabled in the corresponding EU-Rail Grant Agreements. The action that is expected to be funded under this topic will be complementary to the action : • Academics4Rail (GA 101121842) • PhDs EU-Rail (GA 101175856) • The action that is expected to be funded under the following topic : HORIZON-JU-ER -2025-FA4-01: A sustainable and green rail system Please note that the list is non-exhaustive as additional Linked Projects may follow at a later stage of the programme implementation to complement the activity
Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025) [https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]
Award criteria additional details	The award criteria included in part D of the General Annexes of the Horizon Europe Work Programme 2023-2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.

Expected Outcome

With this Research and Innovation Action, the Europe's Rail Joint Undertaking intends further extend the rail research and innovation "community" (cooperation/network/alliance) of scientific research entities (cooperation/network) that was initiated with the award of the EU-Rail project Academics4Rail (GA 101121842) and continued with PhDs EU-Rail (GA 101175856).

The expected outcome is also the realisation of 3-5 PhD positions, teaming up with the industry.

To apply under this Call topic, the related entities are requested to establish a Consortia with the aim to promote fruitful collaboration and share of knowledge on any topics in the area of works related to the EU-Rail Programme[156]or relevant in the context of other European rail research and innovation activities. In doing so, exchanges should also be identified with the linked project.

Scope

In order to achieve the expected outcomes described above, proposals shall consist of the creation of at least 3 – 5 PhDs positions. It is expected that the PhD programmes stemming from this topic will have the possibility to interact with the Funding Members of the Europe's Rail JU. The PhD researchers are expected regularly to liaise with the Europe's Rail JU and to present their research findings to the Europe's Rail JU events and submit scientific papers to relevant conferences (e.g. TRA, WCRR, etc. but also non-rail related). This action may be requested to provide relevant inputs to the Europe's Rail Scientific Steering Group and ERRAC. The Europe's Rail Joint Undertaking expects to finance successful proposals from universities or similar high-level institutes covering each at least one PhD student in the following proposed areas or additional or different scientific areas to be proposed, always in relation to the EU-Rail Programme:

PhD Topic –Low-Height Noise Reduction Barriers in Rail Transport

Rail operations can have a significant negative impact on the environment in general, but mostly on the residents living around rail corridors or urban / sub-urban metro lines.
The expected outcomes for this research topic shall include the investigation of relevant noise reduction techniques, design, construction and validation requirements for low-height noise barriers solutions in the rail sector as follows:

- **Critical design and implementation parameters for Low-Height Noise Barriers.** These parameters must take into consideration the location for the installation of such barriers (i.e. as close to the track as allowed by the safety regulations) , the maximum reduction of noise generated by the trains operating in that area, , providing the most advantageous cost/benefit for such solutions.
- **Model the dependencies between various heights and materials for such solutions and the Noise Reduction levels and noise propagation.** This research should investigate the impact of various barrier heights and material types on the noise reduction levels and the noise propagation models.
- **Identification of sustainable materials for low height noise barrier solutions.** This topic shall explore the use of materials that align with circular economy principles and contribute to meeting the greener transport targets around Europe, while meeting the rail safety requirements. Such solutions may include plant-based barriers, hedges or bushes, which could provide additional environmental benefits.
- **Additional Benefits of Low-Height Barriers** This topic shall assess the secondary benefits of low-height noise barriers. These may include: improved living conditions for residents living next to rail corridors due to reduced rail noise levels; enhanced train passengers experience due to unobstructed views; better on site visibility, leading to better facilitation of rescue operations; improved site accessibility for rail maintenance, etc
- **Cost-Benefit Analysis** This research shall build a solid cost-benefit analysis of various low-height barrier solutions in comparison with the traditional noise barriers. This analysis shall consider all the relevant aspects and benefits for these noise reduction solutions, including: reduced material usage, lower complexity, lower costs, lower manufacturing time, etc.
- **Constructability and the impact on Landscape Aesthetics** The research scope may be combined with any of the above topics. The outcome of this topic shall provide an

[156] https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/

evaluation of the impact of low-height noise barriers on the landscape aesthetics, including the benefit of less visual disruption compared to taller barriers, as well as their constructability and the suitability of their installation in various areas of the rail corridors.

The outcomes of the PhD research topics mentioned above shall also address the following aspects for the low height noise barriers in the rail industry:

- Provide justified actionable insights and recommendations for the design, implementation, adoption
- Detail the benefits and benefits measurements models proving their cost-effectiveness, environmental sustainability, social impact, etc.

PhD Topic – smart grids and micro smart grids in the railway system

The transition towards a sustainable energy efficient multimodal European transport system has been the driver for emerging technologies in the railway sector, such as smart grids and micro smart grids. Such innovations support a more diverse and effective energy supply and demand management in the rail sector while integrating renewable energy sources and optimizing energy consumption in the rail sector. Another area of interest is the elimination of the dependency of the rail energy supply on other external sources by exploring solutions for the integration of less conventional energy sources in the rail electrical power supply network such as hydrogen, etc.. It is expected that the integration of these technologies will improve the efficiency of the rail power supply while reducing greenhouse gas emissions and long-term operational costs, in line with the European Green Deal objective to reach climate neutrality by 2050.

The expected outputs of the proposals under this PhD topic should investigate approaches for systematic analysis of various energy technologies to be integrated in the rail supply network, an effective energy management , challenges, risks and associated controls, as well as solutions to address the technological, regulatory and economic impacts. The relevant areas of focus for these proposals shall cover the following:

- Energy Market Segment Analysis in the Concept of Smart Grids and Micro Smart Grids for Railways. This shall be a first research stage and shall analyse the current market status of smart grids and micro smart grids in the rail sector based on the outputs of EU-RAIL JU's Flagship Area 4 (FA4) be considered in this section[157]. The outcome of this research shall provide the results of the scientific-technical analysis regarding the possible solutions for the integration and/or replacement of 'As Is' rail power supply sources with emerging energy technologies. The analysis shall include technical and economic viability of such solutions. The analysis shall be based on operational concepts, maintenance requirements, technology lifespan, and shall include an assessment of the economic impact on major railway players (i.e. Infrastructure Managers, Railway Undertakings, etc.).
- Impact assessment of new power supply sources/technologies on the current Regulatory Framework and its capacity to adapt to energy innovations in railways. This research topic shall analyse the impact of the current technical and legal regulations on a traditional rail supply network integrated with the renewable energy sources as per the relevant topics above. This analysis shall map the transition towards a self-sustained and green(er) railway energy supply, also taking into consideration the impact on the global energy grid.

[157] https://rail-research.europa.eu/rail-projects/fp4-rail4earth/

- Commercialization and Standardization Roadmap for a self-sustained, integrated rail power supply grid. This topic shall investigate appropriate governance models for such a rail power supply grid and its efficient management, commercialization and standardization. The outcomes of this research shall include proposed solutions for feasible regulatory commercial frameworks for the rail energy market operations, identify the key players in both the railway and energy sectors, opportunities, challenges and risks in case of a large-scale deployment.

The outcome of the PhD should provide a series of practical and theoretical recommendations for deriving a model that could influence energy, regulatory, and technological development for the future of sustainable railway transport.

Other and different PhD subjects can be proposed by the applicants.

Research results are expected to contribute to the Europe's Rail Programme and explore new possibilities and ideas. At the same time, the PhD researchers who are part of the Europe's Rail JU activities, are expected to become European ambassadors of the possible bright and innovative future that the rail sector has in the years to come.

Interactions with other EU-RAIL projects:

The action to be funded under this topic shall interact with PhDs EU-Rail (GA 101175856) and Academics4Rail (GA 101121842) in order to exchange within the community of scientific research and to growth the PhD subjects and interaction with industrial partners, as well as with the action that is expected to be funded under the following topic : HORIZON-JU-ER-2025-FA4-01: A sustainable and green rail system.

HORIZON-JU-ER-2025-EXPLR-04: SUPPORT TO THE EUROPEAN FRMCS DEPLOYMENT GROUP

Expected EU contribution	The Europe´s Rail Joint Undertaking estimates that an EU contribution of EUR 0.7 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic will be 0.7 million EUR Applicant Private Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.26352 times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified. In this respect, the grant agreements will set, in principle, annual deliverable on in-kind contributions for the projects selected under this topic, as well as mandatory reporting requirements, for those applicants who are Private Members of EU-Rail.
Indicative project duration	24 months. This does not preclude submission and selection of a proposal with a different project duration.
Type of Action	Coordination and support actions (CSA)
Admissibility conditions	Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2025 General Annexes applies, with the following exception: the limit for a full Coordination and Support Action application is set to 70 pages.
Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the topic. The applicants are expected to gather expertise leveraging from the knowledge of the rail sector considering the R&I contribution and vision from the EU-Rail Master Plan and Multi-Annual Work Plan.
Linked Projects	As specified in section 2.3.8.1 of this WP 2025/2026, in order to facilitate the contribution to the achievement of the EU-Rail objectives, the options regarding 'linked actions' of the EU-Rail Model Grant Agreement and the provisions therein, is enabled in the corresponding EU-Rail Grant Agreements. The action that is expected to be funded under this topic will be complementary to the following projects: - FP2-R2DATO (GA number: 101102001) - FP2-MORANE-2 (GA number: 101196125) The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics: - HORIZON-JU-ER-2025-FA2-01: Digital & Automatic up to Automated Train Operations Please note that the list is non-exhaustive as additional Linked Projects may follow at a later stage of the programme implementation to complement the activity.
Funding of only one project per topic	EU-Rail may award up to one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.

Retroactive starting date of the grant	The starting date of grants awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible.
Lump Sum grant	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025) [https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf]
Award criteria additional details	The award criteria included in part D of the General Annexes of the Horizon Europe Work Programme 2023-2025 are complemented with additional criteria as specified in Annex VIII to this Work Programme.

Expected Outcome

To facilitate the smooth deployment of innovations and architectures, EU-RAIL has set-up a High-Level Deployment Group. This Group established in 2024 a dedicated FRMCS Deployment Subgroup to focus specifically on FRMCS future deployment activities, drawing upon insights and results from the sector plans, activities as well as EU-Rail test and demonstration initiatives.

The current railway telecommunications system, GSM-R, is based on 3GPP 2G technology and is rapidly becoming obsolete. Railway telecommunications manufacturers have indicated that GSM-R networks, components, and technical support will begin to phase out from 2030 onwards. The CCS TSI 2023 sets a specific implementation rule that there is a minimum notification period of 5 years to turn off GSM-R on a specific track. In recent years, the railway sector has been actively engaged in the development of a new telecommunications system. This new system is mission-critical to ensuring the safe operation of railways. While it will continue to support current functionalities such as voice and data transmission, it will also introduce new capabilities essential for future applications. .

Following the (still ongoing) development of functional and system requirements, EU-RAIL launched a test and demonstrator programme through the EU-RAIL Flagship Project FP2- MORANE2 (GA number: 101196125), which is dedicated to the execution of both lab and field testing to validate the FRMCS specifications.

EU-RAIL System Pillar, will produce an updated report, with commitment of the whole Railway sector, including scope of the FRMCS specifications that will be integrated in TSI and used by the sector to procure/develop the related solutions.

The EU-RAIL FRMCS deployment subgroup is tasked with addressing broader issues related to FRMCS future deployment and implementation. The urgency stems from the railway sector's view that the future availability of telecommunications presents a high-risk challenge. As a result, the sector strongly prioritizes the timely introduction of new 5G-based technology. This should be achieved within the shortest possible timeframe for upgrading existing equipment, while adhering to a European-level synchronisation strategy, taking into account both operational limitations and the individual starting positions of each Member State

The coordination and supporting action of the project stemming from this topic shall :

- Provide support for the activities of the European FRMCS Deployment Group, ensuring well-organised planning, effective execution, and continuous monitoring of all actions related to deployment.

- More specifically, support the EU-RAIL FRMCS deployment subgroup on the :
    - Analysis of (current) Infrastructure, rolling stock, industry and workshop capacity for (fast, easy and cost effective) deployment. Estimate necessary capacities
    - Definition of sound and acceptable solutions for the acceleration and simplification of authorisation,
    - Delivery of cost analyses, CBA and risk assessments
    - Development of toolbox with diverse migration scenario's (greenfield and brownfield situations)
    - Delivery of analyses of plans/installations of currently dedicated –not aligned- cross-border connection interfaces and of public-private mobile networks interfaces
    - Alignment with other major rail upcoming investments for EU system programmes and cooperation with stakeholders

Scope

The coordination and supporting actions of the project stemming from this topic shall deliver the following:

1. **Programme Management Office (PMO) Functions**
    - Set up and operate a central coordination function to oversee timelines, dependencies, and progress across planning of FRMCS future deployment activities.
2. **Capacity Mapping & Planning Analysis**
    - Develop and distribute sector-wide surveys (by sending out questionnaires) to gather data on deployment plans, readiness, and capacity. Analyse responses and identify gaps and challenges across Member States and cross-border situations.
3. **Independent Cost and Time Driver Study**
    - Conduct a study to assess cost structures and investment drivers relevant to FRMCS implementation across different operational contexts (in particular on-board assets).
    - Conduct relevant Cost Business Analyses.. Analyse main factors that determine the required rollout timeline and measures to optimise those.
4. **Stakeholder Management**
    - Facilitate cooperation among rail and telecom stakeholders, as well as with relevant associations.
5. **Communication & Dissemination**
    - Support targeted communications for the FRMCS Deployment Group and Organise outreach and engagement with the broader sector to raise awareness and share developments.
6. **Deployment Guidelines Toolbox**
    - Support the development a non-binding set of practical guidelines and migration scenarios to support railway undertakings and infrastructure managers in their transition to FRMCS.
7. **Expertise & Technical Support**

- Provide subject-matter expertise on key domains including, but not exclusive: System authorisation, Cybersecurity, RAMS (Reliability, Availability, Maintainability, and Safety)

8. **European Deployment Dashboard**
    - Support the establishment and maintenance an online dashboard to: Report on deployment readiness and progress and rack national initiatives and alignment with European goals
9. **Knowledge Sharing and Acceleration**
    - Gather and share test results, best practices, and lessons learned and promote early implementation and innovation in FRMCS assets.
10. **Risk & Deviation Management**
    - Support the development of frameworks for identifying, reporting, and mitigating risks and deviations across the deployment chain.
11. **Develop market readiness**
    - Support the identification of measures needed to be address by the market for ensure a swift FRMCS deployment. This activity should be framed in the context of the anticipated short time frame to conduct the migration from GSM-R to FRMCS that may lead to a high demand on scarce resources in different fields.

The coordination and supporting actions will support measure aimed at ensuring that the future FRMCS deployment will progress smoothly, consistently, and efficiently across Europe—aligning sector-wide objectives, addressing operational and financial risks, and laying the foundation for the future of digital railway telecommunications.

Interaction with the Flagship Area 2, System Pillar and Deployment Group
The action to be funded under this topic shall foresee strong interaction with and support to the EU-RAIL High-Level and its FRMCS Deployment Subgroup.

The action to be funded under this topic shall foresee strong interaction with the projects included in the Flagship Area 2.

The action to be funded under this topic shall exchange regularly with the EU-RAIL System Pillar especially on the interface between the System Pillar Task 2 activities and the EU-RAIL FRMCS Deployment Subgroup.

Gender dimension
In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

3. Call: HORIZON- JU-ER-2026-01 (indicative)

HORIZON-JU-ER-2026-EXPL-01-SNS: EU-RAIL – SNS SYNERGY: EXPLOITABILITY OF 6G IN AUTONOMOUS MOBILITY

The topic text will be further developed at successive stage in cooperation with SNS JU and pending synergy agreement, provided here as indicative topic.

Additionally, possible FA6/FA7 related topics are expected to be included in the HORIZON-JU-ER-2026-01, pending WP2026 adoption and budget availability.

Annex VII – List of Private Founding Members of the Europe's Rail Joint Undertaking

	NAME OF MEMBER	REGISTRATION DETAILS
1	Administrador de Infraestructuras Ferroviarias (ADIF), Entidad Pública Empresarial	public corporate company registered under Spanish law (registration number: Q2801660H), with its registered office at Calle Sor Ángela de la Cruz, 3, 28020 Madrid, Spain
2	Alstom Transport SA	registered under French law (registration number 389 191 982), with its registered office in 48, rue Albert Dhalenne, 93482 Saint-Ouen, France
3	ANGELRAIL consortium led by MER MEC S.p.A.	registered under Italian law (registration number: 05033050963), with its registered office in Via Oberdan 70, 70043 Monopoli (BA), Italy
4	AŽD Praha s.r.o.	registered under Czech law (registration number: 48029483), with its registered office in Žirovnická 3146/2, Záběhlice, 106 00, Praha 10, Czech Republic
5	Construcciones y Auxiliar de Ferrocarriles, S.A. (CAF)	registered under Spanish law (registration number: Volume 983, Folio 144, Sheet number SS-329, entry 239ª), with its registered office in calle José Miguel Iturrioz nº 26, 20200, Beasain (Gipuzkoa), Spain
6	Asociación Centro Tecnológico CEIT	registered under Spanish law (registration number: 28/1986 Registry of Associations of the government of the autonomous community of the Basque Country), with its registered office in Paseo Manuel Lardizabal, nº 15. Donostia-San Sebastián, Spain
7	České dráhy, a.s.	registered under Czech law (registration number: 70994226, entered in the Commercial Register kept by the Municipal Court in Prague, section B, insert 8039), with its registered office in Prague 1, Nábřeží L. Svobody 1222, postal code 110 15, Czech Republic
8	Deutsche Bahn AG	established in Potsdamer Platz 2, 10785 Berlin, Germany
9	Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)	registered under German law (registration number: VR 2780 at Amtsgericht Bonn), with its registered office in Linder Höhe, 51147 Cologne, Germany
10	European Smart Green Rail Joint Venture (eSGR JV), represented by Centro de Estudios de Materiales y Control de Obra S.A (CEMOSA)	registered under Spanish law (registration number: A-29021334), with its registered office in Benaque 9, 29004 Málaga, Spain
11	Faiveley Transport SAS	registered under French law (registration number 323 288 563 RCS Nanterre), with its registered office in 3, rue du 19 mars 1962, 92230 Gennevilliers, France
12	Ferrovie dello Stato Italiane S.p.A. (FSI)	registered under Italian law (registration number: R.E.A. 962805), with its registered office in Piazza della Croce Rossa 1, 00161 Roma, Italy
13	Hitachi Rail STS S.p.A.	registered under Italian law, registration number R.E.A. GE421689, with its registered office in Genova, Italy
14	INDRA SISTEMAS S.A & PATENTES TALGO S.L.U.:	

	NAME OF MEMBER	REGISTRATION DETAILS
	INDRA SISTEMAS S.A.	registered under Spanish law (registration number: A-28599033), with its registered office in Avenida de Bruselas nº 35, 28108 Alcobendas, Madrid, Spain
	PATENTES TALGO S.L.U.	registered under Spanish law (registration number: B-84528553), with registered office in Paseo del tren Talgo, nº 2, 28290 Las Rozas de Madrid, Madrid, Spain
15	Jernbanedirektorate (Norwegian Railway Directorate)	established in Biskop Gunnerus gate 14A, 0185 Oslo, Norway
16	Knorr-Bremse Systeme für Schienenfahrzeuge GmbH	registered under German law (registration number: HRB91181), with its registered office in Moosacher Str. 80, 80809 München, Germany
17	Österreichische Bundesbahnen-Holding Aktiengesellschaft (ÖBB-Holding AG)	registered under Austrian law (registration number: FN 247642f), with its registered office in Am Hauptbahnhof 2, 1100 Wien, Austria
18	Polskie Koleje Państwowe Spółka Akcyjna (PKP)	registered under Polish law (registration number: 0000019193), with its registered office in Aleje Jerozolimskie 142A, 02-305 Warszawa, Poland
19	ProRail B.V. & NS Groep N.V.	
	ProRail B.V.	registered under Dutch law (registration number: 30124359), with its registered office at Moreelsepark 3, 3511 EP, Utrecht, The Netherlands
	NS Groep N.V.	registered under Dutch law (registration number: 30124358), with its registered office at Laan van Puntenburg 100, 3511 ER, Utrecht, The Netherlands
20	Siemens Mobility GmbH	registered under German law (registration number HRB 237219), with its registered office in Otto-Hahn-Ring 6, 81739 Munich, Germany
21	Société nationale SNCF, société anonyme	registered under French law (registration number: 552 049 447), with its registered office in 2 Place aux Étoiles, 93200 Saint-Denis, France
22	Strukton Rail Nederland B.V.	registered under Dutch law (registration number: 30139439 Chamber of commerce Utrecht), established in Westkanaaldijk 2, Utrecht Postbus 1025, 3600 BA Maarssen, The Netherlands
23	THALES SIX GTS France SAS	registered under French law (registration number: 383 470 937), with its registered office in 4 Avenue des Louvresses, 92230 Gennevilliers, France
24	Trafikverket, a Public Sector Body	registered under Swedish law (registration number: 202100-6297), with its registered office in 781 89 Borlänge, Sweden
25	Voestalpine Railway Systems GmbH	registered under Austrian law (registration number: FN 126714w), with its registered office in Kerpelystrasse 199, 8700 Leoben, Austria

Annex VIII – 2025 Call for proposals – Evaluation Criteria

Part D of the Horizon Europe Work Programme 2023-2025 General Annexes applies regarding the award criteria, scores and weighting upon which the proposals will be evaluated, with the following addition:

- Under the criteria "Excellence", "quality of the proposed joint activities to achieve the deliverables"
- Under the criteria "Impact", "quality and credibility of the action to contribute achieving the EU-Rail Master Plan objectives and the expected impact of the EU-Rail Multi-Annual Work Programme".
- Under "quality and efficiency of the implementation", "Appropriateness of the project management structure and quality of the proposed coordination".

	Excellence[158]	**Impact**	**Quality and efficiency of the implementation**
Research and innovation actions (RIA) Innovation actions (IA)	• Clarity and pertinence of the project's objectives, and the extent to which the proposed work is ambitious and goes beyond the state of the art. • Soundness of the proposed methodology, including the underlying concepts, models, assumptions, inter-disciplinary approaches, appropriate consideration of the gender dimension in research and innovation content, and the quality of open science practices, including sharing and management of research outputs and engagement of citizens, civil society and end-users where appropriate. • **Quality of the proposed joint activities to achieve the deliverables.**	• Credibility of the pathways to achieve the expected outcomes and impacts specified in the work programme, and the likely scale and significance of the contributions from the project. • Suitability and quality of the measures to maximise expected outcomes and impacts, as set out in the dissemination and exploitation plan, including communication activities. • **Quality and credibility of the action to contribute achieving the EU-Rail Master Plan objectives and the expected impact of the EU-Rail Multi-Annual Work Programme**	• Quality and effectiveness of the work plan, assessment of risks, and appropriateness of the effort assigned to work packages, and the resources overall. • Capacity and role of each participant, and the extent to which the consortium as a whole brings together the necessary expertise. • **Appropriateness of the project management structure and quality of the proposed coordination.**

[158] The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme.

	Excellence[159]	Impact	Quality and efficiency of the implementation
Coordination and support action (CSA)	• Clarity and pertinence of the project's objectives. • Quality of the proposed coordination and/or support measures including soundness of methodology. • **Quality of the proposed joint activities to achieve the deliverables.**	• Credibility of the pathways to achieve the expected outcomes and impacts specified in the work programme, and the likely scale and significance of the contributions from the project. • Suitability and quality of the measures to maximise expected outcomes and impacts, as set out in the dissemination and exploitation plan, including communication activities. • **Quality and credibility of the action to contribute achieving the EU-Rail Master Plan objectives and the expected impact of the EU-Rail Multi-Annual Work Programme**	• Quality and effectiveness of the work plan, assessment of risks, and appropriateness of the effort assigned to work packages, and the resources overall. • Capacity and role of each participant, and the extent to which the consortium as a whole brings together the necessary expertise. • **Appropriateness of the project management structure and quality of the proposed coordination.**

[159] The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme.

Annex IX – List of Associated Members of the Europe's Rail Joint Undertaking

The list of Associated Members as a result of the "Call for expression of interest with a view to selecting associated members with the potential to contribute to the achievement of the objectives of the Europe's Rail Joint Undertaking" adopted by the Governing Board on 21 June 2024 (GB Decision n° 09/2024):

NAME OF ASSOCIATED MEMBER		REGISTRATION DETAILS
1	Frequentis AG	Joint-stock corporation established under Austrian law, with its registered office in InnovationsstraBe 1, 1100 Vienna, Austria
2	ACCIONA Construcción S.A	Private company established under Spanish law (tax number A81638108) with its registered office in Calle Mesena 80-28003 Madrid, Spain
3	Kontron Transportation GmbH	Limited liability company established under Austrian law, with its registered office in Lehrbachgasse 11, A-1120 Vienna, Austria
4	IP – Infraestruturas de Portugal S.A.	Alliance of 8 organisations represented by IP – Infrastruturas de Portugal S.A.: - IP-Infrastruturas de Portugal S.A.: public limited company established under Portuguese law, with its registered office in Praça da Portagem, 2809-013, Almada, Portugal - CP – Comboios de Portugal, EPE: public corporate entity established under Portuguese law, with its registered office in Calçada do Duque, Nº 20 1249-109, Lisboa, Portugal - Evoleo Technologies, Lda.: limited liability company established under Portuguese law, with its registered office in Rua Gonçalo Mendes da Maia 1350 1ºH, 4425-656, Maia, Portugal - ISQ - Instituto de Soldadura e Qualidade: non-profit private legal entity of public utility established under Portuguese law, with its registered office in Taguspark, Talaíde, Av. Prof. Dr. Cavaco Silva, 33, 2740-120, Porto Salvo, Portugal - ISEP – Instituto Superior de Engenharia do Porto: institution established under Portuguese law, with its registered office in

		Rua Dr. António Bernardino de Almeida, 431, 4249-015, Porto, Portugal - IST – Instituto Superior Técnico: public institution of higher education, with its registered office in Avenida Rovisco Pais, 1, 1049-001, Lisboa, Portugal - SOLVIT, Innovation & Development on Telecommunications, Lda.: private company established under Portuguese law, with its registered office in Rua de Baixo de São Pedro, 37, 9700-025, Angra do Heroísmo, Portugal - Universidade do Porto, through Faculdade de Engenharia do Porto: public foundation established under Portuguese law, with its registered office respectively in Praça Gomes Teixeira, s/n, 4099-002, Porto, and Rua Dr. Roberto Frias, s/n 4200-465, Porto, Portugal
5	XLAB d.o.o	Alliance of 3 organisations represented by XLAB d.o.o.: - XLAB d.o.o.: limited liability company established under Slovenian law, with its registered office in Pot za Brdom 100, Ljubljana, Slovenia - Vías y Construcciones S.A. (VIAS): private company established under Spanish law, with its registered office in Avenida Camino de Santiago 50, Fuencarral-El Pardo 28050, Madrid, Spain - Slovenske železnice (SZ): national operator, established in Kolodvorska 11, Ljubljana, Slovenia