

WORK PROGRAMME 2024

Amendment n°1

***adopted by the EU-Rail Governing Board on 14 February
2024***

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 SUCCESSOR

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.

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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

Acronym/ Abbreviation	Full Title
ETCS	European Train Controlling System
EU	European Union
EU-Rail	Europe's Rail Joint Undertaking
FACTs	Flexible AC Transmission Systems
FDFTO	Full Digital Freight Train Operations
FFIS	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 Security 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 2024 (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 first results of the 2022 Flagship Projects, including the achievement of the planned milestones, in preparation for the demonstration activities of 2025 and 2026,
 - the ramp-up, following the conclusion of the grant agreements in 2024, of the projects resulting from the Call 2023-1 that as part of the Integrated Programme complement the Flagship Projects with additional Exploratory research activities and enlarge the horizon of rail ability to serve European citizen with the development of tools, digital platforms and services for a better integration of aviation and railway transport modes, in collaboration with SESAR 3 JU,
 - the launch of the Call 2024-1 during Q1 2024, followed by the conclusion of the grant agreements, to create new opportunities for inclusiveness and participation, enlarging the Flagship Projects with additional anticipated activities of the related Flagship Areas, as well as provide a platform for more disruptive innovation linked to hyperloop technologies and concepts,
 - the System Pillar:
 - delivering, building upon the first results of the System Pillar Tasks and Domains, the first Standardisation and TSI Input plan to the European Commission and verify in the mid of 2024 the results on the new mandate to allow a continuation of the activities and a clear prioritisation of the expected implementation of harmonised results,
 - launching the activities to be undertaken in the second half of 2024, as well as preparing the outline of the activities to be performed in 2025,
 - the Deployment Group:
 - the operationalisation of the high-level and topical working group(s), following the GB decision for their creation, 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 preparation of a call for expression of interest to select Associated Members, in accordance with articles 7 and 87(1) point c of the SBA , to be launched by the JU by the end of the first half of 2024, after having made an in-depth assessment of the EU-Rail Programme, an update of the Multi-Annual Work Programme (MAWP), and after identifying possible gaps to be filled by new entities’ commitment.
- the R&I activities related to the projects launched in the previous years under the S2R Programme. The focus will be on the contractual closing of the H2020 project activities, having

achieved its targets, and exploit where relevant their positive results in the new EU-Rail Programme.

The EU-Rail Programme aims at contributing to the ambitious targets of the “Sustainable and Smart Mobility Strategy” of the European Commission¹, building upon the many results already achieved and those finalized 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.

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 2024 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 2024, 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 2024 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 2024 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, the 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.

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

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

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 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 SBA⁵. 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 intends to launch during the first half of 2024 a call for expression of interest with a view to selecting Associated members in accordance with Article 7 of the SBA, after having performed an in-depth review of the areas where such type of membership would bring added value to the R&I Programme.

Furthermore, in line with Article 19(4)(v) SBA, EU-Rail will in the upcoming period expand its 2023 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, by reflecting on potential scenarios for the future evolution of the JU including new activities to be performed after the current Europe's Rail integrated Programme under suitable framework conditions. However, the preparation of the phasing-out plan as such will have no impact whatsoever on the actual decision whether the rail sector will have a (re)newed partnership with the EU under the next Framework programme for Research and Innovation.

Work on the update of the EU-Rail Multi-Annual Work Plan will also continue in 2024 with the assistance of the ED System and Innovation Programme Board.

1.2 Mission statement of EU-Rail

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

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

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).

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

⁶ https://rail-research.europa.eu/wp-content/uploads/2020/12/RAIL-Strategic-Research-and-Innovation-Agenda-2020-FINAL_dec2020.pdf

- 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 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 in 2024, 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, TRL 8/9.

The System Pillar activities

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 2024

2.1 Message from the Executive Director a.i.

Following an intense year of running two Programmes and closing the Shift2Rail R&I operational activities largely according to plan and in advance to the end date of 31 December 2024, the Europe's Rail JU, its Programme office, and its Members will focus in 2024 to open up the Programme with new synergy R&I activities, new Members, new proposals for standard items and common approaches, and the operationalisation of its Deployment Group.

2024 is the year that will earmark the first joint project⁷ between two Joint Undertakings in the field of traffic management, SESAR 3 JU⁸ and EU-Rail, demonstrating real synergies in EU Programmes and funds, but especially driving the R&I towards a user-oriented approach, where rail retains its role of backbone of transport and mobility and cooperates and works with other transport modes to ensure attractive, innovative and tailor-made rail services.

EU-Rail has also teamed up with another Joint Undertaking, SNS JU⁹, setting up a joint topic call for the testing and operational validation of the next EU rail communication system. The next EU rail communication system is a key enabler for further innovation that has been added to the EU-Rail Programme, building up on activities previously performed within different organisations, outside the European Union governance. The sector and the Commission have entrusted EU-Rail to drive and to ensure as from 2024 the rail system ability in embracing this new solution, with R&I through the activities of its Innovation Pillar, with preparation for TSI updates with its System Pillar, and with migration planning and deployment recommendations with its Deployment Group. It is a cooperative work to be done with the European Union Institutions and Bodies for policy setting, including ERA, with the rail sector and in particular working with the organisations having heavily invested in FRMCS¹⁰, with the telecommunication sector, with the JU private Members contributing with additional in-kind activities, and with many other researchers contributing to the EU-Rail Programme under Horizon Europe.

Following the successful Space for Innovation in Rail event in 2023¹¹ under the Spanish Presidency of the Council of the European Union, EU-Rail will operationalise in 2024 in a concrete project its cooperation with EUSPA¹², and ESA¹³, under the strategic leadership of the Commission and in full coordination with ERA¹⁴, for delivering through R&I the technical and operational elements to reach competitive and resilient satellite-based rail services.

Additionally, in the Greening Freight Transport communication¹⁵ 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.

⁷ subject to the successful outcome of the call proposals evaluation and GB decision

⁸ <https://www.sesarju.eu/>

⁹ <https://smart-networks.europa.eu/>

¹⁰ <https://uic.org/rail-system/telecoms-signalling/frmcs>

¹¹ <https://rail-research.europa.eu/calendar/space-for-innovation-in-rail-towards-satellite-based-ertms/>

¹² <https://www.euspa.europa.eu/>

¹³ <https://www.esa.int/>

¹⁴ <https://www.era.europa.eu/>

¹⁵ https://transport.ec.europa.eu/system/files/2023-07/COM_2023_440.pdf

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 Area¹⁶, 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 and also prepare the ground in 2024, 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.

In 2024, EU-Rail increases and anticipates its planned R&I activities with new call topics on the Flagship Area on Digital & Automated up to Autonomous Train Operations and on the Flagship Area Sustainable Competitive Digital Green Rail Freight Services. This additional effort is expected to lead to a faster increase in competitiveness and attractiveness of the rail sector, and its European industries worldwide, that can contribute to deliver upon the Union policy expectations. Furthermore, EU-Rail continues to support disruptive innovations in 2024, with the launch of a topic covering new approaches for guided transport modes, on hyperloop.

The planned update of the Multi-Annual Work Programme, the identification of possible R&I areas gaps and the acceleration of some Flagship Area efforts calls upon the launch of the open and transparent call for Associated Members, in accordance with Article 87(c) of the SBA. The year 2024 will therefore be also dedicated to the preparation and launch of a call for expression of interest for the selection of Associated Members.

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.*

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.

¹⁶ https://transport.ec.europa.eu/system/files/2023-07/COM_2023_443_0.pdf

2.2 Executive Summary 2024

The European Green Deal¹⁷ and the related Roadmap¹⁸, 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 Goals¹⁹. 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"²⁰ 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.

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"²¹.

Further to the topic of "Digital Decade", the Commission indicated in its Communication of March 2021²² 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

¹⁷ https://commission.europa.eu/publications/communication-european-green-deal_en

¹⁸ https://commission.europa.eu/publications/communication-european-green-deal_en

¹⁹ <https://sdgs.un.org/goals>

²⁰ https://eur-lex.europa.eu/resource.html?uri=cellar:5e601657-3b06-11eb-b27b-01aa75ed71a1.0001.02/DOC_1&format=PDF

²¹ https://transport.ec.europa.eu/system/files/2023-07/COM_2023_440.pdf

²² <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52021DC0118>

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 2024 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 first results of the 2022 Flagship Projects, including the achievement of the planned milestones, in preparation for the demonstration activities of 2025 and 2026,
 - ii. the ramp-up, following the conclusion of the grant agreements in 2024, of the projects resulting from the Call 2023-1 that as part of the Integrated Programme complement the Flagship Projects with additional Exploratory research activities and enlarge the horizon of rail ability to serve European citizen with the development of tools, digital platforms and services for a better integration of aviation and railway transport modes, in collaboration with SESAR 3 JU,
 - iii. the launch of the Call 2024-1 during Q1 2024, followed by the conclusion of the grant agreements, to create new opportunities for inclusiveness and participation, enlarging the Flagship Projects with additional anticipated activities of the related Flagship Areas, as well as provide a platform for more disruptive innovation linked to hyperloop technologies and concepts,
 - b. the System Pillar:
 - i. delivering, building upon the first results of the System Pillar Tasks and Domains, the first Standardisation and TSI Input plan to the European Commission and verify in the mid of 2024 the results on the the current request for services to allow a continuation of the activities and a clear prioritisation of the expected implementation of harmonised results,
 - ii. launching the activities to be undertaken in the second half of 2024, as well as preparing the outline of the activities to be performed in 2025,
 - c. the Deployment Group:
 - i. the operationalisation of the high-level and topical working group(s), following the GB decision for their creation, 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 preparation of a call for expression of interest to select Associated Members, to be launched around the end of the first half of 2024, after having made an in-depth assessment of the EU-Rail Programme, an update of the MAWP, and after addressing possible gaps to be filled by new entities' commitment.

2. the R&I activities related to the projects launched in the previous years under the S2R Programme:

The focus will be on the contractual closing of the H2020 project activities, having achieved its targets, and exploit where relevant their positive results in the new EU-Rail Programme.

The Communication activities for 2024 will continue ensuring that the JU's mission and objectives, including the new System Pillar and Deployment Group, are communicated and understood widely. 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 activities.

During 2024 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),
- 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 2024, are at the Call 2024 Info Day to be held in February and the General Assembly of the JU in December. Participation of the JU will be ensured at the following external events: the Connecting Europe Days (Brussels, 2-5 April), the Transport Research Arena (Dublin, 15-18 April), and InnoTrans (Berlin, 24-27 September), and where EU-Rail will share a stand area with DG MOVE and the European Agency for Railways (ERA). Other foreseen participations of EU-Rail include the International Transport Forum (ITF) summit in May and Rail Live in November.

Improvements in the JU's internal communication will be in the focus as well, leveraging on the available IT tools, to boost the flow of information among the staff.

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 2024. 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 for accounting services and procurement are already operational, others 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.

On the field of governance, appointing of the EU-Rail Executive Director is expected in 2024 after the completion of the selection process, who would take over the mandate from the current Executive Director *ad interim*.

In the area of internal control and assurance, EU-Rail will finalize by the end of 2023 and subsequently will start implementing its Horizon Europe risk-based Control Strategy for grants reflecting on the specificities and necessary changes in the control practices to be applied by the JU. These are most notably represented by the 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, and by the introduction of the “maturity checkpoints”.

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 2024

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 four 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 be analysed in 2024, 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 for and provide the coordination and resources to enable sector convergence on common solutions at European level. 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 is 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 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", to be operationalised 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 table below presents a summary of the main activities for the year 2024:

Year 2024	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 (*) (instalment)	Open 2024 values	0.0 68,7	0.0 41,1	0.0 27,6	0.0 53,3	
Call for Proposals – Exploratory Research (**)	open	34,6	21,7 (***)	12,9	0,0	Q1 2024

Year 2024	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	12,9	12,9	0,0	0,0	Q1 – Q4 2024 & implementation of new and ongoing contracts/framework contracts
Operational Experts	Open, including through REA, including new SC	0.4	0.4	0.0	0.0	Q1 – Q4 2024
Total		116,6	46,1	40,5	53,3	

(*) This call for proposals was launched in 2022 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. This amount of Maximum EU-Rail co-funding corresponds to the 2024 instalment for the call 2022-1. For more information about the annual instalments, please refer to the “Table of Financial programming per year until 2027” in Chapter 3 “Budget 2024” of the present document.

(**) This call is not launched with using budget commitments divided into annual instalments as the award and GA signature is planned for 2024 and budget immediately available.

(***) which includes EU-Rail – SNS JU Synergy with total EU-funding EUR 13,500,000, of which EUR 12,500,000 from EU-Rail and EUR 1,000,000 from SNS JU. Foreseen as Innovation Action with up to 60% funding.

In accordance with the SBA (recitals 10 and 12 and Article 5(2) c)), to achieve maximum impact, the joint undertakings should develop close synergies with other Horizon Europe initiatives and other Union programmes and funding instruments, particularly with those supporting the deployment of innovative solutions. Following the identification of synergies between them, joint undertakings should aim to determine budget shares which should be used for complementary or joint activities between joint undertakings, in particular by dedicating, where appropriate, a part of the joint undertaking’s budget to joint calls. EU-Rail and SNS Joint Undertakings will launch a joint topic call “Digital & Automated testing and operational validation of the next EU rail communication system” for a total co-funding of EUR 13,500,000, including an expected contribution from SNS JU of EUR 1,000,000. The modalities of this transfer will be detailed in an arrangement between both organisations and adopted with the JUs’ respective Work Programmes 2024.

In addition to the specific research and innovation calls and implementation, EU-Rail will work on the preparation and launch a call for expression of interest to select Associated Members, after having made an assessment of the needs to complement the current membership to deliver the Programme. The Call for Associated Members is expected to be published in 2024.

In line with Regulation (EU) 2021/695 establishing Horizon Europe, 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. Thus, with the interim evaluation being due at the end of 2024 at the latest, the JU already started with the planning of its contribution to this activity, so that its intended purpose – namely the assessment of the Programme's effectiveness, efficiency, relevance, coherence, and Union added value – can be effectively achieved.

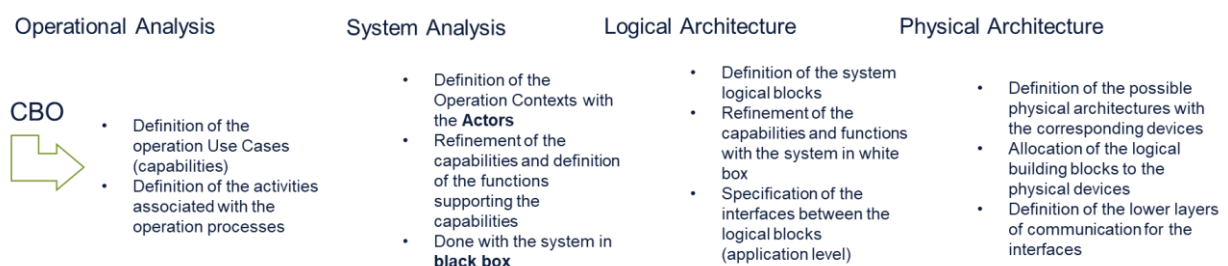
Work on the update of the EU-Rail Multi-Annual Work Plan will also continue in 2024 with the assistance of the ED System and Innovation Programme Board.

Furthermore, EU-Rail will continue to provide support and inputs to the EC for the purposes of preparation of the second Biennial Monitoring Reports (BMR) on the performance of partnerships under Horizon Europe. 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.

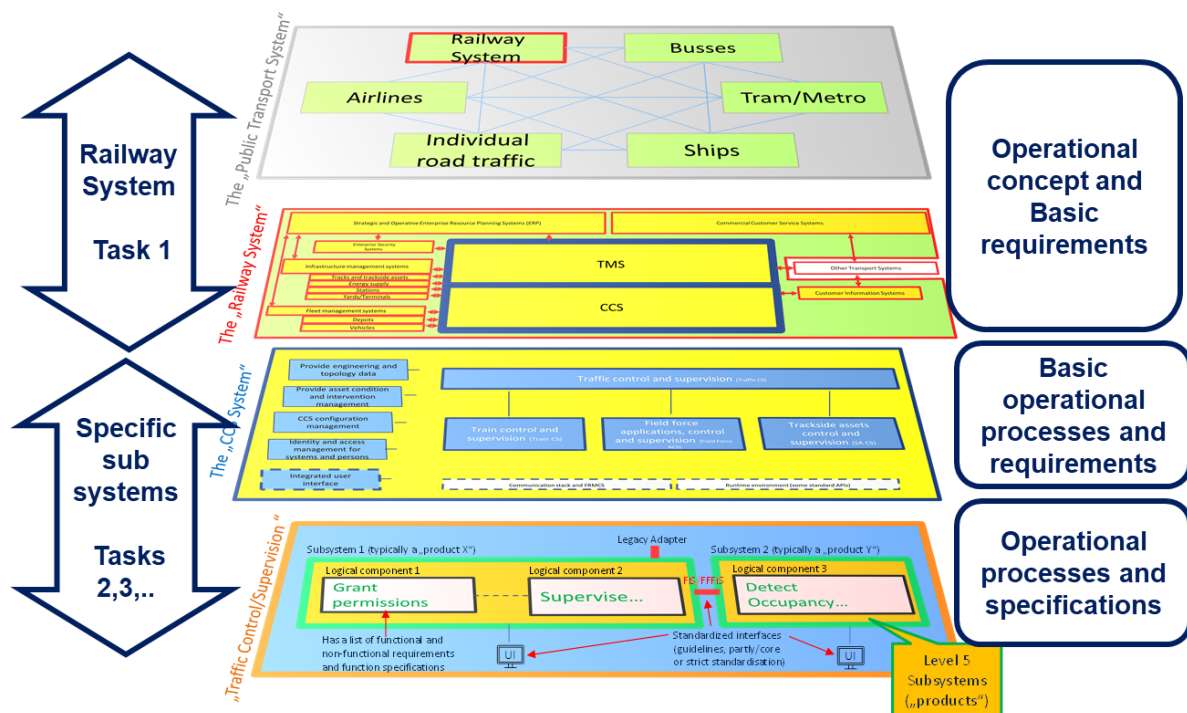
Finally, in line with Article 19(4)(v) SBA, EU-Rail has been requested by the Commission services to further develop its 2023 plan for phasing out from Horizon Europe funding, which was based on an assumption of non-renewal of the JUs after the 31 December 2031, also reflecting on the potential scenario 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

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):



Given that it is necessary to define the whole rail system in order to determine the areas of priority and focus, and in order to ensure consistency of approach, Task 1 of the System Pillar will define the high-level overall railway architecture and operational concept for the EU Rail System, whilst the other tasks, deliver the more detailed view of the systems and their specifications.



Through the Ramp-up phase for the SP 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, 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. The described approach will be pursued in 2024.

2.3.2.1 SP Organisational Structure of the activities

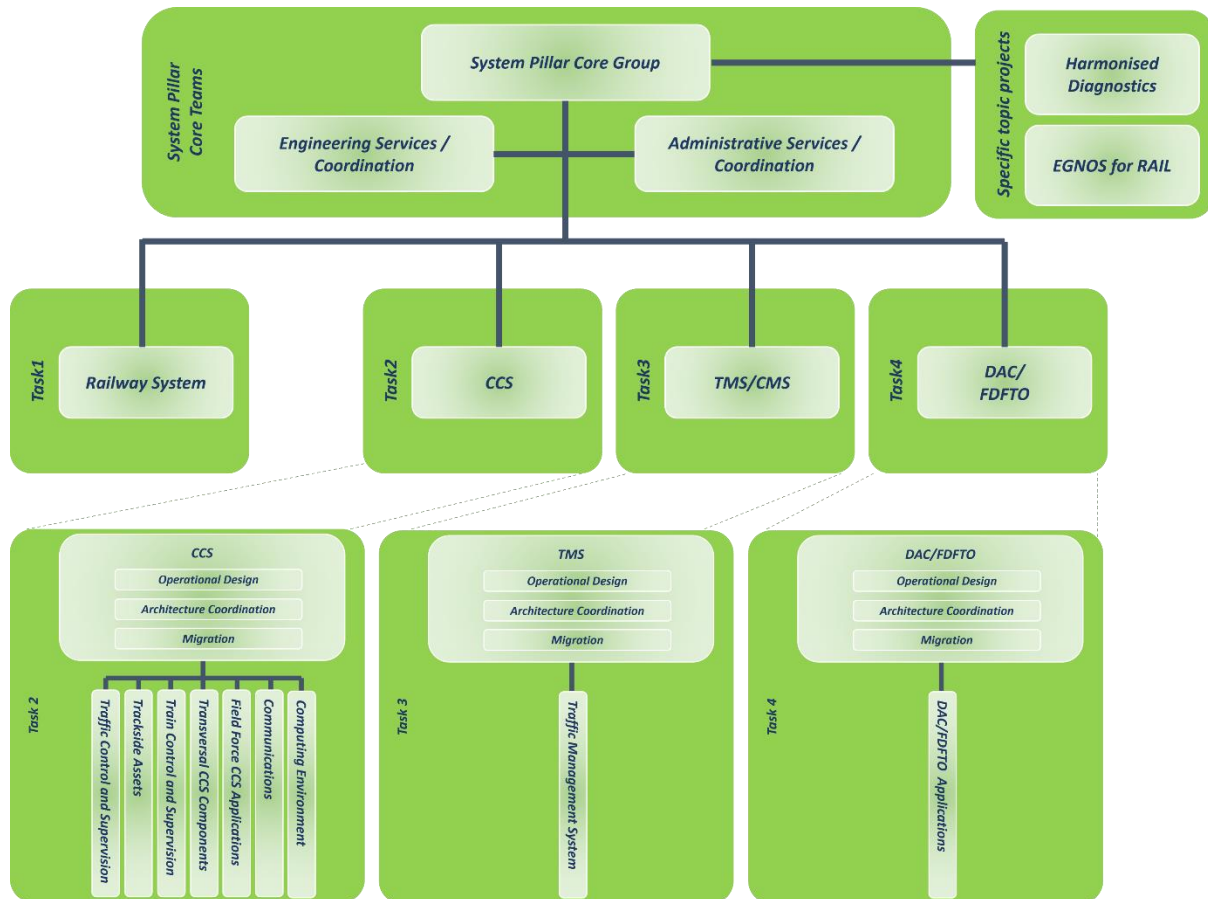
There are two different structures co-existing within the System Pillar organisation of the activities:

- 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 illustrates the first and second level operational breakdown structure of the System Pillar, reflecting both the organizational structure:



The roles and responsibilities of the following SP groups are depicted in the EU-Rail's Governance and Process Handbook²³:

- 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

²³ <https://rail-research.europa.eu/wp-content/uploads/2023/01/EU-Rail-Governance-and-Process-Handbook.pdf>

component, Field force CCS application, Communication team, Computing environment),

- Task 3: TMS system design,
- Task 4: DAC/FDFTO²⁴ System design.
- Specific Topic Projects:
 - Harmonised diagnostics
 - EGNOS for Rail

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 take into account 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.

²⁴ DAC = Digital Automatic Coupler / FDFTO = Full Digital Freight Train Operations (part of FA 5 project)

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 (f.e. waiting for terminal slots) and shunting (yard) work.

Specific topic work items

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.

EGNOS for rail

Current existing EGNOS SoL service has been developed according to aviation requirements. As these requirements are different from railway ones, this service cannot be used in rail safety related applications without additional activities to ensure the compliance with railway standards and to support safety evidence and guarantees.

For the successful adoption of the use of EGNOS within ERTMS framework, it is necessary that both the system/service and the service provision are defined, and where appropriate, properly introduced in the regulations and certified/authorised according to the European Rail regulatory framework.

The resource provided by the SP Consortium will also feed ERA for successive TSI drafting.

2.3.2.2 SP deliverables, milestones and harmonisation planning

The work of the System Pillar is structured along the different tasks described in section 2.3.2.1. In the following section the deliverables and milestones are summarized per task and domain.

Detailed information can be found in Annex VI.

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

Task 1 specifies the Business Process Architecture and the Operational design for the complete railway system up to System Level 2, following the defined Common Business Objectives and the expected future performances. Based on the identified pain points of the current (as-is) railway system, a priority list of operational and system capabilities will be defined, on which the development of an improved to-be architecture should focus. The includes the creation of the as-is operational architecture as well as the operational and system analysis of the proposed to-be architecture.

The deliverables for the period of the Work Programme are:

- *Priority list of capabilities* on which operational analysis and system analysis should focus
- Description of each capability with *operational process and scenarios*, highlighting divergencies between members states
- Identification and mapping of *pain points* in the operational architecture, in order to highlight activities and interactions where there are opportunities for harmonization
- Description of the *performances already reached by the as-is architecture*, identify existing rules, current performance, and process (TSI, EN standards, Operational rules and AMoCs – Accepted Means of Compliance)
- *Operational analysis* of the to-be architecture, based on a set of selected capabilities, including the provision of a draft of performances which could be reached by the To-Be Architecture and derived requirements.

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 Operational Harmonisation

This domain task is 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, including the definition of all performance, safety, and efficiency targets.

The deliverables for the period of the Work Programme are:

- Completed *set of operational requirements*, derived from CBO and operational visions, and from stakeholder input
- Description of *processes and scenarios for the ERTMS capabilities*, including
 - o operational outcomes necessary for the system analysis in T2 ARC
 - o operational hazards and risk assessments of scenarios.
 - o operational concept per scenario describing harmonized processes (concept and modelling level harmonization)

Task 2 CCS: Domain Architecture and Release Coordination

This domain, based on the required operational capabilities, derives the CCS system requirements and translates into system capabilities. The system functions and the overall logical architecture allowing their implementation are defined (System level 3).

The deliverables for the period of the Work Programme are:

- Amendment of system requirements, specification of System Analysis and Logical Architecture on System Level 3, defining the *next iteration of the target architecture model* based on the architecting approaches:
 - o top-down: Based on the outcome of Task2 Operational Harmonization domain
 - o bottom-up: Analysis of existing system architecture from specifications, input initiatives and/or system domains
- Coordinate *overarching architecture processes* like ATO or Absolute Train Positioning specifications (including input to the overall work on EGNOS within the ERJU), analysis and moderation of the technical integration of the bottom up level 4 models and outcomes from system domains
- Identify input from the Domain to the *Standardisation and TSI Input Plan (STIP)* and support the SPCG in the analysis of the STIP draft and updates from architectural point of view
- Performing activities related to the “baseline exercise” of ATPS:
 - o Complete the Operational Analysis linked to Common Business Objectives and the first level of the System Analysis according to SP SEMP and MBSE methodology
 - o Ensure a coordinated and consistent development of the overall specifications (related to the onboard train positioning and its relevant interfaces) produced by different SP domains and possibly other WGs/tasks (e.g. of IP)

Task 2 CCS: Domain Migration & Roadmap

To support and ensure the migration to the developed CCS target architecture, this domain will develop a list of key migration requirements for the target system.

The deliverables for the period of the Work Programme are:

- Identification of *CCS feature packages that are indivisible* in terms of deployment together with the Architecture, Traffic CS and Train CS domains.
- Assessment and recommendation of a scope for *System Pillar Reference Architecture Baseline 1 Release 1* (SPRA B1R1) and succeeding releases according to STIP.
- Elaboration of a *list of key migration requirements* for the target system, based on CBO and other Railway requirements, that will facilitate migration in terms of architectural structure and automated deployment
- Assessment and recommendation of plateaus for a possible regulation process as input for the harmonization process

The detailed logical and physical architecture of the CCS system components (trackside and onboard subsystems) are designed in the following domains. Starting from a detailed description of the subsystem capabilities and related functions, the logical architecture is described. This work integrates top-down system requirements with existing architectures from specifications and previous/ongoing sector initiatives. The main outcome of the logical architecture design will be the agreement and definition of interfaces between the subsystem components, thus providing the physical architecture of the system components.

Task 2 CCS: Domain Traffic Control and Supervision

This domain is in charge of the management and maintenance of the Traffic Control and Supervision system architecture at the functional, logical and physical level, including system interfaces, data sharing and high level functional specification and requirements. Additionally, ensures alignment and cooperation between the System Pillar and the Innovation Pillar flagship area 2

The deliverables for the period of the Work Programme are:

- Description of the *operational requirements and operational capabilities/processes* for providing, configuring, maintaining, and exchanging the Traffic CS components, including needed System capabilities and their functions.
- Amendment of *system requirements, specification of System Analysis and Logical Architecture* on System Level 4

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:

- The *architectural drawing of the target architecture* and descriptions of the functional building blocks
- Preparation for an update of *Subset-121 and Subset-147*
- Proposals for functional enhancements of the *interface of the on-board CCS subsystem to the train*
- Description of a draft physical architecture with defined subtasks, responsibilities, and schedule
- Consolidated collection of agreed and prioritized functions
- Elaboration of a concept for the *simplification of authorization and integration processes* and the framework conditions for better upgradeability
- *Transition of OCORA technical workstream to the SP*: Agreed input for SP related activities and plan for transition of OCORA technical workstreams to related SP documentation

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

The deliverables for the period of the Work Programme are:

- Creation of first *operational standardization specifications* (ORS CONEMP) for computing environment, based on an operational concept based on the Use Case analysis from SC 2.1. The operational analysis includes the deliverables along SEMP process Group 2 (Annex D) for the CONEMP operations (lifecycle processes for construction, maintenance, replacement, etc.).
- *Identification of system capabilities, functions and external actors* in the System Analysis, based on the operational concept, covering all the interfaces identified

- Drafting of *API specifications* coordinated with Innovation Pillar

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, focusing in this period on the remaining topics of the specification after the release of the first version of the interface specification and the clarification of the needs for a light signal object controller.

The deliverables for the period of the Work Programme are:

- Description of the asset management and life cycle processes (installation, setup, maintenance, exchange) and their operational requirements.

Task 2 CCS: Domain Transversal Systems

The Transversal Systems domain and its four 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:

- Definition of the CCS/TMS Data model, including:
 - o Serving the use cases of the System Pillar domains and IP projects
 - o Uptake of the ERA vocabulary (semantic data model)
 - o Linking semantically the SP Data Model with external models outside SP scope
 - o Applying and improving the SP Data Model governance
 - o Updating and amending STIP and Definitions and References
- Definition of the CCS/TMS Diagnostic Data, including:
 - o Finalization of operational requirements and processes
 - o System Analysis, System definition of the specific subsystems
 - o System Requirements for the specific CCS component(s) related to technical diagnostics and monitoring purposes
 - o Updating and amending STIP and Definitions and References
- Configuration management methods and system definition
- Rules and System definition for Railways system User Interface subsystems Integration

Task 3 TMS & CMS

This task 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:

- Addition to the already existing System Concept document the topics of *system interfaces, legislative and economic issues, and System definition and capabilities*.
- Provision of *processes and the logical architecture* in the existing high-level design of the System Architecture, including addition of system requirements and specification of interfaces
- Submission of the complete specification of the interface between TMS and Traffic Control and Supervision system
- Definition of the internal interfaces of the Traffic Management System, including System definition and capabilities

- Description and analysis of pros and cons of different architecture models of *TMS/CMS for the management fo cross border traffic*

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:

- *FDFTO Operational Rule Book* based on sector feedback and final mature input from FP5
- Description of ERTMS related use cases (including agreement), interface ATO <-> ASO (if needed) and automated freight shunting and train formation use cases
- Analysis of further interfaces of train-internal DAC/FDFTO to the "outside" world (in cooperation with Task 1)
- Elaboration of a concept how to share the data generated by the DAC system by loco and wagon between the stakeholders taking into account data ownership and confidentiality topics
- Activities related to STIP input maintenance and to "Authorisation Coordination", with ERA, CEN/CENELEC & others: TSI CR management, EN Standards development, Syst. Pillar documents

Specific Project: Harmonised Diagnostics

It has been identified that the lack of harmonization in regards to exchange of maintenance data between borders across Europe hinders development of the railway sector and blocks business cases. To overcome this, this specific project activity is aimed to select a limited number of examples to demonstrate "proof of concept" European harmonization on the approach for exchanging maintenance data, based on the SP Data Model and the associated Diagnostic Data Model.

The deliverables for the period of the Work Programme are:

- Analysis of *existing framework*, definition of *use cases* (incl. KPI), functional requirement for measuring KPI, outlining certification needs, addressing key obstacles (i.e. Data handling, juridical boundary conditions), outline solution, initiate solution process)
- Detailed elaboration/development of the framework/architecture and applying framework to a concrete example of use cases, measuring systems and parameters; output: harmonized measuring methods and parameters.

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. Its role is to

actively support where needed and take 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)*, including at least: reference management, quality assurance process, verification and validation processes, handbook (MBSE), v1 (on documentation, concept, architecting and modelling), automated traceability check processes (process and tool), revision of all annexes, especially those with open points not addressed in SEMP v2.
- Set up a *requirements management plan* and coordinate the completion of the first complete set of linked requirements (at least on top-level per domain) for the whole system currently in scope
- Creation and publishment of the first complete and consistent *SP Glossary* (incl. terms from European legislation) and creation of a central LiveDoc with all *Reference workitems* in SP-Library, and migration of all decentral references of the projects to it.
- Check all results of the first and second contract (that were finalized on domain level) concerning *formal Quality* (SEMP compliance; results in Polarion and Capella). Deliver optimization report to the domains.
- Capella usage is established in all teams (dedicated modelers) and SysML tool is procured, installed, trained and Trackside Asset specifications (EULYNX) is imported

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:

- Performance definition and KPI's part of EU regulatory framework and methodological approach combining Qualitative criteria and results.
- Analysis of RAM Performance needed to reach overall Performance Targets
- Refinement of CBM RAMS rules
- Update System Concept (RAMS Phase 1) and PRAMS Plan (RAMS Phase 2) according to evolving system architecture and mission profiles
- CENELEC changes proposal for harmonisation and modular approaches.
- Coaching of PRAMS experts throughout ERJU SP and IP to follow the Safety Guideline and assure PRAMS requirements implementation.
- Processes for Hazard and Risk Analysis and harmonized hazard lists for Operation and System level
- Contribution to EGNOS project dealing with *certification and authorisation processes*, to be introduced into TSI CCS

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.

The deliverables for the period of the Work Programme are:

- *Secure Product and Secure Communication* specifications (for Innovation Pillar)
- *Secure Product and Secure Communication* specifications, Shared Security Services specifications and Secure Operational processes (for TSI standardization input)

Standardisation and TSI input plan (STIP)

The harmonisation of the European railway system, aiming at interoperability and an uniform European market for railway technology, is a main goal of the System Pillar. For this purpose, all potential topics for harmonisation, including the channels TSI, European Standardisation and SP documents, will be assessed and collected in the Standardisation and TSI Input Plan (STIP).

The input to the STIP is based on all the relevant potential or known harmonisation topics from the System Pillar and Innovation Pillar activities, being the quality of the information checked for completeness and consistency by EU-RAIL, with support of SP where appropriate.

Once approved by the System Pillar Steering Group, the STIP will provide a validated and complete view of the harmonisation outputs linked to EU-RAIL, endorsed by the European Commission, ERA, the European Standardisation bodies and the sector as a whole. This should enable a more strategic alignment of the outputs of EU-RAIL with the TSI revision process and the European standardisation process, and associated Commission request

This deliverable will be therefore instrumental to support the European Commission in its mandate updates to the European Union Agency for railways for TSI development or to the European Standardisation Bodies (CEN/CENELEC/ETSI) for the EN standards development.

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

The deliverables for the period of the Work Programme are:

- Maintenance of ETCS and ATO specifications: error Change Requests (CRs) management (up to status 'analysis completed'), update of Subset 147 version 2, update of safety analysis and other specifications
- CCS 2023 TSI revision: Review of the Subset 153 (ERA CCM process) and update of the application guide of Subsets 077, 078, 079, 080, 081, 088, 118, 129 and 116
- Maintenance of engineering guidelines: Gap analysis of useful guidelines in the future and overall ETCS engineering guideline version 1
- Principles for ATO Testing: Elaboration of Subset 151, including all the test cases covering integration of OB-ATO and OB-TS, traced from the Subset 125
- Maintenance of GSM-R specifications: error CRs management (up to status 'analysis completed')
- Evolution of FRMCS specifications: Delivery of drafts UIC FRMCS V2 specifications to ERA and EU-Rail, mapping the functional requirements to the system requirements, FRMCS cybersecurity risk assessment, related reports (meetings between stakeholders, contribution in ECC/CEPT subgroups related to FRMCS spectrum, 3GPP activities), input to UIC FRTMCS Program (CRs or equivalent) and preliminary planning for FRMCS V3 specification
- Contribution to ERA TSI CCS Change Control Management Process: Update of the on-board test specifications (Subset-076 and related documents) based on the CCS TSI 2023, in particular the design of the test specifications for on-board said to support a reduced envelope of system versions up to System Version 2.1 and 2.2.

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 Handbook²⁵.

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.

²⁵ <https://rail-research.europa.eu/wp-content/uploads/2023/01/EU-Rail-Governance-and-Process-Handbook.pdf>

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. Activities have started in 2023 and preparation of the enablers will continue in 2024. It 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:

- Tactical and short-term timetable planning including cross-borders with improved models and functions; use of decision support to support integrated capacity planning of the rail network and operations for yards, stations, terminals **[TRL4/7]**;
- HMI for TMS with decision support modules, based on User Experience (UX) Design and human-in-the-loop awareness **[TRL4-8]**
- 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 4-8]**

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 will continue 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 (**TRL6 or higher**), Hybrid Level 3, moving block and TIMS (**TRL6**), connectivity (**TRL6**), perception (**TRL5/6**), train positioning (**TRL5/6**), automated functions and digital register (**TRL6**).
- Demonstration of the remote driving and command in depots and yards, including perception systems (**TRL6**).
- 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 (TRL4/5)
 - Self-driving wagon (TRL4/5)
 - Autonomous path allocation (linked to input from Destination1) (TRL5)
 - Validation and certification (TRL6)
 - Demonstrate a Functional Open Coupling System prototype covering all required subsystems in an operational environment (TRL7)
 - Demonstrate a modular hardware platform using architectural software design patterns and methods (TRL7) allowing SIL2 respective SIL4 (depending on the application)

In 2024, EU-Rail will operationalise with concrete outputs its cooperation with EUSPA, ESA and ERA in a common project (delivered by in the EU-Rail programme by FP2) 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.

Additionally, EU-Rail is expecting to launch a topic in its call for proposals for a European R&I testing and validation of the FRMCS specifications (Version2) which will support the pre-deployment of this major game changer for railway communication. This is a major addition to the current FA2 programme and it will entail an adjustment and update of the MAWP.

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 will continue 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 – **TRL7.**
- **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.**

- **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.

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 will continue in 2024. It is expected notably to deliver the following **by 2025/2026**:

- **Alternative energy solutions for the rolling stock at TRL6**, covering:
 - High performances Batteries Electric Multi-Unit (BEMU) train (reaching TRL6/7);
 - 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 TRL6**, covering:
 - Rail Power Smart Grid in different systems as well as the integration of energy storage solutions;
 - Application of solutions for the production, storage and refuelling of hydrogen for railway vehicles on the example of a prototype refuelling station;
- **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 (**TRL6**);
- **Improvement of electro-mechanical components and sub-systems for the rolling stock, at TRL6**, covering:
 - Technological solutions for the migration to the airless train: Electro-mechanical braking system and novel electro-mechanical pantograph 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 TRL7**);
- **Attractiveness, at TRL6**, covering:
 - Modular rolling stock interiors providing easy access (incl. PRM) and new architectures for drivers' cabin.

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 will continue in 2024. It is expected notably to deliver the following by 2025:

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

- **European full digital freight train operations: (TRL 8-9)** 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.
- **European full digital freight train operations: (TRL 7)** Proposals are expected to deliver within the large scale demonstrator with a lower TRL level for technical solutions for parking brake system, digital wagon inspection (including rolling stock and infrastructure assets), DAC based telematic applications for customer requirements (goods monitoring) / for asset performance management / CBM / for safety related applications, distributed power system and electro-pneumatic brake.
- **European full digital freight train operations: (TRL 8 – 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** at least the following:

- **Seamless freight corridor (TRL 5-8)** 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 multimodal freight (TRL5-8)** 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 2024, EU-Rail is expecting to launch a topic in its call for proposals to anticipate additional R&I activities on DAC within the Flagship Area 5. This important acceleration of the work, that will be reflected in a MAWP update, aim to ensure that DAC pre-deployment pilot trains are ready by 2026.

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 and the project started in December 2022. Activities have started in 2023 and preparation of the enablers will continue in 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 such as carsharing **(TRL4/5)**
- Demonstrate passenger congestion rate monitoring, flow optimization application as well as a low-cost passenger information system for regional services developed within this action **(TRL4/5)**

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 Grant Agreement of the POD4Rail project in this Flagship Area was signed in August 2023 and the project 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.

The Grant Agreement of the MaDe4Rail project in this Flagship Area was signed in June 2023 and the project started in July 2023. The MaDe4Rail project aims 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.

In 2024, EU-Rail is expecting launch a topic in its call for proposals with the aim to strengthen the collaboration of the different hyperloop promoters in the technology convergence of the hyperloop solutions by defining the operational, safety and reliability aspects and assessing the economic viability.

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 twins²⁶, innovative processes enabled by interoperable data sharing as including common 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.

²⁶ A digital twin is a virtual representation which is able to imitate the behaviour of a physical system during the span of its lifecycle.

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 will continue in 2024 and will lead to the following deliveries:

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]**

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.

In this respect, a 2023 Call has been launched in October 2023 and its content has been defined on the input and advice from a large consultation process, starting at the General Assembly and Innovation Days of the at the end of 2022, ERRAC, the Scientific Committee, the States Representatives Group, and also based on possible specific needs identified by the ongoing actions, sector stakeholders or ERA. The evaluation and signature of the awarded proposals is foreseen in S1 2024.

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 2024

During 2024, the main objective is to ensure that all the R&I activities that were awarded in 2022 are running as planned, in particular for the 6 Flagship Projects in view of their demonstrations in 2025 and preparatory research activities in 2026 for the next series of demonstrations. During 2024 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 demos. The exercise conducted in 2023 with the first maturity checkpoints will lead to possible project adjustments in 2024 leading to an analysis of the feasibility of the planned maturity foreseen and possible impact on the MAWP. The

update of the MAWP is another important objective for 2024, providing some clear indication of the gaps and/or new concepts to be covered with additional expertise and R&I activities.

Additionally, as part of the Innovation Pillar activities and objectives, the JU will also monitor the first series of exploratory and other projects (comprising FA7 projects) that would provide in 2024 some initial elements of disruptive technologies or basic research, possibly leading to future breakthrough innovation and further R&I activities towards higher TRLs.

In 2024 FA anticipation activities will be starting for FA1, FA2 and FA5 operationally presenting the challenge of ensuring the proper alignment with the ongoing Flagship projects as well as the proper pace and synchronisation of deliverables. More exploratory research and other activities (comprising FA7) will also be awarded in 2024 and the JU will have to appropriate projects implementation in the Programme.

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

The Deployment Group is expected in 2024 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.

A deployment preparation activity for the transformation of rail (freight) towards an automated and digitised mode of transport is the continued management in 2024 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

All available budgetary appropriations of the former S2R JU were committed by the end of 2021, before the entry into force of the SBA. EU-Rail will continue collecting the cash contributions to be provided by the Members of the former S2R in accordance with Article 174(2) SBA which states that the EU-Rail is the legal and universal successor of the former S2R JU which it replaced and succeeded.

During 2024, the focus on the former S2R Programme will be on the administrative closure of all the projects having finalized their activities in 2023.

Annex IV, Table II provides the list of demonstrators and associated TRL levels achieved in 2023.

EU-Rail will supervise, where needed, the implementation of the S2R Projects to ensure their sound management, in particular to assess their progress to achieve the defined targets and the transition of results to the successor Programme, in line with the provisions of Article 31.5 of the grant agreement.

No projects activities from the S2R programme are expected to be performed in 2024.

The S2R R&I Programme implements the revised S2R MAAP adopted by the GB on 14 November 2019 which re-focuses and prioritizes research and innovation activities in line with the MAAP Part A: it details which innovative solutions resulting from Technology Demonstrators (TDs) deliver the Innovation Capabilities (ICs), more concretely captured in the Catalogue of Solutions. A 2022 edition of the Catalogue of Solutions was presented by the JU at the InnoTrans 2022: <https://rail-research.europa.eu/publications/catalogue-of-solutions-2022-edition/> and an updated edition is part of the work of 2024, taking into account the work from the finalised projects.

The TDs are organized in the following Innovation Programmes (IPs):

2.3.5.1 Innovation Programme 1 (IP1): Cost-efficient and reliable trains

The design of rolling stock plays a key role for the attractiveness of rail transport. Only trains that are comfortable, reliable, affordable and accessible can convince passengers to use rail transport instead of other modes. At the same time, the train design has to meet the requirements of the railway undertakings and the urban operators, who are the main customers of the rail supply industry, in order to deliver high quality and cost-efficient services to their customers.

If rail is to integrate more effectively with other modes and attract more passengers to further develop its role as the backbone of multi-modal mobility in the future, it needs a future generation of passenger trains that will be lighter, automated, more energy and cost-efficient, while at the same time providing a comfortable, connected, reliable and affordable travel experience for all passengers at a defined level of safety and security.

The S2R JU identified the following priority research and innovation areas in which activities should be undertaken with a view to achieving the ambition of IP1:

- Traction (TD1.1)
- Train Control and Monitoring System (TD1.2)
- Carbodyshell (TD1.3)
- Running Gear (TD1.4)
- Brakes (TD1.5)
- Doors and Intelligent access systems (TD1.6)
- Train interiors (TD1.7)
- Heating, Ventilation and Air-Conditioning (HVAC) (TD1.8) (which already ended its activities)

Important areas of attention are those concerning noise and human factors (covered by CCA, and this IP has a significant contribution to make) and the link with the CCS system, in cooperation with IP2.

2.3.5.2 Innovation Programme 2 (IP2): Advanced traffic management and control systems

Control, command and communication systems should go beyond being only a contributor to the control and safe separation of trains, and become a flexible, real-time, intelligent, integrated and fully automated traffic management system.

Although European Rail Traffic Management System (ERTMS) has already become a worldwide dominant solution for railway signalling and control systems, it has the potential to offer increased functionalities and become even more competitive.

Current systems do not sufficiently take advantage of new technologies and practices, including use of satellite positioning technologies, high-speed, high-capacity data and voice communications systems, automation, as well as innovative real-time data collection, processing and communication systems, which have the potential to move towards new traffic management concepts, thereby delivering improved capacity, decreasing traction energy consumption and carbon emissions, reducing operational costs, enhancing safety and security, and providing better customer information.

The S2R JU identified the following priority research and innovation areas in which activities should be undertaken with a view to achieving the ambition of IP2:

- Smart, fail-safe communications and positioning systems (TD2.1 and TD2.4 and TD2.10)
- Automatic Train Operation (ATO) (TD 2.2)
- Moving block (MB) and train integrity (TD2.3 and TD2.5)
- Virtual testing and engineering rules (TD2.6 and TD2.7)
- Virtual coupling (TD2.8) (which already ended its activities)
- Traffic management optimisation (TD2.9)
- Cyber security (TD2.11)

Important areas of attention are those concerning human factors (covered by CCA, but this IP has a significant contribution to make as well) and the link with shared train equipment, in cooperation with IP1.

2.3.5.3 Innovation Programme 3 (IP3): Cost Efficient and Reliable High Capacity Infrastructure

The design, construction, operation and maintenance of rail network infrastructure have to be safe, reliable, supportive of customer needs, cost-effective and sustainable. In order to deliver the benefits of market opening and interoperability and to reduce the life-cycle costs of rolling stock and on-board signalling systems, the network diversity needs to be eliminated, notably through a migration towards common high-performing infrastructure system architecture.

Activities that can support the reduction of infrastructure maintenance costs, such as simplified procedures or automation, need to be led in priority. They should propose solutions that can be rapidly and efficiently deployed. Furthermore, the infrastructures have to be managed in a more holistic and intelligent way, using lean operational practices and smart technologies that can ultimately contribute to improving the reliability and responsiveness of customer service, as well as the capacity and the whole economics of rail transportation.

Compatibility between different elements of cross-modal transport infrastructure (such as multimodal hubs charging points and stations) needs to be ensured and based on principles of interoperability and standardisation.

The S2R JU identified the following priority research and innovation areas in which activities should be undertaken with a view to achieving the ambition of IP3:

- New directions in switches and crossings (TD3.1 and TD3.2)
- Innovative track design and materials (TD3.3 and TD3.4)
- Cost effective Tunnel & Bridge solutions (TD 3.5)
- Intelligent system maintenance (TD3.6, TD 3.7 and TD 3.8)
- Energy efficiency (TD3.9 and TD3.10, this latter already ended its activities)
- Improved station concepts (TD3.11)

Important areas of attention are those concerning human factors (covered by CCA, but this IP has a significant contribution to make as well).

2.3.5.4 Innovation Programme 4 (IP4): IT Solutions for attractive railway services

In order to become more attractive, rail must respond to customer needs to support seamless door-to-door multimodal journeys encompassing different modes of transport. Rail must achieve interoperability with other transport modes and mobility services, within different regions, cities and across borders. In order to achieve this, rail needs to take due advantage of the ever growing connectivity of people and objects, the availability of European Global Navigation Satellite System (GNSS) based location and other means of localisation, the advances in cloud computing, Open Data and Big Data Analytics and the wide dissemination of Internet and social media. Multimodal integration will also take benefit from existing rail standards as FSM and TAP TSI.

To achieve it The IP4 ecosystem aims to integrate and make interoperable all possible transport modes and travel services. In early stages of the program, modes such as rail, urban transport (metro, tram, and buses) and airlines were integrated. Afterwards, the ecosystem was enlarged to include also transport services that entail private cars (such as the use of toll roads and parking, which have an associated price) and also shared modes (cars and bikes). Thereby multimodality and the use of public transport are being fostered, and making it easier for travellers to connect with rail stations and airports, regardless of where and how they start their journey. For the future, Demand Responsive Transport and Ride Sharing will be included in the ecosystem to ease the access to everyone, even those living in now well connected areas, to long distance trips.

IP4 Ecosystem has also evolved to implement at European Level the new Mobility-as-a-Service (MaaS) paradigm, which considers the mobility system as a whole in order to achieve an optimal and sustainable transport scheme. This way, the IP4 ecosystems facilitates the task to create formal contracts that could involve the agreements, business rules and financial compensation that will occur between the different stakeholders when combining their services into a joint product. In the future, this component will be evolved to be used also to create MaaS Packages that integrate a variety of transport services that could include multiple Transport Service Providers.

The work of 6 TDs dealing with the IT framework, travel shopping, booking and ticketing , trip-tracker and travel companion functionalities, as well as business analytics tools, is integrated in the integrated TD 4.7.

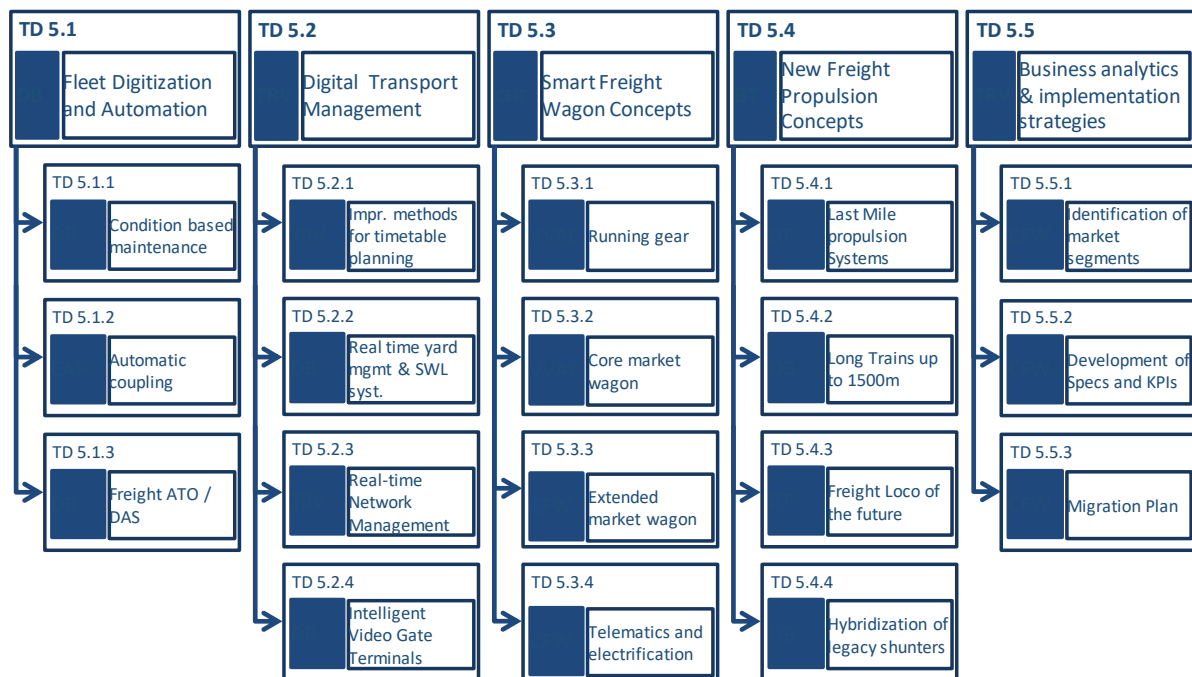
2.3.5.5 Innovation Programme 5 (IP5): Technologies for sustainable and attractive European rail freight

The cost competitiveness and the reliability of freight services need to be considerably improved if the rail sector is to meet the ambitious objectives that were set in the Transport White Paper²⁷ in terms of developing rail freight; almost doubling the use of rail freight compared to 2005, achieving a shift of 30% of road freight over 300 km to modes such as rail or waterborne transport by 2030, and more than 50% by 2050. Rail freight must be in a position to offer a cost-effective, attractive service to shippers, helping to take freight away from the already-congested road network, and becoming the backbone of the Union inland integrated logistic system.

Different market segments with specific technical and operational characteristics and needs have to be identified in order to direct research and innovation projects towards present and future market needs. The first segment is the intermodal segment, which mainly relies on the use of containers/trailer trains and where continued growth can be expected. Reliability, service characteristics and cost competitiveness in this segment can progress significantly with an increase in train length, better length utilisation, innovative rolling stock features for value-added services, progress in the terminal operations, improved real-time customer information to customers and better data exchange between involved parties in the intermodal transport chain using open standards and specifications (including TAF TSI). A second market segment is the wagon load activity segment (either Single Wagon Load (SWL) or Train Load (TL) services), which relies on the use of specific freight wagon. The SWL services have significantly declined in the past years and its significant growth potential can only be fully exploited if a step change is made in terms of service quality and reliability. Solutions such as automated coupling and decoupling and tagging of all wagons with automatically readable Radio Frequency Identification (RFID) tags, provide a huge potential to speed up and reduce costs in train formation and to improve the overall performance of wagonload services. An IT framework with high added value needs to be created for all topics described in this section. The need of comodality/multimodality of freight mobility, i.e. the linkage to other freight modes, has to be ensured.

During the past years, IP5 has re-prioritized its TDs. IP5 includes the following TDs. The TD5.5.3 ended already its activities.

²⁷ [WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system /* COM/2011/144 final](#)



Important areas of attention are those concerning human factors (covered by CCA, but this IP has a significant contribution to make as well).

2.3.5.6 Cross-cutting themes and activities

In addition to the five Innovation Programmes, the work of R&I activities will include cross-cutting activities (CCA) relevant to each of the different sub-systems and taking into account the interactions between these sub-systems.

These CCA activities will ensure that the R&I activities within the different Innovation Programmes are closely aligned in terms of their objectives and their requirements, as well as the methodologies for evaluation and assessment of impacts. These activities include elements already taken into account in the different Innovation Programmes that require horizontal coordination (such as energy and noise management) and additional R&I that will be necessary to complement the technical work of the S2R JU.

The S2R JU identified the following priority research and innovation areas in which activities should be undertaken with a view to achieving the objectives of the CCA:

- Long-term needs and socio-economic research (which already ended its activities).
- Key Performance Indicators (which already ended its activities).
- System integration, safety and interoperability (which already ended its activities).
- Smart Mobility (which already ended its activities).
- Energy and sustainability.
- Human capital (which already ended its activities).

Beyond the technical challenges addressed by IPs and CCA, the market uptake of innovative solutions will address barriers such as: product acceptance, development of specific business cases, development of appropriate charging mechanisms, development of appropriate standards for innovative products, etc.

In addition to the concept underpinning the S2R JU that contributes to eliminating the aforementioned barriers, the new solutions will be supported by cost-benefit analyses (CBA). The overall S2R JU activities will embed, when applicable, suitable work to prepare for future technical standardisation/regulation related to the proposed innovations.

2.3.5.7 IPx - System Architecture and Conceptual Data Model (CDM)

Since 2018 work started at the initiative of some Infrastructure Managers on the Reference Command Control Signalling Architecture (RCA) and recently by some Railway Undertakings with an Open CCS On-board Reference Architecture (OCORA). In addition, the S2R JU during 2019 launched its activities related to the development of a Conceptual Data Model that will contribute to overcome “data” and “systems” fragmentation with a view to produce a system of systems approach; this will become the standardized way for legacy and new systems to interact, ensuring their interoperability.

With the award of the Linx4Rail Project in 2019, and LinX4Rail-2 in 2020, the S2R JU has launched research and innovation activities dedicated to an encompassing Functional System Architecture that cover safety and non-safety aspects, bringing together the different railway subsystems with a modular approach, standard interface between key functional components while preserving know-how and competitiveness.

This work results are incorporated and constitute the starting point of the activities of the System Pillar in the Europe’s Rail integrated Programme.

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 standardized workflows that are part of the grant management process. The assessment of various risks related to projects/beneficiaries will also be performed within the so-called “maturity checkpoints”, and also 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 a result of a risk assessment exercise which was performed in Q4 2023. Within this exercise, current internal and external factors and developments having influence on JU’s business were duly considered, as well as the views of the EC Internal Audit Service (IAS) who conducted their in-depth risk assessment of the JU in the same period.

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
<p>Proposals of participants submitted in response to JU's calls do not adequately reflect in the part providing the foreseen budget of the action the current and future expected inflation rate. This might have negative influence on the successful delivery of the work packages at a later stage of the projects.</p>	<ul style="list-style-type: none"> - Continuous Programme monitoring will be instrumental to assess the capacity to deliver the programme in the determined resources or anticipate the need for prioritization and adjustments. - Draw the attention of potential applicants on this issue during the Info Days.
<p>Intrinsic to the EU-Rail Staff establishment plan and its actual fulfillment, efficiency of operations is impacted by extensive workload of JU's staff. In combination with the ED vacancy (currently filled in by the HoP acting as ED a.i.) and the timeframe of the recruitment process for this senior management position, high staff turnover, difficulties for the JU to attract new people, vacant positions might be filled with delays resulting in shortage of resources becoming critical especially during peak periods. Specific accumulation of tasks and activities following from the transition between the two JUs and from launching of the new Programme may also contribute to difficulties in getting the work done in time and in the desired quality, deteriorating employees' motivation and, eventually, jeopardizing achievement of the JU's objectives.</p>	<ul style="list-style-type: none"> - 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. - Individual and group sessions were organized in 2023 with professional coaches to find strategies, tips and tricks about how to foster the wellbeing at individual staffs' level and also when interacting in the team.
<p>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 misalignments in the completion of activities may lead to negative project cascading effects impacting Programme outputs.</p>	<ul style="list-style-type: none"> - 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. - Application of maturity check points.

Risk identified	Action plan
<p>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.</p>	<ul style="list-style-type: none"> - 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.
<p>Vulnerabilities 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.</p>	<ul style="list-style-type: none"> - Microsoft Direct Access - VPN connection encryption based on computer certificates. - Two-way 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. - Cyber testing with regard to the Cooperation Tool and website. - Computer disk encryption in place. - Internet only for non-corporate devices on the wired network. - Lock, change user password remotely; inform the mobile telephony provider; intunes security policy for mobile phones. - Implementing the mitigation measures resulting from the DPIA performed with regard to the migration to Office365. - Continuous awareness-raising of JU's staff members with regard to cyber security and protection of IT tools and assets. - 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. - Joint ICT strategic plan for all JUs is in place which foresees, i.a. 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.
<p>Deficiencies in dissemination of results may lead to lack of adequate information to the end-user/interested parties and could compromise the intended JU's impact. That can also negatively impact the overall reputation of EU-Rail.</p>	<ul style="list-style-type: none"> - The JU provided a series of guidelines to the projects and fostered the use of the HE instrument as the Common Dissemination Booster. - 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, involvement of 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.

Risk identified	Action plan
	<ul style="list-style-type: none"> - Creating an overall dissemination communication plan at JU-level including the coordinated planning from the EU-Rail projects communication and dissemination activities.

The performed risk assessment included 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.

As a result of the above-mentioned IAS in-depth risk assessment exercise, it is expected by the end of 2023 or at the beginning of 2024 that audit topics to be audited at EU-Rail by the internal auditors in the upcoming years will be identified by IAS in their Strategic Internal Audit Plan (SIAP).

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 table summarizes the values of the operational activities planned in 2024 under EU-Rail/Horizon Europe, including the different calls:

Year 2024	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 Proposals – Exploratory Research *	Open	34,6	21,7 (**)	12,9	0,0	Q2 2024
Which includes - Call for Proposals – EU-RAIL – SNS SYNERGY: Digital & Automated testing and operational validation of the next EU rail communication system; to be launched Q2 2024	Open	22,5(**)	13.5(**)	9,0	0	Q2

(*) This call is not launched with multi-annual instalment as the award and GA signature is planned for 2024 and budget immediately available.

(**) which includes EU-Rail – SNS JU Synergy with total EU-funding EUR 13,500,000, of which EUR 12,500,000 from EU-Rail and EUR 1,000,000 from SNS JU. Foreseen as Innovation Action with up to 60% funding.

In accordance with the SBA (recitals 10 and 12 and Article 5(2) c)), to achieve maximum impact, the joint undertakings should develop close synergies with other Horizon Europe initiatives and other Union programmes and funding instruments, particularly with those supporting the deployment of innovative solutions. Following the identification of synergies between them, joint undertakings should aim to determine budget shares which should be used for complementary or joint activities between joint undertakings, in particular including by dedicating, where appropriate, a part of the joint undertaking's budget to joint calls. EU-Rail and SNS Joint Undertakings will launch a joint topic

call “Digital & Automated testing and operational validation of the next EU rail communication system” for a total co-funding of EUR 13,500,000, including an expected contribution from SNS JU of EUR 1,000,000. The modalities of this transfer will be detailed in an arrangement between both organisations and included with the JUs’ respective Work Programmes 2024.

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 previous years’ 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 2024 Call will follow the rules of the European Union’s Horizon Europe framework programme and in particular the Horizon Europe rules for participation²⁸ as well as the General Annexes to the HE Work Programme 2023-2024²⁹, which apply, unless specified otherwise, to EU-Rail calls for proposals.

Regarding admissibility conditions and related requirements, part A of the Horizon Europe Main Work Programme 2023-2024. General Annexes³⁰ applies 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 Main Work Programme 2023-2024 General Annexes applies for general eligibility conditions.

With regard to financial and operational capacity, part C of the Horizon Europe Work Programme 2023-2024 General Annexes applies.

Part D of the Horizon Europe Main Work Programme 2023-2024 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”.

With regard to the mandatory documents and annexes to be uploaded in the submission system, Part E of the Horizon Europe Main Work Programme 2023-2024 General Annexes applies.

Part F of the Horizon Europe Main Work Programme 2023-2024 General Annexes applies in regard as to the type of the one-stage evaluation procedure and other aspects such as budget flexibility,

²⁸ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018PC0435>

²⁹ 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

³⁰ European Commission Decision C(2022)7550 of 6 December 2022: 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

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 Main Work Programme 2023-2024 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 funding rate for each grant is set at 60% of the total eligible costs for innovation actions (IA); 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%.

The standard funding rates of Horizon Europe will apply to the CSA or RIA topics.

Where private Founding Members of the EU-Rail would be awarded any activities as a result of the Call 2024, 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 Programme³¹.

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 VII of the Work Programme.

Considering the strategic interest of the expected outcomes of actions funded under this call, EU-Rail 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 Annex 5, Article 16 - *Granting authority right to object to transfers or licensing*, and Article 18 – *Specific rules for carrying out the action – Specific rules for JU actions*.

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

³¹ <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-er-ju-2023-explr-01?tenders=false&callIdentifier=HORIZON-JU-ER-2023-01>
https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

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 art. 17 - *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

During 2024, EU-Rail is not expected to be entrusted by any country with national funds.

At this stage, the SRG has not provided any list of national projects that would allow the creation of synergies between large national investments in rail, including those funded with Regional and Cohesion resources, and EU-Rail projects.

2.3.8.3 Country specific eligibility rules

The conditions described in part B of the General Annexes to the Horizon Europe Work Programme 2023-2024 will be applied by EU-Rail without exceptions.

2.3.9 Calls for tenders and other actions

In 2024, EU-Rail is planning to implement the following call for tenders within framework of the MAWP:

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)w
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 2024	Specific contracts 2024 (3 lots) : 10 000 000
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	Q4 2024	Contracts renewal 2024: 900 000

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)w
		a contract, without having recourse to a public procurement procedure as provided in Article 43() of the 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.		
Framework contract's implementation	Studies, Strategic support to the EU-Rail and other impact assessments, evaluations, foresight, analyses and studies	Implementation of a 4-year framework contract (3 lots) following an EU-Rail open call for tenders procedure) a total value (3 lots) of EUR 3.3 million or use of framework contracts from other institutions or agencies	Q1 to Q4 2024	Specific contracts 2024 (3 lots) 800 000
Open tender (direct contract or Framework)	EU-Rail Multi-project Tool	Multi-project (programme) management tool to manage all Flagship Projects, stemming from the EU-Rail annual calls for proposals under the rules for participation of Horizon Europe	Q2-Q3	Total contract's amount 1 200 000

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)w
		and the EU-Rail Regulation.		
Total		Value of commitments for 2024		12 900 000

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 previous years' decisions of the Governing Board, these calls for tenders are not intend 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.

Additionally, as part of other operational actions, the JU will setup in 2023 all needed elements to successfully launch, during the first half of 2024, a **call for expression of interest** with a view to selecting Associated members 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.

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

All the S2R Programme projects, governed by the Horizon 2020 rules, are expected to have closed their operational activities in 2023 and the latest S2R projects are expected to be administratively phased out in 2024.

The ongoing EU-Rail projects are subject to continuous monitoring and evaluation to follow-up on their progress and also to be able 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 Handbook³² 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).

Table I of Annex IV presents the current impact assessment of the projects using the set of KPIs originally defined for the S2R Programme:

³² <https://rail-research.europa.eu/wp-content/uploads/2022/10/EU-Rail-Governance-and-Process-Handbook.pdf>

- a 50 % reduction of the life-cycle cost of the railway transport system, through a reduction of the costs of developing, maintaining, operating and renewing infrastructure and rolling stock, as well as through increased energy efficiency;
- a 100 % increase in the capacity of the railway transport system, to meet increased demand for passenger and freight railway services;
- a 50 % increase in the reliability and punctuality of rail services (measured as a 50 % decrease in unreliability and late arrivals).

These indicators were designed as a monitoring tool to ensure that the S2R Programme research and innovation activities contribute to achieving them as far as possible.

In addition, these originally identified KPIs are dependent on segments and implementation in a situation that is evolving with the evolution of the research and innovation. Hence, the impact introduced by the results of the S2R Programme might be less visible as many of the technological components developed in critical areas of the Programme do not wait for the final project end to be deployed, but they are already introduced in the successive release of products.

It appears clearly from the Table I of Annex IV that the S2R Programme has performed its activities substantially contributing to the targets and, consequently, setting an opportunity for the future deployment of innovative solutions making rail more competitive, resilient and reliable.

The current overview of demonstrators for S2R projects with a Technology Readiness Level (TRL) reaching at least value 6 (=technology demonstrated in relevant environment), is displayed in Table II of Annex IV.

The specific details on how the outputs and achievements of the past 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:

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.

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) will be continued building upon the past experience and new ones be created in particular with the European Partnerships SNS and Chip.

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.

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, CUTRIC (CA), Gulf Countries and India. In line with the policy priority of the Commission in terms of rail international relations, it is also expected that exchanges will take place with ASEAN, Australia, Japan and Mexico.

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, which constitutes one of the enabler of rail digitalization and automation. It will also ensure collaboration with the activities coordinated and carried out by RNE on Capacity allocation and management.

2.4 Support to Operations of EU-Rail in 2024

2.4.1 Communication, dissemination and exploitation

Communication

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.

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

The Communication activities for 2024 will continue to ensure that the JU's mission and objectives, including the System Pillar 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 in to prepare since the beginning for the future deployment of 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.

Further expansion of the stakeholder base will continue, based on the Multi Annual Work Programme, Annual Work Programme and on existing synergies with other European, national and regional programmes and activities, as presented in Section 2.3.11.

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 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 new events, amongst other communication activities.

EU-Rail communication activities aim to:

- **Continue to raise awareness about the JU** among key stakeholders across Europe from the rail sector and beyond, given the ambition of a better integration of rail with other transport modes for both passengers and freight managers, and the need to establish bridges with other thematic areas and sectors as identified in the EU Green Deal.
- **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. This objective will require the organisation of fora and conferences on specific topics stemming from the current Programme content and adaptation of key messages to each stakeholder.

Both of the two 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/or 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. 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 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 initiatives to further reinforce the collaborative message.

- **Lead a coherent dissemination strategy** regarding projects' activities and achievements, notably via coordinating web, documents and event management of the projects, and their presence on the EU-Rail website 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.

- Pro-actively **publish communication material** with regard to external events and meetings related to the EU-Rail. A broad dissemination of factsheets, leaflets, reports and brochures 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.
- **Manage and revamp the EU-Rail website (streamlining key success stories coming from the programme and improving the overall user-friendliness), continue publishing the 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:

- JU Founding 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;
- ERRAC members, including policy makers and decision-makers;
- Members of the Scientific Steering Group (SSG);
- Members of the States' Representatives Group (SRG);
- 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;
- Rail trade media;
- EU-Rail staff acting as ambassadors.

The implementation of the communication 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 two other JUs. The services include editorial support, events management, digital communication and website support. In addition, experts from the Horizon Europe's database might be contracted to support the technical analysis of projects output indirectly supporting the JU corporate communication and dissemination activities.

Dissemination

Dissemination of project results will be enhanced. Efforts to exploit the features of the dedicated Teams platform will be deployed for projects to communicate results to the JU and stimulate exchanges between projects. The results of the ongoing activities and of projects/tenders will be disseminated by EU-Rail via its website, 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, rail press and through social media.

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, taking into consideration the best possible way to exploit the innovative solutions developed under S2R and the future solutions coming from EU-Rail. Regular meetings will take place with Project Coordinators/Project Managers/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. Synergies with the current Programme activities on dissemination will be sought, with respective roles and responsibilities, objectives, timeframe and Key Performance Indicators. EU-Rail will monitor the compliance of the Projects with the communication guidelines that were provided at the beginning of the project cycle.

The main events, where EU-Rail will showcase its results in 2024, are at the Call 2024 Info Day in February and the General Assembly of the JU in December. Participation of the JU will be ensured at the following external events: the Connecting Europe Days on 2-5 April in Brussels, the Transport Research Arena (TRA) on 15-18 April in Dublin, and InnoTrans on 24-27 September in Berlin, where EU-Rail will share a stand area with DG MOVE and the European Agency for Railways (ERA). Other probable participations of EU-Rail include the International Transport Forum (ITF) summit in May, participation in the COP Transport Day jointly with DGMOVE, joint JUs initiative towards the European Parliament.

During 2024, TRA and InnoTrans will be the major events where EU-Rail will showcase its achievements. Synergies with other JUs will be reinforced at TRA, where a common stand will be shared by Clean Aviation, Clean Hydrogen, SESAR3 JU and EU-Rail and at InnoTrans where the JU will share a stand together with DGMOVE and ERA.

Internal communications will be in the focus, with the development of targeted messages as well as analysis of use and possible restructuring of the existing Teams environment to boost the flow of information within the staff. Team building exercises will be organised and regular team meetings will continue to take place weekly.

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 the 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 2024, 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 low-value contracts³³. In addition, if the need arises, EU-Rail will select individual external experts based on a call for expression of interest (CEI).

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 (currently covering years 2023 and 2024). For the inter-Joint Undertaking tender external accounting support and annual Accounts and the on-line data protection services EU-Rail is taken the lead.

Title	Indicative budget (EUR)	Type of procedure	Indicative schedule (Q-quarter)
Communication and event services and supplies	500,000	Specific contracts/order forms implementing a FWC or negotiated procedure for	Q1 to Q4 2024
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, not for call evaluation nor review, based on a CEI	Q1 to Q4 2024
Basic Office Furniture	15,000	Specific Contracts/order forms implementing a FWC	Q1 to Q4 2024
Catering services	35,000	Specific Contracts/order forms implementing a FWC or negotiated procedure for low-value contracts	Q1 to Q4 2024, expected to be performed as part of the BOA SLA

³³ In accordance with Article 43(2) of the EU-Rail's Financial Rules, for contracts with a value between EUR 60 000 and the thresholds laid down in Article 175 of Regulation (EU, Euratom) 2018/1046 the procedures set out in Section 2 of Chapter 1 Annex I to Regulation (EU, Euratom) 2018/1046 for contracts with a value not exceeding EUR 60 000 may be used.

Title	Indicative budget (EUR)	Type of procedure	Indicative schedule (Q-quarter)
IT support and supplies	195,000	Specific Contracts/order forms implementing a FWC or Negotiated procedure for middle or low value contract	Q1 to Q4 2024, expected to be performed as part of the BOA SLA
Team Building and Training	30,000	Negotiated procedure for low value contract or Specific Contracts/order forms implementing a FWC	Q1 to Q4 2024, expected to be performed as part of the BOA SLA and or DG HR FWCs
Finance and audit	25,000	Specific Contracts/order forms implementing a FWC	Q1 to Q4 2024
Legal Assistance	50,000	Specific Contracts/order forms implementing a FWC	Q1 to Q4 2024
Implementation of the Back Office Arrangements (BOA)	50,000 / year out of the FwC for all JUs estimated at 440,000 year	Implementation of a Framework contract External accounting support (lot 1) and Annual Accounts Audits (lot 2) for 10 JUs and for 6 years duration	Q3 to Q4 2024, expected to be performed as part of the BOA SLA
Data protection on-line register (implementation of BOA procurement)	190,000 overall estimation for 7 years contract /22,000 per participating Joint Undertaking	Direct contract with – open tender or Negotiated procedure without prior publication of a contract notice	Q3-Q4

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 procedures put in place as part of the CAAR 2024.

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 started working together on particular solutions regarding the back office arrangements, in accordance with Article 13 of the SBA. These first solutions were presented to the JUs' Governing Boards in their meetings held in June 2022 and finally endorsed at the GB meetings at the end of the year 2022. In particular, EU-Rail suggested to take 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 the back office arrangements for accounting and procurement services are already operational by means of the concluded SLAs, others will follow in the upcoming period (ICT, HR).

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.

EU-Rail collaborates with the other JUs in synergy under a joint strategic ICT plan. This plan includes for 2024 the final steps of the infrastructure migration performed in 2023; the implementation of the EC authentication method for the JU infrastructure; the implementation of a new regulation for a close cooperation with all EU bodies in terms of cybersecurity and data protection; the implementation of a bridge between M365 and the EC document management system; and the upgrade of the common meeting rooms with a videoconference system.

The JU annual work plan also includes in 2024 the implementation of the BOA ICT. It is expected that every year, one lead JU will take 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.

Following the Data Protection Impact Assessment (DPIA) conducted in 2020, the JUs 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 finalized the migration to M365 in 2022 and started an initiative for 2023-2024 to simplify, modernise and digitalise processes and ways of working to increase efficiency, using the newly deployed M365 features.

2.4.3.2 Data protection

As regards the processing of personal data, EU-Rail applies Regulation (EU) 2018/1725 of 23 October 2018³⁴, 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) 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 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 pages³⁵.

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 rules³⁶ 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 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 (Clean Aviation JU and SESAR 3 JU), acting in the role of the accounting service provider.

2.4.4 Human resources

2.4.4.1 HR management

In 2024, EU-Rail will be staffed with 29 staff members including 2 Seconded National Experts (SNEs). In line with the Establishment Plan, recruitment procedures were launched in 2022 and 2023 in order to recruit the additional staff members. Where needed, the JU will make recourse to Interim Staff while the recruitment processes are completed or in case of specific and temporary peaks of activities.

³⁴ 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.

³⁵ <https://rail-research.europa.eu/terms-of-use/>

³⁶ 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>

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 for the first time will welcome 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 an 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 as well as a well-being programme which will continue to be available to the staff in 2024. Individual coaching sessions will be considered both for staff as well as for the management team.

2.4.4.2 Strategy for achieving efficiency gains and synergies

From the HR perspective, in 2024, the JU's major challenge will be to continue to ensure smooth implementation of the new EU-Rail Programme, with novelties in the organisational structure and accommodation of new staff members following also the transition to the new ED appointment.

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.

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:

- Develop a fit-to-purpose competency framework;
- Establish a talent development plan.

In terms of synergies and collaboration with the other Joint Undertakings, in 2024, the JUs will continue sharing the HR-related IT tools (e.g. the e-recruitment tool SYSTAL, SYSPER) and, where necessary, common calls for tender, 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 intended 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.

2.4.4.3 Staff establishment plan³⁷

The Authorized Budget indicated in the tables below refers to the staffing of EU-Rail which started its activities on 30 November 2021 and may therefore differ from the actually filled positions due to the fact that it was not possible to recruit all the staff by the end of 2022. While the remaining additional posts resulting from the current Staff Establishment Plan have been successfully filled during 2023, new recruitment procedures needed to be launched in parallel in the second half of the year 2023 to reflect on some staff members' departures. The new Executive Director is also expected to be appointed in 2024.

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 proposed to be the lead JU for this part of BOA. The Commission services confirmed that 3 additional contract agents could be 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	2022				2023		2024		2025	
	Authorised budget		Filled as of 31/12/2022		Authorised budget		Authorised budget		Authorised budget	
	Permanent posts	Temporary posts	Permanent posts	Temporary posts	Permanent posts	Temporary posts	Permanent posts	Temporary posts	Permanent posts	Temporary posts
AD 16										
AD 15		1								
AD 14				1		1		1		1
AD 13										
AD 12										
AD 11										2
AD 10		2		2		2		2		1
AD 9		1		1		1		1		1
AD 8		1		1		1		1		
AD 7										4
AD 6		4		4		4		4		1
AD 5		1		1		1		1		
AD TOTAL	0	10	0	10	0	10	0	10		10
AST 1-11	0	0	0	0	0	0	0	0		0
AST TOTAL	0	0	0	0	0	0	0	0		0
AST/SC 1-6	0	10	0	10	0	10	0	10		10

³⁷ 2023, 2024 and 2025 staff number are presented based on the Legal Financial Statements annexed to the SBA but are subject to the adoption of the EU General Budget for 2023, 2024 and 2025.

AST/SC TOTAL										
TOTAL										
GRAND TOTAL	10		10		10		10		10	

Contract Agents	FTE corresponding to the authorised budget 2022	Executed FTE as of 31/12/2022	Headcount as of 31/12/2022	FTE corresponding to the authorised budget 2023	FTE corresponding to the authorised budget 2024	FTE corresponding to the authorised budget 2025
Function Group IV	15	8	8	15	15	15
Function Group III	1	7	7	1	4	4
Function Group II	1	2	2	1	1	1
Function Group I						
TOTAL	17	17	17	17	20	20

Seconded National Experts	FTE corresponding to the authorised budget 2023	Executed FTE as of 31/12/2023	Headcount as of 31/12/2023	FTE corresponding to the authorised budget 2024	FTE corresponding to the authorised budget 2025	FTE corresponding to the authorised budget 2026
TOTAL	2	2	2	2	2	2

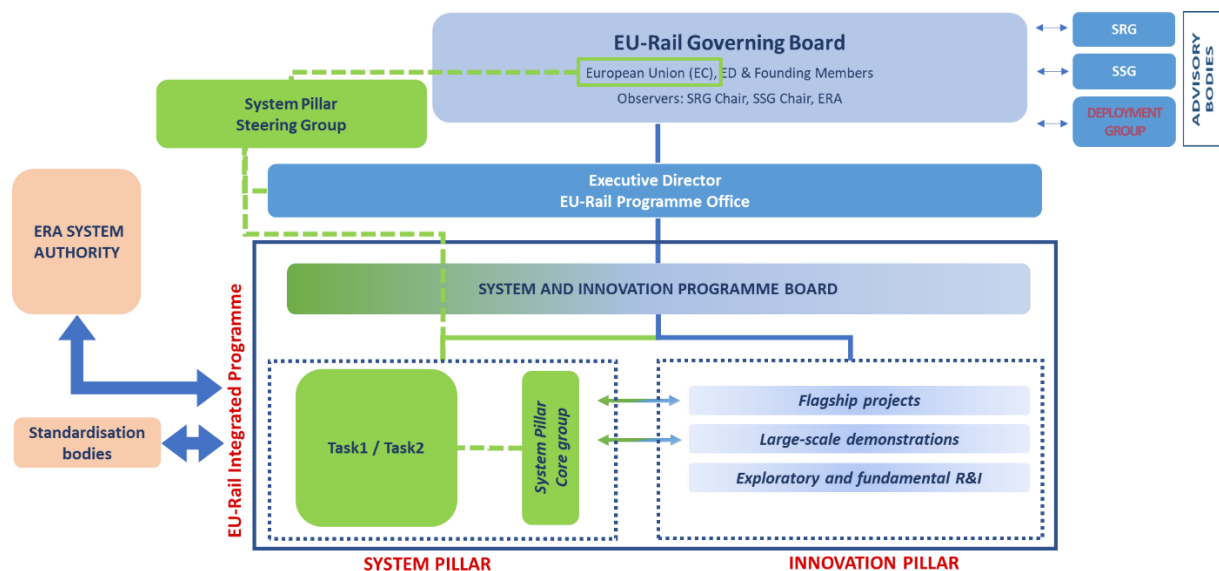
Recruitment forecasts for 2024 following retirement/mobility or new requested posts					
Job title in the JU	Type of contract (Official, CA, TA)		TA/Official		CA
			Function group/grade of recruitment internal (Brackets) and external (single grade) foreseen for publication		Recruitment Function Group (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

2.5 Governance activities

After the Europe's Rail Joint Undertaking was successfully set up, the governing, consultation and advisory bodies of the JU became operational as well.

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 in the first half 2023). In addition to these bodies, the System and Innovation Programme Board (ED-SIPB)³⁸ supports the Executive Director.

³⁸ 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 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 Procedure³⁹. In the same meeting, the GB adopted the so-called “omnibus decision”⁴⁰, 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.

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 chairperson and vice-chairperson 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.

³⁹ GB Decision n°01/2021

⁴⁰ GB Decision n°02/2021

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 will be 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 2024, it is foreseen that the EU-Rail's Governing Board will hold three meetings, in April, June and November, the latter to be followed by a General Assembly.

One of the particular tasks of the GB as per SBA Article 17(2) point (a1) is adopting by the end of 2023 a plan for the phasing-out of the joint undertaking from Horizon Europe funding. Furthermore, EU-Rail has been requested by the Commission services to further develop its 2023 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. It will be subject for a GB decision in by the end 2024.

The GB's key planned activities are listed below:

Key activities in 2024 – timetable	
2023 Call award	Q1
2024 Call award, Approval of the update of the MAWP, Decision on the call for Associated Members, Adoption of the 2023 CAAR and of the Opinion on 2023 Final Annual Accounts	Q2
Adoption of the 2025 Work Programme, Potential IKAA plan update, Phasing out 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)⁴¹

It is expected that in Q1 2024, the new Executive Director will be appointed as a result of the selection process, who would take over the mandate from the current Executive Director *ad interim* acting in this position as of 1 March 2023.

2.5.3 Scientific Steering Group

In the first half of 2023, two meetings of the Scientific Committee (SC) were held providing EU-Rail with a structured scientific advice based on the continued S2R SC mandate re-confirmed via the "omnibus decision".

⁴¹ 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 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.

In 2024, 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 2024.

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 2024, three meetings of the SRG are planned (in Q1, Q2 and Q4).

The tentative key activities are listed below:

Key activities in 2024 – timetable	
1st Meeting of the SRG in which it would: <ul style="list-style-type: none"> – 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. 	Q1
2nd Meeting of the SRG in which it would: <ul style="list-style-type: none"> – Provide opinion on the 2023 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: <ul style="list-style-type: none"> - Provide opinion on the 2025 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 2024, 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 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 State Representative Group and 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 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. The proposal made by EU-RAIL shall be not binding for the Commission.

The European Commission will take a 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.

The activities of the Deployment Group therefore are expected to start not before Q1 2024.

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 COSO⁴² 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 controls⁴³;

⁴² COSO = Committee of Sponsoring Organizations of the Treadway Commission, where the sponsoring organizations are: American 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.

⁴³ 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) aspects of the actions funded by EU-Rail.

- certification by independent auditors of costs representing the in-kind contributions to additional activities provided by the private members of the JU;
- ex-post controls⁴⁴;
- 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 system⁴⁵. 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 2024, 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 recommendations from the *Audit on H2020 grant implementation and closing* conducted by 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 2023 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) and complemented by the EU-Rail financial Rules, adopted in accordance with Commission Delegated Regulation (EU) 2019/887 of 13 March 2019 on the model financial regulation for public-private partnership bodies referred to in Article 71 of Regulation (EU, Euratom) 2018/1046 of the European Parliament and of the Council⁴⁶. 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 bodies 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 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 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

⁴⁴ 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) aspects of the actions funded by EU-Rail.

⁴⁵ 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 cumulative residual error rate of the H2020 Programme.

⁴⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R0887>

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 on main procedures (grants & procurements).

During the past years, the processes and procedures have been further reinforced with the introduction of the JU Cooperation Tool (including for in-kind contribution declarations and certifications) awaiting for the integration of IKOP and IKAA 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

With the new Programme under Horizon Europe (HE) only launched in 2022, the prevailing focus of ex-ante and ex-post controls in the upcoming period will still be with the ongoing projects from the previous Programme governed by the Horizon 2020 (H2020) rules. For these projects, EU-Rail will continue to follow the procedures for ex-ante and ex-post controls established in its Financial Rules as well as in the common guidelines applicable to H2020 introduced by the European Commission.

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 cost claims 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.

For the HE grants, EU-Rail will put in place by yearend 2023 its risk-based Control Strategy to also reflect on the audit recommendations of IAS and ECA. This strategy will cover both ex-ante and ex-post controls for grants and will fully reflect 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 keep/provide financial records, and that such records may not be requested by the JU during or after the implementation of the action⁴⁷. These differences will reflect under a 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

⁴⁷ 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) (Ares(2021)4424362).

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 new 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 include financial audits which are covered by the Horizon 2020 Audit Strategy and carried out by the Common Audit Service (CAS) of the Commission. In Q4 2023, CAS confirmed the selection of the local representative audit sample for the JU with the target closure year 2024. EU-Rail will report the outcome of the financial ex-post audits closed in the course of 2023 in its Consolidated Annual Activity Report. This reporting will include the error rates identified and applicable to the JUs population.

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 introduce 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, drafting of which is currently in progress, and which will take 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 2024, 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).

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, it is expected that IAS will draw up their Strategic Internal Audit Plan for the upcoming period (usually 3 years) which will include the foreseen audit topics, subject to annual reassessments.

The latest IAS' *Audit on H2020 grant implementation and closing*, which started in 2021, and which was finalized in September 2022, brought the conclusion that the management and internal control system in EU-Rail with regard to the H2020 grant implementation and closing process is adequately designed and effectively and efficiently implemented. While the audit work did not result in the identification of any critical or very important findings, IAS identified room for further improvement in relation to:

- JU's risk-based monitoring strategy for the projects and beneficiaries,
- Dissemination and exploitation aspects of the grant management,
- JU's anti-fraud policy and annual exercise for collecting declarations of interests from its staff,
- Implementation of workflows in the respective IT tools within the grant management process.

IAS formally acknowledged in August 2023 that the recommendation under the third bullet point here above is considered closed. EU-Rail will be actively working on the implementation of the measures related to the remaining three audit recommendations so that they can be finalized by the deadline of 31/12/2023, as agreed in the action plan.

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 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 its annual report on EU Joint Undertakings for the financial year 2022, no major issue was reported by the ECA for EU-Rail itself.

One observation was raised for follow-up, similarly to the financial year 2021, regarding the implementation rate for the operational payment appropriations, including operational unused and reallocated appropriations, which fell to 46.6 % (2021: 61 %). The JU replied that as stated in last year's annual report, project extensions were granted due to the impact of the COVID-19 pandemic. In some cases, the beneficiaries had to revise insufficient technical reports/deliverables, or provide additional evidence of project results. Consequently, some interim and final payments of the JU's Horizon 2020 programme agenda had to be postponed but the programme's completion remains on target for the end of 2024. To mitigate as much as possible the delays in technical activities originating in 2021 and continued in 2022, the JU together with its private members have put in place an action plan corresponding to €36.6 million in payments. This action plan, which is being implemented, was endorsed by the JU's Governing Board in April 2023 and revised in June 2023. Its success also depends on the ability of the projects to produce the outputs in the expected quality.

Furthermore, the ECA also issued horizontal observations common to all JUs. More specifically, it was pointed out that the gap between the recognised amount of cash contributions on the one hand, and in-kind contributions on the other hand, could be better addressed in the JUs' 2022 Annual Accounts. With the support of the BOA for Accounting Services, a new dedicated reporting table was prepared to be used for the Annual Accounts 2023 with the objective to immediately close this observation.

Another ECA's horizontal observation was related to the JUs' risk-based control framework for implementing grants. EU-Rail intends to address the related recommended actions by means of the establishment, and the subsequent practical implementation, of its HE Control Strategy for grants, as described in Section 2.6.4.

With regard to the H2020 actions based on actual cost reporting funded by the JU, those grants will still continue to be subject to the financial ex-post audits in line with the Horizon 2020 common Audit Strategy implemented by the CAS, as also mentioned in 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 Q4 2023, in accordance with the JU's policy for risk management as defined in its Governance and Process Handbook, the JU performed a risk assessment exercise with the aim of updating the elements related to risks and opportunities already included in its risk register, as well as identifying potential new ones. Within this exercise current internal and external factors and developments having influence on JU's business were taken into account, as well as the views of the IAS who conducted their in-depth risk assessment of the JU in the same period. Due attention was given also to the fraud risks.

The management of risks during 2024 will be based on the results of the above mentioned risk assessment exercises. In addition, more targeted assessments of risks related to individual projects/beneficiaries will be part of the implementation of the new EU-Rail risk-based Control Strategy for grants, introduction of which is envisaged by the end of 2023. This strategy will reflect the audit recommendations of IAS and ECA.

2.6.7 Anti-fraud strategy

In July 2022, EU-Rail adopted its new Anti-Fraud Strategy for 2022-2025⁴⁸ 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 will be 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,

⁴⁸ https://rail-research.europa.eu/wp-content/uploads/2022/07/ED-DECISION_ED-22-02_Anti-Fraud-Strategy-2022-2025_Annex_AFS.pdf

- 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;
- 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 2024 ⁴⁹

In accordance with the General Annexes of the Horizon Europe Work Programme 2023-2024, 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.

In accordance with the SBA (recitals 10 and 12 and Article 5(2) c)), to achieve maximum impact, the joint undertakings should develop close synergies with other Horizon Europe initiatives and other Union programmes and funding instruments, particularly with those supporting the deployment of innovative solutions. Following the identification of synergies between them, joint undertakings should aim to determine budget shares which should be used for complementary or joint activities between joint undertakings, in particular including by dedicating, where appropriate, a part of the joint undertaking's budget to joint calls. EU-Rail and SNS Joint Undertakings will launch a joint call "Digital & Automated testing and operational validation of the next EU rail communication system" for a total co-funding of EUR 13,500,000, including an expected contribution from SNS JU of EUR 1,000,000. The modalities of this transfer will be detailed in an arrangement between both organisations and included in the JUs' respective Work Programmes 2024.

EUR 1,000,000 is therefore added into the section "EU Contribution" in accordance with the structure of the EU-Rail budget, but is coming from SNS JU and not from the Union.

In accordance with the Single Basic Act Article 10.4, EUR 1,000,000 new revenue in 2024 are considered as additional Union funds complementing the contribution allocated to the EU-Rail Programme implementing Horizon Europe⁵⁰. In this respect, and in accordance with SBA Article 10.6, this additional contributions from Union programmes corresponding to additional tasks entrusted to EU-Rail shall not be accounted for in the calculation of the Union maximum financial contribution to the EU-Rail Programme.

Budget Amendment nr 1 (A1) – Statement of Revenue

Compared to Work Programme 2024 and Budget, this amendment recognises and balance (Revenue and Expenditure) unused payment appropriations on S2R Programme operational expenditure due in relation to the previous budgetary years, in accordance with EU-Rail Financial Rules Article 6.5.

The following is entered in addition to the estimate of revenue:

- **EUR 32.9 million in payment appropriations.** Those will be needed for the last year of the S2R Programme execution in order to pay S2R Programme grants interim and final payments.

In 2023, the Reporting and Payments 2023 action plan forecasted 52 payments for the year with a total value of EUR 36 million, of which the JU achieved 42 payments for a total value of EUR 23.2 million

⁴⁹ 2024 Budget (Commitment and Payment appropriations) are subject to the adoption of the EU General Budget for a

⁵⁰The increase relates to the Pilot Project, as indicated in accordance with the specific provision of the SBA, and no EFTA contribution apply to this added funds. We refer to "pilot" for this joint call which is meant for the implementation of synergies between JUs that have never been implemented previously, not as a "pilot action" requested and funded by the European Parliament.

Forecasted*	52 RPs	36. 7M
Achieved	42 payments	23,2M*
Rescheduled to 2024	10 payments	9,4M

** Out of the 42 achieved payments, 9 projects under-consumed for a total of 4,1m€ with relation to the initial forecast (23.2m€ executed + 4.1m€ under-consumed + 9.4m€ rescheduled = 36.7m€ of total initial planning)*

Of the 52 forecasted payments, 10 projects with a total value of 9,4m€ were postponed to be paid in 2024.

In 2024, the JU is forecasting for S2R Programme:

- 27 interim and final payments for a total amount of maximum EUR 36.6 million (including the 10 postponed from 2023);
- The possible complementary payments after final payments for 10 grant agreements (final payments in status "Actions under observations" in the IT accounting tool of the JU), for a maximum of EUR 3.2 million;
- Other final payments on tenders and experts.

The following table summarises the pending S2R Programme payments to be executed in 2024, showing the available budget, still to be paid and per grant agreement or contract ("Open RAL" or "Reste A Liquider") – for a total of EUR 39.9 million.

	Open RAL EUR	Number of actions / Commitments	Number of payments
Actions with open reporting	36.573.351,19	23	27
Actions under observation	3.206.761,51	10	10
Tenders	16.960,00	2	2
Experts	92.110,00	2	2
Total	39.889.182,70	37	41

The JU will deduct the amount already adopted by the Governing with initial budget 2024 as "unused appropriations of the year" of EUR 7.0 million.

Consequently, the amount to be entered in addition to the estimate of revenue and in payment appropriations is **EUR 32.9 million**.

Budget Amendment nr 1 (A1) – Statement of Expenditure

Title III (Operational S2R Programme):

Increase of the S2R Programme operational payment appropriations of EUR 32.9 million. This is needed to pay the S2R Programme grants interim and final payments (and as applicable also final payments on operational tenders and experts) expected for the year 2024.

In terms of planning, all the final payments of the S2R Programme are expected to be executed by the summer 2024. This would depends on the capacity of the projects to submit those payments on time

and on the quality of reports and deliverables provided, and would require a constant monitoring done by the JU with the projects' consortia.

This increase is covered by entering in addition to the estimate of revenue, the unused payment appropriations from the previous budgetary years, as indicated in previous section.

STATEMENT OF REVENUE					
Title Chapter	Hea ding	Financial Year 2024 - A1			
		Estimate Commitment Appropriation s	In %	Estimate Payment Appropriations	In %
EU contribution (excluding EFTA and third countries contribution)[2]		104.994.557	92%	71.471.785	59%
of which (fresh C1) Administrative (Title 1&2)		2.395.762	2%	2.395.762	2%
of which frontloaded commitments (Title 1 and Title 2)		-		522.228	
of which Operational (Title 3)		102.598.795	90%	68.553.795	57%
Of which related to additional entrusted tasks					
EFTA and third countries contribution		3.681.407	3%	2.524.408,14	2%
of which Administrative EFTA(Title 1&2)		84.810	0%	97.604	0%
Of which administrative third countries excluding EFTA (Title 1&2)					
of which Operational EFTA (Title 3)		3.596.597	3%	2.426.804	2%
Of which operational third countries excluding EFTA (Title 3)					
Financial Members other than the Union contribution		3.015.594	3%	3.015.594	2%
of which Administrative (Title 1&2)		3.015.594	3%	3.015.594	2%
of which Operational (Title 3)					
Financial Contributing partners contribution					
Interest generated					
Unused appropriations from previous years		2.883.647	3%	43.798.082	36%
Of which administrative		2.883.647	3%	3.908.900	3%
Of which operational		-	0%	39.889.183	33%
TOTAL ESTIMATE REVENUE		114.575.205	100%	120.809.870	100%

STATEMENT OF REVENUE - AMENDED - VARIANCE A1													
Title Chapter	Heading	Financial Year 2024				Financial Year 2024 - A1				VARIANCE			
		Estimate Commitment Appropriations	In %	Estimate Payment Appropriations	In %	Estimate Commitment Appropriations	In %	Estimate Payment Appropriations	In %	Estimate Commitment Appropriations	In %	Estimate Payment Appropriations	In %
EU contribution (excluding EFTA and third countries contribution)[2]		104.994.557	92%	71.471.785	81%	104.994.557	92%	71.471.785	59%	-	100%	-	100%
of which (fresh C1) Administrative (Title 1&2)		2.395.762	2%	2.395.762	3%	2.395.762	2%	2.395.762	2%	-	100%	-	100%
of which frontloaded commitments (Title 1 and Title 2)		-		522.228		-		522.228		-		-	
of which Operational (Title 3)		102.598.795	90%	68.553.795	78%	102.598.795	90%	68.553.795	57%	-	100%	-	100%
Of which related to additional entrusted tasks						-		-		-		-	
EFTA and third countries contribution		3.681.407	3%	2.524.408	3%	3.681.407	3%	2.524.408	2%	-	100%	-	100%
of which Administrative EFTA(Title 1&2)		84.810	0%	97.604	0%	84.810	0%	97.604	0%	-	100%	-	100%
Of which administrative third countries excluding EFTA (Title 1&2)						-		-		-		-	
of which Operational EFTA (Title 3)		3.596.597	3%	2.426.804	3%	3.596.597	3%	2.426.804	2%	-	100%	-	100%
Of which operational third countries excluding EFTA (Title 3)						-		-		-		-	
Financial Members other than the Union contribution		3.015.594	3%	3.015.594	3%	3.015.594	3%	3.015.594	2%	-	100%	-	100%
of which Administrative (Title 1&2)		3.015.594	3%	3.015.594	3%	3.015.594	3%	3.015.594	2%	-	100%	-	100%
of which Operational (Title 3)						-		-		-		-	
Financial Contributing partners contribution						-		-		-		-	
Interest generated						-		-		-		-	
Unused appropriations from previous years		2.883.647	3%	10.908.900	12%	2.883.647	3%	43.798.082,23	36%	-	100%	32.889.182,70	401%
Of which administrative		2.883.647	3%	3.908.900	4%	2.883.647	3%	3.908.899,53	3%	-	100%	-	100%
Of which operational		-	0%	7.000.000	8%	-	0%	39.889.182,70	33%	-	#DIV/0!	32.889.183	570%
TOTAL ESTIMATE REVENUE		114.575.205	100%	87.920.687	100%	114.575.205	100%	120.809.870	100%	-	100%	32.889.183	137%

STATEMENT OF EXPENDITURE					
Title Chapter	Heading	Financial Year 2024 - A1			
		Estimate Commitment Appropriations	% Ratio	Estimate Payment Appropriations	% Ratio
			[Year N+1/year N]		[Year N+1/year N]
1- Staff					
Salaries & allowances					
- Of which establishment plan posts	110	1.630.000	124%	1.630.000	139%
- Of which external personnel	111	1.768.000	104%	1.600.000	103%
Expenditure relating to Staff recruitment					
Mission expenses	130	120.000	78%	100.000	100%
Socio-medical infrastructure					
Training	150	52.000	102%	35.000	103%
External Services					
Receptions, events and representation					
Social welfare					
Other Staff related expenditure	190	368.000	102%	300.000	106%
2-Infrastructure and operating					
Rental of buildings and associated costs	200	360.000	90%	360.000	102%
Information, communication technology and data processing	210	195.000	100%	205.000	79%
Movable property and associated costs	220	10.000	100%	10.000	100%
Current administrative expenditure	230	15.000	100%	10.300	67%
Postage / Telecommunications	240	15.000	100%	15.000	100%
Meeting expenses	250	50.000	100%	40.000	190%
Running costs in connection with operational activities	260	50.000	36%	350.000	97%
Information and publishing	270	650.000	144%	650.000	217%
Studies					
Other infrastructure and operating expenditure	290	200.000	133%	200.000	182%
TOTAL ADMINISTRATIVE (1+2)		5.483.000	110%	5.505.300	120%
3-Operational					
TOTAL OPERATIONAL (3)		106.195.392	112%	111.404.804	100%
Unused Appropriations					
TOTAL Unused		2.896.813	100%	3.899.766	100%
ESTIMATE TOTAL EXPENDITURE		114.575.205	112%	120.809.870	101%

The EUR 1.000.000 increasing the section “EU Contribution” in accordance with the structure of the EU-Rail budget is coming from SNS JU and not from the Union.

STATEMENT OF EXPENDITURE - AMENDED - VARIANCE A1													
Title Chapter	Heading	Financial Year 2024				Financial Year 2024 - A1				VARIANCE			
		Estimate Commitment Appropriations	% Ratio [Year N/year N- 1]	Estimate Payment Appropriations	% Ratio [Year N/year N- 1]	Estimate Commitment Appropriations	% Ratio [Year N+1/year N]	Estimate Payment Appropriations	% Ratio [Year N+1/year N]	Estimate Commitment Appropriation s	% 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	1.630.000,00	124%	1.630.000,00	139%	1.630.000,00	124%	1.630.000,00	139%	-	0%	-	0%
- Of which external personnel	111	1.768.000,00	104%	1.600.000,00	103%	1.768.000,00	104%	1.600.000,00	103%	-	0%	-	0%
Expenditure relating to Staff recruitment						0	0	0	0				
Mission expenses	130	120.000,00	78%	100.000,00	100%	120.000,00	78%	100.000,00	100%	-	0%	-	0%
Socio-medical infrastructure						0	0	0	0				
Training	150	52.000,00	102%	35.000,00	103%	52.000,00	102%	35.000,00	103%	-	0%	-	0%
External Services						0	0	0	0				
Receptions, events and representation						0	0	0	0				
Social welfare						0	0	0	0				
Other Staff related expenditure	190	368.000,00	102%	300.000,00	106%	368.000,00	102%	300.000,00	106%	-	0%	-	0%
2-Infrastructure and operating													
Rental of buildings and associated costs	200	360.000,00	90%	360.000,00	102%	360.000,00	90%	360.000,00	102%	-	0%	-	0%
Information, communication technology and data processing	210	195.000,00	100%	205.000,00	79%	195.000,00	100%	205.000,00	79%	-	0%	-	0%
Movable property and associated costs	220	10.000,00	100%	10.000,00	100%	10.000,00	100%	10.000,00	100%	-	0%	-	0%
Current administrative expenditure	230	15.000,00	100%	10.300,00	67%	15.000,00	100%	10.300,00	67%	-	0%	-	0%
Postage / Telecommunications	240	15.000,00	100%	15.000,00	100%	15.000,00	100%	15.000,00	100%	-	0%	-	0%
Meeting expenses	250	50.000,00	100%	40.000,00	190%	50.000,00	100%	40.000,00	190%	-	0%	-	0%
Running costs in connection with operational activities	260	50.000,00	36%	350.000,00	97%	50.000,00	36%	350.000,00	97%	-	0%	-	0%
Information and publishing	270	650.000,00	144%	650.000,00	217%	650.000,00	144%	650.000,00	217%	-	0%	-	0%
Studies						-	0%	-	0%				
Other infrastructure and operating expenditure	290	200.000,00	133%	200.000,00	182%	200.000,00	133%	200.000,00	182%	-	0%	-	0%
TOTAL ADMINISTRATIVE (1+2)		5.483.000,00	110%	5.505.300,00	120%	5.483.000,00	110%	5.505.300,00	120%	-	0%	-	0%
3-Operational													
TOTAL OPERATIONAL (3)		106.195.392,00	112%	78.515.621,14	100%	106.195.392,00	112%	111.404.803,84	100%	-	0%	32.889.182,70	0%
Unused Appropriations													
TOTAL Unused		2.896.812,98	100%	3.899.765,67	100%	2.896.812,98	100%	3.899.765,67	100%	-	0%	-	0%
ESTIMATE TOTAL EXPENDITURE		114.575.204,98	112%	87.920.686,81	73%	114.575.204,98	112%	120.809.869,51	101%	-	0%	32.889.182,70	27%

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
<i>Total amount to be assigned via annual instalments (Calls)</i>	232.764,7					
<i>Amount of annual instalments 2022-1</i>	135.707,2	55.936,1	41.121,3	232.764,7	40,0%	
<i>Amount to be assigned on annual budget (other calls/tenders/experts)</i>	28.800,0	38.535,3	35.000,0	102.335,3		
<i>Available Commitment appropriations</i>			30.074,1			
<i>Total annual budget (operational EU-Rail Programme)</i>	164.507,2	94.471,4	106.195,4			365.174,1
	2025	2026	2027	Total	Ratio cumulative budget of the residual years (min 20%)	Gran total 2022-2027
<i>Total amount to be assigned via annual instalments (Calls)</i>	133.371,0					
<i>Available Commitment appropriations</i>	30.074,1					
<i>Amount of annual instalments</i>	76.563,0	26.733,9		133.371,0		
<i>Amount to be assigned on annual budget (other calls/tenders/experts)</i>	14.900,0	50.642,1	47.686,9	113.229,0	45,9%	
<i>Total annual budget (operational EU-Rail Programme)</i>	91.463,0	77.376,0	47.686,9			581.700,0

4. ANNEXES

Annex I - IKAA plan

The IKAA plan has been provided following the outcome of the first Call 2022 as the additional activities proposed by the Founding Members in their letter of commitment are related to the future EU-Rail Projects.

The IKAA Plan follows the award decision of the Governing Board on the first Call 2022; it is based on the input received from all the Private Founding Members by 29 November 2022.

OVERVIEW ESTIMATED AMOUNT OF IKAA FOR 2023	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project
1. Support to additional R&I	5.348.900,49	37.086.673,97
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area	337.648,76	4.570.144,21
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area	1.018.116,44	8.358.184,00
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	1.493.556,85	8.965.770,84
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	393.688,09	7.108.793,93
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area	179.098,77	4.783.666,67
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	44.218,12	1.023.447,67
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 7 in the context of achieving the objectives and KPIs of the related Flagship Area	-	10.000,00
CFD Simulations and Real operations 1:1 scale tests to determine the admissible pressure load in a freight train during the crossing with a HST in a tunnel	281.069,80	-
High efficiency power electronics and electromagnetic machines, rare earth recovery sustainable processes	400.000,00	-
Infrastructure degradation models of metallic components and customized powder manufacturing for AM	200.000,00	1.000.000,00
Low costs signalling system for train collision avoidance (e.g. EGNSS)	200.000,00	1.000.000,00
Maintenance of ETCS lab Quality system for ISO/IEC 17025 Accreditation and Internal activities/projects to maintain ERTMS labs	75.403,68	-
OCORA: Non-funded activities	150.000,00	-
R&D internal projects related to and complementary to ERJU FAs topics.	100.000,00	-
Reduced models for efficient optimization processes	200.000,00	-
Smart Structural Health Monitoring for High Speed Railway Bridges, including Predictive Maintenance of these infrastructures through Intelligent Systems.	40.000,00	-
SW development to automatize ETCS tests, ETCS simulation tools to be adapted to the new TSI releases, Development of a Robot actuator for remote tests, Image Processing system to process images at ETCS DMI to perform automatic tests analysis	36.100,00	-
System Pillar: Non-funded activities	200.000,00	-
TT - Project NGT Fun System dynamics: Simulation digital Twin concept	-	266.666,67
2. Scale up of technologies	1.174.295,00	3.756.428,24
Account based ticketing and new validation systems	200.000,00	-
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	2.412.655,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	469.651,00
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	-	160.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area	-	529.922,24
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	-	184.200,00
ATO Functionality GoA3/4	200.000,00	-
Implementation Methodology for Cloud-based native Architecture. Developing Work Model Definition. Digital Enterprise Architecture	25.000,00	-
Innovative system to perform digital visits to the railway network and support asset management and infrastructure maintenance.	249.295,00	-
Moving Block -TRL 5 to 7	500.000,00	-

3. Demonstrators	1.512.209,74	8.046.001,31
Activities for the definition of the basic equipment for the detection of elements of infrastructure and its digitization, equipment for the monitoring trains, track measurement campaign with inspections train.	68.983,49	-
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	544.932,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	848.654,00
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	-	952.400,00
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	-	791.815,31
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area	-	4.353.200,00
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	-	555.000,00
ASTP - Absolute safe train positioning	150.000,00	-
Carrying out tests lab test on models, at a 1:1 scale, in the railway track box to analyze and assess any development or technological innovation considered necessary to quickly upgrade track behavior as a whole or to individual track components	95.680,00	-
Compile the information available from tests in which have simulated the passage of trains at a speed greater than 300 km/h (Very High Speed Trains) and extract the relevant conclusions regarding the maximum vertical deflection and levels of acceleration that might be expected in the rail and the sleeper for the improved commercial, nominal and future design speeds, among others.	59.000,86	-
Construction of zero emission areas around the stations, to promote sustainable mobility in the first and last mile of travelers (transfer from the initial origin to the station and from the station to the final destination), including implementation of Electric Charging Points fed by DC-powered Railway Network	90.772,65	-
Deepen the knowledge of the network, through the characterization of the parameters influencing the vertical dynamics of the track, to optimize the standards for design, construction and maintenance of track superstructure	105.487,83	-
Development of demonstrators at TRL 7 level for early detection of rail defects or broken rails. Human Machine Interface (HMI) and its Integration in the Central Supervision Post, including development of Web platform and mobile APP for real-time data viewing and alarm notification	313.286,19	-
Onboard Platform HW prototype developmt	200.000,00	-
Rock fall detection system based on DAS (Distributed Acoustic Sensing) Technology, supported by the use of CCTV cameras. Also, with a Human Machine Interface (HMI) including development of a Web platform for real-time data viewing and alarm notification	268.282,14	-
Solution for the digitization of the linear infrastructure in BIM 3d format from the massive capture of data from Lidar sensors, 360° RGB cameras, GNSS, inertial positioning systems and automatic processing.	160.716,58	-
4. Creating new business opportunities	26.962,00	-
Software DISC EMAN	26.962,00	-
5. Training & skills development	22.402,51	1.200.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	1.200.000,00
Training activities to maintain the level of skills of the ETCS experts and SW development	22.402,51	-
6. Contribution to the development of new standards, regulations and policies	66.836,70	-
Participation in both Spanish UNE Standardisation and CEN (JTC-20) frameworks and WGs for Hyperloop	11.040,50	-
Participation in the European Group modifying SubSet SS-076 (ETCS Test Specs) to the new TSI releases	55.796,20	-
7. Supporting ecosystem development	506.100,00	2.880.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	2.500.000,00
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	-	120.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area	-	260.000,00
Implementation of LL-type brake blocks shoes on freight wagons minimizing noise emission to replace phosphorous cast iron brake blocks shoes are noisier and exceed the limits set by noise regulations. Likewise, with this type of brake blocks shoes, part of the unwanted fires that are produced by sparks from phosphorous cast iron shoes are avoided.	356.100,00	-
Participation in national organisations and possible pilots and support of inniatives in the shape of contributions towards new concepts and ideas (Railforum, Energy Roundtable, etc.)	150.000,00	-
8. Communication, dissemination, awareness raising, citizen engagement	29.243,08	50.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area	-	8.333,33
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area	-	8.333,33
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	-	8.333,33
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	-	8.333,33
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area	-	8.333,33
Events, conventions and articles on BIM and Digital Twin internal research activities and applications.	10.000,00	-
Participation in Conferences and/or Seminars to communicate and disseminate lab knowledge	19.243,08	-
TT - Participation with own Stand at Innotrans	-	8.333,35

9. Others	630.000,00	1.824.200,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area		370.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area		450.000,00
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		330.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area		644.200,00
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		30.000,00
Preliminary design for the implementation of an IT platform, for use by all actors in the supply chain	280.000,00	
Participation in meetings and active input into WP2, 3 and 4 of EDDP. DAC4EU, DACcellerate, participation in meetings.	350.000,00	
TOTAL ALL PLANNED IKAA	9.316.949,52	54.843.303,52

Country - Estimated All planned IKAA 2023	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) Link to JU project/ topic
Austria	200.000,00	3.371.685,71
Belgium		717.500,00
France	3.016.327,01	2.491.375,00
Germany	850.000,00	14.291.584,00
Hungary	-	529.922,24
India	-	76.000,00
Italy	1.290.000,00	9.600.569,00
Norway	-	870.000,00
Portugal		30.000,00
Spain	3.433.660,51	10.522.416,31
Sweden		3.646.875,00
Switzerland	-	2.666.000,00
The Netherlands	150.000,00	2.594.200,00
Czech Republic	376.962,00	760.000,00
USA		640.000,00
Poland		2.035.176,26
Grand Total	9.316.949,52	54.843.303,52

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.

The following tables present the planned IKAA for the years 2024:

OVERVIEW ESTIMATED AMOUNT OF IKAA FOR 2024		Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project
1. Support to additional R&I		4.735.357,80	33.396.244,86
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area		337.648,76	5.733.662,91
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area		1.018.116,44	5.858.123,33
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		1.493.556,85	7.237.748,49
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		393.688,09	5.855.929,13
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area		179.098,77	5.088.666,67
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		44.218,12	1.345.447,67
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 7 in the context of achieving the objectives and KPIs of the related Flagship Area		-	10.000,00
High efficiency power electronics and electromagnetic machines, rare earth recovery sustainable processes		400.000,00	-
Infrastructure degradation models of metallic components and customized powder manufacturing for AM		200.000,00	1.000.000,00
Low costs signalling system for train collision avoidance (e.g. EGNSS)		200.000,00	1.000.000,00
Maintenance of ETCS lab Quality system for ISO/IEC 17025 Accreditation and Internal activities/projects to maintain ERTMS labs		56.980,80	-
OCORA: Non-funded activities		-	-
R&D internal projects related to and complementary to ERJU FAs topics.		100.000,00	-
Reduced models for efficient optimization processes		200.000,00	-
Smart Structural Health Monitoring for High Speed Railway Bridges, including Predictive Maintenance of these infrastructures through Intelligent Systems.		40.000,00	-
SW development to automatize ETCS tests, ETCS simulation tools to be adapted to the new TSI releases, Development of a Robot actuator for remote tests, Image Processing system to process images at ETCS DMI to perform automatic tests analysis		72.050,00	-
TT - Project NGT Fun System dynamics: Simulation digital Twin concept		-	266.666,67
2. Scale up of technologies		1.174.295,00	4.290.296,24
Account based ticketing and new validation systems		200.000,00	-
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area		-	2.292.655,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area		-	560.951,00
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		-	70.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area		-	1.164.690,24
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		-	202.000,00
ATO Functionality GoA3/4		200.000,00	-
Implementation Methodology for Cloud-based native Architecture. Developing Work Model Definition. Digital Enterprise Architecture		25.000,00	-
Innovative system to perform digital visits to the railway network and support asset management and infrastructure maintenance.		249.295,00	-
Moving Block -TRL 5 to 7		500.000,00	-
3. Demonstrators		966.567,92	5.509.618,96
Activities for the definition of the basic equipment for the detection of elements of infrastructure and its digitization, equipment for the monitoring trains, track measurement campaign with inspections train.		68.983,49	-
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area		-	390.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area		-	1.172.939,30
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		10.000,00	1.316.150,00
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		-	848.929,66
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area		-	1.416.600,00
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		-	365.000,00

ASTP - Absolute safe train positioning	150.000,00	-
Carrying out tests lab test on models, at a 1:1 scale, in the railway track box to analyze and assess any development or technological innovation considered necessary to quickly upgrade track behavior as a whole or to individual track components	95.680,00	-
Compile the information available from tests in which have simulated the passage of trains at a speed greater than 300 km/h (Very High Speed Trains) and extract the relevant conclusions regarding the maximum vertical deflection and levels of acceleration that might be expected in the rail and the sleeper for the improved commercial, nominal and future design speeds, among others.	59.000,86	-
Construction of zero emission areas around the stations, to promote sustainable mobility in the first and last mile of travelers (transfer from the initial origin to the station and from the station to the final destination), including implementation of Electric Charging Points fed by DC-powered Railway Network	90.772,65	-
Deepen the knowledge of the network, through the characterization of the parameters influencing the vertical dynamics of the track, to optimize the standards for design, construction and maintenance of track superstructure	105.487,83	-
Development of demonstrators at TRL 7 level for early detection of rail defects or broken rails. Human Machine Interface (HMI) and its integration in the Central Supervision Post, including development of	186.643,09	-
Web platform and mobile APP for real-time data viewing and alarm notification	200.000,00	-
Onboard Platform HW prototype developmt		
4. Creating new business opportunities	600.000,00	
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		300.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 7 in the context of achieving the objectives and KPIs of the related Flagship Area		300.000,00
Software DISC EMAN		
5. Training & skills development	7.467,50	1.022.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area		1.000.000,00
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	-	22.000,00
Training activities to maintain the level of skills of the ETCS experts and SW development	7.467,50	-
6. Contribution to the development of new standards, regulations and policies	66.836,70	-
Participation in both Spanish UNE Standardisation and CEN (JTC-20) frameworks and WGs for Hyperloop	11.040,50	-
Participation in the European Group modifying SubSet SS-076 (ETCS Test Specs) to the new TSI releases	55.796,20	-
7. Supporting ecosystem development	506.100,00	2.910.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area		2.500.000,00
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	-	150.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area		260.000,00
Implementation of LL-type brake blocks shoes on freight wagons minimizing noise emission to replace phosphorous cast iron brake blocks shoes are noisier and exceed the limits set by noise regulations. Likewise, with this type of brake blocks shoes, part of the unwanted fires that are produced by sparks from phosphorous cast iron shoes are avoided.	356.100,00	-
Participation in national organisations and possible pilots and support of inniatives in the shape of contributions towards new concepts and ideas (Railforum, Energy Roundtable, etc.)	150.000,00	
8. Communication, dissemination, awareness raising, citizen engagement	29.243,08	250.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area		41.666,67
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area		41.666,67
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		41.666,67
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		41.666,67
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area		41.666,67
Events, conventions and articles on BIM and Digital Twin internal research activities and applications.	10.000,00	
Participation in Conferences and/or Seminars to communicate and disseminate lab knowledge	19.243,08	-
TT - Participation with own Stand at Innotrans		41.666,65
9. Others	321.000,00	2.516.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 1 in the context of achieving the objectives and KPIs of the related Flagship Area		370.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 2 in the context of achieving the objectives and KPIs of the related Flagship Area		450.000,00
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		330.000,00
Additional activities are part and contribute to the Member's activities performed and described within the Flagship Project 5 in the context of achieving the objectives and KPIs of the related Flagship Area		1.336.000,00
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		30.000,00
Input into EDDP, DAC4EU, DACcellerate	321.000,00	
TOTAL ALL PLANNED IKAA	7.806.868,01	50.494.160,06

Country - Estimated All planned IKAA 2024	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project/ topic
Austria	200.000,00	1.906.600,00
Belgium		757.500,00
France	3.016.327,01	2.535.125,00
Germany	500.000,00	10.425.390,00
Hungary	-	1.164.690,24
India	-	126.000,00
Italy	1.010.000,00	9.680.096,00
Norway	-	870.000,00
Portugal		30.000,00
Spain	2.609.541,00	8.053.129,96
Sweden		8.682.675,00
Switzerland	-	2.080.000,00
The Netherlands	150.000,00	2.004.000,00
Czech Republic	321.000,00	670.000,00
USA		800.000,00
Poland		708.953,86
Grand Total	7.806.868,01	50.494.160,06

MULTI-ANNUAL OVERVIEW ESTIMATED AMOUNT OF IKAA FOR 2023-2024	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project	TOTAL
TOTAL ALL PLANNED IKAA	17.123.817,53	105.337.463,58	122.461.281,11

Amendment to the plan 2024

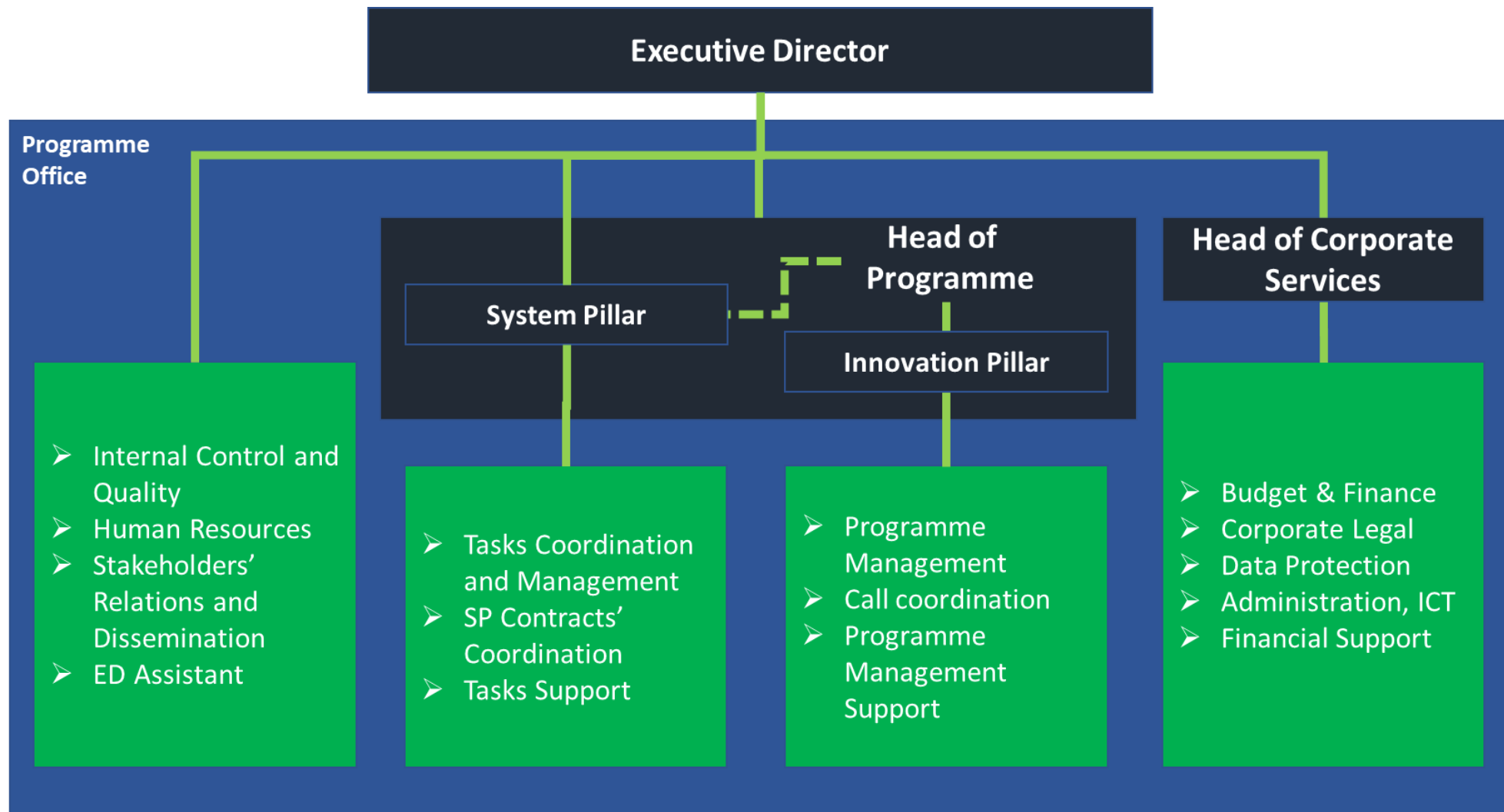
Proposal received from Members to amend the IKAA plan 2024

OVERVIEW ESTIMATED AMOUNT OF IKAA AMENDMENT FOR 2024	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project
1. Support to additional R&I	70.000,00	340.000,00
2. Scale up of technologies		- 42.000,00
3. Demonstrators		231.400,00
TOTAL AMENDED IKAA 2024	70.000,00	529.400,00

OVERVIEW ESTIMATED AMOUNT OF IKAA AMENDMENT FOR 2024	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project/ topic
Austria	70.000,00	142.400,00
France		387.000,00
Grand Total	70.000,00	529.400,00

MULTI-ANNUAL OVERVIEW ESTIMATED AMOUNT OF IKAA FOR 2023-2024		Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project	TOTAL
TOTAL ALL PLANNED IKAA ADOPTED IN 2022		17.123.817,53	105.337.463,58	122.461.281,11
AMENDMENT 2023		140.000,00	1.223.357,09	1.363.357,09
TOTAL ALL PLANNED IKAA		17.263.817,53	106.560.820,67	123.824.638,20

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



Annex III – Key Performance Indicators for Europe’s Rail Joint Undertaking⁵¹

TABLE I - Horizon Europe Common Key Impact Pathway Indicators⁵²

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

⁵¹ 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>

⁵² 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 2022	Target 2027
Additionality	Progress towards (financial and in-kind) contributions from partners other than the Union – i.e. committed vs. actual	N/A	No data available for 2022	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: 2022 = EUR 28,1 million Estimated 2022 value of IKAA linked to JU objectives/KPIs - EUR 4,8 million Estimated 2022 value of IKAA link to JU project/topics - EUR 23,8 million	Target 2022-2024: EUR 150,5 million
Directionality	Overall (public and private, in-kind and cash) investments mobilised towards EU priorities	0	EUR 232,5 million linked both to: - European Green Deal - Europe fit for digital age	EUR 600 million

International visibility and positioning	International actors involved	0	<p>12 entities from Associated countries and Third countries are participating in projects as associated partners (8 from Norway and 4 from Switzerland)</p> <p>By type: 1 public organizations (8%), 2 higher or secondary education establishment (17%), 4 research organizations (33%) and 5 private for profit organizations (42%)</p>	N/A
Transparency and openness	Share & type of stakeholders and countries invited/engaged	0	<p>In general the entire rail value chain.</p> <p>In projects: 203 beneficiaries (6 public organizations (3%), 17 higher or secondary education establishment (8%), 26 research organizations (13%), 147 private for profit organizations (73%) and 7 others(3%)) from: 14 countries (12 from EU and 2 associated countries)</p> <p>In the EU-Rail State Representatives Group: 25 member states demonstrating interest (21 from EU and 4 associated countries)</p>	N/A

Transparency and openness			0	Organisation Name	Category	Country	N/A
Transparency and openness	No and types of newcomer members in partnerships and their countries of origin (geographical coverage)	0		Administrador de Infraestructuras	[PRV Other Industrial and/or profit Private organisation]	ES	N/A
				Alstom Transport SA	[PRV Other Industrial and/or profit Private organisation]	FR	
				ANGELRAIL consortium leader	[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 de Ferrocarriles	[PRV Other Industrial and/or profit Private organisation]	ES	
				Asociación Centro Tecnológico de Ferrocarriles	[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 Luft- und Raumfahrt	[RES Public research organisation (including international research organisation as well as private research organisation controlled by a public authority)]	DE	
				European Smart Green Rail	[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 Italiane	[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. & PATER	[PRV Other Industrial and/or profit Private organisation]	ES	
				Jernbanedirektoratet (Norway)	[PRV Other Industrial and/or profit Private organisation]	NO	
				Knorr-Bremse Systems für Eisenbahnen	[PRV Other Industrial and/or profit Private organisation]	DE	
				Österreichische Bundesbahnen	[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, société	[PRV Other Industrial and/or profit Private organisation]	FR	
				Strukton Rail Nederland B.V.	[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 Systems	[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	<p>99 newcomers (90 EU & 9 Non-EU) of which 22 are SMEs.</p> <p>PRC: 74 PUB: 2 REC: 12 OTH: 3 HES: 8</p>	
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	<p>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.</p> <p>Rail system architecture coordinated in the System Pillar with national and sectorial input notably around signalling activities.</p> <p>Coordination also with Rail Net Europe on infrastructure capacity planning and R&I on traffic management.</p>	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	<p>Synergies with EU Missions - EUR 0,7 million for Smart Cities</p> <p>Following the signature in 2022 of a 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". In accordance with SBA Article 10.6, this additional contributions from Union programmes corresponding to additional tasks entrusted to EU-Rail shall not be accounted for in the calculation of the Union maximum financial contribution to the EU-Rail Programme.</p>	N/A
International visibility and positioning	Visibility of the partnership in national, European, international policy/industry cycles	0	<ul style="list-style-type: none"> • Published 10 newsletters • Published 7 press releases • Released 3 publications • Organised 4 events • Participated in 37 industry events • Average number of tweets per month was 33 • 4.701 twitter followers by the end of 2022 • 8.996 LinkedIn followers by the end of 2022 • 1.857 newsletter subscribers by the end of 2022 • 125 members in the general contact list (receiving the newsletter and mailshots) • 158 members in media list • 160 mentions in press articles 	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)

5		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
	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	Indicator for more efficient border crossing	State of art in 2020 (including results from S2R)	-50%

		increase number of trains on given infrastructure), mins			
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

TABLE I – Estimation from Release 5 of the Key Performance Indicators of the Shift2Rail Programme

SPD	LCC	Capacity	Punctuality
Target	-50%	+100%	+50%
High Speed	-20% -21% -14% -15% -18%	58% 58% 68% 69% 74%	39% 35% 35% 29% 19%
Regional	-29% -30% -21% -21% -24%	90% 90% 62% 57% 49%	55% 53% 52% 51% 15%
Metro	-16% -16% -15% -16% -18%	21% 21% 27% 23% 28%	n/a n/a n/a n/a 19%
Freight	-41% -40% -39% -39% -40%	96% 87% 111% 42-114% 91%	57% 57% 57% 78% 71%

release 4.0

release 3.0

release 2.0

release 1.0

TABLE II – Overview of demonstrators for S2R JU projects with a Technology Readiness Level reaching at least value 6

IP	Research Area	Specific Technological demonstration of	characteristics					Overall high level focus/objective
			Market	Testing time - YEAR start	Testing time - YEAR end	Country	TRL	
IP1	TD1.2 Train Control & Monit. System	Wireless TCMS	Regional	2022	2023	DE	6	Incorporate wireless technologies to the train communication network solutions (i.e. train backbone, consist network and train to ground communication).
	TD1.3 Carbody Shell	New materials in train carbody structures	High Speed	2022	2023	ES	6	Full high speed intermediate coach interfacing with the adjacent coaches and the running gear, together with the internal interfaces of the main representative equipment of the train (HVAC, etc.) and integrated in a high speed train
	TD1.4 Running Gear	Sensing functionality	Urban/Suburban	2022	2023	ES	6/7	New health monitoring systems that allows a condition based maintenance of the track with Novel sensor system (hardware), Wireless communication of some sensor, Innovative algorithms
			Regional	2022	2023	HU	6/7	Wireless on-board, in-service monitoring system with access to external information that provides the required data for a condition-based maintenance.
	TD1.5 Brakes	Electro Mechanic Brake	Generic	2022	2023	HU or DE	6	Mechatronic brake actuator
	TD1.6 Door and Intelligent Access system	PRM access and communicating door	Regional	2022	2023	FR, ES	7	New door functionalities like platform detection, passenger detection, passenger protection during boarding aid deployment and retract...
		Light and high comfort door	Regional	2022	2023	FR and/or ES	6	Opening and closing mechanism and the leaves new innovative design: - one door will be based on metallic solutions - another door will be based on composite solutions
	TD1.7 Interiors	New Passengers Interiors	Regional	2022	2023	N/A	6	New users experiences on board thanks to modular interiors

IP	Research Area	Specific Technological demonstration of	characteristics					Overall high level focus/objective
			Market	Testing time - YEAR start	Testing time - YEAR end	Country	TRL	
IP2	TD2.1 Advanced Communication System	markets applications	Mainline/High Speed	2021	2023	FR/DE tbc	6/7	The demonstrators will be used to validate aspects and capabilities defined in the ACS specification documents (incl. support VoIP communication) and assess them in the context of related FRMCS specifications.
		markets applications	Urban/Suburban	2021	2023	UK	6/7	
		markets applications	Regional/Freight	2021	2023	IT	6/7	
	TD2.2 Automatic Train Operation	Demonstrate the feasibility of GoA3/4 solution on actual pilot train and line	Urban/High Speed/Regional/Freight	2022	2023	DE, IT, NL	6/7	For GoA3/4, to check the behaviour of the system (ATO on board and ATO trackside) in a real pilot line.
	TD2.3 Moving Block	Higher Capacity	Urban/Suburban	2021	2023	UK	6/7	Moving Block Demonstration for Urban / Suburban, High Speed and Low traffic railway, aiming to show capacity increase on existing infrastructure, compared with traditional signalling, in lab environment
		Higher Capacity	High Speed Railways	2021	2023	DE, FR	6/7	
		Lower Cost	Low Traffic Railway	2021	2023	SE, IT	6/7	
	TD2.6 Zero on-site testing	Simulation and testing environment able to support automated laboratory testing	Mainline/Regional/Freight	2021	2023	N/A	6	Corridor 1 of ETCS System could be used for verification of the testing activities with distributed test environments connected to each other from different trackside and on-board suppliers + Human Factors testing
	TD2.9 Traffic management system	Conflict Prediction System	Generic	2022	2023	CZ	6	Prototype demonstrating complex Conflict Prediction System.
		Wayside ATO constituents		2022	2023	SE, PL	6	Constituents needed for ATO GOA2 operation based on data management based on the integration Layer.

IP	Research Area	Specific Technological demonstration of	characteristics					Overall high level focus/objective
			Market	Testing time - YEAR start	Testing time - YEAR end	Country	TRL	
IP3	TD3.1 Enhanced Switch & Crossing System Demonstrator	RAMS optimised S&C	Generic	2019	2023	AT	6/7	Monitoring programme for S&C including: Geometry and overrunning, casting, novel rail grade, resilient pads, rail fastening system, base plates, switch roller system, etc.
	TD3.2 Next Generation Switch & Crossing System Demonstrator	Low N&V Tramway Crossing	Urban/Suburban	2021	2023	TBD	6/7	Test overall performance of a girder rail swing nose crossing in service for the reduction of N&V
		Materials and Components	Generic	2019	2023	UK, SE, FR	4/7	Next generation S&C materials and components tests (i.e. adjustable fastening systems)
		Asphalt Track		2021	2023	UK	6/7	A site trial for demonstration to assess future assessment of asphalt performance.
	TD3.3 Optimised Track System	new slab track	Generic	2019	2023	SE	7	test of a Modular Slab track solution reducing maintenance costs
	TD3.4 Next Generation Track System	Rail Defect Repair		2020	2023	UK	7	Thermocouple instrumented trials on process for different rail steel grades
	TD3.5 Proactive Bridge and Tunnel Assessment, Repair and Upgrade Demonstrator	Tunnel improvements	Generic	2020	2023	FR, UK	7	Reduce track and tunnel closure by offsite manufacturing and increase quality
		Bridge improvements		2020	2023	AT	7	Predict calcite clogging over time
			Urban/Suburban	2020	2023	DE	6	Efficient monitoring of noise emission and installation of passive noise dampers.
			Generic	2020	2023	UK	7	Extend bridge service life by lowering fatigue
				2021	2023	SE	7	Increase bearing capacity and remaining fatigue life of concrete bridges and increasing safety.
		High Speed	2020	2023	SE	7	Make high speed traffic possible on existing bridges with proven dynamic properties	
	Integrated Technological Demonstrators Asset Management (TD3.6, TD3.7, TD3.8)	Strategic long-term	Generic	2021	2023	PT, UK	6	Test of a strategic decision support tool based on the tactical planning tool
		Tactical and Operational short term		2021	2023	UK, SE DE NL, ES, FR	6/7	maintenance process and strategies through knowledge extracted from information coming from available data and monitoring systems
		Metro/ Tram Asset Management	Urban/Suburban	2021	2022	IT	7	Demonstrator focusing on minimising maintenance costs, optimising the use of resources while maximising network
	TD3.9 Smart Power Supply Demonstrator	SMART Control of Rail Power Supply	Electric Railways all Systems	2020	2022	DE	7	Demonstration of functionality, capacity, application and integration in the systems.

IP	Research Area	Specific Technological demonstration of	characteristics					Overall high level focus/objective
			Market	Testing time - YEAR start	Testing time - YEAR end	Country	TRL	
IP4	Integrated TDs of all IP4 ecosystem	Towards the MaaS concept	Shared modes and on-demand	2021	2023	GR,IT,FI,CZ	6/7	Test of a scalable eco-systems which enables pan European multimodal travels and MaaS. Demonstration of the functional ecosystem with the full integration of Ride-sharing and MaaS. Scalable (near-) market ready eco-systems enables pan European intermodal travels and MaaS, including cross-platform approaches.
		Fully dynamic door-to-door travel	Multimodal (rail, bus, metro,...)	2022	2023	IT, GR, HR, ES, CZ, PL	6/7	Demonstrations of IP4 technologies in 6 different locations involving different transport operators, translating/combining IP4 solutions into specific demo sites solutions:
IP5	TD5.2 Digital Transport Management	Improved terminals	Freight	2021	2023	SE	6	A gate equipped with intelligence as part of a connected decision platform optimizing the work process in a terminal. Sata exchange platform to ensure efficiency and security (of data handling) in the transport chain. Equipment prototypes with HMI interface validated in live demonstration for a selected large and complex terminal.
	TD5.3 Smart Freight Wagon Concepts	Core market wagon		2022	2023	SK	7	Modular, logistics-capable and cost-efficient, low weight, high-payload and aerodynamically optimised freight wagons
		Extended Market Wagon		2022	2023	TBD	5/6	Modular, logistics-capable and cost-efficient, low weight, high-payload and aerodynamically optimised freight wagons

Annex V – 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 time line 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 resource, 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 and 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 VI – System Pillar deliverables and milestones

The remits and related deliverables and milestones for every task and domain for 2024 can be found in the following tables. They are based on the Specific Contract SC2.3 for Lot2 with the SP consortium.

Engineering Environmental Team

No	Regular tasks / improvement deliverable	Milestone
01	SEMP	
01a Regular tasks	<ol style="list-style-type: none"> 1. Check SEMP application once in 6 months per domain and create a report and issue list. 2. Analyse and detect inefficiencies und unused aspects of the SEMP application in the teams and define optimization issues. Check every SEMP process in at least two teams during the contract period. 3. Collect actively feedback about the SEMP and create optimization issue workitem in Polarion. 4. Collect and react on user questions about the SEMP application (hotline). Create a FAQ list and provide it to the domains. Create issue workitem of SEMP optimizations and report to the requesting users when they are solved. 	List of issues solved every month
01b Improvements / single deliverable	<p>a. <u>Description of Deliverable:</u> Two new SEMP versions are expected (one version per six month) in this contract (V3, V4) V3 must contain:</p> <ul style="list-style-type: none"> • Quality assurance process, • Documentation, concept, architecting and modelling handbook (MBSE), v1. • Revision of all annexes, especially those with open points not addressed in SEMP v2. <p>b. <u>Sub-Milestones:</u></p> <ul style="list-style-type: none"> • SEMP V3: May 2024 <p>c. <u>Definition of done:</u></p> <ul style="list-style-type: none"> • SEMP update is approved by Coregroup, domain and all domains leads <p>d. <u>Interaction with other Domains:</u> All</p>	Oct 2024

No	Regular tasks / improvement deliverable	Milestone
02	Requirements management	
02a Regular tasks	<ol style="list-style-type: none"> 1. Refine the requirement management process in the SEMP. Check the process application in the domains (at least every 6 months per domain) and give feedback and instructions. Register issues for the process improvements. 2. Check the quality of newly (or externally) created requirements (probes) once per month, and give feedbacks to the domains, e.g., about the following aspects: <ol style="list-style-type: none"> 1. Textual quality 2. Correct derivation 3. Links and traceability 4. Unassigned requirements 3. Prepare and coordinate the functional team meetings (every 1-2 month) for requirements: Coordination for the assignment of requirements to the domains, if the assignment is unclear 4. Assure the coherence, quality, and completeness of the full requirement implementation in the specification (requirements from all sides, like from sector, Task 1 or between other Tasks or domains), as well as for the processes and interfaces between tasks. Create two reports per year about the requirement implementation. <p>Manage all points above as a prioritized Issue (with linked tasks) list in Polarion and create monthly work reports out of this list</p>	List of issues solved every month
02b Improvements / single deliverable	<ol style="list-style-type: none"> a. <u>Description of two deliverables:</u> <ol style="list-style-type: none"> I. Set up a requirements management plan that gathers which requirement areas in all domains will be worked on and completed when. II. Coordinate the completion of the first complete set of linked requirements (at least on top-level per domain) for the whole system currently in scope based on contributions of the tasks and domains. b. <u>Sub-Milestones:</u> none c. <u>Definition of done:</u> <ol style="list-style-type: none"> 1. Requirements management plan is defined and agreed d. <u>Interaction with other Domains:</u> All domains 	Dec 2023 July 2024
03	SP meta data (Definitions and References)	
03a Regular tasks	<ol style="list-style-type: none"> 1. Refine the glossary and Reference management process in the SEMP. Check the process application in the domains (at least every 6 months per domain) and give feedback and instructions. Register issues for the process improvements. 2. Check the quality of newly (or externally) created Definitions (probes) and references once per month, and give feedbacks or change tasks to the domains about the following aspects <ol style="list-style-type: none"> a. Preciseness and specificity (e.g. domain specific language only allowed for very generic terms) b. Textual quality c. Links and traceability (correct linked usage in specifications) 	List of issues solved every month

No	Regular tasks / improvement deliverable	Milestone
	<p>3. Prepare and coordinate the functional team meetings (every 1-2 month) for Glossaries: Coordination for the assignment of definition work to the domains, if the assignment is unclear</p> <p>Manage all points above as a prioritized Issue (ith linked tasks) list in Polarion and create monthly work reports out of this list for the domain reporting (new issues and solved issues)</p>	
03b Improv ements / single deliver ables	Create and publish the first complete and consistent SP Glossary (incl. terms from European legislation)	Apr 2024

No	Regular tasks / improvement deliverable	Milestone
04	Specification and model integration, quality assurance, and result/import integration	
04a Regular tasks	<ol style="list-style-type: none"> 1. MBSE model administration (creation, model management, import on demand, role assignment, ...). Assess SP-external specification and models as the single point of contact, assign it to the domains, and import/link it to the Mastermodel/Specification(Polarion) in collaboration with the domains (main workload in the domains) 2. Prepare and coordinate the functional team for all modelers of the domains 3. Integrate OA, SA & LA models based on the inputs of the tasks and domains according to their milestone structure, integrated in the master model and fulfilling the decide requirements. Create integration assessments together with the responsible domains. Propose model amendments to the modelers in the domain 4. Prepare and coordinate the functional team meetings (every 1-2 month) for modelling: Coordination for the assignment of modelling tasks if the assignment is unclear <p>Manage all points above as a prioritized Issue (evtl. with linked tasks) list in Polarion and create monthly work reports out of this list (new issues and solved issues).</p>	List of issues solved every month
04b Improvements / single deliverable	<p>Description of Deliverable: Check all results of the first and second contract (that were finalized on domain level) concerning formal Quality (SEMP compliance; results in Polarion and Capella). Deliver optimization report to the domains.</p> <p>Interaction with other Domains: All</p>	Quarterly

No	Regular tasks / improvement deliverable	Milestone
05	Tool support for Polarion, Capella, SysML tool, SP sharepoints, Git, publication platform	
05a Regular tasks	<ol style="list-style-type: none"> 1. Manage relevant licenses and technical support 2. Administer the SP Sharepoint and Git installation 3. Polarion-Capella bridge maintenance and training for EET and other domains / tasks. 4. Provide Tool hot line for trouble shooting and user support <p>Manage all points above as a prioritized Issue/Task (evtl. With linked tasks) list in Polarion and create monthly work reports out of this list (new issues and solved issues).</p>	List of issues solved every month
05b Improvements	<p>Description of Deliverable and definition of done: Capella usage is established in all teams (dedicated modelers) and SysML tool is procured, installed, trained and Trackside Asset specifications (EULYNX) is imported</p> <p>Interaction with other Domains: All domains</p>	June 2024

PRAMS

No	Deliverable	Milestone
	Performance and RAM	
01	Refinement of Performance KPIs and definition of Performance Targets for a modular railway architecture <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: Performance definition and KPI's part of EU regulatory framework Methodological approach combining Qualitative criteria and results b. <u>Sub-Milestones</u>: KPIs and Qualitative methods preliminary release c. <u>Definition of done</u>: Document is in Polarion, reviewed by the mirror groups (if applicable) and ready for SPCG revision. d. <u>Interaction with other Domains</u>: All 	Q3/2024 Q1/2024
03	Refinement of CBM RAMS rules CBM part of EU regulatory framework <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: <ul style="list-style-type: none"> a. Standardized set of requirements for CBM b. Provide inputs to STIP b. <u>Sub-Milestones</u>: No c. <u>Definition of done</u>: Document is in Polarion, reviewed by the mirror groups (if applicable) and ready for SPCG revision. d. <u>Interaction with other Domains</u>: All 	Q3/2024
	Safety	
06	Update System Concept (RAMS Phase 1) and PRAMS Plan (RAMS Phase 2) according to evolving system architecture and mission profiles <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: Scope of ERJU (boundaries), system architecture and mission profiles (like cargo, mixed traffic, passenger, high speed) are defined more precisely. The existing deliverables of SC 2.1 will be updated, processes for hazard and risk analysis and design rules changed if needed. b. <u>Sub-Milestones</u>: No c. <u>Definition of done</u>: Documents updated are in Polarion, reviewed by the mirror groups (if applicable) and ready for SPCG revision. d. <u>Interaction with other Domains</u>: Mostly with task 1 and ARC-F for input 	Q2/2024
07	CENELEC changes proposal for harmonisation and modular approaches. <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: Proposal of possible changes to CENELEC standards starting with EN 50126, 50128 (or 50716 likely replacing it), 50129 to better support harmonisation and modular approaches. Feedback from CG on the existing PRAMS Plan and the modularization approach for safety assurance therein will be a vital input to decide how to b. <u>Sub-Milestones</u>: Q1/2024: input plan, Q3/2024 proposals for changes to standards c. <u>Definition of done</u>: All standards to be changed by PRAMS identified in TSI input plan, proposals for changes forwarded to the appropriate standardisation committees. d. <u>Interaction with other Domains</u>: No direct interaction, but experience and feedback of other domains on modular approach to be used 	Q3/2024
08	Coaching of PRAMS experts throughout ERJU SP and IP to follow the Safety Guideline and assure PRAMS requirements implementation.	Monthly

No	Deliverable	Milestone
	<ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: No documents b. <u>Sub-Milestones</u>: Ongoing task, regular meetings c. <u>Definition of done</u>: Set-up of Functional Teams for PRAM and Safety d. <u>Interaction with other Domains</u>: All 	
10	PRAMS will contribute to EGNOS project dealing with certification and authorisation processes, to be introduced into TSI CCS	Q3 / 2024

Security

No	Deliverable	Milestone
	Security	
01	<p>Draft security specifications for innovation pillar</p> <p>CG Feedback for architecture assumption</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable:</u> <ul style="list-style-type: none"> - Secure Product Specification - Secure Communication Specification b. <u>Sub-Milestones:</u> None c. <u>Definition of done:</u> Drafts available for Innovation Pillar 	Q4/2023
02	<p>Continue security specification for TSI standardization input:</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable:</u> <ul style="list-style-type: none"> - Secure Product Specification - Secure Communication Specification - Shared Security Services Specification (TIME, PKI, IAM, LOG) - Secure Operational Processes (Application Guide) b. <u>Sub-Milestones:</u> Drafts for Shared Security Services Specification and Secure Operational Processes available for review for CG and other domains c. <u>Definition of done:</u> input for the STIP ready for final review 	<p>Q3/2024</p> <p>Q2/2024</p>

Task 1 Railway systems

No	Deliverable	Milestone
01	Task management and reporting <ul style="list-style-type: none"> a. Description of Deliverable: Collaboration and sector endorsement (Polarion) b. Description of Deliverable: Teams' setup/role and deliverables responsible Architecture explicitation and Modelling support (Polarion/Capella) c. Sub-Milestones: Create mirror group for task 1 and organise sector commitment process (In coordination with SPCG). d. Definition of done: minutes of meeting, presentations, internal process, planning documents e. Interaction with other Domains: Planning of interaction with other domains and FPs. Regular coordination with the Core group on project management and associated reporting. 	Continuous Q1/2024 (mirror group)
02	Capability prioritization based on identified pain points (agreement in first step: Q1). <ul style="list-style-type: none"> a. Description of Deliverable: Define a priority list of capabilities on which operational analysis and system analysis should focus on the main issue addressing in ERJU (with SPCG). Any potential additional requests such as energy management, military mobility, multimodality should be discussed separately. b. Sub-Milestones: none c. Definition of done: Prioritized capability document approved by SP-STG The (2 to 3) identified capabilities (harmonisation areas), which are then further investigated. d. Interaction with other Domains: Depend on different domain maturity, interaction should be organized in coordination with the SPCG 	Q1/2024
03	As is (AI) Operational Architecture on the prioritized capabilities reflecting the differences between the countries: Continue and consolidated the operational analysis to provide a basis for the diagnosis of the possibilities of harmonization. Setup the sectorial discussion in polarion (Mirror group and sector alignment) <ul style="list-style-type: none"> a. Description of Deliverable: <ul style="list-style-type: none"> a. For each selected capability describe activities, involved entities and activities interactions. b. Provide operational architecture diagrams, and map on it the identified pain point to highlight activities and interactions where we can have opportunities for harmonization. Describe the performances already reached by the as-is architecture, identify existing rules, current performance, and process (TSI, EN standards, Operational rules and AMoCs – Accepted Means of Compliance) b. Sub-Milestones: <ol style="list-style-type: none"> 1. Diagnosis of the pain points for selected capabilities and process and identity performance target 2. Handling sector commitment and alignment 	Q1-Q2/2024

04	Operational analysis of to be (TB) architecture. Setup the sectorial discussion in polarion (Mirror group and sector alignment) <ol style="list-style-type: none"> <u>Description of Deliverable</u>: Selected capabilities based on expected performances of the railway system, related improvements, pain points and CBO. The introduction of game changers (ATO, DAC, FRMCS) will be considered (Benchmarking). Provide a draft of performances which could be reached by the To-Be Architecture and derived requirements. Define the performances which could be reached for to-be architecture. Derive a requirement set reflecting the Common Business Objectives. 	Q2-Q3/2024
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Task 2 CCS: Operational Harmonisation domain

No	Deliverable	Milestone
01	Collected operational requirements from the sector (RU, IM) <ol style="list-style-type: none"> <u>Description of Deliverable</u>: Completed set of operational requirements, derived from CBO and operational visions, and from stakeholder input of the Mirror group or other RU an IM <u>Sub-Milestones</u>: Intermediate results for SPCG on Dec. 2023 <u>Definition of done</u>: The requirements describe the full stakeholder needs concerning the operational production (CONUSE) and are agreed in domain and mirror group <u>Interaction with other Domains</u>: T2 ARC, T2 MIG 	03/2024
02	Harmonised processes of 80% of the capabilities and their scenarios (according to the focus of first specification iteration) <ol style="list-style-type: none"> <u>Description of Deliverable</u>: Processes and scenarios, including the operational outcomes necessary in SEMP for the system analysis in T2 ARC. Operational concept per scenario describing harmonized processes including the description of parametrisation, incl. OA model described in Capella <u>Sub-Milestones</u>: 7% of the scenarios are described per monthly sprint and approved on domain level. <u>Definition of done</u>: The differences of the countries are identified and analysed, and the harmonized process version is designed and agreed on domain level <u>Interaction with other Domains</u>: output to T2 ARC 	09/2024
03	Preliminary operational risk analysis based on deliverable 2 <ol style="list-style-type: none"> <u>Description of Deliverable</u>: Operational hazards and risks as Polarion work items for the scenarios described in 2. <u>Sub-Milestones</u>: 7% of the scenarios are assessed per monthly sprint and the assessment approved on domain level. <u>Definition of done</u>: The PRAMSS team checked the completeness of the risk assessment against known hazard list <u>Interaction with other Domains</u>: Deliverable reviewed by PRAMSS 	09/2024

04	<p>Contribute to the clarification Task of the T2MIG team concerning the need of special lineside signals</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: Concept contribution with an operational analysis that assesses the feasibility of a production completely without lineside signals, also for shunting, stations, at the border of supervised areas, and for degraded modes with vehicles having no working ETCS onboard. b. <u>Sub-Milestones</u>: No c. <u>Definition of done</u>: Concept agreed with the domain, the T2MIG and SPCG d. <u>Interaction with other Domains</u>: all T2 domains 	02/2024
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Task 2 CCS: Architecture and release coordination domain

No	Deliverable	Milestone
01	<p>Amend system requirements, specify System Analysis and Logical Architecture in Polarion/Capella on System Level 3</p> <p>e. <u>Description of Deliverable:</u> Next iteration target architecture model and its conversion to text and requirements in Capella, 2 revisions are expected. Architecture guidelines (design Rule workitems) are amended where needed.</p> <p>Top-down architecting based on the outcome of T2 OD</p> <ul style="list-style-type: none"> • Described system actors • List of described system capabilities • Functional chains with description of functions, perhaps specific versions for single configuration variants. • Logical architecture of CCS (basic model as a draft in Q4 2023) • Allocation of functions to logical components • Logical functional exchanges <p>Bottom-up architecting by:</p> <ul style="list-style-type: none"> • Analysing the existing system architectures from the specifications, input initiatives, and/or the system domains <p><u>Interaction with other Domains:</u> Dependency from T2 OD input. Output for the other T2 System domains.</p>	Q3 2024
02	<p>Moderation and Coordination</p> <p>Coordinate overarching architecture processes for</p> <p>a. <u>Description of deliverable:</u></p> <ul style="list-style-type: none"> • Coordinate ATO specifications (compare/synchronize R2DATO specification work with current SP specification iteration 1 which is done without ATO GoA3/4) • Coordinate specifications about absolute Train Positioning, and responsibility for SP work in joint activity (EU-Rail, ERA, EUSPA, ESA) to support EGNOS (in SP, synced with R2DATO) • Interaction and input to FP2, and linked maturity checkpoints • Analysis of the technical integration of the bottom up level 4 models and outcomes from system domains, moderation for resolution: <ul style="list-style-type: none"> a. identification of functional and technical misalignments, b. Revision of the granularity criteria in each of the systems from the domains c. Revision of the evolvability of the systems through the requirements received from the system domains <p>b. <u>Sub-Milestones:</u></p> <ul style="list-style-type: none"> • ATO action plan for 2023/24 defined and work allocated: Oct 2023, separate monthly status reporting started • Absolute Train Positioning action plan for 2023/24 defined and work allocated: Nov 2023, separate monthly status reporting started. <p>c. <u>Definition of done:</u> The coordination tasks are successful if</p> <ul style="list-style-type: none"> • All necessary tasks are listed and allocated, • a clear understanding of the results was agreed, • the progress is monitored on a monthly basis <p>d. <u>Interaction with other Domains:</u> All T2 domains</p>	Monthly

No	Deliverable	Milestone
03	Standardization and TSI Input Plan V1 (STIP) <ol style="list-style-type: none"> <u>Description of Deliverable:</u> <ul style="list-style-type: none"> Identify input from the Domain to the STIP Support to the SPCG in the analysis of the STIP draft and updates from architectural point of view, by analyzing the proposals against the target architecture, the architecture roadmap, the granularity principles and the architecture guidelines. <u>Sub-Milestones:</u> STIP V1 end of 2023, update in 2024 <u>Interaction with other Domains:</u> All Task 2 domains 	Q4 2023

Task 2 CCS Migration & Roadmap domain

No	Deliverable	Milestone
01	CCS features packages indivisible for deployment <ol style="list-style-type: none"> <u>Sub-Milestones:</u> Quarterly intermediate results for SPCG <u>Interaction with other Domains:</u> Architecture, Traffic CS, Train CS 	03/2024
02	Scope for System Pillar Reference Architecture Baseline 1 Release 1(SPRA B1R1) <ol style="list-style-type: none"> <u>Sub-Milestones:</u> Quarterly intermediate results for SPCG <u>Definition of done:</u> The criteria, assessment and scope of the B1R1 recommendation is approved in domain and mirror group <u>Interaction with other domains:</u> All Task 2 domains 	06/2024
03	Migration Requirements for Target System <ol style="list-style-type: none"> <u>Sub-milestones:</u> Quarterly intermediate result for SPCG. <u>Interaction with other Domains:</u> Task 2 Architecture domain, to implement in target system. 	09/2024
04	Input for STIP <ol style="list-style-type: none"> <u>Description of Deliverable:</u> Assess and recommend plateaus for a possible regulation process as input for the harmonization process <u>Sub-Milestones:</u> Quarterly intermediate result for SPCG. <u>Definition of done:</u> The plateau(s) recommendation are accepted and approved on domain level incl. mirror group <u>Interaction with other Domains:</u> Task 2 Architecture domain and Operational Design domain 	09/2024

Task 2 CCS Traffic Control and supervision domain

No	Deliverable	Milestone
01	Traffic CS Operational analysis (CONEMP) - Operational Analysis (ORS) <ol style="list-style-type: none"> <u>Description of deliverable:</u> The operational requirements and operational capabilities/processes for providing, configuring, maintaining, and exchanging the Traffic CS components are described according to SEMP. Needed System capabilities and their functions are listed. <u>Sub Milestones:</u> No <u>Definition of done:</u> Documents described in a. in Polarion. Formal quality checked by EET, content approved by the advisor group and the mirror group and ready for SPCG revision <u>Interaction with other Domains:</u> T2 OD, T2 ARC, T2 Train CS, T2 TCCS 	Q4 2023

No	Deliverable	Milestone
02	<p>Traffic CS System capabilities, functions and system requirements - System Analysis (FRS)</p> <p>Amend system requirements, specify System Analysis and Logical Architecture in Polarion/Capella on System Level 4</p> <p>f. <u>Description of Deliverable:</u></p> <ul style="list-style-type: none"> • System requirements Traffic CS • Described system actors • List of described system capabilities • Functional chains with description of functions • Logical architecture of Traffic CS on System Level 4 (subsystems) • Allocation of functions to logical components • Logical functional exchanges, especially to TMS, Trackside Assets, Train and TCCS SD1,2,3; station (ATO process); FRMCS application services; yard/depot standard interfaces <p>Bottom up architecting by:</p> <ul style="list-style-type: none"> • Analysing the existing system architectures from the specifications, input initiatives, and/or the system domains <p>g. <u>Sub-Milestones:</u> List of functional chains until Nov 2023, afterwards [10%] of the functional chains allocated to the logical architecture of System Level 4 per month and approved in the domain/mirror group.</p> <p>h. <u>Definition of done:</u> Documents described in a. and b. in Polarion/Capella. Formal quality checked by EET, content approved by the advisor group and the mirror group and ready for SPCG revision.</p> <p>i. <u>Interaction with other Domains:</u> T2 OD, T2 ARC, T2 Train CS</p>	Q3 2024

Task 2 CCS Train Control and Supervision domain

No	Deliverable	Milestones
01	<p>Train CS logical architecture</p> <p>a. Requirements and interfaces, taken into account: ATO, RTO, Advanced Positioning System, Event recognition, Virtual coupling, C-DAS, Voice communication” and “future communication strategy, Absolute Safe Train Positioning Diagnosis, monitoring, configuration and maintenance and evolvability</p> <p><u>Description of Deliverable:</u> document with the description and the requirements (up to the defined percentage of detailing) of the target logical architecture to be able to define the large building blocks including</p> <p>b. Update, refine and extension Specification of communication layer SS147.</p> <p>c. Update and refine Specification of application layer e.g. SS119/139/...</p> <p>d. <u>Sub-Milestones:</u></p> <p>e. B.1 Analysis by the domain of the percentage of requirement description progress that will be reached by logical module – End 2023</p> <p><u>Definition of done:</u> Documents described as B.1 and the final deliverables itself are in Polarion, reviewed by the Train CS mirror group and ready for SPCG revision.</p> <p>f. <u>Interaction with other Domains:</u> dependency from T2OD and T2 ARC input. Deliverable reviewed by ARC and the domains with which the module has interface.</p>	Q3/2024

No	Deliverable	Milestones
02	Agreement and definition of Interfaces (Deliverable: Physical architecture) A physical architecture will be defined based on the result of point 01.	Q3/2024
03	Update and more precisely specify Train CS System capabilities Prioritization of functions derived from T2OD operational scenarios and apportionment to short-term and long-term architectures for new functionalities. <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: List of agreed and prioritized functions a. <u>Definition of done</u>: Document described in point a is in Polarion, reviewed by the Train CS mirror group and ready for SPCG revision. b. <u>Interaction with other Domains</u>: dependency to T2 ARC and OD. 	Q3/2024
04	Specification for Authorization, Integration and Upgradability of modular train CS system including train interface The proposals for this deliverable from a deployment, technical and economical point of view. <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: TSI requirement updates for the authorisation of train CS systems including the necessary analysis for the justification of the change. b. <u>Sub-Milestones</u>: No c. <u>Definition of done</u>: Document including proposal for TSI updates and the justification of changes is available in Polarion and ready for SPCG approval. d. <u>Interaction with other Domains</u>: PRAMSS 	Q3/2024
05	CCS Onboard Definition (Replacement of CCS Onboard relevant OCORA Topics) It is expected that Train CS domain take over the publication of relevant information and documents under the system pillar. <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: B.2 revision of the identified OCORA documents that will be incorporated to SP if identified for 2024. b. <u>Sub-Milestones</u>: <ul style="list-style-type: none"> 1. B.1 Identification of the documents from OCORA that will be taken over as SP document and identification of expected publication in 2024. c. <u>Definition of done</u>: Reviewed OCORA document that will be incorporated to SP are in Polarion, reviewed by the Train CS mirror group, OCORA and ready for SPCG revision. d. <u>Interaction with other Domains</u>: To be confirm once the action is done 	Q3/2024
06	Update of Standardisation & TSI Input plan for train CS topics This deliverable will be based on the work and first draft delivered within SC2.1 <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: input of topics to the plan. For the topics that will be ready in 2024 the input to the pre- assessment template. b. <u>Sub-Milestones</u>: STIP draft Q4/2023 <u>Definition of done</u>: STIP content of train CS delivered, consolidation by SPCG achieved with answers where necessary from domain. Successful preassessment achieved for the 2024 TSI elements in STIP c. <u>Interaction with other Domains</u>: no 	Ongoing

Task 2 CCS Computing environment domain

No	Deliverable	Milestone
	Regular coordination with the Core group on project management and associated reporting.	Continuous
01	Computing Environment Operation concept - Operational Analysis (=ORS CONEMP, Operational Requirement Specification)- <ol style="list-style-type: none"> <u>Description of Deliverable</u>: First operational standardization specifications (ORS CONEMP, as defined in the SEMP) for computing environment. The CE Domain will create an operational concept based on the Use Case analysis from SC 2.1, considering the decided specification granularity. The operational analysis includes the deliverables along SEMP process Group 2 (Annex D) for the CONEMP operations (lifecycle processes for construction, maintenance, replacement, etc.). <u>Sub-Milestones</u>: No <u>Definition of done</u>: Documents described in a. are in Polarion, reviewed by the mirror group (if applicable) and ready for SPCG revision. <u>Interaction with other Domains</u>: T2OPE 	03/2024

Task 2 Trackside assets control and supervision domain

No	Deliverable	Milestone
01	Maintaining the specifications <ol style="list-style-type: none"> <u>Description of Deliverable</u>: Update BL4 Release 2 specifications with integrated priority backlog topics, with the following tasks: <ol style="list-style-type: none"> Import of the relevant specifications into 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 imported to Polarion, linked and integrated. Complete priority backlog topics on specifications (SMI, SDI, SCI-P) Publish a release update with integrated priority backlog topics. <u>Sub-Milestones</u>: <ol style="list-style-type: none"> Import of the relevant specifications into the System Pillar engineering environment. - Dec 2023 Model import and explanation and requirements documents imported in Polarion. – June 2024 Documents with priority backlog topics on specifications are completed, resulting in new release BL4 Release 3 – By June 2024 <u>Definition of done</u>: Documents described in a. and b. are in Polarion, reviewed by the mirror group (if applicable) and ready for SPCG revision. In addition, model is import into SP engineering environment. <u>Interaction with other Domains</u>: <ol style="list-style-type: none"> Imports coordinated with Engineering Environment Team. Deliverables to be reviewed by the domains with which an interface is described. 	Q3 2024

No	Deliverable	Milestone
02	<p>Need of Light Signals (Lead T2 MIG, TACS supports)</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: Report of the impact on the specification and requirements for light signals within the SERA system based on: <ul style="list-style-type: none"> ○ The envisaged system is specified without light signals. Discussions within the Operational Process and in the Migration Domain indicating also the possible need for optical wayside indicators (light signals). Possible examples are shunting signals, fallback signals and border signals between existing and new lines. On the other hand, a trackside design with light signals creates more complex functionalities and operational processes. ○ The TACS domain should clarify the impact on the specification and requirements for light signals within the SERA system, if really needed. b. <u>Sub-Milestones</u>: No c. <u>Definition of done</u>: Documents described in a. are/is in Polarion are approved by T2 MIG and TACS domain and no further support is requested by Migration Domain. d. <u>Interaction with other Domains</u>: Dependency from Migration and Operational design. 	Q2 2024
03	<p>Add basic Operational Analysis (CONEMP) and System Analysis according to SEMP</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: Description of the asset management and life cycle processes (installation, setup, maintenance, exchange) and their operational requirements. b. <u>Sub-Milestones</u>: No c. <u>Definition of done</u>: Document described in a. is in Polarion, approved by the domain and mirror group and ready for SPCG revision. d. <u>Interaction with other Domains</u>: T2 Traffic CS and T2 TCCS, PRAMSS 	Q4 2024

Task 2 Transversal systems domain

No	Deliverable	Milestone
SD1	Digital Engineering, CCS/TMS exchange data <ul style="list-style-type: none"> j. <u>Description of Deliverable</u>: CCS/TMS Data Model definition. k. <u>Sub-Milestones</u>: <ul style="list-style-type: none"> 1. SD11 Data Model schema extensions following the Domain Model contracts, i.e. serving the use cases of the System Pillar domains and IP projects by modelling and integrating the requested data model objects 2. SD12 Uptake of the ERA vocabulary (semantic data model) by static references and increasing the common ground for standardisation on SP and ERA side 3. SD13 Linking semantically the SP Data Model with external models beyond scope and control of the SP 4. SD15 Applying and improving the SP Data Model governance, including the application of Data Model Domain contracts 5. SD16 Updating and amending STIP 6. SD17 Updating and amending Definitions and References l. <u>Definition of done</u>: Documents described in a. and b. are in Polarion, reviewed by mirror group and ready for SPCG revision. m. <u>Interaction with other Domains</u>: All 	Q3/24
SD2	CCS Diagnostics <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: CCS/TMS Diagnostic Data and system component interfaces definition b. <u>Sub-Milestones</u>: <ul style="list-style-type: none"> 1. SD21 Finalization of operational requirements and processes (according to SEMP) 2. SD22 System Analysis, System definition of the specific subsystems (logical architecture according to SEMP) 3. SD3 System Requirements for the specific CCS component(s), the component(s) being introduced in the architecture for technical diagnostic and monitoring purposes 4. SD25 Updating and amending STIP 5. SD26 Updating and amending definitions and references c. <u>Definition of done</u>: Documents described in a. and b. are in Polarion, reviewed by mirror group and ready for SPCG revision. d. <u>Interaction with other Domains</u>: All 	Q3/24

No	Deliverable	Milestone
SD3	Configuration, CMDB <ol style="list-style-type: none"> a. <u>Description of Deliverable</u>: Configuration management methods and system definition b. <u>Sub-Milestones</u>: <ol style="list-style-type: none"> 1. SD31 Finalization of operational requirements and processes (according to SEMP) 2. SD32 System Analysis, System definition of the specific subsystems (logical architecture according to SEMP) 3. SD33 System Requirements for the specific CCS component(s), the component(s) being introduced in the architecture for technical diagnostic and monitoring purposes 4. SD35 Updating and amending STIP 5. SD36 Updating and amending definitions and references c. <u>Definition of done</u>: Documents described in a. and b. are in Polarion, reviewed by mirror group and ready for SPCG revision. d. <u>Interaction with other Domains</u>: All 	Q3/24
SD4	User interface <ol style="list-style-type: none"> a. <u>Description of Deliverable</u>: Rules and System definition for Railways system User Interface subsystems Integration b. <u>Sub-Milestones</u>: <ol style="list-style-type: none"> 1. SD41 Definition of User Interface Framework 2. SD43 Updating and amending STIP 3. SD44 Updating and amending Definitions c. <u>Definition of done</u>: Documents described in a. and b. are in Polarion, reviewed by mirror group and ready for SPCG revision. d. <u>Interaction with other Domains</u>: All 	Q3/24

Task 3 TMS & CMS

No	Deliverable	Date
01	<p>Task management, regular exchange with other tasks and IP</p> <p>a. <u>Description of Deliverable:</u></p> <ol style="list-style-type: none"> 1. Task management includes detailed backlog of activities to reach objectives and management of the team including training where necessary 2. Regular exchange with tasks and IP includes the necessary meetings and email exchange with other tasks, IP, and PMO 3. Involvement of SPCG by invitation to Task 3 plenary <p>b. <u>Sub-Milestones:</u> No</p> <p>c. <u>Definition of done:</u> minutes of meeting, presentations and planning documents</p> <p>d. <u>Interaction with other Domains:</u> Yes, coordination Task.</p> <p>Regular coordination with the Core group on project management and associated reporting.</p>	Ongoing
02	<p>System Concept document:</p> <p>a. <u>Description of Deliverable:</u> With respect to the release submitted as part of SC2.1, the following topics must be added:</p> <ul style="list-style-type: none"> • system interfaces (Topology, Incident Mngt., TAP/TAF) • legislative and economic issues • System Definition • System capabilities <p>b. <u>Sub-Milestones:</u> No</p> <p>c. <u>Definition of done:</u> System concept document in Polarion and ready for SPCG revision. Including the above-mentioned topics</p> <p>d. <u>Interaction with other Domains:</u> Task 2</p>	Q2/2024
06	<p>Interface between TMS and Traffic Control and Supervision system:</p> <p>a. <u>Description of Deliverable:</u> The complete specification of this interface must be submitted. Task 3 should take the lead and align with Traffic CS domain</p> <p>b. <u>Sub-Milestones:</u> As a basis the SCI- CC (SCI-OP in RCA terms) interface specification from EUlynx should be taken</p> <p>c. <u>Definition of done:</u> Interface requirement document (FIS) with the basis of the updated SCI-CC (and other EUlynx documents related to this interface) to be outcome as per STIP and approved in Polarion</p> <p>d. <u>Interaction with other Domains:</u> Traffic CS for coordination of the technical aspect and to ensure that the specification of the interface is complete comparing with other defined interfaces to CCS. Trackside Assets domain to be contacted to learn from the experience for the object controller interfaces</p>	Q3/2024

No	Deliverable	Date
07	<p>System Analysis (=FRS, Functional Requirement Specification)</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: <ul style="list-style-type: none"> • Traffic Management – internal interfaces (Capacity Planning (CM), Conflict Resolution, and Incidence Impact Management) <ul style="list-style-type: none"> ○ System Definition ○ System capabilities b. <u>Sub-Milestones</u>: No c. <u>Definition of done</u>: Interface description document, including above mentioned content and proposing the clear next steps to achieve FRS and FIS for the decided necessary modules and interfaces in the coming years in Polarion and reviewed by the Task 3 mirror group and ready for SPCG revision d. <u>Interaction with other Domains</u>: TBD 	Q3/2024
09	<p>Cross border TMS & CMS</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: To improve the management of the European Railway system especially for cross border traffic, there are different architecture models possible. Starting from a decentralized system where each Infrastructure manager operates an own TMS /CMS up to a fully centralized European TMS / CMS system there are several solutions possible. The domain should describe and analyse the pros and cons of 5 options. b. <u>Sub-Milestones</u>: No c. <u>Definition of done</u>: document in Polarion reviewed by the Task 3 mirror group and ready for SPCG revision. Including: <ul style="list-style-type: none"> a. Description of the variants b. Analysis of the variants against CBO c. Analysis on advantages and disadvantages d. Description of the impact for each variant (technical, economic, governance, regulation, time for migration, etc) d. <u>Interaction with other Domains</u>: No 	Q4/2023

Task 4 DAC/FDFTO

No	Deliverable	Milestone
01	Onboarding of new team members (team setup, information and training, Polarion, ...) [WP0] <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: All new (and old!) members are onboarded (see SharePoint "OpenShare", folder "22-10-10 Onboarding Information for domains" and Task 4 related documents) and trained especially in Polarion (at least basic training) b. <u>Sub-Milestones</u>: <ul style="list-style-type: none"> 1. <u>Onboarding regarding working procedures, documents and results of ramp-up and period 1</u> 2. <u>Polarion training</u> c. <u>Definition of done</u>: Confirmation of document onboarding and Polarion training from Task Leads d. 	11/2023
02	Continuation of Sector alignment & Elaboration Scheme for EU Harmonised Operation Procedures: second set of Ops Concepts [WP1] <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: Execution of very well-prepared remaining webinar(s) and collection and evaluation of feedback b. <u>Sub-Milestones</u>: <ul style="list-style-type: none"> 1. Webinar (depending on progress within SC2.1) – 10/2023 2. Report on collected feedback (incl. evaluation) to hand-over to FP5 – 12/2023 c. <u>Definition of done</u>: Report on collected feedback (incl. evaluation), approved in Polarion and ready for SPCG revision to finally hand-over to FP5. d. <u>Interaction with other Domains</u>: OD 	10/2023 12/2023
03	Finalization of Operations Architecture related to FDFTO interfaces: ERTMS use cases, ASO/ATO [WP3.2, WP3.3] <ul style="list-style-type: none"> a. <u>Description of Deliverable</u>: <ul style="list-style-type: none"> ➤ Description and agreement of ERTMS related use cases (e.g., cab anywhere, supervised manoeuvres) ➤ Description of interface ATO <-> ASO (if needed) ➤ Description of automated freight shunting and train formation use cases ➤ Alignment with Task 2 ATO functional team b. <u>Sub-Milestones</u>: <ul style="list-style-type: none"> 1. Description and agreement of ERTMS related use cases (e.g., cab anywhere, supervised manoeuvres) - 12/2023 2. Description of automated freight shunting and train formation use cases - 03/2024 3. Alignment with Task 2 ATO functional team / Description of interface ATO <-> ASO (if needed) / Alignment with FP5 (and FP2) - 06/2024 c. <u>Definition of done</u>: Documents described in item b. are in Polarion, reviewed by mirror groups (at least in coordination with ERA TWG Freight@DAC) and ready for SPCG revision. d. <u>Interaction with other Domains</u>: dependency from Task 2 TrainCS and TrafficCS. Alignment must be ensured. 	12/2023 03/2024 06/2024

No	Deliverable	Milestone
04	<p>Analysis of further interfaces of train-internal DAC/FDFTO to the "outside" world in cooperation with Task 1 [WP3.4]</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable:</u> Based on FDFTO related use cases identification of further interfaces to be considered by FP5. Report incl. a complete diagram showing all interfaces to the train internal DAC/FDFTO system and showing the place in the overall railway system (System of Systems picture down to level 5) b. <u>Sub-Milestones:</u> <ul style="list-style-type: none"> 1. Report incl. a complete diagram showing all interfaces to the train internal DAC/FDFTO system and showing the place in the overall railway system (System of Systems picture down to level 5) - 03/2024 d. <u>Definition of done:</u> Document described in item b. is in Polarion, reviewed by mirror groups (at least in coordination with ERA TWG Freight@DAC) and ready for SPCG revision. e. <u>Interaction with other Tasks/Domains:</u> Dependency from Task 1. Deliverable reviewed by Task 1, 2 and 3. 	03/2024
05	<p>Central Instance Management of data & software (updates) – final proposal incl. requirements for FP5, with the potential support of a POC [WP4]</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable:</u> The SW versions and updates of the DAC system needs stringent control to avoid incompatibilities between wagons and loco. Also the access to the DAC data needs regulation wayside. The WP should analyse the existing solutions in the field of freight wagon management about suitability to be extended for such additional tasks. Based on the results from WP 3.4 elaboration of a concept how to share the data generated by the DAC system by loco and wagon between the stakeholders taking into account data ownership and confidentiality topics. b. <u>Sub-Milestones:</u> <ul style="list-style-type: none"> 1. Analysis of existing freight wagon SW platforms (to be concluded in SC2.1) – 09/2023 2. Concept for DAC SW version management – 09/2024 3. Concept for architecture for wayside exchange of DAC on board data between the stakeholders- 09/2024 4. Proposal for the organisation (incl. data classification and management policy and authorization process)- 09/2024 c. <u>Definition of done:</u> Documents described in item b. are in Polarion, reviewed by mirror groups (at least in coordination with ERA TWG Freight@DAC) and ready for SPCG revision. d. <u>Interaction with other Domains:</u> Task 2 TrainCS 	09/2024

No	Deliverable	Milestone
06	<p>STIP & “Authorisation Coordination”, with ERA, CEN/CENELEC & others: TSI CR management, EN Standards development, Syst. Pillar documents [WP5]</p> <ul style="list-style-type: none"> a. <u>Description of Deliverable:</u> Continuous maintenance of STIP input in close cooperation with SPCG, liaison with standardisation body, having a complete overview on activities, following the activities by Task 4 members actively, developing reports on the progress, being present, managing and steering b. <u>Sub-Milestones:</u> <ul style="list-style-type: none"> 1. Report on the performed activities, representation in harmonisation/standardisation groups, developing a plan in advance, overview, etc. - Continuous c. <u>Definition of done:</u> Reports described in item b. are in Polarion, regularly maintenance of STIP inputs in Polarion, submitted to SPCG for revision when stable status is available. d. <u>Interaction with other Tasks/Domains:</u> Any Task/Domain that can be affected by each of the harmonisation issues. Regarding TSI input liaison is necessary with ERA, i.e. TWG Freight@DAC. 	Continuous

Specific work item on Harmonised Diagnostics

No	Deliverable	Milestone
01	<p>Analyzing existing framework, definition of use cases (incl. KPI), functional requirement for measuring KPI); outlining certification needs. Address key obstacles (i.e. Data handling, juridical boundary conditions), outline solution, initiate solution process)</p> <ul style="list-style-type: none"> ○ SD31 Use Cases & Framework <ul style="list-style-type: none"> ▪ Analysis of existing frameworks and standards for data and asset information exchange; description of gap analysis, what's missing ▪ Description of the approach including a first proposal for detailed use cases (with a focus on quick wins); incl. definition of the relevant KPI to be measured for the respective use cases ▪ Description of homologated methods and subsequently harmonized parameters ▪ Listed key obstacles (i.e. Data handling, juridical boundary conditions), outline solution, initiate solution process ○ SD32 Certification needs & stakeholder involvement <ul style="list-style-type: none"> ▪ Outlining certification needs for acceptance ▪ Proposal for anchoring the European Rail Diagnostic approach in European conventions (i.e. TSI, CEN, GCU, ...) ▪ Proposal for sensitizing IM/RU for gaining benefit ○ SD33 Data Exchange <ul style="list-style-type: none"> ▪ Leverage developments of European dataspace solutions, including in the FP1, that provide digital enforcement of data ownership, distribution and usage policies in the federation of existing frameworks and standards for cybersecure, reliable, scalable and interoperable data and asset information exchange. <p>Definition of Done Deliverable D1: document finished and ready for assessment. At the end of the feasibility work, an assessment will be made and put to EU-Rail on the continuation of the work on detailed use cases</p>	Q1/2024

No	Deliverable	Milestone
02	<p>Detailed elaboration/development of the framework/architecture and applying framework to a concrete example of use cases, measuring systems and parameters; output: harmonized measuring methods and parameters. .Detailed elaboration of the framework/architecture</p> <ul style="list-style-type: none"> ○ SD34 Concrete Use Cases and Framework application <ul style="list-style-type: none"> ▪ Apply framework to a concrete example/set of use cases, measuring systems and parameters ▪ finalize use cases incl. concrete requirements for methods, measuring systems and harmonized parameters and finalize relevant KPI ▪ Propose solutions for key obstacles (i.e. Data handling, juridical boundary conditions) ▪ Clear definition of harmonized methods and parameters for harmonized diagnostics ○ SD35 Certification needs & stakeholder involvement <ul style="list-style-type: none"> ▪ Propose a concrete anchoring of the European Rail Diagnostic approach in European conventions (i.e. TSI, CEN, GCU, ...) ▪ Defining if there are certification needs for acceptance and which ▪ Recommendation of specific standardization and regulation output ○ SD36 Data Exchange <ul style="list-style-type: none"> ▪ Final description of which data can be shared through which systems <p><u>Definition of Deliverable D2: Definition of done: Documents are in Polarion;</u> harmonized measuring methods and parameters. Detailed elaboration/development of the framework/architecture and applying framework to a concrete example of use cases, measuring systems and parameters; output: harmonized measuring methods and parameters ready for take-up by TSI/standard etc. .</p>	Q3 2024

Specific work item on EGNOS for Rail

No	Deliverable	Milestone
01	Support to produce the document “Overview of Aviation & ETCS Railways regulations and processes” Review and comment of the output of the work of EUSPA	December 2023
02	Support to produce the document “Overall certification and authorisation approach for introduction of EGNOS”	July 2024

Annex VII – Call for proposals 2024

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 Plan⁵³ and Multi-Annual Work Programme⁵⁴.

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

⁵³ Master Plan available at <https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/>

⁵⁴ MAWP available at <https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/>

- 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 2016/797⁵⁵ 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 2024 Call for Proposals is structured around one topic under Destination 2, one topic under Destination 5 and one topic under Destination 7.

- **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 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
- **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.

⁵⁵ 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.

Conditions for the Call

Call: HORIZON-ER-JU-2024	2024 Budget (EUR million)	Opening	Deadline
Overall indicative budget	21.7	25/01/2024	7/05/2024

By analogy with the Horizon Europe Annual Work Plan 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 apply to all call topics here-in detailed.

DESTINATION 2 – Digital & Automated up to Autonomous Train Operations

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ⁵⁶	Number of projects expected to be funded
		2024		
	Opening: 25/01/2024 Deadline(s): 7/05/2024			
HORIZON-ER-JU-2024-FA2-SNS: EU-RAIL – SNS SYNERGY: Digital & Automated testing and operational validation of the next EU rail communication system	IA	13.5	13.5	1

DESTINATION 5 – Sustainable Competitive Digital Green Rail Freight Services

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ⁵⁷	Number of projects expected to be funded
		2024		
	Opening: 25/01/2024 Deadline(s): 7/05/2024			
HORIZON-ER-JU-2024-FA5: DIGITAL AUTOMATIC COUPLER – testing to support DAC authorisation, mix	IA	5.9	5.9	1

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.

and match for DAC coupler head and draft gear interchangeability and DAC hybrid coupler fitting solutions				
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DESTINATION 7 - Innovation on new approaches for guided transport modes

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ⁵⁸	Number of projects expected to be funded
		2024		
	Opening: 25/01/2024 Deadline(s): 7/05/2024			
HORIZON-ER-JU-2024-FA7 : Hyperloop – roadmap towards industrialisation and harmonized implementable concept	RIA	2.3	2.3	1

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in part A of the General Annexes to the Horizon Europe Work Programme 2023–2024.
<i>Eligibility conditions</i>	The conditions are described in part B of the General Annexes to the Horizon Europe Work Programme 2023–2024.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in part C of the General Annexes to the Horizon Europe Work Programme 2023–2024.
<i>Award criteria</i>	The criteria are described in part D of the General Annexes to the Horizon Europe Work Programme 2023–2024.
<i>Documents</i>	The documents are described in part E of the General Annexes to the Horizon Europe Work Programme 2023–2024.
<i>Procedure</i>	The procedure is described in General Annex F to the Horizon Europe work programme for 2023–2024.

⁵⁸ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

DESTINATION 2 – Digital & Automated up to Autonomous Train Operations

DESTINATION 2 – description (included in the Expected Outcome in the Funding Portal)

Today, urbanisation and population growth are already leading to rail capacity problems on main lines across Europe. To increase the railway capacity there are two main options: building new infrastructure and/or operating the rail system in a way that more trains can be safely running on the existing network, taking advantage of new technological and operational solutions.

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, which builds upon a next generation of Automatic Train Control (ATC), in addition to enhancements on the Train Control and Monitoring System (TCMS) allowing for integration at the on-board level. ATC 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 –termed CCS+.

This destination will focus in particular on addressing aspects related to the next generation of telecommunication system for railways. GSM-R is the commonly used railway telecommunication system (over 200.000 km of equipped tracks worldwide). Based on the 2G technology, this system is now approaching obsolescence.

The new system will be based on the 3GPP standardized 5G technology for radio Access and MCX (Mission Critical) to secure communication exchanges, but open to the use of various radio access technologies (5G evolution, WiFi, satellite communication, ...) enabling further levels of digitalization of railway operation, and be able to manage and monitor new services such as ATO up to Grade of Automation 4 (GoA4) on top of the existing features (Voice, Radio Emergency Calls, ETCS, ...).

Testing and validating of this new telecommunication system for rail in Europe is necessary in order to bring certainty to the quality and performance of the future system and on the other side thus diminishing risks associated to deployment. The work starts from the specification v2 developed for FRMCS⁵⁹, in accordance with the EU-RAIL JU System Pillar Report on FRMCS V2 and V3 Scope and Planning document⁶⁰.

The below set of workstreams is implemented in the context of a cooperation between the Rail Joint Undertaking (Rail JU) and the Smart Networks and Services Joint Undertaking (SNS JU). In that context, proposal(s) are expected to include a significant participation of the communication/networking R&I stakeholders, both from the supply and demand sides, and a strong and demonstrated track record to bring results to standardization bodies, notably under the main mobile communication standardization groups (e.g., ETSI MSG and 3GPP) where elaboration of FRMCS as a 5G evolution will be addressed.

⁵⁹ FRMCS stands for “Future Railway Mobile Communication System” and it is a sector led initiative

⁶⁰ <https://rail-research.europa.eu/wp-content/uploads/2023/08/20230718-FRMCS-report-final.pdf>

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:

- Increasing the overall capacity of the rail operation;
- Increasing the punctuality ;
- Improving the quality of operation;
- Improving cybersecurity;
- Increasing the communication features.

Proposals under this Destination should set appropriate monitoring and demonstration activities to measure the following KPIs:

Type of impact	KPI	Expected improvements
Responsiveness, robustness and flexibility of the system	Verification of data transmission at 300km/h	Latency between 1 and 5ms (real time communication for time critical applications) Data rate up to 20Mbit/s downlink and up to 10Mbit/s uplink
	Verification of interoperability between GSM-R and FRMCS.	
	Verification of voice function in conventional and high speed traffic	
	Verification that MCX is compatible with communication while trains are running.	Availability: 99.999%

HORIZON-ER-JU-2024-FA2-SNS: EU-RAIL – SNS SYNERGY: DIGITAL & AUTOMATED TESTING AND OPERATIONAL VALIDATION OF THE NEXT EU RAIL COMMUNICATION SYSTEM

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 13.5 million would allow these outcomes to be addressed appropriately considering the expected leverage effect on top of the EU funding. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	<p>The total indicative budget in term of Total Project Costs for the project stemming from this topic is indicatively up EUR 68.0 million, which is built from the expected leverage effect up to 5x out of a total maximum EU contribution estimated at EUR 13.5 million. The additional leverage effect is expected to be reached through either reduced co-funding rate, and including with possible external investments (e.g. national funding), and/or possible Private members both in-kind contributions to operational and additional activities.</p> <p>Applicant Private⁶¹ 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 1.263⁶² times the funding request, in aggregate, of these applicant Private Members. Any discrepancy must be well and duly justified.</p> <p>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.</p>
Indicative project duration	30 months
Type of action	Innovation action
Technology readiness level	All activities <u>are expected to achieve a</u> TRL 6/7. The output should be included as part of the EU-Rail Standardisation and TSI Input plan, and follow the associated processes linked to the ERA Change Control Management process. 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 2023-2024 General Annexes applies with the following exception: the limit for a full Innovation Action application is set to 120 pages

⁶¹ As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

⁶² 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.

<p>Special skills and/or capabilities expected from the Applicants</p>	<p>Applicants should ensure that their proposals and consortium reflect the aggregated expertise:</p> <ul style="list-style-type: none"> • Expertise from railway infrastructure managers and railway undertakings which should allow: <ul style="list-style-type: none"> - hosting the demonstrations and providing test trains/facilities; - verifying all necessary operational processes • Expertise from railway and telecom suppliers (system integrators, manufacturers and/or technology providers), which should allow: <ul style="list-style-type: none"> - proposing operational and technological innovative solutions to identified use cases and functional needs related to the application of the FRMCS V2 Specifications; - the capability in executing the lab or field tests. • Expertise from research institutes and academia, which should allow <ul style="list-style-type: none"> - 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.
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<p>Contribution to the monitoring and implementation, standardisation of the EU-Rail Programme</p>	<p>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 ⁶³ as further detailed in the Multi-Annual Work Programme⁶⁴.</p> <p>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 Pillars⁶⁵ 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 this WP 2024, and to facilitate contributions to European or international standards, the EU-Rail grant agreements will include an additional 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.</p> <p>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.</p> <p>The proposal should 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/wp-content/uploads/2023/01/EU-Rail-Governance-and-Process-Handbook.pdf</p>
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⁶³ Master Plan available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf.

⁶⁴ MAWP available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf.

⁶⁵ Refer to the Multi-Annual Work Programme available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf

Linked Projects	<p>As specified in section 2.3.8.1 of this WP 2024, 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.</p> <p>The action that is expected to be funded under this topic will be complementary to the following projects:</p> <ul style="list-style-type: none"> - FP2-R2DATO (GA number: 101102001) - FP6-FutuRe (GA number: 101101962) <p>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.</p>
Funding of only one project per topic	EU-Rail JU 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/lsc-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 – 2024 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 this WP 2024, and considering the key contributing role of this topic, in designing the dissemination and communication activities, the proposal should consider that the “Flagship Project” will be part of the overall EU-Rail Programme and the planning of key events – demonstrations, participations to fairs, etc. – will be coordinated at Programme level and by the “Stakeholder Relations and Dissemination” structure of the JU.

Expected outcomes:

The project stemming from this topic should address all the following work streams and it is expected to provide:

Workstream 1: Development of a future proof telecom architecture including all necessary network elements, based on **5G SA, IMS/SIP Core, MCX** and more generally on 3GPP standards, and conform to all FRMCS Specifications from UIC, 3GPP and ETSI. This must include pre-commercial versions of on-board equipment (**TOBA**, Telecom On-Board Architecture) and of the corresponding **Trackside Gateway** ensuring the relevant management of telecom streams, independently of carried services, and then facilitating the bearer flexibility of the solution.

The action to be funded under this topic should ensure application communication support by FRMCS Multipath using data paths via MNO and FRMCS/RMR.

Workstream 2: Testing of key functions necessary for daily operations of trains, including safety related functions, with the adequate quality of service and all necessary telecom interfaces and protocols: **voice operational functions** (necessary for the daily operations of trains, in the continuity of GSM-R operational functions, including safety related functions such as the voice emergency call), **ETCS level 2 support, ATO over ETCS (GoA1/2)**, additional FRMCS features such as **Messaging, Train Control & Management System (TCMS), CCTV** and **Passenger Information System (PIS)** using video over Mission Critical (MC) Data if video is needed. **Demonstration of possible additional supporting functions**, like Key Management System (KMS), Public Key Infrastructure (PKI), location and positioning and time sync to support train operations is also required. Cybersecurity should also be ensured and be an integral part of developments (*protection by design*).

Quality of service should be ensured, adapted to service categories, such as critical services or essential services. **Interoperability** between manufacturers equipment (infrastructure and board), particularly for cross-border situations, but also for multi-sourced systems, should be demonstrated.

Development of associated **test specifications** and test plans, including definition of common acceptance test criteria and performance metrics necessary to carry out testing and validation in the next phases of the action to be funded under this topic is also expected.

Workstream 3: Validation and return on experience: the action to be funded under this topic should:

- Validate **the capacity of the systems to meet KPIs and Fault Configuration Accounting Performance Security (FCAPS)** in order to estimate and predict service behaviour.
- **deliver technical inputs for Migration strategy** to move from GSM-R to FRMCS;
- include the necessary **return of experience** (from the results of the action to be funded under this topic, and also possible national FRMCS testing campaigns) to provide feedback to specifications (refinement of possible gaps and input to future specifications) and ultimately, start pilots (or initial deployments in safe operational and economic conditions).

Scope:

To successfully address the expected outcomes, the action to be funded under this topic should research, develop, and deliver all the following capabilities:

Workstream 1: Development of a future proof telecom architecture including all necessary network elements (TRL7):

- Telecommunication equipment, compliant with FRMCS specifications and ready for integration and testing:
 - core network telecom elements compliant with 3GPP 5G Stand-Alone;
 - 5G Base Transceiver Stations (BTS) and related access elements managing FRMCS frequencies;
 - IMS (IP Multimedia Subsystem) and/or Session Initiation Protocol (SIP) elements, as per FRMCS Specifications;
 - MCX servers and clients in all relevant network elements;
 - application servers, typically for voice services;
 - IP addressing compliant to FRMCS Specifications;
 - Railway trackside gateways with all specified FRMCS interfaces;
 - On-board TOBA with all specified FRMCS interfaces (OBapp, OBom, OBrad, etc.), multi-frequency capabilities and multipath capabilities;
 - Dispatchers with hybrid (GSM-R / FRMCS) capabilities;
 - Voice cabs with hybrid (GSM-R / FRMCS) capabilities;
 - Registration telecom systems (SIM Cards or equivalent).
- FRMCS-ready signalling equipment (or simulators, able to reproduce behavior):
 - ETCS compliant with OBapp interface and FRMCS-ETCS defined protocols (SS 037);
 - Interface to Key Management System (Subset-137);
 - ATO GoA1/2, with compliant OBapp interface and FRMCS-ATO defined protocols.
- The validation of Cab Radios to the applicable version of FRMCS Specifications and/or other relevant technical specifications including TOBA interfaces.
- The assessment of adapted antennas to equip trains for testing, based on outcomes from other projects⁶⁶.
- The adaptation to FRMCS system of monitoring solutions (voice / ETCS), to be used during test runs.

Workstream 2: Testing of key functions (TRL 7):

- The integration at on-board level and infrastructure level of all above-mentioned equipment.
- The definition of a comprehensive list of tests (in view of its execution in this call topic), in line with Chapter 5 of the CCS TSI:
 - Conformance testing for all equipment.
 - Functional testing in laboratory condition:
 - Local systems (network attachment, local binding, security credentials, etc.);
 - End-to-end entities and items (FRMCS System);
 - More globally, the complete functional testing of all these products as per FRMCS V2 Specifications.
 - Functional testing in field condition:
 - Conventional line test runs;
 - High-speed test runs;

⁶⁶ Reference to D3.4 “Antenna system specifications for adaptable communications in railway environment” from X2RAIL-3: https://projects.shift2rail.org/s2r_ip2_n.aspx?p=X2RAIL-3

- Interworking for GSM/R (Voice);
 - ETCS Transition scenario (GSM-R to FRMCS and FRMCS to GSM-R);
 - The testing in “real” conditions of FRMCS / GSM-R coexistence (trackside / on-board):
 - Frequency management (Change of FRMCS frequencies 900 (N100) / 1900 (N101) / MNO/ other) between 2 networks -
 - Cross-borders scenarios for the various mission critical services (Voice and Data)
 - Breakdown simulations / Degraded Modes;
 - More globally, the complete functional testing of all these products as per FRMCS V2 Specifications.
- A precise and complete campaign of measures (**conventional line, high-speed line and cross border conditions**) to define radio parameters ensuring the required qualities of service (preparing the evolution of SS-093 / O-2475 evolutions), including mitigation of potential impacts from interferences.
 - Interoperability testing between manufacturers: the following elements should be tested:
 - Network provider 1 / Network provider 2 (at level of network elements, typically core and access);
 - On-board provider 1 / Network provider 2;
 - On-board provider 1 / Trackside gateway provider 2;
 - MCX Client /MCX Server.

Workstream 3: Validation and return on experience:

The Flagship Project stemming from this topic is expected to provide a return on experience from the laboratory and in field tests and provide detailed feedback, which will be used to conclude a release of specifications for the next EU railway communication system. Coordination with the EU-Rail System pillar (and ERA through it) is required. It will also leverage outcomes and results in the context of standardisation by submitting the results to the appropriate standardization organizations such as ETSI, 3GPP etc, to work towards the evolution of 5G in the right direction. This part will necessitate a strong partnership between the communication/networking industrial stakeholders and the railway use case industrial actors. To contribute to FRMCS specifications Version 3 that are as ready as possible for deployment in different Member States' contexts, this project needs to consider the return of experience of any national FRMCS testing and validation project that shares its results with this project⁶⁷.

Assumptions for the scheduling of the operations:

The applicants to this topic can consider for their activities planning the following assumptions:

- The V2 specifications, as described, in the EU-Rail System Pillar Report on “FRMCS V2 and V3 Scope and Planning” dated 05/07/2023 (version 1.3)⁶⁸, will be delivered to ERA in stable draft in March 2024 in order to launch a EECT review process. The final draft will be delivered to ERA in October 2024 after this review process. An ERA technical opinion will be released.

⁶⁷ The Commission and ERA will be informed about national projects and will share information about them based on Article 10 of Commission Implementing Regulation (EU) 2023/1695 of 10 August 2023 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union and repealing Regulation (EU) 2016/919 OJ L 222, 8.9.2023, p. 380–560 ELI: http://data.europa.eu/eli/reg_impl/2023/1695/oj

⁶⁸ <https://rail-research.europa.eu/wp-content/uploads/2023/08/20230718-FRMCS-report-final.pdf>

Collaboration work required with other FAs

The action to be funded under this Destination should take into account the results of the work from FP2-R2DATO, most notably, regarding the work to be done in the Automation Cluster on ATO over ETCS.

Interaction with the EU-Rail System Pillar

The EU-Rail System Pillar aims to guide, support and secure the work of the EU-Rail 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.

A dedicated link between the action to be funded under this Destination and the EU-Rail System Pillar should be established, in particular for workstreams 2 and 3.

Interaction with other relevant actions

Work under this topic should link to other relevant actions, financed by the European Commission e.g., in the context of 5G PPP, and the Connecting Europe Facility (CEF2). Link to other external initiatives, such as national activities, can also be relevant.

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.

DESTINATION 5 - Sustainable Competitive Digital Green Rail Freight Services

DESTINATION 5 – description (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 in a smart way for all types of rail freight transport (e.g. with Digital Automatic Coupler (DAC) and other technological and operational solutions), Improving cross-border operation (cross border implies an important share of freight traffic and it 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. 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 LCC⁶⁹, 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. This will result in higher productivity, better capacity utilisation and improved planning possibilities for railway undertakings and intermodal operators, through the reduction of cross-border barriers and multimodality, faster transport handling with higher reliability. A seamless rail freight where transparent and comprehensive multimodal information is available will lead to an increase in customer satisfaction and easier access to rail-based services by combining easy booking and managing functions. Being based on harmonised European data this leads, to higher predictability and planning possibilities.

The selected proposal for funding under this Destination will be a Flagship Project of the 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's Rail JU Master Plan.



Meeting
evolving
customer
requirements



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

⁶⁹ LCC = Life Cycle Costs

Proposals under this Destination should set appropriate monitoring and demonstration activities to contribute to the measurement by means of 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% Increase reliability of freight wagons equipped with DAC:
 - Expected malfunction reduction targeting 50-70%.
- Demonstrate the interchangeability of DAC across DAC solutions:
 - Expected success rate targeting 90-100%.
- Demonstrate technical integration of power supply and communication systems for DAC hybrid coupler:
 - Expected success rate targeting 100% for the loco types considered.

In the field of seamless rail freight

- 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 intermodal 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:
 - Reduced energy consumption by a minimum of 6% targeting towards the overall MAWP objective of 10%.

HORIZON-ER-JU-2024-FA5: DIGITAL AUTOMATIC COUPLER – TESTING TO SUPPORT DAC AUTHORISATION, MIX AND MATCH FOR DAC COUPLER HEAD AND DRAFT GEAR INTERCHANGEABILITY AND DAC HYBRID COUPLER FITTING SOLUTIONS

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 5.9 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 5.9 million. Applicant Private ⁷⁰ 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 ⁷¹ times the funding request, in aggregate, of these applicant Private Members. Any discrepancy must be well and duly justified.

⁷⁰ As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

⁷¹ 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.

	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
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve a TRL 6/7 – 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 2023-2024 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)	<p>Applicants should ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the topic.</p> <p>The applicants are expected to gather the necessary technical expertise from Operators, Infrastructure Managers, DAC Suppliers, Loco Suppliers, Loco Keepers as well as the capabilities, capacity and proven experience to execute the required test program and to provide the test results. The applicants should also ensure the provision of the required test infrastructure and test assets and the managerial expertise for its execution. Applicants must ensure their capacity to industrialise and respect the normative landscape applicable to electronic / electropneumatic / electromechanical products for passenger and/or freight railway applications.</p> <p>Complementary expertise from research institutes and academia, could allow</p> <ul style="list-style-type: none"> - 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. <p>Complementary expertise from other sectors and parties, with particular attention to SMEs and Start-ups, which may contribute to enhance the actions' outcome.</p>
Contribution to the monitoring and implementation, standardisation, of the EU-Rail Programme	<p>The action resulting from this topic is contributing the Flagship Area 5 and it is a contributor to the achievement of the objectives identified in the Master Plan⁷² as further detailed in the Multi-Annual Work Programme⁷³.</p> <p>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 Pillars⁷⁴ activities, as well as in view of the development and implementation of EU</p>

⁷² Master Plan available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

⁷³ MAWP available at <https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/>

⁷⁴ Refer to the MAWP available at <https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/>

	<p>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 this WP 2024, 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.</p> <p>The proposal should 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/wp-content/uploads/2023/01/EU-Rail-Governance-and-Process-Handbook.pdf</p>
Linked Projects	<p>As specified in section 2.3.8.1 of this WP 2024, 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.</p> <p>The action that is expected to be funded under this topic will be complementary to the following actions:</p> <ul style="list-style-type: none"> - FP5-TRANS4M-R (GA: 101102009) - DACcord (GA: 101121855) <p>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.</p>
Funding of only one project per topic	EU-Rail JU 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/lis-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 2023-2024 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 this WP 2024, and considering the key contributing role of this topic, in designing the dissemination and communication activities, the proposal should consider that the “Flagship Project” will be part of the overall EU-Rail Programme and the planning of key events – demonstrations, participations to fairs, etc. – will be coordinated at Programme level and by the “Stakeholder Relations and Dissemination” structure of the JU.

Expected Outcome:

Building upon the results of S2R freight innovation pillar 5 (IP5)⁷⁵, European Digital Automatic Coupler Delivery Programme (EDDP)⁷⁶ and upon the work being delivered by Europe’s Rail Joint Undertaking (EU-Rail) Flagship Project 5 (FP5-TRANS4M-R)⁷⁷, the Project stemming from this topic is expected to contribute to the EU-Rail Programme addressing the activities on Full Digital Freight Train Operations considered within FP5-TRANS4M-R.

Stakeholders gathered under the open European DAC Delivery Programme (EDDP)⁷⁸ have agreed to a overall plan which target to have DAC pre-deployment pilot trains by early 2026, having them running for a couple of years in European freight operations to gather the necessary data and confidence before launching the full deployment of such solution. To reach this target, the following goals need to be achieved:

- ensure that the pre-deployment trains are using the starter/basic package considering the activities to support DAC authorisation. The starter/basic package comprises the following digital/automation functions: mechanical or push-button uncoupling from wagon side, uncoupling in-train from locomotives, energy/data management ready for other functions, train composition/wagon order, automated brake test, train integrity as functionality and automated technical wagon inspection,
- initiate mix and match tests⁷⁹ as a first step towards the interchangeability of DAC interface where the two main components of a DAC unit (coupler head and draft gear) are connected, herewith called Interface A,
- enlarge the number of Wagon Onboard Units (WoBu) compliant with the full digital freight train operation system architecture developed by FP5-TRANS4M-R and which would be made available to the Project stemming out of this call by the time of its start,
- reach a sufficient number for future deployment of the most common existing locomotives types ready to integrate hybrid couplers.

The interaction with FP5-TRANS4M-R is fundamental as the activities considered within the workstreams identified within this call are linked to the functional specifications, technical architecture and deliverables of the Flagship Project. This link is crucial to ensure that the project

⁷⁵ Results from Shift2Rail activities should be taken into account, please see FR8RAIL II (https://projects.shift2rail.org/s2r_ip5_n.aspx?p=FR8RAIL%20ii) D1.2-FR82 Automatic coupling and wagon design spec

⁷⁶ <https://rail-research.europa.eu/european-dac-delivery-programme/>

⁷⁷ Indication of the expected input to be taken into account is provided in the workstream below

⁷⁸ <https://rail-research.europa.eu/european-dac-delivery-programme/>

⁷⁹ Tests intended to prove and ensure the different DAC coupler head and draft gear solutions are interchangeable through a standardisation of interface A.

stemming from this topic will be a valuable contribution to the FP5-TRANS4M-R. The project resulting from this topic should also support FP5-TRANS4M-R on the related DAC authorisation process, which the expected tests will be part of.

All project deliverables should ensure a broad exploitation of the results and take up in the context of the European DAC Delivery Programme (EDDP).

Scope

To successfully address the expected outcomes, the Flagship Project stemming from this innovation action topic should research, develop, and deliver all the following capabilities and/or any other relevant capability within the following workstreams:

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.

The Flagship Project work should contribute to specifically provide:

- the execution of derailment tests, crash tests and climate chamber tests with DAC interface A⁸⁰
- test results for the DAC authorisation and standardisation activities within TSI and RID⁸¹ requirements and potentially also other requirements depending where the successive pre-deployment pilot tests will take place under authorisation from the related NSAs.

In relation to the above, the action to be funded under this topic is expected to provide:

- 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). By doing so, running safety of freight wagons equipped with DAC interface A can be proven and TSI requirements for authorisation fulfilled,
 - 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,
 - providing input to the EU-Rail System Pillar, in the Standardisation and TSI input plan (at least once in Q4 for each calendar year), and to the ERA as needed for the upcoming TSI revision package with regards to DAC.
 - Testing requirements and assets to be considered:
 - locomotives to perform compressive forces (minimum of 500 kN)
 - three (3) different wagon types as test specimen
 - barrier wagons
 - twenty (20) DAC interface A and spare parts
 - measuring equipment
- Crash tests considering (TRL 6/7):
 - validated figures for DAC interface A couplers according to the crash test requirements based on the requirements of EN 15227 and RID,
 - provision of input to the EU-Rail System Pillar, in the Standardisation and TSI input plan (at least once in Q4 for each calendar year), and to the ERA as needed for the upcoming TSI revision package with regards to DAC.
 - Testing requirements and assets to be considered:
 - ten (10) DAC interface A units

⁸⁰ Refers to the specific interface where the two main components of a DAC unit (coupler head and draft gear) are connected.

⁸¹ Regulations concerning the International Carriage of Dangerous Goods by Rail (RID).

- measuring equipment
- 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
 - Testing requirements and assets to be considered:
 - three (3) different wagon types as test specimen
 - four (4) DAC interface A coupler per DAC supplier. Those units could be reused from the ones used on the measuring equipment.

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

The R&I work should provide the first results for interchangeable DAC interface A couplers for the handling, the transmission of forces and the behaviour for defined operational test cases.

Based on the test results, a comprehensive test specification should be defined for a fully developed mix and match test aiming for the interchangeability of interface A in DAC couplers.

The action to be funded under this topic is expected to:

- manage tests to ensure the interchangeability across all project-involved DAC suppliers,
- provide bench tests to measure the force transmission at different coupling angles and perform operational tests (TRL 7) on defined test cases from FP5-TRANS4M-R.
- Testing requirements and assets to be considered:
 - rail infrastructure: straight, curve and S-shape tracks
 - three (3) different wagon types
 - one locomotive
 - six (6) DAC interface A couplers per DAC supplier
 - measuring equipment

Workstream 3: Hybrid coupler for mainline and shunting locomotives, technical analysis and development of fitting solutions.

The Flagship Project stemming from this innovation action topic should first identify the most suitable locomotive types (mainline and shunter locomotives) for the technical integration of power supply and communication systems.

The action to be funded under this topic is expected to deliver:

- the evaluation and assessment of existing technical documentation of the locomotive types considered.
- the analysis of technical boundaries:
 - Technical solutions for full system integration of hybrid couplers/ power supply system.
- the evaluation and assessment of potential technical solution for the integration of power supply and communication systems within the locomotive types considered.
- a roadmap for technical integration within the planned timeframe to allow the preparation of test runs (TRL 7) (based on the FP5- TRANS4M-R test specifications for DAC hybrid coupler and which would be made available to the Project stemming out of this call by the time of its start), support of trials and document/assessment of the results.
- Testing requirements and assets to be considered:
 - minimum eight (8) hybrid couplers,
 - pre-deployments trains considering a mixture of mainline and shunting locomotives.

The specific tests considered within the workstream actions are expected to comply with the requirements mentioned above and the applicants are expected to perform the number of tests needed to reach this goal.

Workstream 4: Wagon Onboard Unit (WoBu).

The activities within this workstream should contribute to:

- The provision of wagon onboard unit prototypes for FP5-TRANS4M-R.

Different suppliers will have to be involved and to deliver the needed number of WoU. The wagon onboard unit prototypes can be provided by different companies if compliance to the requirements is reached. These units should be conceived according to the applicable Full Digital Freight Train requirements of FP5-TRANS4M-R, which would be made available to the Project stemming out of this call by the time of its start, and should already have demonstrated an adequate level of interoperability on the reference test system in a relevant environment. The project should perform demonstrations in operational environments (TRL 7). It must be foreseen that the number of WoUs provided and supporting the EDDP train functions would amount to minimum thirty (30) units. These units should be conceived according to the applicable Full Digital Freight Train requirements

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) and to areas linked with the EDDP). 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.

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.

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 complementary solution for the increased demand, increasing also the availability of sustainable transportation solutions. Hyperloop technology could be a promising alternative, since it promises very high-speed travel with low energy needs while relying on electricity.

Hyperloop is an ultra-high speed guided transport system based on magnetic levitation and with “capsules” movement inside a vacuum tube. To analyse the feasibility of this type of transport, the operational, safety and reliability aspects should be considered and the economic viability assessed. This call aims to strengthen the collaboration of the different hyperloop promoters in facilitating the harmonisation/interoperability of hyperloop technologies, which would support the possibility of the creation of a hyperloop network coming from different technology providers. In addition, this new technology should complement existing mobility solutions and it should consider how hyperloop can be properly interconnected and interfaced with the other transport modes.

HORIZON-ER-JU-2024-FA7: HYPERLOOP – ROADMAP TOWARDS INDUSTRIALISATION AND HARMONIZED IMPLEMENTABLE CONCEPT

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 2.3 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	<p>The total indicative budget for the topic is EUR 2.3 million.</p> <p>Applicant Private⁸² 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 1.263⁸³ times the funding request, in aggregate, of these applicant Private Members. Any discrepancy must be well and duly justified.</p> <p>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.</p>
Indicative project duration	24 months. This does not preclude submission and selection of a proposal with a different project duration.
Type of Action	Research and Innovation Action

⁸² As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

⁸³ 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.

Technology Readiness Level	Activities are expected to achieve a at least TRL 2 for a design concept and at least TRL 4 sub-system validation– 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 2023-2024 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 should ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the topic. This includes but is not limited to technical, engineering and operational competencies. The applicants are expected to gather and reflect expertise from hyperloop technology providers and promoters, European Research Institutes, rail stakeholders to encompass Knowledge and vision on hyperloop solutions, bring the necessary expertise to deliver a design of concept and subsystem validation as well as contribute to the process of innovation.
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.
Contribution to the monitoring and implementation, standardisation, of the EU-Rail Programme	Applicants are expected to deliver relevant information (data, results, etc.) as mutually agreed, to the JU to contribute to the advancement of the Innovation and System Pillars ⁸⁴ 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 this WP 2024, 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.
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/lis-decision_he_en.pdf
Award criteria additional details	The award criteria included in the General Annexes of the Horizon Europe – Work Programme 2023-2024 are complemented with additional criteria as specified in Annex VIII to this Work Programme.

⁸⁴ Refer to the Multi-Annual Work Programme available at <https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/>

Expected outcome:

The Project stemming from this topic should address all the following work streams and is expected to provide the associated outcomes:

Work-stream 1: Technical harmonisation, roadmaps on industrialisation and applicability

This work-stream should enable towards harmonisation/interoperability of the hyperloop technologies using commonly identified definitions for operational, safety and reliability requirements. Hazard analysis should be performed while aiming to define a commonly agreed architecture design. This outcome should reflect a common view on the main hyperloop technology providers and promoters. The work is expected to be the basis for a future market uptake of the hyperloop technologies, in particular thanks to the development of an industrial roadmap, reflecting relevant parties such as developers, engineering and design & supply companies and operators, covering all steps and milestones needed for the technologies industrialisation and deployment.

Another expected outcome of this work-stream, the areas of possible application considering operational scenario, business case will be defined together with specific feasible routes in the European mobility network.

Work-stream 2: Design concept and validation of key sub-systems

The outcome of this work-stream is a blue print concept for 1:1 scale demonstrators based on commonly defined and agreed architecture and requirements. In addition, this work-stream should validate a proof of concept to carry out compatibility tests of the different subsystems for vehicle and or infrastructure from different solution providers.

Scope

To successfully address the expected outcomes, the action to be funded under this topic should research, develop, and deliver upon all following research activities :

Work-stream 1: Technical harmonisation, roadmaps on industrialisation and applicability

The R&I work should focus on the:

- identification of use cases (e.g. freight/passengers/mixed operations on urban/intercity/long-haul/international connections) by assessing possible business cases and defining possible operating models. This should be done by taking into account the following: network effects, interoperability (cross-border in the EU) and integration with the EU multimodal mobility network (existing infrastructures like railways, ports, airports, and other emerging transportation systems like Maglev Derived Systems).
- the definition of an initial common system architecture and to identify functional, operational, and safety related requirements for the infrastructure and the vehicle, with insofar as possible performance and technical related elements. The interfaces between different subsystems (e.g. Command and Control, Infrastructure, Power Traction, Telecommunication systems) should also be defined, along with those elements necessary to obtain a network. This should be achieved building on existing work from the S2R funded project Hypernex⁸⁵ and standardisation work from

⁸⁵ Hypernex (D3.1) https://projects.shift2rail.org/s2r_ipX_n.aspx?p=S2R_HYPERNEX

JTC20, to support further harmonisation of different ultra-high speed guided transport systems based on vacuum tube applications.

- Carrying out preliminary Hazard Analysis based on identified operational requirements, taking into account operational processes and applicable safety standards from other modes such as rail and aviation, to ensure safe, reliable and efficient operations while striving towards interoperability.
- identification of an industrial roadmap for the finalisation of the necessary technical elements including system/subsystems qualifications and validations steps, to reach the commercial implementation of such technology at scale. The industrial roadmap could be expanded looking at the economic feasibility of possible lines being operated with hyperloop technology in Europe, maximising private investments, aiming at creating a network in synergies with other existing or expansion of transport network (e.g. highspeed rail network).

Work-stream 2: Design concept and validation of key sub-systems

The R&I work should focus on the:

- development of a design concept (TRL2) of a demonstrator for the complete hyperloop system (including all sub-systems at 1:1 scale in relevant environment) taking into account the current ongoing Hyperloop technical developments and the results of WS1 in order to assess the feasibility of the requirements set in WS1 and to set a standard for the future in the perspective of harmonisation and interoperability. The design concept of the demonstrator should be applicable in different sites.
- validation of existing technologies for key sub-systems taking into account the developed design concept, at least TRL4. This validation is considered as a proof of concept also to perform a compatibility checks between different existing or adapted solutions for infrastructure and/or vehicle.

An indicative scheduling of the deliverables is suggested below:

Outcomes under Work-stream 1 are expected by M15;

Outcomes under Work-stream 2 are expected by M24.

Annex VIII – 2024 Call for proposals – Evaluation Criteria

Part D of the Main Horizon Europe Work Programme 2023-2024 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”.

	Excellence⁸⁶	Impact	Quality and efficiency of the implementation
Research and innovation actions (RIA) Innovation actions (IA)	<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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.

⁸⁶ 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 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 239 ^a), 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

NAME OF MEMBER		REGISTRATION DETAILS
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.:	
	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	Jernbanedirektoratet (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

NAME OF MEMBER		REGISTRATION DETAILS
25	Voestalpine Railway Systems GmbH	registered under Austrian law (registration number: FN 126714w), with its registered office in Kerpelystrasse 199, 8700 Leoben, Austria