

WORK PROGRAMME 2023-2024 Amendment n°1

adopted by the EU-Rail Governing Board on 23 June 2023

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

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 2/2021 listing the decisions adopted by the Governing Board of S2R 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
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
D&E-Net	Dissemination and Exploitation Network
DMI	Driver Machine Interface
DOI	Digital Object Identifier
DRIMS	Dynamic Railway Information Management System
DSS	Decision Support System
EC	European Commission
ED	Executive Director
EN	European Norm
ERA	European Union Agency for Railways (formerly European Railway Agency)
ERRAC	European Rail Research Advisory Council
ERTMS	European Rail Traffic Management System
ETCS	European Train Controlling System
EU	European Union
EU-Rail	Europe's Rail Joint Undertaking
FACTs	Flexible AC Transmission Systems

Acronym/ Abbreviation	Full Title
FFFIS	Form Fit Functional Interface Specifications
FIS	Functional Interface Specifications
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
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 Plan
MB	Moving block
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

Acronym/ Abbreviation	Full Title
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
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
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)
SWL	Single Wagon Load
SteCo	Steering Committee
TAF	Telematic Application for Freight
TAP	Telematic Application for Passengers
TCMS	Train Control and Monitoring System

Acronym/ Abbreviation	Full Title
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 2023-2024 (hereinafter the “Work Programme” or “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 2023 and, indicatively, in 2024, related to its Research and Innovation (R&I) Programme governed by the Horizon Europe rules. The main focus will be on
 - o the ramp up of the 2022 Flagship Projects, following the conclusion of the grant agreements signature, to ensure that by the end of 2023 the planned milestones are achieved,
 - o the delivery of the first results of the System Pillar Tasks and Domains, following the signature of the first Service Request and the ramp up phase during Q4 2022 the conclusion of the Call 2022-2 and launch of the relatives projects as from mid-2023 indicatively, to ensure that new exploratory and other R&I activities complement the main Programme,
 - o the launch of the Call 2023-1 during Q4 2023 to create new opportunities for inclusiveness and participation; the scope of this call will be defined during Q2 and Q3 2023, taking into consideration the aforementioned activities and their progress. The scope of the Call 2023-1 will result from an extensive open consultation of the rail stakeholders and beyond,
 - o the preparation of a call for Associated Members to be launched in the first half of 2024, after having made a in depth assessment of the possible gaps in terms of entities involved in the EU-Rail Programme to its full extent;
- the R&I activities related to the projects launched in the previous years under the S2R Programme; the focus will be on the execution of the research and innovation activities previously signed and needed to advance in delivering the Technology Demonstrators, and in view of reaching the complete phase of the S2R Programme by 2024, having achieved its targets.

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 still to be finalized of the ongoing S2R Programme, ensuring the adequate phase out and ramp up. 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 supply chain.

It also provides details on the corporate and supporting activities for the period to come and explains the governance structure of EU-Rail, including the tasks of individual bodies of the JU. Finally, the WP 2023-2024 presents information on the 2023 Budget, as well as estimated figures for 2024.

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”).

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://shift2rail.org/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/>

³ Adopted by Governing Board Decision n° 02/2022 and available at <https://shift2rail.org/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents>

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 2023 and 2024, as applicable, the corporate and supporting activities, the EU-Rail governance, as well as it provides information on the organisational management and internal management and control framework. Section 3 details the EU-Rail's 2023-2024 Budget. Further information regarding ICAA, organisational chart, KPIs, demonstrators, EU-Rail's Founding Members, as well as regarding the System Pillar milestones and planning, 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 as public-private partnership in the rail sector established under Article 187 of the Treaty on the Functioning of the European Union.

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

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

⁴ OJ L 427, 30.11.2021, p. 17–119

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 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 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.

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

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.

1.2 Mission statement of EU-Rail

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

The vision of EU-Rail is

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

The Mission Statement of EU-Rail is

Rail Research and Innovation to make rail the everyday mobility

1.3 Background and link with the Master Plan

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

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

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

⁶ https://shift2rail.org/wp-content/uploads/2020/12/RAIL-Strategic-Research-and-Innovation-Agenda-2020-FINAL_dec2020.pdf

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

- facilitate the research and innovation activities necessary to achieve the objectives of EU-Rail, including low TRLs rail-focused research and innovation activities. In that respect, EU-Rail shall:
 - define and organise the research, innovation, demonstration, validation and study activities to be carried out under its authority, while avoiding fragmentation of such activities;
 - exploit standardisation and modularity opportunities, and facilitate the interfaces with other modes and systems;
 - develop demonstration projects;
 - develop close cooperation and ensure coordination with related European, national and international research and innovation activities in the rail sector and beyond as necessary, in particular under Horizon Europe, thereby enabling the Europe's Rail 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 2023 and 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 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. This integrated system shall on the one hand deliver unrestricted movement of trains, on the other hand, it shall create a single market for rail components.

The System Pillar *Task 1* is to define the high-level overall railway architecture and operational concept for the EU Rail System. It focuses on the European railway network to which Directive 2016/797 applies.

Task 2 of the System Pillar is in the area of control-command and signalling (CCS). The regulation and implementation of European rail CCS is of central importance in the running of a safe, efficient, interoperable, robust and reliable rail service in Europe. CCS deals with all the on-board and trackside equipment required to ensure safety and to command and control movements of trains authorised to travel on the network. The task is to develop the operational concept(s) 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 Technical Specification for Interoperability, with much greater standardisation and much less variation than at present. This integrated CCS system shall on the one hand deliver unrestricted movement of trains, on the other hand, it shall create a single market for rail components. Task 2 will evolve and encompass relevant activities to answer other research and innovation areas of the Innovation Pillar, such as the Digital Automatic Coupling for rail freight.

Task 3 of the System Pillar covers the area of Traffic and Capacity management (TMS/CMS). Improvements in this area enable more flexible end to end journeys at European level including short term planning. TMS/CMS activities will encompass the internal improvements of the systems such as automation and focus on the necessary interfaces to improve cross border operations.

Task 4 of the System Pillar focuses on the Digital Automated Coupling and freight advances that will be a gamechanger for digital freight operations. System Pillar shall ensure an alignment on its development to the overall system architecture and operational concept.

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 transform the European rail system. Its activities are organised in seven Flagship Areas and the Transversal Topic, more details of which are presented in Section 2.3.1.

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. In general, these objectives include the following:

- contribute towards the achievement of the Single European Railway Area;
- 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;
- support the development of a strong and globally competitive European rail industry.

These general objectives can be further specified as follows:

- (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 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.

The Deployment Group Activities

The Deployment Group should consist of European rail representatives, in particular of Infrastructure Managers and Rail Operators, but also of suppliers to ensure the preparedness of products, to advise the JU on the way coordinated and integrated deployment can be organised, in particular on the following elements to be proposed by the JU Executive Director, and in consultation with rail stakeholders (such as users associations, logistics associations, environment NGOs etc.), including a representative of the state representative group:

- (a) Examine and provide recommendations on alternative scenarios for the rollout of innovative solutions.
- (b) A roadmap for the coordinated and integrated deployment of the relevant rail research and innovation results, (incl. investment plan if needed).
- (c) Consideration of human factors as a result of deployment.
- (d) Assessment of the relevant legal framework, its necessary adaptations, and the options for the transition phase.
- (e) Ensure consideration of diversity of situations across the Union.
- (f) Alignment of deployment and investment plans.
- (g) Risks and opportunities associated to uncoordinated initiatives.
- (h) Phasing out of existing legacy systems and consideration on the necessary accompanying funding and financial measures.
- (i) Use of a performance scheme that would contribute to accelerating deployment and/or any other relevant measures.
- (j) Any other relevant matter that would contribute to reducing the innovation lifecycle and increase the performance of rail, maintaining the same level of safety or increasing it.

The activities of the Deployment Group are expected to start early 2023.

2. WORK PROGRAMME 2023

2.1 Message from the Executive Director

Message of the Europe's Rail Executive Director

Following the 2022 ambitious and successful ramp up phase, the Europe's Rail JU and its Programme are fully operational, including Innovation Pillar, System Pillar and, soon, the Deployment Group.

The Research and Innovation activities performed under one integrated Programme covering innovative solutions' lifecycle, from exploratory research to pre-implementation and deployment, are designed to deliver the transformation of the rail sector needed to answer clients needs, passengers and supply chain. Not only to contribute addressing the European Green Deal but also the energy crises and new challenges.

Nevertheless, the EU-Rail Programme does not cover all the necessary key enablers and telecommunications is one of the areas not fully included, due to the fact that activities started earlier and have been performed within different organizations, outside the European Union governance.

It is the time to reverse this process. It is the time to ensure that the European Union reappropriates itself of the key enablers that create the backbone of the future digital rail system, such as new generation of telecoms. With this Work Programme 2023 – 2024, the JU, its membership and all the stakeholders involved in the EU-Rail activities shall consider how to fully integrate telecoms design, development, demonstrations, and pre-deployment within the EU-Rail Programme, under the umbrella of the European Union represented by the European Commission and together with the system authority for safety and interoperability, the European Union Agency for Railway, Any solution that would reproduce previous lock-in products, due to company' or organizations' IPRs, technology, past thinking, it is obsolete and cannot be considered future proof.

Similarly, the work performed in the S2R Programme on satellite navigation as well as complementary work performed within the EUSPA Programme shall be part of an industrial roadmap to deliver the necessary key elements of a resilient digital rail system.

The EU-Rail Programme is not designed to digitalize how today operations are performed. This is a failure and would not require European Union funding and resources: it is designed to transform rail and make it future proof. It is not with the people and thinking that created today problems and inefficiencies that we will solve them. The EU-Rail membership, the organizations and entities involved in Research and Innovation shall have the ambition to challenge the current ways of working, operationally, technologically and embrace a new way of working, engaging the workforce in such endeavour.

Not only. In the years before Shift2Rail and now Europe's Rail, large investments in rail research and innovation resulted in minor impacts on the performance of the rail system; this has now been substantially reversed with the setting up of the first rail European institutionalized partnership in 2016, but still the current situation is suboptimal as there is no planning of the deployment of R&I results. The Deployment Group, expected to be active by early 2023, will have to tackle the design, definition and proposal of future European coordinated deployment.

Without such courage and ambition, the rail sector will replicate in the digital and automation designed future the current way of working, passing away to the opportunity for effectiveness, efficiency and lifecycle economy that only an in depth transformation can deliver.

By the end of this decade, Europe's Rail shall *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.*

I would like also to take this opportunity to mention the objectives of inclusiveness and openness that are underpinning this Work Programme, built on the SBA terms and conditions for the partnerships:

- Recital 15, which requires the joint undertakings **to deliver European added value compared to calls under the main Horizon Europe work programme.**
- Recital 16, which confirms Horizon Europe principles of *openness and transparency, strong leverage effect and long term commitments*. In particular, *partnerships should be open to any entity that is willing and able to work towards the common goal, should promote broad and active participation of stakeholders in their activities, membership and governance, and should ensure that the results would be for the benefit of all Europeans, in particular through a broad dissemination of results and pre-deployment activities across the Union.*
- Recital 19, where it is clarified that *Horizon Europe Regulation requires that the **financial or in-kind contributions from members other than the Union should be at least equal to 50 % and may reach up to 75 % of the aggregated joint undertaking budgetary commitments.** Also, that the Union should be in a position to reduce its contribution if members other than the Union fail to fulfil their commitments.*
- Recital 21, that establishes that *in line with the ambitions set out in the Horizon Europe Regulation, one of the preconditions of setting up institutionalised European partnerships is ensuring partners' contributions throughout the lifetime of the joint undertakings... Joint undertakings should be able to identify measures to facilitate those contributions through their work programmes, **in particular by reducing funding rates.** In duly justified cases, it should be possible to **introduce additional conditions that require the participation of a member of the joint undertaking** or their constituent or affiliated entities, targeting activities where the industrial partners of the joint undertaking can play a key role such as large-scale demonstrations and flagship projects closer to the market, and **contribute more via lower funding rates.***

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 shall provide opportunities to complement the series of actions expected from the rail sector, including interacting with ERRAC on complementary activities. Stakeholder relations and dissemination of results ensure the visibility of the progress achieved. Sound financial and risk management and compliance will underpin the implementation of the Programme along its lifecycle.

2.2 Executive Summary 2023

The European Green Deal⁷ and the related Roadmap⁸, published in December 2019, form an integral part of the European Commission's strategy to implement the United Nation's 2030 Agenda and

⁷ https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf

⁸ https://ec.europa.eu/info/sites/info/files/european-green-deal-communication-annex-roadmap_en.pdf

associated Sustainable Development Goals⁹. 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”¹⁰ 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.

Further to the topic of “Digital Decade”, the Commission indicated in its Communication of March 2021¹¹ how digital transformation can improve the ecosystems related to mobility and transport. Digitalisation can improve environmental and cost performance and simultaneously increase safety levels contributing to a higher quality of life. It will be achieved through more advanced levels of automation, faster and more reliable connectivity, and IT enabled profound transformation of the management of mobility services. The public could also benefit from fast internet connectivity for passengers on most stations and lines, user oriented telematics and facilitated multi-modality.

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

⁹ <https://sdgs.un.org/goals>

¹⁰ https://eur-lex.europa.eu/resource.html?uri=cellar:5e601657-3b06-11eb-b27b-01aa75ed71a1.0001.02/DOC_1&format=PDF

¹¹ <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52021DC0118>

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

More specifically, the JU's 2023 and 2024 priorities in this respect will be on:

- a. the ramp up of the 2022 Flagship Projects, following the conclusion of the grant agreements signature, to ensure that by the end of 2023 the planned milestones are achieved, followed by a second year of R&I in 2024, while assessing the capacity to reach the targets defined by the end of 2026;
- b. the delivery of the first results of the System Pillar Tasks and Domains, in particular those identified in Annex VI following the signature of the first Service Request and the ramp up phase during Q4 2022; the conclusion of the Call 2022-2 and launch of the relatives projects as from mid-2023 indicatively, to ensure that new exploratory and other R&I activities complement the main Programme;
- c. the launch of the Call 2023-1 during Q4 2023 to create new opportunities for inclusiveness and participation; the scope of this call will be defined during Q2 and Q3 2023, taking into consideration the aforementioned activities and their progress. The scope of the Call 2023-1 will result from an extensive open consultation of the rail stakeholders and beyond;
- d. the preparation of a call for Associated Members to be launched in the first half of 2024, after having made a in depth assessment of the possible gaps in terms of entities involved in the EU-Rail Programme to its full extent;
- e. the R&I activities related to the projects launched in the previous years under the S2R Programme; the focus will be on the execution of the research and innovation activities previously signed and needed to advance in delivering the Technology Demonstrators, and in view of reaching the complete phase of the S2R Programme by 2024, having achieved its targets.

These priorities will build upon the monitoring and review of the ongoing R&I activities to ensure the delivery of the results expected for the demonstrators and to pave the way for the next generation of the Rail Research and Innovation Programme.

The Communication activities for 2023 and 2024 will continue ensuring that the mission and objectives, including the new System Pillar and Deployment Group as well as the new corporate and visual identity of the new partnership, 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 2023 and 2024 will seek the continuation of the close collaboration established between EU-Rail and:

- the European Railway Research Advisory Council (ERRAC),
- the European Union Agency for Railways (ERA),
- other programmes and partnerships, such as the Clean Hydrogen Partnership, SESAR3 JU, Clean Aviation JU, BATT4EU, etc. with the objective to establish synergies that will results in coordinated and consistent activities, up to joint projects,
- 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 2023, are the annual EU-Rail Innovation Days in December, EU-Rail/ERA/EUSPA joint event (Stockholm, March tbc). Participation to external events is foreseen at the UIC World Congress on High-Speed Rail (Marrakesh, 7-10 March), and the UITP Global Transport Summit (Barcelona, 4-7 June). Other probable participations of EU-Rail include events such as the SIFER in March, the 8th Railway Forum 2023 in September, the UIC – Second African Digital Rail Congress in October, ExpoFerroviaria in October, World Passenger Festival in October, or Rail Live in November. As from the end of 2023, the preparatory activities for the major events expected in 2024 will be planned, such as TRA in Ireland and InnoTrans in Berlin in September 2024.

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 2023 and 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.

Following the entry into force of the SBA, Article 13 required the European institutionalized partnerships to assess the possibility to establish back office arrangements between themselves in relation to a list of services. The SLA that will be finalized by year end 2022 will be operational during 2023 and the future years. The costs and benefits of such SLAs will be assessed during the future years while possibly new services will be considered for synergies.

In the area of internal control and assurance, EU-Rail will face in 2023 the challenge of establishing a methodology for reviews/audits aimed at qualitative aspects of the project management to be applied for lump sum grants under Horizon Europe. A dedicated programme of such ex-post audits will be planned for 2024.

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 2023

2.3.1 Objectives, indicators and risks

As mentioned in Section 1.4, the R&I activities of the EU-Rail Programme are structured around 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 shall 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 shall cover the full lifecycle of R&I, from exploratory research to deployment coordination. The KPI model shall be based on input delivered by each of the JU projects and reported on a yearly basis, through the 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.

Operationally, the System Pillar tasks and the Flagship Projects will start to work together in 2023 and the objective in 2023 is to ensure an appropriate integration model. This start with the provision of a toolset for Model-Based System Engineering, Conceptual Data Model and Federated Dataspace to the SP and IP activities, from the output of the Tender launched in 2022. The process of exchange of information, of work on common tasks and of collaboration in general as one integrated programme will also be finalised in 2023, with the first output on this subject by the FPs and SP working groups.

The System Pillar contributes defining the concept of Operations for Rail, through a System of Systems service-oriented approach, providing the overall framework for delivery of R&I, 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 shall therefore in particular coordinate and consolidate all relevant sector initiatives, noting the importance of unified requirements from the Railways. This is complementing and underpinning the focus on research and innovation towards impact-oriented solutions. Indeed, the work to define and then maintain the operational concept and functional system architecture will be the framework within which the R&I work progresses with logical interactions.

The R&I activities to deliver the Concept of Operations, addressing the specific segments' interfaces, 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.

EU-Rail focus is on key priorities but addressing the subsystems of the various rail market segments and, where relevant and cost-effective, standardisation or commonly agreed harmonised specifications needed to deliver them. Automation will require converging on digital solutions, artificial intelligence, imaging, robotics, etc. but also addressing sub-components, e.g. mechanical, that otherwise would jeopardise the transformation to be delivered. In order to achieve such ambition, EU-Rail acts as "single coordinating body" to ensure the convergence of the sector towards the aforementioned new Concept of Operations and the related Reference Functional System architecture, both addressing different segments. This would allow setting the right conditions towards modular (standard interfaces), scalable, plug & play, etc. solutions in view of large-scale market introduction and their evolution.

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 the definition of specifications and 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 activated by Q1 2023, will tackle the transition from R&I to coordinated and consistent deployment at European level, to avoid creating new barriers to a one single European network.

The table below present a summary of the main activities per year, for the years 2023 to 2024

Year 2023	Type of call	Value of the actions	Maximum EU-Rail co-funding	Non-funded activities	Target contributions from Members in case of award	Indicative publication date
Multi-annual Call for Proposals * (instalment)	Open <i>2023 values</i>	0.0 <i>96.8</i>	0.0 <i>57.9</i>	0.0 <i>38.8</i>	0.0 <i>75.2</i>	
Call for Proposals – Exploratory Research (**)	Open	23.3	21.2	2.1	0.0	Q4 2023
Call for Tenders	Open	16.7	14.9	1.8	0.0	Q1 – Q4 2023 & 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 2023
Total		40.4	36.5	3.9	0.0	

Year 2024	Type of call	Value of the actions	Maximum EU-Rail co-funding	Non-funded activities	Target contributions from Members in case of award	Indicative publication date
Multi-annual Call for Proposals * (instalment)	Open <i>2024 values</i>	0.0 <i>65.3</i>	0.0 <i>39.1</i>	0.0 <i>26.2</i>	0.0 <i>50.8</i>	

Year 2024	Type of call	Value of the actions	Maximum EU-Rail co-funding	Non-funded activities	Target contributions from Members in case of award	Indicative publication date
Call for Tenders	Open	11.7	11.7	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		12.1	12.1	0.0	0.0	

(*) This call for proposals was launched in 2022 implementing multi-annuality by instalment, 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 2023 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 2023-2024” of the present document.

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

In addition to the specific research and innovation calls and implementation, during 2023 EU-Rail will prepare the launch of a call for 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 for publication early 2024.

In line with Regulation (EU) 2021/695 establishing Horizon Europe, in particular with regard to Article 52 thereof, 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 will start in 2023 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.

Furthermore, EU-Rail will continue to provide support and inputs to DG RTD for the purposes of preparation of the Biennial Monitoring Reports on partnerships in Horizon Europe. These reports 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.

2.3.2 The System Pillar

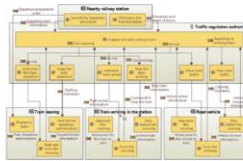
To achieve an architecture that offers the demanded functional improvements concerning production performance, reliability, quality, and cost as well as the needed architecture quality, the System Pillar (SP) follows the defined process:

Operational Analysis

CBO

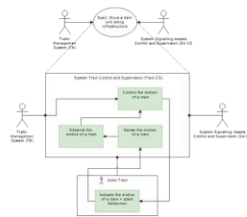


- Definition of the operation Use Cases (capabilities)
- Definition of the activities associated with the operation processes



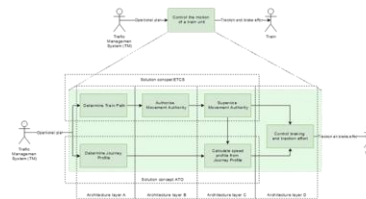
System Analysis

- Definition of the Operation Contexts with the **Actors**
- Refinement of the capabilities and definition of the functions supporting the capabilities
- Done with the system in **black box**



Logical Architecture

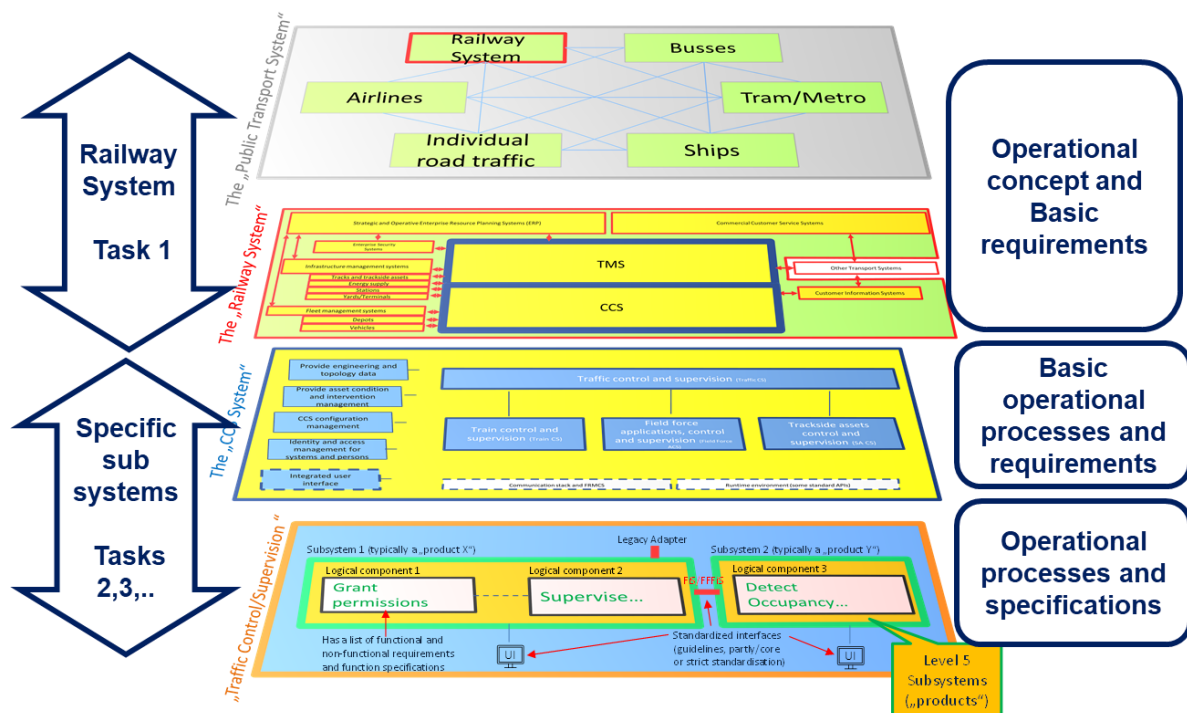
- Definition of the system logical blocks
- Refinement of the capabilities and functions with the system in white box
- Specification of the interfaces between the logical blocks (application level)



Physical Architecture

- Definition of the possible physical architectures with the corresponding devices
- Allocation of the logical building blocks to the physical devices
- Definition of the lower layers of communication for the interfaces

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.

2.3.2.1 SP deliverables during Ramp up phase

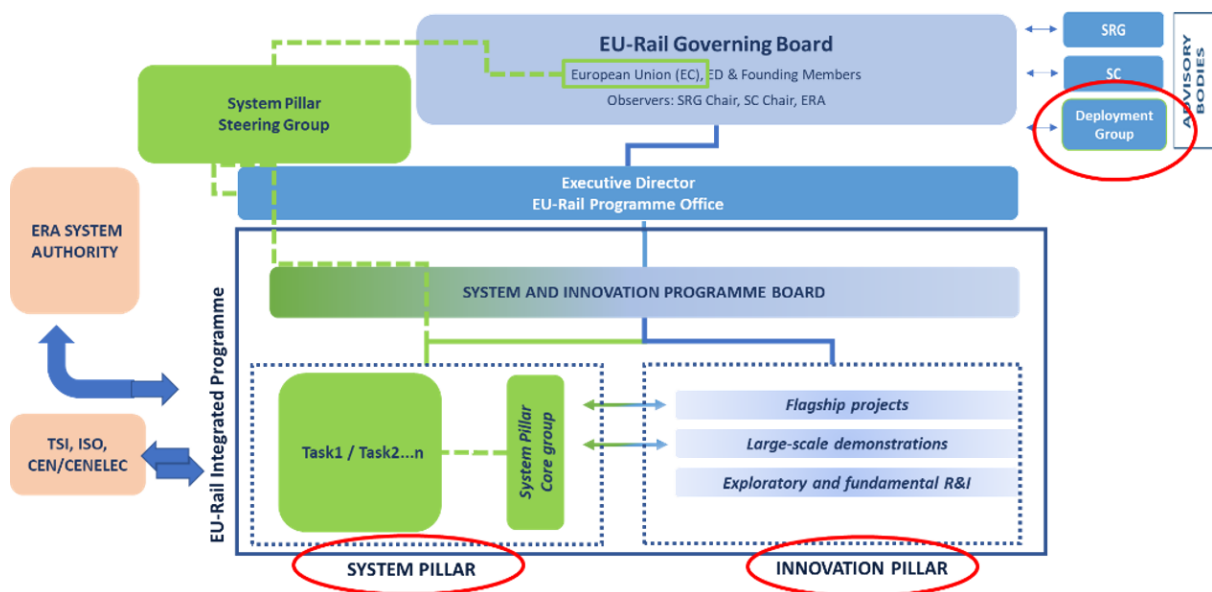
EU-Rail made available resources already mid-2021 to enhance the work on concept(s) of operations and system architecture to pave the way for the establishment of the System Pillar with the entry into force of the SBA. These activities include a series of deliverables setting up different elements for the process and governance of the functioning of the System Pillar and the interaction with the Innovation Pillar, but also initial elements from the content point of view to contribute to the ramp up phase of the future Innovation Pillar Projects.

These results include:

- Common Business Objectives, setting out the targets and improvements to guide the development of the outputs of the System Pillar within Europe’s Rail Joint Undertaking.
- Operational Vision, starting point for the top-down discussion about the operational concept. It defines general directions and the ambitions for the future CCS and TMS/CM target systems as a discussion basis.
- CCS and TMS/CMS System Architecture, describing the CCS and TMS system architecture, including the first iteration and alignment of the CCS and TMS system architecture, as a baseline for the development work when the System Pillar starts.
- Governance organisation and working arrangement of the System Pillar, focusing on the structure of the System Pillar, role of the Core Group in relation to both the System Pillar activities and the interaction with the Innovation Pillar, and on the working arrangements with external bodies.
- System Pillar Roadmap, defining the major milestones
- Migration principles for CCS, TMS/CMS and DAC as a whole system, including functional and RAMSS considerations.

The results were delivered by mid 2022, when the formal structure of the System Pillar was set and duly funded via a tender procedure (see below), fully operational in Q3 2022 and aligned its activities during the grant preparation phase of the Innovation Pillar Projects.

2.3.2.2 Governance and Organisational Structure



The main governance bodies involved in the System Pillar are :

- **The System Pillar Steering Group**, responsible for providing advice to the Executive Director and the Governing Board on:
 - the approach to operational harmonisation and the development of system architecture,
 - the detailed annual implementation plan for the System Pillar in line with the work programmes adopted by the Governing board,
 - monitoring the progress of the System Pillar.
- **The System Pillar Unit** which:
 - Chairs the System Pillar Core Group,
 - Reports to System Pillar Steering Group,
 - Coordinates related resources, budget and timescales to the System and Innovation Pillar Programme Board.
- **The System Pillar Core Group** which:
 - Provides the competent leadership and expertise of the development of the functional layered railway system architecture, specification models and Operational Concepts that enable safe, secure and efficient delivery of the new systems,
 - Manages the common business objectives and deliverables from the Tasks.
- **The System and Innovation Programme Board**, advising the Executive Director on:
 - the coordination of resources, budgets and timescales of the System and Innovation Pillars,
 - project and programme management of the JU including interaction between the two pillars as well as change management and conflicts, supported by the System Pillar Core Group.

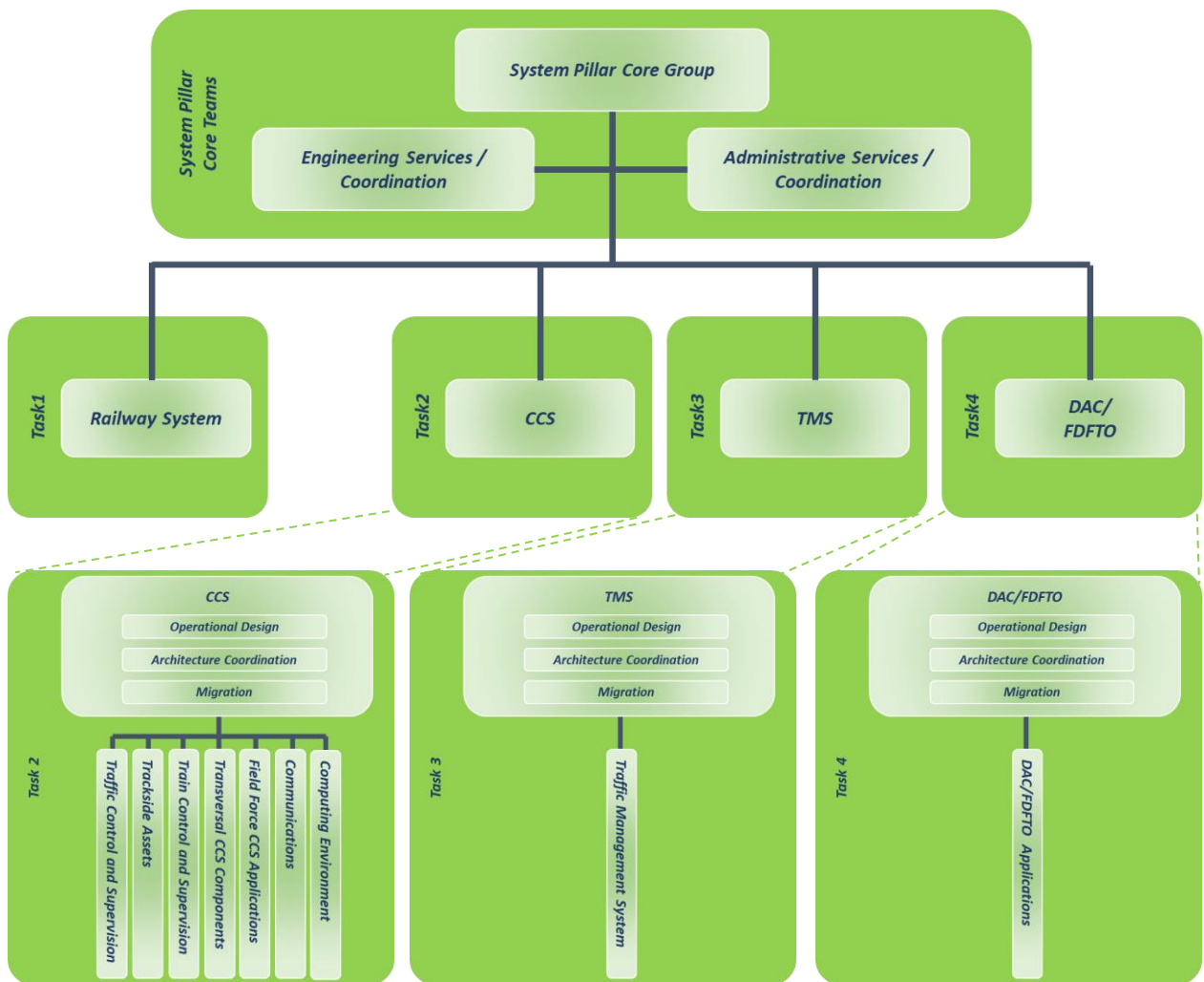
The EU-Rail Governing Board, as the body responsible for the overall oversight over the EU-Rail's activities, is the final decision body within the System Pillar decision-making process.

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

- 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 Coregroup/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 Handbook:

- SP Steering Group, Core Group, Engineering Services / Coordination (comprising Central modelling service, Standardisation and TSI input planning, External Architectural support, PRAMMS Management and Assurance), Administrative Services (comprising Programme Office, Economic Analysis),
- Task 1: Railway System,
- Task 2: (Advanced) CCS system design,

- The cross-cutting domain teams (comprising Operational Design, Architecture and release coordination and Migration and roadmap),
- The CCS System Design Teams (comprising Traffic control and supervision, Trackside assets control & supervision, Train control and supervision, Transversal CCS component, Field force CCS application, Communication team, Computing environment),
- Task 3: TMS system design,
- Task 4: DAC/FDFTO¹² System design.

System Pillar Task 1: EU Rail System

The System Pillar Task 1 will be focussed 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.

¹² 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 shall on the one hand deliver unrestricted movement of trains, on the other hand, it shall create a single market for rail components.

CCS – both on-board and trackside - shall 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 coupling 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.

2.3.2.3 System Pillar working method and System Engineering management plan

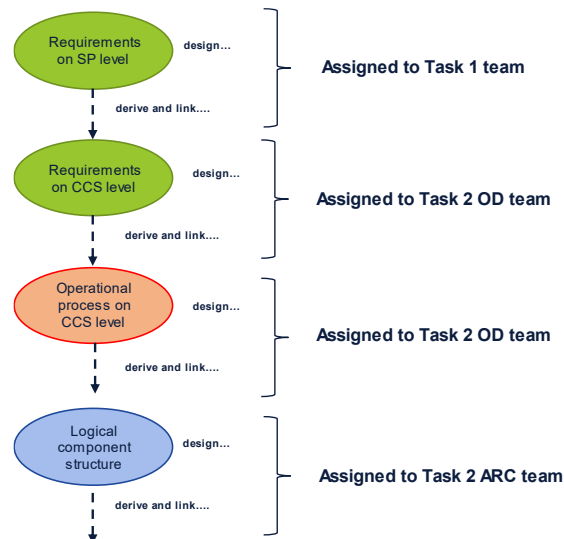
The System Pillar working method aims at fast and balanced decision making with full sector involvement. Integrated teams within one place - the System Pillar - will work on and propose developed positions for sector consideration:

- To ensure best results, the System Pillar design process will ensure 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.
- 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.
- Decisions can be made on the lower levels (within the Task cross-cutting or 'Domain teams'), under coordination of the System Pillar Core Group.
- Where required, more detailed sector consultation – working circles - will be organized to critically assess the output of the System Pillar teams. The working circles do not have an explicit governance role, but are established to achieve broad sector alignment.

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

The Working Method regarding the System Pillar Tasks will follow the philosophy set forth in the System Engineering Management Plan, in which the work is organised by breaking down the work allocated to each Task into work items within workflows, defining dependencies and relationships between them, covering several layers of the system of systems layer structure of the Railway Systems, and arranging them into traces.

The following figure gives an example of a trace structure:



In order to implement this working method, the SP SEMP task force has created a first version of the SEMP. The System Pillar Central Modelling Service will develop the full version 2023, including:

- 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,
 - 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,
 - 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 an draw a function or interface, or how requirements or use cases should be formulated.
- Tools to be used:
 - For the temporary platform and for the later target platform (public procurement),
 - 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.

2.3.2.4 SP Milestones and planning

The System Pillar is defined on the basis of MBSE processes and the identification of the workitems that will allow to reach specific objectives. These objectives are mainly described by the standardisation areas for the target architecture and are included in the System Pillar roadmap. The roadmap is a matrix of a large amount of standardisation processes.

Instead of analysing all detailed dependencies in the current stage (like normally done for a project planning), unique milestones shall be used for all standardisation processes that lead to an overall synchronisation. To decide about the right timing ambition for those major milestones, the determining factors per standardisation area are assessed:

1. Market priorities (link to Innovation Pillar, obsolescent solutions, start of large rollout programs) and Common Business Objectives
2. Difficulty level of the standardisation, amount of existing basic research
3. Maturity and progress of existing work

The indicative roadmap that was constructed during the ramp up phase of the SP can be found in Annex VI.

The detailed milestones of the System Pillar Task and domain teams is in Annex VI as based on the work of the System Pillar Ramp up phase. Even if the milestones are detailed in the objective of the deliverable, additional detailing of the technical content for each of them is necessary for a better monitoring of the work of SP and facilitating that the objectives of the works are achieved. For this, during October and November 2022 SPCG is engaging directly with the Domain leaders of the different teams in SP to reach this level of detail and aiming to have detailed programme plan of the activities and milestones during the first year and including the specific technical content per milestone. This will also enable to draft the contents of the first Standardisation and TSI input plan and define in detail the contents foreseen for the first release of the SP target architecture.

2.3.2.5 System Pillar and Innovation Pillar interactions

EU-Rail, through the System Pillar 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 digital automatic coupling as enabler of future much more performant railfreight, 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 Handbook.

Currently, EU-Rail lead meetings including SPCG and the Flagship projects leaders are achieving further alignment of milestones and activities during the gap phase of the grant agreement. The main objective at this phase is to:

- 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

From October 2022 until March 2023 more detailed planning will be achieved since the MBSE processes will have started for the target system in SP and the Flagship projects will have already started the activities. Additional detail for the way of interaction and specific deliverables between the SP and IP will be defined then.

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 which ensure the engineering integration of the Programme.

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.

Subject to the grant agreement conclusion, 2023 will mark the start of the first EU-Rail Flagship Project 1 implementing this Flagship Area. It will notably focus on two work-streams, and the first workstream will deliver the following parts of the FA:

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 effects 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.

Subject to the grant agreement conclusion, 2023 will mark the start of the first EU-Rail Flagship Project 2 implementing this Flagship Area. It will notably deliver the following **by 2025**:

- 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)

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.

Subject to the grant agreement conclusion, 2023 will mark the start of the first EU-Rail Flagship Project 3 implementing this Flagship Area. It will notably 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 shall 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 shall be to present the monitoring of rolling stock (including on board and wayside technologies) leading to decisions and planning of interventions, and redirecting rolling stock to workshops to execute the (re)scheduled work both manually as well as by new technologies and solutions to conduct inspection tasks automatically – **TRL6**.
- **Long Term Asset Management.** Development of Life Cycle Cost (LCC) models for infrastructure and rolling stock. This demonstrator shall include cross-border infrastructure remaining useful-life analysis and space-time cross-analysis and visualisation – **TRL6**.
- **Asset Management & Infrastructure.** The objective shall be to integrate on field and on board systems with central platforms capable of managing Big Data to enable prescriptive interventions, minimising dangerous situations and service disruptions during operation – **TRL6**.
- **Asset Management & Digital Twins.** The focus shall be on design, maintenance, upgrade and renewal interventions driven by Digital Twins for the optimisation of processes, maintenance planning and involved logistics. This shall enforce the use of BIM to standardise system configuration and AI tools to execute simulations and predictions. The Digital Twin demonstrator shall include visualisation, prediction and simulation – **TRL7**.
- **Design & Manufacturing.** This demonstrator shall 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 shall be the showcase of high-tech automated execution solutions for construction and interventions supported by robotics and wearables, among other devices, building a safer and more automated railway environment - **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.

Subject to the grant agreement conclusion, 2023 will mark the start of the first EU-Rail Flagship Project 4 implementing this Flagship Area. It will notably 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.

Subject to the grant agreement conclusion, 2023 will mark the first steps of the first EU-Rail Flagship Project 5 implementing this Flagship Area. will notably focus on two work-streams, and will deliver the following:

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.

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.

Subject to the grant agreement conclusion, 2023 will mark the start of the first EU-Rail Flagship Project 6 implementing this Flagship Area. It will notably 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 shall 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 shall 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.

Pending the results of the evaluation for proposals submitted under the EU-Rail second call for proposal 2022, the following subjects are expected to be started with project activities in 2023:

- CONCEPTUAL DEVELOPMENT OF AUTOMATED MULTI-MODAL MOBILITY-SYSTEMS (“MOVING INFRASTRUCTURES”):
 - o WS1: Identification of Use Cases, Business Cases / CBA, operational concept
 - o WS2: “Moving infrastructure” vessel and the operation system
 - o WS3: “Moving infrastructure” carrier incl. locking system and handling system
- TECHNOLOGICAL DEVELOPMENT OF MAGLEV DERIVED SYSTEMS:
 - o WS1: Technical definitions
 - o WS2: Development of business case analysis, including feasibility studies and use cases
- HYPERLOOP INDUSTRIAL ROADMAP AND PILOTS:
 - o WS1: Industrial Roadmap, including business case, in parallel to the regulatory framework run by the European Commission
 - o WS2: Pave the way to proof of concept

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 twins¹³, 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.

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.

Subject to the grant agreement conclusion, 2023 will mark the start of the first activities implementing this Transversal Topic. Those activities have been integrated in the second work-stream of Flagship Project 1. It will deliver the following:

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

¹³ A digital twin is a virtual representation which is able to imitate the behaviour of a physical system during the span of its lifecycle.

- 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 Innovation Pillar specific objectives for 2023 and 2024

During 2023, 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 shall be duly managed to avoid jeopardizing the 2025 demos. The exercise conducted in 2022 of alignment between FPs and with the SPs should be operationalised and if needed corrections will be made. In 2023 the first maturity checkpoints will be conducted for the Innovation Pillar Flagship Projects (but also for the SP) with the objective to validate the maturity of the requirement specifications for uses cases, technical solutions and future demonstrations.

Additionally, as part of the Innovation Pillar activities and objectives, the JU will implement the first series of exploratory and other projects (comprising FA7 projects) that would look into disruptive technologies or basic research possibly leading to future breakthrough innovation and further R&I activities towards higher TRLs. The JU, based on the reporting to be provided by the actions on a yearly basis, based on the maturity checkpoints outputs 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 Exploratory Research and Other

The activities relate to the System and Innovation Pillars shall be complemented by blue sky research, complementary research and other activities to ensure the successful implementation of the Programme. This will require external professional and independent expertise, support and know-how.

In this respect, a 2023 Call is planned to be launched in Q4 2023 and its content will be defined on the input and advice following a large consultation process, starting at the General Assembly of the at the end of November 2022, ERRAC, the Scientific Committee (or its successor, as established by the Governing Board), the States Representatives Group, and also based on possible specific needs identified by the ongoing actions, sector stakeholders or ERA.

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

The definition of the 2023 Call and the other activities may require the Executive Director to submit an amended Work Programme to the Governing Board for adoption at the end of Q2 or early Q3.

Another transversal topic for the transformation of rail (freight) towards an automated and digitised mode of transport is the continued management in 2023 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, close and 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, as started in 2020.

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 the surviving provisions of the relevant regulation.

During 2023, the work of the former S2R Programme will continue to perform with the objective to achieve the foreseen last demonstrators and to phase out of the projects entering the final stages. It is expected that the S2R Programme will end all its R&I activities within the timeframe of this work-programme. These results will be essential inputs and constitute the baseline of the EU-Rail Programme's projects.

Annex IV, Table II provides the list of demonstrators and associated TRL levels expected in 2023. It is expected that those demonstrators will be presented at InnoTrans 2024.

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.

The Programme structure organized by Innovation Programmes and Cross-Cutting Activities is maintained to ensure that risks and opportunities are addressed properly, while the former ED Programme Board used under the S2R JU is incorporated into the System and Innovation Programme Board for EU-Rail.

The estimated amount of activities to be performed in 2023 is EUR 92.0 million in co-funding for the ongoing projects and tenders.

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/>

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 shall 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.

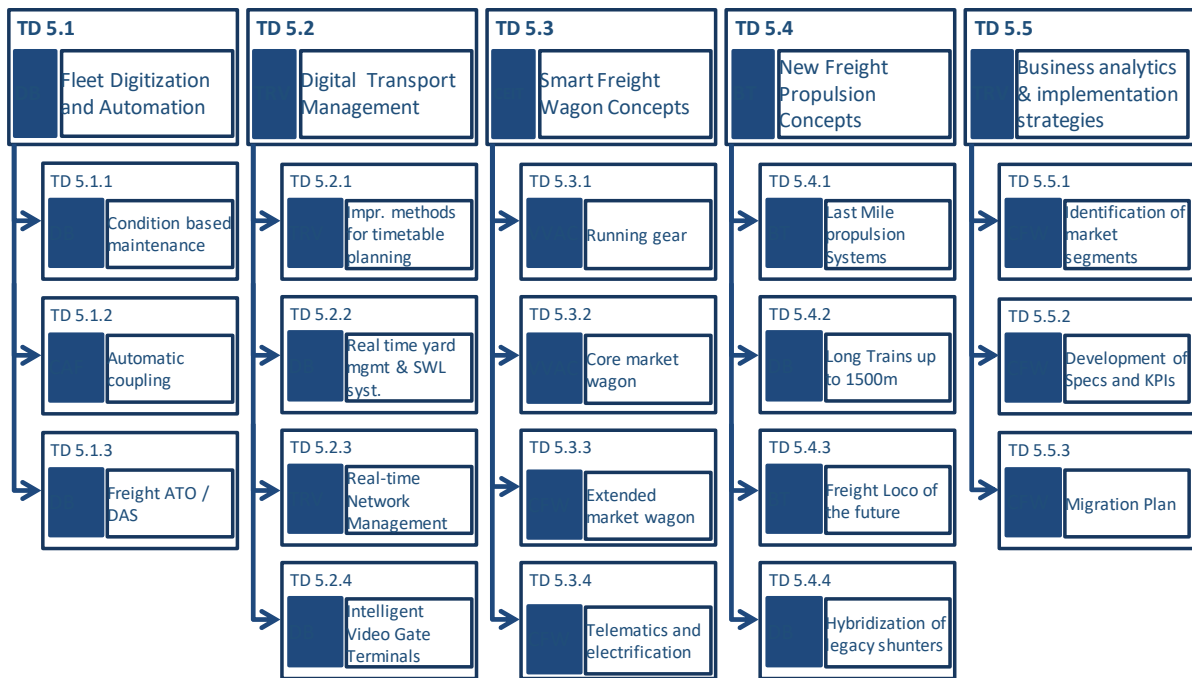
2.3.5.5 Innovation Programme 5 (IP5): Technologies for sustainable and attractive European rail freight

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 Paper¹⁴ 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.

¹⁴ [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).
- Smart materials and processes (which already ended its activities).
- System integration, safety and interoperability (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 shall 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, 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.

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 the months of September and October 2022. Within this exercise, current internal and external factors and developments having influence on JU’s business were duly considered.

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
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.	- 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.

Risk identified	Action plan
<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 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"> - Once the actual staffing according to the EU-Rail Staff establishment plan is 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. - 3 different projects have been organized since 2021 on strategic support, workload, cultural aspects, and coaching, with the objective to address internal issues of work allocation, satisfaction at work, cultural affiliation, wellness and wellbeing. - While taking account of the pandemic situation and the related measures and of the rules on hybrid working, staff is encouraged to work onsite to strengthen the team spirit and cohesion. - Team-building activities are performed to the extent possible.
<p>Given the interdependencies of complementary R&I projects, considering as well the start up of a complex and integrated new Programme (including input/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.
<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"> - Controls of requirements and appropriate management of expectations. - Application of maturity check points. - Constant communication on outputs, focusing on concrete results that can be implemented taking into account the legacy system, migration aspects, business cases, etc.

Risk identified	Action plan
<p>Breach of intellectual property rights due to unauthorised access and misuse of information related to EU-Rail's Programme by contractors or subcontractors of the Commission, such as service providers maintaining the EC-owned IT tools/systems used for Programme management purposes (SyGMa, Compass, Corda, Cortex, etc.). Even though, if this risk materialized, the primary responsibility would reside with the Commission having the contractual relationship with the respective contractor/subcontractor, the situation could have an impact on EU-Rail as well, e.g. in terms of disruptions of good relations with the respective JU's member/beneficiary, or even financial and reputational impact (stepping out from the project(s)/Programme, litigation, etc.).</p>	<ul style="list-style-type: none"> - Communication by the JU about this risk towards the Commission. - Requesting the Commission for formal recognition of this risk and for confirmation that measures are/will be applied at their side to mitigate this risk.
<p>Due to deployment/application of diverse processes, methods and tools, the integration between the Flagship Projects and the System Pillar could experience problems, including negative effects on inputs for specifications and standards, and overall architecture. Therefore, the effectiveness of management of the Programme as a whole could suffer, eventually jeopardizing achievement of the Programme objectives.</p>	<ul style="list-style-type: none"> - Continuous efforts to converge on common approaches. - Correct utilisation of System Pillar tools and processes for architecture and specification work. - Clearly defined IT framework.
<p>Unbalanced distribution of personnel and technical capacities of the participants to JU's R&I projects between the ongoing ones (S2R Programme) and the new ones (EU-Rail Programme), e.g. due to unjustified preferences of the participant or overall lack of capacities, might result in difficulties with parallel delivering of outcomes of the S2R/EU-Rail Programmes and thus jeopardizing the JU's key objectives.</p>	<ul style="list-style-type: none"> - Addressing the potential issues in the GAP phase of the new EU-Rail projects. - Ongoing monitoring of projects and actions and timely reactions to identified issues at project/participant level. - Formal reminders sent for projects with delay of more than 30 days.
<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 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.

Risk identified	Action plan
	<ul style="list-style-type: none"> - 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 for 2023, 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>Timely and qualitatively adequate execution of the daily Programme management activities may be jeopardized due to accumulation of tasks within the SyGMa/Compass workflows (GAP for the new projects in combination with REPA for the existing projects). This could result, for example, in late payment or late delivery of approval of reports/deliverables, or even delaying the start of a grant.</p>	<ul style="list-style-type: none"> - Increased frequency of meetings between the Executive Director and the Heads of Units to monitor the current status of workflows and possible delays. - Increased intensity of the current status monitoring by the Heads of Units. - Temporary partial reassignment of tasks of some of the existing staff members to support the POs, FOs and LOs involved in the respective SyGMa/Compass workflows. - Potential deployment of temporary external resources allowing POs, FOs and LOs involved in the respective SyGMa/Compass workflows transferring some of their clerical/administrative tasks to such temporary external resources.
<p>Failure to achieve the requirement of Article 13 of the SBA, starting with the assessment of the cost effectiveness of the possible services to be included in the back office arrangements (BOA), may result in a missed opportunity to achieve efficiencies. It may also represent a non-compliance with the respective provisions of the SBA with a negative impact on JU's reputation. In addition, the lack of clarity may negatively impact the JU's staff in terms their motivation, should the BOA arrangements experience delays.</p>	<ul style="list-style-type: none"> - Utilisation of the flexibility that the SBA provisions provide regarding BOA so as to find the best possible solutions with regard to their practical establishment. - Preparing a proper planning of implementation, with efficient monitoring and regular meetings at appropriate level (EDs, Heads of Units) to discuss the modalities of BOA, including setting up the SLAs, with the support of DG BUDG and DG RTD (CIC). - Involvement of decision making bodies - first BOA suggestions were presented in GB meetings of all JUs in June 2022, further written information to EU-Rail GB was provided on 6 September 2022, further discussion foreseen in the GB meeting to be held on 30 November 2022. - Steering of the process and active guidance is ensured by the Commission via DG RTD.

Risk identified	Action plan
	<ul style="list-style-type: none"> - Early involvement of the respective EU-Rail staff members who should participate in BOA in terms of providing services to other JUs. - Timely launch and execution of recruitment procedures to hire additional EU-Rail staff for the purposes of the accounting BOA.
<p>Deficiencies in dissemination of results may develop in vague information to the end-user/interested parties and could compromise the intended JU's impact. That can also negatively impact the overall reputation of the EU-Rail Programme.</p>	<ul style="list-style-type: none"> - The JU provided a series of guidelines to the projects and fostered the use of the H2020 instrument as the Common Dissemination Booster. - Proper planning and regular follow up at IPSteCo/SIWG and within the projects' control gates. - Demos at EU-Rail stand at InnoTrans and other relevant events. - Everytime 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. - Creating an overall dissemination communication plan at JU-level including the possible handover to the JU of communication activities of all projects.
<p>Delay or lack of expected inputs from the Flagship Projects into the continuous integration architecture activities under the System Pillar. This would also impact the topic on the Standardisation and TSI input plan and the respective specifications that would accompany the results of the plan. Eventually, effective implementation of EU-Rail Programme could be affected.</p>	<ul style="list-style-type: none"> - Continuous alignment and interaction between the System Pillar and the Innovation Pillar. - Involvement of the System Pillar steering group in the grant agreements preparation phase.

In March 2023, IAS confirmed to EU-Rail that their engagement planned to be carried out in the JU in 2023 will take form of a new in-depth risk assessment. EU-Rail will grant to IAS full cooperation in exercising this assessment and will take advantage of its results so that duplication of efforts with similar internal JU activities are avoided. Further details on the JU's risk management are provided in Section 2.6.6.

With regard to risks of fraud, a thorough assessment was performed in 2022 both at Research Family level and individually by EU-Rail. The identified fraud risks were a starting point for drafting the new EU-Rail Anti-Fraud Strategy for 2022-2025, and they are depicted in the JU's comprehensive risk register. In parallel to the separate attention paid to fraud risks and their mitigation via a dedicated Anti-Fraud Strategy, their potential amendments will also be part of the ongoing general risk assessment exercises.

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 2023 under EU-Rail/Horizon Europe, including the different calls (in 2022 commitment appropriations):

Year 2023 and 2024	Type of call	Value of the actions	Maximum EU-Rail co-funding	Non-funded activities	Target contributions from Members in case of award	Indicative publication date
Call for Proposals– Exploratory Research (*) to be launched Q4 2023 and activities starting as from Q2 2024	Open	23.3	21.2	2.1	0	Q4

Year 2023 and 2024	Type of call	Value of the actions	Maximum EU-Rail co-funding	Non-funded activities	Target contributions from Members in case of award	Indicative publication date
Which includes - Call for Proposals – EU-Rail SESAR Synergy: Integrated air and rail network backbone for a sustainable and energy-efficient multimodal transport system; to be launched Q4 2023 and activities starting as from Q2 2024	Open	7.1(**)	2.5(**)	0	0	Q4

(*) The expected amount of non-funded activities (currently set at zero) will be further clarified depending on the nature of technical activities associated to the call topics.

(**) Total EU-funding 5.000.000 EUR, of which 2.500.000 EUR by EU-Rail, 2.500.000 from SESAR. Foreseen as Innovation Action with up to 70% 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 SESAR3 Joint Undertakings will launch a joint call "Integrated air and rail network backbone for a sustainable and energy-efficient multimodal transport system" for a total of EUR 5,000,000 of co-funding and EUR 7.143.000 of total costs at 70% funding rate with a fairly shared contribution between SESAR and EU-Rail (i.e.: EUR 2,500,000). The modalities of this transfer will be detailed in an arrangement between both organisations.

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 2023 Call will follow the rules of the European Union's Horizon Europe framework programme and in particular the Horizon Europe rules for participation¹⁵ as well as the General Annexes to the HE Work Programme 2023-2024, which apply, unless specified otherwise, to EU-Rail calls for proposals.

Regarding admissibility conditions and related requirements, part A of the Horizon Europe Work Programme 2023-2024 General Annexes 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 IA topics.

Part B of the Horizon Europe 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 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 Work Programme 2023-2024 General Annexes applies.

Part F of the Horizon Europe 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, joint/coordinated calls, indicative timetables for evaluation and signature of the grant agreement(s) and the evaluation review procedure if a complaint is submitted.

Part G of the Horizon Europe Work Programme 2023-2024 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 standard funding rates of Horizon Europe will apply to the Call 2023. Where private Founding Members of the EU-Rail would be awarded any activities as a result of the Call 2023, 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 https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/lis-decision_he_en.pdf.

¹⁵ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018PC0435>

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 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 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 Council Regulation 2021/2085.

2.3.8.2 List of countries entrusting the JU with national funds for the calls

During 2023 and 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 2023, 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)
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 2023	Specific contracts 2023: 10 000 000 per year
Other procedures provided for in the EU-Rail Financial Rules	Project management	The Europe's Rail Joint Undertaking has launched in 2022 a procedure provided in the Financial Rules for one or more contract to set up a dedicated management structure for projects and foster synergies with other programmes, European, national, regional, etc.	Q4 2023	Contracts renewal 2023: 900 000
Framework contract's implementation	Strategic support to the EU-Rail and other impact assessments, evaluations, foresight,	Implementation of a 4-year framework contract (3 lots) following an EURail open call for tenders procedure) a total value (3	Q1 to Q4 2023	1 000 000*

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)
	analyses and studies	lots) of EUR 3.3 million or use of framework contracts from other institutions or agencies		
Open Procedure	Locomotive fleet retrofit and engineering solutions for DAC (and ERTMS)	The objective of this tender is to obtain engineering solutions for locomotives retrofitting of DAC (and ERTMS) that will support a technical, economical and coordinated feasible deployment of DAC	Q1 2024	3 000 000
Total		Value of commitments for 2023		14 900 000

** Whilst the System Pillar Framework provides the resource for the majority of the defined tasks within the System Pillar, there are three identified horizontal support areas outside of the scope, which are intended to be supported in the short term through this framework contract and LOT 1 Strategy Advice in particular. The procurement budget is slightly increased to cover in 2023 the activities of Standardisation and TSI Input planning, Programme Office and Economic Analysis.*

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)
Implementation framework contracts for services	Europe's Rail System Pillar	Implementation of a 6-year framework contract (3 lots) following an open call for	Q1-Q4 2024	Specific contracts 2024: 10 000 000 per year

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)
		tenders procedure with a total value (3 lots) of EUR 45 million.		
`Other procedures provided for in the EU-Rail Financial Rules	Project management	The Europe's Rail Joint Undertaking has launched in 2022 a procedure provided in the Financial Rules for one or more contract to set up a dedicated management structure for projects and foster synergies with other programmes, European, national, regional, etc.	Q4 2024	Contracts renewal 2024: 900 000
Framework contract's implementation	Strategic support to the EU-Rail and other impact assessments, evaluations, foresight, analyses and studies; subject to the use of the contract, a new tender procedure for a FwC for a similar total value EUR 3.3 million might	Implementation of a 4-year framework contract (3 lots) following an EURail 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	800 000

Procurement procedure	Title	Scope	Indicative timetable (Q-quarter)	Indicative budget (EUR)
	be launched, possibly with other JUs, or making use of Commission FwC			
Total		Value of commitments for 2024		11 700 000

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 accountend 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

Most of the S2R Programme ongoing projects governed by the Horizon 2020 rules, are getting to the late stages of their lifecycle. The latest S2R projects are expected to be phased out between 2023 and early 2024.

The ongoing 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 undergo a monitoring stage gate as a check launched by the JU, described in the Governance and Process Handbook¹⁶ chapter 7.4 called "Flagship Project Maturity checkpoint". This will enable a clear status to be reached before proceeding to the next phase and facilitate consistency across and interaction between the Flagship Areas, but also with the System Pillar (which is also expected to undergo a similar process).

¹⁶ <https://rail-research.europa.eu/wp-content/uploads/2022/10/EU-Rail-Governance-and-Process-Handbook.pdf>

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

- 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, together with the provisional planning for test end.

The specific details on how the outputs and achievements of the past or ongoing 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 for 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 will be continued building upon the past experience.

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, notably project RIMA, the network of Digital Innovation Hubs for I&M. In addition, EU-Rail will ensure the collaboration with the ongoing 5Grail Project in relation to FRMCS, which constitutes one of the enabler of rail digitalization and automation.

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.

2.4 Support to Operations of EU-Rail in 2023

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.

Following the identification of the communication objectives performed jointly with the Founding Members, a new JU Stakeholder Relations, Dissemination & Communication Strategy for 2022-2027 was endorsed end of June 2022.

The Communication activities for 2023 will continue to ensure the mission and objectives, including the new System Pillar and the Deployment Group as well as the new corporate and visual identity of the new partnership are communicated and understood widely.

Ensuring that the objectives of the new Programme are well understood by the community is fundamental to have the necessary buying 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.

A stakeholders' analysis exercise will confirm the existing audiences for EU-Rail and identify new potential partners who will be invited to join the EU-Rail community, based on the Multi Annual Work Programme and on other JU's aims in terms of cooperation and synergies, 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. This will be achieved through organisation and participation to a number of new events, amongst other communication activities.

EU-Rail communication activities aims 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 new key priority areas 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) 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 (ERA, other JUs) 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.

- 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.
- **Establish and develop a 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.
- **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;
- ERRAC members, including policy makers and decision-makers;
- Members of the Scientific Committee (SC);
- Local stakeholders;
- 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.

Dissemination

Dissemination of project results will be enhanced. A dedicated Teams platform will be set up 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 (the platform for Railway R&I), press releases, newsletters, mailshots, presentations at internal (EC, Governing Board, Scientific Committee, States Representatives Group, System and Innovation Programme Board) 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. It is important to remind that access to information should be always driven by two principles: the need to be able to track and have access to all past information, while at the same time creating opportunities for further dissemination.

An internal task force has been set up to take stock and expand communication activities related to the dissemination of project results, taking into consideration the best possible way to exploit the innovative solutions developed under S2R and the future solutions coming from EU-Rail. The task force will issue guidelines for projects to lead a coherent communication campaign at project level, ensuring 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 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. A template for dissemination actions will be created and communicated to the Projects.

The main events, where EU-Rail will showcase its results in 2023, are the the annual EU-Rail Innovation Days in December, EU-Rail/ERA/EUSPA joint event (Stockholm, March tbc). Participation to external events is foreseen at the UIC World Congress on High-Speed Rail (Marrakesh, 7-10 March), and the UITP Global Transport Summit (Barcelona, 4-7 June). Other probable participations of EU-Rail include the SIFER in March, the 8th Railway Forum 2023 in September, the UIC – Second African Digital Rail Congress in October, ExpoFerroviaria in October, World Passenger Festival in October, or Rail Live in November

During 2024, TRA and InnoTrans will be the major events where EU-Rail will showcase its achievements.

Internal communications will be in the focus, with the development of a creative Teams environment to boost the flow of information within the staff. Team buildings will take place twice this year 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.

Only via a coordinated and integrated deployment of system integrated solutions can rail reap the benefits of the investments made, accelerate its transformation and deliver new services to its clients.

In the past years, the deployment of innovative solutions has too often resulted in a patchwork system, where the intrinsic benefits of investments were lost and even resulted in additional costs as, in many cases, such solutions have been deployed as additional layers to existing systems. This resulted in an increase in the maintenance costs, in additional complexities, in a lack of trust in the new solutions and, de facto, has anchored Europe rail systems to their legacy, missing the opportunity for a major transformation.

There is a clear and shared sector vision that accelerating the deployment of future technological and operational solutions requires decisions that will shape also the execution of the future EU-Rail projects and a different approach: where the introduction of innovative solutions has a clear impact on rail in its systemic nature, deployment shall be coordinated and consistent to accelerate the return on investment and phase out legacy products. This new way of working shall 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.

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.

In terms of the market uptake of the future rail R&I solutions and their deployment, 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.

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 2023 and 2024, EU-Rail foresees to run several procurement procedures for middle or low-value contracts¹⁷, to implement existing FWCs and to 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.

Title	Indicative budget (EUR)	Type of procedure	Indicative schedule (Q-quarter)
Communication and event services and supplies	300,000	Middle or low-value contracts or specific contracts/order forms implementing a FWC	Q1 to Q4 2023
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 2023
Basic Office Furniture	<15,000	Specific Contracts/order forms implementing a FWC	Q1 to Q4 2023
Catering services	35,000	Low-value contracts or specific Contracts/order forms implementing a FWC	Q1 to Q4 2023, expected to be performed as part of the BOA SLA
IT support and supplies	150,000	Specific Contracts/order forms implementing a FWC or Negotiated procedure for middle or low value contract	Q1 to Q4 2023, expected to be performed as part of the BOA SLA
Team Building and Training	20,000	Negotiated procedure for low value contract or Specific Contracts/order forms implementing a FWC	Q1 to Q4 2023, expected to be performed as part of the BOA SLA and or DG HR Fwk Contracts

¹⁷ 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)
Finance and audit	25,000	Specific Contracts/order forms implementing a FWC	Q1 to Q4 2023
Legal Assistance	50,000	Specific Contracts/order forms implementing a FWC	Q1 to Q4 2023
Implementation of the Back Office Arrangements (BOA)	50.000€ / year out of the FwC for all JUs estimated at 440 000 EUR 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 2023, expected to be performed as part of the BOA SLA

This list shall 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 2023 and 2024 respectively.

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 Director-General of DG RTD, 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 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). During 2023, the implementation of the BOA IT, HR and Procurement is expected to reach full speed, based on the specific models defined in each respective SLA.

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. To be noted that at the moment of the preparation of this Work Programme, the JUs seem not to benefit from all the features available, increasing the need

for manual interventions and ad hoc solutions. One of the key examples is that, with the lump sum grants, the submission of financial data for budget proposals is still done via Excel tables.

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 in 2017 to a private cloud platform. Since 2019, this service falls under the inter-agency cloud framework contract led by EFSA in Parma. 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 2023 the transition to the new contract for ICT managed services for which a call for tenders was launched in 2022; 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 setup of a second fully featured videoconference system in common meeting rooms.

With the implementation as from 2023 of the BOA ICT, it is expected that 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 2018¹⁸, 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

¹⁸ 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.

operation is available in the EU-Rail website. More information is available on the EU-Rail data protection and legal notices pages¹⁹.

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.

2.4.3.3 Accounting

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

EU-Rail implements its financial rules 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.

However, in October 2021 DG BUDG announced the intention to terminate their role of the Accounting Officer of the JU, now confirmed to be effective as of 1 December 2022, except for the treasury function. The resulting situation is expected to be tackled by applying the back office arrangements solution for the accounting function of the JUs. In fact, within this solution, EU-Rail will perform the role of the Lead JU and will also, being one of the respective three JUs, act in the role of the accounting service provider.

2.4.4 Human resources

2.4.4.1 HR management

In 2023 and 2024, EU-Rail shall be staffed with 29 staff members including 2 Seconded National Experts (SNEs). In line with the Establishment Plan, recruitment procedures were launched in 2022 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. 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 EU Staff Regulations' Implementing Rules 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.

A new staff survey will take place in 2023 with a view to assess the evolution compared to the results of the previous one.

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,

¹⁹ <https://shift2rail.org/terms-of-use/>

social events and team building activities will be proposed on regular basis as well as a well-being programme which will be developed and proposed to the staff in 2023. Individual coaching sessions will be considered both for staff as well as for the newly established Senior Programme Managers and the management team.

2.4.4.2 Strategy for achieving efficiency gains and synergies

From the HR perspective, in 2023, the JU's major challenge will be to ensure smooth implementation of changes related to the launch of EU-Rail Programme, such as novelties in the organisational structure and accommodation of new staff members.

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 2023, 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 be fully implemented in 2023.

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 plan²⁰

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. Recruitments have been launched and all vacant positions are expected to be filled by Q1 2023.

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

²⁰ 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.

the reinforcement of the BOA, 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				1		1		1
AD 14				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
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	1	1
Function Group II	1	2	2	1	1	1
Function Group I						
TOTAL	17	17	17	17	17	17

Seconded National Experts	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
TOTAL	2	1	1	2	2	2

Recruitment forecasts for 2023 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 Committee. In addition to these bodies, the System and Innovation Programme Board (ED-SIPB)²¹ supports the Executive Director.

In the field of governance, the JU will continue in the process of the revision and updating of its key internal guiding documents, 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 Procedure²². In the same meeting, the GB adopted the so-called "omnibus decision"²³, 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.

²¹ 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.

²² GB Decision n°01/2021

²³ GB Decision n°02/2021

Representatives of the European Union Agency for Railways (ERA) and of the European Rail Research Advisory Council (ERRAC) shall be invited to attend meetings of the Governing Board as observers and take part in its deliberation, but shall have no voting rights.

The GB shall hold 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 shall meet once a year in a general assembly and all participants to the research and innovation activities of EU-Rail shall be 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. Such meeting in a general assembly composition is foreseen to be held once the new projects are launched and running.

In 2023, it is foreseen that the EU-Rail's Governing Board will hold three meetings, in March, June and December, the latter to be held as 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. The Executive Director will ensure that the related supporting documents and the respective recommendation towards the GB is prepared in due time.

The GB's key planned activities are listed below:

Key activities in 2023 – timetable	
2022-02 Call award	Q1
Adoption of the 2022 CAAR and Final Annual Accounts	Q2
Adoption of the 2024 Work Programme and General Assembly	Q4

2.5.2 Executive Director

The Executive Director 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 Executive Director is accountable to the Governing Board. He is supported by the JU staff.

The mandate of the current Executive Director was renewed in 2021 for a period of five years until 15 May 2026.

2.5.3 Scientific Committee

In line with the SBA, EU-Rail continues to use a structured scientific advice of the Scientific Committee by means of re-confirming the S2R Scientific Committee by the Governing Board via the "omnibus decision".

During 2023, on a proposal from the Executive Director, the Governing Board will decide on the set-up of scientific advice to be established for EU-Rail for the future years.

Three meetings of the Scientific Committee will be held in 2023.

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. This role was not performed during 2022 and it will have to be implemented as from 2023.

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 2023, three meetings of the SRG are planned (in Q1, Q2 and Q4).

The tentative key activities are listed below:

Key activities in 2023 – timetable	
1 st Meeting of the SRG in which it would: <ul style="list-style-type: none">– Provide advice on the results achieved in the previous years and the alignment with the work programme.	Q1
2 nd Meeting of the SRG in which it would: <ul style="list-style-type: none">– Provide advice on the priorities to be addressed in the 2024 Work Programme, including links with similar research activities carried out for example in HE;– Provide advice to the GB on the EU-Rail Programme progress and on other strategic issues;	Q2

<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. 	
<p>3rd Meeting of the SRG in which it would:</p> <ul style="list-style-type: none"> - Provide opinion on the 2024 Work Programme 	Q4

2.5.5 The System Pillar steering group

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

It shall be 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 SPSG 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 2023, one each quarter.

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 under EU-Rail. It shall provide recommendations on issues related to the deployment of rail innovative solutions, either upon request of the Governing Board, or on its own initiative.

The Deployment Group should consist of European rail representatives, in particular of Infrastructure Managers and Rail Operators, but also of suppliers, to ensure the preparedness of products and to advise the JU on how a coordinated and integrated deployment can be organised. The composition of this group may be variable, considering the scope of its activities.

More specifically, the Deployment Group should:

- Examine and provide recommendations on alternative scenarios for the rollout of innovative solutions;
- Prepare a roadmap for the coordinated and integrated deployment of the relevant rail research and innovation results, where relevant in cooperation with other modes of transport;

- Examine the human factor elements and the behavioural and organisational changes resulting from deployment;
- Ensure consideration of diversity of situations across the Union, including most cost-effective possibilities of retrofitting from a medium and long-term perspective;
- Contribute to the alignment of deployment and investment plans also including other modes of transport and other relevant infrastructures;
- Assess the risks and opportunities associated to uncoordinated initiatives;
- Contribute to phasing out of existing legacy systems and consideration on the necessary accompanying funding and financial measures, from public and private sources, including EIB;
- Suggest a performance scheme that would contribute to accelerating deployment and/or any other relevant measures;
- Examine any other relevant matter that would contribute to shortening of the innovation lifecycle and increasing the performance of rail, while maintaining the same or even higher level of its safety.

It is expected that the activities of the Deployment Group will start formally in Q1 2023.

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 some other functions reporting directly to the Executive Director. The Programme Unit is further broken 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. The Head of Corporate Services reports to the Executive Director, and is responsible for providing the necessary financial, administrative and compliance support in relation to the activities of the JU. Other functions of the Programme Office, such as the Internal Control Coordinator, the HR Officer and the Chief Officer for Stakeholders' Relations and Dissemination, 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 COSO²⁴ 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

²⁴ 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.

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 of claims, including receipt of audit certificates and ex-ante certification of cost methodologies;
- ex-post certification by independent auditors of costs representing the in-kind contributions to additional activities provided by the private members of the JU;
- ex-post audits on a sample of claims as part of the Horizon 2020/Horizon Europe ex-post audit strategy;
- qualitative evaluation of project results.

Furthermore, the adherence to ethical and organisational values will continue to be one of the key roles of the Joint Undertaking, subject to monitoring by the Commission. The Executive Director, as the Authorising Officer, will promote a cost-effective system of internal control and management and will be required to report to the GB in this respect. The JU will monitor, with the oversight of its GB, the risk of non-compliance through the developed reporting system, as well as by following up on the results of ex-post audits on the recipients of EU funds from EU-Rail, as part of the common ex-post audit strategy covering the whole of the Horizon 2020 and Horizon Europe framework programmes. In the application of its control system, the JU will strive for striking a balance between attaining an acceptable error rate 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 and to prevent fraud 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 2023, 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 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 2022 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). In compliance with its Article 71, the Joint Undertaking will 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. Any departure from this Model Financial Regulation, required for the purpose of the Joint Undertaking's specific needs, shall be 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.

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 the 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), 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 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 has commenced the process of its key internal guiding documents underpinning its day-to-day activities, such as the Governance and Process Handbook, to adapt them to the new Programme and organizational framework. This process will continue also in the upcoming period.

2.6.4 Ex-ante and ex-post controls

With the new Programme under Horizon Europe only launched in 2022, the main focus of ex-ante and ex-post controls will remain with the ongoing projects governed by the Horizon 2020 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 common guidelines applicable to Horizon 2020. With regard to the proposals received in response to the first call under the Horizon Europe Programme and the subsequent GB approval of the list of actions selected for funding, EU-Rail performed the checks within the grant agreement preparation workflows, as required by the common Horizon Europe guidance documents.

EU-Rail follows *the Article 21(1)* of its Financial Rules 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 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 and other). In addition to the processes defined internally, EU-Rail is implementing the Horizon 2020 ex-ante control framework for its grants.

In accordance with *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 EU-Rail's projects 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 July 2022, CAS confirmed the selection of the local representative audit sample for the JU with the target closure year 2023. EU-Rail will report the outcome of the ex-post audits performed in 2022 in its Consolidated Annual Activity Report. This reporting will include the error rates identified and applicable to the JUs population.

With the application of the lump sum form of grants under the new EU-Rail Programme, the above-mentioned financial audits performed by the CAS used for grants based on reporting costs actually incurred by the beneficiaries, will no longer be applicable to the new actions funded by EU-Rail. The JU has therefore already launched activities aiming at establishing a framework for the conduct of reviews or audits of qualitative (technical) nature, that is reviews/audits focused on the assessment of whether the agreed work was performed, and whether it was performed in line with the grant agreement provisions. In the establishment of this framework, EU-Rail will seek support from other interested JUs and from the external stakeholders involved in auditing activities (e.g. the Court of Auditors), as relevant. The JU also intends to cooperate with external contractors/experts in this activity. The establishment of the review/audit framework is foreseen in the first half of 2023, with its subsequent testing by means of pilot reviews/audits.

Further to the above-mentioned types of controls, the JU has introduced since 2018 an internal mechanism of ex-post controls on financial transactions related to administrative expenditure as another element in the control framework to provide assurance on the effective functioning of the system. In 2023, 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 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 a risk assessment performed at the JU during 2020, the Internal Auditor drew up the Strategic Internal Audit Plan for 2021-2023 which will be the basis for the internal audit work to be carried out as of 2021. In view of establishing their new audit plan for the JU, IAS decided to perform a new in-depth risk assessment in 2023. In Q4 2022 the JU provided IAS with an update on the internal and external developments having influence on its business, as well as with its updated version of the risk register.

The IAS' *Audit on H2020 grant implementation and closing*, which started in 2021, was finalized in September 2022 by issuing the final audit report. IAS concluded 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 issues, 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.

In response to the above-mentioned final audit report, EU-Rail provided to IAS the action plan for addressing the identified issues. These actions will be implemented and followed up in the course of 2023.

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 DG Budget, on the basis of the joint tendering of the services by the EC, agencies and other JUs.

Each year, the European Court of Auditors shall prepare 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 shall consider 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 2021, no major issue was reported by the ECA for EU-Rail itself.

One observation was raised for follow-up regarding the implementation rate for the JU's 2021 payments available under the operational budget, including operational unused and reallocated appropriations, that decreased to 61%, compared to the 76% of 2020. With regard to the operational payment implementation, the JU confirmed the importance of the quality of the beneficiaries' reporting and the need for beneficiaries to comply with deadlines in the submission. This was duly followed up with the Governing Board in November 2021 and will continue to be thoroughly followed up in 2022 and 2023 as well, until the S2R Programme is fully completed.

Furthermore, the ECA also issued horizontal observations common to all JUs. The most relevant one deals with the fact that, as from January 2016, JUs which are only partly financed from the EU budget, should have paid the part of the employer's contributions to the EU pension scheme, corresponding to the ratio of their non-EU subsidised revenues to their total revenues²⁵. As the Commission has neither provided for this expenditure in the JU's budgets, nor formally requested the payments, EU-Rail (and its predecessor the S2R JU) had not yet paid such contributions.

EU-Rail agrees to pay its employer's pension contributions in line with the calculation to be provided by the Commission's services, once de jure aspects are ascertained and invoices are issued by the PMO. Although the JUs have no mandate to accept that a contradiction exists between the estimation approach provided by Commission's services and the referenced provisions of the SBA, EU-Rail is open and willing to resolve the matter in cooperation with the Commission's services. This issue will be followed-up together with the relevant Commission services and with the other concerned JUs in the course of 2022 and 2023.

With regard to the ex-post audits of grants, the actions funded by the JU are subject to the Horizon 2020 common Audit Strategy implemented by the CAS, as mentioned in Section 2.6.4.

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

²⁵ [Article 83a of Regulation No 31 \(EEC\), 11 \(EAEC\)](#) laying down the Staff Regulations of Officials and the Conditions of Employment of Other Servants of the European Economic Community and the European Atomic Energy Community.

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 endorses the JU's risk register brought to its attention by means of the Consolidated Annual Activity Report.

In the months of September and October 2022, 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. Due attention was given also to the fraud risks.

The management of risks during 2023 will be based on the results of the above mentioned risk assessment exercise carried out during 2022 (see also Section 2.3.6 titled "Other risks"), taking into consideration the most recent developments. In March 2023, IAS confirmed to EU-Rail that their engagement planned to be carried out in the JU in 2023 will take form of a new in-depth risk assessment. EU-Rail will grant to IAS full cooperation in exercising this assessment and will take advantage of its results so that duplication of efforts with similar internal JU activities are avoided. Further insight into risks related to individual Flagship Areas, projects and beneficiaries, will be part of the new risk assessment, as relevant. This activity is expected to contribute also to the process of further formalization of EU-Rail risk-based monitoring strategy, as was recommended by IAS in result of their *Audit on H2020 grant implementation and closing*.

2.6.7 Anti-fraud strategy

In July 2022, EU-Rail adopted its new Anti-Fraud Strategy for 2022-2025²⁶ 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,
- 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.

²⁶ https://rail-research.europa.eu/wp-content/uploads/2022/07/ED-DECISION_ED-22-02_Anti-Fraud-Strategy-2022-2025_Annex_AFS.pdf

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 2023-2024^{27,28}

In accordance with the General Annexes of the Horizon Europe Work Programme 2023-2024 (European Commission Decision C(2022)7550 of 6 December 2022), with regard to budget flexibility, the budgets set out in the calls and topics are indicative. Unless otherwise stated, final budgets may change following evaluation. The final figures may change by up to 20% compared to the total budget indicated in each individual part of the Work Programme. Changes within these limits will not be considered substantial within the meaning of Article 110(5) of Regulation (EU, Euratom) No 2018/1046.

Budget Amendment nr 1 (A1) – Statement of Revenue

Compared to Work Programme 2022-2024 and Budget, this amendment recognises and balance (Revenue and Expenditure) unused appropriations on S2R Programme operational expenditure due in relation to the previous budgetary years, in accordance with EU-Rail Financial Rules Article 6.5.

Are entered in addition to the estimate of revenue:

- EUR 0.08 million in commitment and payment appropriations recovered from S2R Programme project that had to be re-paid through the EC Guarantee Fund
- EUR 26.1 million in payment appropriations due in relation to the unused appropriations of previous budgetary years that are required in 2023 in order to pay S2R Programme grants interim and final payments, following an action plan of “REPA 2023” discussed and agreed with the EU-Rail SIPB and project coordinators between January and May 2023.

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 SESAR3 Joint Undertakings will launch a joint call “Integrated air and rail network backbone for a sustainable and energy-efficient multimodal transport system” for a total of EUR 5.000.000 of co-funding and EUR 7.143.000 of total costs at 70% funding rate with a fairly shared contribution between SESAR and EU-Rail (i.e.: EUR 2.500.000). The modalities of this transfer will be detailed in an arrangement between both organisations.

The 2 500 000 is appearing in the section “EU Contribution” in accordance with the structure of the EU-Rail budget, but is coming from SESAR 3 JU and not from the Union.

In accordance with the Single Basic Act Article 10.4, the 2.500.000 € new revenue in 2023 are considered as additional Union funds complementing the contribution allocated to the EU-Rail Programme implementing Horizon Europe²⁹. 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.

²⁷ 2023 and 2024 Budget (Commitment and Payment appropriations) are subject to the adoption of the EU General Budget for 2023 and 2024. All figures may be updated during both of these adoption procedures.

²⁸ The EFTA rate used for 2024 is the one known and applicable for the year 2022. This could be subject to revision when the EFTA rate 2024 will be available.

²⁹ The 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.

Budget Amendment nr 1 (A1) – Statement of Expenditure

Title I and II:

Minor adaptation of the Budget appropriation per line is proposed considering the evolution of budget needs identified since the estimates made in Octobre 2022.

The increase of payment appropriations in Title 2 is to ensure the implementation via interim and final payments of JU activities agreed with the GB in 2022, mainly about the support of the initial activities of the System Pillar – on the transition to the full System Pillar running, on the setting up of the System Pillar programme and project management plan, and on the drafting of the Standardisation and TSI input plan.

This increase is covered by the administrative unused appropriations coming from the Title 5 “Unused”.

Title III (Operational S2R Programme):

Increase of the S2R Programme operational payment appropriations of 26.2m€, in order to pay the S2R Programme grants interim and final payments expected for the year 2023.

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

Title IV (Operational EU-Rail Programme):

The commitment appropriations are increased by EUR 2.500.000 for the joint call between EU-Rail and SESAR 3 JU.

STATEMENT OF REVENUE							
Title Chapter	Heading	Financial Year 2023 - A1			Financial Year 2024		
		Estimate Commitment Appropriations	Estimate Payment Appropriations	In %	Estimate Commitment Appropriations	Estimate Payment Appropriations	In %
EU contribution (excluding EFTA and third countries contribution)[2]		94.234.167	83.767.283	70%	104.420.806	71.764.329	89%
of which (fresh C1) Administrative (Title 1&2)		2.346.053	3.578.712	3%	2.405.582	2.929.548	4%
of which frontloaded commitments (Title 1 and Title 2)		-	-		-	-	
of which Operational (Title 3)		91.888.114	80.188.571	67%	102.015.224	68.834.781	85%
Of which related to additional entrusted tasks							
EFTA and third countries contribution		2.651.117	2.370.050	2%	2.579.194	1.770.693	2%
of which Administrative EFTA(Title 1&2)		67.801	98.001	0%	59.418	70.474	0%
Of which administrative third countries excluding EFTA (Title 1&2)							
of which Operational EFTA (Title 3)		2.583.316	2.272.049	2%	2.519.776	1.700.219	2%
Of which operational third countries excluding EFTA (Title 3)							
Financial Members other than the Union contribution		3.676.713	3.676.713	3%	3.000.022	3.000.022	4%
of which Administrative (Title 1&2)		3.676.713	3.676.713	3%	3.000.022	3.000.022	4%
of which Operational (Title 3)							
Financial Contributing partners contribution							
Interest generated							
Unused appropriations from previous years		1.877.449	30.313.831,51	25%	2.988.647	4.543.287	6%
Of which administrative		1.795.420	3.652.641,42	3%	2.988.647	3.114.220	4%
Of which operational		82.029	26.661.190,09	22%	-	1.429.067	2%
TOTAL ESTIMATE REVENUE		102.439.446	120.127.878	100%	112.988.669	81.078.330	100%

STATEMENT OF REVENUE - AMENDED - VARIANCE A1											
Title Chapter	Heading	Financial Year 2023				Financial Year 2023 - A1			VARIANCE		
		Estimate Commitment Appropriations	In %	Estimate Payment Appropriations	In %	Estimate Commitment Appropriations	Estimate Payment Appropriations	In %	Estimate Commitment Appropriations	Estimate Payment Appropriations	In %
EU contribution (excluding EFTA and third countries contribution)[2]		91.734.167	92%	83.767.283	89%	94.234.167	83.767.283	70%	2.500.000	-	100%
of which (fresh C1) Administrative (Title 1&2)		2.346.053	2%	3.578.712	4%	2.346.053	3.578.712	3%	-	-	100%
of which frontloaded commitments (Title 1 and Title 2)		-		-		-	-		-	-	
of which Operational (Title 3)		89.388.114	90%	80.188.571	85%	91.888.114	80.188.571	67%	2.500.000	-	100%
Of which related to additional entrusted tasks									-	-	
EFTA and third countries contribution		2.651.117	3%	2.370.050	3%	2.651.117	2.370.050	2%	-	-	100%
of which Administrative EFTA(Title 1&2)		67.801	0%	98.001	0%	67.801	98.001	0%	-	-	100%
Of which administrative third countries excluding EFTA (Title 1&2)									-	-	
of which Operational EFTA (Title 3)		2.583.316	3%	2.272.049	2%	2.583.316	2.272.049	2%	-	-	100%
Of which operational third countries excluding EFTA (Title 3)									-	-	
Financial Members other than the Union contribution		3.676.713	4%	3.676.713	4%	3.676.713	3.676.713	3%	-	-	100%
of which Administrative (Title 1&2)		3.676.713	4%	3.676.713	4%	3.676.713	3.676.713	3%	-	-	100%
of which Operational (Title 3)									-	-	
Financial Contributing partners contribution									-	-	
Interest generated									-	-	
Unused appropriations from previous years		1.795.420	2%	4.148.868	4%	1.877.449	30.313.831,51	25%	82.029	26.164.964	731%
Of which administrative		1.795.420	2%	3.652.641	4%	1.795.420	3.652.641,42	3%	-	-	100%
Of which operational		-	0%	496.226	1%	82.029	26.661.190,09	22%	82.029	26.164.964	5373%
TOTAL ESTIMATE REVENUE		99.857.417	100%	93.962.914	100%	102.439.446	120.127.878	100%	2.582.029	26.164.964	128%

The EUR 2.500.000 increasing the section “EU Contribution” in accordance with the structure of the EU-Rail budget, is coming from SESAR 3 JU and not from the Union.

STATEMENT OF EXPENDITURE									
Title Chapter	Heading	Financial Year 2023 - A1				Financial Year 2024			
		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]
1- Staff									
Salaries & allowances									
- Of which establishment plan posts	110	1.310.360,00	116%	1.310.360,00	116%	1.703.520,00	130%	1.703.520,00	130%
- Of which external personnel	111	1.700.000,00	106%	1.700.000,00	106%	1.539.200,00	91%	1.539.200,00	91%
Expenditure relating to Staff recruitment									
Mission expenses	130	153.000,00	102%	153.000,00	102%	156.060,00	102%	156.060,00	102%
Socio-medical infrastructure									
Training	150	51.000,00	102%	51.000,00	102%	52.020,00	102%	52.020,00	102%
External Services									
Receptions, events and representation									
Social welfare									
Other Staff related expenditure	190	361.080,00	102%	361.080,00	102%	368.301,60	102%	368.301,60	102%
2-Infrastructure and operating									
Rental of buildings and associated costs	200	351.900,00	102%	351.900,00	102%	358.938,00	102%	358.938,00	102%
Information, communication technology and data processing	210	195.000,00	100%	250.000,00	63%	195.000,00	100%	195.000,00	78%
Movable property and associated costs	220	10.000,00	100%	10.000,00	100%	10.000,00	100%	10.000,00	100%
Current administrative expenditure	230	15.000,00	100%	15.000,00	100%	15.000,00	100%	15.000,00	100%
Postage / Telecommunications	240	15.000,00	100%	15.000,00	100%	15.000,00	100%	15.000,00	100%
Meeting expenses	250	50.000,00	100%	50.000,00	100%	50.000,00	100%	50.000,00	100%
Running costs in connection with operational activities	260	140.000,00	37%	660.000,00	37%	50.000,00	36%	50.000,00	8%
Information and publishing	270	345.000,00	55%	300.000,00	65%	550.000,00	159%	550.000,00	183%
Studies									
Other infrastructure and operating expenditure	290	200.000,00	100%	160.000,00	100%	200.000,00	100%	200.000,00	125%
TOTAL ADMINISTRATIVE (1+2)		4.897.340,00	98%	5.387.340,00	98%	5.263.039,60	107%	5.263.039,60	98%
3-Operational									
TOTAL OPERATIONAL (3)		94.553.458,94	56%	111.626.317,98	50%	104.535.000,00	111%	72.499.088,81	65%
Unused Appropriations									
TOTAL Unused		2.988.646,84	166%	3.114.219,53	87%	3.190.629,00	107%	3.316.201,69	106%
ESTIMATE TOTAL EXPENDITURE		102.439.445,78	58%	120.127.877,51	52%	112.988.668,60	110%	81.078.330,10	67%

STATEMENT OF EXPENDITURE - AMENDED - VARIANCE A1													
Title Chapter	Heading	Financial Year 2023				Financial Year 2023 - 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 Appropriations	% Ratio [Year N+1/year N]	Estimate Payment Appropriations	% Ratio [Year N+1/year N]
1- Staff													
Salaries & allowances													
- Of which establishment plan posts	110	1.670.760,00	116%	1.670.760,00	116%	1.310.360,00	116%	1.310.360,00	116%	- 360.400,00	0%	- 360.400,00	0%
- Of which external personnel	111	1.509.600,00	106%	1.509.600,00	106%	1.700.000,00	106%	1.700.000,00	106%	190.400,00	0%	190.400,00	0%
Expenditure relating to Staff recruitment						0	0	0	0				
Mission expenses	130	153.000,00	102%	153.000,00	102%	153.000,00	102%	153.000,00	102%	-	0%	-	0%
Socio-medical infrastructure						0	0	0	0				
Training	150	51.000,00	102%	51.000,00	102%	51.000,00	102%	51.000,00	102%	-	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	361.080,00	102%	361.080,00	102%	361.080,00	102%	361.080,00	102%	-	0%	-	0%
2-Infrastructure and operating													
Rental of buildings and associated costs	200	351.900,00	102%	351.900,00	102%	351.900,00	102%	351.900,00	102%	-	0%	-	0%
Information, communication technology and data processing	210	150.000,00	100%	150.000,00	63%	195.000,00	100%	250.000,00	63%	45.000,00	0%	100.000,00	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%	15.000,00	100%	15.000,00	100%	15.000,00	100%	-	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%	50.000,00	100%	50.000,00	100%	50.000,00	100%	-	0%	-	0%
Running costs in connection with operational activities	260	100.000,00	37%	100.000,00	37%	140.000,00	37%	660.000,00	37%	40.000,00	0%	560.000,00	0%
Information and publishing	270	300.000,00	55%	300.000,00	65%	345.000,00	55%	300.000,00	65%	45.000,00	0%	-	0%
Studies						-	0%	-	0%				
Other infrastructure and operating expenditure	290	160.000,00	100%	160.000,00	100%	200.000,00	100%	160.000,00	100%	40.000,00	0%	-	0%
TOTAL ADMINISTRATIVE (1+2)		4.897.340,00	98%	4.897.340,00	98%	4.897.340,00	98%	5.387.340,00	98%	-	0%	490.000,00	0%
3-Operational													
TOTAL OPERATIONAL (3)		91.971.430,00	56%	85.461.354,04	50%	94.553.458,94	56%	111.626.317,98	50%	2.582.028,94	0%	26.164.963,94	0%
Unused Appropriations													
TOTAL Unused		2.988.646,84	166%	3.604.219,53	87%	2.988.646,84	166%	3.114.219,53	87%	-	0%	- 490.000,00	0%
ESTIMATE TOTAL EXPENDITURE		99.857.416,84	100%	93.962.913,57	100%	102.439.445,78	103%	120.127.877,51	128%	2.582.028,94	3%	26.164.963,94	22%

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	57.936,1	39.121,3	232.764,7	40,1%	
<i>Amount to be assigned on annual budget (other calls/tenders/experts)</i>	28.800,0	36.535,3	12.100,0	77.435,3		
<i>Available Commitment appropriations</i>			53.313,7			
<i>Total annual budget (operational EU-Rail Programme)</i>	164.507,2	94.471,4	104.535,0			363.513,7
	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>	141.750,0					
<i>Available Commitment appropriations</i>	53.313,7					
<i>Amount of annual instalments</i>	73.263,0	15.173,3		88.436,3		
<i>Amount to be assigned on annual budget (other calls/tenders/experts)</i>	18.200,0	62.202,7	48.347,3	128.750,0	59,3%	
<i>Total annual budget (operational EU-Rail Programme)</i>	91.463,0	77.376,0	48.347,3			580.700,0

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 €) -	Estimated annual value (in €)
	Link to JU objectives / KPIs	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, the adoption of the present annual additional activities' plan and the signature of the respective grants, Additional Activities shall 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:

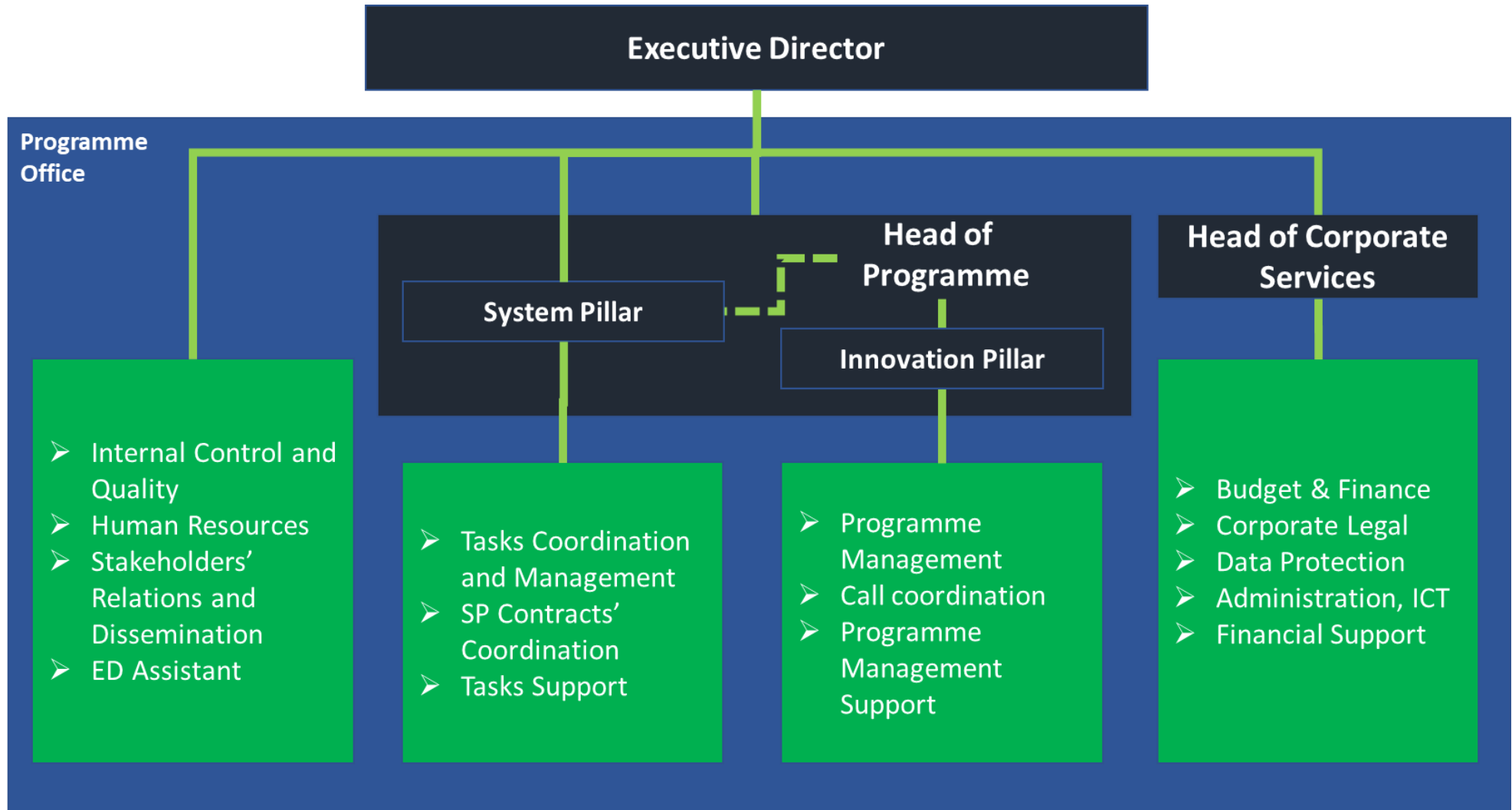
OVERVIEW ESTIMATED AMOUNT OF IKAA FOR 2024	Estimated annual value (in €) - Link to JU objectives / KPIs	Estimated annual value (in €) - Link to JU project
1. Support to additional R&I	4.735.357,80	33.396.244,86
Additional activities are part and contribute to the Member's activities performed and described 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 Web platform and mobile APP for real-time data viewing and alarm notification	186.643,09	-
Onboard Platform HW prototype developmt	200.000,00	-
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 initiatives in the shape of contributions towards new concepts and ideas (Railforum, Energy Roundtable, etc.)	150.000,00	
8. Communication, dissemination, awareness raising, citizen engagement	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

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



Annex III – Key Performance Indicators for Europe’s Rail Joint Undertaking³⁰

TABLE I - Horizon Europe Common Key Impact Pathway Indicators

PARTICULAR INDICATORS AND THEIR TARGET VALUES NOT YET DEFINED

TABLE II - Horizon Europe Partnership Common Indicators

PARTICULAR INDICATORS AND THEIR TARGET VALUES NOT YET DEFINED

³⁰ 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 framework for the Biennial Monitoring Report on European Partnerships - second interim report”, Section 4.3, available here: <https://op.europa.eu/en/publication-detail/-/publication/8c558fae-ec57-11ec-a534-01aa75ed71a1>





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 indicators	Rationale	Driver Targets ¹
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	75%
	Traffic planning certainty, #	Planning certainty, considering the demand forecast, is a key requirement for planning on time, reliable and efficient service delivery	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	-50%
2. Improved Capacity 	Trains on line per hour and direction, #	Increased frequency is a key element for improved capacity	At least +10% ²
	Reduction of total freight transport time, mins	Reduced freight transport time leading to better asset utilization and increased capacity	-33%
	Increased average freight train length in existing infrastructure limitations or higher loads, meters	Increased length directly leads to more available capacity	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	tbc ³
	Maintenance costs, including thanks to the use of digital twins, €	Direct link to lower costs	-10% ⁴
	Design and manufacturing costs, €	Leading to reduced investment cost	-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	+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)	-10% (energy); +15% (punctuality)
	CO ₂ equivalent emissions	Further decrease rail carbon intensity	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	<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	tbc ⁷

Impact areas	Key performance indicators	Rationale	Driver Targets ¹
5. Harmonized approach 	CCS system CAPEX and OPEX (of main line and regional lines systems), while maintaining or increasing the present safety level	Reducing costs associated with the interoperability of the network will enhance harmonization	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	N/A
	Reduction of answering time between the short term request of a cross-border train path and the answer with a firm offer, <i>mins</i>	Indicator for more efficient border crossing	down to 5 mins
	Operational dwell time at borders and other handover points relying also on relying on more homogenous system approaches (leading to increase number of trains on given infrastructure), <i>mins</i>	Indicator for more efficient border crossing	-50%
6. Reinforced role for rail 	Accuracy in total planned travel time of passengers from improved matching between supply and demand, %	The combination of the indicators from Impact Areas 1 and 3 contribute to more effective and cost-efficient rail transport, thereby improving attractiveness of rail compared with other transport modes	75%
	Traffic planning certainty, #		between 65% and 80% ¹
	Handling/response time for intermodal freight offers and regional passenger services, <i>mins</i>		-50%
	Overall OPEX and CAPEX costs of regional lines, incl. maintenance, infrastructure and vehicles		Tbc ³
	Maintenance costs, including thanks to the use of digital twins, €		-10% ⁴
	Design and manufacturing costs, €		-20%
	Virtual certification tasks that can be conducted in a laboratory, #		+80% ⁵
7. Improved 	Maturity of innovative technologies	Innovative technologies will deploy rail capabilities and leverage potential competitive advantages for the EU rail industry	TRL 8

¹ Depending on point in time, e.g. one week in advance or one hour in advance

² At the moment this KPIs is linked with the outcome of FA2 only, in the course of the programme a consolidated KPI will be measured

³ The nature of the activity requires a full system approach analysis from improvements at components level, which will be conducted during the course of the programme

⁴ In specific use cases for both rolling stock and infrastructure and asset management

⁵ Costs only related to the execution of the on-site tests

⁶ In a typical scenario of at least 100 trains running in a 2h interval ahead of actual time

⁷ Due to the confidentiality nature of the baseline, a KPI measure will be assessed and consolidated during the course of the programme

⁸ As reflected in the ERA database(s) in relation to OPE TSI Appendix A, annex C and other TSIs in relation to ERTMS and interlocking

Annex IV – KPIs and TRLs for Shift2Rail Programme

TABLE I – Estimation of 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 st	Testing time - YEAR en	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
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 st	Testing time - YEAR en	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	Generic	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		2020	2023	FR, UK	7	Reduce track and tunnel closure by offsite manufacturing and increase quality
				2020	2023	AT	7	Predict calcite clogging over time
	TD3.5 Proactive Bridge and Tunnel Assessment, Repair and Upgrade Demonstrator	Bridge improvements	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.
	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
TD3.6, TD3.7, TD3.8)	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 – 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.:	registered under Spanish law (registration number: A-28599033), with its registered office in Avenida de Bruselas nº 35, 28108 Alcobendas, Madrid, Spain
	INDRA SISTEMAS S.A. PATENTES TALGO S.L.U.	
15	Jernbanedirektorate (Norwegian Railway Directorate)	established in Biskop Gunnerus gate 14A, 0185 Oslo, Norway
16	Knorr-Bremse Systeme für Schienenfahrzeuge GmbH	registered under German law (registration number: HRB91181), with its registered office in Moosacher Str. 80, 80809 München, Germany
17	Österreichische Bundesbahnen-Holding Aktiengesellschaft (ÖBB-Holding AG)	registered under Austrian law (registration number: FN 247642f), with its registered office in Am Hauptbahnhof 2, 1100 Wien, Austria
18	Polskie Koleje Państwowe Spółka Akcyjna (PKP)	registered under Polish law (registration number: 0000019193), with its registered office in Aleje Jerozolimskie 142A, 02-305 Warszawa, Poland
19	ProRail B.V. & NS Groep N.V.	registered under Dutch law (registration number: 30124359), with its registered office at Moreelsepark 3, 3511 EP, Utrecht, The Netherlands
	ProRail B.V. NS Groep N.V.	
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 Maarsse, 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	Voest Alpine Railway Systems GmbH	registered under Austrian law (registration number: FN 126714w), with its registered office in Kerpelystrasse 199, 8700 Leoben, Austria

Annex VI – System Pillar milestones and planning

To note – there are ongoing scoping and milestone discussions since the Task and Domain teams have been in place since the beginning of October. It is expected that these discussions will be finalised by the end of the year. Therefore the following information should be treated as indicative and subject to change.

The milestones and planning of the SP has different levels of detail and addresses different purposes.

The following indicative table includes the dates identified during the System Pillar ramp up phase and included in the roadmap for the first wave of standardisation. This will be updated through the initial planning phases of the System Pillar.

Nr.	Task	Area	Standardisation Area	Priority	Difficulty	Maturity	date
1.	4	DAC	DAC architecture and interfaces to CCS	Very High	High	Low	2023
2.	1-2	Security	Security systems services for CCS/TMS	High	High	Low	2024
3.	1-2	Yards/Term.	Coordinated capacity planning with TM	Medium	High	Low	2025
4.	1-2	Yards/Term.	Coordinated traffic control with TM	Medium	High	Low	2025
5.	1-2	Stations	CCS/TMS<>Station interfaces for ATO Processes	Medium	Medium	Low	2025
6.	2	CCS operations	Operational concept (harmonized)	Very high	Medium	Low	2023
7.	2	CCS operations	Operational processes (harmonized)	Very high	Very high	Low	2024
8.	2	CCS operations	Operational rulebooks	Very high	Very high	Low	2026
9.	2-3	CCS core	Interface between Traffic Management and Traffic Control.	Very high	Medium	Medium	2024
10.	2	CCS core	Interfaces between Traffic Control and Train Control. (e.g. way of using SS26/126 for level R; and additional channels e.g. for onboard digital maps).	Very high	Medium	Medium	2024
11.	2	CCS Core	Cross-company/cross-installation/cross-border interfaces for Traffic Control	Very High	Very High	Low	2024

12.	2	CCS core	Interfaces between Traffic Control and Trackside Asset Control.	Very high	Medium	Medium	2023
13.	2	CCS core	Interfaces Traffic Control and Mobile CCS/TMS applications (e.g. for trackworker safety)	Very high	Medium	Medium	2026
14.	2-3	CCS assets	Engineering, asset and topology data	Very high	Medium	Medium-High	2023
15.	1-2	CCS assets	Asset condition and intervention management (Integrated diagnostics protocols, analytics, event channelling, and smart/integrated event pattern recognition)	High	Medium	Low	2025
16.	2	CCS vehicle	Vehicle CCS internal modularisation and interfaces to the train	Very high	High	Medium	2024
17.	2	CCS config	Integrated configuration management	High	Medium	Low	2025
18.	2	CCS UI	Standardisation of integrated workbenches / UI	High	Medium	Low	2024
19.	2	Computing	Standard (safe) computing environments (e.g. API and communication methods)	Medium	Medium	Medium	2025
21.	2	FRMCS	FRMCS incl. vehicle/trackside architecture V2	Very High	High	High	2024
22.	2	FRMCS	FRMCS incl. vehicle/trackside architecture V3	Very High	High	High	2026
23.	3	TM	Traffic Management – internal interfaces (for example between Planning, Deviation Management, and Incidence Management)	High	High	Low	2025
24.	3	TM	TM common service APIs (e.g. to company systems or customer requirement)	Very High	Medium	Low	2024
25.	3	TM	Cross-company / cross-border /Multimodal Traffic Management (Deviation management, planning synchronisation and managed planning partner networks for railway production)	High	Very High	Low	2026

Deliverables and milestones

The following sections sets out for horizontal services and the different tasks the current planning for the deliverables and milestones. This is still **indicative** and will be confirmed and potentially amended in the initial stages of the System Pillar process, which has begun from the start of October 2022 (with the signature of the Lot 2 contract).

1. Central Modelling Service

1.1 Deliverables

First 12 months

- Finalize the System Engineering Management Plan V2 (full version)
- Install and train tool target platform
- Define and start the synchronisation process with TT

Running Tasks

- Maintain and update the high level requirements, operational concept, and architecture based on the input of the sector or the SP tasks. Allocate requirements and functions to the System Pillar Tasks.
- Integrate and consolidate in the master model the different operational concepts and architectural designs to one solution that fulfils the decided requirements.
- Define, assign, and coordinate tasks for design of interfaces and design on interactive operational processes between System Pillar tasks 2,3,4 (ff) and their domains
- Provide the central modelling service that integrates form- and requirement-compliant conceptual inputs or external model fragments into the master model.
- Design tests and perform model proving for the overall model validation
- Define, train, continuously improve, and supervise a homogenous and integrated System Engineering Management plan for SP level, tasks and domains. Design and describe the engineering process in the System Pillar (according to INCOSE/ISO15288) with roles, working steps and type of artefacts; processes change requests and proposals to the processes and methods
- Choose, develop and provide the documentation, concept, architecting and modelling handbook (MBSE), the ontology, the architecting framework, and the Railway Dictionary
- Design, hosts and maintains the central tool platforms and the master concept/model/CDM databases and edits and consolidates their content as a central service
- Manage relevant licences and technical support for the necessary technical modelling software.
- Requirements management platform (for all requirements) and methods and moderation of the creation, negotiation and CCM process for requirements
- 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
- Provide document management platform and methods, such as the repository for conceptual documents, coordination of the translation of concepts into formal models and derived views and exports like for CDM

- Guide and support appropriate MBSE-training to contributors to the SP

1.2 Indicative milestones

(Central) Modelling Service	Training prepared and executed	TBD
	Existing functional models translated, imported and consolidated	TBD
	Modelling rules defined	TBD
	First complete set of requirements for the system currently in scope based on contributions of the tasks and domains	Q3 2023
	Work breakdown plan, assigned tasks and coordination for an integrated operational concept and process set (work assigned to the tasks),	Q3 2023
	Operational analysis model based on the inputs of the tasks and domains according to their milestone structure Work breakdown plan, assigned tasks and coordination for an integrated systems architecture (work assigned to the tasks)	Q4 2022
	Maintain and update the high level requirements, operational concept, and architecture based on the input of the sector or the SP tasks.	TBD
	Allocate requirements and functions to the System Pillar Tasks.	TBD
	Tool Platform Administration	TBD
	CDM consolidated for running SP domains	TBD
	Collaboration tool established	TBD
	Concept editing /content management / ALM established:	TBD
	MBSE platform established,	TBD
	Document version/release Mgt. Platform established,	TBD
	SP Publishing platform established (Website)	TBD
	System architecture model based on the inputs of the tasks and domains according to their milestone structure System Engineering Management Plan V1 defined and trained,	TBD
	Integrate and consolidate in the master model the different operational concepts and architectural designs to one solution that fulfils the decided requirements.	TBD
	Define, assign, and coordinate tasks for design of interfaces and design on interactive operational processes between System Pillar tasks 2,3,4 (ff) and their domains	TBD
	Provide the central modelling service that integrates form- and requirement-compliant conceptual inputs or external model fragments into the master model .	TBD
	Design tests and perform model proving for the overall model validation	TBD
	o Define, train, continuously improve, and supervise a homogenous and integrated System Engineering Management plan for SP level, tasks and domains. Design and describe the engineering process in the System Pillar (according to INCOSE/ISO15288) with roles, working steps and type of artefacts; processes change requests and proposals to the processes and methods	TBD
	o Choose, develop and provide the documentation, concept, architecting and modelling handbook (MBSE), the ontology, the architecting framework, and the Railway Dictionary	TBD
	o Design, hosts and maintains the central tool platforms and the master concept/model/CDM databases and edits and consolidates their content as a central service	TBD
Manage relevant licenses and technical support for the necessary technical modelling software.	TBD	
Requirements management platform (for all requirements) and methods and moderation of the creation, negotiation and CCM process for requirements	TBD	

	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	TBD
	Provide document management platform and methods, such as the repository for conceptual documents, coordination of the translation of concepts into formal models and derived views and exports like for CDM	TBD
	Guide and support appropriate MBSE-training to contributors to the SP	TBD

2. PRAMSS

2.1 Deliverables

First 12 months

- Development of harmonized approaches and strategies for PRAMSS at European level – for example overall safety levels
- Defining strategies (e.g. safety strategy), policies, methods (e.g. concerning security design) in cooperation with the Tasks and Domains
 - Security:
 - Security in the light of new system design approach (modularization, standard interfaces, ..)
 - Security and Domains:
 - All domains: every domain has to work on Security - doing "security by design" in all steps.
 - Task 2 Transversal (Security dedicated team): Designing the Security systems, network protocols (Identity management, security monitoring, etc.)
 - Safety:
 - Establish the principles to be followed in the system design (e.g. Identify and 'isolate' Vital components)
 - Elaborate new (simplified) authorization processes (steps needed to put system in service and for update) to simplify the introduction of the railways products in the European Member States:
 - As is Analysis (countries processes).
 - How to introduce full automatic Operation (ATO GoA3/4)
 - How to remove barriers linked to the different countries safety authority.
 - PRAM:
 - Performance target: e.g. Systems response time according to the system configuration (Scalability)
 - RAM: Define Redundancies evaluation criteria, Maintenance aspects on the base of Modularization, Standardization, Scalability design guidelines
- PRAMSS definitions (From existing to target) on top-level
- Assure requirement implementation in the System Pillar Tasks
- Support the consideration of applicability and the development of new approaches for example - Model based safety analysis (MBSA); generic safety cases as the prerequisite of harmonized engineering and subsequent operational rules; development of flexible and configurable system for different rail environments

- Coordinate and support Tasks and Domain Teams in the break-down process for the PRAMSS requirements.

2.2 Indicative Milestones

PRAMSS Management & Assurance Team	Development of harmonized approaches and strategies for PRAMSS at EU level - for example, overall safety levels	Q3 2023
	Defining strategies (e.g. safety strategy), policies, methods (e.g. concerning security design) in cooperation with the Tasks and Domains	Q3 2023
	Safety plan	Q3 2023
	Security Plan	Q3 2023
	PRAM plan	Q3 2023
	PRAMSS definitions (From existing to target) on top-level	
	Non-functional requirements,	Q3 2023
	Concept,	Q3 2023
	Assure requirement implementation in the System Pillar Tasks	Q3 2023
	Support the consideration of applicability and the development of new approaches for example: - Model based safety analysis (MBSA); - Generic safety cases as the prerequisite of harmonized engineering and subsequent operational rules - Development of flexible and configurable system for different rail environments	Q3 2023

3. Task 1 Railway System

3.1 Deliverables

First 12 months

- As-is railway system architecture view, considering operational, functional, logical & physical assets
- Diagnosis of the pain points for selected operational interaction processes and derive target performance of railways system functions and the requirement set reflecting the Common Business Objectives

As is architecture task 1 should provide analysis for to be architecture using identified enablers and innovation to improve railways process or to reach collectively European ambitions.

Different activities should fit the international standard of System engineering/architecting (ISO 15288 or, later, ISO 29110). The main activities should include

- Identification of the system perimeter
 - Identification of business (CBO) and stakeholder requirements along life cycle from their need.
 - Expected deliverable: Identification at EU railways system of main internal and external stakeholders of railways system and their requirement

- Identification of main system concepts (ConOps and OpsCon) that define capability, quality and performance needed in the system (stakeholder alignment).
 - Requirement analysis of as-is railways system for layer 1 and 2 should be based on defined use cases
 - Describe technical as-is railways system including functional boundary, performances objectives, non-functional requirements
 - Identification of as-is external and internal interfaces requirement (eg. function flow diagram) and requirements flow-down
 - Identify the pain points for selected operational interaction processes
 - Derive a requirement set reflecting the Common Business Objectives
 - Input to CMS
- High-level Business Process Architecture view and Operational Design (Organisational needs, Generic automation needs, ...) for the (to-be) Railway System

The high level business process architecture view and operational design for the to be railway system should include:

- Consideration to layer 2 of all main railways subdomain and sub-systems including infrastructure (Track, Energy, Telecom, Civil Works), rolling stock, railways operation and services,
- Identification from CBO of expected system performance for each function at layer 1-2
- Analysis of concept candidate for target performances and describe functional and performance requirement for to-be system
- Identification of main system concepts (ConOps and OpsCon) that define capability, quality and performance needed in the system (stakeholder alignment).
- Input to CMS
- Identification of internal interfaces and requirements flow-down for to be
- Identification of critical external interfaces to the railway system, in particular as part of the integration of rail within the transport system
- Alignment with relevant Flagship Project activities.
- Proposition of future architecture that can reach CBO objective by analysing new concept in SP domain and IP ongoing project in to be architecture suitable for specific objectives

3.2 Indicative milestones

Domain Task 1	Operational Analysis (ORS)	
	Definition of uses cases of the railway system, also to be consistent with domain, considering external interfaces of Task 2, 3, 4 and FP	Q4 2022
	Identification of the system perimeter	Q2 2023
	Identification of business (CBO) and stakeholder requirements along life cycle from their need	
Identification and modelling of use cases focus on those who include SP domain		

	Identification of main system concepts (ConOps and OpsCon) that define capability,	
	As-is analysis of the railway system, considering Operational assets, Functional assets, Logical assets Physical assets	
	Technical as-is railways system including functional boundary, performances objectives, non-functional requirements	
	Identification of as-is external and internal interfaces requirement (eg. function flow diagram) and requirements flow-down	Q3 2023
	Identify the pain points for selected operational interaction processes	
	Derive a requirement set reflecting the Common Business Objectives	Q4 2023
	Specify the high-level Business Process Architecture and Operational Design for the (to-be) Railway System	
	Identification from CBO of expected system performance for each function at layer 1-2	Q1 2024
	Analysis of innovation concept candidate for target performances and describe functional and performance requirement for to-be system	Q2 2024
	Identification of internal interfaces and requirements flow-down for to be	Q3 2024
	Proposition of future architecture that can reach CBO objective by analysing new concept in SP domain and IP ongoing project dans to be architecture suitable for specific objectives.	Q4 2024
	Organizational Needs; Generic Automation needs	TBD
	Operational Capabilities	TBD
	Assign high-level input requirements to other tasks	TBD
	Define requirements, including reduction of total cost of ownership	TBD
	Assess migration roadmap of the Tasks 2...n Regarding overall Business Process Architecture and Operational Design consistency	TBD
	For physical assets, start with the inventory of existing tools/repositories before making the analysis	TBD
	Assess migration roadmap of the Tasks 2...n Regarding overall Business Process Architecture and Operational Design consistency	TBD

4. Task 2: CCS. Domain Operational Design

4.1 Deliverables

First 12 months

- Collection of existing operational designs from Railways
 - Transfer existing documentation from the Ramp Up
 - Request additional examples (from EUG/NPM) for Level 2/3
 - Create a short overview document that explains the existing content
 - Consolidate (“copy and paste”) a first raw description as a starting basis for the operational design
 - Create a first complete collection of “basic” operational requirements
 - Clarify the need / process for border signals protecting supervised areas
- Collection of operational improvement requirements (SEMP processes)
 - Collect and consolidate operational improvement requirements from
 - Common business objectives
 - Sector input documents (Ramp Up)
 - Refine problem descriptions
 - Create problem analysis
 - Design process improvements
- Operational design down to SEMP process 2.5
 - Transfer the raw description to a structured operational analysis description (CONUSE, CONEMP, CONOPS for CCS, based on ARCADIA method as described in the SEMP) as a basic structure (mission, capabilities, process structure) and
 - Describe the operational design (up to SEMP process 2.5) while applying the improvement requirements and completing the list of operational requirements.

4.2 Indicative milestones

Operational Design Teams	Collection of existing operational designs from Railways	Before Q4 2023
	Transfer existing documentation from the Ramp Up	
	Request additional examples (from EUG/NPM) for Level 2/3	
	Create a short overview document that explains the existing content	
	Consolidate (“copy and paste”) a first raw description as a starting basis for the operational design	
	Create a first complete collection of “basic” operational requirements	
	Clarify the need / process for border signals protecting supervised areas	
	Collection of operational improvement requirements (SEMP processes)	
	Collect and consolidate operational improvement requirements from	
	Common business objectives	
	Sector input documents (Ramp Up)	
	Refine problem descriptions	
	Create problem analysis	
	Design process improvements	
	Operational design down to SEMP process 2.5	
Transfer the raw description to a structured operational analysis description (CONUSE, CONEMP, CONOPS for CCS, based on ARCADIA method as described in the SEMP) as a basic structure (mission, capabilities, process structure) and		

	Describe the operational design (up to SEMP process 2.5) while applying the improvement requirements and completing the list of operational requirements.	
	Operational Analysis for the system ("OCS"): Operational Concept Harmonized	Q3 2023
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Process hazards and risks	
	Rule Books	
	Operational Migration	
	Operational standardization specification: Operational Concept	
	Operational Analysis for the system ("OCS"): Operational Processes	Q4 2024
	As-Is Analysis	
	CBO: Translate business objectives into operational target processes (business re-engineering)	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	
	Operational Entities	
	Operational Capabilities	
	HSI Plan	
	PRAMSS Targets and Breakdown	Q4 2026
	Rule Books	
	Operational rulebooks (Harmonized): Human Interaction. Driver-system-signalman-maintainer	
Operational rulebooks (Harmonized): Signaling Rules	TBD	
· Work on the root cause of different operational concepts of radio based ETCS:		
<i>Planning</i>		
<i>Projecting</i>		
<i>Implementation engineering rules</i>		
<i>Timely harmonization on EU-level</i>	Periodical	
· Support and guide technical design teams for functional requirements & harmonization according to target operational processes		

5. Task 2 CCS. Domain Architecture Release and Coordination

5.1 Deliverables

First 3 months

- Define the strategy to be followed to design the and release the fully integrated system architecture

- Refined version of the high-level logical architecture from the ramp up as a basis
- Sequence and priorities in the interface catalogue
- Workaround for the missing operational analysis
- Coordination with the Transversal Domain Teams to ensure overall consistency regarding architecture and release coordination
 - Architecture guideline for transversal systems (protocols on network level)
 - Dependency management for independent component releases

First 12 months

- Collect and evaluate existing work (research projects, state-of-the-art documents) as input to design the System architecture.
 - Model import
 - Document Import and restructuring
 - Fast approval process
- Continuous Interaction with IP and SP Core group and SP domains to provide and receive inputs and mediate conflicts
 - Prioritized and transparent architecture issue list with important open points assigned to workgroups or teams
 - Strategy to get a fast clarification process
- Design/Develop/Maintain the System Architecture on System Level 3 according to the defined principles, the existing work and to the Operational concept into Logical architecture
- Design architectural roadmap and migration, ensuring “integrity per migration step”
 - Design architecture migration steps based on the requirement input of the migration team
 - Define architecture strategy for legacy adapters
- End2End integration of functional chains, assure architectural quality on Task level
 - Efficient quality assessment method and process
- Ensure and verify architecture consistency on functional and logical level
 - Trace validation method and criteria
- Manage the input to the standardization and TSI plan for Task activities and issue the input according to the “TSI and Standardization input plan”
 - Maturity management process for the release preparation
 - Design to time management process for the architectural domain work

5.2 Indicative Milestones

Architecture and Release Coordination Team	Define the strategy to be followed to design the and release the fully integrated system architecture	TBD
	Collect and evaluate all the existing work (research projects, state-of-the-art documents) as input to design the System architecture.	TBD
	Coordinate the work and inputs of the Tasks Architecture-linked Domain Teams and cross cutting teams	TBD
	Continuous Interaction with IP and SP Core group and SP domains to provide and receive inputs and mediate conflicts	TBD
	System Analysis (FRS), Functional Requirement Specification)	
	System Definition	

Actor description and roles	TBD Before Q4 2023
System capabilities	
Functional chains per use case	
Function details (with external relevance)	
Design/Develop/Maintain the System Architecture (SRS) according to the defined principles, the existing work and to the Operational concept into Logical architecture	TBD Before Q4 2023
Structure of contained systems of the next system level	
Logical Components Description	
Physical architecture	
Technical and physical hazards and risks	TBD
Design architectural roadmap and migration, ensuring “integrity per migration step”	TBD
End2End integration of functional chains, assure architectural quality on Task level	TBD
Ensure and verify architecture consistency on functional and logical level	TBD
Manage the input to the standardization and TSI plan for Task activities and issue the input according to the “TSI and Standardization input plan”	TBD
Coordination with the Cross Cutting Domain Teams of other Tasks to ensure overall consistency regarding architecture and release coordination	TBD
Organize plenary meetings with all Domain leadership teams to share status reports between all teams	TBD
Manage releases	TBD

6. Task 2 CCS: Domain Migration and roadmap

6.1 Deliverables

First 12 months

- Analyse national situations, product, and deployment constraints
 - What are the quantitative drivers for cost, duration, and constraints
 - What are the reasons for the specific strategies
 - What are the planned migration steps from architecture perspective
- Design standard architectural migration roadmaps, principles and derive system requirements
 - Create overview over migration roadmaps and big rollouts
 - Design main migration variants/steps (architecture + operations) --> define migration related requirements for the architecting process in Task 2
 - Identify interfaces for whom special migration features make sense
 - Design technical strategy and derive requirements for the upgradeability of current and future investments, including the evolveability of future systems
- Design operational process migration roadmap, principles, and process requirements (including initial intermediate scenarios)
 - What are the quantitative drivers for cost, duration, and constraints
 - Define principles, means, and requirements that shall be integrated into the SP engineering process to simplify operational migration (e.g. simplify deployment or training)
- Propose generic interface forward and backwards compatibility principles and requirements for migration and safe investments

- Enhanced version management
- Extensible interface architecture (simplify connection of “old with new”)
- Self-declaration of services
- Remote upgrades
- Simplification of upgrades

6.2 Indicative Milestones

Migration and Road Map Team	· Analyze national situations, product, and deployment constraints	TBD
	· Design standard architectural migration roadmaps, principles and derive system requirements	TBD
	· Design operational process migration roadmap, principles, and process requirements (including initial intermediate scenarios)	TBD
	· Propose interface forward and backwards compatibility for migration and safe investments	TBD
	· Continuous interaction with Architecture and Release Coordination Team	TBD
	· Defining migration concepts for existing vehicle design.	TBD

7. Task 2 CCS: Domain Trackside Assets Control and Supervision

7.1 Deliverables

First 12 months

- The Trackside Assets Interfaces standardisation
 - The target for 2023 is to fully release an agreed Trackside Assets interface specification for the System Pillar target architecture (based on EULYNX BL4 V2 roadmap) and to bring it to the standardisation process via ESO and /or TSI.
 - Agree on scope of Trackside Assets interfaces for the standardization process as input to the Standardization and TSI Input plan
 - Import relevant EULYNX documentation into SP engineering environment
 - Assess and propose the grade and channel of standardisation (TSI versus ESO)
 - Finalise and propose the scope of connected trackside assets
 - What type of trackside assets
 - Just the interface interlocking<>OC, or also the interface OC<>TA?
- Ensure alignment and close cooperation with Innovation Pillar Flagship Area 2
 - Integrate the specification into the demonstrator developments
- Evaluate ETCS-compliant interface and protocol solution (together with Traffics CS) for border signals, fallback signals, and overlaid signals
 - The approach to be evaluated is “showing ETCS DMI information also trackside” (very basic, no traditional signalling logic, with or without trackside ATP equipment).
 - Evaluate and assess use cases, operational requirements, and basic system design

7.2 Indicative Milestones

Trackside Asset control & supervision Domain	Trackside Internal Interfaces Standardization	TBD
	The Trackside Assets Data sharing Management/Maintenance	TBD
	Ensure alignment and close cooperation with Innovation Pillar Flagship Area 2	TBD
	Operational Analysis (=ORS, Operational Requirement Specification)	Q4 2022
	Interfaces between Traffic Control and Trackside Asset Control	Q4 2022
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Process hazards and risks	
	Rule Books	
	Operational Migration	
	Operational standardization specification	
	Layer with Trackside Assets and respective Object Controllers	
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Process hazards and risks	
	Rule Books	
	Operational Migration	
	Operational standardization specification	
Integrated possession management (Task 1/2)	Q4 2022	
Trackside Asset Internal Interfaces	TBD	
System Analysis (=FRS, Functional Requirement Specification)	Q4 2022	
Interfaces between Traffic Control and Trackside Asset Control	Q4 2022	
System Definition		
Actor description and roles		
System capabilities		
Functional chains per use case		
Function details (with external relevance)		
Functional hazards and risks		
System Requirements		

Functional standardization Specification	
Layer with Trackside Assets and respective Object Controllers	TBD Before Q4 2023
System Definition	
Actor description and roles	
System capabilities	
Functional chains per use case	
Function details (with external relevance)	
Functional hazards and risks	
System Requirements	
Functional standardization Specification	
Integrated possession management (Task 1/2)	
Trackside Asset Internal Interfaces	TBD
System Architecture (=SRS, System Requirement Specification or FFFIS for interfaces)	Q4 2022
Interfaces between Traffic Control and Trackside Asset Control	Q4 2022
Structure of contained systems of the next system level	
Logical Components Description	
Physical architecture	
Technical and physical hazards and risks	
Technical migration strategy	
Technical functional Requirements	
Non-functional requirements	
Interface specification (system/user/physical interfaces)	
Technical standardization specification	
Layer with Trackside Assets and respective Object Controllers	TBD Before Q4 2023
Structure of contained systems of the next system level	
Logical Components Description	
Physical architecture	
Technical and physical hazards and risks	
Technical migration strategy	
Technical functional Requirements	
Non-functional requirements	
Interface specification (system/user/physical interfaces)	
Technical standardization specification	
Integrated possession management (Task 1/2)	Q4 2022
Trackside Asset Internal Interfaces	
Application Specification	Q4 2022
configuration 1	Q4 2022
Application configurations	
Application conditions	
Application lifecycle and its requirements	
System user handbook	
Engineering and maintenance rules	
Engineering and maintenance handbook	
configuration 2	Q4 2022
Application configurations	
Application conditions	

	Application lifecycle and its requirements	
	System user handbook	
	Engineering and maintenance rules	
	Engineering and maintenance handbook	
	configuration 3	
	Application configurations	
	Application conditions	
	Application lifecycle and its requirements	Q4 2022
	System user handbook	
	Engineering and maintenance rules	
	Engineering and maintenance handbook	
	configuration n	
	Application configurations	
	Application conditions	
	Application lifecycle and its requirements	Q4 2022
	System user handbook	
	Engineering and maintenance rules	
	Engineering and maintenance handbook	
	Validation, Model proving, Test Specification (VMT)	Q4 2022
	Interfaces between Traffic Control and Trackside Asset Control	Q4 2022
	Integrated possession management (Task 1/2)	Q4 2022
	Layer with Trackside Assets and respective Object Controllers	
	Validation method, model proving, test cases	
	Result documentation of model proving	Q4 2022
	Specification of simulations/test environment	
	Result of simulation / test	
	Release, Standardization and Publication process documentation (RSP)	
	Layer with Trackside Assets and respective Object Controllers	
	Standardization process documentation	Q4 2022
	Quality assurance, approval and decision documentation	
	Change Management Process Documentation	

8. Task 2 CCS. Domain Traffic Control and Supervision

8.1 Indicative Milestones

Traffic control & supervision Domain	Prioritization analysis: Complete scope definition for release1 in Q1	Q1 2023
	Analysis if and how specific issues are considered, inter alia: APS vs HL3, Event recognition, Virtual coupling, C-DAS, Voice communication” and “future communication strategy, Enhanced backwards compatibility by “switching between major releases”	TBD
	Communication (Radio) Analysis of if and how: Voice communication” and “future communication strategy	TBD
	Ensure alignment and close cooperation with Innovation pillar FA2	TBD
	Yard/Depot/Terminals System Interfaces standardization Management/Maintenance (interface yard to CCS)	TBD
	Operational Analysis (=ORS, Operational Requirement Specification)	
	Traffic Control – internal interfaces (e.g. between ATP and ATP processes)	Q3 2023

As-Is Analysis	
Common business objectives	
Process Innovations	
Application definition and categories	
Operational Requirements	
Operational Entities	
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Operational hazards and risks	
Traffic Control legacy adapters	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application definition and categories	
Operational Requirements	
Operational Entities	Q4 2023
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Operational hazards and risks	
Concept for operational migration	
Interface between Traffic Management and Traffic Control	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application definition and categories	
Operational Requirements	
Operational Entities	Q4 2023
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Operational hazards and risks	
Concept for operational migration	
Interfaces between Traffic Control and Train Control. (e.g. way of using SS26/126 for level R; and additional channels e.g. for onboard digital maps).	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application definition and categories	
Operational Requirements	
Operational Entities	Q4 2023
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Operational hazards and risks	
Concept for operational migration	

	Cross-company/cross-installation/cross-border interfaces for Traffic Control	
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	Q4 2023
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Operational hazards and risks	
	Concept for operational migration	
	Interfaces between Traffic Control and Trackside Asset Control	
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	Q4 2023
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Operational hazards and risks	
	Concept for operational migration	
	Interfaces Traffic Control and Mobile CCS+ applications (e.g. for trackworker safety)	
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	Q4 2023
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Operational hazards and risks	
	Concept for operational migration	
	CCS<>Station interfaces for ATO Processes (Task 1/2)	
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	Q4 2023
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	

Operational hazards and risks	
Concept for operational migration	
Computing Platform: Standard (safe) computing environments (e.g. API and communication methods)	TBD
Communication (Radio): FRMCS incl. vehicle/trackside architecture	TBD
System Analysis (=FRS, Functional Requirement Specification)	
Traffic Control – internal interfaces (e.g. between ATP and ATP processes)	
System definition	Q2 2024
Detailed system actor descriptions and roles	
System capabilities	
Traffic Control legacy adapters	
System definition	Q1 2025
Interface between Traffic Management and Traffic Control	
System Definition	Q4 2023
Actor description and roles	
System capabilities	
Functional chains per use case	
Function details (with external relevance)	
Functional hazards and risks	
Interfaces between Traffic Control and Train Control. (e.g. way of using SS26/126 for level R; and additional channels e.g. for onboard digital maps).	
System Definition	Q4 2023
Actor description and roles	
System capabilities	
Functional chains per use case	
Function details (with external relevance)	
Functional hazards and risks	
Cross-company/cross-installation/cross-border interfaces for Traffic Control	
System Definition	Q4 2023
Actor description and roles	
System capabilities	
Functional chains per use case	
Function details (with external relevance)	
Functional hazards and risks	
Interfaces between Traffic Control and Trackside Asset Control	
System Definition	Q4 2022
Actor description and roles	
System capabilities	
Functional chains per use case	
Function details (with external relevance)	
Functional hazards and risks	
CCS<>Station interfaces for ATO Processes (Task 1/2)	
System Definition	Q2 2024
Communication (Radio): FRMCS incl. vehicle/trackside architecture	TBD
Computing Platform: Standard (safe) computing environments (e.g. API and communication methods)	TBD
System Architecture (=SRS, System Requirement Specification or FFFIS for interfaces)	

Traffic CS + Train CS	Traffic Control – internal interfaces (e.g. between ATP and ATP processes)	Q4 2025
	Traffic Control legacy adapters	Q4 2026
	Interface between Traffic Management and Traffic Control	Q4 2024
	Interfaces between Traffic Control and Train Control. (e.g. way of using SS26/126 for level R; and additional channels e.g. for onboard digital maps).	Q4 2024
	Cross-company/cross-installation/cross-border interfaces for Traffic Control	Q4 2024
	Interfaces between Traffic Control and Trackside Asset Control	Q4 2022
	Interfaces Traffic Control and Mobile CCS+ applications (e.g. for trackworker safety)	Q4 2026
	CCS<>Station interfaces for ATO Processes (Task 1/2)	Q4 2025
	Communication (Radio): FRMCS incl. vehicle/trackside architecture	TBD
	Release, Standardization and Publication process documentation (RSP)	TBD
	APS vs HL3:	TBD
	Describe the additional requirements of APS compared to HL3	TBD
	Describe the additional business case of APS compared to HL3	TBD
	Assess the difference for the migration paths (HL3, APS, APS via HL3)	TBD
Virtual coupling:	TBD	
Analyze S2R results for virtual coupling	TBD	
Compare the 3 solutions relative to ETCS Level 3 incl. business case and describe the recommendation	TBD	
Enhanced backwards compatibility by “switching between major releases”:	TBD	
Analyze the use and business cases for safe systems, using the “dynamic RBC” as an example.	TBD	
Analyze the consequences for the functional architecture (impacts/complexity) and design a recommendation for enhanced backwards compatibility	TBD	
C-DAS	TBD	
Identify the reasonable future needs, use cases and business cases for enhanced C-DAS	TBD	
Compare different architecture strategies for an economic solution	TBD	
Event recognition:	TBD	
Analyze needs, potential and business case for event recognition	TBD	
Design operational and functional concept	TBD	
Voice communication” and “future communication strategy:	TBD	
Define the future communication architecture strategy that simplifies the communication architecture, reduces the cost, and defines an optimized (perhaps strongly reduced) footprint for voice applications.	TBD	

9. Task 2 CCS. Domain Train Control and Supervision

9.1 Deliverables

First 3 months

- Prioritisation analysis
 - Complete the scope definition of the domain that will be included for the release 1 of the SP target architecture and the respective deliverables, standards, and regulations
 - Clarify the work split for OA with the function team OD-F (what are purely domain specific processes)

First 12 months

- Domain responsibilities for the agreed scope
 - Train CS System Functional Architecture and requirements Management/Maintenance
 - Train CS System Logical Architecture and requirements Management/Maintenance
 - Train CS System Physical Architecture and requirements Management/Maintenance
 - Train CS System Data sharing Management/Maintenance
 - Train CS System functional specification and requirements Management/Maintenance
- Ensure alignment and close cooperation with Innovation Pillar Flagship Area 2
 - Close collaboration with FP2 WP26

9.2 Indicative Milestones

Train control & supervision Domain	Prioritization analysis: Complete scope definition for release1 in Q1	Q4 2022	
	Trackside Assets Data sharing Management/Maintenance	TBD	
	Ensure alignment and close cooperation with Innovation Pillar Flagship Area 2	TBD	
	Analysis if and how specific issues are considered, inter alia: APS vs HL3, Event recognition, Virtual coupling, C-DAS, Voice communication” and “future communication strategy, Enhanced backwards compatibility by “switching between major releases”	TBD	
	Operational Analysis (=ORS, Operational Requirement Specification)		
	Vehicle CCS and TMS/CMS internal modularization and interfaces to the train		Q2 2023
	As-Is Analysis		
	Common business objectives		
	Process Innovations		
	Application definition and categories		
	Operational Requirements		
	Operational Entities		
	Operational Capabilities		
	PRAMSS Targets and Breakdown		
	Operational Processes		
	Process hazards and risks		
	Rule Books		
	Operational Migration		
	Operational standardization specification		
	Onboard legacy adapters		Q4 2023
	Interfaces between Traffic Control and Train Control. (e.g. way of using SS26/126 for level R; and additional channels e.g. for onboard digital maps).		Q2 2023
	As-Is Analysis		
	Common business objectives		
	Process Innovations		
	Application definition and categories		
	Operational Requirements		
	Operational Entities		
Operational Capabilities			
PRAMSS Targets and Breakdown			
Operational Processes			
Process hazards and risks			

	Rule Books	
	Operational Migration	
	Operational standardization specification	
	Diagnosis and monitoring; configuration and maintenance	Q2 2023
	External CCS interfaces	Q2 2023
	DAC vehicle architecture and interfaces to CCS+	
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	
	Operational Entities	Q2 2023
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Process hazards and risks	
	Rule Books	
	Operational Migration	
	Operational standardization specification	
	System Analysis (=FRS, Functional Requirement Specification)	
	Vehicle CCS and TMS/CMS internal modularization and interfaces to the train	
	System Definition	
	Actor description and roles	
	System capabilities	
	Functional chains per use case	Q3 2023
	Function details (with external relevance)	
	Functional hazards and risks	
	System Requirements	
	Functional standardization Specification	
	Onboard legacy adapters	Q1 2025
	Interfaces between Traffic Control and Train Control. (e.g. way of using SS26/126 for level R; and additional channels e.g. for onboard digital maps).	
	System Definition	
	Actor description and roles	
	System capabilities	
	Functional chains per use case	Q3 2023
	Function details (with external relevance)	
	Functional hazards and risks	
	System Requirements	
	Functional standardization Specification	
	Onboard legacy adapters	
	Diagnosis and monitoring; configuration and maintenance	Q3 2023
	External CCS interfaces	Q3 2023
	DAC vehicle architecture and interfaces to CCS+	
	System Definition	Q3 2023
	Actor description and roles	

	System capabilities	
	Functional chains per use case	
	Function details (with external relevance)	
	Functional hazards and risks	
	System Requirements	
	Functional standardization Specification	
	System Architecture (=SRS, System Requirement Specification or FFFIS for interfaces)	
	Vehicle CCS and TMS/CMS internal modularization and interfaces to the train	Q4 2024
	Onboard legacy adapters	Q4 2026
	Interfaces between Traffic Control and Train Control. (e.g. way of using SS26/126 for level R; and additional channels e.g. for onboard digital maps).	Q4 2024
	Diagnosis and monitoring; configuration and maintenance	Q4 2024
	External CCS interfaces	Q4 2024
	DAC vehicle architecture and interfaces to CCS+	Q4 2024
	Application Specification	
	configuration 1	TBD
	configuration 2	TBD
	configuration 3	TBD
	configuration n	TBD
	Validation, Model proving, Test Specification (VMT)	
	Vehicle CCS and TMS/CMS internal modularization and interfaces to the train	TBD
	Onboard legacy adapters	TBD
	Interfaces between Traffic Control and Train Control. (e.g. way of using SS26/126 for level R; and additional channels e.g. for onboard digital maps).	TBD
	Diagnosis and monitoring; configuration and maintenance	TBD
External CCS interfaces	TBD	
DAC vehicle architecture and interfaces to CCS+	TBD	
Release, Standardization and Publication process documentation (RSP)	TBD	
Traffic CS + Train CS	APS vs HL3:	
	Describe the additional requirements of APS compared to HL3	TBD
	Describe the additional business case of APS compared to HL3	TBD
	Assess the difference for the migration paths (HL3, APS, APS via HL3)	TBD
	Virtual coupling:	
	Analyze S2R results for virtual coupling	TBD
Compare the 3 solutions relative to ETCS Level 3 incl. business case and describe the recommendation	TBD	
Traffic CS + Train CS+T3	C-DAS	
	Identify the reasonable future needs, use cases and business cases for enhanced C-DAS	TBD
	Compare different architecture strategies for an economic solution	TBD
Traffic CS + Train CS+ communication fix radio+T3	Voice communication” and “future communication strategy:	TBD
	Define the future communication architecture strategy that simplifies the communication architecture, reduces the cost, and defines an optimized (perhaps strongly reduced) footprint for voice applications.	TBD

10. Task 2 CCS: Domain Transversal CCS

10.1 Deliverables

First 12 months

- Prioritisation analysis
 - Complete the scope definition of the domain that will be included for the release 1 of the SP target architecture and the respective deliverables, standards, and regulations
 - Define the architectural solution to include TMS in the transversal domain, including links to FP3.
- Domain responsibilities for the agreed scope
 - Engineering and asset data, functional network topologies (maps)
 - Define in cooperation with the other SP Domains and IP the standardized set of data
 - Define methods and tools to prepare and share the data between systems and stakeholders;
 - Provide Asset Condition data and technical intervention management to
 - Specify the minimal standard functionality, interfaces and protocols to collect asset condition data from CCS-external asset management systems and provide them as a service for the CCS systems.
 - Provide a system specification for an integrated technical diagnostic system on CCS level
 - Configuration Management
 - Define methods/protocol/data to be shared by the system components;
 - Define the configuration management set of functions to be provided as a basis for a standardized management process on network level for CCS systems (both trackside and onboard) and TMS systems
 - Remote upgrade interface, operational process, safety concept.
 - Security systems for systems and persons
 - Specify the standard functionality, interfaces and protocols for security systems like identity and access management, security monitoring, etc.
 - Requirements (Security, roles) definition to access the system;
 - Define methods and tools to interact with the whole Railways system;
 - Propose priorities and get validation regarding Security Management Systems, e.g.
 - Security Logging
 - Security Information and Event Management (SIEM)
 - Identity Management (PKI)
 - Identity and Access Management (IAM)
 - control and monitor access to CCS/TMS systems and data to manage security
 - Security Backup
 - Provide integrated user interface
 - Specify a workbench system that integrates different user interfaces services from different CCS systems

- Define a user interface framework to include all the components user interfaces;
- Define methods and tools to be integrated in the framework.
- Define rules, tools and guidelines concerning human and organisational factors
- Ensure alignment and close cooperation with Innovation Pillar Flagship Area 2

10.2 Indicative Milestones

Transversal CCS systems Domain	Provide integrated user interface	TBD
	○ Specify a workbench system that integrates different user interfaces services from different CCS systems	TBD
	○ Define a user interface framework to include all the components user interfaces;	TBD
	○ Define methods and tools to be integrated in the framework.	TBD
	○ Define rules, tools and guidelines concerning human and organizational factors	TBD
	Prioritization analysis	Q4 2022
	Operational Analysis (=ORS, Operational Requirement Specification)	TBD
	Engineering, asset and topology data	Q1 2023
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Process hazards and risks	
	Rule Books	
	Operational Migration	
	Operational standardization spcification	
	Asset condition and intervention management (Integrated diagnostics protocols, analytics, event channeling, and smart/integrated event pattern recognition)	Q3 2023
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	
Operational Entities		
Operational Capabilities		
PRAMSS Targets and Breakdown		
Operational Processes		
Process hazards and risks		
Integrated configuration management	Q3 2023	
As-Is Analysis		
Common business objectives		
Process Innovations		
Operational Requirements		

Operational Entities	
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Process hazards and risks	
Standardization of integrated workbenches / UI	Q2 2023 (TBD)
Security Management System	Q2 2023 (TBD)
System Analysis (=FRS, Functional Requirement Specification)	
Engineering, asset and topology data	
System Definition	Q1 2023
Actor description and roles	
System capabilities	
Functional chains per use case	
Function details (with external relevance)	
Functional hazards and risks	
System Requirements	
Functional standardization Specification	
Asset condition and intervention management (Integrated diagnostics protocols, analytics, event channeling, and smart/integrated event pattern recognition)	
System Definition	Q3 2023
Actor description and roles	
System capabilities	
Integrated configuration management	
System Definition	Q3 2023
Actor description and roles	
System capabilities	
Standardization of integrated workbenches / UI	Q2 2023 (TBD)
Security Management System	Q2 2023 (TBD)
System Architecture (=SRS, System Requirement Specification or FFFIS for interfaces)	
Engineering, asset and topology data	
Structure of contained systems of the next system level	Q4 2023
Logical Components Description	
Physical architecture	
Technical and physical hazards and risks	
Technical migration strategy	
Technical functional Requirements	
Non-functional requirements	
Interface specification (system/user/physical interfaces)	
Technical standardization specification	
Asset condition and intervention management (Integrated diagnostics protocols, analytics, event channeling, and smart/integrated event pattern recognition)	Q4 2025
Integrated configuration management	Q4 2025
Standardization of integrated workbenches / UI	Q4 2024 (TBD)

	Security Management System	Q4 2024 (TBD)
	Application Specification	TBD
	configuration 1	TBD
	configuration 2	TBD
	configuration 3	TBD
	configuration n	TBD
	Validation, Model proving, Test Specification (VMT)	TBD
	Engineering, asset and topology data	TBD
	Asset condition and intervention management (Integrated diagnostics protocols, analytics, event channeling, and smart/integrated event pattern recognition)	TBD
	Integrated configuration management	TBD
	Standardization of integrated workbenches / UI	TBD
	Security Management System	TBD
	Release, Standardization and Publication process documentation (RSP)	TBD

11. Task 2 CCS. Domain Communications

11.1 Deliverables

First 12 months

- Coordinate FRMCS related aspects
 - Standardisation for FRMCS (according to agreed TSI roadmap)
 - Import and uplink existing specification, especially requirements, services and applications (e.g. voice applications)
- Concept for a flexible IP network based on fixnet and multiple radio carriers
 - Identify together with all other SP domains, as well as relevant Innovation Pillar FAs, all the Railways system interfaces and needed services
 - Derive the generic communication topology
 - Define/propose communication solutions (Media, protocols,..)
 - Ensure alignment and close cooperation with Innovation Pillar Flagship Area 2

11.2 Indicative Milestones

Communication (Fix/Radio) Domain	Identify together with all other SP domains, as well as relevant Innovation Pillar FAs, all the Railways system interfaces and needed services, and derive the generic communication topology and strategy for fix net and radio	TBD
	Analysis of if and how "Voice Communication" and "future communication strategy"	Q4 2022
	Coordinate FRMCS related aspects	TBD
	Ensure alignment and close cooperation with Innovation Pillar Flagship Area 2	TBD
	Operational Analysis (=ORS, Operational Requirement Specification)	
	FRMCS incl. vehicle/trackside architecture	Q4 2022
	As-Is Analysis	
	Common business objectives	
Process Innovations		

	Application definition and categories	
	Operational Requirements	
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Process hazards and risks	
	Rule Books	
	Operational Migration	
	Operational standardization specification	
	Fix communications	TBD
	System Analysis (=FRS, Functional Requirement Specification)	
	FRMCS incl. vehicle/trackside architecture	Q2 2023
	System Definition	
	Actor description and roles	
	System capabilities	
	Functional chains per use case	
	Function details (with external relevance)	
	Functional hazards and risks	
	System Requirements	
	Functional standardization Specification	
	Fix communications	TBD
	System Architecture (=SRS, System Requirement Specification or FFFIS for interfaces)	
	FRMCS incl. vehicle/trackside architecture	Q4 2023
	Structure of contained systems of the next system level	
	Logical Components Description	
	Physical architecture	
	Technical and physical hazards and risks	
	Technical migration strategy	
	Technical functional Requirements	
Non-functional requirements		
Interface specification (system/user/physical interfaces)		
Technical standardization specification		
Fix communications	TBD	
Application Specification		
configuration 1	TBD	
configuration 2	TBD	
configuration 3	TBD	
configuration n	TBD	
Validation, Model proving, Test Specification (VMT)		
FRMCS incl. vehicle/trackside architecture	TBD	
Fix communications	TBD	
Release, Standardization and Publication process documentation (RSP)		
Traffic CS + Train CS+ communication fix radio+T3	Voice communication” and “future communication strategy:	TBD
	Define the future communication architecture strategy that simplifies the communication architecture, reduces the cost, and defines an optimized (perhaps strongly reduced) footprint for voice applications.	TBD

12. Task 2 CCS. Domain Computing Environment

12.1 Deliverables

First 12 months

- Input Business Analysis
Economically viable use cases for SW/HW independency or measure for reduced integration effort) to support the decision if and how to setup a standardization Domain Team and propose standardization scope of the Computing Environment

12.2 Indicative Milestones

The table below reflects the milestones as per the Request for Services for deliverables for the first 12 months.

Note: for full scope on the long-term expected delivery dates, see Roadmap.

Computing Environment Domain	Input Business Analysis (economically viable use cases for SW/HW independency or measure for reduced integration effort) to support the decision if and how to setup a standardization Domain Team and propose standardization scope of the Computing Environment	Q3 2023
	Operational Analysis (=ORS, Operational Requirement Specification)	tbc
	Standard (safe) computing environments (e.g.) API and communications	
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
	Application definition and categories	
	Operational Requirements	
	Operational Entities	
	Operational Capabilities	
	PRAMSS Targets and Breakdown	
	Operational Processes	
	Process hazards and risks	
	System Analysis (=FRS, Functional Requirement Specification)	tbc
	Standard (safe) computing environments (e.g.) API and communications	
	System Definition	
	Actor description and roles	
System capabilities		

13. Task 3 Traffic Management/Capacity Management

13.1 Deliverables

First 3 months

- Prioritisation analysis
 - Complete the scope definition of the domain that will be included for the release 1 of the SP target architecture and the respective deliverables, standards, and regulations

First 12 months

First steps included clarification of the terms and functions, then the catalogue of the possible interfaces and the scope in detail for the minimum viable product including the considerations. In addition, included in the RfS there are the following specific analysis considerations:

- Multi-tier architecture, back-end/front-end architecture
 - Answer the question on the functions within the scope and how they will work at EU level. Is it necessary a European coordination activity or not?
- Analyse external TMS interfaces for data exchange with foreign actors and applications that help in the management of deviations
 - Interface prioritisation activity to answer the data exchange
- List and describe the planning partners and the interactions
 - Planning partners and interactions related to interfaces
 - operational design to include the needs and responsibilities for each of the planning partners
- Detailed information structure of the “operational plan”
 - Detailed structure of operational plan (interfaces TMS-traffic CS) including the first list of operational commands and their description to be sent to traffic CS

13.2 Indicative Milestones

TMS Domain	Ensure alignment and close cooperation with Innovation Pillar Flagship Area 1	TBD
	Prioritisation analysis	Q1 2023
	Analysis if and how specific issues are considered, inter alia:	Q1 2023
	Event recognition	
	C-DAS	
	Voice communication” and “future communication strategy	
	Multi-tier architecture, back-end/front-end architecture	
	Analyse external TMS interfaces for data exchange with foreign actors and applications that help in the management of deviations	
	List and describe the planning partners and the interactions	
	Detailed information structure of the “operational plan”	
	Specific analysis	
	Multi-tier architecture, back-end/front-end architecture	
	Analyse external TMS interfaces for data exchange with foreign actors and applications that help in the management of deviations	
	List and describe the planning partners and the interactions	
	Detailed information structure of the “operational plan”	Q3 2023
	Cross cutting activities	Q3 2023
	Operational concept (harmonized)	
	As-Is Analysis	
	Common business objectives	
	Process Innovations	
Application desinition and categories		
Operational Requirements		
Operational Entities		
Operational Capabilities		

PRAMSS Targets and Breakdown	
Operational Processes	
Prozess hazards and risks	
Rule Books	
Operational Migration	
Operational standardisation spcification	
Operational processes (harmonized)	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application desinition and categories	
Operational Requirements	Q4 2024
Operational Entities	
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Operational rulebooks	Q4 2026
Architecture	
o Define the strategy to be followed to design the and release the fully integrated system architecture	
o Collect and evaluate all the existing work (research projects, state-of-the-art documents) as input to design the System architecture.	
o Coordinate the work and inputs of the Tasks Architecture-linked Domain Teams and cross cutting teams	
o Continuous Interaction with IP and SP Core group and SP domains to provide and receive inputs and mediate conflicts	
o Design/Develop/Maintain the System Architecture according to the defined principles, the existing work and to the Operational concept into Functional & Logical architecture	Q3 2023
o End2End integration of functional chains, assure architectural quality on Task level	
o Ensure and verify architecture consistency on functional and logical level	
o Manage the input to the standardization and TSI plan for Task activities and issue the input according to the "TSI and Standardization input plan"	
o Coordination with other Tasks to ensure overall consistency regarding architecture and release coordination	
Migration path	TBD
o Analyse national situations, product and deployment constraints	TBD
o Design standard architectural migration roadmaps, principles and derive system requirements	TBD
o Design operational process migration roadmap, principles and process requirements (including initial intermediate scenarios)	TBD
o Decide interface forward and backwards compatibility for migration and safe investments	TBD
o Continuous interaction with Architecture and Release Coordination Team	TBD
Operational Analysis (=ORS, Operational Requirement Specification)	
Multimodal traffic management (Planning, deviation management, production information management)	Q3 2023
As-Is Analysis	

Common business objectives	
Process Innovations	
Application desinition and categories	
Operational Requirements	
Operational Entities	
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Prozess hazards and risks	
Rule Books	
Operational Migration	
Operational standardisation spcification	
Traffic Management – internal interfaces (for example between Planning, Deviation Management, and Incidence Management)	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application desinition and categories	Q3 2023
Operational Requirements	
Operational Entities	
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Prozess hazards and risks	
TM common service APIs (e.g. to company systems or customer requirement)	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application desinition and categories	
Operational Requirements	
Operational Entities	Q2 2023
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Prozess hazards and risks	
Rule Books	
Operational Migration	
Operational standardisation spcification	
Cross-company/cross-installation/cross-border interfaces for Traffic Control	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application desinition and categories	Q3 2023
Operational Requirements	
Operational Entities	
Operational Capabilities	

PRAMSS Targets and Breakdown	
Operational Processes	
Prozess hazards and risks	
Rule Books	
Operational Migration	
Operational standardisation spcification	
Traffic Management legacy adapters	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application desinition and categories	
Operational Requirements	
Operational Entities	
Operational Capabilities	Q3 2023
PRAMSS Targets and Breakdown	
Operational Processes	
Prozess hazards and risks	
Rule Books	
Operational Migration	
Operational standardisation spcification	
Interface between Traffic Management and Traffic Control	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application desinition and categories	
Operational Requirements	
Operational Entities	
Operational Capabilities	Q2 2023
PRAMSS Targets and Breakdown	
Operational Processes	
Prozess hazards and risks	
Rule Books	
Operational Migration	
Operational standardisation spcification	
Synchronized catenary control CCS/EN (Task 1/2)	TBD
Synchronized energy planning CCS/EN (Task 1/2)	TBD
Coordinated capacity planning with TM (Task 1/2) [yards and terminals]	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application desinition and categories	
Operational Requirements	
Operational Entities	
Operational Capabilities	Q3 2023
PRAMSS Targets and Breakdown	
Operational Processes	

Prozess hazards and risks	
Coordinated traffic control with TM (Task 1/2) [yards and terminals]	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application desinition and categories	
Operational Requirements	
Operational Entities	Q3 2023
Operational Capabilities	
PRAMSS Targets and Breakdown	
Operational Processes	
Prozess hazards and risks	
System Analysis (=FRS, Funcional Requirement Specification)	
Multimodal traffic management (Planning, deviation management, production information management)	Q1 2025
Traffic Management – internal interfaces (for example between Planning, Deviation Management, and Incidence Management)	
System Definition	Q2 2024
Actor description and roles	
System capabilities	
TM common service APIs (e.g. to company systems or customer requirement)	
System Definition	
Actor description and roles	
System capabilities	
Functional chains per use case	Q3 2023
Function details (with external relevance)	
Functional hazards and risks	
System Requirements	
Functional standardisation Specification	
Cross-company / cross-border planning synchronisation and managed planning partner networks for railway production	Q1 2025
Traffic Management legacy adapters	Q1 2025
Interface between Traffic Management and Traffic Control	
System Definition	
Actor description and roles	
System capabilities	
Functional chains per use case	Q3 2023
Function details (with external relevance)	
Functional hazards and risks	
System Requirements	
Functional standardisation Specification	
Synchronized catenary control CCS/EN (Task 1/2)	TBD
Synchronized energy planning CCS/EN (Task 1/2)	TBD
Coordinated capacity planning with TM (Task 1/2) [yards and terminals]	
System Definition	
Actor description and roles	Q2 2024
System capabilities	

Coordinated traffic control with TM (Task 1/2) [yards and terminals]	
System Definition	Q2 2024
Actor description and roles	
System capabilities	
System Architecture (=SRS, System Requirement Specification or FFFIS for interfaces)	
Multimodal traffic management (Planning, deviation management, production information management)	Q4 2026
Traffic Management – internal interfaces (for example between Planning, Deviation Management, and Incidence Management)	Q4 2025
TM common service APIs (e.g. to company systems or customer requirement)	Q4 2024
Cross-company / cross-border planning synchronisation and managed planning partner networks for railway production	Q4 2026
Traffic Management legacy adapters	Q4 2026
Interface between Traffic Management and Traffic Control	Q4 2024
Synchronized catenary control CCS/EN (Task 1/2)	TBD
Synchronized energy planning CCS/EN (Task 1/2)	TBD
Coordinated capacity planning with TM (Task 1/2) [yards and terminals]	Q4 2025
Coordinated traffic control with TM (Task 1/2) [yards and terminals]	Q4 2025
Application Specification	TBD
configuration 1	TBD
configuration 2	TBD
configuration 3	TBD
configuration n	TBD
Validation, Modelproving, Test Specification (VMT)	TBD
Multimodal traffic management (Planning, deviation management, production information management)	TBD
Traffic Management – internal interfaces (for example between Planning, Deviation Management, and Incidence Management)	TBD
TM common service APIs (e.g. to company systems or customer requirement)	TBD
Cross-company / cross-border planning synchronisation and managed planning partner networks for railway production	TBD
Traffic Management legacy adapters	TBD
Interface between Traffic Management and Traffic Control	TBD
Synchronized catenary control CCS/EN (Task 1/2)	TBD
Synchronized energy planning CCS/EN (Task 1/2)	TBD
Coordinated capacity planning with TM (Task 1/2) [yards and terminals]	TBD
Coordinated traffic control with TM (Task 1/2) [yards and terminals]	TBD
Release, Standardisation and Publication process documentation (RSP)	TBD

14. Task 4 DAC/FDFTO

14.1 Deliverables

First 3 months

Operations/Architecture: Hand-over of trains from ETCS-controlled mainline to local yard authority (alignment Task 4 with Task 2 and 3)

First 12 months

- Ensuring close alignment and cooperation with Innovation Pillar Flagship Area 5 (FA5) and EDDP@EU-RAIL
 - Including participation in mediation of conflicts with other Innovation Pillar Flagship Areas
 - Continuous collaboration and synchronisation expected
- Managing cross-cutting activities for Task 4
 - Based on EDDP input where available and aligned with EDDP (in the sense of sector alignment) and FA5 (operational and technical solutions)
 - As-is analysis focusing on existing IT systems for freight operation, wagon handling and wagon keeping in use at the main operators (contributions by ROC members necessary). Special focus on relationship to FDFTO in alignment with Task 1.
 - Review input from EDDP (European DAC Delivery Program) and FA5 on operational concept, ensuring consistency and including the results in the overall operational concept, including for CCS-related processes in collaboration with Task 2, with a focus on harmonisation of operational procedures controlled by ERTMS (mainly CCS and TMS). Detailed operational procedures in shunting yards are to be developed within FA5.

As soon as input from FP5 (based on pre-work of EDDP) is available, sector alignment will be managed by SP Task 4 firstly through the EDDP sounding board as a sector mirror group and finally approved through the SP governance to make sure that adaptations of local rules will be implemented in time to ensure smooth roll out of DAC/FDFTO
 - Until end of 2022, the overall architecture related to FDFTO in collaboration with Task 1 (and Task 2 and 3) should be defined and interfaces to the train internal architecture, developed by FP5, should be identified, and agreed.
 - Alignment Task 4 with Task 02 and 3 to be clarified with special focus on shunting on supervised tracks (basic operational and architectural design)
 - Ensure consistency and take responsibility for overall architecture coherence of any architecture output from FA5 and EDDP and embed it into the overall Rail System Architecture

Until end of period, overall architecture coherence of any architecture output from FP5 and EDDP need to be ensured and be embed into the overall Rail System Architecture.
 - In addition, provide a proposal for a central instance for managing data access and processes for SW updates (bug fixing and system upgrades) a.s.a.p., but at least until end of first period.
 - Propose a DAC/FDFTO architecture migration roadmap, in collaboration with FA5 and EDDP
 - Closely follow activities of EDDP on migration and deployment, but probably no high priority during the first period
- Managing the input to the Standardization and TSI Input Plan for Task 4 activities
 - Based on (but not exclusively) detailed standardisation requests from FA5
 - Continuous collaboration and synchronisation expected

- Including any standardization need identified in the collaboration between FP3 and FP5 (Diagnostics & Maintenance Interface to Asset Management System)
- Consideration of the Chapter 7 TSI texts
- Supporting FA5 and EDDP regarding authorisation strategy
 - Closely follow activities of FP5 and EDDP and support if requested, but probably no high priority during the first period
- Checking CBA provided by EDDP and FA5 for consistency with CBOs
 - Closely follow activities of FP5 and EDDP, but probably no high priority during the first period

14.2 Indicative Milestones

DAC Domain	Managing the input to the Standardization and TSI Input Plan for Task 4 activities based on (but not exclusively) detailed standardization requests from FA5	Continuous	
	Supporting FA5 and EDDP regarding authorization strategy	On request	
	Checking CBA provided by EDDP and FA5 for consistency with CBOs	TBD	
	cross cutting activities		
	Conduct an as-is analysis of the railway system, considering operational, functional, logical & physical assets, and identifying the pain points related to DAC/FDFTO	if deemed necessary, agree on date with Task 1	
	Assign prioritized pain points to existing domain teams or propose new domain teams		
	Review input from EDDP (European DAC Delivery Program) and FA5 on operational concept, ensuring consistency and including the results in the overall operational concept, including for CCS-related processes in collaboration with Task 2, with a focus on harmonization of operational procedures controlled by ERTMS (mainly CCS and TMS). Detailed operational procedures in shunting yards are to be developed within FA5.	Q3 2023	
	Operational concept (harmonized)	TBD	
	Operational processes (harmonized)	Before Q4 2023	
	Operational rulebooks		
	Provide the overall architecture to Level [3/4], and associated requirements, within which detailed specifications and architecture (to Level 5) are to be developed by FA5	See description Above	
	Ensure consistency and take responsibility for overall architecture coherence of any architecture output from FA5 and EDDP and embed it into the overall Rail System Architecture		
	Propose a DAC/FDFTO architecture migration roadmap, in collaboration with FA5 and EDDP	TBD Before Q4 2023	
	Operational Analysis (=ORS, Operational Requirement Specification)		
	DAC Operational Conception (Harmonized)	TBD Before Q4 2023	
	As-Is Analysis		
	Common business objectives		
	Process Innovations		
	Application definition and categories		
Operational Requirements			
Operational Entities			
Operational Capabilities			
PRAMSS Targets and Breakdown			

Operational Processes	
Proses hazards and risks	
Rule Books	
Operational Migration	
Operational standardization specification	
DAC Operational Processes (harmonized)	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application definition and categories	TBD
Operational Requirements	Before Q4
Operational Entities	2023
Operational Capabilities	
PRAMSS Targets and Breakdown	
DAC interfaces to CCS/TMS/CMC	
As-Is Analysis	
Common business objectives	
Process Innovations	
Application definition and categories	
Operational Requirements	
Operational Entities	First draft
Operational Capabilities	12/2022
PRAMSS Targets and Breakdown	Before Q4
Operational Processes	2023
Proses hazards and risks	
Rule Books	
Operational Migration	
Operational standardization specification	
System Analysis (=FRS, Funtional Requirement Specification)	
DAC architecture and interfaces to CCS/TMS/CMC	First draft
	12/2022
	Before Q4
	2023
System Definition	
Actor description and roles	
System capabilities	
Functional chains per use case	First draft
Function details (with external relevance)	12/2022
Functional hazards and risks	Before Q4
System Requirements	2023
Functional standardization Specification	
System Architecture (=SRS, System Requirement Specification or FFFIS for interfaces)	
DAC architecture and interfaces to CCS/TMS/CMC	TBD
	Before Q4
	2023

	Structure of contained systems of the next system level	
	Logical Components Description	
	Physical architecture	
	Technical and physical hazards and risks	
	Technical migration strategy	TBD Before Q4 2023
	Technical functional Requirements	
	Non-functional requirements	
	Interface specification (system/user/physical interfaces)	
	Technical standardization specification	
	Application Specification	TBD
	configuration 1	TBD
	configuration 2	TBD
configuration 3	TBD	
configuration n	TBD	
Validation, Model proving, Test Specification (VMT)	TBD	
DAC vehicle architecture and interfaces to CCS/TMS/CMC	TBD	
Release, Standardization and Publication process documentation (RSP)	TBD	

Annex VII – Call for proposals 2023

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 Plan³¹ and Multi-Annual Work Programme³².

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

³¹ Master Plan available at <https://shift2rail.org/about-europes-rail/europes-rail-reference-documents/europes-rail-key-documents/>

³² MAWP available at <https://shift2rail.org/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 2016/797³³ 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 2023 Call for Proposals is structured around one topic under Destination1, that will generate a first joint project managed together with SESAR 3 JU and its programme³⁴, as well as 6 topics under Destination8.

- **Destination 1 – Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers.** The objective is to achieve the Single European Rail Area by researching, developing and delivering a flexible, efficient, resilient and high-capacity European rail network. It also about the implementation of a railway Digital enabler and Digital twin environment, where all digital elements of the system can play together in a coherent and interoperable way.
- **Destination 8 – Exploratory Research and other activities.** EU-Rail promote forward looking activities, tackling disruptive technologies and thinking, performing exploratory research to accelerate the pace towards radical system innovations in the guided transport modes and supporting the evolution of the Innovation Programme in scope and targets.

Conditions for the Call

Call: HORIZON-ER-JU-2023	2023/2024 Budget (EUR million)	Deadline
Overall indicative budget	21.2	7 February 2024

³³ 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.

³⁴ <https://www.sesarju.eu/>

DESTINATION 1 – Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers – topic:

Topics	Type of Action	Budgets (EUR million)		Expected EU contribution per project (EUR million) ³⁵	Number of projects expected to be funded
		2023	2024		
Opening: 4 October 2023 Deadline(s): 7 February 2024					
HORIZON-ER-JU-2023-FA1-SESAR: EU-RAIL – SESAR SYNERGY: INTEGRATED AIR AND RAIL NETWORK BACKBONE FOR A SUSTAINABLE AND ENERGY-EFFICIENT MULTIMODAL TRANSPORT SYSTEM	IA	3.0	2.0	5.0	1

DESTINATION 8 – Exploratory Research and other activities – topics:

Topics	Type of Action	Budgets (EUR million)		Expected EU contribution per project (EUR million) ³⁶	Number of projects expected to be funded
		2023	2024		
Opening: 4 October 2023 Deadline(s): 7 February 2024					
HORIZON-ER-JU-2023-EXPLR-01: NOISE AND VIBRATIONS	RIA	4.1	0	4.1	1
HORIZON-ER-JU-2023-EXPLR-02: FUTURE METRO SYSTEMS	RIA	3.1	0	3.1	1
HORIZON-ER-JU-2023-EXPLR-03: BIODIVERSITY	CSA	2.8	0	2.8	1
HORIZON-ER-JU-2023-EXPLR-04: DISRUPTIVE ASSETS MANAGEMENT SOLUTIONS, INCLUDING URBAN USE CASES	RIA	2.7	0	2.7	1
HORIZON-ER-JU-2023-EXPLR-05: EXTENDING THE RAIL NETWORK OF PHDS	RIA	2.0	0	2.0	1

³⁵ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

³⁶ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

HORIZON-ER-JU-2023-EXPLR-06: DAC FLEET RETROFITTING AND RETROFIT CAPACITY PLAN	CSA	1.5	0	1.5	1
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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. The following exception applies: <ul style="list-style-type: none"> the evaluation committee may be composed partially of representatives of EU institutions and agencies (internal experts).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in part G of the General Annexes to the Horizon Europe Work Programme 2023–2024.

DESTINATION 1 – Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers

HORIZON-ER-JU-2023-FA1-SESAR: EU-RAIL – SESAR SYNERGY: INTEGRATED AIR AND RAIL NETWORK BACKBONE FOR A SUSTAINABLE AND ENERGY-EFFICIENT MULTIMODAL TRANSPORT SYSTEM

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 5 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 5 million.</p> <p>Applicant Private³⁷ 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 1.263³⁸ times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall 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> <p>SESAR 3 JU members will report their IKOP and IKAA as per standard guidance, with no impact on the evaluation procedure.</p>
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration.
Technology Readiness Level	Activities are expected to be at TRL 6, higher TRL are possible – see General Annex B for a guide to the TRL definitions and criteria to be used.
Type of Action	Innovation Action
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 70 pages.

³⁷ As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

³⁸ In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

Special skills and/or capabilities expected from the Applicant(s)	<p>Applicants shall 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 expertise on rail Traffic Management Systems, Air Traffic Management systems and its architectures, rail and airport planning and operations, Artificial Intelligence for operation and planning, data exchange and Cybersecurity and other relevant related aspects and concepts.</p>
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	<p>The action resulting from this topic is contributing the Flagship Area 1 and it is a contributor to the achievement of the objectives identified in the Master Plan³⁹ as further detailed in the Multi-Annual Work Programme⁴⁰.</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 Pillars⁴¹ activities, as well as in view of the development and implementation of EU policy and legislation (including Technical Specifications for Interoperability and Common Safety Methods) and the development of European standards. As specified in section 2.3.8.1 of the WP 2023-2024, 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.</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>
Linked Projects	<p>As specified in section 2.3.8.1 of the WP 2023-2024, 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"> • FP1-MOTIONAL (GA 101101973)

³⁹ Master Plan available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

⁴⁰ MAWP available at https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf

⁴¹ Refer to the https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf

	<ul style="list-style-type: none"> • FP6 – FutuRe (GA 101101962) <p>The action that is expected to be funded under this topic will be complementary to the following actions expected to be funded under the topic:</p> <ul style="list-style-type: none"> • HORIZON-SESAR-2022-DES-ER-01-WA1-5 • HORIZON-SESAR-2022-DES-ER-01-WA2-6 • HORIZON-SESAR-2022-DES-IR-01-WA5-3 <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>
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/20212027/horizon/guidance/ls-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.
Additional dissemination obligations	In addition, as specified in section 2.3.8.1 of the WP 2023-2024, and to facilitate contributions to considering the key contributing role of this topic, in designing the dissemination and communication activities, the proposal shall consider that the “Flagship Project” will be part of the overall EU-Rail Programme and the planning of key events – demonstrations, participations to fair, etc. – will be coordinated at Programme level and by the “Stakeholder Relations and Dissemination” structure of the JU.

Expected Outcome:

Project results are expected to contribute to the following outcomes:

- **Operational efficiency:** improved predictability and punctuality for journeys involving both air and railway modes of transport, thanks to a better overall planning and monitoring of operations;

- **Capacity:** a better integration of air and railway modes of transport will enable a better use of existing and future capacity e.g. by monitoring multimodal passenger flows information (e.g., status, demand, delays, etc.), share it to relevant stakeholders in air and railway modes e.g., transport service operators (TSPs) to take mitigation actions to help reducing potential delays;
- **Resilience:** improved resilience in case of disruption in either railway or air transport modes, or both will contribute to improve the passenger experience;
- **Environment:** optimised operations in rail and air transport due to improved intermodal planning, contributing to the optimisation of fuel-burn and therefore reductions of CO₂ emissions per journey. Additional environmental benefits (i.e. emissions, noise and/or local air quality) will come from alleviating congestion at and around airports / railway stations by improving passenger flows (through multimodal decision making, etc.), from helping access/egress to/from airports / railway stations via environmentally-friendly means, etc.;
- **Passenger experience:** optimised and seamless passenger experience by reducing the inefficiencies and friction points and overall travel time and transfer time between air-rail modes;
- **Cost-efficiency:** the data-sharing-powered applications between air and railway modes of transport will enable increased predictability of traffic flows coupled with increased intermodal network flexibility and resilience. This would in turn help reduce congestion and costs.

Scope

Aviation and railway are integral parts of the intermodal transport ecosystem expected to optimise door-to-door (D2D) mobility for people, and ultimately to meet citizens' expectations for increasingly seamless mobility, where they can rely on the predictability of every planned door-to-door journey and can choose how to optimise it (shortest travel time, least cost, minimal environmental impact, etc.).

To successfully address the expected outcomes, and improve the attractiveness of combined air-rail travel for passengers, in a door-to-door context, the following research elements shall be delivered:

- **Benchmark on existing solutions** of integrated rail and air traffic;
- **Integration of aviation and railway transport modes.** Development of tools, digital platforms and services for a better integration of aviation and railway transport modes, as part of an intermodal transport ecosystem expected to optimise multimodal mobility. This shall include:
 - Definition of single, common and collaboratively-agreed intermodal (airport / railway) operations plan. The objective is to deliver a shared airport/railway operations plan including agreed performance indicators and objectives e.g. punctuality, and building on information from different players and stakeholders from the two modes of transportation. The connection to the Network Operations Plan (NOP) is expected to be done via the (Airport Operations Plan) AOP (airport part of the intermodality plan). The intermodal operation may include optimised timetables, luggage handling and passenger information, etc.;
 - Definition of the interface between the air traffic management systems (ATMS) (in particular regarding airport-rail connection) and the rail traffic management systems (TMS), both for planning purposes and operations, including disruptions;
 - Real-time information exchange services between aviation and railway giving stakeholders (including mobility providers) an increased knowledge of the multimodal journey and mobility providers the means to adapt and optimise traffic offers in the short term. This includes the elaboration of rationalised data-driven ATM/railway dashboards enabling stakeholders to have an up to date picture of the actual situation

in both transport modes. These dashboards could be fed with key performance aviation and train indicators covering inter-modal management processes. These dashboards could also include predictive functionalities enabling stakeholders to proactively identify demand and capacity imbalances (location, duration, criticality, etc.), deviations compared to the shared plan, etc. This will enhance the reliability of multimodal journey planning, identifying as soon as possible potential access issues that could affect the punctuality of operations, and trigger the need for potential coordinated actions for alleviating congestion, mitigating regulatory constraints, optimising process, passengers journey management, etc.

- ATM-airport-railway collaborative decision making process. This enables collaborative decision-making involving both air transport and railway transport stakeholders with the aim of facilitating a more efficient strategic and tactical planning and management of intermodal operations, passenger flows and enhancing passenger experience between the two modes of transportation. This research element covers:
 - The evolution of ATM related concepts developed within ATM boundaries e.g. airport operations plan (AOP), airport operations centre (APOC), airport collaborative decision making (A-CDM), total airport management (TAM), network operations plan (NOP), etc.;
 - The integration of data from aviation and railway transport information systems;
 - The development of an integrated capacity management process to ensure modal shift from feeder flights to railway;
 - The development of visualisation and decision support tools to allow the involved stakeholders to perform “what-if”, “what-else” analyses and assess the impact of different decisions / scenarios in order to determine the optimal course of action (this could make use of artificial intelligence and machine learning techniques).

Research may also address:

- Post-operations analysis capabilities to allow both air and railway transport stakeholders to better plan operations and resources in the future aiming at a continuous improvement of intermodal operations;
- Use of AI/ML to support the optimisation of the ATM-rail multimodal interface developing smart digital solutions to streamline the management of multimodal air-rail transport flows (e.g. AI/ML-powered demand-driven predictions of flights, trains, passengers and departure/arrival queues/sequences for improving operations efficiency and for service offer across air-rail modes accommodating as much door-to-door journeys as possible, etc.);
- Business intelligence and machine learning to help intermodal stakeholders collaboration to align process and resource capacity with predicted demand to reduce queues.

(R&I need: An integrated transport network performance cockpit (from ATM SRIA))

- **An integrated aviation-railway transport network disruption and crisis management process.** Enable the coordination – when managing disruption and crisis – between air and railway transport modes and a multitude of actors, including local and national authorities’ representatives. Research shall address the definition of the required data exchange for a situation of disruptions and crisis. The research should also lead to proposals for mitigation measures based on the timely acquisition and sharing of information, as well as it should consider a broad set of threats affecting, directly or indirectly, the intermodal system e.g. terrorism, volcanic ash dispersions, hazardous

chemicals events, spread of diseases/pandemic, earthquakes, flooding, major failure of a pan-European function, (massive) cyberattack, etc. The proposal may include simulation scenarios to validate applicable use cases e.g. airport closure, rail strike, etc. *(R&I needs: an integrated transport network crisis management process (from ATM SRIA) and incident and disruption management (from Rail strategic SRIA))*

Additionally, the project to be funded under this topic shall:

- Target maturity level is TRL6 and validation activities should be defined accordingly. In particular, activities including system, subsystems model/prototypes in a relevant end-to-end environment;
- Propose a concept of operations (ConOPs) and high-level architecture of the proposed solution(s), further detail them into operational scenarios / use cases, leading to the definition and validation of requirements/specifications for data exchange, also in real-time, related to available capacity, disruptions, etc., and consequent respective airport operations - ATM – rail networks integration. Include a CBA for the proposed solutions ;
- Consider the following potential scenarios:
 - City pairs from different EU Member States, which have both airports and high-speed train connections;
 - International airport hub connected to a high-speed railway station. This scenario may also consider other transport modes serving and/or connecting both the airport and railway station if applicable e.g. local / regional train operators, local bus lines, trams, metros, taxis etc.;
 - Regional rail line serving a smaller (regional) airport. This may also consider as well other transport modes.
- Consider standards whenever possible, especially important with data sharing, integration of different transport modes, combination of ATMS and TMS and creation of new tools;
- Take into consideration the following reference material:
 - The interfaces definition should consider:
 - From SESAR: European ATM Architecture (EATMA)⁴² and the relevant links to elements in the ATM architecture (e.g. capabilities, systems);
 - From EU-Rail: Conceptual Data Model (CDM)⁴³, the work done within Shift2Rail TD2.9⁴⁴ on TMS.
 - The EU Data Strategy which aims to create a Common European Mobility Data Space⁴⁵. Please consider also the existing work of EU-Rail (Flagship Project 1 – MOTIONAL⁴⁶, Federated Data Spaces) for building a trusted, reliable, cybersecure federated data space for the rail ecosystem - the Rail Data Space. The Rail Data Space provides exchange and sharing of digital resources across Rail operators, Infrastructure Managers and Suppliers as a component in the creation of a Common European Mobility Data Space. It is compliant with the principles of the European Strategy for Data, e.g., Data Sovereignty, Data level playing field, public-private Governance and Decentralized soft infrastructure. Furthermore, it is interoperable with other sectorial data spaces;
 - State-of-the-art documentation on existing solutions on integrated rail and air traffic.
- Involve relevant stakeholders from at least two EU Member States:
 - From the air sector perspective the proposals should foresee participation of, at least, airspace users (AUs) and airport operators;

⁴² <https://www.eatmportal.eu/working/signin>

⁴³ https://projects.shift2rail.org/s2r_ipx_n.aspx?p=LINX4RAIL

⁴⁴ https://projects.shift2rail.org/s2r_ip_TD_r.aspx?ip=2&td=a86b26b5-2680-4765-9bc6-c935804d6aa6

⁴⁵ https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13566-Transport-data-creating-a-common-European-mobility-data-space-communication_en

⁴⁶ <https://projects.rail-research.europa.eu/eurail-fp1/>

- From the rail sector perspective the proposals should foresee participation of, at least, High speed train operators, infrastructure managers and TMS operators, as well as regional/capillary line operators and TMS operators;
- Research may include (if required) other stakeholders e.g. urban transport operators (metro, bus, etc.);
- The inclusion of other modes of transport (e.g., UAM, cooperative, connected and automated mobility (CCAM), etc.) will be considered advantageous, in order to provide a full door-to-door experience validation.
- Take into consideration the existing work developed within SESAR and EU-Rail (especially IP4 projects⁴⁷, Flagship Project 1) in terms of state-of-the-art of existing solutions, tools, algorithms and approaches (e.g. passenger flow, predictions and traffic modelling, total airport management concept, etc.);
- Address data confidentiality e.g. GDPR aspects, as well as the approach on data sharing (including dataspace tackled within EU-Rail project FP1-MOTIONAL);
- Address (cyber)security and safety aspects of the proposed architecture in close collaboration with the System Pillar. Also, the availability and integration of external services able to supply data and information to the air and rail network management systems to improve air-rail intermodality shall be investigated;
- Target a balanced participation of entities from both the rail and aviation sector. The contribution brought by those entities is also expected to be insofar as possible balanced between the rail and aviation stakeholders. The applicants can justify a different approach for the correct implementation of the action.

A joint execution framework is currently under development between SESAR 3 JU and Europe's Rail JU. This common framework will provide more details on aspects related to the implementation of the proposal retained for funding, once the Grant Agreement is signed. It will be made available in the Question & Answers (Q&A) during the call for proposals submission period.

Interactions with other EU-RAIL and SESAR projects and EU-Missions

The action to be funded under this topic shall:

- Take into account the state of play on multimodality, either completed or ongoing (under Horizon 2020/Horizon Europe programmes or beyond) activities that already tackle some of the aspects under this topic.
- Collaborate with linked projects EU-RAIL Flagship Areas 1⁴⁸ and 6⁴⁹ and work together for any potential interfaces.
- Collaborate and integrate the EU-Rail System Pillar⁵⁰ outputs related to concept of operations, Data Model, the Architecture and the interface with rail Traffic Management Systems.

Gender dimension

⁴⁷ https://projects.shift2rail.org/s2r_ip.aspx?ip=4

⁴⁸ <https://projects.rail-research.europa.eu/eurail-fp1/>

⁴⁹ <https://projects.rail-research.europa.eu/eurail-fp6/>

⁵⁰ https://rail-research.europa.eu/system_pillar/

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

DESTINATION 8 – Exploratory Research and other activities

HORIZON-ER-JU-2023-EXPLR-01: NOISE AND VIBRATIONS

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 4.1 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	<p>The total indicative budget for the topic is EUR 4.1 million.</p> <p>Applicant Private⁵¹ Members of the EU-Rail part of consortia responding to this topic should provide in-kind contributions to additional activities to be declared via the template model available on the F&T portal. The amount of total in-kind contributions (i.e. in-kind contributions for operational activities and in-kind contributions for additional activities) should be no less than 1.263⁵² times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall be well and duly justified.</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	36 months. This does not preclude submission and selection of a proposal with a different project duration.
Technology Readiness Level	Activities are expected to be at TRL 5/6 – see General Annex B for a guide to the TRL definitions and criteria to be used.
Type of Action	Research and Innovation Action
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 70 pages.

⁵¹ As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

⁵² In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

Special skills and/or capabilities expected from the Applicant(s)	<p>Applicants shall 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 expertise on in railway noise and vibrations, soil-dynamics, acoustics, standardization processes (ISO, CEN)</p>
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.
Linked Projects	<p>As specified in section 2.3.8.1 of the WP 2023-2024, 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 action :</p> <p>- FP4 – Rail4EARTH (GA number: 101101917)</p> <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>
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/20212027/horizon/guidance/lump-sum-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.

Expected Outcome

Railway noise is still the main rail externality and according to the EEA’s Outlook to 2030 report, the number of people who are touched by railway noise is projected to increase under both optimistic and conservative scenarios. This has an impact on the political decisions when upgrading existing or building new railway lines.

During the past years, along with noise, the effects from railway-induced vibrations has come more and more in the focus. In this perspective, the project to be developed under this call shall provide feasible solutions on improvement of prediction tools on vibration impact. It should also provide an assessment method on how vibration emissions can be determined and specified independently of location and track influences in the future to determine the effect of the train alone independent from the track.

A strong cooperation with standardization and regulation committees through the EU-RAIL SP should enable simplified vibration impact assessment as well as N&V certification procedures.

Noise

The main objective of this work area is to improve EU noise mapping and to define relevant limit values that could potentially serve as a basis for upcoming revisions of the Technical Specifications for Interoperability on Noise.

The R&I work of this work area should contribute to/is expected to:

- Deliver noise mitigation strategies for reprofiling/grinding processes;
- Facilitate the development and implementation of onboard measurement systems for rail acoustic roughness, by providing a common technical measurements guideline in Europe;
- Deliver a user-friendly tool making use of open-source data to help optimise future re-profiling processes to minimise the noise impact of railways;
- Deliver track LCC analyses based on the knowledge of acoustic and track experts from a holistic approach and deliver a user-friendly tool making use of open-source data to support the minimisation of Noise externalities during LCC analyses. Such analyses should be made publicly available;
- Progress towards virtual and cost-effective vehicle certification considering uncertainties of pass-by noise measurement;
- Improve the prediction of noise in curves for urban and inter-urban railway lines against state of the art.

Ground Vibrations

The main objective of this work area is to improve the prediction tools capabilities for holistic ground vibration impact.

The R&I work of this work area is expected to provide tools:

- with simulation capabilities for ground vibration;
- for large scale environmental impact studies, making use as much as possible of existing soil databases and Geographic Information System.

Additionally, considering that existing TSIs do not cover vibration emissions from rolling stock, and in general there is no standardised procedure for vibration emissions measurement, the R&I work should deliver:

- A procedure for the track- and site-independent verification of vibration emissions, including an analysis and determination of applicable conditions for its re-use on other sites.
- An assessment method on how ground-borne vibration emission of rolling stock can be

determined.

These outputs should serve as an input to the EU-Rail System Pillar for possible consideration on standardisation (EN) and regulation updates (TSI). The work should therefore also include proposals for the definition of suitable, demanding but realistic limit values for the development and acceptance of new 'low vibration' rolling stock.

Scope

The following R&I areas have been identified within the scope of this topic. It is up to the applicant to identify the most appropriate R&I work-streams, taking into account the state of the art and previous R&I work – in particular in the context of Shift2Rail activities⁵³ – for delivering upon all of the above expected outcome.

On-board measurements of the rail acoustic roughness

The research activities around this area should investigate an effective approach for optimised rail reprofiling processes that minimises nuisance to lineside residents and avoid high maintenance costs.

They should look at on-board measurement of rail acoustic roughness aiming at establishing harmonised technical European guidelines.

They should support the development of the necessary tools enabling the introduction of on-board measurement data for acoustic rail roughness, to support the optimisation of future re-profiling process by minimizing the noise impact of railways. The maintainability of the tool shall be addressed.

Rail optimisation for noise, vibrations, and life cycle costs

The research activities around this area should investigate how to integrate noise and vibration abatement methods into asset management plans, considering the impact on environmental and health conditions, to optimise the track system for LCC, noise and vibrations simultaneously.

The research action should deliver the necessary tools supporting the whole system optimisation for noise, vibrations and life cycle costs (LCC) on railway tracks. The maintainability of the tool shall be addressed.

Noise in curves

Rolling noise is in many situations the major railway noise source. However, in urban areas, especially for tramway systems, curve noise is the dominating reason for noise complaints. Furthermore, current standards, e.g. ISO 3095/3381, and regulations, e.g. TSI Noise, only cover rolling noise in straight alignments. In order to improve prediction and to reduce noise, research activities around this area should look into:

- Rolling noise in curves, developing a digital twin-based approach to predict rolling noise for curves

⁵³ SILVARSTAR (<http://silvarstar.eu/>), FINE-2 (https://projects.shift2rail.org/s2r_ipcc_n.aspx?p=fine-2), TRANSIT (<https://transit-prj.eu/home.aspx>),

with radius $R > 150$ m, validated by on-field measurements.

- Squeal and flange noise, developing an engineering tool for the prediction of critical curve situations and the assessment of the impact of noise mitigation solutions with a focus on urban rail (curve radius < 150 m). The tool shall be validated against on-field measurements.
- Improve the EU-CNOSSOS curve noise factor⁵⁴.

Transposition and uncertainties of pass-by noise

Virtual or simplified acoustic certification of rolling stock needs to consider uncertainties regarding measurements and, therefore, research activities around this area should look into:

- Transposition from one site to another, investigating application and looking for improvement of the methods developed in the S2R funded project TRANSIT⁵⁵ especially to sites with important differences in the track architecture.
- Assessment of uncertainties in pass-by noise measurements.
- Identification of a methodology to acoustically certify freight wagons without testing - at least for freight wagons without additional noise sources apart from the rolling noise.
- Study of the current noise emissions of new propulsion technologies (Battery propelled rolling stock, hydrogen rolling stock). Propose specific limit values for these propulsion technologies for pass-by, starting and stationary noise, if needed.

Ground vibrations Prediction Tool

The research activities should advance the state of the art, see Silvarstar public deliverables D1.1, 1.3, 2.1 and D3.2⁵⁶ possibly based on existing prediction tools for ground vibration impact. In particular the following areas are in the scope of interest:

a) Urban railway traffic

Prediction tool for ground vibration impact supporting urban areas (with tramways, metro, and light rail systems) and investigating excitation mechanisms in curves, switches and crossings as well as dedicated urban soil characteristics.

b) Integration into environmental impact assessment tools

Integration in the prediction tool of GIS data concerning track, soil and building data and further automated processing of large-scale projects should be part of the R&I activities. The research activities should consider the application of a user-friendly graphical user interface for the usage of the simulation and prediction tool, preferably with interfaces to commercial geographical information system (GIS) based software for noise and general environmental impact.

The Project stemming from this topic shall also consider the future acceptance and reliability of the developed tool, by addressing aspects such as the assessment of prediction uncertainties and its integration into ground vibration standards. Additionally, the prediction for mitigation measures at

⁵⁴ CNOSSOS-EU noise mapping (<https://publications.jrc.ec.europa.eu/repository/handle/JRC72550>)

⁵⁵ Please refer to the project's public deliverables (<https://transit-prj.eu/Page.aspx?CAT=DELIVERABLES&IdPage=aeae1af3-e01e-499b-bfab-52b38411eafb>) and other publications (<https://transit-prj.eu/Page.aspx?CAT=DOCUMENTS&IdPage=ece4856c-d4a8-4ebe-8ece-c77c069f71a2>).

⁵⁶ https://projects.shift2rail.org/s2r_ipCC_n.aspx?p=S2R_SILVARSTAR

track side, suitable for both tunnels and open track lines, and to the integration of mitigation measures in the transmission path (e.g. tranches, walls) and estimation of their insertion loss shall be addressed.

The tool shall provide enough open interfaces to enable the integration of further improvements and developments.

Requirements and specifications for ground-borne vibration emission of rolling stock

The research activities should address this area by investigating:

- Numerical analysis/simulation of the most important parameters in vehicle construction responsible for vibration emissions.
- A suitable descriptor which can describe and compare vibration emissions of trains.
- A procedure to determine the most important parameters of track influences on ground-borne vibration and proposals for a normalized reference track surrounding vibration emission specification.
- An assessment method on how to specify and verify vibration emission of vehicles alone, independently from track influences, including some specifications on how to transfer the data from a test site to a reference track.
- The typical state-of-the-art vibration emission for different train categories including some proposals for limit values.
- A way to determine and compare vibration emission values track and site independently, in support of possible future standardisation activities.

Interactions with other EU-RAIL projects and EU-Missions

The action to be funded under this topic shall:

- Take into account the outputs of linked projects from EU-RAIL Flagship Areas 4⁵⁷ and work together for any potential interfaces.
- Interact with EU-Rail System Pillar⁵⁸ for the aspects related to standards and EU-regulations.

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.

⁵⁷ <https://projects.rail-research.europa.eu/eurail-fp4/>

⁵⁸ https://rail-research.europa.eu/system_pillar/

HORIZON-ER-JU-2023-EXPLR-02: FUTURE METRO SYSTEMS

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 3.1 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	<p>The total indicative budget for the topic is EUR 3.1 million.</p> <p>Applicant Private⁵⁹ 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 1.263⁶⁰ times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall 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.
Technology Readiness Level	Activities are expected to be at TRL 3/4, higher TRL are possible – see General Annex B for a guide to the TRL definitions and criteria to be used.
Type of Action	Research and Innovation Action
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 70 pages.
Special skills and/or capabilities expected from the Applicant(s)	<p>Applicants shall 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 expertise on ATO “GoA4” and/or similar concepts (Dynamic TMS Offer Demand Balancing, AI for operation and maintenance, Train Control Systems – TCMS) for metro systems based on automation and digitalization.</p>

⁵⁹ As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

⁶⁰ 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.

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.
Linked Projects	<p>As specified in section 2.3.8.1 of the WP 2023-2024, 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"> - FP1 - MOTIONAL (GA 101101973) - FP2 - R2DATO (GA 101102001) - FP3 - IAM4RAIL (GA 101101966) <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>
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/20212027/horizon/guidance/ls-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.

Expected Outcome:

Metro lines are traditionally operated through a combination of planned levels of demand and of availability of rolling stock and drivers along different periods of typical days. The adaptation of operations to face changes of the traffic patterns and levels are largely influenced by the constraints of staff management and by the knowledge of customers expectations.

Additionally, AI and data science are frequently praised as a solution to address transport issues by handling large set of data, combining information from many sources being indicators and sensors.

The Project stemming from this topic should aim to identify and initially exploit key areas of innovation of the future metro system. The initiative shall identify new requirements, develop new concepts, and implement early stages of development of the solutions based on new emerging technologies (automation and digitalization, AI, telecom, etc.).

These new technologies, concepts and new ways of operation shall contribute to a better mass rapid transport system with:

- Optimized Capacity – Flexi Demand, making the most of the existing infra and rolling stock following customer commuting habits, flows and better managing disruptions.
- Efficient Train Control Systems that enable cost reductions and better operational response.
- Sustainable transport system, applying different technologies and concepts to better manage the total cost of ownership and deliver better energy footprint.

The final objective is to increase efficiency, sustainability, attractiveness, and resilience against current state of the art. Making the system future metro systems answering the needs of an evolving society with the metro as the backbone of urban mobility.

Scope

Considering the current state of the art regarding automation in the metro system, the action to be funded under this topic shall deliver R&I which first step is to determine requirements and needs for future different type of metro users, while also taking into consideration the resilience to external challenges/future threats (climate threats, sanitary, terrorism, etc.) aiming at making metro systems future proof.

The following R&I areas have been identified as key enablers of the expected outcome. The Project stemming from this topic shall address all the following work streams and is expected to provide all the following:

Workstream 1: Increased adaptability of metros to fluctuations in demand. The project shall deliver a feasibility study, potentially using simulation tools as Proof of Concept to demonstrate to what extent it is possible to increase the adaptability of metros to fluctuations in demand; and how to benefit from new opportunities provided by the trend towards full automation of metro operation (Grade of Operation 4 with no staff on board train), by a better knowledge of customers profiles and travel conditions (expected and actual) thanks to digitalization, by new technologies and by improved coordination with other modes and new mobility services.

Workstream 2: Future of train control. The project shall deliver a feasibility study, including an analysis of the different trends in train control and existing / future technological solutions as well as a definition of future needs and functional requirements for the different categories of metro systems. The objective is not to focus on one solution with respect to another, but to explore equidistantly the topic from the different point of view like economic, operational, technologic and considering the potential impact on existing systems.

Workstream 3: Advantages and trends brought by AI and data science in metro operation for different types of metros (old/new, large/small, etc.). While their area of relevance is rather associated with large networks, the project shall deliver concepts on the most

promising AI and data science implementation applications in metro operation, with a cost-effective approach, in different categories of metro systems (greenfield/brownfield, city or regional, connection with long distance modes...). Relevant aspects like application to operational processes and cybersecurity threat identification and management should also be considered. Preliminary results of this workstream may be considered for Workstream 1 and 2 implementations.

Interactions with other EU-RAIL projects and EU-Missions

The action to be funded under this topic shall:

- Take into account the outputs of linked projects from EU-RAIL Flagship Areas 1⁶¹, 2⁶² and 3⁶³ and work together with them for any potential interfaces.
- Interact with EU-Rail System Pillar⁶⁴ for the aspects related to the interface between mainline rail (SERA) and urban mobility systems of which metro is part.
- Explore possible collaboration with cities participating in the EU Mission for Climate-Neutral and Smart Cities⁶⁵.

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.

⁶¹ <https://projects.rail-research.europa.eu/eurail-fp1/>

⁶² <https://projects.rail-research.europa.eu/eurail-fp2/>

⁶³ <https://projects.rail-research.europa.eu/eurail-fp3/>

⁶⁴ https://rail-research.europa.eu/system_pillar/

⁶⁵ <https://ec.europa.eu/mission-cities> and Cities Mission Platform <https://netzerocities.eu>

HORIZON-ER-JU-2023-EXPLR-03: BIODIVERSITY

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 2.8 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	<p>The total indicative budget for the topic is EUR 2.8 million.</p> <p>Applicant Private⁶⁶ 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 1.263⁶⁷ times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall 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	36 months. This does not preclude submission and selection of a proposal with a different project duration.
Type of Action	Horizon Coordination and Support Actions (CSA)
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 70 pages.
Special skills and/or capabilities expected from the Applicant(s)	<p>Applicants shall 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 expertise on the subject of matter (biodiversity, transport, energy) and demonstrate capacity to liaise with stakeholders (administrations, regulators, etc).</p>
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.

⁶⁶ As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

⁶⁷ 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.

Linked Projects	<p>As specified in section 2.3.8.1 of the WP 2023-2024, 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"> - FP4 - Rail4EARTH (GA 101101917) - FP3 - IAM4RAIL (GA 101101966) <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>
Retroactive starting date of the grant	<p>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.</p>
Lump Sum grant	<p>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/20212027/horizon/guidance/lump-sum-decision_he_en.pdf].</p>
Award criteria additional details	<p>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.</p>

Expected Outcome:

The Project stemming from this topic should deliver the following outcomes, considering rail as the backbone of the future mobility system:

- Reach applicable recommendations for the development and improvement of cross-cutting biodiversity and climate policies. This will serve as a baseline for the transport and energy sector, to be used in a holistic way when planning future endeavours so the design, construction, and maintenance phases of the any relevant projects shall take into account biodiversity and net zero emissions all throughout the lifecycle including the land use management in railways.
- Develop technical methodologies to evaluate the environmental efficiency of rail transport infrastructure and its impact on ecosystem services and climate challenge. The methodology

should address how to score / the expected scoring performance on innovative green infrastructure solutions. This should lead to an identification of metrics/KPI and targets for them that will help monitor the progress.

- Inclusive assessment framework of the impacts from infrastructure on biodiversity enabling compiling heterogeneous data.
- Filling gaps in the accounting of joint carbon and biodiversity "transboundary" impacts between energy and transport sectors and identify ways to address them.
- Providing a user-friendly, open data-driven carbon emission calculator for use in railway infrastructure projects.

Scope:

Railways are the key transport mode to design a better future and to achieve a sustainable mobility. The project to be funded under this call aims to facilitate the implementation of the EU biodiversity policy and guidelines with a coordinated approach among stakeholders, in particular looking at the rail sector and how the application of a more homogenous biodiversity baseline can be defined across the transport and energy sector. This coordination and support action aims also at supporting the PRIME⁶⁸ initiative by achieving a harmonised / common acknowledged environmental scorecard for rail infrastructure manager and identifying opportunities for improvement in ecosystem services resulting from the management of habitats, vegetation, water and soil quality, while leading the elaboration of national transport management plans to be used in new construction projects. The following R&I work-streams have been identified for addressing all the above expected outcomes:

Workstream 1: Bridging the transport infrastructure & energy distribution and production networks together with biodiversity to tackle climate change

The development of a biodiversity-friendly approach for different types of transport infrastructure has been included in the actions of national and international authorities in various forms for several years. The aim of this workstream is to bridge energy at its latest technology state of the art / innovation and rail transport identifying best possible matches that deliver rail solutions to tackle climate change.

The technical objectives of the funded project include addressing the approach and promoting synergies between transport and energy sectors, the development of an inclusive assessment framework of the impacts from infrastructure on biodiversity enabling procurement improvements through harmonised, transparent, and robust data generation. The project shall aim to support stakeholders in decision-making by analysing the existing situation.

The economic aspects of the project include leveraging the use of multilateral platform(s) for the preparation of sustainable infrastructure projects and enabling the achievement of green bonds, with criteria and scoring to be established, and contributing to its support and dissemination as capacity

⁶⁸ <https://wikis.ec.europa.eu/display/primeinfrastructure/About+PRIME>

building in developing countries, in particular in connection with the EU Global Gateway. Furthermore, the funded project is to identify tools to help sector actors integrate biodiversity more thoroughly into their strategic and operational plans.

Proposals should take into account the societal perspective. The objective is to promote the development of a holistic approach to environmental mainstreaming of infrastructure by producing comparable results to demonstrate the benefits and impacts of infrastructure projects on public health and well-being, and better integration in the policy-making processes. The information obtained will also support capacity building through the development of an initial and continuing training programme. It will also aim at supporting the emergence of a European knowledge hub on infrastructure and biodiversity.

Workstream 2: Valuing the nature on railways

A well-managed green infrastructure will bring biodiversity benefits, but also helps support safer and more reliable railways operations. With the increasing importance given to railways to ensure net zero emissions reality, it is expected that the amount of land designated to railways, including infrastructure and real estate, will increase in Europe. This land take may be challenged in terms of environmental impact and loss of habitats.

Railways must be able to clearly demonstrate the value from railway green infrastructure and that there is no loss of value from investing in new infrastructure when it is designed well. Through innovative digital remote monitoring and biodiversity consideration in early design of infrastructure, the way the lineside is understood is changing. The project to be funded through this call will set a direction of travel for biodiversity net gain as well as no net loss. A standardised approach to ensure the sustainability of railways and to guide different stakeholders towards effective and efficient land management practices will strengthen the development of a common European biodiversity metric to benchmark data on railways and other cross-cutting transport modes.

The framework set under the project aims to harmonise the European railway community in identifying opportunities for improvement in ecosystem services resulting from the management of habitats, vegetation, water and soil quality, while leading the elaboration of national transport management plans to be used in new construction projects.

The project stemming from this topic focusses on providing a ranking system to generate new sources of funding, as well as the development of a long-term monitoring and reporting system with a carbon emission calculator developed for use in new construction projects based on the metrics identified in the habitat management context., as well as to guide the sector with a tool for the collection of harmonised transparent and robust data for use on European railways and to improve procurement processes.

Additionally, a standardised approach to ensure the sustainability of railways and to guide different stakeholders towards effective and efficient land management practices will strengthen the development of a common European biodiversity metric to benchmark data on railways.

Interactions with other EU-RAIL projects and EU-Missions

The action to be funded under this topic shall:

- Take into account the outputs of linked projects from EU-RAIL Flagship Areas 3⁶⁹ and 4⁷⁰ and work together for any potential interfaces.
- Take into account the EU Biodiversity Strategy 2030⁷¹.
- Take into account the outcome of the H2020-BISON CSA⁷², which paved the way to an innovative multimodal approach to tackle biodiversity and infrastructure.

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.

⁶⁹ <https://projects.rail-research.europa.eu/eurail-fp3/>

⁷⁰ <https://projects.rail-research.europa.eu/eurail-fp4/>

⁷¹ https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en

⁷² <https://bison-transport.eu/>

**HORIZON-ER-JU-2023-EXPLR-04: DISRUPTIVE ASSETS MANAGEMENT SOLUTIONS,
INCLUDING URBAN USE CASES**

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 2.7 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	<p>The total indicative budget for the topic is EUR 2.7 million.</p> <p>Applicant Private⁷³ 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 1.263⁷⁴ times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall 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. This does not preclude submission and selection of a proposal with a different project duration.
Technology Readiness Level	Activities are expected to be at TRL 4/5, higher TRL are possible – see General Annex B for a guide to the TRL definitions and criteria to be used.
Type of Action	Research and Innovation Action

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 70 pages.
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⁷³ As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

⁷⁴ In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

Special skills and/or capabilities expected from the Applicant(s)	Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the topic.
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.
Linked Projects	<p>As specified in section 2.3.8.1 of the WP 2023-2024, 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</p> <p>- FP3-IAM4RAIL (GA 101101966)</p> <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>
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/20212027/horizon/guidance/lump-sum-decision_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.

Expected Outcome:

Building upon the work delivered by IP3 in S2R and other research and innovation activities, the Project stemming from this topic shall ensure the innovative/disruptive aspect of proposed Technologies / Use cases thanks to a thorough state of the art of existing solutions and on-going R&I activities. The project shall not undertake any (similar) activities currently implemented in the context of FP3-IAM4RAIL as describe in the project deliverable D2.6 – Definition of Use Cases, including

Innovation, Business Assessment, KPIs definition and roadmap (first issue)⁷⁵. More specifically, no robotic/unmanned application shall be considered as use case.

The Project stemming from this topic is expected to deliver relevant environment validation of three innovative demonstrators of innovative:

- assets monitoring solutions and/or
- inspections solutions and/or
- remotely controlled interventions solutions.

Among the proposed demonstrators, at least two urban specific use cases (metro/tramway/...) shall be addressed.

Scope

Rail asset management is a key area to enhance via research and innovation, especially as more rail services will be needed to solve existing challenges and meet societal demands, following EU guidelines such as the Green Deal. The objective of the project is to enhance the capability for monitoring/inspection solutions evolving towards non-invasive and self-diagnostic systems with no or minimal service disruptions and/or remotely controlled interventions, through the usage of innovative/disruptive technologies concerning data acquisition, data analysis and maintenance decision making.

In order to fulfil the expected demonstration outputs, research activities should detail specific, tangible and suitable use cases illustrating the impact of the technologies in concrete solutions. While the innovative/disruptive aspect of the technologies implementation choice shall be considered, the definition of the use cases shall ensure a possible deployment of the outcomes. Those proposed innovative solutions should contribute to a significant improvement in reliability, availability, maintainability and safety of the system or work conditions versus state of the art.

Interactions with other EU-RAIL projects and EU-Missions

The action to be funded under this topic shall take into account the outputs of linked projects from EU-RAIL Flagship Area 3⁷⁶ and work together for any potential interfaces.

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.

⁷⁵ <https://projects.rail-research.europa.eu/eurail-fp3/deliverables/>

⁷⁶ <https://projects.rail-research.europa.eu/eurail-fp3/>

HORIZON-ER-JU-2023-EXPLR-05: EXTENDING THE RAIL NETWORK OF PHDS

Specific Conditions	
Expected EU contribution per project	The Europe's Rail Joint Undertaking estimates that an EU contribution of EUR 2 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 million.</p> <p>Applicant Private⁷⁷ 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 1.263⁷⁸ times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall 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>
Technology Readiness Level	Activities are expected to be of low TRL1, with possible technology concept formulated at TRL2, higher TRL are also possible – see General Annex B for a guide to the TRL definitions and criteria to be used.
Indicative project duration	No indication given, applicants should indicate the most appropriate period for the action, in particular in relation to the PhD works.
Type of Action	Research and Innovation Action
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 70 pages.

⁷⁷ As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

⁷⁸ In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union and the Union financial contribution, as on the basis of Articles 88 and 89 of Council Regulation (EU) 2021/2085.

Special skills and/or capabilities expected from the Applicant(s)	<p>EU-Rail expects proposals to be submitted by consortia that consider PhD researchers/doctorships in the area of works of the topics presented in the Call text or in other scientifically relevant areas. Applicants shall ensure that their proposals and consortium reflect the aggregated expertise to perform the activities and achieve the objectives set by the topic.</p> <p>The applicants are expected to gather expertise leveraging from the knowledge of Academia and of the rail supply industry, SMEs and start-ups. In addition, applicants should leverage from the expectations of the clients, in the horizon 2030, considering the R&I contribution and vision from the EU-Rail Master Plan and Multi-Annual Work Plan.</p>
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.
Linked Projects	<p>As specified in section 2.3.8.1 of the WP 2023-2024, 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 action:</p> <ul style="list-style-type: none"> - Academics4Rail (GA 101121842) <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>
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/20212027/horizon/guidance/lump-sum-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.

Expected outcome

With this Research and Innovation Action, the Europe's Rail Joint Undertaking intends further extend the rail research and innovation "community" (cooperation/network/alliance) of scientific research entities (cooperation/network) that was initiated with the recent award of the EU-Rail project Academics4Rail (GA 101121842).

The expected outcome is also the realisation of 6-10 PhD positions, teaming up with the industry.

To apply under this Call topic, the related entities are requested to establish a Consortia with the aim to promote fruitful collaboration and share of knowledge on any topics in the area of works related to the EU-Rail Programme⁷⁹ or relevant in the context of other European rail research and innovation activities. In doing so, exchanges should also be identified with the linked project.

Scope

In order to achieve the expected outcomes described above, proposals shall consist of the creation of at least 6 – 10 PhDs positions. It is expected that the PhD programmes stemming from this topic will have the possibility to interact with the Funding Members of the Europe's Rail JU.

The PhD researchers are expected regularly to liaise with the Europe's Rail JU and to present their research findings to the Europe's Rail JU events and submit scientific papers to relevant conferences (e.g. TRA, WCRR, etc. but also non-rail related). This action may be requested to provide relevant inputs to the Europe's Rail Scientific Steering Group and ERRAC. The Europe's Rail Joint Undertaking expects to finance successful proposals from universities or similar high-level institutes covering each at least one PhD student in the following proposed areas or additional or different scientific areas to be proposed, always in relation to the EU-Rail Programme:

PhD Topic – Measures and mechanisms to support implementation of rail technical innovations supporting the decarbonisation of transport

Innovations in the transport domain.

Innovation will only contribute to the future of rail if they are implemented. Sometimes good R&I outputs encounter barriers that hinder their possibility to become innovations implemented into the market. Those barriers may be linked to market factors, standards, regulations, etc. The barriers may become greater when dealing with seamless integration with other modes of transport.

Proposals addressing this PhD topic should research and identify possible measures and mechanisms that would help the promotion of such innovations and overcome the identified barriers. Case studies may also be part of the work.

The work should take into account the CERRE⁸⁰ Report: The Future of Rail: Regulation and Competition for an Innovative Industry.

PhD Topic - Change Making for Gender Equality in Rail

The main aim of this topic is to research on the gender gap in rail companies with the focus on how to improve the experience of women in rail, both as users of rail services and as members of the workforce.

⁷⁹ https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf

⁸⁰ <https://cerre.eu/publications/future-rail-regulation-competition-innovative-industry/>

Proposals addressing this PhD topic should contribute through research activities to one or more of the following (or similar) non exhaustive list (more than one PhD can be proposed on this topic addressing different subjects as well):

- Knowledge-based approach regarding the role of the women as rail passengers, understanding their travel behaviours and patterns and identifying potential specific needs.
- Effective practices and solutions that could attract more female workers across the different departments of rail companies as well as training plans/solutions for Human resources department regarding recruitment, training, spreading excellence, technical cooperation, and promotions of women.
- A study on the current challenges for women in rail, including literature review, data collection focusing on disaggregated data on women (both as workers and as passengers), and stakeholder mapping.

PhD Topic – Education and training in rail

Education and training are critical to ensuring a highly skilled and competent rail workforce. ERASMUS+ funded projects have provided valuable feedback on the current state of rail education and training and identified areas for improvement.

In the last two decades, the European rail sector has undergone major changes. European rail mobility is sustained by a skilled workforce, that daily delivers maintenance, operations, planning, and services. Nevertheless, major changes are affecting this workforce: on one hand, about 30% is expected to retire in the next decade; on the other hand, the major transformation process driven by research and innovation, with special reference to digitalisation and automation, requires bringing in suitable skills and competencies. Digitalisation is progressing rapidly and is leading to an increased demand for more ICT and broad technical skills, as well as for soft skills. Moreover, there is a growing need for skills related to modernisation of rail infrastructure, traffic management and rolling stock. In such a framework, a major challenge to face is the difficulty to recruit suitably educated people. The transformation related to digital and high-tech technologies creates mismatches between available and demanded skills, which results in enterprises reporting difficulties to find staff with the needed competencies.

The above-described changes represents also a challenge for the education and training in rail. On one side there is the need of providing potential rail staff with the needed skills, but on the other there is the necessity of educating people capable to provide such skills to (graduated) students, using suitable teaching and training methodologies. More important, such methodologies should become the same over all Europe in a near future.

Starting from the public outputs of the EU-funded project STAFFER⁸¹, proposals addressing this PhD topic should further developed relevant research subjects that would allow addressing the above challenge.

PhD Topic – Rail enabled urban logistics

Logistics City Hubs aiming at zero-emission freight transport at city level are a new concept. Transport currently accounts for about a third of all climate emissions in Europe. Without significant measures,

⁸¹ <https://www.railstaffer.eu/>

transport will be the largest source of climate gas emissions by 2030. It is expected that passenger and freight transport will grow by more than 40% and 60%, respectively by 2050⁸², connects urban systems in an integrated approach and addresses both goods and passenger transport. The aim is to improve efficiency, capacity utilisation of existing vehicles and transport related infrastructure, accessibility, and innovation capacity in urban transport.

These Logistic City Hubs should integrate with freight rail and future rail freight multimodal terminals that could interchange with any local last mile clean mean of transport (electric delivery vans, electric motorbikes, cargo-bikes, even local mass transit bus, etc.). This topic should look at freight rail and how can freight rail multimodal terminals and rail freight traffic integrate in smart cities and implement efficient and cost-effective integration with sustainable last mile solutions.

Proposals addressing this PhD topic should contribute through the following or similar research activities :

- Conduct a comprehensive study analysing ongoing initiatives that European cities are already initiating, (for example Amsterdam Logistics City hub) and how /what are the condition for rail services to fit into those. This study should not only look into infrastructure needs but also new production rail freight models. Expected rail freight traffic and routes within the city should comply with all environmental (noise, etc) and timetable (operations that are compatible with passenger trains) requirements.
- Look into different case scenario, with a short / medium- and long-term look taking appropriate consideration of the technological evolution in the rail sector (see S2R IMPACT-2 D7.2 Use-Cases for advanced Freight operation ⁸³and FR8HUB Rail Freight Technologies evolution D1.2_Migration_Plan.pdf⁸⁴).
- Lay out the conditions and recommendations for such services to be successfully deployed, making the necessary investigation on the regulatory and business model side.

PhD Topic – Fast Night Train Operations

Night trains are an important mode of transportation for passengers traveling long distances overnight. These services will help balancing CO2 footprint offering other alternative that delivers better environmental profile. The main issue is still the long travel times which raise a growing demand for faster night trains, which can reduce travel times and improve the overall passenger experience. To achieve this, there is a need to address several technical, operational, and market-related challenges.

Proposals addressing this PhD topic should contribute through research activities to one or more of the following (or similar) non exhaustive list:

- Feasibility study: Conduct a comprehensive study to determine the feasibility of fast and high-speed night trains in Europe, including technical, financial, and logistical considerations.
- Market analysis: Analyse the potential market for high-speed night trains in Europe, based on the experience of established high-speed rail networks, including customer preferences, demand, and potential revenue streams.

⁸² H2020 funded MOVE21 project <https://move21.eu/>

⁸³ <https://projects.shift2rail.org/download.aspx?id=48cdc377-e4cd-485a-b32f-dea77f354a31>

⁸⁴ <https://projects.shift2rail.org/download.aspx?id=cdef064b-9b51-47e9-a55c-fae90ccd76dd>

- **Route analysis:** Identify the most viable routes for high-speed night trains in Europe, based on international travel available statistics, taking into account factors such as distance, connectivity, and existing infrastructure.
- **Fleet assessment:** Evaluate the existing fleet of trains and assess their suitability for use as high-speed night trains, including modifications and upgrades needed to meet the required services and performance.

Other and different PhD subjects can be proposed by the applicants.

Research results are expected to contribute to the Europe's Rail Programme and explore new possibilities and ideas. At the same time, the PhD researchers who are part of the Europe's Rail JU activities, are expected to become European ambassadors of the possible bright and innovative future that the rail sector has in the years to come.

Interactions with other EU-RAIL projects and EU-Missions:

The action to be funded under this topic shall interact with Academics4Rail (GA 101121842) in order to exchange within the community of scientific research and to growth the PhD subjects and interaction with industrial partners.

**HORIZON-ER-JU-2023-EXPLR-06: DAC FLEET RETROFITTING AND RETROFIT
CAPACITY PLAN**

Specific Conditions	
Expected EU contribution per project	EU-Rail estimates that an EU contribution of EUR 1.5 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 1.5 million.</p> <p>Applicant Private⁸⁵ 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 1.263⁸⁶ times the funding request, in aggregate, of these applicant Private Members. Any discrepancy shall 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	Coordination and Support Action
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 70 pages.
Special skills and/or capabilities expected from the Applicant(s)	<p>Applicants shall 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 on retrofit capacity aspects (Workshop operation, design and planning, engineering service providers, entities in charge of maintenance and workshop certifiers) and fleet retrofitting activities (Freight operations, design and planning, asset management, maintenance/overhaul planning and workshop operation).</p>

⁸⁵ As defined in Article 2(5) of Council Regulation (EU) 2021/2085.

⁸⁶ 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.

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.
Linked Projects	<p>As specified in section 2.3.8.1 of the WP 2023-2024, 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>
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/20212027/horizon/guidance/lump-sum-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.

Expected Outcome:

During the past years and within the scope of the S2R freight innovation pillar (IP5), rail stakeholders have been working on the freight Digital Automatic Coupler (DAC). This solution, in addition to the mechanical and pneumatic coupling, will integrate digital communications and energy for the rail freight segment. DAC is an enabler that will enhance the performance and safety of rail freight as it will eliminate manual interventions and, by transmitting data and power through the freight train consist, it will allow addressing the operational gaps to increase the competitiveness of rail freight.

The project stemming from this topic should deliver :

- a plan for a full-scale European DAC upgrading/retrofitting of existing freight locomotives and freight wagons;

- the identification and assessment of the retrofitting capacity, and develop an implementation plan.

All project deliverables shall be of Public nature to ensure a broad exploitation of the results and take up in the context of the European DAC Delivery Programme (EDDP)⁸⁷.

Scope

The coordinated support action support the Europe's Rail Joint Undertaking with the needed technical expertise for the development of the above mentioned plans.

The following areas have been identified as key research area to cover the expected outcome. The project stemming from this topic shall address all the following workstreams:

Workstream 1: Fleet retrofitting readiness

The project should collect and analyse the status of wagons and locomotives in operations in Europe. The processed information should consider the number of wagons and locomotives, the usage, the technical state and its retrofitting ability (fleet retrofitting readiness). The project shall deliver a sound assessment on the retrofitting readiness of wagons and locomotives which will serve as the basis for the strategic sector alignment, in the context of the EDDP, on the future DAC deployment plans. The project shall cover for its assessment the following elements (non-exhaustive list):

- Locomotives difference between shunting and mainline ones and the possibility to have hybrid coupling or DAC only;
- Wagons based on the type of traffic (Core Wagonload System (CWS), intermodal,...);
- TSI compliance and safety level achieved (e.g. inner-coupling for rakes).

Workstream 2: DAC Retrofitting capacity plan

The project should identify the required workshop capacity and locations (in Europe), workforce skills for retrofitting of locomotives, freight wagons and other on track machines, as well as the planned/required retrofitting rolling stock quantities. The outputs of the workstream 1 are an important element to take into account in the analysis.

It should also propose a DAC retrofitting plan considering the optimisation of workshop locations and the major sidings/terminals in Europe (e.g. through predominant traffic type) use, and related vehicle fleets. A gap analysis should be performed and required countermeasures analysed, with the aim to propose alternative technical and operational solutions.

The project should develop a comprehensive retrofitting capacity plan, including concrete operational and technical recommendations (including timing) per traffic type (Block Train, Single Wagon Load,...) and concerned fleet. The plan should include (non-exhaustive list):

- an allocation of vehicles per retrofitting workshops;

⁸⁷ <https://rail-research.europa.eu/european-dac-delivery-programme/>

- an identification of the rolling stock, timing and retrofitting process per type/vehicle;
- an estimate of the foreseen DAC components quantity required per retrofitting location.

Additionally, the project should propose further recommendation based on the analysis on how mobile workshops could cover (in part) the retrofit needs and their impact on:

- Retrofitting plan on infrastructure (e.g. buffer stop retrofitting plan, changes needed to shunting yards/sidings and planning).
- Requirements for the wagons for operations at shunting yards (e.g. uncoupling button or lever at the side).

Interactions with other EU-RAIL projects and EU-Missions

The action to be funded under this topic shall:

- Take into account the outputs of linked projects from EU-RAIL Flagship Area 5⁸⁸ and work together for any potential interfaces.
- Interact with EU-Rail System Pillar⁸⁹ for the aspects related to the TSI compliance aspects and planning and with the European DAC Delivery Programme groups⁹⁰, to which is expected to report on a regular basis to the Programme Board and Supervisory Board.

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.

⁸⁸ <https://projects.rail-research.europa.eu/eurail-fp5/>

⁸⁹ https://rail-research.europa.eu/system_pillar/

⁹⁰ https://projects.shift2rail.org/s2r_ip5_n.aspx?p=6%20EU-DAC

Annex VIII – 2023 Call for proposals – Evaluation Criteria

Part D of the 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”.

	Excellence⁹¹	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 [for the first stage: overall] 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.

⁹¹ The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme.

	Excellence⁹²	Impact	Quality and efficiency of the implementation
Coordination and support action (CSA)	<ul style="list-style-type: none"> • Clarity and pertinence of the project's objectives. • Quality of the proposed coordination and/or support measures including soundness of methodology. • Quality of the proposed joint activities to achieve the deliverables. 	<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.

⁹² The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme.