



ANNEX to GB decision no 08/2021

DRAFT

ANNUAL WORK PLAN and BUDGET 2022

adopted by the S2R GB on 25 November 2021

In accordance with the Statutes of the S2R JU annexed to Council Regulation (EU) No 642/2014 and with Article 33 of the S2R JU Financial Rules adopted by the Governing Board's Decision n° 11/2019.

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

NOTICE RELATED TO THE AWP 2022 ON ACTIVITIES FUNDED UNDER THE 2014-2020 EU PROGRAMMES, INCLUDING HORIZON 2020

Please be aware that following the entry into force of the EU-UK Withdrawal Agreement on 1 February 2020 and in particular Articles 127(6), 137 and 138, the references to natural or legal persons residing or established in a Member State of the European Union are to be understood as including natural or legal persons residing or established in the United Kingdom. UK residents and entities are therefore eligible to participate under the call for proposals, call for tenders and prizes indicated in this annual work plan.

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LIST OF ACRONYMS

Abbreviation	
AAR	Annual Activity Report
ABAC	Accrual Based Accounting
AI	Artificial Intelligence
ATO	Automatic Train Operation
ATP	Automatic Train Protection
A&V	Auralisation and Visualisation
AWP	Annual Work Plan
BEMU	Battery Electric Multiple Unit
BIM	Building Information Modelling
CA	Commitment Appropriation
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CBM	Condition-Based Maintenance
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)
ER JU	Europe's Rail Joint Undertaking
ERRAC	European Rail Research Advisory Council
ERTMS	European Rail Traffic Management System
ETCS	European Train Controlling System
EU	European Union
FACTs	Flexible AC Transmission Systems
FFFIS	Form Fit Functional Interface Specifications
FIS	Functional Interface Specifications

Abbreviation	
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
MB	Moving block
MFF	Multiannual Financial Framework
MoU	Memorandum of Understanding
N&V	Noise and Vibration
NLOS	Non-line-of-sight
NTP	Network Time Protocol
OC	Open Call
OCORA	Open CCS On-board Reference Architecture
ODM	Operational Data Management
OPEX	Operating Expenditure
OTM	On Track Machine
PA	Payment Appropriation
PPP	Public-Private Partnership

Abbreviation	
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	Shift2Rail
SaaS	Software as a Service
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
SPD	System Platform Demonstration
SRG	States Representatives Group
SWL	Single Wagon Load
SteCo	Steering Committee
TAF	Telematic Application for Freight
TAP	Telematic Application for Passengers
TCMS	Train Control and Monitoring System
TC	Tender Call
TD	Technology Demonstrator
TL	Train Load
TMS	Traffic Management System
TRA	Transport Research Arena
TRL	Technology Readiness Level
TSI	Technical Specifications for Interoperability
TSN	Time Sensitive Networking
TSP	Travel Service Providers
UAV	Unmanned Aerial Vehicle
URID	User Requirements Working Group

Abbreviation	
V&V	Verification & Validation
WA	Work Area
WCRR	World Congress on Railway Research

1. INTRODUCTION

The Draft Annual Work Plan and Budget 2022 (AWP 2022) of the Shift2Rail Joint Undertaking (S2R JU) outlines the scope of the Research and Innovation (R&I) activities performed under the S2R programme that will be performed as from 2022. It also details the governance structure of S2R JU and the underpinning 2022 budget. The AWP 2022 further includes a description of the ongoing work in view of the preparation of rail research and innovation activities post-2020, under the new Multiannual Financial Framework (MFF) Programme 2021 – 2027.

With the implementation of the Call 2021, there are no more resources available for commitment for operational activities of the S2R JU (currently no more unused appropriations available). Hence, the AWP 2022 focuses on the execution of the research and innovation activities previously signed and needed to advance to delivering the Technology Demonstrators, including for presenting them at InnoTrans 2022, and in view of reaching Programme targets by 2024. Nevertheless, the completion of the Programme is only a step towards the 2030 targets defined in the Master Plan, which requires the necessary rail industry commitment and Union funding to cover the period till then.

It is another key step towards the digitalization and automation of railway systems, to achieve sustainable (climate neutral, life-cycle cost efficient, connected, integrated through a system approach) mobility for passengers and freight businesses, in line with the ambitious targets of the “Sustainable and Smart Mobility Strategy” of the European Commission¹.

The AWP 2022 shall be read in conjunction with the previous AWP, Annual Activity Reports (AARs) and the work planned in the new S2R JU Multi-Annual Action Plan, finally adopted by the S2R JU Governing Board on 14 November 2019².

In the introduction (Section 1), S2R JU’s background, mission and objectives are described. Section 2 outlines the activities planned for 2022 including the support to operations, the S2R JU governance and internal control framework. Section 3 explains the S2R JU 2021 Budget.

NB: The present document is based on the template provided by the Commission Services, with some adaptations to introduce the specific needs of the S2R JU and to provide an encompassing view to its Governing Board.

1.1 Transition towards Europe’s Rail Joint Undertaking

In 2022, following the foreseen adoption of the EC’s proposal for a Council Regulation establishing the Joint Undertakings under Horizon Europe, it is expected that the current Council Regulation (EU) No 642/2014 of 16 June 2014, establishing the S2R JU (S2R Regulation), will be repealed. As a result, new European Partnership on Rail Research and Innovation, Europe’s Rail Joint Undertaking (ER JU), will be established, becoming the successor of the current S2R JU.

The objective of the ER JU, building upon S2R JU’s achievements, should be 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. This should exploit the huge potential for digitalisation and automation to reduce rail’s costs, increase 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.

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 Decision N° 9/2019 of 14 November 2019

Once becoming operational, a new 2022 Annual Work Plan and Budget for ER JU will be adopted.

1.2 The Shift2Rail Joint Undertaking

The S2R JU was established by S2R Regulation with, in Annex I, the S2R JU Statutes.

The S2R JU is a public-private partnership in the rail sector established under Article 187 of the Treaty on the Functioning of the European Union, providing a platform for the rail sector as a whole to work together with a view to driving innovation in the years to come.

The primary task of the S2R JU is to establish the priority research and innovation activities to accelerate the penetration of integrated, interoperable, and standardised technological innovations to support the Single European Railway Area (SERA) and to achieve operational excellence of the railway system. The European Railway Research Advisory Council (ERRAC) and the European Union Agency for Railways (ERA) consultations contribute to this process. Research activities with impact on ERA activities e.g. the technical specifications for Interoperability (TSIs), vehicle authorisations, safety certification, are always performed in close cooperation with ERA.

In addition, the S2R JU shall manage all rail-focused R&I actions co-funded by the Union, including outside the resources it has directly received.

Rail Research & Innovation (R&I) conducted within the S2R JU must contribute to address the challenges faced by the rail sector, through a comprehensive and coordinated approach to research and innovation focusing on the needs of the rail system and of its users, including in Member States that do not currently have a railway system within their territory.

In addition to the Union, which is a Founding Member, the S2R JU has eight other Founding Members³ and nineteen Associated Members⁴ ('hereinafter jointly referred to as members other than the Union'). The latter were selected following a call for expression of interest to become associated member of the S2R JU⁵.

1.3 Mission and Objectives

The S2R JU is a mission-oriented Programme delivering a major system transformation, bringing railway at the centre of advanced integrated mobility.

The Vision of S2R JU is

To deliver, through railway research and innovation, the capabilities to bring about the most sustainable, cost-efficient, high-performing, time driven, digital and competitive customer-centred transport mode for Europe.

Its mission statement is

"Shift2Rail: moving European railway forward".

³ Consisting of rail equipment manufacturers Alstom Transport, Hitachi Rail STS, Bombardier Transportation, Construcciones y Auxiliar de Ferrocarriles (CAF), Siemens AG, Thales and infrastructure managers Trafikverket and Network Rail

⁴ AERFITEC consortium, Amadeus IT Group SA, AZD Praha s.r.o., CFW consortium, Deutsche Bahn AG, CS GROUP, EUROCC consortium, Faiveley Transport, HaCon Ingenieurgesellschaft mbH, Indra Sistemas S.A., Kontron, Knorr-Bremse GmbH, MER MEC S.p.A., Patentes Talgo S.L., Railenium Swi'TRACK'EN consortium, Smart DeMain consortium, SmartRaCon consortium, SNCF, Virtual Vehicle Austria consortium+

⁵ Commission Decision C(2014) 7084 final

In this respect, its main objective is to implement the S2R JU Programme and R&I activities in the railway sector in Europe, through the collaboration between stakeholders of the entire railway value chain, also outside the traditional rail sector, with particular attention to small and medium-sized enterprises (SMEs), research and technology centres and universities.

The rail R&I activities to be performed within the S2R JU are defined in the its Regulation and Statutes, translated in the strategic S2R Master Plan⁶ and further detailed in the new S2R JU Multi-Annual Action Plan and its evolutions. Overall, the S2R JU shall:

- establish, develop and ensure the effective and efficient implementation of the S2R Master Plan, as referred to in Article 1(4) of the S2R Statutes;
- contribute to the implementation of Horizon 2020 Regulation and in particular part of the Smart, Green and Integrated Transport Challenge under the Societal Challenges pillar of Decision No 2013/743/EU;
- contribute to the achievement of the Single European Railway Area, to a faster and less costly transition to a more attractive, user-friendly (including for persons with reduced mobility), competitive, efficient and sustainable European rail system, and to the development of a strong and globally competitive European rail industry;
- play a major role in rail-related research and innovation, ensuring coordination among projects within its overall Programme. It provides all stakeholders with relevant and available information on R&I activities funded across Europe. It shall also manage all rail-focused research and innovation actions co-funded by the Union;
- actively promote the participation and close involvement of all relevant stakeholders from the full rail value chain and from outside the traditional rail industry. In particular, it fosters the involvement of small and medium sized enterprises (SMEs), as defined in Commission Recommendation 2003/361/EC (8);
- develop demonstration projects in interested Member States including those that do not currently have a railway system established within their territory.

The S2R JU shall, more specifically, seek to develop, integrate, demonstrate, and validate innovative technologies and solutions that uphold the strictest safety and security standards, the value of which can be measured against, *inter alia*, the following key performance indicators:

- 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);
- the removal of remaining technical obstacles holding back the rail sector in terms of interoperability, product implementation and efficiency, in particular by endeavouring to close points which remain open in Technical Specifications for Interoperability (TSIs) due to lack of technological solutions and by ensuring that all relevant systems and solutions developed by the S2R JU are fully interoperable and fitted, where appropriate, for upgrading;
- the reduction of negative externalities linked to railway transport, in particular noise, vibrations, emissions and other environmental impacts.

R&I activities are performed by members other than the Union and any other eligible entity co-funded by the S2R JU in accordance with its budget availabilities and in compliance with the Horizon 2020

⁶ <http://ec.europa.eu/transport/modes/rail/doc/2015-03-31-decisionn4-2015-adoption-s2r-masterplan.pdf>

Regulation⁷ and its Rules of Participation⁸. To this end, the S2R JU shall organise calls for proposals for supporting the R&I activities and/or call for tenders, as needed.

As specified in Article 17 of the S2R JU Statutes, up to 70% of the total Union financial contribution to the S2R JU overall budget may be allocated to the R&I activities performed by the S2R JU's members other than the Union and their affiliated entities following competitive and transparent calls for proposals open to them. A minimum of 30% of the total Union financial contribution to the S2R JU overall budget must be implemented through open, competitive calls for proposals or calls for tenders (S2R JU members other than the Union are not eligible).

1.4 R&I priorities

The S2R Master Plan identifies the key strategic priorities, looking at a 2030 horizon, therefore encompassing R&I activities beyond the programmatic period of S2R JU. It proposes a holistic approach of the rail system that takes into consideration the relevant railway subsystems and actors, as well as their complex interaction (system demonstrators).

The revised MAAP adopted by the GB on 14 November 2019 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 presented by the JU at the WCRR 2019. The TDs are organized in the following Innovation Programmes (IPs):

1.4.1 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
- Train Control and Monitoring System
- Carbodyshell
- Running Gear
- Brakes
- Doors and Intelligent access systems
- Train interiors
- Heating, Ventilation and Air Conditioning (HVAC)

⁷ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0104:0173:EN:PDF>

⁸ http://ec.europa.eu/research/participants/data/ref/h2020/legal_basis/rules_participation/h2020-rules-participation_en.pdf

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.

1.4.2 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 to 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 (Wi-Fi, 5G and their future generations), automation, as well as innovative real-time data collection, processing and communication systems. These technologies and practices have the potential to move towards new traffic management concepts (including predictive and adaptive operational control of train movements), 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 Master Plan identifies seven 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
- Traffic Management Evolution
- Automation
- Moving block (MB) and train integrity
- Smart procurement and testing
- Virtual coupling
- Cyber security

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

Since 2019, the Programme integration, with particular regard to the IP2 activities, has also been ensured by a new stream of work (IPx) dedicated to the Functional System Architecture to be derived from a sector shared vision on future rail operations. This work is framed in the project Linx4Rail which takes stock of the input from different initiatives, in particular RCA and OCORA, and it is underpinning the “One Vision CCS” presented by the European Commission Services – DG MOVE at the ERTMS Conference (CCRCC) in October 2019.

1.4.3 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 Master Plan identifies six priority areas in which activities should be undertaken with a view to achieving the ambition of IP3:

- New directions in switches and crossings
- Innovative track design and materials
- Cost-effective Tunnel & Bridge solutions
- Intelligent system maintenance
- Energy efficiency
- Improved station concepts

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

1.4.4 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 this, the IP4 ecosystem aims to integrate and make all possible transport modes and travel services interoperable. In early stages of the Programme, 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.

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.

1.4.5 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 Paper⁹ 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 co-modality/multimodality of freight mobility, i.e. the linkage to other freight modes has to be ensured.

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

1.4.6 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 subsystems and taking into account the interactions between these subsystems.

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.

⁹ WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system COM/2011/0144 final

The S2R Master Plan identifies five 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
- Smart materials and processes
- System integration, safety and interoperability
- Energy and sustainability
- Human capital

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.

1.4.7 IPx - System Architecture, Conceptual Data Model (CDM) and Disruptive Technologies

As indicated in the section dedicated to IP2, since 2018 work has 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, already in 2019 the S2R JU launched its activities related to the development of a Conceptual Data Model (CDM) 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, renewed in 2020 with the Linx4Rail2 project, the S2R JU has now, formally, 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. It will be a cornerstone for coherently framing the R&I results into a system implementable and commonly agreed approach. It will contribute to achieve a major transformation with the creation of an integrated and connected railway system, introduce a structured approach to the functional evolution of the railway systems, integrating within the S2R JU the Members and actors currently not directly involved in the JU, relying on the progress achieved within different stakeholder groupings, or at company level, in view of providing the sector with a shared path and vision of the future operations of rail systems, under the policy leadership of the European Commission and in strict coordination and collaboration with ERA.

Additionally, IPx activities focus on emerging and non-traditional technologies and operational concepts, which will accelerate the pace towards new services to passengers and cargo. The projects in this innovation programme are therefore “open” by nature, with mainly low TRL activities to investigate the impact of new technologies and sciences, such as Blockchain, Artificial Intelligence, IoT, etc., in view of their implementation in rail applications.

2. WORK PLAN AND BUDGET 2022

2.1 Executive Summary

The European Green Deal¹⁰, published in December 2019, presented the Commission's vision for a climate neutral continent in 2050. It foresees that achieving this goal will require mobilising research and fostering innovation in order to bring new technologies and sustainable solutions.

In December 2020, the "Sustainable and Smart Mobility Strategy – putting European transport on track for the future"¹¹ 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 which have a clear impact on the acceleration needed by rail research and innovation to meet them, such as:

- 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.

The Strategy makes clear reference to a future Rail Research and Innovation Programme as part of the MFF 2021 – 2027 to contribute substantially to deliver such targets.

In this context, the S2R JU and its Programme should enhance their impact to meet the expectations of the European citizens as framed in the President priorities, thus contributing to the key actions provided in the Commission's Roadmap¹². In the same context, the S2R JU Programme will continue to assess its contribution to the Sustainable Development Goals of the United Nations and report on them.

In this respect, the MAAP - Part A provides an Executive View clarifies the S2R JU vision and its contribution to delivering European Union societal goals and identifies the associated set of twelve new Innovation Capabilities that the S2R JU will help develop and bring to the market. It describes the S2R JU Programme as a whole, summarising its purpose, structure, methodology and content and focuses on the series of intermediate steps through which it will bring about a radically improved railway system (urban/suburban, regional and high-speed passenger rail, freight), shaping the future mobility of people and goods. These steps will be taken through the development and implementation of the R&I activities planned in the MAAP Part-B, complemented by the commitments identified in the MAAP 2015 if needed, while capturing new technologies and following an European-wide system of systems approach that is novel for the sector.

In 2022, the priorities will be on:

1. delivering the R&I for the ERTMS game changers (telecoms, localization, moving blocks, automation), also in view of their integration in the TSI 2022 package, with the objective to ensure the evolution of the system towards Baseline 3 and its market uptake;
2. implement and obtain final results on the technologies demonstrated through R&I in relevant environment or even system prototypes demonstration in operational environment. In this respect, possible integration of TD (Integrated Technology Demonstrators) will also be fostered in the different IPs, with a view of showing them at InnoTrans 2022;
3. explore new areas and new technologies that will contribute to foster the system transformation of railway;

¹⁰ https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf

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

¹² https://ec.europa.eu/info/sites/info/files/european-green-deal-communication-annex-roadmap_en.pdf

4. continue preparing the successor of the S2R JU, subject to the adoption of the Single Basic Act regulation, with particular reference to the System Pillar, Innovation Pillar and Deployment Coordination Group.

These priorities will build upon the monitoring and review of the 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.

Europe's Rail, the successor of S2R JU, is expected to speed up the development and deployment of innovative technologies (especially digital and automation) to achieve the radical transformation of the rail system and deliver on European Green Deal objectives, for example, shift a substantial part of the 75% of inland freight carried by road towards transport by rail and inland waterways. The partnership will develop solutions that are widely supported across the EU, resulting in a market uptake of up to 75% by 2030, improving the competitiveness of rail and supporting the European technological leadership in rail.

All activities embedded within the S2R ongoing Members' and OC' projects, latest projects started in 2021, and expected to be phased out between 2023 and early 2024.

In the domain of stakeholder management and external relations, stakeholders include European and national decisionmakers, S2R JU Members, other participants to the JU activities, European and national funding bodies, and also forwarders, carriers as well as the transport and passenger traffic associations.

The year 2022 will seek the continuation of the close collaboration established between the S2R JU and:

- the European Railway Research Advisory Council (ERRAC),
- the European Union Agency for Railways (ERA),
- other programme and partnerships, such as the FCH JU, SESAR JU, CLEANSKY JU, etc.
- different associations representing the key stakeholders of the rail sector and beyond, in different areas.

Since 2017, the S2R JU has started working on Memorandum of Understandings (MoU) or cooperation agreements with European Regions: two have been signed since then, with the Czech Republic and the region of the Basque Country.

- In addition, MoUs with different organizations and bodies have been signed, such as CUTRIC, CEN/CENELC, ETSI and UIC.

Stakeholder engagement will also continue to be developed within the context of the EU's external Transport Policy.

The S2R JU will continue participating in specific activities, workshops and events in order to advertise, communicate and disseminate the successful achievements of its Partnership. The S2R JU intends to showcase its key achievements at events throughout 2022. Envisaged events for 2022 include the World Congress on Railway Research 2022 (6 – 10 June), InnoTrans 2022 (20 – 23 September), the International Rail Forum and Conference (5 – 7 October), the Transport Research Arena (TRA) 2022 (14-17 November 2022), and the Shift2Rail Innovation Days (planned in Q4).

In 2022, the S2R JU will build on the visibility gained during the European Year of Rail in 2021 to continue conveying the message to European citizens that rail can answer their concerns about unsustainable and unreliable mobility options. The JU's key messages and events will continue to reinforce the objectives of the European Green Deal and the Sustainable and Smart Mobility Strategy,

by disseminating R&I results and showing the future evolution of rail in terms of services for passengers and freight clients.

Together with the European Commission, the S2R JU will support the rotating Presidency of the Council on railway events organized in the different Member States. In the same manner, the S2R JU will interact with the European Parliament, in particular the TRAN and ITRE Committees.

In addition, the S2R JU will:

- continue raising awareness about R&I in railway as an instrument for the industry's sustainability and competitiveness, growth and jobs;
- promote stakeholder engagement;
- promote the S2R JU within the EU Institutional arena;
- maintain a network of press and media contacts;
- pro-actively publish communication material, including monthly newsletters, press releases and ad hoc mailshots;
- manage the S2R JU website and social media;
- continue leading a coherent dissemination strategy;
- prepare the corporate and visual identity of the successor of the S2R JU.

At a corporate level, the S2R JU will ensure an accurate baseline for workloads, costings and staffing levels needed to ensure successful delivery of the Programme. As part of a continuous learning/improving approach, relevant processes within the S2R JU will be configured and managed effectively throughout 2022 to ensure continuity of service delivery.

2022 will also be critical in the phasing in of the next generation of the railway R&I Programme, expected to be under the new Europe's Rail Partnership. In the last five years, the S2R JU has demonstrated the progress achieved through the commitment of its Members and stakeholders. The system transformation to which the S2R JU is expected to substantially contribute does not end with S2R, but it requires 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 S2R JU has proved to be capable of delivering such major transformation, involving legislator, regulator, standardisation bodies and stakeholders.

Finally, the S2R JU will also take direct actions to reduce the Carbon Footprint of its activities and will review the impact that its specific action plan, which has been implemented during 2021, will have achieved.

2.2 Operations

2.2.1 Objectives & indicators

The overall objectives for the S2R JU programme in 2022 are the following:

1. as already mentioned, particular focus will be on the ERTMS Game Changers innovation from the performed R&I activities to be integrated within the TSI 2022 package; similarly, prioritizing and accelerating activities to achieve relevant results in the final high TRL demonstrations in view of a future market implementation;
2. ensure the performance of the "European DAC Delivery Programme", towards the effective implementation of the freight Digital Automated Coupler around Europe;

3. ensure sound budget implementation through the effective and efficient management of operations, in particular through timely monitoring and assessment of technological and operational results, including the necessary financial flows;
4. promote S2R project results and achievements (outcome of R&I activities) through communication and dissemination activities, in cooperation with Industry Members;
5. continue the formalisation of collaborations with specific stakeholders, in particular similar national and/or international programmes and especially with other European regions;
6. ensure the proper transition between S2R JU and its successor Programme, the Europe's Rail Partnership, in particular setting up all its key elements.

An updated overview of demonstrators with a Technology Readiness Level reaching at least 6 (technology demonstrated in relevant environment), many of which are foreseen to be performed starting from 2021, is displayed below, together with the provisional planning for test end.

IP	Research Area	Specific Technological demonstration of	characteristics					Overall high level focus/objective
			Market	Testing time - YEAR start	Testing time - YEAR end	Country	TRL	
IP1	TD1.1 Traction	New Technology Traction Systems	Metro	2022	2022	ES	6/7	New generation traction converter based on advanced semiconductor technologies : Reduction in weight and size and increase in energy efficiency
			Regional	2021	2022	FR	6/7	SiC based powertrain demo on a Regional Train
		New Traction Architectures	High Speed	2021	2022	ES	6/7	Traction motor and traction drive architecture
	TD1.2 Train Control & Monit. System (TCMS)	Wireless TCMS	Metro	2022	2023	ES	6/7	Incorporate wireless technologies to the train communication network solutions (i.e. train backbone, consist network and train to ground communication).
			Regional	2022	2023	DE	6	
		Drive-by-data	Metro	2022	2023	ES	6/7	Provide a train-wide communication network for full TCMS support including the replacement of train lines, connecting safety functions up to SIL4 (incl. signalling).
			Regional	2022	2023	DE	6	
		Functional distribution architecture	Metro	2022	2023	ES	6/7	New architectural concept based on standard framework & application profiles, distributed computing to allow execution of compliant functions on end devices distributed meeting different safety & integrity requirements
			Regional	2022	2023	DE	6	
	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.
		Optimised Materials	Regional	2022	2022	FR	6/7	Composite Antenna Beam: Design of an Antenna Beam out of composite material to reduce weight
		Bogie Control	Generic	2022	2022	AT/DE	6/7	Active wheelset guidance system for reduction of wheelwear and therefore maintenance cost
	TD1.5 Brakes	SIL 3/4 electronic solutions for Brake Control	Urban/Regional	2021	2022	ES	7	Train braking system, based on new architectural HSIL concept, including the replacement of conventional train lines(tbc) and connecting braking safety functions up to SIL4.
		Innovative Friction Pair Solutions		2021	2022	ES	7	High power and eco-friendly friction pairing solution to be tested in a relevant environment
		Adhesion Management	Generic	2021	2022	ES	6	Function of a new adhesion management concept/ function within an relevant environment on a test train
		Electro Mechanic Brake		2022	2023	HU or DE	6	Mechatronic brake actuator
	TD1.6 Door and Intelligent Access system	PRM access and communicating door	Regional	2022	2023	FR, ES	7	New door functionalities like platform detection, passenger detection, passenger protection during boarding aid deployment and retract...
		Light and high comfort door	Regional	2022	2023	FR and/or ES	6	Opening and closing mechanism and the leaves new innovative design: - one door will be based on metallic solutions - another door will be based on composite solutions
	TD1.7 Interiors	New Passengers Interiors	Regional	2022	2023	ES	6	Modular interiors: physical mock-up of a partition and two virtual mock-ups of global concepts
	TD1.8 HVAC	HVAC-Technology with natural gases	Regional	2020	2022	DE	7	Test in real operation on regional trains, suggestion for Standardisation of interfaces, reduction of climatic impact and energy consumption

IP	Research Area	Specific Technological demonstration of	characteristics					Overall high level focus/objective
			Market	Testing time - YEAR start	Testing time - YEAR end	Country	TRL	
IP2	TD2.1 Advanced Communication System	markets applications	Mainline/High Speed	2021	2023	FR/DE	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	
	TD2.4 Safe Train Positioning	functional block integrated into an ERTMS based solution	Regional/Freight	2021	2022	IT	6	Under review for successful Fail Safe Train positioning demonstration innovative solution integrated with an ERTMS based system
	2.5 On-board Train Integrity	On-Board Train Integrity	Low density traffic lines	2022	2022	CZ	6/7	On-Board Train Integrity, wired on-board communication
		On-Board Train Integrity	Freight	2022	2022	UK	6/7	On-Board Train Integrity, wireless on-board communication and energy harvesting
		On-Board Train Integrity	Regional	2022	2022	IT	6/7	On-Board Train Integrity, wired on-board communication, ETCS backward compatibility.
	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	Connected Driver Advisory System	Generic	2021	2022	IT	6	Prototype that implements the computation of speed profile and driving modalities to feed a Connected Driver Advisory System (C-DAS)
		Conflict Prediction System		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.
		Conflict Detection and Resolution		2020	2022	DE	6	Business service applications for the detection of future conflicts, the presentation of the results to the operator and conflict resolution measures and integration into workflow.
		Application Modules		2020	2022	DE	6	Interaction between the TMS providing indication of asset failure on the Integration Layer + selected features of Operator workstation with 3rd party application HMI
	TD2.10 Smart radio-connected all-in-all wayside objects	Verification of Wireless Low Power Object Controller	Generic	2021	2022	ES	6	Autonomous (energy power) object controller prototype to interface with ERTMS balises, signals and track circuits on areas far from stations.
		Track vacancy detection SWOC		2021	2022	DE	6	Track Vacancy Detection (axle counters) with optional signal management and with safe and secured communication over wireless networks.
		Verification of Multiple Networks Scalable SWOC		2021	2022	IT	6	A prototype of wayside object controller that will be able to communicate using the available heterogeneous wireless public networks (e.g. 2G/3G/4G, satellite, ..)
		Verification of SWOC network for managing WOs demonstrator		2021	2022	N/A	6	SWOC and a Wireless Sensor Network for a safe and secure communication as well as transparent routing for the IXL to the object to be controlled.
		Verification of a LX Smart wayside objects		2021	2022	CZ	6	SWOC connected via radio connection to the IXL or to the level crossing (LX) controller to control wayside objects commonly used at an LX – axle counter, gate signal, warning light, light signal or barrier drive.
		Verification of SWOC for points machines		2021	2022	ES, DE	6	Controlling of point machines with wireless communication, advanced diagnostic features, optimized distribution, low power consumption + autonomous power supply and storage
		Verification of adaptable Wireless sensor Network for way side objects		2021	2022	FR	6	New generation of low-power and resource-constrained wireless sensor networks (WSN) for adaptive data collection and forwarding for railway environment

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	7	Monitoring programme foe S&C including: Geometry and overrunning, casting, novel rail grade, resilient pads, rail fastening system, base plates, switch roller system, etc.
		cast manganese frog with welded bainitic component		2020	2023	FR	7	Experimental evaluation of fatigue of cast manganese-crossing for welding technology to join bainitic with pearlite steel components.
	TD3.2 Next Generation Switch & Crossing System Demonstrator	Low N&V Tramway Crossing	Urban/Suburban	2021	2023	AT	6	Test overall performance of a girder rail swing nose crossing in service for the reduction of N&V
		Autonomous inspection of S&C using drone technology	Generic	2021	2023	UK	6	Use of drones to undertake basic visual inspection and potentially supervisor inspections of S&Cs, specifically in areas non-accessible or visible by other means
		Autonomous repair of S&C using additive manufacturing techniques	Generic	2021	2023	UK	6	Discrete Defect repair (DDR) unit being applied to the automated restoration of worn/ damaged crossings.
		Materials and Components	Generic	2019	2023	UK, SE, FR	4/7	Next generation S&C materials and components tests (i.e. adjustable fastening systems)
		Vertical moving switch		2022	2023	SE	7	New vertical moving switch addressing the main issues of classic horitontal movement of the frog
		TD3.3 Optimised Track System	Transition zone	Generic	2019	2023	SE	5/6
	new slab track		2019		2023	SE	7	test of a Modular Slab track solution reducing maintenance costs
	Innovative use of materials		2019		2023	AT	5/6	test of innovative use of materials and advanced manufacturing techniques
	Laser clad coating on rails		2020		2023	AT	5/6	test of laser clad coatings on rails nearby and on rail joints; laser hardening and laser cladding of worn rail zones
	TD3.4 Next Generation Track System	Contactless EMAT ultrasonic defect detection	Generic	2020	2023	FR	6	Contactless ultrasonic method to identify rail-level defects using the EMAT method
		Rail Defect Repair		2020	2023	UK	7	Thermocouple instrumented trials on process for different rail steel grades
	TD3.5 Proactive Bridge and Tunnel Assessment, Repair and Upgrade Demonstrator	Tunnel improvements	Generic	2020	2023	FR, UK	7	Reduce track and tunnel closure by offsite manufacturing and increase quality
				2020	2023	AT	7	Predict calcite clogging over time
		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.
			High Speed	2020	2023	SE	7	Make high speed traffic possible on existing bridges with proven dynamic properties
		Integrated Technological Demonstrators Asset Management (TD3.6, TD3.7, TD3.8)	Strategic long-term	Generic	2021	2022	PT, UK	6
	Tactical and Operational short term		2021		2022	UK, SE DE NL, ES, FR	6/7	maintenance process and strategies through knowledge extracted from information coming from available data and monitoring systems
	Metro/ Tram Asset Management		Urban/Suburban	2021	2022	IT	7	Demonstrator focusing on minimising maintenance costs, optimising the use of resources while maximising network

IP	Research Area	Specific Technological demonstration of	characteristics					Overall high level focus/objective
			Market	Testing time - YEAR st	Testing time - YEAR en	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	TD5.1 Fleet Digitalization and Automation	Condition based maintenance	Freight	2020	2022	DE	6/7	End-to-end solution for predictive maintenance, including processes, data handling, analytics and dashboards, for locomotives and wagons.
	TD5.2 Digital Transport Management	Improved terminals		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 / SE	6/7	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
		Telematics		2021	2022	SE	7	Demonstration activities of the intelligent wagon based on telematics and electrification
	TD5.4 New Freight Propulsion Concepts	Hybrid / advanced Propulsion		2021	2022	DE, SE	6/7	Demonstration of distributed power (3 Locos) technology developed using LTE with a 700 m heavy coal freight train with loco at the end of the train being remote controlled. Second demonstrator 835 m train.

The list is subject to regular updates to take into consideration the progress of projects and different elements which may influence a demonstration to take place (e.g. necessary authorizations, etc.).

An indicative list of Key Performance Indicators (KPIs) has been elaborated by the European Commission aiming at the establishment of three groups of indicators, namely:

- Horizon 2020 Key Performance Indicators¹³ common to all JTI JUs;
- Indicators for monitoring Horizon 2020 Cross-Cutting Issues¹⁴ common to all JTI JUs;
- Key Performance Indicators specific for the S2R JU, as a result of the new model established in 2018.

The indicative list of KPIs can be consulted in the Annex III to this document.

¹³ Based on Annex II to Council Decision 2013/743/EU

¹⁴ Based on Annex II to Council Decision 2013/743/EU

2.2.2 Risks & mitigations

The table below indicates the main risks associated with the Programme activities and the corporate management of the S2R JU, as well as the corresponding risk mitigation actions. Only risks requiring continuous Executive Director (ED) and, where relevant, S2R JU GB attention and treatment, due to their criticality, are reported.

A new risk assessment exercise was performed in the months of September and October 2021, the results of which are reflected in the present table.

Risk identified	Action plan
Intrinsic to the S2R JU Staff establishment plan, efficiency of operations is impacted by extensive workload, high staff turnover, together with difficulties for S2R JU to attract new people which may result in positions being filled in with delays, shortage of resources especially (during peak moments), and as a consequence, leading to difficulties in getting the work done and achieving the JU's objectives (continuity); this may include a negative impact on employees' motivation.	<ul style="list-style-type: none">- .- Enhancing the planning of activities will allow for better personnel risk management.- Recruitment of short term resources (interim or trainees) has been extended.- 3 different projects in 2021 were organized 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.
Inadequate timing of the new legislative framework (SBA) for Europe's Rail JU becoming effective may lead to having 2 years without calls for proposals for the new Programme under Horizon Europe, thus having 2 years without any major technical activities launched with the JU Members.	<ul style="list-style-type: none">- Continuous follow-up on the developments regarding adoption of the SBA.- To the extent possible, steering of the related negotiations with the respective bodies, members of the new JU, and other interested parties, enabling smooth transition to the new JU.- Preparation of the new templates documents related to the running of the programme under Horizon Europe.- Keeping all staff informed on the current developments and re-prioritising of tasks and activities, if needed, in order to successfully execute the transition.
Operational capability of the JU may be endangered in the transition period due to uncertainty related to timing of the new legislative framework (SBA) becoming effective, having effect on e.g. Europe's Rail JU bodies going operational.	<ul style="list-style-type: none">- Continuous follow-up on the developments regarding adoption of the SBA.- To the extent possible, steering of the related negotiations with the respective bodies, members of the new JU, and other interested parties, enabling smooth transition to the new JU.- Keeping all staff informed on the current developments and re-prioritising of tasks

Risk identified	Action plan
	and activities, if needed, in order to successfully execute the transition.
<p>Impediments during a project (e.g. changes in regulation/ non-achievement of harmonised requirements/unforeseen planning difficulties in resource planning etc.) might lead to the project not being executed in a timely and/or adequate manner preventing S2R solutions to reaching the market.</p> <p>This may in particular include force-majeure events (e.g. COVID) of longer duration which may lead to difficulties in obtaining the necessary authorisation(s) to organise project demonstrations, resulting in non-completion of such activity in the project concerned.</p>	<ul style="list-style-type: none"> - Ensure appropriate implementation/exploitation plans in GA and at TD/IP level + national migration strategies + investigate possible instrument to support deployment at EU level and implement JU strategy/support+regular follow up of S2R standardisation roadmaps + coordination with RASCOP, and also directly with ERA, CEN/CENELEC/ETSI + regular follow up at IPSteCo/SIWG + regular updated with EURID WG + follow up of regulatory environment. - Change management approach (EDPB). - Continuous risk management and risk response (e.g. regular Covid risk assessment at project level). - Revision of AWP/MAAP/MA.
<p>The European Commission's Accounting Officer has notified the JU of the intention to terminate the role of Accounting Officer of the JU, but the treasury function. This seems to be linked to the provisions of the establishment of the Common Back office between the JUs in accordance with the proposal of the European Commission of 23 Feb 2021. There is a risk that the qualitative work performed by the Commission Accounting Officer will not be so easily replaced by the CBO, as it requires skill and competences that are scarce and limited in the JU and overall JUs. There is a risk that the transition process and ramp up phase of the new function would jeopardise the reporting cycle and legal obligations of the JU.</p>	<p>To discuss with DG BUDG the postponement of the termination of the Accounting Officer function to 2023 instead of 2022.</p> <p>Set up with the other JUs without delay the new accounting officer function within the CBO, once the SBA is adopted</p> <p>Outsource the accounting activities, for example to private companies which can also sign off the accounts, while keeping in house the accounting officer</p>

The risks listed here above take in particular consideration the situation of the S2R Programme, which entered in its final phases as from 2021; in this respect, many risks previously listed are not anymore relevant.

2.2.3 Scientific priorities & challenges

The R&I priorities of the S2R JU Programme are described in section 1.3.

The S2R JU published its first calls for proposals on 17 December 2015 and since then and up to 2021; the activities are now engaged in all IPs and TDs are well on their way to perform demonstrations activities, enabling the timely completion of TDs and their further incorporation into Integrated Technology Demonstrators (ITDs), where planned. The impact of the 2020 pandemic is monitored regularly and mitigating measures put in place as necessary.

2.2.4 Operational activities planned in 2022

As pointed out above, no call for proposals is planned to be launched during 2022.

2.2.5 Call for proposals and/or Call for tenders - S2R JU members eligible only

As pointed out above, no call for proposals nor call for tenders are planned to be launched during 2022.

2.2.6 Open call for proposals for non-JU members

As pointed out above, no call for proposals is planned to be launched during 2022.

2.2.7 Call planning

Not applicable, cf. above.

2.2.8 Call for tenders

Not applicable, cf. above.

2.2.9 Dissemination and information about projects results

The results of the ongoing activities and of projects/tenders will be disseminated by the S2R JU via the S2R JU website (the platform for Railway R&I), press releases, newsletters, presentations at internal (EC, S2R JU Governing Board, Scientific Committee, States Representatives Group) and external (conferences, Info days, etc.) stakeholder events, and through social media.

The S2R JU participates 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 2020 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.

The main events where S2R JU will showcase its results in 2022 are: the World Congress on Railway Research 2022 (6 – 10 June), InnoTrans 2022 (20 – 23 September), the International Rail Forum and Conference (5 – 7 October), the Transport Research Arena (TRA) 2022 (14 – 17 November), and the Shift2Rail Innovation Days (planned in Q4). This will require to converge substantial budget for Communication activities and missions on these key events.

2.3 Call management rules

As pointed out above, no call for proposals is included in the AWP 2022.

Nevertheless, for information purposes, to be noted that the S2R JU follows the rules of the European Union's Horizon 2020 framework programme (Horizon 2020) and in particular the Horizon 2020 Rules for participation¹⁵.

2.4 Support to Operations

2.4.1 Communication and events

In order to ensure strong engagement from a wide range of stakeholders, communication must be truly integrated into the overall framework of the S2R JU Programme.

Communication on S2R JU results and their impact on citizens' everyday lives will be one of the focus points of the S2R JU's efforts in 2022. Actions in this area aim to support and demonstrate the added-value of the S2R JU R&I Programme.

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.

S2R JU communication activities aim to:

- **Continue to raise awareness about the S2R JU** among key stakeholders across Europe from the rail sector and beyond, given the ambition of a better integration of rail with other modes for both passengers and freight managers.
- **Support and promote the recognition of S2R JU results at global level** to contribute 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 Innovation Programmes and a thorough analysis of the current and future stakeholder community.
 - Both of the two aforementioned objectives will require close work with different stakeholders and their associations.
- **Promote S2R JU within the EU Institutional arena.** This objective consists of maintaining and further developing political support for the S2R JU from the EU institutions and EU Member States through the promotion of S2R JU, its objectives and achievements. Target audiences for this objective includes the European Parliament and/or the Council and policy-makers in EU Member States, the Committee of the Regions and European Economic and Social Committee. 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. Shift2Rail 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 S2R JU website as well as providing information to projects on Horizon 2020 dissemination tools. This will include assisting to project results dissemination via Shift2Rail newsletter and social media channels.

¹⁵ http://ec.europa.eu/research/participants/data/ref/h2020/legal_basis/rules_participation/h2020-rules-participation_en.pdf

- Pro-actively **publish communication material** with regard to external events and meetings related to the S2R JU. A broad dissemination of factsheets, leaflets, reports and brochures will enhance the visibility of the S2R 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 S2R JU's activities.
- **Manage the S2R JU website, newsletters and social media platforms** in order to stimulate the public interaction on key issues and improve public awareness on S2R JU activities, and prepare the corporate and visual identity of the future Europe's Rail Joint Undertaking.

Further to the above, the S2R JU will rely on key multipliers:

- S2R JU Members, including S2R JU project coordinators, corporate Communication managers and project participants, who will communicate the success of the S2R JU to various audiences;
- ERRAC members, including policy makers and decision-makers;
- Members of the Scientific Committee (SC);
- Local stakeholders;
- Members of the SRG;
- Wider stakeholders reached through S2R JU 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;
- S2R JU staff acting as ambassadors.

The implementation of the communication activities will continue to be supported through a framework contract established with a communication agency/ies, as well as through inter-institutional framework contracts put in place by the European Commission.

2.4.2 Procurement and contracts

In order to reach its objectives and adequately support its operations and infrastructures, the S2R JU 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, the S2R JU makes use of Service Level Agreements (SLAs) concluded with relevant Commission Services and inter-institutional framework contracts (FWC) available to them, as well as established and future synergies with system partnerships.

In 2022, the S2R JU foresees to run several procurement procedures for middle or low-value contracts¹⁶, implement existing FWCs and select individual external experts based on a call for expression of interest (CEI).

Indicative Title	Indicative expenditure (EUR)	Type of procedure	Indicative schedule
Communication and event services and supplies	400,000	Middle or low-value contracts or specific Contracts/order forms implementing a FWC	1Q, 2Q and 3Q 2022

¹⁶ According with Article 43(2) of the new S2R JU Financial Rules adopted by the Governing Board's Decision n° 11/2019 and entered into force on 01/01/2020, for contracts with a value between EUR 60,000 and the thresholds laid down in Article 175 of Regulation (EU, Euratom) 2018/1046 the procedure set out in Section 2 of Chapter 1 Annex I of Regulation (EU, Euratom) 2018/1046 for contracts with a low value not exceeding EUR 60,000 may be used.

Indicative Title	Indicative expenditure (EUR)	Type of procedure	Indicative schedule
Assistance and support of external experts	25,000	Ad-hoc support contracts, not for call evaluation nor review, based on a CEI	1Q and 2Q 2022
Basic Office Furniture	<5,000	Specific Contracts/order forms implementing a FWC	1Q and 2Q 2022
Catering services	10,000	Low-value contracts or specific Contracts/order forms implementing a FWC	1Q and 2Q 2022
IT support and supplies	120,000	Specific Contracts/order forms implementing a FWC or Negotiated procedure for middle or low value contract	1Q and 2Q 2022
Team Building and Training	10,000	Negotiated procedure for low value contract or Specific Contracts/order forms implementing a FWC	1Q and 2Q 2022
Finance and audit	25,000	Specific Contracts/order forms implementing a FWC	1Q and 2Q 2022

This list shall not be considered exhaustive and other procurement procedures may need to be launched within the budgetary limits approved by the S2R JU Governing Board. The Executive Director shall report to the Governing Board about the procedures put in place as part of the AAR 2022.

2.4.3 IT and logistics

The S2R JU has implemented common ICT tools designed and offered by the European Commission on the financial management, human resources management and Horizon 2020 call management. These tools are updated and maintained on a regular basis by the EC; they require continuous input from the side of the S2R JU, on the one hand, in terms of future developments to meet the expectations of the partnership and, on the other hand, to correct mistakes.

Since 2018, the S2R JU has implemented ARES (EC document management system) in order to streamline document flow as well as to ensure their proper archiving and registration and has implemented SYSPER for staff administration in 2019, thereby leveraging on the existing EC infrastructure and processes. The S2R JU has procured on behalf of the other JUs a tool for the management of the GDPR Register, which is used since 2020.

In addition, the S2R JU is making use of the training services offered by the EC on these applications to assure their correct usage and implementation.

The S2R JU is collaborating with the Joint Undertakings located in the White Atrium building under a joint strategic ICT plan. During 2017, the physical infrastructure was moved to private cloud computing. During 2018, with the participation in the Inter-Agency Cloud Framework Contract led by EFSA in Parma, the S2R JU continued using the latest information technology of the cloud in order to maximize the systems uptime, resource availability and staff mobility.

Following the *Data protection impact assessment* (DPIA) work, during 2021 the JUs migrated to Microsoft 365 services to improve the support provided to staff in performing their tasks.

2.4.4 S2R JU Programme Office – HR matters

In 2022, the S2R JU shall be fully staffed with 23 staff members including 2 Seconded National Experts (SNEs). Where needed, the S2R JU will make recourse to CAs or Interim Staff to cover long-term absences, including maternity leaves, after consultation with the Commission Services.

Further details are provided in Section 3 in the Staff Establishment Plan.

In addition to statutory staff members and the SNE's already in place, the S2R JU will also resort to the European Commission's Bluebook trainees. The S2R JU HR function ensures continuous improvement of all HR processes and will continue to develop its internal guidelines, policies and its legal framework, paying particular attention to how EU Staff Regulations' Implementing Rules shall apply to the S2R JU 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 S2R JU Financial Rules.

A new e-recruitment tool, developed and tested in 2021, will be used with a view to streamline the management of selection procedures.

Trainings for staff members will be further developed and social events will be organised in order to reinforce the cohesion of the team.

During 2020, the S2R JU performed a Staff Survey which resulted in an action plan implemented in 2021 via three streams:

- a. Review of the processes implemented, including in view of the new R&I Programme;
- b. A "well being" year long programme, including to support staff, collectively and individually, during the pandemic;
- c. A dedicated training programme to re-think the corporate culture of the organization.

The monitoring of the actions taken in reply to the staff survey will continue in 2022 and a new staff survey will take place with a view to assess the evolution compared to the previous staff survey.

Also, following the remote working experience due to the Covid-19 constraints and subject to any new Implementing Rule adopted by the Commission in this respect, the S2R JU will reconsider its way of working and combination of presence/remote working set-up.

2.4.5 Administrative budget and finance

The European Commission's Accrual Based Accounting system (ABAC) has been rolled out in the S2R JU in 2016 and is used for accounting purposes.

The S2R JU implements the new S2R JU financial rules adopted by the S2R JU Governing Board on 20/12/2019 and entered into force on 1 January 2020, which define powers and responsibility of the

S2R JU Accounting Officer, inter alia. They also make an explicit reference to the possibility that this function could be attributed to the Accounting Officer of the EC.¹⁷

In this respect, the S2R JU Governing Board has also appointed the Accounting Officer of the EC as the Accounting Officer to the JU. In October 2021, the European Commission has notified the JU that it does not intend to perform anymore the role of Accounting Officer, but for the treasury services, as from the end of 2022. The Governing Board will have to assess the situation and set up the necessary measures.

In addition, the S2R JU Governing Board examined at different stages the need for an internal audit capability, in addition to the Internal Audit Service of the Commission (the S2R JU Internal Auditor), and considered that the current processes and procedures provide reasonable assurance on the functioning of the organization.

2.4.6 Data protection

As regards the processing of personal data, the S2R JU 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 S2R JU's Chief Legal Officer assisted by an external contractor since early 2021.

2.5 Governance

The S2R JU is composed of two Executive bodies: the Governing Board and the Executive Director. In addition, there are two advisory bodies: the Scientific Committee and the States Representatives Group.

2.5.1 Governing Board

The S2R JU Governing Board has the overall responsibility for the strategic orientation and the operations of the S2R JU and supervises the implementation of its activities, in accordance with Article 8 of the S2R JU Statutes.

The S2R JU Governing Board was established after the eight Founding Members of the S2R JU other than the Union listed in Annex II to the S2R Regulation, endorsed the S2R JU Statutes and once all founding members, including the Union, nominated their representatives and alternate representatives to the Board.

In accordance with Art. 6 of the S2R JU Statutes, once the process of selection of the Associated Members was completed in late 2015, the representatives of the Associated Members to the S2R JU Governing Board were selected, after nomination by the IP Steering Committees and appointment by the Board. Following this process, the final composition of the S2R JU Governing Board was reached beginning of 2016. The Governing Board is currently composed of two representatives from the Commission, one representative from each of the 8 Founding Members of the S2R JU other than the

¹⁷ Commission Delegated Regulation (EU) 2019/887 on the on the model financial regulation for public-private partnership bodies referred to in Article 71 of Regulation (EU, Euratom) 2018/1046 of the European Parliament and of the Council

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

Union, and 10 representatives of Associated Members. The remaining Associated Members can attend the meeting of the S2R JU Governing Board as observers.

In line with the provisions of the S2R JU Statutes, a representative of the ERA and the chairperson or the vice-chairperson of the States Representatives Group will have the right to attend meetings of the S2R JU Governing Board as observers and take part in its deliberations, but with no voting rights. The chairperson of the Scientific Committee will be invited to attend meetings of the S2R JU Governing Board as an observer and take part in its deliberations, whenever issues falling within its remit are discussed, but has no voting rights.

In 2022, the S2R JU Governing Board is planning to hold three ordinary meetings.

The key activities are listed below:

Key activities in 2022 – timetable	
Approve 2021 Annual Activity Report	Q1
Discuss draft 2023 Annual Work Plan	Q4
Discuss draft budget 2023	Q4
Adopt the key documents for the S2R JU's operations in 2023: 2023 budget and staff establishment plan	Q4

2.5.2 Executive Director

According to Article 10 of the S2R JU Statutes, the Executive Director is the chief executive responsible for the day-to-day management of the S2R JU in accordance with the decisions of the Governing Board. The Executive Director is the legal representative of the S2R JU. The Executive Director is accountable to the Governing Board. He is supported by the S2R JU staff. The mandate of the Executive Director has been renewed in 2021 and it will last till May 2026.

2.5.3 Scientific Committee

According to Article 13 of the S2R JU Statutes, the Scientific Committee is an advisory body to the S2R JU Governing Board. During the year 2021, two meeting of this body are planned.

The tentative key activities are listed below:

Key activities in 2022 – timetable	
17 th Meeting of the SC. The SC would: <ul style="list-style-type: none"> – Provide advice on the results achieved in the previous years and the alignment with the MAAP. 	Q2
18 th Meeting of the SC. The SC would: <ul style="list-style-type: none"> – Provide advice on the scientific priorities to be addressed in the 2023 Annual Work Plan, including links with similar research activities carried out for example in Horizon 2020 and linking to Horizon Europe. – Provide advice to the S2R JU GB on the programme progress of the S2R JU and other strategic issues. 	Q4

As implemented since 2019, the possibility will also exist in 2022 to contract Scientific Committee Members as experts in the review and monitoring of the S2R JU Projects.

2.5.4 States Representatives Group

Following the entry into force of the S2R JU Regulation, Members States and countries associated to the Horizon 2020 framework programme were asked to nominate their representatives to the States Representatives Group (SRG), in accordance with Article 14 of the S2R Statutes. To date, 33 countries have nominated representatives to the Group.

The States Representatives Group shall be involved in particular in the review of information and provision of opinions on the following matters:

- strategic orientation, the S2R Master Plan, and progress towards achievement of the S2R JU targets;
- the S2R JU Annual Work Plans;
- links to Horizon 2020/Horizon Europe and to other Union and Member State funding instruments, including the Connecting Europe Facility and the European Structural and Investment Funds;
- links to the Union rail transport legislation and the goal of achieving a Single European Railway Area;
- involvement of SMEs and relevant actors from outside the traditional rail sector.

The States Representatives Group also provides information to, and acts as an interface within the S2R JU on the following matters:

- a) the status of relevant national or regional research and innovation programmes and identification of potential areas of cooperation, including deployment of relevant technologies to allow synergies and avoid overlaps;
- b) specific measures taken at national or regional levels with regard to dissemination events, dedicated technical workshops and communication activities.

The States Representatives Group may issue, on its own initiative, recommendations or proposals to the S2R JU Governing Board on technical, managerial and financial matters as well as on annual work plans, in particular when those matters affect national or regional interests.

During the year 2022, two meetings of the States Representatives Group are planned (Q2 and Q4).

The tentative key activities are listed below:

Key activities in 2022 – timetable	
16 th Meeting of the SRG. The SRG would: <ul style="list-style-type: none">– Provide advice on the draft 2023 Annual Work Plan.– Provide advice on the results achieved in the previous years and the alignment with the MAAP.	Q2
17 th Meeting of the SRG. The SRG would: <ul style="list-style-type: none">– Provide advice on the priorities to be addressed in the 2023 Annual Work Plan, including links with similar research activities carried out for example in Horizon 2020– Provide advice to the S2R JU GB on the programme progress of the S2R JU and other strategic issues– Provide updated information and discuss initiatives on: regional and national research and innovation programmes to allow synergies; dissemination and communication activities; and deployment activities in relation to S2R JU.	Q4

It is expected that the election of the new SRG Chairperson and Vice-Chairperson may take place by written procedure before the end of 2021 if the new partnership will not be in place.

2.6 Internal Control framework

2.6.1 Financial procedures

In 2016, the S2R JU adopted an ICT tool, ABAC Workflow, to support its financial procedures. At the same time, it adopted its Manual of Financial Procedures including the Financial Circuits applicable to the S2R JU. This Manual of Financial Procedures was further revised in a new version in 2017.

The Manual of Financial Procedures has been designed to guarantee a segregation of duties and to apply the four eyes principle in S2R JU financial transactions. It describes in detail the financial circuits the S2R JU 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 S2R 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. During 2019, the S2R JU implemented the remaining elements of the Internal Control System which had been in place since 2016.

In 2020, in accordance with the revised S2R JU Financial Rules, the S2R JU started implementing a revised Internal Control Framework, following the adoption of the ED Decision on the Adoption of the Shift2Rail Joint Undertaking Internal Control Framework (ED-20-08). The impact of the new internal control framework on the S2R JU financial procedures continues to be assessed, and further adjustments may be introduced, also taken into account experience gained with the implementation of these processes and procedures. For the AAR 2021, the compliance and effectiveness of internal control will be assessed on the basis of the revised Framework.

2.6.2 Ex-ante and ex-post controls

The S2R JU follows the procedures for ex-ante and ex-post control established in its Financial Rules as well as guidelines applicable to Horizon 2020.

The S2R JU is aligning *with the Article 21 of the new S2R Financial Rules* providing that “Each operation shall be subject at least to an ex ante control based on a desk review of documents and on the available results of controls already carried out relating to the operational and financial aspects of the operation”. 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 S2R JU projects and other). In addition to the process’ defined internally, the S2R JU is implementing the Horizon 2020 ex-ante control framework for its grants.

Ex-post controls are defined as the controls executed to verify financial and operational aspects of finalised budgetary transactions *in accordance with Article 22 of the S2R JU Financial Rules*. 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 S2R JU projects include financial audits which are covered by the Horizon 2020 Audit Strategy and administrated by the Common Audit Service (CAS) of the Commission. In July 2021, CAS confirmed the selection for the 2022 local representative audit targets for S2R JU. The S2R JU will report the outcome of the ex-post audits performed in 2021 on the specific sample on its validated cost claims. This reporting will include the error rates identified and applicable to the JUs population.

In addition, the S2R 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 2022, the ex-post review on administrative expenditure will continue to be organised as an annual exercise.

2.6.3 Audits

In accordance with the Article 28 of the Financial Rules applicable to the S2R JU, the internal audit function shall be performed by the Commission's Internal Auditor (IAS).

The internal auditor shall advise the S2R JU on dealing with risks, by issuing independent opinions on the quality of management and control systems and by issuing recommendations for improving the conditions of 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 Q4 2021 the S2R 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. IAS will take this input into account for the preparation of its planning of the audit work for 2022 and for the establishment of the next in-depth risk-assessment and strategic internal audit plan of S2R JU.

The financial audit of the S2R JU 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 S2R 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 his or her findings.

In its annual report on EU Joint Undertakings for the financial year 2020, no major issue was reported by the ECA for the S2R JU.

Two observations were raised for follow-up on:

- The management of conflicts of interests applicable to the bodies of the JUs, requires that up-to-date CVs and conflict of interest declarations of the JU's GB members are published on the JU's website;
- As part of the operational payment control, the ECA audits revealed for two beneficiaries wrong method for the calculation of declared personnel costs and control weakness related to the absence of the beneficiary's validation procedure for the hours declared as worked on the project.

The JU as duly taken note of the observations raised and will therefore carefully follow-up the two findings above in 2022.

Regarding the ex-post audits on grants, the S2R JU is part of the Horizon 2020 common Audit Strategy. The strategy has been developed and implemented by the Common Audit Service of the Commission, as mentioned in the previous section.

2.6.4 Risk Management

During 2021, in accordance with the S2R JU Policy for Risk Management as defined in the Governance and Process Handbook, the S2R JU performed a risk assessment exercise to ensure that the internal control system in place provides the reasonable assurance to achieve the strategic objectives of its Programme, as established in the Master Plan and MAAP. This process reflects the implementation of the new Internal Control Framework.

The management of risks during 2022 will be based on the results of the risk assessment exercise carried out during 2021 (cf. section 2.2.2). In 2022, it is foreseen to run an in-depth risk assessment to identify both operational and non-operational risks that may affect the achievement of the JU's objectives.

3. BUDGET 2022

3.1 Budget information

The S2R JU 2022 Budget takes into consideration the general budget of the Union for 2022, which was adopted on 24 November 2021 and is subject to the adoption of the EU General Budget for 2022 and to the adoption of the S2R JU Governing Board. All figures have been updated during both of these adoption procedures.

The present Budget is based on the initial amounts submitted to the Commission Services in view of the preparation of the Union Draft Budget 2022, duly updated taking into account the final budget availabilities. It might be subject to adjustments considering the appropriations made available by the Union and to amendments to take into account any unexpected elements. Any possible Budget amendment will be subject to the S2R JU Governing Board approval on a proposal from the Executive Director.

The European Union has already provided all the necessary budget (commitment) appropriations till the end of 2024. In accordance with Amendment N1 to the AWP and Budget 2021, some of the budget (commitment) appropriations provided for the Administrative Costs of the JU for the period 2022-2024 have been transferred to Operational Activities. As a result, the Budget 2022 revenues are those provided solely by the Industry Members of the JU.

The budget appropriations included in the Budget 2022 are not foreseen to cover the full financial year 2022, but to ensure the running of the activities till the launch of the new partnership, Europe's Rail JU. Where the new partnership would not be established in the first months of 2022, a budget amendment will be submitted to the Governing Board by the Executive Director to ensure the necessary business continuity of the activities.

Revenue

The S2R JU details three types of revenue in its Budget 2022:

- The contributions from the Union, including the EFTA contribution, which have been provided by the Union by the end of 2021 to cover the period till 2024;
- The contributions from the members other than the EU;
- The un-used appropriations from the previous years.

Expenditure

The amount included in the 2022 Budget takes into account the overall ceiling established in the S2R JU Regulation on the total amount of the S2R JU Running Costs until 2024.

Staff Expenditure (Title 1)

Title 1 includes the following Chapters:

- The full cost of staff in Active Employment for Temporary Agent Staff (110) and Contractual Agents, Interim Staff, trainees and SNEs (111);
- Mission Costs (13);
- Training (15);
- Other Staff Expenditure (19), such as medical service, recruitment, mobility costs and other social expenses.

The estimated expenditure under Title 1 amounts to EUR 770,000 and represents 63% of the total administrative budget. A majority of this amount covers the Salaries & allowances of the S2R JU staff.

Administrative Expenditure (Title 2)

The S2R JU details its staff expenditure into following Chapters to cover the costs of:

- Rental of buildings and associated costs (20)
Amongst which: Rents; Provisions for other charges in relation to housing
- IT Expenditure and technical facilities (21)
Amongst which: Hardware purchases; Software development & purchases; Day-to-day maintenance
- Movable property and associated costs (22)
Amongst which: The purchase / maintenance of office equipment and furniture
- Current Administrative Expenditure (23)
Amongst which: Stationery and office supplies; Petty expenditure; Documentation and library expenditure, subscriptions; Translation, interpretation
- Postage and telecommunications (24)
Amongst which: postage, telephone, internet and mobile communication expenses
- Administrative Board Expenditure (25)
Amongst which: Governing Boards, SRG meetings, SC meetings and other meeting expenditure

- Administrative support services (26)
Amongst which: Experts other than ones related to evaluations and project reviews under operational budget, Beneficiary portal.
- PR and Events (27)
Amongst which: All communication costs of the JU, design and printing or promotional items, organising and attendance of events, website
- Other Infrastructure and operating Expenditure (29)
Amongst which; auditing, studies, ABAC fees and other service fees to support the JU infrastructure

Operational expenditure (Title 3)

This chapter includes all operational expenditure of the S2R JU, only in payment appropriations, necessary to implement the R&I activities signed in previous year's calls for proposals and calls for tenders.

Un-used Appropriations not required in current year (Title 4)

At the time of preparing the AWP 2022, no unused Commitment Appropriations were available and therefore placed under Title 4 to be available for re-activation in future budget years.

Shift2Rail Joint Undertaking Budget 2022

STATEMENT OF REVENUE

Title Chapter	Heading	2020 Budget Executed		% of Budget 2022		2021 Budget A2		2022 Budget		CA Variance 2021/2022		PA Variance 2021/2022	
		CA	PA	CA	PA	CA	PA	CA	PA	EUR	%	EUR	%
9	REVENUE												
9 0	CONTRIBUTIONS												
	CONTRIBUTION FROM THE EUROPEAN UNION	81,839,584	75,997,838		170%	-	41,453,722	-	44,654,066	0	#DIV/0!	3,200,344	7.7%
9 0 0	Administrative Budget	5,317,621	1,056,000	-	86%		1,232,595	-	1,231,145	0	#DIV/0!	(1,449)	(0.1%)
9 0 1	Operational Budget	76,521,963	74,941,838	-	173%		40,221,127	-	43,422,921	0	#DIV/0!	3,201,794	8.0%
	CONTRIBUTION FROM MEMBERS OTHER THAN THE EU	1,706,098	1,056,098	139%	86%	1,232,595	1,232,595	1,231,145	1,231,145	(1,449)	(0.1%)	(1,449)	(0.1%)
9 0 2	Administrative Budget	1,706,098	1,056,098	139%	86%	1,232,595	1,232,595	1,231,145	1,231,145	(1,449)	(0.1%)	(1,449)	(0.1%)
9 3	UN-USED APPROPRIATIONS PREVIOUS YEARS*	6,165,180	3,234,850		18%	12,391,996	25,753,455	-	18,126,076	(12,391,996)	(100.0%)	(7,627,379)	(29.6%)
9 3 0	Un-used appropriations previous years Administrative	552,103	672,281		107%	5,984,663	1,791,648	-	626,076	(5,984,663)	(100.0%)	(1,165,572)	(65.1%)
9 3 1	Un-used appropriations previous years Operational	5,613,077	2,562,570		15%	6,407,332	23,961,807	-	17,500,000	(6,407,332)	(100.0%)	(6,461,807)	(27.0%)
TOTAL REVENUE		89,710,862	80,288,786	7287%	125%	13,624,590	68,439,772	1,231,145	64,011,288	(12,393,445)	(91.0%)	(4,428,484)	(6.5%)

STATEMENT OF EXPENDITURE													
Title Chapter	Heading	2020 Budget Executed				2021 Budget A2		2022 Budget		CA Variance 2021/2022		PA Variance 2021/2022	
		CA	PA			CA	PA	CA	PA	EUR	%	EUR	%
1	STAFF EXPENDITURE												
11	STAFF IN ACTIVE EMPLOYMENT	2,179,951	2,144,913	330%	217%	2,121,000	2,154,300	660,000	990,000	(1,461,000)	(68.9%)	(1,164,300)	(54.0%)
1 1 0	Temporary Agents	728,079	728,079	280%	187%	777,000	777,000	260,000	390,000	(517,000)	(66.5%)	(387,000)	(49.8%)
1 1 1	Contract Agents, Interim Staff, trainees and SNEs	1,451,872	1,416,834	363%	236%	1,344,000	1,377,300	400,000	600,000	(944,000)	(70.2%)	(777,300)	(56.4%)
13	MISSION COSTS	25,009	30,585	125%	102%	46,000	46,462	20,000	30,000	(26,000)	(56.5%)	(16,462)	(35.4%)
15	TRAINING	24,485	15,073	245%	100%	25,000	38,500	10,000	15,000	(15,000)	(60.0%)	(23,500)	(61.0%)
19	OTHER STAFF EXPENDITURE	197,358	202,261	247%	169%	209,500	225,500	80,000	120,000	(129,500)	(61.8%)	(105,500)	(46.8%)
TITLE 1 TOTAL		2,426,802	2,392,832	315%	207%	2,401,500	2,464,762	770,000	1,155,000	(1,631,500)	(67.9%)	(1,309,762)	(53.1%)
2	ADMINISTRATIVE EXPENDITURE												
20	RENTAL OF BUILDINGS AND ASSOCIATED COSTS	316,438	308,125	422%	274%	799,913	321,500	75,000	112,500	(724,913)	(90.6%)	(209,000)	(65.0%)
21	IT EXPENDITURE AND TECHNICAL FACILITIES	207,938	236,187	416%	315%	183,500	235,000	50,000	75,000	(133,500)	(72.8%)	(160,000)	(68.1%)
22	MOVABLE PROPERTY AND ASSOCIATED COSTS	-	-	0%	0%	-	-	2,500	3,750	2,500	#DIV/0!	3,750	#DIV/0!
23	CURRENT ADMINISTRATIVE EXPENDITURE	31,241	30,352	1250%	809%	10,000	13,000	2,500	3,750	(7,500)	(75.0%)	(9,250)	(71.2%)
24	POSTAGE AND TELECOMMUNICATIONS	27,000	21,864	2700%	1458%	5,534	18,500	1,000	1,500	(4,534)	(81.9%)	(17,000)	(91.9%)
25	ADMINISTRATIVE BOARD EXPENDITURE	22,000	6,739	220%	45%	5,000	5,000	10,000	15,000	5,000	100.0%	10,000	200.0%
26	ADMINISTRATIVE SUPPORT SERVICES	69,689	32,786	279%	87%	164,000	75,500	25,000	37,500	(139,000)	(84.8%)	(38,000)	(50.3%)
27	PR AND EVENTS	319,104	236,378	145%	72%	341,000	325,000	220,000	330,000	(121,000)	(35.5%)	5,000	1.5%
29	OTHER INFRASTRUCTURE AND OPERATING EXPENDITURE	154,000	161,220	205%	143%	150,000	172,500	75,145	112,718	(74,855)	(49.9%)	(59,783)	(34.7%)
TITLE 2 TOTAL		1,147,410	1,033,651	249%	149%	1,658,947	1,166,000	461,145	691,718	(1,197,802)	(72.2%)	(474,283)	(40.7%)
TOTAL ADMINISTRATIVE EXPENDITURE (Title 1 and Title 2)		3,574,212	3,426,483	290%	186%	4,060,447	3,630,762	1,231,145	1,846,718	(2,829,302)	(69.7%)	(1,784,044)	(49.1%)

OF EXPENDITURE

Heading	2020 Budget Executed				2021 Budget A2		2022 Budget		CA Variance 2021/2022		PA Variance 2021/2022	
	CA	PA			CA	PA			EUR	%	EUR	%
OPERATIONA EXPENDITURE												
OPERATIONAL EXPENDITURE	80,504,893	57,656,646		95%	9,564,143	46,682,934	-	60,426,695	(9,564,143)	(100.0%)	13,743,761	29.4%
UL	80,504,893	57,656,646		95%	9,564,143	46,682,934	-	60,426,695	(9,564,143)	(100.0%)	13,743,761	29.4%

UNUSED APPROPRIATIONS NOT REQUIRED IN CURRENT YEAR

ADMINISTRATIVE BUDGET	5,301,611	657,896		53%	-	626,076	0	1,241,649	0	#DIV/0!	615,573	98.3%
OPERATIONAL BUDGET	330,146	18,547,761		3738%	-	17,500,000	-	496,226	0	0.0%	(17,003,774)	0.0%
UL	5,631,757	19,205,657		1105%	-	18,126,076	0	1,737,876	0	#DIV/0!	(16,388,201)	(90.4%)

VDITURE	89,710,862	80,288,786	7287%	125%	13,624,590	68,439,772	1,231,145	64,011,288	(12,393,445)	(91.0%)	(4,428,484)	(6.5%)
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Contributions overview

CONTRIBUTIONS OVERVIEW	2020	2021	2022
CONTRIBUTIONS FROM THE UNION (incl EFTA)	81,839,584	0	0
Title 1 and Title 2 (financial)	5,317,621	0	0
Title 3 (financial)	76,521,963	0	0
CONTRIBUTIONS FROM MEMBERS OTHER THAN THE UNION	70,056,896	1,232,595	1,231,145
Title 1 and Title 2 (financial)	1,706,098	1,232,595	1,231,145
Title 3 (in-kind)	68,350,896	0	0
TOTAL CONTRIBUTIONS	151,896,480	1,232,595	1,231,145

Schedule of Payments in 2022

	Commitment Appropriations		Payment Appropriations	
	RAL from earlier years	Budget 2022	Budget 2022	Estimated Budget 2023 and after
2015 Work Plan Operational	0		0	0
2016 Work Plan Operational	0		0	0
2017 Work Plan Operational	4,069,660		3,037,298	1,032,362
2018 Work Plan Operational	1,788,418		9,799,726	0
2019 Work Plan Operational	12,385,077		11,175,017	6,258,986
2020 Work Plan Operational	37,083,699		34,759,439	6,580,688
2021 Work Plan Operational	1,630,000		1,655,215	0
2022 Work Plan Administrative	3,156,811	3,190,950	1,846,718	4,501,043
2022 Work Plan Operational		1,143,987	0	1,143,987
Total	60,113,666	4,334,937	62,273,412	19,517,067

3.2 Staff Establishment Plan

Shift2Rail Joint Undertaking Budget 2022								
STAFF ESTABLISHMENT PLAN								
Establishment plan posts								
Function group and grade	2020				2021		2022	
	Authorised Budget		Filled as of 31/12/2020		Authorised Budget		Authorised Budget	
	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		1				
AD 13								
AD 12								
AD 11								
AD 10						2		2
AD 9		2		2				
AD 8		1		1		1		1
AD 7		1		1		1		1
AD 6								
AD 5								
AD TOTAL	0	5	0	5	0	5	0	5
AST 1-11								
AST TOTAL	0	0	0	0	0	0	0	0
AST/SC 1-6								
AST/SC TOTAL	0	0	0	0	0	0	0	0
TOTAL		5		5		5		5
GRAND TOTAL	5		5		5		5	

(1) The upgrade from AD 14 to AD 15 shall take place only after the adoption of Single Basic Act

External personnel

Contract agents	Authorised 2020	Recruited as of 31/12/2020	Authorised 2021	Authorised 2022
Function Group IV	13	12	13	12
Function Group III	3	3	3	3
Function Group II	1	1	1	1
Function Group I				
TOTAL	17	16	17	16

Seconded National Expert

Seconded National Experts	Authorised 2020	Recruited as of 31/12/2020	Authorised 2021	Authorised 2022
TOTAL	2	2	2	2

4.ANNEXES

4.1 ANNEX III – Indicators and Scoreboard of KPIs

4.1.1 TABLE I - Horizon 2020 Key Performance Indicators¹⁹ common to all JTI JUs

	Correspondence to general Annex 1	Key Performance Indicator	Definition/Responding to question	Type of data required	Data to be provided by	Baseline at the start of H2020 (latest available)	Target at the end of H2020	Automated
INDUSTRIAL LEADERSHIP	12	SME - Share of participating SMEs introducing innovations new to the company or the market (covering the period of the project plus three years);	Based on Community Innovation Survey (?). Number and % of participating SMEs that have introduced innovations to the company or to the market;	Number of SMEs that have introduced innovations;	H2020 beneficiaries through project reporting	n.a. [<u>new approach</u> under H2020]	50%	Yes
	13	SME - Growth and job creation in participating SMEs	Turnover of company, number of employees	Turnover of company, number of employees;	H2020 beneficiaries through project reporting	n.a. [<u>new approach</u> under H2020]	to be developed based on FP7 ex-post evaluation and /or first H2020 project results	Yes
SOCIETAL CHALLENGES	14	Publications in peer-reviewed high impact journals in the area of the JTI	The percentage of papers published in the top 10% impact ranked journals by subject category.	Publications from relevant funded projects (DOI: Digital Object Identifiers); Journal impact benchmark (ranking) data to be collected by commercially available bibliometric databases.	H2020 beneficiaries through project reporting; Responsible Directorate/Service (via access to appropriate bibliometric databases)	n.a. [<u>new approach</u> under H2020]	[<u>On average, 20 publications per €10 million funding (for</u>	Yes

¹⁹ (based on Annex II to Council Decision 2013/743/EU)

	Correspondence to general Annex 1	Key Performance Indicator	Definition/Responding to question	Type of data required	Data to be provided by	Baseline at the start of H2020 (latest available)	Target at the end of H2020	Automated
							<u>all societal challenges]</u>	
	15	Patent applications and patents awarded in the area of the JTI	Number of patent applications by theme; Number of awarded patents by theme	Patent application number	H2020 beneficiaries through project reporting; Responsible Directorate/Service (via worldwide search engines such as ESPACENET, WOPI)	n.a. [<u>new approach</u> under H2020]	On average, 2 per €10 million funding (2014 - 2020) RTD A6	Yes
	16	Number of prototypes testing activities and clinical trials ²⁰	Number of prototypes, testing (feasibility/demo) activities, clinical trials	Reports on prototypes, and testing activities, clinical trials	H2020 beneficiaries through project reporting	n.a. [<u>new approach</u> under H2020]	<u>[To be developed on the basis of first Horizon 2020 results]</u>	Yes
	17	Number of joint public-private publications in projects	Number and share of joint public-private publications out of all relevant publications.	Properly flagged publications data (DOI) from relevant funded projects	H2020 beneficiaries through project reporting; Responsible Directorate/Service (via DOI and manual data input-flags)	n.a. [<u>new approach</u> under H2020]	<u>[To be developed on the basis of first Horizon 2020 results]</u>	Yes
	18*	New products, processes, and methods launched into the market	Number of projects with new innovative products, processes, instruments, methods, technologies	Project count and drop down list allowing to choose the type processes, products, instruments, methods, technologies	H2020 beneficiaries through project reporting	n.a. [<u>new approach</u> under H2020]	<u>[To be developed on the basis of first Horizon 2020 results]</u>	Yes

²⁰ Clinical trials are IMI specific

	Correspondence to general Annex 1	Key Performance Indicator	Definition/Responding to question	Type of data required	Data to be provided by	Baseline at the start of H2020 (latest available)	Target at the end of H2020	Automated
EVALUATION	NA	Time to inform (average time in days) <u>all applicants</u> of the outcome of the evaluation of their application from the final date for submission of completed proposals	To provide applicants with high quality and timely evaluation results and feedback after each evaluation step by implementing and monitoring a high scientific level peer reviewed process	Number of days (average)	Joint Undertaking	FP7 latest know results		Yes
	NA	Time to inform (average time in days) <u>successful applicants</u> of the outcome of the evaluation of their application from the final date for submission of completed proposals		Number of days (average)	Joint Undertaking	FP7 latest know results		Yes
	NA	Redress after evaluations	To provide applicants with high quality and timely evaluation results and feedback after each evaluation step by implementing and monitoring a high scientific level peer reviewed process	Number of redresses requested	Joint Undertaking	FP7 latest know results		
GRANTS	NA	Time to grant measured (average) from call deadline to signature of grants	To minimise the duration of the granting process aiming at ensuring a prompt implementation of the Grant Agreements through a simple and transparent grant preparation process	Cumulatively in days Average under H2020 (days) TTG < 270 days (as % of GAs signed)	Joint Undertaking (automatized)	n.a. [new approach under H2020]		Yes
	NA	Time for signing grant agreements from the date of informing successful applicants (average values)		Average under H2020 (days)	Joint Undertaking	n.a. [new approach under H2020]		Yes

	Correspondence to general Annex 1	Key Performance Indicator	Definition/Responding to question	Type of data required	Data to be provided by	Baseline at the start of H2020 (latest available)	Target at the end of H2020	Automated
AUDITS	NA	Error rate		% of common representative error; % residual error	CAS	n.a. [new approach under H2020]		Yes
	NA	Implementation of ex-post audit results		Number of cases implemented; in total €million; 'of cases implemented/total cases	CAS	n.a. [new approach under H2020]		Yes
PAYMENTS	NA	Time to pay (% made on time) -pre-financing - interim payment -final payment	To optimize the payments circuits, both operational and administrative, including payments to experts	Average number of days for Grants pre-financing, interim payments and final payments; Average number of days for administrative payments; Number of experts appointed	Joint Undertaking	FP7 latest know results	-pre-financing (30 days) - interim payment (90 days) -final payment ((90days)	Yes
HR	NA	Vacancy rate (%)		% of post filled in, composition of the JU staff ²¹	Joint Undertaking	n.a. [new approach under H2020]		
JU EFFICIENCY	NA	Budget implementation/execution: 1. % CA to total budget 2. % PA to total budget	realistic yearly budget proposal, possibility to monitor and report on its execution, both in commitment (CA) and payments (PA), in line with sound financial management principle	% of CA and PA	Joint Undertaking		100% in CA and PA	Yes

²¹ Additional indicators can be proposed/discussed with R.1 and/or DG HR

	Correspondence to general Annex 1	Key Performance Indicator	Definition/Responding to question	Type of data required	Data to be provided by	Baseline at the start of H2020 (latest available)	Target at the end of H2020	Automate d
	NA	Administrative Budget: Number and % of total of late payments	realistic yearly budget proposal, possibility to monitor and report on its execution in line with sound financial management principle	Number of delayed payments % of delayed payments (of the total)	Joint Undertaking			Yes

NOTES:

18* This indicator is not a legally compulsory one, but it covers several additional specific indicators requested for more societal challenges by the services in charge.

4.1.2 TABLE II - Indicators for monitoring H2020 Cross-Cutting Issues²² common to all JTI JUs

Correspondence in the general Annex 2	Cross-cutting issue	Definition/Responding to question	Type of data required	Data to be provided by	Data to be provided in/to	Direct contribution to ERA	Automated
2	Widening the participation	2.1 Total number of participations by EU-28 Member State	Nationality of H2020 applicants & beneficiaries (number of)	H2020 applicants & beneficiaries at the submission and grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes
		2.2 Total amount of EU financial contribution by EU-28 Member State (EUR millions)	Nationality of H2020 beneficiaries and corresponding EU financial contribution	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes
NA		Total number of participations by Associated Countries	Nationality of H2020 applicants & beneficiaries (number of)	H2020 applicants & beneficiaries at the submission and grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes
NA		Total amount of EU financial contribution by Candidate Country (EUR millions)	Nationality of H2020 beneficiaries and corresponding EU financial contribution	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes

²² (based on Annex III to Council Decision 2013/743/EU)

Correspondence in the general Annex 2	Cross-cutting issue	Definition/Responding to question	Type of data required	Data to be provided by	Data to be provided in/to	Direct contribution to ERA	Automated
3	SMEs participation	3.1 Share of EU financial contribution going to SMEs (Enabling & industrial tech and Part III of Horizon 2020)	Number of H2020 beneficiaries flagged as SME; % of EU contribution going to beneficiaries flagged as SME	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report		Yes
6	Gender	6.1 Percentage of women participants in H2020 projects	Gender of participants in H2020 projects	H2020 Beneficiaries through project reporting		YES	Yes
		6.2 Percentage of women project coordinators in H2020	Gender of MSC fellows, ERC principle investigators and scientific coordinators in other H2020 activities	H2020 beneficiaries at the grant agreement signature stage		YES	Yes
		6.3 Percentage of women in EC advisory groups, expert groups, evaluation panels, individual experts, etc.	Gender of memberships in advisory groups, panels, etc.	Compiled by Responsible Directorate/Service /Joint Undertaking based on existing administrative data made available by the CSC		YES	
7	International cooperation	7.1 Share of third-country participants in Horizon 2020	Nationality of H2020 beneficiaries	H2020 beneficiaries at the grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes
		7.2 Percentage of EU financial contribution attributed to third country participants	Nationality of H2020 beneficiaries and corresponding EU financial contribution	H2020 beneficiaries at the grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes

Correspondence in the general Annex 2	Cross-cutting issue	Definition/Responding to question	Type of data required	Data to be provided by	Data to be provided in/to	Direct contribution to ERA	Automated
9	Bridging from discovery to market ²³	9.1 Share of projects and EU financial contribution allocated to Innovation Actions (IAs)	Number of IA projects	Project Office – at GA signature stage he/she will be required to flag on SYGMA. Responsible Directorate/Service (WP coordinator)/Joint Undertaking - via tool CCM2	JU AAR RTD Monitoring Report		Yes
		9.2 Within the innovation actions, share of EU financial contribution focussed on demonstration and first-of-a-kind activities	Topics properly flagged in the WP; follow-up at grant level	Responsible Directorate/Service (WP coordinator)/Joint Undertaking - via tool CCM2	JU AAR RTD Monitoring Report		Yes
NA		Scale of impact of projects (High Technology Readiness Level)	Number of projects addressing TRL ²⁴ between...(4-6, 5-7)?	Joint Undertaking	JU AAR RTD Monitoring Report		
11	Private sector participation	11.1 Percentage of H2020 beneficiaries from the private for profit sector	Number of and % of the total H2020 beneficiaries classified by type of activity and legal status	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report		Yes
		11.2 Share of EU financial contribution going to private for profit entities (Enabling & industrial tech and Part III of Horizon 2020)	H2020 beneficiaries classified by type of activity; corresponding EU contribution	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report		Yes

²³ This indicator (9.2) is initially intended to monitor the Digital Agenda (its applicability could be only partial)

²⁴ TRL: Technology Readiness Level

Correspondence in the general Annex 2	Cross-cutting issue	Definition/Responding to question	Type of data required	Data to be provided by	Data to be provided in/to	Direct contribution to ERA	Automated
12	Funding for PPPs	12.1 EU financial contribution for PPP (Art 187)	EU contribution to PPP (Art 187)	Responsible Directorate/Service	JU AAR RTD Monitoring Report		Yes
		12.2 PPPs leverage: total amount of funds leveraged through Art. 187 initiatives, including additional activities, divided by the EU contribution	Total funding made by private actors involved in PPPs - in-kind contribution already committed by private members in project selected for funding - additional activities (i.e. research expenditures/investment of industry in the sector, compared to previous year)	Joint Undertaking Services	JU AAR RTD Monitoring Report		
13	Communication and dissemination	13.3 Dissemination and outreach activities other than peer-reviewed publications - [Conferences, workshops, press releases, publications, flyers, exhibitions, trainings, social media, web-sites, communication campaigns (e.g radio, TV)]	A drop down list allows to choose the type of dissemination activity. Number of events, funding amount and number of persons reached thanks to the dissemination activities	H2020 Beneficiaries through project reporting	JU AAR RTD Monitoring Report	YES	Yes
14	Participation patterns of independent experts	14.2 Proposal evaluators by country	Nationality of proposal evaluators	Responsible Directorate /Service/Joint Undertaking in charge with the management of proposal evaluation			
		14.3 Proposal evaluators by organisations' type of activity	Type of activity of evaluators' organisations	Responsible Directorate /Service/Joint Undertaking in charge		YES	

Correspondence in the general Annex 2	Cross-cutting issue	Definition/Responding to question	Type of data required	Data to be provided by	Data to be provided in/to	Direct contribution to ERA	Automated
				with the management of proposal evaluation			
NA	Participation of RTOs and Universities	Participation of RTO ²⁵ s and Universities in PPPs (Art 187 initiatives)	<p>Number of participations of RTOs to funded projects and % of the total</p> <p>Number of participations of Universities to funded projects and % of the total</p> <p>% of budget allocated to RTOs and to Universities</p>	H2020 beneficiaries at the grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes
NA	Ethics	The objective is ensuring that research projects funded are compliant with provisions on ethics efficiently	% of proposals not granted because non-compliance with ethical rules/proposals invited do grant (target 0%); time to ethics clearance 5target 45 days) ²⁶	Responsible Directorate /Service/Joint Undertaking	JU AAR RTD Monitoring Report		

Notes:

*H2020 applicants - all those who submitted H2020 proposals

*H2020 beneficiaries - all those who have signed a H2020 Grant Agreement

*Responsible Directorate - DG RTD Directorates and R&I DGs family in charge with management of H2020 activities
Executive Agencies and other external bodies in charge with H2020 activities

*Services -

*Project officer - is in charge of managing H2020 projects in Responsible Directorate/Service including Executive Agencies

²⁵ RTO: Research and Technology Organisation

²⁶ Data relates to pre-granting ethics review. This time span runs in parallel to granting process.

4.1.3 TABLE III - Key Performance Indicators specific for the S2R JU

#	Key Performance Indicator	Objective	Data to be provided by	Baseline at the start of H2020	Target at the end of H2020	Automated
S2R						
1	% reduction in the costs of developing, maintaining, operating and renewing infrastructure and rolling stock and increase energy efficiency compared to "State-of-the-art"	Reduce the life-cycle cost of the railway transport system	JU	"State-of-the-art" 2014	> 50 %	No
2	% increase the capacity of railway segments to meet increased demand for passenger and freight railway services compared to "State-of-the-art" 2014	Enhance the capacity of the railway transport system	JU	"State-of-the-art" 2014	100%	No
3	% decrease in unreliability and late arrivals compared to "State-of-the-art" 2014	Increase in the quality of rail services	JU	"State-of-the-art" 2014	> 50%	No
4	Reduce noise emissions and vibrations linked to rolling stock and respectively infrastructure compared to "State-of-the-art" 2014	Reduce the negative externalities linked to railway transport	JU	"State-of-the-art" 2014	> 3 - 10 dBA	No
5	Addressing open points in TSIs, compared to "State-of-the-art" 2014	Enhance interoperability of the railway system	JU	"State-of-the-art" 2014		No

#	Key Performance Indicator	Objective	Data to be provided by	Baseline at the start of H2020	Target at the end of H2020	Automated
6	Number of Integrated Technology Demonstrators (ITDs) and System Platform demonstrations	Improve market uptake of innovative railway solutions through large-scale demonstration activities	JU	tbd in the Multi-Annual Action Plan		Yes
7	Share of the fund allocated to the different Innovation Programmes and to cross-cutting themes	Ensure that funding covers the railway system as a whole	JU	n.a.	> 80%	No
8	Percentage of topics resulting in signature of GA	Ensure a sufficiently high call topics success rate	JU	n.a.	> 90%	Yes
9	% of resources consumption versus plan (members only)	WP execution by members - resources	JU	n.a.	> 80%	Yes
10	% of deliverables available versus plan (members only)	WP execution by members - deliverables	JU	n.a.	> 80%	Yes

4.1.4 TABLE IV – Initial estimation of Release 4.0 - of the Key Performance Indicators of the Shift2Rail Programme

To be updated at the GB meeting, following the KPI presentation of Release 4

SPD	LCC	Capacity	Punctuality
Target	-50%	+100%	+50%
High Speed	-19% <small>-20%</small> <small>-15%</small> <small>-18%</small>	62% <small>62%</small> <small>69%</small> <small>74%</small>	35% <small>35%</small> <small>29%</small> <small>19%</small>
Regional	-36% <small>-37%</small> <small>-21%</small> <small>-24%</small>	74% <small>74%</small> <small>57%</small> <small>49%</small>	53% <small>53%</small> <small>51%</small> <small>15%</small>
Metro	-18% <small>-18%</small> <small>-16%</small> <small>-18%</small>	25% <small>25%</small> <small>23%</small> <small>28%</small>	n/a <small>n/a</small> <small>n/a</small> <small>19%</small>
Freight	-39% <small>-39%</small> <small>-39%</small> <small>-40%</small>	94% <small>94%</small> <small>42-114%</small> <small>91%</small>	57% <small>57%</small> <small>78%</small> <small>71%</small>

release 3.2

release 2.0

release 1.0

4.2 ANNEX IV – List of Members of S2R JU other than the Union

NAME OF MEMBER	CONSTITUENT ENTITIES OF CONSORTIA	COUNTRY
AERFITEC Consortium	<i>AERNNOVA AEROSPACE S.A.U.</i>	ES
	<i>FIDAMC</i>	ES
	<i>FUNDACION TECNALIA RESEARCH & INNOVATION</i>	ES
ALSTOM Transport SA		FR
Amadeus IT Group SA		ES
Hitachi Rail STS S.p.A.		IT
AZD Praha s.r.o.		CZ
Bombardier Transportation GmbH		DE
Competitive Freight Wagon Consortium (CFW)	<i>Contraffric GmbH</i>	DE
	<i>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)</i>	DE
	<i>Waggonbau Niesky GmbH</i>	DE
	<i>Centro de Estudios e Investigaciones Técnicas (CEIT)</i>	ES
	<i>Verband der Bahnindustrie in Deutschland (VDB)</i>	DE
Construcciones y Auxiliar de Ferrocarriles		ES
Deutsche Bahn AG		DE
CS Group		FR
EUropean Rail Operating community Consortium (EUROC)	<i>Infraestruturas de Portugal, S.A.</i>	PT
	<i>BLS AG</i>	CH
	<i>CP</i>	PT
	<i>Finnish Transport Agency</i>	FI
	<i>ÖBB-Infrastruktur AG</i>	AT

NAME OF MEMBER	CONSTITUENT ENTITIES OF CONSORTIA	COUNTRY
	<i>Polskie Koleje Państwowe S.A. (PKP)</i>	PL
	<i>PRORAIL B.V.</i>	NL
	<i>Schweizerische Bundesbahnen (SBB)</i>	CH
	<i>Slovenske železnice (SZ)</i>	SI
	<i>Türkiye Cumhuriyeti Devlet Demiryolları (TCDD)</i>	TR
Faiveley Transport		FR
HaCon Ingenieurgesellschaft mbH		DE
INDRA SISTEMAS S.A.		ES
Kontron Transportation Austria AG		AT
Knorr-Bremse Systems für Schienenfahrzeuge GmbH		DE
MER MEC S.p.A		IT
Network Rail Infrastructure Limited		UK
Siemens Aktiengesellschaft		DE
Smart DeMain (SDM) consortium	<i>Strukton Rail BV</i>	NL
	<i>ACCIONA INFRAESTRUCTURAS SA</i>	ES
	<i>Deutsches Zentrum für Luft-und Raumfahrt e.V. (DLR)</i>	DE
	<i>Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.</i>	DE
	<i>Centro de Estudios de Materiales y Control de Obra S.A</i>	ES
Smart Rail Control (SmartRaCon) consortium	<i>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)</i>	DE
	<i>Centro de Estudios e Investigaciones Técnicas (CEIT)</i>	ES
	<i>FONDATION DE COOPERATION SCIENTIFIQUE RAILENIUM</i>	FR

NAME OF MEMBER	CONSTITUENT ENTITIES OF CONSORTIA	COUNTRY
	<i>Nottingham Scientific Ltd</i>	UK
Société Nationale des Chemins de Fer Français Mobilités (SNCF Mobilités)		FR
Swi'Tracken consortium	<i>FONDATION DE COOPERATION SCIENTIFIQUE RAILENIUM</i>	FR
	<i>UNIVERSIDADE DO PORTO</i>	PT
	<i>TATASTEEL</i>	FR
	<i>UNIVERSIDAD DEL PAIS VASCO</i>	ES
	<i>UNIVERSIDADE DO MINHO</i>	PT
	<i>VOSSLOH-COGIFER</i>	FR
	<i>INSTITUT FÜR ZUKUNFTSSTUDIEN UND TECHNOLOGIEBEWERTUNG</i>	DE
	<i>EGIS RAIL</i>	FR
	<i>GROUPE EUROTUNNEL SA</i>	FR
	<i>TRONICO ALCEN</i>	FR
Patentes Talgo S.L.U.		ES
THALES		FR
Trafikverket		SE
Virtual Vehicle consortium+ (VVAC+)	<i>Kompetenzzentrum - Das virtuelle Fahrzeug, Forschungsgesellschaft mbH (Virtual Vehicle)</i>	AT
	<i>FCP Firtsch, Chiari & Partner ZT GmbH</i>	AT
	<i>Getzner Werkstoffe GmbH</i>	AT
	<i>Kirchdorfer Fertigteilholding GmbH</i>	AT
	<i>Plasser&Theurer GmbH</i>	AT
	<i>voestalpine Schienen GmbH</i>	AT
	<i>voestalpine VAE GmbH</i>	AT
	<i>Wiener Linien GmbH & Co KG</i>	AT
	<i>AVL List GmbH</i>	AT

NAME OF MEMBER	CONSTITUENT ENTITIES OF CONSORTIA	COUNTRY
	<i>PJM Messtechnik GmbH</i>	AT
	<i>TATRAVAGONKA a.s.</i>	SK
	<i>AC2T research GmbH</i>	AT
	<i>Materials Center Leoben Forschung GmbH</i>	AT