ANNEX to GB decision no 19/2018

ANNUAL WORK PLAN and BUDGET 2019

ADOPTED BY THE S2R JU GOVERNING BOARD ON 4 DEC 2018

11-01-2019: Editorial corrections have been applied on the version adopted by the S2R JU Governing Board on 4 December 2018.

In accordance with the Statutes of the S2R JU annexed to Council Regulation (EU) No 642/2014 and with Article 31 of the Financial Rules of the S2R JU.

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

TABLE OF CONTENTS

LIST OF ACRONYMS 4

1. INTRODUCTION 7

1.1 THE SHIFT2RAIL JOINT UNDERTAKING 7
1.2 MISSION AND OBJECTIVES 8
1.3 R&I PRIORITIES 9
1.3.1 Innovation Programme 1 (IP1): Cost-efficient and reliable trains 10
1.3.2 Innovation Programme 2 (IP2): Advanced traffic management and control systems 10
1.3.3 Innovation Programme 3 (IP3): Cost Efficient and Reliable High Capacity Infrastructure 11
1.3.4 Innovation Programme 4 (IP4): IT Solutions for attractive railway services 12
1.3.5 Innovation Programme 5 (IP5): Technologies for sustainable and attractive European rail freight 12
1.3.6 Cross-cutting themes and activities 14

2. DRAFT ANNUAL WORK PLAN AND BUDGET 2019 15

2.1 EXECUTIVE SUMMARY 15
2.2 OPERATIONS 17
2.2.1 Objectives & indicators 17
2.2.2 Risks & mitigations 18
2.2.3 Scientific priorities & challenges 20
2.2.4 Operational activities planned in 2019 21
2.2.5 Call for proposals and/or Call for tenders - S2R JU members eligible only 22
2.2.6 Open call for proposals for non-JU members 23
2.2.7 Call planning 25
2.2.8 Call for tenders 26
2.2.9 Dissemination and information about projects results 27
2.3 CALL MANAGEMENT RULES 27
2.3.1 Types of calls for proposals 28
2.3.2 List of countries eligible for funding 28
2.3.3 Standard admissibility conditions and related requirements 29
2.3.4 Standard eligibility conditions 29
2.3.5 Types of action: specific provisions and funding rates 29
2.3.6 Evaluation rules 30
2.3.7 Budget flexibility 30
2.3.8 Financial support to third parties 30
2.3.9 Consortium agreement 30
2.3.10 Dissemination and information about projects results 31
2.4 SUPPORT TO OPERATIONS 31
2.4.1 Communication and events 31
2.4.2 Procurement and contracts 33
2.4.3 IT and logistics 34
2.4.4 JU Programme Team – HR matters 35
2.4.5 Administrative budget and finance 35
2.4.6 Data protection 35
2.5 GOVERNANCE 36
2.5.1 Governing Board 36
2.5.2 Executive Director 36
2.5.3 Scientific Committee 37
2.5.4 States Representatives Group 37
2.6 INTERNAL CONTROL FRAMEWORK 38

2.6.1 Financial procedures 38
2.6.2 Ex-ante and ex-post controls 39
2.6.3 Audits 39
2.6.4 Risk Management 40

3. BUDGET 2019 40

3.1 BUDGET INFORMATION 40
3.2 STAFF ESTABLISHMENT PLAN 47

4. ANNEXES 48

4.1 ANNEX I – 2019 CALL FOR PROPOSALS FOR THE JU MEMBERS – TOPIC DESCRIPTIONS 49
4.1.1 S2R-CFM-IP1-01-2019: Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Car body, Running Gear, Brakes, Doors, Modular interiors and HVAC 49
4.1.2 S2R-CFM-IP2-01-2019: Completion of activities for enhanced automation systems (including Freight ATO GoA4), train integrity, object controller. 56
4.1.3 S2R-CFM-IP3-01-2019: Intelligent asset management finalisation 63
4.1.4 S2R-CFM-IP5-01-2019: Smart data-based assets and efficient rail freight operation 67
4.1.5 S2R-CFM-CCA-01-2019: Integrated mobility management (I2M), Energy and Noise & Vibration . 74
4.1.6 S2R-CFM-IPX and CCA-01-2019: Definition of the S2R Conceptual Data Model 83
4.2 ANNEX II – 2019 CALLS FOR NON-JU MEMBERS – TOPIC DESCRIPTIONS 87
4.2.1 S2R-OC-IP1-01-2019: Advanced Car body shells for railways and light material and innovative doors and train modularity 87
4.2.2 S2R-OC-IP1-02-2019: Tools, methodologies and technological development of next generation of Running Gear 95
4.2.3 S2R-OC -IP1-03-2019: Support to the development of technical demonstrators for the next generation of brake systems 101
4.2.4 S2R-OC-IP2-01-2019: Demonstrator development for the use of Formal Methods in railway environment - Support to implementation of CSIRT to the railway sector 104
4.2.5 S2R-OC-IP2-02-2019: Support to development of demonstrator platform for Traffic Management 107
4.2.6 S2R-OC-IP3-01-2019: Future traction power supply for railways and public transport 110
4.2.7 S2R-OC-IP4-01-2019: Complementary Travel Expert Services 112
4.2.8 S2R-OC-IP5-01-2019: Condition-based and preventive maintenance for locomotive bogie 115
4.2.9 S2R-OC-IP5-02-2019: Advanced obstacle detection and track intrusion system for autonomous freight train 117
4.2.10 S2R-OC-CCA-01-2019: Noise & Vibration 119
4.2.11 S2R-OC-IPX-01-2019: Artificial Intelligence (A.I.) for the railway sector 124
4.2.12 S2R-OC-IPX-02-2019: Breaking language barriers 126
4.3 ANNEX III – INDICATORS AND SCOREBOARD OF KPIS 127
4.3.1 TABLE I - Horizon 2020 Key Performance Indicators common to all JTI JUs 127
4.3.2 TABLE II - Indicators for monitoring H2020 Cross-Cutting Issues common to all JTI JUs 132
4.3.3 TABLE III - Key Performance Indicators specific for the S2R JU 137
4.3.4 TABLE IV – Initial Estimation of the Key Performance Indicators of the Shift2Rail Programme ... 139
4.4 ANNEX IV – LIST OF MEMBERS OF S2R JU OTHER THAN THE UNION 140

LIST OF ACRONYMS

Abbreviation	
ABAC	Accrual Based Accounting
ATO	Automatic Train Operation
AWP	Annual Work Plan
AAR	Annual Activity Report
CA	Commitment Appropriation
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CBM	Condition-Based Maintenance
CCA	Cross Cutting Activities
CEI	Call for Expression of Interest
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CFM	Call for Members
(C)COLA	(Common) Collaboration Agreement
CSA	Coordination and support action
D&E	Dissemination and Exploitation Network
DOI	Digital Object Identifier
DRIMS	Dynamic Railway Information Management System
EC	European Commission
ED	Executive Director
EN	European Norm
ERRAC	European Rail Research Advisory Council
ERTMS	European Rail Traffic Management System
ETCS	European Train Controlling System
EU	European Union
ERA or EUAR	European Union Agency for Railways
FACTs	Flexible AC Transmission Systems
FFFIS	Form Fit Functional Interface Specifications
FIS	Functional Interface Specifications
FWC	Framework Contract
GA	Grant Agreement
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GoA	Grade of Automation
H2020	Horizon 2020, EU Framework Programme for Research and Innovation
IA	Innovation Action
IC	Innovation Capabilities
ICT	Information and Communications Technology
IEC	International Electrotechnical Commission
IKAA	in-kind contributions to additional activities
IM	Infrastructure Manager
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
MB	Moving block
MFF	Multiannual Financial Framework
MoU	Memorandum of Understanding
NLOS	non-line-of-sight
NTP	Network Time Protocol
OC	Open Call
ODM	Operational Data Management
OPEX	Operating Expenditure
PA	Payment Appropriation
RCA	Railway Command Control and Signalling Architecture
R&I	Research and Innovation
RU	Railway Undertaking
PPP	Public-Private Partnership
PRM	Persons with Reduced Mobility
PTC	Positive Train Control
PTI	Platform Train Interface
RAL	Unpaid amount
RAMS	Reliability and Maintainability System
RBC	Radio Block Centre
RFID	Radio Frequency Identification
RIA	Research and Innovation Action
RoI	Return of Investment
S2R	Shift2Rail
SC	Scientific Committee
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
TRL	Technology Readiness Level
TSI	Technical Specifications for Interoperability
UAV	Unmanned Aerial Vehicle
URID	User Requirements Working Group
WA	Work Area

1. INTRODUCTION

The Draft Annual Work Plan and Budget 2019 (AWP 2019) of the Shift2Rail Joint Undertaking (S2R JU) outlines the scope of the Research and Innovation (R&I) activities that will be performed as from 2019, implemented through call(s) for proposals and/or call(s) for tenders open to its Members, other than the Union, and third parties. It also details the governance structure of S2R JU and the underpinning 2019 Budget.

It is another key step towards the digitalization and automation of the railway systems, to achieve sustainable (decarbonised, life-cycle cost efficient, connected, integrated through a system approach) mobility for passengers and freight business.

The AWP 2019 shall be read in conjunction with the previous AWPs and Annual Activity Reports (AARs) and the work planned in the S2R Multi-Annual Action Plan (MAAP), including the MAAP Part A – Executive View adopted by the Governing Board on 27 October 2017[1]. At the same time and in parallel, work is progressing on updating the remaining chapter of the MAAP in parallel to ensure policy priorities are reflected as alreay in the present AWP 2019. The present AWP 2019 takes into account the work achieve so far.

In the introduction (Section 1), S2R JU's background, mission and objectives are described. Section 2 outlines the activities planned for 2019 including the support to operations, the S2R JU governance and internal control framework. Section 3 explains the S2R JU 2019 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 JU and to provide an encompassing view to its Governing Board.

1.1 The Shift2Rail Joint Undertaking

The S2R JU was established by Council Regulation (EU) No 642/2014 of 16 June 2014 (S2R Regulation) with, in Annex I, the S2R 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 Area 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.

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.

[1] Decision N° 6/2017 of 27 October 2017

In addition to the Union, which is a Founding Member, the S2R JU has eight other Founding Members[2] and nineteen Associated Members ('hereinafter referred to as Other Members'[3]'). The latter were selected following a call for expression of interest to become associated member of the S2R JU[4]

1.2 Mission and Objectives

The mission of the S2R JU is to coordinate and manage the Union R&I investments in the European rail sector.

In this respect, its main objective is to implement the S2R 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 entreprises (SMEs), research and technology centres and universities.

The rail R&I activities to be performed within the S2R JU are defined in the S2R Regulation and Statutes, translated in the strategic S2R Master Plan[5] and further detailed in the S2R Multi-Annual Action Plan (MAAP)[6] 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 -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 JUJU 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;

---

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

3 AERFITEC consortium, Amadeus IT Group SA, AZD Praha s.r.o., CFW consortium, Deutsche Bahn AG, DIGINEXT, EUROC consortium, Faiveley Transport, HaCon Ingenieurgesellschaft mbH, Indra Sistemas S.A., Kapsch CarrierCom, 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+

4 Commission Decision C(2014) 7084 final

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

6 http://www.shift2rail.org/wp-content/uploads/2013/07/S2R-JU-GB_Decision-N-15-2015-MAAP.pdf complemented by the new MAAP Part A agreed upon by the GB on 27 October 2017, Decision 7/2017

- 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 JUJU 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 Other Members and any other eligible entity co-funded by S2R in accordance with its budget availabilities and in compliance with the Horizon 2020 Regulation[7] and its Rules of Participation[8]. To this end, the S2R JU shall organise calls for proposals for supporting the R&I activities or call for tenders, as needed.

As specified in Article 17 of the S2R 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 Other Members 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 Other Members are not eligible).

1.3 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).

On 27 October 2017, the Governing Board adopted the new MAAP Part A – Executive View which replaces Part 1 and 2 of the MAAP adopted by the Governing Board with Decision No 15/2015 of 27 November 2015. The new MAAP Part A provides an executive view, clarifying the S2R vision and its contribution to delivering European Union societal goals and identifying the associated set of twelve new capabilities that S2R will help develop and bring to the market. It describes the S2R 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, while capturing new technologies and following a European- wide System-of-Ssystems (approach that is novel for the rail sector.

It explains how the MAAP and its detailed activities (as set out in Part B), within the framework of the original S2R Master Plan, are designed to deliver the vision of a radically improved railway system. It also explains the opportunities that this could bring to the railway industry and to society as a whole.

The Innovation Capability delivery strategy and associated implementation plan requires full cooperation between all stakeholders to prioritise and align efforts and resources.

---

[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

As alreadye mentioned, work is progressing on the MAAP Part B to re-focus and prioritize reseach and innovation activities in line with the MAAP Part A. The MAAP Part B details which innovative solutions resulting from Technical Demonstrators (TDs) deliver the Innovation Capabilities (ICs). The TDs are organized in the following Innovation Programmes (IPs):

1.3.1 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 Master Plan identifies seven 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.

In the review process of IP1 a new area of work is included to research on how to address new legislation on the matter of HVAC.

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

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

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

Current systems do not sufficiently take advantage of new technologies and practices, including use of satellite positioning technologies, high-speed, high-capacity data and voice communications systems (Wi-Fi, 4G/Long Term Evolution (LTE) and their future generations), automation, as well as innovative real-time data collection, processing and communication systems, which 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

In July 2018, the infrastructure managers (IM) and railway undertakings (RU) members of the S2R JU brought up a series of concerns about the progress of IP2 as well as some focus areas to deliver the key system transformation that is expected from the S2R Programme in the years to come. In particular, they brought forward the idea of a "railway command, control and signalling architecture" (RCA) that would contribute to a system integrated approach towards IP2 innovative solutions.

This work was discussed in different meetings within IP2 and it was agreed to assess the impact of the RCA on the S2R Programme (IP2 mainly but also IP1 and IP5). The initial content of RCA is expected by mid 2019 and, where needed, it will allow the planning of IP2 in a manner to bring the in depth discussion within the S2R community, so that R&I requirements will meet technology solutions to deliver the next generation of railway systems.

1.3.3 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

1.3.4 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 intermodal 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, the advances in cloud computing, Open Data and Big Data Analytics and the wide dissemination of Internet and social media. The step towards sharing data needs to be considered and progressively developed, using open standards and specifications (including TAP TSI), in order to enable service developers to provide connected travellers with the services they need and expect.

To achieve a full seamless multimodal travel experience, the customers must be able to easily plan, book and purchase door-to-door journeys. Ticketless or multi-application solutions that guarantee interconnectivity no matter where the traveller journey should become the norm. The development of truly multimodal infrastructure, providing for simple and seamless interchanges, including among different transport modes (urban and regional rail, public transport including demand transport, air transport, road transport, cycling and walking), should make transfers easy, comfortable and reliable. For this reason, the timetables should be increasingly integrated across transport modes to allow better modal integration and minimise travellers' inconvenience.

The S2R Master Plan identifies three priority research and innovation areas in which activities should be undertaken with a view to achieving the ambition of IP4:

- Technical framework
- Customer experience applications
- Multimodal travel services

IP4 has been suffering some delays due to the unclarity of the membership status of one of its key partners. The situation has been solved and, taking into consideration the action plan submitted by IP4 Projects, it can be considered that the short delay will be reabsorbed in the year to come.

1.3.5 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 Paper[9] 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

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

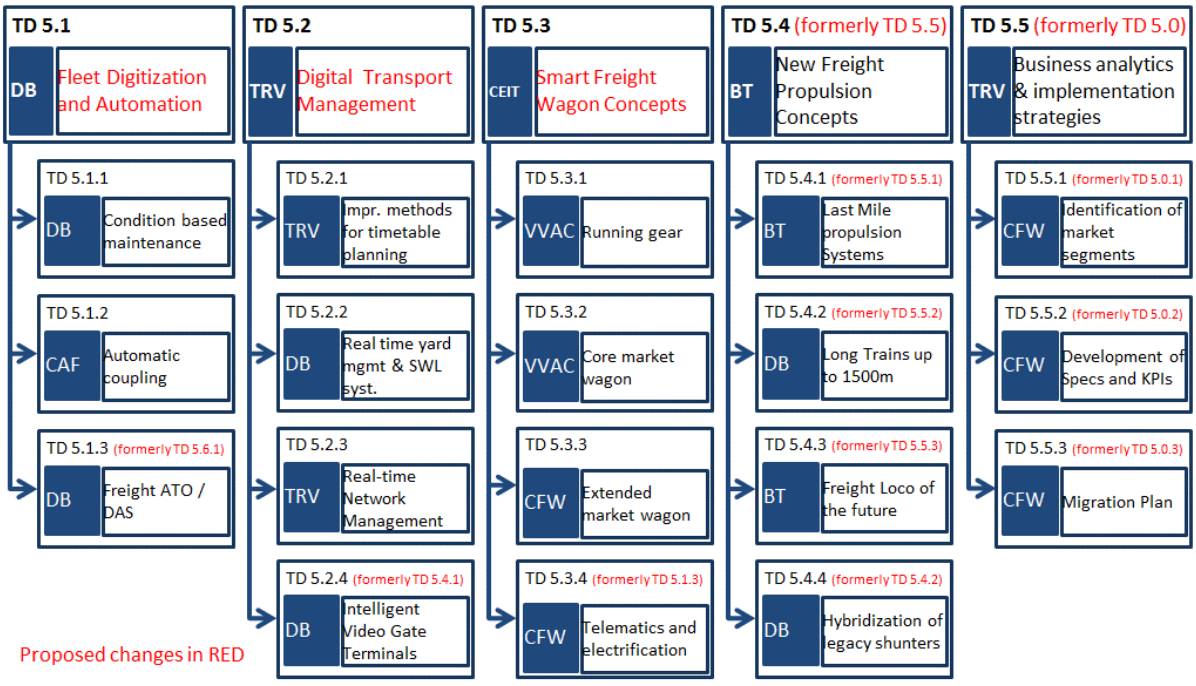
containers/trailer trains and where continued growth can be expected. Reliability, service characteristics and cost competitiveness in this segment can progress significantly with an increase in train length, better length utilisation, innovative rolling stock features for value-added services, progress 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.

The S2R Master Plan identifies eight priority research and innovation areas in which activities should be undertaken with a view to achieving the ambition of IP5:

- Implementation Strategies and Business Analytics
- Freight Electrification, Brake and Telematics
- Access and Operation
- Wagon design
- Novel Terminal, Hubs, Marshalling yards, Sidings
- New Freight Propulsion Concepts
- Sustainable rail transport of dangerous goods
- Long-term vision for an autonomous rail freight system

IP5 has progressed very well in the re-prioritization of its Technology Demonstrators (TDs). While in terms of content no much difference shall be reported, the reorganization of the TDs allows for a more focused and prioritized series of R&I activities, with clear targets towards digitalization, automation and sustainability.

The new draft structure of IP5, although not yet adopted by the Governing Board (GB), includes the following TDs, which are a reference point for the present AWP2019.



1.3.6 Cross-cutting themes and activities

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

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

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

In addition, system aspects shall evolve including automation and security.

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

2. DRAFT ANNUAL WORK PLAN AND BUDGET 2019

2.1 Executive Summary

On 27 October 2017, the S2R JU published the new MAAP Part A. It provides an Executive View, clarifying the S2R vision and its contribution to delivering European Union societal goals and identifying the associated set of twelve new Innovation Capabilities that the S2R JU will help develop and bring to the market. It describes the S2R 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, while capturing new technologies and following a European wide system of systems approach that is novel for the sector. Building upon the ongoing R&I work framed in the 2015 – 2018 Projects, the AWP 2019 brings, on the one hand, R&I activities to a higher TRL level towards demonstrators and possibly future ITDs (Integrated Technology Demonstrators) and, on the other hand, explores new areas and new technologies that will contribute to foster the system transformation of railway.

More specifically, the R&I projects and activities began in 2015-2016; they were followed by projects launched as from September 2017 and new ones are on the way to start by the end of 2018. With this AWP 2019, 18 new projects will consist of:

- either demonstration with prototypes of new technologies into operation or test facilities,
- or in supporting activities with lower Technology Readiness Level (TRL,), based on new emerging concepts and coming from the digital world, basic science or elsewhere, to pave the way for future research and innovation.

The S2R JU's AWP 2019 describes the R&I activities to be executed by its Other Members and beneficiaries of Open Calls (OCs) in the next years building upon the results coming from ongoing S2R projects.

The 2019 AWP foresees the following operational activities:

- launch of calls for proposals and tenders for a total foreseen value of the action of EUR 1513 million :
    - competitive calls for proposals (IA) for S2R JU Members with a total foreseen value of the actions of EUR 129.5 million (max S2R co-funding EUR 57.5 million);
    - open calls for proposals (RIA and IA), where the S2R JU Members are excluded from participation, with a total foreseen value of the actions of EUR 20.8 million (max S2R co-funding EUR 19.3 million);
    - EUR 0.7 million to implement a framework contract awarded during 2018;
    - a call for tenders up to EUR 0,4 million for technical solutions for intermodal information exchange for freight rail;
- other activities include: monitoring and review of the R&I activities up to EUR 0.8 million.

In the domain of stakeholder management and external relations, stakeholders include European and national decision makers, S2R JU Members, other JU's, potential applicants for calls for proposals and new stakeholders, European and national funding bodies, and also forwarders, carriers and the transport as well as passenger traffic associations.

The year 2019 will see 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),
- different associations representing the key stakeholders of the rail sector and beyond, in different areas.

The ongoing work on collaboration agreements, in the form of a Memorandum of Understanding (MoU) or cooperation agreement, signed by the S2R JU with various European regions and Member States, European and international organizations and bodies will be pursued. In addition to the cooperation agreement signed with SEESARI on 18th September 2018, MoU's are expected to be signed with ETSI and the Czech Republic, and a cooperation agreement with CUTRIC-CRITUC. Further agreements or letters of intent could be foreseen in areas of interest for the programme, e.g. with standard setting organisations or sector organisations that facilite the implementation of the rail related European legal framework (e.g. RNE, etc.).

Stakeholder management will also provide answers to some recommendations included in the S2R Interim Evaluation of 2017. Stakeholder engagement will also continue being 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 worldwide the successful achievements of its Partnership. Building upon the achieved results, the S2R JU intends to show samples of its first achievements at events throughout 2019, such as the Transportion Research Board Annual Meeting, on 13-17 January in Washington DC, the Global Public Transport Summit in Stockholm on 9-12 June 2019 and the 12th World Congress on Railway Research on 28 October- 1^{t} November in Tokyo. The possibility of organizing a S2R Innovation Day dedicated to the research community is also considered.

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 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;
- mobilise applicants for S2R JU Open calls for proposals, with particular focus on SMEs and EU-13 Member States;
- manage the S2R JU website;
- continue leading a coherent dissemination strategy, including a standardisation and regulation roadmap, to foster market uptake.

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 2019 to ensure continuity of service delivery.

The AWP 2019 aims to provide a detailed view of all activities to be undertaken and objectives to be achieved during 2019 to meet these goals, drawing from S2R JU's MAAP and its evolution.

2019 will be also critical in all the discussions related to the next generation of the railway research and innovation programme, as part of the Horizon Europe proposal of the European Commission to the Member States and European Parliament. In the last two 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 in 2020, or 2024, 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.

2.2 Operations

2.2.1 Objectives & indicators

The overall objectives for the S2R programme in 2019 are the following:

- To progress in the R&I activities, taking into account the review of the MAAP performed in 2017 and now progressing on its part B, with the objective of, as far as possible, prioritize and accelerate some activities; this will be achieved through the award of grants/contracts resulting from call(s) for proposals and/or call(s) for tenders;
- To ensure that the 2019 wave of calls for proposal and/or tenders takes due consideration of the relevant results achieved by the ongoing projects and that relevant mechanisms to address it are embedded in the specific agreements and or contracts;
- To ensure that the assessment of intermediary and/or final results and the respective payments are made within the set time limits for the relevant agreements and/or contracts;
- To ensure demonstration activities are duly prepared and performed also in view of the authorisation/certification processes for their testing in operational environments, together with ERA and national authorities;
- To follow up and provide due feedback on the implementation of the Lump Sum Pilot Grants, in line with the simplification measure introduced by the Commission, while providing for sound financial management;
- To contribute to the preparation of railway R&I beyond the present Programme, covering the full spectrum of R&I activities from Blue Sky and fundamental Research to demonstrations and management deployment;
- To monitor and ensure the continuous follow up of the actions agreed at the Governing Board in response to the recommendations of the interim evaluations of the S2R JU.

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

- Horizon 2020 Key Performance Indicators[10] common to all JTI JUs;
- Indicators for monitoring Horizon 2020 Cross-Cutting Issues[11] common to all JTI JUs;
- Key Performance Indicators specific for S2R JU, as a result of the new model established by year end 2018;.
- Additionally, in November 2018, a more specific list of KPIs developed by the S2R CCA IMPACT-2 will be finalized and attached to the AWP 2019 .

They can be consulted in the Annex III to this document.

[10] Based on Annex II to Council Decision 2013/743/EU
[11] 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 financial administration of the JU, as well as the corresponding risk mitigation actions. Only risks requiring continuous Executive Director (ED) - and where relevant, S2R GB attention and treatment, due to their criticality, are reported.

The table results from a Risk Management exercise performed within the S2R JU during Q2 and Q3 2018 and will be further updated during 2019 in accordance with the S2R JU Risk Policy. For this annual exercise, it was decided to take into consideration the Other Members' input, when communicated to the JU, and the overall exercise has been performed with the support of an external advisory company.

Risk identified	Action Plan
Due to the evolving needs of the users and stakeholders' expectations, the MAAP is no longer adequate/in line with stakeholders' acceptance resulting in not achieving the JU's objectives.	In general: • proper planning and regular follow up at IPSteCo/SIWG • projects' control gates • regular reporting to GB, including with the support of the S2R JU advisory groups. At project level: • decision made on consensus based approach in IP Steering Committee (SteCo)/ System Implementation Working Group (SIWG)/GB • use of advisory group in Projects • involvement of SRG • involvement of (User Requirement Implementation and Deployment Working Group (URID-WG).
In accordance with the Horizon 2020 Rules of Participations and considering the resources available on a yearly basis, the Programme shall be implemented through Projects financed by annual grants. Largely, this may result in a piecemeal approach instead of innovative solutions towards a new integrated, connected and automated railway system. This may result in questioning the sound financial management of the implementation process through grants, especially regarding Members already selected through open competition and commitment.	Qualitative mitigating measures are identified and implemented to contain and monitor the identified risks. This is realised through the Governing Board, SIWG and IP SteCos which maintain a Programme view compared to a piecemeal project view. S2R JU will keep on assessing the sound financial management risks and possible adequate measures implemented accordingly.
Interdependencies create delays or inadequacies in the completion of activities in grants that are complementary or prerequisites to grants to be awarded under following AWPs, generating a negative cascading effect.	Ensure, through adequate program management, strengthened monitoring and reporting of projects, including gate reviews to determine whether specific actions need to be taken with regard to a specific project (re-orientation, early closure, etc.).
Cross-project collaboration required to achieve the programme objectives may not be achieved due to 'silo-project management' or restrictions related to 'licenses', 'patents', 'IPR Member's sharing policies' or 'accessibility of past OC project results'.	• significant implication of SIWG • decoupling IP structure from AWP topics • further fostering the use of a common S2R Cooperation Tool and sharing functionalities • dedicated cross-IP meeting • IP coordinators meeting

Risk identified	Action Plan
	• models and guidance from S2R JU • SIWG informal conflict resolutions • simplification of legal structure for collaboration. A S2R JU Common Collaboration Agreement (Common COLA, or 'CCOLA') is under preparation. • in order to ensure connection with national activities, the JU will consider signing specific collaboration agreements with other European and international Organizations, Regions and Member States.
Delays in project execution or other impediments (e.g. staff-resource constraints) might lead to underspending of resources.	• Better monitoring of the consumption • Re-allocation of activities (Revision of activities in the Programme & MAAP) • Monitoring from conception phase of Grant Agreement (GA) until final payment (and multi-annual objective at programme level).
High staff turnover together with difficulties to attract new people (e.g. due to the general 'rivalry for talent') might result in positions being filled in with delays (increased risk during peak moments) and as a consequence leading to difficulties in getting the work done or achieving the JU's objectives; this may include a negative impact on other employees' motivation).	This risk is intrinsic to the S2R JU Staff establishment plan. Nevertheless, within the budget constraints, a career plan for staff has been prepared and business continuity is ensured. In 2018, the Governing Board adopted a revised decision on Learning and Development; implementing policy was adopted in April 2018 by the ED. Enhancing the planning of activities will allow for better risk management. Recruitment of short term resources (interim or trainees) should be aligned accordingly.
Significant cuts in the EU's budget might lead to a decrease in the JU's budget which might result in insufficient (financial) resources to realise the objectives of the JU.	The S2R JU Membership shall put in place all the measures to provide all the elements to the budget authority to reduce such a risk. The S2R JU together with the Other Members are working actively in demonstrating that the S2R Programme is already providing results (TRA, Innotrans, Demo, etc.). Moreover, the available resources will be subject to proper planning and regular follow up with Members and at IPSteCo/SIWG level, Projects control gates level, and subject to regular reporting to the GB.
Lack of adequate dissemination of results may result in suboptimal information reaching the end-user/interested parties, which could compromise the JU's impact.	The S2R JU provided a series of guidelines to the projects and fostered the use of the Horizon 2020 instrument as the Common Dissemination Booster. Proper planning and regular follow up at IPSteCo/SIWG and projects' control gates' levels are ensured.
Characteristics of the project setup (e.g. the project execution team at a task/sub-task level belongs to one and the same private company without applying a broader scope) might result in a project outcome that represents a single company solution and is therefore non-	Demo planning, regular follow up at IPSteCo/SIWG and projects control gates' levels are ensured.

Risk identified	Action Plan
interoperable on a broader spectrum, and is not in line with the philosophy of the JU.	
Difficulties in obtaining the necessary authorisation(s) to organise project demonstrations might provoke a significant delay resulting in the inability to organise these demonstrations or in their partial organization.	Planning anticipation (Demo planning) and regular follow up at IPSteCo/SIWG, ERA involvement and regular reporting to GB are ensured.
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 from reaching the market.	Ensure the following actions: • 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 S2R 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 URID WG • Monitoring of the regulatory environment
The rollout of the developed technologies is not taken into account, but should be already considered at the design stage to reach high market acceptance in a short time-frame.	Project design should consider the identification of a proper business case to accelerate market acceptance, within the overall partnership of the S2R JU.
Risk that a lengthy process leading to a possible S2R2 Programme may negatively impact the ongoing R&I activities, with, on the one hand, Members looking at the future instead of investing on current R&I activities, and, on the other hand, de-commitment in case of negative decision	Transparent and timely involvement of the membership in the next Multiannual Financial Framework (MFF) preparation

2.2.3 Scientific priorities & challenges

The R&I priorities of the S2R Programme are described in section 1.3. This section introduces the priorities which will be important in 2019 and are reflected in the topics included in the 2019 calls for proposals and/or for tenders.

The S2R JU published its first calls for proposals on 17 December 2015 and since then and up to the AWP2018 whose implementation just started, around EUR 280 million of funding has been committeed (+/- 24 months). Moving from initial lower TRLs, the activities are now engaged in all Innovation Programmes and some Technology Demonstrators have started to work on the setting up of the demonstrations activities, enabling the timely completion of TDs and their further incorporation into Integrated Technology Demonstrators.

In 2019, the S2R JU on the basis of the results of the ongoing projects, including the Lighthouse Projects, will launch a call aiming, on the one hand, at reaching the next Technology Readiness Level, thus bringing the Programme closer to completion and, on the other hand, new exploratory research activities that will be looking beyond current approaches and may bring disruptive innovative solution through the implementation of new technologies, artificial intelligence, integrated digitalisation, etc.

The call encompasses topics for proposals to the five Innovation Programmes and the CCA. In this way, both an adequate coverage of the Programme activities and its rail value chain as well as the integration of new actors and components will be ensured.

2.2.4 Operational activities planned in 2019

Following an analysis conducted with the contribution of the IP SteCo's and the SIWG, and after having had a fist consultation with the Scientific Committee (SC), the States Representatives Group (SRG) and ERA, the AWP 2019 includes integrated topics to further enhance the synergies between IPs and CCA.

Overall, the following types of activities have been identified:

- projects progressing up to TRL-7 by 2024 which build on the work conducted in the Lighthouse Projects and the last S2R calls;
- projects achieving lower TRL by 2022, which embed some flexibility and may result in readjusted innovative solutions more adapted to the evolving medium-term needs;
- "blue sky" and fundamental research projects (mostly OC Projects) which may offer the opportunity to plant the seeds of the future R&I work beyond 2020, still in line with the time horizon considered in the Master Plan. This activity in exploratory research is essential to ensure that the railway system evolves to capture the mobility needs of the passengers and logistic aspects beyond addressing identified shortcomings;
- Innovation activities to establish the baseline upon which S2R Innovative solutions will be built, such as those needed to support the implementation of the European Deployment Plan related to ERTMS.

The table below identifies the topics related to the call that the S2R JU is planning to launch in 2019.

Activity	Type of call	Value of the actions (*)	Maximum S2R co-funding (*)	In-kind contribution (*)	Indicative publication date
Call for Proposals	JU members eligible only	129.5	57.5	71.9	Q1 2019
Call for Proposals	Open, JU Members excluded	20.8	19.3	1.5	Q1 2019
Call for Tenders	Open	1.4	1.4	0.0	Q1 & Q2 2019
Operational Experts	Open, including through REA and Call for expression of interest (CEI)	0.5	0.5		
Total		**152.2**	**78.7**	**73.4**	

(*) indicative figures in EUR million

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

This section presents the list of topics that will be included in the call for proposals/call for tenders for JU Members.

In 2019, the S2R JU is planning to issue a call for proposals and/or call for tenders addressed to JU Members only. The budget for this call is estimated at EUR 57.5 million (in S2R co-funding). This amount will be the co-funding estimated to be paid by the S2R JU against R&I activities for EUR 129.5 million (the difference, EUR 71.9 million, corresponds to the indicative minimum value of the net in-kind contributions of the Other Members, which is subject to audit certification).

Detailed topic descriptions are provided in the Annex I to this AWP 2019.

The topics that are included in the calls are broad in nature, but combine tasks which need to be developed in close cooperation and in the same initial timeframe for achieving the long-term objectives included in the S2R Programme.

It is foreseen that the call for proposals will be launched in Q1 2019, with activities expected to start towards year end 2019.

Proposals should be invited against the following topics:

Topic number - IP	Topic name	Type of action and expected TRL	Value of the actions (*)	Maximum S2R co-funding (*)	In-kind contributions from Other Members (*)
S2R-CFM-IP1-01-2019	**Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Carbody, Running Gear, Brakes, Doors, Modular interiors and HVAC**	IA up to TRL7	40,155,423	17,845,070	22,310,353
S2R-CFM-IP2-01-2019	**Completion of activities for enhanced automation systems (including Freight ATO GoA4), train**	IA up to TRL 7	40,435,689	17,969,620	22,466,069

Topic number - IP	Topic name	Type of action and expected TRL	Value of the actions (*)	Maximum S2R co-funding (*)	In-kind contributions from Other Members (*)
	integrity, object controller (IP2 and IP5)				
S2R-CFM-IP3-01-2019	**Intelligent asset management finalisation**	IA up to TRL7	23,133,258	10,280,420	12,852,838
S2R-CFM-IP5-01-2019	**Smart, data-based assets and efficient rail freight operation**	IA up to TRL7	13,061,904	5,804,710	7,257,194
S2R-CFM-CCA-01-2019	**Integrated Mobility Management I2M), Energy and Noise & Vibration**	IA TRL 6	8,179,973	3 635 180	4,544,793
S2R-CFM-IPX/CCA-01-2019	**S2R System Architecture and Conceptual Data Model**	RIA TRL 3/4	4,500,450	2,000,000	2,500,450
TOTAL			**129,466,697**	**57,535,000**	**71,931,697**

(*) indicative figures in EUR

2.2.6 Open call for proposals for non-JU members

This section presents the indicative list of topics that will be included in the open call for proposals for non-JU members, addressing the broader research and innovation community.

In 2019, the S2R JU is planning to issue one call for proposals addressed to non-JU members. The budget for this call is estimated at EUR 19.3 million (in S2R co-funding). This amount will be the co-funding estimated to be paid by the S2R JU against R&I activities for EUR 20.8 million (the difference, EUR 1.5 million, corresponds to the non-funded activities of non-JU Members).

Detailed topic descriptions are provided in the Annex II to this AWP 2019.

It is foreseen that the call for proposals will be launched in Q1 2019, with activities expected to start towards year end 2019.

Proposals should be invited against the following topics:

Topic number - IP	Topic name	Type of action and expected TRL	Value of the actions (*)	Maximum S2R co-funding (*)	Other contributions from non Members (*)
S2R-OC-IP1-01-2019	**Advanced Car body shells for railways and light material and innovative doors and train modularity**	RIA up to TRL5/6	3,550,000	3,550,000	0
S2R-OC-IP1-02-2019	**Tools, methodologies and technological development of next generation of Running Gear**	RIA TRL5/6	2,580,000	2,580,000	0
S2R-OC-IP1-03-2019	**Support to the development of technical demonstrators for the next generation of brake systems**	RIA TRL4	2,130,000	2,130,000	0
S2R-OC-IP2-01-2019	**Demonstrator development for the use of Formal Methods in railway environment and Support to implementation of CSIRT to the railway sector**	RIA TRL 4-5	550,000	550,000	0
S2R-OC-IP2-02-2019	**Support to development of demonstrator platform for Traffic Management**	IA TRL6/7	2,714,286	1,900,000	814,286
S2R-OC-IP3-01-2019	**Future traction power supply for railways and public transport**	RIA TRL3-4	750,000	750,000	0
S2R-OC-IP4-01-2019	**Complementary Travel Expert Services**	RIA TRL 5	3,000,000	3,000,000	0

Topic number - IP	Topic name	Type of action and expected TRL	Value of the actions (*)	Maximum S2R co-funding (*)	Other contributions from non Members (*)
S2R-OC-IP5-01-2019	**Condition-based and preventive maintenance for locomotive bogie**	RIA TRL5/6	1,500,000	1,500,000	0
S2R-OC-IP5-02-2019	**Advanced obstacle detection and track intrusion system for autonomous freight train**	IA TRL 6-7	2,142,857	1,500,000	642,857
S2R-OC-CCA-01-2019	**Noise & Vibration**	RIA TRL 4	1,309,000	1,309,000	0
S2R-OC-IPX-01-2019	**Articial Intelligence (A.I.) for the railway sector**	RIA TRL2/3	300,000	300,000	0
S2R-OC-IPX-02-2019	**Breaking language barriers**	RIA TRL5 - 7	250,000	250,000	0
TOTAL			**20,776,143**	**19,319,000**	**1,457,143**

(*) indicative figures in EUR

2.2.7 Call planning

The S2R JU plans to launch a call for proposals addressed to JU Members and an open call for proposals addressed to non-JU Members. The key activities for the management of the foreseen 2019 calls for proposals are presented in the table below:

2019 Management process for the call for proposals addressed to JU Other Members	Indicative timing
Preparation of the call for proposals	Q4 2018
Publication of the call for proposals	Q1 2019
Deadline for the submission of proposals	Q2 2019
Selection of the experts and evaluation of proposals	Q3 2019
Preparation and signature of S2R Model Grant Agreement for JU members (*)	Q3 and Q4 2019

2019 Management process for the open call for proposals addressed to non-JU members	Indicative timing
Preparation of the call for proposals	Q4 2018
Publication of the call for proposals	Q1 2019
Deadline for the submission of proposals	Q2 2019
Selection of the experts and evaluation of proposals	Q3 2019
Preparation and signature of S2R Model Grant Agreement for non-JU members (*)	Q3 and Q4 2019

(*) Maximum Time to Grant of 8 months from the deadline for the submission of proposals.

A similar timetable will be applied in the case call for tenders will be implemented. The rules applicable to a call for tender will be in compliance with the S2R JU Financial Rules and consequently Title VII of the General EU Financial Regulation[12].

2.2.8 Call for tenders

In 2019, the S2R JU is planning to issue or implement the following call for tenders relevant within the IP2 and IP4/IP5 scopes and within framework of the S2R JU MAAP.

The call for tender (indicated in table '1-contract') is scheduled not later than Q3 2019; they will be subject to the provision of article 33 of the S2R JU Financial Rules No 21/2015 of 11 December 2015.

Number	Subject of tender	Indicative scope	Maximum budget*
1 – contract (tender procedure)	Technical solution for intermodal information exchange for freight	Looking at further innovation possibilities than mere standardisation of data proposing a technical solution able to implement TAF and benefit of it beyond the rail freight sector (e.g. last mile with a truck, consignements from harbours). The starting point should be the results of IP4 interoperable IT framework and methodologies, coupled with the work done in IP5 and with the S2R Conceptual Data Model, that would allow multimodality for passenger without a need of imposing common standards.	350,000
2 – contract (implementation)	Support to ERTMS European Action Plan tp pave the way for the deployment of the future S2R Innovative Solutions	Implementation of a 4-year framework contract with a total estimated value of EUR 8 million. The estimated respective share for 2019 amounts to EUR 0.7 million. This activity aims at supporting the implementation of the ERTMS European Action Plan, published by the European Commission in June 2017. Under the supervision of the JU and together with	700,000 (specific contracts for 2019)

[12] Regulation (EU, Euratom) 2018/1046 on the financial rules applicable to the general budget of the Union, repealing Regulation (EU, Euratom) No 966/2012 (2012 Financial Regulation). Official Journal of the European Union, L 193, 30 July 2018.

		Commission Services (DG Move), inter alia, the contractor will perform tasks such as support the ERA Change Control Management process' and related update of specification documentation (including test specifications); Identification of the existing sets of engineering rules regarding transitions between systems; Contribution to the technical review of trackside deployment of ERTMS in cross-border sections; Contribution to the drafting/updating of technical specifications for upcoming ERTMS communication system set to replace GSM-R and to the appraisal of the impact on interoperability of its roll-out.	
3- contract (tender procedure and implementation)	Strategic support to the S2R JU (open procedure -framework contract)	Ad-hoc activities in view of refocusing the programme and integration of a new architecture	250,000 (specific contracts for 2019)
4- contract (tender procedure)	Ad hoc support from railways associations	2 – 3 tender procedures (low or middle-low contracts)	100,000
Total			**1,400,000**

(*) indicative figures in EUR

2.2.9 Dissemination and information about projects results

The results of the calls for proposals for JU Members and open calls for proposals for non-JU members will be disseminated by the S2R JU via the S2R website (the platform for Railway R&I), press releases, newsletters, presentations at internal (EC, 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 Disemination and Exploitations activities, to ensure that R&I results are integrated with the overall work performed in the rest of Horizon 2020. 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.

In addition to the events the S2R JU is organizing during 2019 (e.g. S2R 2019 Information Day), the JU results will be also be presented at events such as the Transportion Research Board Annual Meeting, on 13-17 January in Washington DC, the Global Public Transport Summit in Stockholm on 9-12 June 2019 and the 12th World Congress on Railway Research on 28 October - 1 November in Tokyo.

2.3 Call management rules

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 participation[13] which apply, unless specified otherwise, to both calls for proposals addressed to JU members and open calls for proposals addressed to non-JU members.

2.3.1 Types of calls for proposals

Article 25 of Horizon 2020 Framework Regulation provides that "(…) *public-private partnerships shall make public funds accessible through transparent processes and mainly through competitive calls, governed by rules for participation in compliance with those of Horizon 2020. Exceptions to the use of competitive calls should be duly justified*".

In light of this and considering that by the end of the duration of the S2R Programme the Union financial contribution to S2R JU shall be allocated in accordance with Article 17(a), (b) and (c) of the S2R Statutes, the S2R JU will publish the necessary calls.

Following the simplification provisions introduced by the Commission on the implementation of Horizon 2020, the S2R JU has decided to enter in a test phase making use of lump sum grants for the call open to its Other Members. The lump sum approach was implemented in 2018 fixing an overall ceiling per topic and leaving it to the candidates submitting proposals to define the level of resources to be requested to achieve the call topic objectives. The use of lump sum will introduce administrative simplification during the reporting phase, while ensuring that the focus will be on R&I progress and content results.

Considering the lessons learned from the implementation of lump sum pilot during the 2018 evaluation and first reporting period, the S2R JU may propose to further continue in 2019 with Call for proposals that will take the form of lump sums as defined in Commission Decision C(2017) 7151 of 27 October 2017[14].

In addition, as already foreseen in calls of previous years, in 2019 the S2R Grant Agreements will also include the options regarding 'complementary grants' of the S2R JU Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s). This should ensure the complementary of activities performed in the calls in the interest of the Programme and independently from the nature of the beneficiary. In this respect and as far as possible, the S2R JU may implement the "complementary" concept between calls launched in different years, if deemed necessary for the overall achievement of the objectives of the IPs and/or CCAs.

Complementarity between particular topics is specified within their scope, in Annexes I and II to this AWP 2019.

2.3.2 List of countries eligible for funding

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

[14] Commission Decision on authorising the use of reimbursement on the basis of a lump sum for the eligible costs of actions under the Horizon 2020 Framework Programme for Research and Innovation and under the Research and Training Programme of the European Atomic Energy Community (2014-2018). http://ec.europa.eu/research/participants/data/ref/h2020/other/legal/lump_sum/lumpsumdecision_en.pdf

Part A of the General Annexes to the European Commission (EC) Horizon2020 Work programme 2018-2020 applies[15].

2.3.3 Standard admissibility conditions and related requirements

Part B of the General Annexes to the EC Horizon2020 Work Programme 2018-2020 applies.[16]

2.3.4 Standard eligibility conditions

In line with the distinction between different types of calls for proposals, presented in Section 2.2.4, the JU will distinguish between two types of calls for proposals with specific eligibility conditions:

- competitive calls for proposals, which, pursuant to Article 9.5 of Horizon 2020 Rules for Participation and Article 17.1(a) and (b) of S2R JU Statutes, will restrict the type of beneficiary to JU Members (founding and associated), and their affiliated entities. In the case of Members in the form of consortia or groupings of legal entities, the individual constituent entities of these consortia or groupings, and the affiliated entities of these individual constituent entities, are eligible to participate in the restricted calls for JU Members;
- and open, competitive calls for proposals that, pursuant to Article 9.5 of Horizon 2020 Rules for participation, will be addressed only to entities that are not Members of the S2R JU (founding or associated), nor constituent entities of Members in the form of consortia or groupings, nor affiliated entities either to the S2R JU Members or to the constituent entities of Members in the form of consortia or groupings.

The full list of S2R JU Members and, in the case of Members in the form of consortia or groupings of legal entities, the individual constituent entities of these Members can be found in Annex IV.

Furthermore, Part C of the General Annexes to the EC Horizon 2020 Work Programme 2018-2020 applies[17].

Within the call for proposal for JU Members, in the case of S2R JU Members comprised of several legal entities, such legal entities shall not be deemed independent[18] of each-other in the sense of the eligibility conditions for participation set out in Part C.

2.3.5 Types of action: specific provisions and funding rates

Part D of the General Annexes to the EC Horizon 20202020 Work Programme for 2018-2020 applies.[19]

[15] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

[16] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

[17] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

[18] Art.8 of the H2020 Rules for Participation

[19] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

This means that the funding rate for grants will be 100% of the total eligible costs for research and innovation actions (RIA) and coordination and support actions (CSA), and 70% of the total eligible costs for innovation actions (IA) (except for non-profit legal entities where a rate of 100% applies) [20].

2.3.6 Evaluation rules

Part H of the General Annexes to the EC Horizon 20202020 Work Programme 2018-2020 applies.[21] Selection criteria include 'financial capacity' and 'operational capacity'. Award criteria include 'excellence', 'impact' and 'quality and efficiency of the implementation'.

For full proposals, each award criterion will be scored out of 5. The threshold for individual criteria will be 3. The overall threshold, applying to the sum of the three individual scores, will be 10. For innovation actions, to determine the ranking, the score for the criterion 'impact' will be given a weight of 1.5.

Proposals submitted within the call for proposals for JU members or within the open call for proposals for non-JU members will be evaluated by independent experts, as foreseen by the S2R Regulation in its Article 17.2. The evaluation of award criteria will take into account the coherence of the proposal with the S2R MAAP.

Details on the submission and evaluation process are described in the Grants Manual - Section on: Proposal submission and evaluation.

2.3.7 Budget flexibility

Part I of the General Annexes to the EC Horizon 2020 Work Programme 2018-2020 applies.[22]

2.3.8 Financial support to third parties

Part K of the General Annexes to the EC Horizon 2020 Work Programme 2018-2020 applies for actions performed by non-JU members, supported by the JU[23].

Part K of the General Annexes to the EC Horizon2020 Work Programme 2018-2020 applies for actions performed by JU members, supported by the JU.[24]

2.3.9 Consortium agreement

[20] As set out in Article 28(5) of Regulation (EU) No 1290/2013, the 70% upper limit for innovation actions does not apply to non-profit legal entities.

[21] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

[22] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

[23] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

[24] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

The legal entities wishing to participate in a project shall form a consortium and appoint one of its members to act as its coordinator. They will conclude a Consortium agreement among themselves prior to the signature of the Grant agreement.

Following the introduction of the Lump Sum Pilot with the call of 2018, the respective Consortium Agreements should ensure to accommodate the new process in accordance with the changed provisions in the Lump Sum Grant Agreement.

2.3.10 Dissemination and information about projects results

Part L of the General Annexes to the EC Horizon 2020 Work Programme 2018-2020 applies for actions performed by non-JU Members, supported by the JU[25].

Part L of the General Annexes to the EC Horizon2020 Work Programme 2018-2020 applies for actions performed by JU Members, supported by the JU.[26]

In addition to the dissemination of the results already foreseen in the Horizon 2020 portals, the results of the S2R calls will be disseminated by the S2R JU in accordance with the Communication Strategy adopted by the Executive Director in September 2017.

Together with the Scientific Committee, the S2R JU will investigate as well the possibility to disseminate and showcase the emerging S2R findings and impacts through key academic journals.

With regard to topics related to TSI, on the one hand, the European Union Agency for Railways will ensure the necessary resources are made available to facilitate and accelerate dissemination. On the other hand, the S2R JU will provide the necessary material in a timely manner. Dissemination success is the result of a strong commitment towards innovation.

These channels will also be used to disseminate and communicate significant results of on-going S2R JU 'Lighthouse' projects co-funded following Horizon 2020 2014 call for proposals under the Challenge "Smart, green and integrated transport", call "Mobility for Growth", topic 2. Rail, to which the S2R JU provides technical oversight.

As already mentioned, the S2R JU will participate in the activities of the new working groups of the Dissemination and Exploitation Network (D&E-Net). The D&E is a Horizon 2020 interinstitutional group created to coordinate and facilitate the exchange of best practices for project management between the Joint Undertakingsthrough the creation of a dedicated collaborative platform as well as the organization of joint meetings. D&E-Net will regulary submit progress reports to the Common Support CentreCentre Executive Committee.

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 Programme.

[25] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

[26] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

A major point of attention in communication activities continues to be the need to ensure the involvement of stakeholders from the entire rail value chain, including actors from outside the traditional rail sector.

Communication activities will also focus on promoting S2R results to support and demonstrate the added value of the S2R R&I Programme.

Globally, the communication activities of the S2R JU 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.
- **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.
  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 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. This objective might require the organisation of events inside the European Parliament, the participation in visibility events such as exhibitions, Open Days, and production of publications and presentations of key achievements.
- **Promote the S2R vision and the MAAP Parts A and B**, around which the long term vision of the sector beyond S2R Membership is built.
- **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 website as well as providing information to projects on Horizon 2020 dissemination tools.
- **Support and promote the recognition of results at global level**, including through standards, to contribute to the competitiveness of the European railway industry.
- **Mobilise applicants for S2R JU Open calls for proposals and/or for tenders** across Europe, ensuring a balanced representation of Member States and actors from different stakeholder groups. This will also include the organisation of the S2R Info Day in Brussels, once the S2R call for proposals is open.
- Pro-actively **publish communication material** with regard to external events and meetings related to S2R JU. A broad dissemination of factsheets, leaflets and brochures will enhance the visibility of 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 activity.
- **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.

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

- S2R Members, including S2R project coordinators, corporate Communication managers and project participants, who will communicate the success of S2R to various audiences;
- ERRAC reaching out to policy makers and decision makers inside ERRAC;
- S2R Scientific Committee (SC);
- Local multipliers in the Member States such as States Representative Group reaching out to local stakeholders;

- Information days for stakeholders;
- Major stakeholders present at key events, within and outside the Union;
- S2R 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 interinstitutionnal 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 tender and contract management as effective and cost-efficient as possible, S2R JU makes use of Service Level Agreements (SLAs) concluded with relevant Commission Services and inter-institutional framework contracts (FWC) available to them.

In 2019, the S2R JU foresees to run several tender procedures for low-value contracts[27], implement existing FWC and select individual exteral 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	300,000	Low-value contracts or specific Contracts/order forms implementing a FWC	1Q, 2Q, 3Q and 4Q 2019
Subscriptions to journals & periodicals	Max. 10,000	Negotiated procedure for low-value contracts	
Assistance and support of external experts	100,000	Ad-hoc expert contracts, not for call evaluation nor review, based on a CEI; specific contracts to implement a FWC for strategic support (estimated at EUR 0.5 million in 4 years)	1Q, 2Q, 3Q and 4Q 2019
Basic office furniture	<25,000	Specific Contracts/order forms implementing a FWC	1Q, 2Q, 3Q and 4Q 2019
Catering services	20,000	Low-value contracts or specific Contracts/order forms implementing a FWC	1Q, 2Q, 3Q and 4Q 2019
IT support and supplies	150,000	Specific Contracts/order forms implementing a FWC or Negociated procedure for low value contract	1Q, 2Q, 3Q and 4Q 2019
Team Building and Training	50,000	Negociated procedure for low value contract or	1Q, 2Q, 3Q and 4Q 2019

[27] According with Article of the S2R JU Revised revised financial rules, for contracts with a value between EUR 60,000 and the thresholds laid down in Article 118 of Regulation (EU, Euratom) No 966/2012 (Article 175 of the new Financial Regulation 2018) the procedure set out for contracts with a low value not exceeding EUR 60,000 may be used.

Indicative Title	Indicative expenditure (EUR)	Type of procedure	Indicative schedule
		Specific Contracts/order forms implementing a FWC	
Finance and audit	25,000	Specific Contracts/order forms implementing a FWC	1Q, 2Q, 3Q and 4Q 2019
Legal Assistance	25,000	Negotiated procedure for middle-low value contracts – FWC for 4 year duration, with a total estimated value of 100,000 EUR	Q1 2019

This list shall not be considered exhaustive and other procurement procedures may need to be launched within the budgetary limits approved by the Governing Board. The Executive Director shall report to the Governing Board about the procedures put in place as part of the AAR 2019.

2.4.3 IT and logistics

S2R has implemented common ICT tools designed and offered by the European Commission on the financial 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 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.

In 2018, S2R JU has implemented ARES, the EC document management system, to streamline document flow, ensure proper archiving and registration, and SYSPER for staff administration, thereby leveraging on the existing EC infrastructure and processes.

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

For the calls for proposals in the AWP 2019, the Horizon 2020 IT systems will be used for the publication of the call, as well as for the submission and evaluation of the proposals and grant preparation.

The S2R JU is participation in the joint strategic ICT plan of the Joint Undertakings located in the White Atrium building. 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 will continue leveraging the latest information technology of the cloud to maximize the systems uptime, resource availability, and geographical accessibility, ensuring better business continuity and response globally. It is expected that during 2019, the rationalization process will continue to maximize the limited resources available. The Implementation project to move the entire IT infrastructure from the existing private cloud provider into the Inter-Agency Cloud environment in Germany, shared among other EU Agencies and European bodies commenced in Q3 2018, with go live scheduled by November 2018. A new joint call for tender for local IT support provision and cloud infrastructure management was also launched, with the award scheduled in Q4 2018. The selected ICT service provider will start its activity end 2018 – beginning 2019.

2.4.4 JU Programme Team – HR matters

By 2019, the JU shall be fully staffed with 23 staff members including 2 Seconded National Experts (SNEs). In addition, a third SNE will be hired for one year to replace two Contractual Agents (Programme Managers) on maternity leave. The possibility will be further assessed to extend the duration of the contract of the one-year SNE, subject to budget availabilities. Also, one short-term Contractual Agent will be hired to replace a staff member on long term parental leave.

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 Shift2Rail 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 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 Financial Rules.

2.4.5 Administrative budget and finance

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

Furthermore, the specific Financial Rules, adopted by the S2R JU Governing Board on 30 July 2014, and amended on 15 December 2015, define powers and responsibility of the S2R JU Accounting Officer. They also make an explicit reference to the possibility that this function could be attributed to the Accounting Officer of the EC.

In this respect, the Governing Board of the S2R JU has also appointed the Accounting Officer of the EC as the Accounting Officer to the JU. This appointment is not expected to be revised in 2019. In addition, the Governing Board has 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 (EC) N° 45/2001 of the European Parliament and of the Council of 18 December 2000. A new Data Protection Regulation will enter into force at the end of 2018 in order to be brought in line with the General Data Protection Regulation that enered into force in May 2018. To ensure compliance with the new data protection principles – even before the entry into force of the new Regulation- , the S2R JU requested the services of an external company specialised in EU data protection law.

The role of the data protection officer is exercised by the S2R JU's Legal Adviser. During 2019, the implementation of the new data protection regime will continue*, inter alia*, drafting new S2R JU privacy statements; reviewing data processing operation; updating the data protection register; including the new provisions in grant and contract templates; and providing guidance to S2R staff.

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 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 Governing Board of the JU was established after the 8 Founding Members of the S2R JU other than the Union listed in Annex II to the S2R Regulation, endorsed the S2R 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 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 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 Union, and 10 representatives of associated members. The remaining Associated Members can attend the meeting of the GB as observers.

In line with the provisions of the S2R 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 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 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 2019, the Governing Board is planning to hold three ordinary meetings.

The key activities are listed below:

Key activities in 2019 – timetable	
Adopt 2018 Annual Activity Report	Q1
Decision on proposals for funding from call 2019	Q3
Discuss draft 2020 Annual Work Plan	Q4
Discuss draft budget 2020	Q4
Adopt the key documents for the S2R JU's operations in 2020: 2020 Annual Work Plan, 2020 budget and staff establishment plan	Q4

2.5.2 Executive Director

According to Article 10 of the S2R 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 JU staff.

2.5.3 Scientific Committee

According to Article 13 of the S2R Statutes, the Scientific Committee is an advisory body to the S2R Governing Board. During the year 2019, two meeting of this body are planned.

The tentative key activities are listed below:

Key activities in 2019 – timetable	
11th Meeting of the SC. The SC would: Provide advice on the draft 2020 Annual Work Plan. – Provide advice on the planned calls for proposals and/or for tenders. – Provide advice on the results achieved in the previous years and the alignment with the MAAP.	Q2
12th Meeting of the SC. The SC would: – Provide advice on the scientific priorities to be addressed in the 2020 Annual Work Plan, including links with similar research activities carried out for example in Horizon 2020. – Provide advice to the GB on the programme progress of the S2R and other strategic issues.	Q4

Following different discussions on the effectiveness of the Scientific Committee, the Executive Director will propose to the GB in December 2018 an adjustment of the role of the Scientific Committee, including the possibility to contract the Scientific Committee Members as experts in the review and monitoring of the S2R Projects. This will be implemented as from 2019.

2.5.4 States Representatives Group

Following the entry into force of the S2R Regulation, Members States and countries associated to the Horizon 2020 framework programme were asked to nominate their representatives to the States Representatives Group, 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 and, in particular, review information and provide opinions on the following matters:

- updating of strategic orientation and of the S2R Master Plan and progress towards achievement of its targets;
- the S2R JU Annual Work Plans;
- links to Horizon 2020 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 level 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 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 2019, at least two meetings of the States Representatives Group are planned (Q2 and Q4). The tentative key activities are listed below:

Key activities in 2019 – timetable	
10th Meeting of the SRG. The SRG would: – Provide advice on the draft 2020 Annual Work Plan. – Provide advice on the planned calls for proposals. – Provide advice on the results achieved in the previous years and the alignment with the MAAP.	Q2
11th Meeting of the SRG. The SRG would: – Provide advice on the priorities to be addressed in the 2020 Annual Work Plan, including links with similar research activities carried out for example in Horizon 2020 – Provide advice to the 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

A new Chairperson and Vice-Chairperson of the SRG are elected as of 1st January 2019, for a period of two years.

2.6 Internal Control framework

2.6.1 Financial procedures

In 2016, S2R JU has adopted an ICT tool, ABAC Workflow, to support its financial procedures. At the same time, it has adopted its Manual of Financial Procedures including the Financial Circuits applicable to the 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 eye 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 Cooperation Tool (including for in-kind contribution declarations and certifications), the Governance and Process Handbook, different specific procedures that enhance the

sound financial management in the implementation of the activities. The S2R intends to have the remaining elements of the new Internal Control Framework in place by the end of 2018.

In 2019, in accordance with the adoption of the new Financial Rules 2018, it is expected to consider the implementation of the new Internal Control Framework and assess the impact it may have on the S2R JU financial procedures. In addition, based on the experience gained in the implementation of these processes and procedures, it can be expected that further adjustments will be introduced.

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 and in Horizon 2020 guidelines.

S2R JU is aligning with the Article 18 of the 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 avoid the need for ex-post corrective actions. They are taking 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 projects and other). In addition to the process' defined internally, S2R 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 19 of the S2R Financial Rules. The main objectives of the ex-post controls are to ensure that 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.

S2R JU ex post controls of S2R 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 2019, S2R will report the outcome of the ex-post audits performed on the JU specific sample on its validated cost claims. This reporting will include the error rates identified and applicable to the JUs population.

In addition, the JU has introduced 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. It already took place at Q1 and Q2 2018.

This exercise will be performed on a quarterly basis until 2019, by when remaining weaknesses should have been addressed correctly. From 2019 onwards, the ex-post review will be organised either on a bi-annual or annual basis.

2.6.3 Audits

In accordance with the Article 26 of the Financial Rules applicable to the S2R JU, the internal audit function shall be performed by the Commission's Internal Auditor.

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.

The financial audit of the S2R JU accounts is performed by an external entity 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.

Regarding the ex-post audits on grants, 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.

2.6.4 Risk Management

During 2019, in accordance with the relevant S2R JU Policy, the JU will perform a risk management 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.

3. BUDGET 2019

3.1 Budget information

The S2R JU 2019 Budget is subject to the adoption of the EU General Budget for 2019 and to the adoption of the S2R Governing Board. All figures may be 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 2019, 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 Governing Board approval on a proposal from the Executive Director.

Revenue

S2R JU details three types of revenue in its Budget 2019:

- The contributions from the Union, including the EFTA contribution;
- The contributions from the members other than the EU;
- The un-used appropriations from the previous years.

The revenue includes EUR 0.5 Mio relating to the Expert Evaluators; this amount, although included in the S2R Budget, is managed by the REA Services. Unused amounts will be returned to the S2R JU.

Expenditure

The amount included in the 2019 Budget takes into account the overall ceiling established in the S2R Regulation on the total amount of the S2R JU Running Costs till 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 2,277,000 and represents 69% of the total administrative budget. A majority of this amount covers the Salaries & allowances of the JU staff.

Administrative Expenditure (Title 2)

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

- 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 JU necessary to implement the R&I activities described in the present document.

As already indicated with regard to the Revenues, this chapter also includes EUR 0.5 Mio relating to the Expert Evaluators which is managed by the REA Services.

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

It should be noted that in the 2019 Budget almost all unused appropriations coming from the previous years will be made available for the Operational Activities. It is expected that by the end of the JU, the unused administrative appropriations transferred to the Operational Activities shall be returned to finance the running cost. This will be neutral with respect to the Other Members contributions.

Title 4 details the un-used appropriations not required in the current year and will be carried over to the next year in accordance with S2R Financial Rules.

STATEMENT OF REVENUE

Title / Chapter	Heading	2017 Executed CA	2017 Executed PA	% of Budget 2019 CA	% of Budget 2019 PA	2018 Budget CA	2018 Budget PA	2019 Budget CA	2019 Budget PA	CA Variance 2018/2019 EUR	CA Variance 2018/2019 %	PA Variance 2018/2019 EUR	PA Variance 2018/2019 %
9	**REVENUE**												
9 0	**CONTRIBUTIONS**												
	CONTRIBUTION FROM THE EUROPEAN UNION	**63,126,601**	**32,857,939**	**79%**	**52%**	**79,227,979**	**77,503,542**	**79,982,327**	**62,866,928**	***754,348***	***1.0%***	***(14,636,614)***	***(18.9%)***
9 0 0	*Administrative Budget*	*1,618,419*	*1,618,419*	*97%*	*97%*	*1,661,839*	*1,661,839*	*1,661,627*	*1,661,627*	*(212)*	*(0.0%)*	*(212)*	*(0.0%)*
9 0 1	*Operational Budget*	*61,508,182*	*31,239,520*	*79%*	*51%*	*77,566,140*	*75,841,703*	*78,320,700*	*61,205,301*	*754,560*	*1.0%*	*(14,636,402)*	*(19.3%)*
	CONTRIBUTION FROM MEMBERS OTHER THAN THE EU	**1,618,419**	**1,618,419**	**97%**	97%	**1,661,839**	**1,661,839**	**1,661,627**	**1,661,627**	***(212)***	***(0.0%)***	***(212)***	***(0.0%)***
9 0 2	*Administrative Budget*	*1,618,419*	*1,618,419*	*97%*	***97%***	*1,661,839*	*1,661,839*	*1,661,627*	*1,661,627*	*(212)*	*(0.0%)*	*(212)*	*(0.0%)*
9 3	**UN-USED APPROPRIATIONS PREVIOUS YEARS***	**3,830,408**	**9,640,858**	**385%**	**58%**	**3,866,664**	**2,474,382**	**995,651**	**16,728,472**	***(2,871,013)***	***(74.3%)***	***14,254,090***	***576.1%***
9 3 0	*Un-used appropriations previous years Administrative*	*1,772,253*	*3,347,763*	*315%*	***324%***	*1,359,401*	*2,474,382*	*563,218*	*1,033,626*	*(796,183)*	*(58.6%)*	*(1,440,756)*	*(58.2%)*
9 3 1	*Un-used appropriations previous years Operational*	*2,058,155*	*6,293,095*	*476%*	*40%*	*2,507,263*	-	*432,433*	*15,694,846*	*(2,074,830)*	*(82.8%)*	*15,694,846*	-
TOTAL REVENUE		**68,575,428**	**44,117,216**	**83%**	**54%**	**84,756,482**	**81,639,763**	**82,639,605**	**81,257,027**	***(2,116,877)***	***(2.5%)***	***(382,736)***	***(0.5%)***

STATEMENT OF EXPENDITURE

Title		2017 Executed		% of Budget 2019		2018 Budget		2019 Budget		CA Variance 2018/2019		PA Variance 2018/2019	
Chapter	Heading	CA	PA	CA	PA	CA	PA	CA	PA	EUR	%	EUR	%
1	**STAFF EXPENDITURE**												
11	STAFF IN ACTIVE EMPLOYMENT	1,728,156	1,681,255	88%	85%	1,869,000	2,001,062	1,970,000	1,970,000	*101,000*	*5.4%*	*(31,062)*	*-1.6%*
1 1 0	*Temporary Agents*	*555,571*	*555,571*	*77%*	*77%*	*690,000*	*690,000*	*720,000*	*720,000*	*30,000*	*4.3%*	*30,000*	*4.3%*
1 1 1	*Contract Agents, Interim Staff, trainees and SNEs*	*1,172,585*	*1,125,683*	*94%*	*90%*	*1,179,000*	*1,311,062*	*1,250,000*	*1,250,000*	*71,000*	*6.0%*	*(61,062)*	*-4.7%*
13	MISSION COSTS	70,721	51,717	118%	86%	85,000	98,931	60,000	60,000	*(25,000)*	***(29.4%)***	*(38,931)*	***(39.4%)***
15	TRAINING	25,000	2,146	83%	7%	40,000	60,494	30,000	30,000	*(10,000)*	***(25.0%)***	*(30,494)*	***(50.4%)***
19	OTHER STAFF EXPENDITURE	258,122	145,241	119%	67%	211,000	309,263	217,000	217,000	*6,000*	***2.8%***	*(92,263)*	***(29.8%)***
TITLE 1 TOTAL		**2,082,000**	**1,880,358**	**91%**	**83%**	**2,205,000**	**2,469,750**	**2,277,000**	**2,277,000**	***72,000***	***3.3%***	***(192,750)***	***(7.8%)***
2	**ADMINISTRATIVE EXPENDITURE**												
20	RENTAL OF BUILDINGS AND ASSOCIATED COSTS	285,973	319,199	89%	100%	320,000	324,863	320,000	320,000	*0*	*0.0%*	*(4,863)*	*(1.5%)*
21	IT EXPENDITURE AND TECHNICAL FACILITIES	165,885	271,163	151%	247%	159,000	302,750	150,000	150,000	*(9,000)*	*(5.7%)*	*(152,750)*	*(50.5%)*
22	MOVABLE PROPERTY AND ASSOCIATED COSTS	74,276	19,044	248%	63%	20,000	105,787	30,000	30,000	*10,000*	*50.0%*	*(75,787)*	*(71.6%)*
23	CURRENT ADMINISTRATIVE EXPENDITURE	25,000	22,545	100%	90%	40,000	41,767	25,000	25,000	*(15,000)*	*(37.5%)*	*(16,767)*	*(40.1%)*
24	POSTAGE AND TELECOMMUNICATIONS	25,000	15,513	100%	62%	30,000	36,840	25,000	25,000	*(5,000)*	*(16.7%)*	*(11,840)*	*(32.1%)*
25	ADMINISTRATIVE BOARD EXPENDITURE	39,080	38,812	98%	97%	60,000	59,324	40,000	40,000	*(20,000)*	*(33.3%)*	*(19,324)*	*(32.6%)*
26	ADMINISTRATIVE SUPPORT SERVICES	66,075	136,337	132%	273%	85,500	104,477	100,000	100,000	*14.500*	*17.0%*	*(4,477)*	*(4.3%)*
27	PR AND EVENTS	597,438	235,405	199%	78%	300,000	795,172	300,000	300,000	*0*	*0.0%*	*(495,172)*	*(62.3%)*
29	OTHER INFRASTRUCTURE AND OPERATING EXPENDITURE	164,132	138,215	113%	96%	163,579	257,331	54,632	54,632	*(108,947)*	*(66.6%)*	*(202,699)*	*(78.8%)*
TITLE 2 TOTAL		**1,442,859**	**1,196,234**	**138%**	**115%**	**1,178,079**	**2,028,311**	**1,044,632**	**1,044,632**	***(133,447)***	***(11.3%)***	***(983,679)***	***(48.5%)***
TOTAL ADMINISTRATIVE EXPENDITURE (Title 1 and Title 2)		**3,524,859**	**3,076,592**	**106%**	**93%**	**3,383,079**	**4,498,060**	**3,321,632**	**3,321,632**	***(61,447)***	***(1.8%)***	***(1,176,428)***	***(26.2%)***

STATEMENT OF EXPENDITURE

Title / Chapter	Heading	2017 Executed CA	2017 Executed PA	% of Budget 2019 CA	% of Budget 2019 PA	2018 Budget CA	2018 Budget PA	2019 Budget CA	2019 Budget PA	CA Variance 2018/2019 EUR	CA Variance 2018/2019 %	PA Variance 2018/2019 EUR	PA Variance 2018/2019 %
3	**OPERATIONAL EXPENDITURE**												
30	OPERATIONAL EXPENDITURE	61,056,079	31,587,329	78%	41%	81,373,403	67,392,143	78,753,133	76,900,147	*(2,620,270)*	(3.2%)	*9,508,004*	*14.1%*
TITLE 3 TOTAL		**61,056,079**	**31,587,329**	**78%**	**41%**	**81,373,403**	**67,392,143**	**78,753,133**	**76,900,147**	***(2,620,270)***	**(3.2%)**	***9,508,004***	***14.1%***
4	**UNUSED APPROPRIATIONS NOT REQUIRED IN CURRENT YEAR**												
40	ADMINISTRATIVE BUDGET	1,484,232	3,508,009	263%	339%	0	-	564,840	1,035,248	*564,840*	-	*1,035,248*	-
41	OPERATIONAL BUDGET	2,510,259	5,945,287	-	-	-	9,749,560	-	-	*0*	-	*(9,749,560)*	*(100.0%)*
TITLE 4 TOTAL		**3,994,491**	**9,453,296**	**707%**	**913%**	**0**	**9,749,560**	**564,840**	**1,035,248**	***564,840***	**-**	***(8,714,312)***	**(89.4%)**
TOTAL EXPENDITURE		**68,575,428**	**44,117,216**	**83%**	**54%**	**84,756,482**	**81,639,763**	**82,639,605**	**81,257,027**	***(2,116,877)***	**(2.5%)**	***(382,736)***	***(0.5%)***

Contributions overview

CONTRIBUTIONS OVERVIEW	2017	2018	2019
CONTRIBUTIONS FROM THE UNION (incl EFTA)	**63,126,601**	**79,227,979**	**79,982,327**
Title 1 and Title 2 (financial)	1,618,419	1,661,839	1,661,627
Title 3 (financial)	61,508,182	77,566,140	78,320,700
CONTRIBUTIONS FROM MEMBERS OTHER THAN THE UNION	**52,421,296**	**78,223,467**	**75,092,240**
Title 1 and Title 2 (financial)	1,618,419	1,661,839	1,661,627
Title 3 (in-kind)	50,802,877	76,561,628	73,430,613
TOTAL CONTRIBUTIONS	**115,547,897**	**157,451,446**	**155,074,567**

Schedule of payments

	Commitment Appropriations		Payment Appropriations		
	RAL from earlier years	**Budget 2019**	**Budget 2019**	**Estimate Budget 2020**	**Estimated Budget 2021 and after**
2015 Work Plan	6,611,500		6,611,500	0	
2016 Work Plan	6,087,646		6,087,646	0	
2017 Work Plan	21,859,718		19,114,970	2,744,748	0
2018 Work Plan	41,474,849		851,401	38,769,891	1,853,557
2019 Work Plan Administrative		3,321,632	3,321,632	-	0
2019 Work Plan Operational		78,753,133	44,234,629	13,372,990	21,145,513
Total	**76,033,713**	**82,074,765**	**80,221,779**	**54,887,629**	**22,999,071**

3.2 Staff Establishment Plan

Establishment plan posts

Temporary Agents

Function group and grade	2017				2018		2019	
	Authorised under the EU Budget		Actually filled as of 31/12/2017		Authorised under the EU Budget		Request of the Agency	
	Permanent posts	Temporary posts	Permanent posts	Temporary posts	Permanent posts	Temporary posts	Permanent posts	Temporary posts
AD 16								
AD 15								
AD 14		1		1		1		1
AD 13								
AD 12								
AD 11								
AD 10								
AD 9		2		2		2		2
AD 8						1		1
AD 7		1		1		1		1
AD 6		1		1				
AD 5								
AD TOTAL		5		5		5		5
AST 1-11								
AST TOTAL								
AST/SC 1-6								
AST/SC TOTAL								
TOTAL		5		5		5		5
GRAND TOTAL	5		5		5		5	

Contract Agents

Contract agents	Authorised 2017	Recruited as of 31/12/2017	Authorised 2018	2019 Request of the Agency
Function Group IV	11	9	11	12
Function Group III	3	5	3	3
Function Group II	2	1	2	1
Function Group I				
TOTAL	16	15	16	16

Seconded National Experts

Seconded National Experts	Authorised 2017	Recruited as of 31/12/2017	Authorised 2018	2019 Request of the Agency
TOTAL	2	0	2	2

4. ANNEXES

4.1 ANNEX I – 2019 Call for proposals for the JU members – Topic descriptions

4.1.1 S2R-CFM-IP1-01-2019: Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Car body, Running Gear, Brakes, Doors, Modular interiors and HVAC

SPECIFIC CHALLENGE

A range of key rolling stock technologies oriented at achieving the overall Shift2Rail objectives (high reliability, high capacity, low cost and improved performance) need to be developed to a point that enables the future development of the demonstrators foreseen in Shift2Rail. These high level objectives are influenced by many functional elements of the vehicle, so the fundamental challenge to be addressed is to define the specific solutions at sub-system level which will work together to produce the desired benefits at system level. The following individual challenges relating to the different subsystems can contribute to these objectives:

Car body shell

The activities of this CFM proposal will deal with the detailed design, manufacturing and testing of several composite/hybrid railway car body structure demonstrators as were defined in PIVOT (S2R-CFM-IP1-01-2017) project, they should be focused on High Speed and Urban carbodies. The high-level challenges behind this project are the following:

i) A weight reduction between 15 and 30%.
ii) Associated energy savings in operation, resulting from the weight reduction.
iii) Improvements of maintainability, coming from new concepts of material and joining methods.
iv) Introduction of a specific health monitoring system for the structures coming from S2R-OC-IP1-01-2019, for both monitoring life cycle of the structures and assessing safety coefficients for the design of the structures.
v) The behaviour of those composite/hybrid structures in a railway environment is not well known at the moment, mainly because of a lack of experience with those materials in railway application. The activities involved in this CFM will lead to the accumulation of sufficient experience in order to allow the use of these new materials for future car body structures.

Running Gear

The next generation of running gear solution needs to deliver reduced infrastructure / wheel wear and damage, whilst providing higher reliability and availability, with lower maintenance costs. This challenge is made greater by the need for increased high-speed stability, excellent curving performance, improved comfort and optimized systems for both airborne and structure-borne noise.

Brakes

The brake system of a train is a mission critical system, which ensures safety of transport of passengers and goods and also safety of humans in the environment. In order to follow the mega trends in the rolling stock development, the brake system has to take the following specific challenges:

i) Introduction of new materials (with contribution of S2R-OC -IP1-03-2019) for friction pairing to comply with the railway market demand for more economical driven solution
ii) New solutions for drive-by-wire mechatronics brake system to increase line capacity and improve maintenance performance
iii) New solutions for safe braking under all adhesion conditions, especially low adhesion situations (with contribution of S2R-OC -IP1-03-2019)
iv) Advanced Brake Control hardware/software solutions compliant with High Safety Integrated Level SIL3-SIL4 that can be integrated in the next generation of TCMS (with contribution of considering the results of S2R-OC -IP1-03-2019)
v) Development and Integration of Virtual Certification methodologies for the brake system

Accessibility and Doors
The challenge is to provide seamless and flexible access to the train to persons with reduced mobility, while reducing the weight and the cost, improving the comfort features (noise, thermal, etc.), and adding functionalities of door and access systems with a long-term target of self-managed door. The main target is the Sub-urban / Regional market. Nevertheless, the impact on other markets like Metro, Tramway or High Speed will be measured.

Modular interiors in use
To increase attractiveness to passengers and flexibility to operators, interiors design should follow the needs and be able to evolve easily and quickly without costly process. To prepare for fully autonomous trains, interiors design should include the new use of driver's cabin.

HVAC
Conventional "Heating, Ventilation Air conditioning and Cooling" systems (HVAC) of rail vehicles use artificial refrigerants that have a very high impact on the global warming (e.g. R134a). To limit the climatic impact from HVAC systems, the European Commission adopted in 2014 Regulation No 517/2014 which aims to reduce the use of artificial refrigerants within the EU. Rail service operators and vehicle integrators need to act quickly due to the long lifetime of the rolling stock. Hence new and redesigned trains should be equipped with eco-friendly HVAC systems using natural gases such as air or CO_2.

SCOPE

Having regard to the Union policies and targets on decarbonisation, taking into consideration that automation and digitalization are key enablers of a drastic railway system transformation, in order to address the challenges described above, the proposals should address all of the following work streams, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

Car body shell
In line with the S2R MAAP – TD1.3 description, the scope of this CFM has been divided into groups of activities and will ensure continuation of the tasks in PIVOT (S2R CFM_IP1 AWP 2017):

- Assessment Methodology
- Design for Manufacturing
- Behavioural Research
- The activities will deal with safety, economy, sustainability, reparability and maintainability of the new structures.
- Manufacturing
- Validation Tests.

A comprehensive final report is expected in order to collect all the relevant tasks and findings that will lead to the validation of the demonstrators. These should include the lessons learnt during all the stages of the project and will constitute the state-of-the-art of the structure construction in railway vehicles, in order to feed into possible standardization activities for these technologies in the future.

This group of tasks should cover all the tests necessary to allow the demonstrators to reach their respective TRLs (from TRL3/4 demonstrators to TRL7 of a whole High Speed carbody).

Development of concepts & technologies towards future running gear
In line with the S2R MAAP – TD1.4 description, the scope of this CFM is the development of new/innovative technologies and technical demonstrators for running gear applications. A multi-technology approach will have to address several functions of running gear (comfort, curving, structural function, rolling components, health monitoring, etc.).

Proposals should address the following aspects: new sensor architectures and functionality to monitor both running gear and track, light weight and optimized materials validated and certified for the running gear environment, definition and validation of actuator technology to control running gear and wheelsets and the development of a new noise and vibration assessment methodology.

The activities are expected to prepare specific innovative solutions, but especially providing technical demonstrators for running gear applications up to TRL7, for all segments – Metro, Regional, High Speed and Freight (Loco).

Development of future noise-reduced brake system solutions
In line with the S2R MAAP – TD1.4 description, the work shall focus on the continuation of the development and test of hardware and methodologies for future brake system solutions in the following innovation areas:

- High Safety Level electronic Solutions for Brake Control with High Safety Integrity Level (SIL3-SIL4), TRL 4/5
- Adhesion Management, TRL 3/4
- Innovative Friction Pair Solutions, for all vehicles classes TRL 4/5
- Electro-Mechanic Brake for Railway Applications (Urban, Regional, High Speed), TRL 6
- Certification Process incl. Virtual Certification, TRL 3.

Development of generic concepts towards new generation of door system
Based on the results of the PIVOT project (S2R-CFM-IP1-01-2017) and in line with the S2R MAAP – TD1.6 description, the proposals are expected to address the following aspects, in addition to a general target of LCC reduction:

- Continuation on research activities on door leaves technologies (TLR 3)).
- Adaptable gap filler for easier and independent access for Persons with Reduced Mobility (PRM) compatible with the two standard European station platforms (550 mm and 760 mm) and vertical gaps up to 200/250 mm compatible with existing and future station platforms: design, laboratory testing (TLR 4/5)). The assessment of the adaptable gap filler will be performed with the contribution of S2R-OC-IP1-01-2019.
- Integration and utilization of new technologies for door entry surveillance, passenger information and passenger safety in the direction of a self-managed access system as long term target: continuation of new technologies and product assessment, integration of selected and developed solutions in an entrance system, laboratory testing (TRL 4/5)).
- **Development of new leaves architecture with integration of new metallic and composite** technologies for weight, comfort and energy optimization with a modular approach (TRL 4/5).
- Demonstration: integration in the technical demonstrator – Regional train (TRL 6/7). The demonstrator will integrate as far as possible the solutions developed in the others tasks: solutions for accessibility, safety and door entry surveillance, metallic based leaves and composite leaves. The acoustic and thermal solutions developed within S2R-OC-IP1-01-2019 will be also integrated and tested as far as feasible. Solution for other segments could also be integrated with a lower TRL.

Development of concepts towards new generation of interiors modularity:
In line with the S2R MAAP – TD1.7 description, the scope of this CFM is**:**

i) For INTERIORS: Studies and functional mock-ups of a full plug-and-play interiors design allowed by new fixation systems for floor, wall and roof following the pre-studies of PIVOT. The aim is to show the capabilities of reconfiguration to suit customer requirements and to demonstrate the quick change of elements. Following the economic studies of PIVOT, the action should identify the market and the time to market.

The functional mock-up will represent a part of a consist with the main interiors panels: floor, wall panel and roof to see how the new concept of fixation system is made and to test it. Expected TRL 5/6.

ii) For CABIN: pre-studies and business cases to develop ideas from PIVOT by new technologies and new uses of the driver's cabin and allow the design of Cabin & Driving 2030: technologies, requirements and partners. A virtual mock-up with immersive technologie will be done. Expected TRL: 4/5

The concepts from INTERIORS and CABIN should allow the possibilities to be easily modified. A mixed virtual and physical mock-up will be proposed at Innotrans 2022.

The new concepts resulting from any of the proposed activities will be supported by cost-benefit analyses that will be used as the basis to justify higher TRL developments in future Calls. The activities will consider, when applicable, suitable work to prepare for future technical standardisation related to the proposed innovations.

Development of HVAC

There are two different eco-friendly HVAC solutions in discussion, using the natural gases air or CO_2. In contrast to conventional HVAC solutions HVACs with natural gases open the opportunity to integrate a heat pump for increasing the efficiency for heating. Natural gases allow the operation of the heat pump within a larger temperature range (, CO2 up to -20°C, Air no limit, R134a up to -5°C). The increasing efficiency is especially very important for hybrid vehicles with batteries, where the reduced HVAC-energy consumption reduces the operating km-range of the vehicle.

In line with the S2R MAAP – TD1.8 description, the following actions should be taken:

- Preliminary studies on Pre-standardization of interfaces and functions of HVAC subsystems.
- Evaluation of requirements for HVACs with natural gases for application in high speed and regional trains.
- Analysing existing HVAC-prototypes with CO2 refrigerant with respect to the fulfilment of the requirements and identification of further research and adoptions to that has to be carried out.
- Further development and adoption of existing prototypes of HVAC.

The work in these innovation areas will result in TRL3.

Work Streams results should be placed in the context of the demo plans, which are developed in conjunction with MAAP part B. In addition, the demo plans should be accompanied with integration and migration plans to implement produced solutions in the rail environment to support and speed up deployment.

Considering the "18C044-0C WHITE PAPER REFERENCE CCS ARCHITECTURE (RCA) BASED ON ERTMS" developed by the ERTMS Users Group and the EULYNX consortium and provided to S2R in July 2018, and following the ongoing collaboration initiated with the promoters of such initiative for the integration of the RCA in the S2R Programme, a final high level decomposition of RCA is expected be delivered to S2R by April 2019. The S2R Members should firstly verify the impact that the RCA would have or potentially have on the content of each work streams activities and subsequently each CFM proposal should be aligned, as far as possible, against the latest progress on the Reference CCS Architecture, in particular the system approach and interoperability of solutions must be ensured across S2R IP/CCA activities and for future developments.

COMPLEMENTARITY

As specified in section 2.3.1 of S2R AWP for 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background

and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-OC-IP1-01-2019: Advanced Car body shells for railways and light material and innovative doors and train modularity
- S2R-OC-IP1-02-2019: Tools, methodologies and technological development of next generation of Running Gear .
- S2R-OC-IP1-03-2019: Support to the development of technical demonstrators for the next generation of brake systems.

The action stemming from this topic will also be complementary to actions carried out within the following project of IP1:

- PIVOT (GA 777629)

The action shall actively contribute to the S2R standardisation rolling development plans wherever relevant.

The action shall actively contribute to the S2R KPIs development. This shall lead to publicly available deliverable, quantified indicatively on a semi-annual basis.

The planned activities of the action should take into account the revised MAAP part A.

The S2R JU will only fund one proposal under this topic.

EXPECTED IMPACT

The most significant benefits expected from these actions, once the developed technologies are fully implemented and deployed, are for the different users. The expected impacts are the following:

Car body shell

The outcome of the above mentioned groups of tasks will have impact in the following strategic aspects linked to LCC at carbody and railway level according the MAAP:

- Weight reduction: A lighter structure (between 15% and 30%) will allow an increase of the payload or technical equipment weight up to the TSI limits. While keeping the price of maintenance steady, an increased train capacity will allow the division of the maintenance cost between more passengers per train, thus increasing profitability per passenger.
- Energy savings in operation, resulting from the weight reduction.
- Improvements in manufacturing technologies: It is also expected that replacement of some composite parts within the car body could be quicker and less costly than welded metallic parts (repairing certain metallic structures can be complex). Depending on the chosen raw materials, it is expected that processes used for forming composites can compete with those use for metals.
- Integrating functions in the parts made of new materials: train functions such as , e.g. thermal isolation, can be integrated in a car body made of several materials, mainly composites, thus saving space and weight. Additionally, integrating functions like air conduction, piping , etc. can make the whole car body system less prone to corrective maintenance.
- More attractive products: Vehicle structures made with these new materials will benefit from improved space within the vehicle and therefore passenger comfort. A reduction of the time-to-market in both manufacturing and operation (repairs) periods is also expected.
- Development of new skills in the Railway Industry: These technologies will have an impact on the way railway vehicles are produced and maintained, keeping the value added by the conventional metal constructions and adding the new value coming from industries that are already producing systems for the aerospace and automotive industry.

- More attractive products: Vehicle structures made with these new materials will benefit from an improved space within the vehicle and therefore passenger comfort. Also reductions in the time-to-market of both manufacturing and operation (repairs) periods are expected.
- Positive side effects for suppliers and research institutes: The need for the physical characterization of composite material systems will bring activity for industries and research centres specialized in composite materials that are already working for other sectors, now gaining experience in composite railway structural applications.

Running Gear

The main expected impacts are:

- Weight reduction, considering material-specific design and structural optimisation (up to 5% on High Speed and Regional platform))
- Lower unsprung mass: this will help reduce track damage, wear and vibrations, which will contribute to a reduction in system cost (weight reduction up to 10% on metro application)
- Lower unsprung mass: increase the critical stability speed of the vehicle
- Reduction in wheel & rail wear (especially RCF) through improved (controlled) performance on straight as well as curved track including wear-resistant materials, which will contribute to a cost reduction (maintenance cost reduction up to 15% for running gear, up to 10% for track – Regional and High Speed segments)
- Improved ride conditions through the usage of active/semi-active suspension systems
- Reduction of LCC, inspection and maintenance by monitoring which will contribute to a maintenance cost reduction (maintenance cost reduction up to 20% for running gear, up to 10% for track)
- Reduction of costs for running gear sensor equipment (to soften the increase of capital costs for additional equipment)
- Development of standards that support the introduction of advanced materials, sensors and monitoring and active control systems (to soften the increase of capital costs for additional equipment)
- Recommendations for validation methods for reduced noise and vibration running gear
- More efficient authorisation with a reduction in cost, time and effort.

Brake System

The most significant benefits from the action as a result of the new technology developments, methodologies and simulations besides the continues qualification of the brake related KPI's are:

- Reduction of Time and Cost of Brake System Assessment thanks to new certification and validation methods and tools
- Greening of the rail transport through reduction of the energy consumption by reducing the rotating mass of brake discs
- LCC reduction due to better diagnostics, lower energy consumption and introduction of life time brake components due to an advanced SIL3/4 compliant electronic hardware and software architecture for brake components
- Support capacity increase through higher track throughput enabled by shorter and/or more reliable braking distances thanks to braking concepts for adhesion control

Doors

- Significant weight reductions in major sub-systems of railway vehicles, such as doors leaves (10%).

- This weight reduction will have several side effects as the reduction of the Life Cycle Cost of the vehicle and the whole railway system (the reduction of track damage and improved health monitoring system)
- Reduction of the LCC for doors with a 20% target
- Increase in passenger comfort thanks to acoustic and thermal insulation
- Improved passenger experience and accessibility thanks to an easier/independent access and the improvement of information available for passenger
- Improved access system surveillance and safety.

Interior

- Reduction of assembled time, quick assembly and disassembly : 50%
- Increase in modularity and functionality during the life of the train
- Increase in flexibility of operation : capacity to test and deploy new furnitures
- Reduction of the refurbishment costs including design cost : 50% less for a complete refurbishment
- Increase in attractiveness : add services and/or change confort easily.

HVAC

The action will contribute to the market introduction of eco-friendly HVAC systems taking into account the time near-term shortage of conventional refrigerants. Additional impacts are the following:

- Reduction of life-cycle costs by reducing energy consumption of about 20-45% by integrating heat pumps and the usage of standardized interfaces
- Increasing reliability and availability of HVAC systems due to a shorter repair time and condition based maintenance
- Standardized control interface for optimization of energy management and diagnostic data for condition based maintenance
- Standardized safety measures for product shareholders.

Specific metrics and methods to measure and achieve impacts should be included in the proposals, with the objective to achieve by the end of the S2R Programme the “Specific Achievements” defined quantitatively and qualitatively in the S2R MAAP related to TD1.3, TD1.4, TD1.5, TD1.6, TD1.7 and TD 1.8, in line with the relative Planning and Budget.

<u>Type of Action:</u> Innovation Action (IA)

4.1.2 S2R-CFM-IP2-01-2019: Completion of activities for enhanced automation systems (including Freight ATO GoA4), train integrity, object controller.

SPECIFIC CHALLENGE

The challenge is to contribute to developing an advanced signalling and automation system able to apply the highest grade of automation, to enable trains to self-detect their integrity, to improve and standardise traffic management services, to provide smart radio connected signalling wayside object controllers achieving the requested targets in terms of reliability, enhanced capacity, lower investments, reduced operating costs, improved standardization and therefore simplified certification and authorization needs. Additionally, the Freight ATO activities will validate the applicability of the work for freight operation. The proposals will build and take further work started in X2RAIL-1 (GA 730640) and X2RAIL-2 (GA 777465).

SCOPE

Having regard to the Union policies and targets on decarbonisation, taking into consideration that automation and digitalization are key enablers of a drastic railway system transformation, in order to address the challenges described above, the proposals should address all of the following work streams, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

Work stream 1

1. **TD2.2 – Railway network capacity increase (ATO up to GoA3/4):** in line with the S2R MAAP, the scope is to bring to conclusion the activities started in X2RAIL-1. The action will define, develop and test a complete GoA3/4 system prototype applicable within all the market segments (Main Line, High Speed, Regional and Freight). This includes the specification of "obstacle detection" and "track intrusion detection" solutions required for GoA3/4 operation.

   In the framework of the introduction of ATO system up to GoA3/4 (TD2.2) the activities are expected to cover the following points:

   - **Specification** of **interoperable** ATO system up to GoA3/4 (complete set of documents that allows the development and testing of GoA3/4 solution including "obstacle detection" and "track intrusion detection");
   - Definition of **operation scenarios** of ATO system up to GoA3/4 (including obstacle detection and track intrusion);
   - **Development** of ATO on-board and trackside interoperable **prototypes**;
   - **Development** of ATO interoperable **Reference Test Bench platforms**.
   - **Interoperability tests** on ATO Reference Test Bench platforms.

   Research and innovation activities shall foster the achievement of a ATO GoA 3/4 system prototype able to prove the system features in terms of performance, applicability, adaptability and interoperability. Functional and System specifications shall be defined within a cooperative framework which actively involves Railways (IMs/RUs) and Industries taking into account their needs (e.g. interoperability, modularity, interchangeability, …), experiences, competencies in order to cope with the demands and the opportunity of the market (possibly supported by business/societal cases) and enabling seamless operations along European networks. The action shall guarantee the cooperation with the Work-Stream 2 (TD5.3.1 – Freight ATO**)** and shall implement all the necessary steps to achieving the expected TRL level by means of proved prototypes.

   Foreseen achievable Technology Readiness Level: TRL 7

2. **TD2.5 – On Board Train Integrity**: in line with the actions planned in S2R MAAP, the scope is to bring to conclusion the activities started in X2RAIL-2. The action will define, develop and test a complete On Board Train Integrity system prototype able to be applied in every train typology (Passengers and Freight trains: wired and wireless).

   In the framework of the introduction of On Board Train Integrity (OTI) technologies (TD2.5) the activities are expected to cover the following points:

   - Complete activities started in X2Rail-2 in relation to Technology Research and Development and Adaptation of existing solutions:
     - Complete laboratory testing activities with mock-ups and related validation tools for freight and regional lines, with the support of new technologies developed in X2Rail-2;
     - Complete laboratory testing activities related to adaptation of existing technologies for wireless communication suitable to NLOS situations, energy harvesting solutions and related energy storage;
     - Complete the RAMS analysis my means of conducting reliability, availability, maintainability, and safety (RAMS) studies in conformity with RAC (Risk Acceptance Criteria) guideline by ERA and CENELEC 50126 standard.
   - Demonstration and Assessment:
     - Contribute to the integration and demonstration activities of the OTI prototype for freight & low traffic lines scenarios, starting from the laboratory simulations and tests, to the final test trial in a real environment;
     - Contribute to the development of a demonstration unit suitable for both regional and freight lines;
     - Carry out laboratory tests and pilot line tests on a regional line, using the defined test scenarios and test cases;
     - Perform the preliminary safety assessments of candidate new solution and define the complete test scenarios, test cases and procedures;
     - Define and implement laboratory validation environment for OTI solutions. In particular, focus on the integration with the ETCS/ERTMS railway laboratories RailSiTe® and RailDriVE® by defining generic validation and verification processes and proposing standardisation rules for the assessment of the train integrity simulation prototype (an on-train GNSS-based locator, wireless communications);
     - Perform dependability study for the candidate solution, developing the safety integrity level (SIL) allocation methodology to the new train integrity solution on different rail segments, assessing (performance and security evaluation included) innovative wireless communication technologies for train integrity, integrating dependability and safety requirements (e.g. SIL 4 requirements) and contributing to the safety case for certification and authorisation;

   The following results shall be achieved as a result of this task:
     - ✓ OTI prototypes for both freight and regional lines tested both in laboratory and in field;
     - ✓ First Safety assessment.

   - Standardisation proposal:
     - The goal of this task is to provide an analysis of the impacts on the signalling system, by defining a preliminary proposal for standardisation. Since today the train integrity functionality is performed by track side equipment influencing the interlocking, the new architecture, interfaces and processes have to be rearranged taking into account the new solution developed (on-board detection).

   Foreseen achievable Technology Readiness Level: TRL7

3. **TD 2.9 - Traffic Management Evolution**: in line with the actions planned in S2R MAAP, the scope is to bring to conclusion the activities started in X2RAIL-2. The action will define, develop and test a complete Train Management System platform prototype. The main innovation is the definition and design of a communication platform (Integration Layer) using standardized data structures and processes to manage the Communication/Data exchange between different services/clients and supporting TMS applications connected to other multimodal operational systems.

   In the framework of the introduction of new Traffic Management technologies (TD2.9), the work stream should cover the following points:

   - Integrate and automate data exchange processes between the various Rail Services with defined persistency in one common communication layer;
   - Specify and develop the architecture, the interfaces and the data model allowing the integration of new and legacy installations to guarantee the acceptance of the various stakeholders involved in Traffic Control, Traffic Management and other Rail Business Services;
   - Specify and develop "Publish-Subscribe" communication methodology for Rail Operations;
   - Specify and develop new Business Applications/Principles for Traffic Control to integrate new functionalities developed inside S2R Innovation Programme 2, such as ATO or Moving Block, into the Rail Operation processes as well as to improve the efficiency of Traffic Management processes by optimizing the flow of traffic and the decision making to deliver the production timetable with less delays;
   - Standardize an Operator's Workstation and a framework with "Plug & Play" features to manage and operate applications;
   - Contribute to the design of a S2R Conceptual Data Model CDM and implement this data-structure into the communication process to integrate legacy and new services or applications into one communication into one Layer.

   Close cooperation with action to be funded under topic S2R-OC-IP2-03-2019: "Support of the development of demonstrator platform for Traffic Management" will be key to establish an integrated Platform to test and validate the prototypes developed from different partners within the Technology Demonstrator.

   Foreseen achievable Technology Readiness Level: TRL 6

4. **TD 2.10 – Smart Radio connected all-in-all wayside objects**: in line with the actions planned in the S2R MAAP, the scope is to bring to conclusion the activities started in X2Rail-1. On this basis technical demonstrators will be developed, implemented and validated.

   In the framework of the introduction of new and Smart Object Controller (TD2.10), the activities are expected to cover the following areas:

   - Development and verification of Prototypes:

   In accordance with the specifications developed in X2RAIL-1, the objective of that task is to develop prototypes, to define the tests to be performed and to provide the Lab test report. The action shall include:

     - Validation of the defined rules and requirements;
     - Development and verification of prototypes taking into account the real environment for testing.

- Validation of prototypes:

The objective of this task is the validation of the prototypes in the real environment. Validation will be executed according to test and validation plans.

- Optimisation works:

The results of the validation phase will serve as an input for optimizing prototypes, specifications review and conclusions.

Foreseen achievable Technology Readiness Level: TRL6/7

Work stream 2

5. **TD5.1.3– Freight ATO: Cargo** in the context of freight Autonomous train operation, the main objective is to test the "ATO up to GoA3/4" specification for freight application and to develop/test "obstacle detection" and "track intrusion detection" solutions**.**

   In the framework of the Innovation Programme 5 related TD 5.1.3 Freight ATO the activities are expected to cover the following points:

   - **Review** of the ATO GoA3/4 **specification** provided in Main Work Stream 1 in order to guarantee that it is suitable for freight application;
   - **Review** of the ATO GoA3/4 **operation scenarios** provided by Main Work Stream 1 in order to guarantee that it is suitable for freight application;
   - **Supply track plan data** and **train data** required for the Reference Test Bench dedicated to freight application.
   - **Interoperability tests** for freight application on the ATO Reference Test Bench platforms.

   Research and innovation activities shall foster the achievement of an Obstacle Detection and Intrusion system prototypes able to prove the system features in terms of performance, applicability, adaptability, in complementarity with the action stemming from the topic S2R-OC-IP5-02-2019.
   The action shall guarantee the cooperation with the Work-Stream 1.1 (TD2.2 – Railway network capacity increase (ATO up to GoA3/4)) actively involving Railways (IMs/RUs) and Industries taking into account their needs, experiences, competencies in order to cope with the demands and the opportunity of the market. The action shall implement all the necessary steps to achieving the expected TRL level by means of proved prototypes.

   Foreseen achievable Technology Readiness Level: TRL 6/7

Work Streams results should be placed in the context of the demo plans, which are developed in conjunction with MAAP part B. In addition, the demo plans should be accompanied with integration and migration plans to implement produced solutions in the rail environment to support and speed up deployment.

Considering the "18C044-0C WHITE PAPER REFERENCE CCS ARCHITECTURE (RCA) BASED ON ERTMS" developed by the ERTMS Users Group and the EULYNX consortium and provided to S2R in July 2018, and following the ongoing collaboration initiated with the promoters of such initiative for the integration of the RCA in the S2R Programme, a final high level decomposition of RCA is expected be delivered to S2R by April 2019. The S2R Members should firstly verify the impact that the RCA would have or potentially have on the content of each work streams activities and subsequently each CFM

proposal should be aligned, as far as possible, against the latest progress on the Reference CCS Architecture, in particular the system approach and interoperability of solutions must be ensured across S2R IP/CCA activities and for future developments.

COMPLEMENTARITY

Most of the activities of this work area will need to set up a collaboration with the European Union Agency for Railways (ERA) in order to evaluate the potential impacts of the solutions developed on the current ERTMS/ETCS specifications, included in the Control Command Signalling Technical Specification for Interoperability.

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-CCA-01-2019: “Integrated Mobility Management + Energy + Noise”.
- S2R-OC-IP2-02-2019 - Support to development of demonstrator platform for Traffic Management.
- S2R-CFM-IPX and /CCA-01-2019: S2R System Architecture and Conceptual Data Model.
- S2R-CFM-IP5-01-2019: Smart, data-based assets and efficient rail freight operation.
- S2R-OC-IP5-02-2019: Advanced obstacle detection and track intrusion system for autonomous freight train.

The action stemming from this topic will also be complementary to actions carried out within the following projects of IP2:

- S2R-CFM-IP1-02-2018: Validation of new technologies for the TCMS.
- S2R-CFM-IP5-01-2018: Technology demonstrators for competitive intelligent rail freight.
- X2RAIL-1 (GA 730640).
- X2RAIL-2 (GA 777465).

The action shall actively contribute to the S2R standardisation rolling development plans wherever relevant.

The action shall actively contribute to the S2R KPIs development. This shall lead to publicly available deliverable, quantified indicatively on a semi-annual basis.

The planned activities of the action should take into account the revised MAAP part A.

The S2R JU will only fund one proposal under this topic.

EXPECTED IMPACT

Regarding the work stream 1 - “TD2.2 – Railway network capacity increase (ATO up to GoA3/4)”, the actions are expected to contribute to:

- the improvement of the overall line capacity thanks to train traffic optimisation which contributes to achieving service punctuality and to optimising headway between trains;
- the reduction of traction energy consumption, and carbon emissions, notably by means of improvement of automatic train operation and train control;

- improve optimisation of the train control according to the real needs of traffic through the contribution of automation and specifically of ATO up to GoA3/4 implementation;
- OPEX reduction in terms of maintenance of train braking systems and of mechanical parts of the vehicle and in terms of optimisation of staff utilisation.

Regarding the work stream 1 - "TD2.5 – On Board Train Integrity", the actions are expected to contribute to:

- contribute to the implementation of advanced Train Separation systems based on self-train localization (Moving or Fixed Virtual block) and therefore improving line capacity and better line exploitation;
- Contribute to removing wayside track detection systems (e.g.: Track Circuit, Axle Counter);
- Contribute to fostering innovation for new solution for energy generation and harvesting;
- Contribute to improving innovation in Train-to-Train communication thanks to high performing requirement demands to accomplish the On Board Train Integrity functionality.

Regarding the work stream 1 - "TD 2.9 - Traffic Management Evolution", the actions are expected to contribute to:

- Improve reliability of train operations in terms of service and availability of wayside assets. Standardisation of the frameworks, data structures and interfaces within the Integration Framework and Application Layer will deliver a reduction of the investment for new integrated installations;
- Allow, through the new communication platform, the integration of now and fore-casted status data of scheduled train services, infrastructure assets, rolling stock and information from external clients and services into Traffic Control, Traffic Management and other services processes to secure the delivery of the production time table to reduce delays hence improve reliability of train services and availability of assets;
- Reduce the investment for new integrated installations as well as the operating cost through the standardization of the data structures and interfaces within the communication network, Application Framework and standardized Operator Workstation;
- Secure Automated Train Operation (ATO) and Moving Block Operation to be implemented in real rail traffic environment;
- Contribute to achieving additional benefit by deploying the specified structures foreseen in this project to other services management facilities e.g. Maintenance Services, Energy Management (cooperation with IP3), Passenger Information (cooperation with IP4) and Freight Management (cooperation with IP5).

Regarding the work stream 1 - "TD 2.10 – Smart Radio connected all-in-all wayside objects", the actions are expected to contribute to:

- reduce CAPEX and OPEX by reducing the need of cables and therefore by reducing the related overall cost;
- foster the evolution to Train-Centric-Systems in which a self-sufficient smart equipment ("box") is able to connect with any signalling wayside and on-board sub-system in the area;
- foster new signalling system architectures based on locally derived power and radio communications (or any wireless network communication) together with maximum de-centralization (up to the level of one Object Controller for every individual trackside object);
- enhancing reliability, capacity, by reducing investments and improving standardization and therefore simplified certification and authorization.

Regarding the work stream 2 - "TD5.1.3 – Freight ATO", the actions are expected to contribute to:

- the reduction of traction energy consumption, and carbon emissions, notably by means of improvement of automatic train operation and train control;
- improve optimisation of the train control according to the real needs of traffic through the contribution of automation and specifically of ATO up to GoA3/4 implementation;

- OPEX reduction in terms of maintenance of train braking systems and of mechanical parts of the vehicle and in terms of optimisation of staff utilisation;
- Demonstrate interoperability of ATO up to GoA 3/4 solution/implementations due to the use of formal design;
- Deliver solutions for interoperability of ATO up to GoA 3/4 by using open source approach under the European Union Public Licence.
- Reduce lifecycle cost by applying open source business models and formal design to ATO GoA3/4.

Type of Action: Innovation Action (IA)

4.1.3 S2R-CFM-IP3-01-2019: Intelligent asset management finalisation

SPECIFIC CHALLENGE

Approximately 25% of the annual operational cost of High Speed infrastructure is generated by maintenance[28], due to different causes: the age of the current rail infrastructure, accelerated deteriorations, inspection activities done manually or with a series of heterogeneous monitoring tools and systems.

The challenge is to move forward the research activities currently under development in the IN2SMART project, by finalizing, testing and validating the Intelligent Asset Management System, in order to optimize railway infrastructure maintenance. Using a limited budget, it is possible to contribute to the S2R objectives, through the usage of new technologies concerning data acquisition (preferably COTS monitoring), data analysis (big data analytics) and maintenance decision making, logistics and execution. This has to be demonstrated in some selected use cases context, but also in a more comprehensive demonstrator.

SCOPE

Having regard to the Union policies and targets on decarbonisation, taking into consideration that automation and digitalization are key enablers of a drastic railway system transformation, in order to tackle the challenges described above, the proposed activities should address all work streams, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

The work expected in the work stream 1 concerning **"**Railway Integrated Measuring and Monitoring System (RIMMS)" (TD3.7) should provide:

- In field validation of a track and switch & crossing geometry monitoring on board system (TRL6/7). The starting point is the development of an on-board COTS based geometry monitoring system at TRL 4/5 (IN2RAIL and IN2SMART), taking also into account the relative outcome of the project ASSETS4RAIL (GA 826250);
- In field validation of a rail thermal stress monitoring on board system (TRL 5/6). Starting point is the definition of an on-board COTS based temperature monitoring system at TRL 3/4 and the definition of an innovative non-intrusive method for measuring rail stress free temperature (IN2RAIL);
- In field validation of monitoring from unmanned autonomous vehicles approach (TRL5/6). Starting point is the definition of relevant use cases and their testing up to TRL 3/4 to be used as a feasibility study for the expected work (IN2SMART);
- In operation validation of a generic framework for monitoring of an existing and a new signalling system, providing recommendations and a risk mitigation analysis of the impact on the safety case (TRL6/7). Starting point is the development of a seamless proxy for retrieving signalling information and its testing in a TRL 3/4 environment (IN2SMART), taking also into account the relative outcome of the project ASSETS4RAIL (GA 826250);
- Wayside installation and in-operation validation of a monitoring system of the rolling stocks impact on the infrastructure. (TRL6/7). Starting point is the definition of relevant parameters and development of monitoring systems for video monitoring, wheel-rail interaction measurements and vehicles identification done in the project IN2SMART, taking also into account the relative outcome of the project ASSETS4RAIL (GA 826250).

The work expected in the work stream 2 concerning **"**Dynamic Railway Information Management System (DRIMS)" (TD3.6) should provide operation validation of:

[28] Economic Analysis of High Speed Rail In Europe, De Rus et al., BBVA Foundation, 2009

- An open standard interface for maintenance applications focused on these categories: data model, data format, data transfer and security (TRL6/7). The starting point of this activity is the standards selection for each category done in the projects IN2RAIL and IN2SMART;
- Analytic tools for automatic detection of anomalies (TRL6/7). The starting point of this activity is the definition of relevant use cases and the development of an anomaly detection system prototype done in the prject IN2SMART;
- Analytic tools predicting railway assets decay towards prescriptive analytics for maintenance (TRL6/7). The starting point of this activity is the definition of relevant use cases and the development of predictive models of railway assets decay (IN2RAIL WP9, IN2SMART WP8);
- Analytic tools discovering and describing the maintenance workflow process (TRL5/6). The starting point of this activity is the prepared, cleaned and organized data recorded during maintenance processes done in the project IN2SMART;
- Data Analytics Architecture (Communication Layer + Data Platform) (TRL6/7). The starting point of this activity is the implementation of In-Lab demonstrators for data exchange (both for analytics input and for analytics output) meeting the defined standards done in the projects IN2RAIL and IN2SMART.

The work expected in the work stream 3 concerning **"**Intelligent Asset Management Strategies (IAMS)" (d*ecision support systems and planning tools for predictive maintenance)* (TD3.8) should provide:

- In field validation of decision support tools for long, mid- and short-term maintenance planning. The starting point is the work of IN2SMART:
    - the detailed description of the framework for the IAMS process (the guiding principles of predictive, risk- and condition-based, opportunistic, reliability-centred, integrative maintenance decision support and the "building blocks" of the IAMS process, their respective functionalities and interaction, the workflow and the flow of information within the framework) and
    - use cases;
- In field demonstration of maintenance tools – using technology applicable for the next generation robot platform. Technology can be shown on the actual robot platform itself or on existing machines and equipment improving their performance (for e.g. using of remote control technology will increase efficiency and safety) based on work of IN2SMART;
- In field demonstration of lean inspection and maintenance procedures including predictive approaches and combined maintenance activities based on the work of IN2SMART; demonstration of the benefits of a system approach, including root cause analysis, LCC and RAMS analysis;
- Work should possibly include solutions focussing on possession management and work site management systems, optimised working methods, strategies or processes, etc. Data analytics approaches should be demonstrated to show how a control centre view of the overall infrastructure, combined with access to long and mid-term maintenance decisions, can be integrated with operational planning.

All Activities are expected to finish with technologies demonstrated/validated in a TRL6/7 environment as a continuation of work already conducted in previous projects (IN2SMART). In case of new work, it should be considered to build upon technologies found in the market which can be easily integrated in existing work and demonstrated at a high TRL level (5/6 minimum).

Work Stream esults should be placed in the context of the demo plans, which are developed in conjunction with MAAP part B. In addition, the demo plans should be accompanied with integration and migration plans to implement produced solutions in the rail environment to support and speed up deployment.

Considering the "18C044-0C WHITE PAPER REFERENCE CCS ARCHITECTURE (RCA) BASED ON ERTMS" developed by the ERTMS Users Group and the EULYNX consortium and provided to S2R in July 2018, and following the ongoing collaboration initiated with the promoters of such initiative for the

integration of the RCA in the S2R Programme, a final high level decomposition of RCA is expected be delivered to S2R by April 2019. The S2R Members should firstly verify the impact that the RCA would have or potentially have on the content of each work streams activities and subsequently each CFM proposal should be aligned, as far as possible, against the latest progress on the Reference CCS Architecture, in particular the system approach and interoperability of solutions must be ensured across S2R IP/CCA activities and for future developments.

COMPLEMENTARITY

As specified in section 2.3.1 of S2R AWP for 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-IPX and /CCA-01-2019: S2R System Architecture and Conceptual Data Model.

The action stemming from this topic will also be complementary to actions carried out within the following projects of IP3 and IP1:

- IN2SMART (GA 730569)
- PIVOT (GA 777629)

The action shall actively contribute to the S2R standardisation rolling development plans wherever relevant.

The action shall actively contribute to the S2R KPIs development. This shall lead to publicly available deliverable, quantified indicatively on a semi-annual basis.

The planned activities of the action should take into account the revised MAAP part A.

The S2R JU will only fund one proposal under this topic.

EXPECTED IMPACT

Actions will contribute to achieve an increase in the attractiveness and competitiveness of the railway transport in Europe through an efficient, safe, intelligent infrastructure maintenance approach.

Expected impacts are the following:

- Increase in operational reliability (less service disruptions and decrease of 50% of avoidable incidents) through continuous and precise condition monitoring of key components predicting failures in advance and scheduling preventive maintenance actions during regular possessions or, in the worst case, outside peak hours, leading towards zero avoidable failures.
- Improvement in cooperation between different stakeholders in the supply chain, such as Infrastructure Managers, Railway Undertakings, Service Providers and Suppliers, etc. through the definition of standard open interfaces to access heterogeneous multi-owner maintenance-related data with the adequate degree of privacy, security and quality.
- Reduction of maintenance cost and complexity of maintenance processes and optimize maintenance execution thanks to (prescriptive) maintenance planning support systems, LCC reduction and less personnel involved in monitoring activities:
    - Optimize maintenance execution by reducing the number of needed possessions by 50%
    - Reducing maintenance cost by optimised planning by 30 to 50%

- Increase of the target capacity of the network by 10% through a modern and more cost-effective approach to predictive maintenance
- Reduction of rolling stock maintenance & repair costs thanks to the improved maintenance of the infrastructure
- Homogenization and simplification of maintenance by identification and removal of most impacting root causes making use of condition based monitoring and analytics methods

Type of Action: Innovation Action (IA)

4.1.4 S2R-CFM-IP5-01-2019: Smart data-based assets and efficient rail freight operation

SPECIFIC CHALLENGE

In the framework of the general challenges highlighted in the IP5 part of the S2R Master Plan, the following specific challenges should be addressed by the proposal in answer to this topic:

1. **Condition based maintenance (CBM)**: Rail operators are facing an increasing complexity of influencing factors on their competitiveness. The required flexibility and agility for adaption can only be granted, if digital technologies are used globally – which is today often not the case. Condition Based and Predictive Maintenance need to transform from a support function of rail freight and asset operation to a source of innovation.
   In the future, CBM plays a key role in identifying additional revenue and profitability potentials using current freight locomotives and wagons. Nowadays each European country is using its own maintenance rulebook with individual thresholds which indicates required maintenance activities. This will affect the roll-out of the defined condition monitoring thresholds tremendously. CBM use cases need to be defined for rail freight, resulting in user-centric specification and design of CBM dashboards with the objective of being used all over Europe with their individual specifications. In this manner, CBM use cases would be aligned with the European rail traffics. The challenge is to create an advanced monitoring solution of locomotive and wagon components to monitor the conditions in different rolling stock types across Europe in a centralised way. Central collection of performance metrics for development of digital maintenance rules is essential.

2. **Real-time Network Management**: It is a complex task to manage yards and to interact traffic operations at lines and network with the yard. Today operational traffic in yards is handled manual with much oral communication and the interaction between yards and the network planning and dispatching at infrastructure manager level is poor. This leads to long lead times and manual sequential processes when there are disturbances. The connection between timetable and operational traffic is low. The freight trains are not following their planned train path between yards. This problem has a huge impact on overall system punctuality. The challenges can be described as follows: i) the challenge to improve manual process at yards with better decision support for the personal; ii) The challenge to improve the interaction between the yard manager and the infrastructure manager; iii) the challenge of automation in traffic operation and dispatching processes. These challenges will generate changes in the work for different actors.

3. **Intelligent Video Gate Terminals (IVG)**: Lack of information and thereby lack of optimal terminal processes with problems in reliability and poor lead times represent a problem in terminals. Therefore, definition of relevant use cases enabling better data capture and information flow for rail freight terminals is important. User-centric specification and design of Intelligent Video Gate Terminals are also affected and are currently suboptimal. It is therefore essential to select a relevant pilot site and performance of a demonstrator for IVG-Terminal Operation tackling the involved challenges.
   Freight wagon availability and flexibility is a key factor for success in today's rail freight transport market. The market is highly under pressure from road freight transport alternatives which are often more competitive and flexible. This hinders a shift traffic flows from road to rail.
   Efficiency improvements during the inbound and outbound trains operations at terminal gates and improved data exchange of relevant information between terminals will speed up the process gaining in efficiency (e.g. saving time in terminal operation, increasing punctuality in delivering, etc.) and reducing costs.
   A collateral benefit that is expected with IVG technology is related the support to wagon inspection useful in maintenance and automatic damaging detection.

4. **Core Market Wagon**: Definition of validation scenarios for the novel designs following the 5L-Wagon designs are required in order to accelerate the market-uptake. Enhancing the function of the Core-Market Wagon Design putting it in the context of connected asset by established and affordable add-ons such as Wagon on-Board unit (WoBu) with energy harvesters shall address the challenge of fast and practical deployment of packages. Providing mechanical solutions and interfaces for future solutions such as automatic couplers shall enable modular and scalable system.

5. **Extended Market Wagon**: Final specification of the wagon structure and the wagon equipment, the integration of mechanical and electrical components in the wagon design will create the basis for the prototype manufacturing in future projects. This work will include the preparation of the authorisation process for the extend market wagon in TSI Wagon. The main challenges in this area are related to the structural integrity of the wagon and the safety of its technical equipment, especially for the supervision of the wagon. The energy efficiency of rail freight transport in terms of aerodynamic drag can be significantly increased by technical and operational measures. The requirements for a successful optimization of the numerical tools differ greatly from the methods used for passenger trains. The numerical methods must be adapted to these complex flow conditions and validated accordingly in order to be able to carry out loadable resistance predictions.

6. **Telematics & Electrification**: Nowadays, digitalisation is changing processes in many sectors, improving competitiveness and offering new innovative services. Rail freight transport is not an exception and it needs to take advantage of digitalisation, i.e. by introducing IoT by means of telematics, sensors and electrification leading to the intelligent wagon. This should fill the gap with respect to other means of freight transport and increase the reliability, trustability and efficiency of the rail freight transport. However, there is a need to clearly develop the required systems and services according to the demand of each operator i.e. cargo monitoring for logistics, wagon monitoring for maintenance, exact weighing, etc. These services make use of other services such as positioning and communication with standardize interfaces. The intelligent wagon will be, among others, one of the enablers of CBM, which will make use of the information provide; or the automatic coupler which could be controlled by the intelligent wagon. The challenge is to develop the required systems and services for the intelligent wagon as enabler for further services.

7. **Freight Loco of the future**: The challenge is to further improve the high-power propulsion system of mainline freight locomotive (including the auxiliary network) to lower significantly the LCC and TCO of the traction chain.

SCOPE

Having regard to the Union policies and targets on decarbonisation, taking into consideration that automation and digitalization are key enablers of a drastic railway system transformation, in order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP.

The work expected in work stream 1 concerning “condition based maintenance” (TD 5.1) should:

- Support the orchestration of the current CBM use cases which is developed within FR8RAIL and FR8RAIL II Projects with the target of European harmonisation;
- Make current European maintenance programmes transparent by looking at how different European countries manage their assets, and test the CBM use cases from FR8RAIL project on additional fleets in Poland, UK and France;

- Install trackside systems for measuring wheelset and brake block condition, link this data to route and freight information and identify algorithms which allows to optimise the maintenance and implement an efficient route planning;
- Assess all required information from a Digital Perspective e.g. prevailing IT Landscapes architectures and data handling in these countries to enable condition-based maintenance;
- Categorise observations into strengths areas for improvement and untapped opportunities, including the assessment of new business benefits linked to the maintenance program change.

This work stream should consider the work carried out in previous/ongoing research projects/initiatives in the field of CBM, e.g. FR8RAIL, INNOWAG and FR8RAIL II.

The activity is expected to finish with prototype demonstration in a TRL 6.

The work expected in work stream 2 concerning "real-time network management" (TD 5.2) should:

- Building on previous projects, this project will define use cases for real-time Network management with special focus on international traffic aiming at improving automated sequential planning and efficient human interaction among infrastructure managers, yard/terminal managers, railway undertakings. Special focus will be given to the interaction with maintenance contractors in order to maximise the use of the network capacity and to improve also the maintenance activities based upon the traffic needs;
- Develop an integrated information system with improved interaction with defined roles between infrastructure managers, yard/terminal managers, railway undertakings and maintenance contractors. Special focus will be given to international operations and how to better handle classified disturbances based on the replacement of uncertain data with correct real-time information. Wherever relevant, this activity should be aligned with the planned tender on "Technical solution for intermodal information exchange for freight";
- Demonstrate real-time Network management applications based on the information system according to the defined use cases.

This work stream should consider the work carried out in previous/ongoing research projects/initiatives in the matter of freight train/traffic/time management, e.g. RNE, ARCC, FR8HUB, OPTIYARD and FR8RAIL II.

The activity is expected to finish with a demonstrator in a TRL 6.

The work expected in work stream 3 concerning "intelligent video gate terminals" (TD 5.2) should:

- Study best usage of the data capture (optical and Rfid) and development of information services for example via platform (dashboards) using Internet of logistics (IoL);
- Build trackside camera gate/s as a demonstrator in operational environment for identification of passing locomotives and wagons, including identification of asset conditions relevant to operational and maintenance activities such as CBM, wagon/load units' rental, passing borders, etc;
- Investigate the potential use of the IVG for further activities such as automated start-up/departure process for the freight train and enable digital wagon inspections, early maintenance commissioning, brake test, etc.;
- Investigate the change of terminal processes with the use of IVG in the context of interfacing with road side processes for a seamless transport;

This work stream should consider the work carried out in previous/ongoing research projects/initiatives e.g. FR8HUB implementation plan for IVG.

The activity is expected to finish with a demonstration in a TRL 7.

The work expected in work stream 4 concerning “core and extended market wagon” (TD 5.3) should:

Core Market Wagon

- Finalise the specification of the wagon for prototype manufacturing;
- Define and validate rail freight specific use cases according the 5L approach and define a verification and validation plan for new sub-systems already developed in previous IP5 projects;
- Use and integrate new subsystems developed in previous/ongoing IP5 projects into a functional mock-up, as a demonstrator of the core market wagon, also enabling CBM and Continuous System Monitoring;
- Assess of Vehicle & Track Friendliness of the developed components by means of verified (measurements) simulation;
- Perform final lab tests to validate the 5L attributes of the core market wagon and its components.

Extended Market Wagon

- Finalise the specification of the wagon for prototype manufacturing;
- Deliver a Concept for certification and authorisation of new wagon design according to TSI with a new appropriate approach for fast time to market;
- Use and integrate electrical and mechanical components developed in previous/ongoing IP5 projects in the new wagon design as a demonstrator of the extended market wagon;
- Develop numerical tools for the aerodynamic design of the freight car concept for block train and single wagon transport, based on state of the art numerical methods in the field of aerodynamic;
- Perform final lab tests to assess the wagon design using numerical simulations and scaled models;
- Development a new generation of disks for freight concept.

This work stream should consider the work carried out in previous/ongoing research projects/initiatives in the field of core and extended market wagon, e.g. FR8RAIL, INNOWAG and FR8RAIL II.

The activity is expected to finish with a demonstration in TRL 6/7.

The work expected in work stream 5 concerning “Telematics & Electrification” (TD 5.3) should:

- Definition of functionalities of the demonstrators related to wagon intelligence (e.g. harmonized digital brake test, weighting, localisation, etc.);
- Definition of the validation tests protocols and field test areas with special attention to cross-border operation to ensure the rollout across European countries;
- Testing of the subsystems and services, i.e. telematics as well as sensor connection concepts. If needed, improvement and development of subsystems (i.e. Wheel Slide Protection (WSP) system for EMS, wagon intelligence algorithms for localization as well as cargo and wagon monitoring, etc.);
- Assessment of the interoperability of wOBUs from technical, operational and cross-border perspectives;
- Definition of the integration of wOBU on the wagon, in preparation of the prototype manufacturing in a 2020 project linked to work stream 4.

This work stream should consider the work carried out in previous/ongoing research projects/initiatives in the field of telematics and electrification, e.g. FR8RAIL, INNOWAG and FR8RAIL II.

The activity is expected to finish with a demonstrator definition in a TRL 6.

The work expected in work stream 6 concerning "Freight Loco of the future" (TD 5.4) should:

- Study of new design approaches to further improve the high-power traction chain, including the auxiliary network of an electric mainline freight locomotive with respect to power density, modularity, RAMS-LCC and TCO.
- Evaluation of the use of SiC components for high power and high voltage locomotive converters. This activity shall rely on the results achieved in the IP1 PINTA project, if applicable.
- Development of a small-scale prototype (e.g. a traction converter module) of a high- power traction chain in preparation of the prototype manufacturing in a 2020 project.
- Development and lab validation with prototypes of new efficient power converter, Energy Storage System and Energy management System for hybrid locomotive.

This work stream should consider the work carried out in previous/ongoing research projects/initiatives in the field of new freight propulsion concepts, e.g. FFL4E, PINTA2, FR8HUB and FR8RAIL II.

The activity is expected to finish with a demonstrator in a TRL 5/6.

Work Streams results should be placed in the context of the demo plans, which are developed in conjunction with MAAP part B. In addition, the demo plans should be accompanied with integration and migration plans to implement produced solutions in the rail environment to support and speed up deployment.

Considering the "18C044-0C WHITE PAPER REFERENCE CCS ARCHITECTURE (RCA) BASED ON ERTMS" developed by the ERTMS Users Group and the EULYNX consortium and provided to S2R in July 2018, and following the ongoing collaboration initiated with the promoters of such initiative for the integration of the RCA in the S2R Programme, a final high level decomposition of RCA is expected be delivered to S2R by April 2019. The S2R Members should firstly verify the impact that the RCA would have or potentially have on the content of each work streams activities and subsequently each CFM proposal should be aligned, as far as possible, against the latest progress on the Reference CCS Architecture, in particular the system approach and interoperability of solutions must be ensured across S2R IP/CCA activities and for future developments.

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-OC-IP5-01-2019: Condition-based maintenance for locomotive bogie and running gear.
- S2R-CFM-IPX and /CCA-01-2019: S2R System Architecture and Conceptual Data Model.

- S2R-CFM-IP2-01-2019: Completion of activities for enhanced automation systems (including Freight ATO GoA4), train integrity, object controller.

The action stemming from this topic will also be complementary to actions carried out within the following project of IP1:

- FR8RAIL (GA 730617)
- INNOWAG (GA 730863)
- CFM-IP5-01-2018: Technology demonstrators for competitive, intelligent rail freight operation.
- FR8HUB (GA 777402)
- CFM-IP1-01-2018: Development of technology demonstrators for the next generation of traction systems and adhesion management systems.

The action shall actively contribute to the S2R standardisation rolling development plans wherever relevant.

The action shall actively contribute to the S2R KPIs development. This shall lead to publicly available deliverable, quantified indicatively on a semi-annual basis.

The planned activities of the action should take into account the revised MAAP part A.

The S2R JU will only fund one proposal under this topic.

EXPECTED IMPACT

The foreseen research activities are expected to contribute to the creation of a framework for an effective railway for freight as a part of the logistical value chain in a more automated way via intelligent equipment and railway terminals enabling the provision of accurate information to end customers and operators.

The foreseen research activities in work stream 1 “condition based maintenance” are expected to lead to:

- Improved services and user quality
- Reduced train composition times (up to 30%), and lower operation costs.
- Reduced system costs
- Enhanced interoperability
- Simplified business processes
- Reduced maintenance costs
- Increased locomotive and wagon availabilities

The foreseen research activities in work stream 2 “Real-time Network Management” are expected to:

- Provide processes and tools that reduce the need for freight trains to run outside their planned timetable channel. This decreases the need for operational rescheduling.
- Better handle disturbances by improved interaction and communication between infrastructure manager, railway undertakings and other actors.
- Enhance flexibility and competitiveness of train paths for freight trains and better punctuality for passenger and freight trains.
- Increase punctuality for freight trains arrivals and freight trains departure to and from yards of approximately 20 %. It will also have a big impact on overall system punctuality for passenger and freight trains.

The foreseen research activities in work stream 3 “Intelligent Video Gate Terminals” are expected to:

- Increase the effectiveness in the production/operational process in the terminal with 20%
- Enhance the communication between different stakeholders in the terminal
- Enhance the communication between the terminals and the network

- Increased customer service with regards to more accurate and reliable information
- Reduce the time of commissioning maintenance at workshops
- Reduce the time of performing maintenance at workshops (ordering materials in time, placing locomotive or wagon on right track, preparing works in time etc.)
- Increase success for claims of misconduct and damages by third parties
- Benefit from expertise and deep knowledge of high aged employees by facilitating new, flexible and digital working models

The foreseen research activities in work stream 4 “Core and Extended Market Wagon” are expected to contribute to the overall MAAP Impacts through an:

- Increase in payload while maximising reliability
- Increase in aero-dynamical and acoustical performance
- Increase in flexibility of train compositions to maximise logistics capability
- Maximisation of track friendliness
- Optimisation of maintenance intervals
- Decrease in maintenance costs by providing intelligent assets

The foreseen research activities in work stream 5 “Telematics & Electrification” are expected to:

- Complete the final activities before the demonstration validation tests in 2020 project.
- Stress the need for interoperable wOBUs from a technical, operational and cross border perspective that will drive the market uptake.
- Contribute to dialogue between ERA/NSA on conditions for test authorisations.

The foreseen research activities in work stream 6 “Freight Loco of the future” are expected to generally reduce LCC through:

- Increased energy efficiency (in the range of 2-5%)
- Increased maintenance intervals (in the range of 10-20%)
- Reduced maintenance costs (in the range of 10-20%)
- Reduced complexity (in the range of 2-5%)
- Improved availability (in the range of 2-5%)

Type of Action: Innovation Action (IA)

4.1.5 S2R-CFM-CCA-01-2019: Integrated mobility management (I2M), Energy and Noise & Vibration

SPECIFIC CHALLENGE

Integrated Mobility Management (I2M)
The project IN2RAIL (GA number 635900) has delivered a first system design for an integrated Communication Infrastructure to link the defined rail operation services and their field assets. This platform (Integration Layer) uses standardized data structures and processes to manage the data exchange between different stakeholders and provides a gateway for data exchange with external clients. The availability of such data will enable analyses to enhance rail traffic management, including improved planning and timetabling, reliable and resilient operations and informed asset investment and maintenance decision making.

The most critical factor to realize the proposed system concept is the maturity of the Conceptual Data Model with embedded elements of information required from the different applications of subscribed services/clients. To achieve this goal, applied operational procedures or technical functionalities must be described in such depth that the necessary data to be received or send from/to other clients can be specified. If preceding projects deliver their targeted outputs, the works proposed for WA4.2 in this project will not face significant risk to be completed.

Energy
The challenge regarding energy is linked to the need to reduce energy consumption within the railway sector in order to ensure that the environmental advantage of railways remains or increases. The necessity to reduce energy costs, an important part of the total Life-Cycle Cost, to contribute to the general S2R objective "Reduced operating costs" is also a priority. Furthermore, reduction energy consumption from HVAC is needed is required, as HVAC accounts for a major part of the energy consumption from the traction.

Noise and Vibration
In order to ease vehicle certification and reduce the associated cost and time expenses without penalising the real vehicles noise performance, virtual certification will play an important role in the near future. Thus, current exterior noise simulation tools require further research and validation in order to ensure that the procedures and methodologies applied, and the results obtained represent the noise performance the real train will have. Additionally, current noise measurement procedures lack the possibility to accurately separate noise sources on pass-by noise tests, and do not cover the common vehicle scenarios (including different track types). Separation of contributions is relevant both for vehicle validation and for source ranking prior to mitigation measure implementation, and the improvement of separation techniques shall finally lead to more flexibility, better comparability and hence a better vehicle characterization in current homologation procedures and for the customers.

SCOPE

Having regard to the Union policies and targets on decarbonisation, taking into consideration that automation and digitalization are key enablers of a drastic railway system transformation, in order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP.

Work stream 1: I2M
The action to be funded under topic S2R-CFM-IP-01-2019 is expected to develop prototypes up to TRL6 for the TMS integration layer.

IN2SMART (grant agreement number 730569) further progressed Railway Information Measuring and Monitoring System (RIMMS), Dynamic Railway Information Management System (DRIMS) and Intelligent Asset Management Strategies (IAMS) demonstrators, complementing the work previously done in past project (IN2RAIL).

The action to be funded under the topic S2R-OC-IP2-02-2019 (linked to TD2.9) will provide a demonstration platform for an Integration Layer-enhanced TMS.

The action to be funded under this topic will therefore specify and develop necessary Interfaces to allow Freight and Passenger Operations, Maintenance Services and Traffic Management Systems to access the different databases via the integrated ICT and design a concept and to test and validate the proposed prototypes on the platform to be delivered by the action to be funded under the topic S2R-OC-IP2-02-2019.

- Integration of Business Services

Technical Engineering: This activity shall encompass all coordination and system engineering activities required to ensure compatibility, interoperability and design of the Interfaces of the Integration Layer to TMS, Asset Management Systems, Passenger and Freight Planning and Operation Services.
Development Specification and Prototypes for APIs including specific Plug-ins: The objective of this activity is to specify and develop prototypes up to TRL 3 for the APIs between the Integration Layer, TMS, Asset Management Systems and Passenger and Freight Planning and Operation services. These activities are based on the requirement specification developed under the WP6 of X2RAIL2 (GA number 777465) and WP7 of IMPACT-2 (GA number 777 513).
Develop a concept and design Guidelines for a Demonstrator: Developing a concept and the design guidelines for a demonstrator to test and validate the prototypes. This task is closely linked with the coordination and the works proposed for the action to be funded under the topic S2R-OC-IP2-02-2019 (establish a test bench to test and validate all prototypes related to the Integration Layer).

- Advanced Business Service Applications

Specification and Development of prototypes for TMS applications: The Objective of this work is to specify and develop prototypes for applications in a TMS addressing traffic prediction, real-time control of the operation, maintenance planning and operational decision support features. This will enable:

I. Optimised service intent, timetable and schedule planning across different time-resolutions for efficient TM operations;
II. The ability to predict and prevent (e.g. pre-planned alterations for predictive maintenance interventions); or quickly detect unplanned operational disruptions and minimise their impact and incident recovery (e.g. reactive maintenance, conflict resolution);
III. The ability to re-optimise timetable planning, as more rail and mobility system operation data is made available, thereby facilitating continuous improvement in TM and;
IV. Additional data to be provided to other non-rail mobility providers, to enhance overall mobility offering.

Examples of additional data which can be used to improve Traffic Management (TM) operations can include but are not limited to:

- Rolling stock and crew availabilities (planned vs. actual), small events which may affect effectiveness of macro-level timetabling;
- Live passenger movements and overcrowding, availability and incentivising multi-modal options to alleviate demand on rail during abnormal operational conditions;
- Smart maintenance operations based on predicted behaviour of infrastructure assets (outputs from IN2SMART).

This could lead to the creation of advanced prototypes, including but not limited to:

I. Rolling stock and crew availability management systems to reduce likelihood of disruption to planned TM operations;
II. Enhanced freight tracking including better coordination with 'last-mile' logistics providers;
III. Automated decision support tools for TMS to cater for preventative maintenance requests of a railway asset, based on Intelligent Asset Management Strategies developed under IN2SMART, minimising system disruption on macro-level timetable;
IV. Demonstration of pre-emptive information output to minimise disruption to passenger journeys and maximise speed of rail operational recovery, based on discrete events, e.g. passenger overcrowding, rail network disruption, TMS failure.
V. Enhanced standard operator workstation HMI design to accommodate new information flow and decision support functionalities for above prototypes.

Work stream 2: Energy

The activity should provide support to all S2R Innovation Programmes (IPs) and Technology Demonstrators (TDs), most notably as regards the energy calculation methodology and agreed boundary conditions produced in the project FINE-1 (Grant agreement number 730 818).

The existing list of energy-related TDs shall be reviewed for matching with the updated MAAP. Once the energy related tasks have been confirmed, respectively identified for each IP, they should be analysed with respect to their potential contribution to energy saving.

The action shall undertake the following activity:

I. Update of the energy KPI, creating specific TD input consolidation groups by market segments and continue the data gathering from the TDs;
II. Supporting the IPs and TDs for estimating energy improvement;
III. Carry out pre-standardisation work: Energy-efficient technologies and strategies should be analysed from a whole life cycle perspective;
IV. Review the energy baseline defined in FINE-1 and collect lessons learned in the application as a reference for the evaluation of energy savings of new S2R technologies;
V. Review and update the "future railway system with respect to energy" deliverable work of FINE-1 as ;
VI. Evaluation of energy savings achieved on demonstrators (new driving strategies, DAS implementation savings, new optimised auxiliary management) by real measurement campaigns;
VII. Theoretical Evaluation of energy savings achieved (via simulations and calculations with the support of the tool developed in the project OPEUS[29];
VIII. Regarding HVAC, the activity should define the state-of-the-art of the technology, define additional sub-level KPIs as well as energy savings evaluation methods; deliver an analysis of potential energy (HVAC related) savings shall be carried out along a train journey in order to investigate e.g. wasted heat and braking energy utilisation. The thermal car body model used for this purpose shall apply energy baseline scenarios as calculated by the OPEUS tool.

Work stream 3: Noise

1. <u>Exterior noise simulation tools</u>

The objective is to support the development in the complementary action to improve simulation capabilities for exterior noise at standstill and pass-by, based on existing tools stemming from ongoing and past projects. The modelling of exterior noise includes adding together noise sources placed on different parts of the train to simulate the resulting noise levels. The exterior noise modelling tools

[29] Grant agreement number 730 827 – Deliverable D2.2 "OPEUS simulation model"

and methodologies to be enhanced and validated are those currently in use by industry members with respect to standstill and pass-by noise. The focus will be set on modelling of noise sources sound power and directivity and of integration effects.

The activity should consequently focus on the following two areas:

I. Defining requirements for the modelling to be carried out by the action to be funded under the topic S2R-OC-CCA-01-2019.
II. Analysing existing methodologies in comparison to the enhanced modelling procedures developed for reference cases.
III. Applying an uncertainty assessment of the whole prediction by using the methods developed by the OC or own methods.

An indicative scheduling of the deliverables is suggested below[30]:

- Requirement definition based on current industry needs - M5
- Implementation of new modelling methodologies on industry members tools and improvement assessment - M36

2. Pass-by noise source characterisation

I. The objective is to support the development of innovative techniques to separate and define the sound power level and directivity of the different types of sources during pass-by at constant speed of a train.
II. A specification should be delivered based on the results from ROLL2RAIL and FINE-1, with the purpose to be used by the action to be funded under the topic S2R-OC-CCA-01-2019 on the work on separation techniques including aerodynamic sources, traction noise sources as well as rolling noise (rolling noise shall be considered as an entity, with no need to separate track noise from wheel noise.) Two vehicle scenarios will be specified together with additional requirements to be complied with by the methodologies to be proposed. The separation techniques developed shall be tested by the action to be funded under the topic S2R-OC-CCA-01-2019 for each vehicle scenario separately. This action will on the other hand define and give access to vehicles and tracks to be used for this purpose.
III. Analysis of strengths and weaknesses of the methodology proposals to be developed by the action to be funded under the topic S2R-OC-CCA-01-2019.
IV. The test results provided by the Open Call shall be tested in this action's pass-by noise simulation tools in order to assess the suitability of the test methodologies developed to feed simulations fitting real train pass-bys.

An indicative scheduling of the deliverables is suggested below:

- Specification of vehicle scenarios and requirements for methodologies to be delivered to the Open call project - M6
- Analysis and recommendations for implementation of new methodologies proposed by the Open call project - M33

3. Separation of track noise versus vehicle noise

[30] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling.

The objective of this work stream is to support both the simplification and the enhancement of methodologies for separation of the track versus the vehicle part of the rolling noise. Validation and data collection including several vehicle scenarios is expected.

The focus shall be put on:

I. Delivering specifications based on FINE-1 and ROLL2RAIL, with the purpose for use by the action to be funded under the topic S2R-OC-CCA-01-2019 on separation techniques. For this purpose, three vehicle scenarios shall be specified including a detailed goal and requirement definition;
II. Study the feasibility of normalizing pass-by noise to a reference TSI/ISO track reference in terms of roughness and TDR (Track Decay Rate);
III. Analyse performance of the methodologies proposed for exterior noise pass-by separation technologies;
IV. The separation techniques developed shall be tested and validated by action to be funded under the topic S2R-OC-CCA-01-2019 for each vehicle scenario separately. This action will define and give access to vehicles and tracks to be used for this purpose.

An indicative scheduling of the deliverables is suggested below:

- Specification of vehicle scenarios and requirements for methodologies for the Open Call - M5
- Analysis and recommendations for possibility to implement separation methodologies for authorisation and other exterior noise testing - M36

4. Ground Vibration

The objective to support the future development of a commonly accepted, practical and validated prediction tool for ground vibration impact studies:

I. Specification of model requirements including descriptors and indicators for the overall prediction tool. Predictions should be made in free-field conditions (without buildings) and on the foundations of buildings as well as on floor levels of living rooms;

II. Specification to define and characterize typical vehicles and in different situations involved i.e. based on the different dynamics characteristics of bogies and their interaction with track conditions;

III. Performing measurements of the same type of train in at least two different situations in order to test the models for the transfer of vibration emissions data;

IV. Validation of the prediction tool (final version) using either already existing measurements and/or the measurements to be performed in the project as well as the integrated methods by comparison to numerical results and measurements.

An indicative scheduling of the deliverables is suggested below:

- Specification of model requirements including descriptors for vibration evaluation - M10;
- Specification how to define and characterize typical vehicles, track and soil conditions including tests - M14;
- Results from test campaign - M26;
- Validation and uncertainties - M36.

5. New Technologies:

The objectives are to support the action to be funded under topic S2R-OC-CCA-01-2019 on developing new and innovative approaches to improve the acoustic design for the interior on future rolling stock and on auralisation (A&V) and visualisation systems for railway noise:

I. Regarding new materials and concepts, the activity shall provide input, review analysis and recommend preferred designs proposed in feasibility studies on innovative solutions for railway noise abatement developed in the complementary Open Call;
II. Permanent follow-up and supervision of the Open Call during the simulation and validation phases (new materials and concepts);
III. Evaluate the simulation and validation results provided by the complementary Open Call and analyse the improved configurations;
IV. Regarding the development of functional system for (A&V), this activity shall revise or fine-tune the system specification, which was delivered in FINE1 , if necessary. Information and measurement data shall be compiled to support the activities of the complementary Open call, as well as provide support for digital mock-ups of railway noise scenarios. All software version (external noise, test version and final user version) developed by the complementary open call shall be reviewed and tested in this activity.

An indicative scheduling of the deliverables is suggested below:

- Provide input to feasibility studies of innovative designs - M4;
- Analysis of and recommendations for most promising proposals in feasibility study - M10;
- Analysis of improved configurations on vehicle level - M36;
- Evaluation and analysis of the A&V software tool - M36.

6. Technical assessment on system level

This part shall focus on the integration of the noise activities within the Shift2Rail program. The coordination with the Technical Demonstrators shall be done as well as a follow up of N&V targets for each noise relevant TD to reach an optimal result, at system level. S2R Results may be compared to other relevant innovations done outside Shift2Rail.

An indicative scheduling of the deliverables is suggested below:

- Report on technical assessment on system level - M36

7. Evaluation and monitoring of impact on traffic noise scenarios of Shift2Rail innovations

This activity aims at following up on the scenarios defined in FINE-1. These scenarios will be used as a basis in order to assess the impact of the overall work done on Noise in the programme (WA5.2 of the S2R MAAP). Effect of the new technologies developed in the S2R IPs may also be compared with other relevant innovations outside Shift2Rail.

An indicative scheduling of the deliverables is suggested below:

- Comprehensive report on the improvements of S2R for noise and vibration - M36

In order to address the challenges described above, the proposed research shall address all the work-streams described above, in line with the Shift2Rail Multi-Annual Action Plan (MAAP).

Work Streams results should be placed in the context of the demo plans, which are developed in conjunction with MAAP part B. In addition, the demo plans should be accompanied with integration and migration plans to implement produced solutions in the rail environment to support and speed up deployment.

Foreseen achievable Technology Readiness Level: TRL3/4

Considering the "18C044-0C WHITE PAPER REFERENCE CCS ARCHITECTURE (RCA) BASED ON ERTMS" developed by the ERTMS Users Group and the EULYNX consortium and provided to S2R in July 2018, and following the ongoing collaboration initiated with the promoters of such initiative for the integration of the RCA in the S2R Programme, a final high level decomposition of RCA is expected be delivered to S2R by April 2019. The S2R Members should firstly verify the impact that the RCA would have or potentially have on the content of each work streams activities and subsequently each CFM proposal should be aligned, as far as possible, against the latest progress on the Reference CCS Architecture, in particular the system approach and interoperability of solutions must be ensured across S2R IP/CCA activities and for future developments.

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-IP2-01-2019: Tools, methodologies and technological development of next generation of Running Gear.
- S2R-OC-CCA-01-2019: Noise & Vibration.
- S2R-CFM-IPX and /CCA-01-2019: S2R System Architecture and Conceptual Data Model.
- S2R-OC-IP2-02-2019: Support to development of demonstrator platform for Traffic Management.

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- FINE-1 (GA 730818).
- X2RAIL2 (GA 777465)
- IMPACT-2 (GA 777513)
- IN2SMART (GA 730569).

The action shall actively contribute to the S2R standardisation rolling development plans wherever relevant.

The action shall actively contribute to the S2R KPIs development. This shall lead to publicly available deliverable, quantified indicatively on a semi-annual basis.

The planned activities of the action should take into account the revised MAAP part A.

The S2R JU will only fund one proposal under this topic.

EXPECTED IMPACTS

I2M

- Additional services through integrated communication processes and permanent availability of status data in one common layer will significantly improve the performance of TMS. This is key to achieve the targets for capacity growth, reliability improvement and cost reduction.

- Capacity Increase and Cost Reduction
  Improved business logic in the TMS integrating dynamically updated asset status data received via the proposed interfaces asset will enable the creation of a much more flexible and consistent time tables for cargo services which will reduce the "disturbances" caused by freight traffic on lines which are used also by passenger trains.
  This will lead to a higher utilization of the theoretical line capacity hence decrease the operational cost for IMs. Also a more robust (flexible) time table for Freight trains will reduce unnecessary waiting times for slots and reduce the OPEX for Freight Services.

- Customer experience
  Overall customer experience is affected by not only the rail assets controlled by TMS, but also the interconnecting service providers at either end of their journey, including modes of transport to and from stations and pedestrian experience within stations. Therefore the proposed scope should enable service providers at each stage to deliver services to improve seamless customer experience.
  Where disruptions to regular service occur, such sharing of data can enable enhanced 'service-recovery' actions to take place, to minimise any negative effects to the customer experience.

- Increase of Reliability of Train Services through increase of the Availability of Assets
  Maintenance operations will benefit from a dynamic update of the traffic status via the Integration Layer and its Interfaces. This will allow those services to plan much better their services operations. A quantification of improvement of this KPI must be originated from IP3 TD6 and TD8 (Maintenance Strategies) reflecting the better usage of available slots for maintenance.
  Improved effectiveness of maintenance operations will increase the reliability of all train services, hence increase further the capacity utilization and decrease operational cost.

Energy

- The expected impact of the research and innovation action in the field of energy will be linked to determining the potential energy improvement of technical innovations in order to decide which innovations should be applied when new trains or infrastructure assets are purchased.
- In addition, the reduced energy consumption, thanks to the use of new technologies, should contribute to the reduction of the environmental impact of the railway sector and help to increase the competitiveness of rail transport due to reduced energy cost.

- The standardisation of the simulation methodology and parameters as well as measurement procedures for the estimation and verification of energy consumption supports the general S2R objective of “simplified business processes”.
- Actions will contribute to contribute to energy-related standardisation and reinforcement of energy-efficient technologies development both through technical developments inside Shift2Rail and also market demand for Life Cycle Cost-optimized solutions.

Noise and vibration

Exterior Noise:

- Reduction on rail vehicles noise validation lead time and cost
- Reduction of requirement non-compliances at product delivery
- More precise and better-founded requirement definition for equipment suppliers, reducing time (and cost)
- Lower operators’ track occupation for testing
- Better understanding of noise contributors exterior noise
- Higher comparability and reproducibility of pass-by measurements.
- The new assessment method will allow silent vehicles to show up
- A better basis for possible noise dependent track access charges
- Reduce the need of a TSI-compliant test track (e.g. slab track is also possible without high risk)
- Detection of main noise contributors to pass-by noise.

Ground Vibration:

- Access to a commonly accepted, practical and validated prediction tool for ground vibration impact studies

New Technologies:

- Access to a fully functional software for Auralisation and Visualisation allowing the possibility of listening and experiencing visually the noise of trains passing a certain track, long before it is built and test different noise mitigation measures as well as assess modification on the interior noise.
- Availability of new, innovative and validated design solutions for interior noise control.

Type of Action: Innovation Action (IA)

4.1.6 S2R-CFM-IPX and CCA-01-2019: S2R System Architecture and Conceptual Data Model

SPECIFIC CHALLENGE

Digitalization is a reality of the railway sector. In almost all areas of operation, computerized systems are available, ranging from computer-based interlockings to systems for analysing asset diagnostics which have emerged over the last few years. We have computer systems for timetabling, traffic management, energy management, asset maintenance, rolling stock inventory, crew rostering etc.
What is missing is an efficient, automated and standardized/agreed way for these systems to act as **one** ecosystem, sharing and integrating or give meaning/correlate to their data and making use of the sum of this information. Hereby improving existing services, in terms of time-to-market and maintainability, or to offer innovative solutions, new type of services, also taking advantage from integration of not purely railway data source (e.g. intermodality).
The sector needs to overcome its current "data" and "systems" fragmentation, the "silofication", and produce within S2R a system of systems approach and one Shift2Rail Conceptual Data Model (S2R-CDM) that, with the commitment of the S2R Members, will become the standardised way for legacy and new systems to interact, thus ensuring interoperability between systems.
The system of systems approach and the S2R-CDM are not meant to model the whole railway system and it should not have the expectation to model everything. Its objective is to define a unified conceptual structure representing the components of the railway system, identify the relations between them and provide a common language and data dictionary to describe them. They can be used as a foundation for new products or for exchanging/giving interpretation to data between different railway systems (or different components within a railway system).

The challenge consists in defining a system of systems approach that is widely accepted by the sector, starting with the RCA initiative, and the Shift2Rail Conceptual Data Model (S2R-CDM) to be used without license fees as free and open standard like LINUX in the world of operating systems. The S2R-CDM structure should allow the inclusion of complementary modelling initiatives in a collaborative effort (e.g. BIM, RTM, Eulynx, railML, TAP/TAF, , IP4 ontology based modelling approach), avoiding competing and overlapping models, and creating new business cases.
The core model will be such that no limitations are created related to the implementation of the model, i.e. the model must support different ways of implementing an interface with today well-known formats and protocols but also non-restrictive for future formats and protocols.
S2R partnership will have to develop governance in order to ensure the consistency and scalability of the system architecture and the S2R-CDM in the future.

Different ongoing S2R projects (IN2SMART, X2RAIL2, CONNECTA, CONNECTIVE, FR8RAIL, IMPACT2) are already dealing with the concept of data standardization and data integration, confirming that a common understanding of data is a need to be addresses more broadly.

SCOPE

Having regard to the Union policies and targets on decarbonisation, taking into consideration that automation and digitalization are key enablers of a drastic railway system transformation, in order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP.

Work Stream 1:

- Harmonisation of modelling chains, description methods and tooling selection for CDM development.
- Definition of a conceptual and structured representation of data that need to be shared between systems; not to define rules of data exchange but limited to the definition of the conceptual structure. The structure should allow the inclusion of complementary modelling

initiatives in a collaborative effort (e.g. BIM, RTM, Eulynx, railML, TAP/TAF, IP4 ontology based modelling approach.

- An active collaboration governance process aiming at avoiding overlapping areas among models (in particular of existing initatives) must be developed and coordinated.
- Existing integration and exchange facilitiation type of activities (including ontology approach of IP4) in the considered domains must be taken into account.
- Clear rules for model integration and model extension, both for core model extension and for customization extensions, must be defined.
    - It should also provide (identify) mechanisms for overall uniqueness of identifiers for objects within the model (naming conventions, etc…).
- Definition of the domains to be included and its growth should be use-case driven taking into account existing use cases already produced by existing projects
    - and providing a methodology, a process, that will allow to take into account needs of incoming projects and allowing the extension of existing model
    - and the use case driven should not define use cases but receive use cases from existing projects.
- The interaction with other initiatives shall take into account Business Cases related to the usage of the S2R-CDM and to data exchange and Licenses topics (between different initiatives). Ownership of the CDM and extensions to it must be thoroughly specified
    - To the extent that CDM is based on independent models, an agreement of license and non-restrictive use must be settled.
- A clear and robust governance model for the S2R-CDM must be defined. The research results and work already conducted on the IP4 possible future governance should be looked at and synergies considered. In particular: implementing a methodology to guarantee unified development on S2R-CDM among all current and future S2R projects independent from project running times
- The CDM definition process must be aligned with ongoing S2R developments and possibly with the identified relevant developmnets outside S2R: that means that use case should come from S2R projects and that a process for helping projects in their implementation should be defined

Work Stream 2:

- Setting the ground for a comprehensive railway system approach, bringing the IP2 Reference CCS Architecture into a broader system level context, ready for S2R Europe
- Map the implementation of the S2R innovations and any other relevant technology in the new rail system approach and assess the interdependencies
- Analyse which system/subsystem and related operation/maintenance procedures will be affected and how
- Analyse its business case and produce a business plan, analysing who bear the costs and who will benefit from it. Provide recommendation for improvements of the business cases
- Define a strategy for implementation, dissemination and communication, considering possible sectorial resistencies and propositing mitigation actions
- Draft a first migration plan, taking into account the above

The output of this action should be:

- a S2R-CDM conceptual model, defining a unified hierarchical structure representing the components of the railway system, identifing the relations between them and providing a common language and data dictionary to describe them

- a Governance Model of the S2R-CDM which guarantee a unified development of the model
- a first comprehensive model/architecture, mapping the technologies and strategy for implementation of a new comprehensive railway system approach

Wherever relevant, this activity in Work stream 1 should be aligned with the planned tender on "Technical solution for intermodal information exchange for freight".

Considering the "18C044-0C WHITE PAPER REFERENCE CCS ARCHITECTURE (RCA) BASED ON ERTMS" developed by the ERTMS Users Group and the EULYNX consortium and provided to S2R in July 2018, and following the ongoing collaboration initiated with the promoters of such initiative for the integration of the RCA in the S2R Programme, a final high level decomposition of RCA is expected be delivered to S2R by April 2019. The S2R Members should firstly verify the impact that the RCA would have or potentially have on the content of each work streams activities and subsequently each CFM proposal should be aligned, as far as possible, against the latest progress on the Reference CCS Architecture, in particular the system approach and interoperability of solutions must be ensured across S2R IP/CCA activities and for future developments.

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-CCA-01-2019: Integrated mobility management (I2M), Energy and Noise & Vibration.
- S2R-CFM-IP2-01-2019: Completion of activities for enhanced automation systems .(including Freight ATO GoA4), train integrity, object controller.
- S2R-CFM-IP3-01-2019: Intelligent asset management finalisation.
- S2R-CFM-IP5-01-2019: Smart data-based assets and efficient rail freight operation.

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- X2RAIL-2 (GA 777465)
- IN2SMART (GA730569)
- CONNECTIVE (GA 777522)
- IMPACT-2 (GA 777513)
- S2R-CFM-IP5-01-2018: Technology demonstrators for competitive, intelligent rail freight operation
- S2R-CFM-IP1-02-2018: Implementing new technologies for the TCMS

The action shall actively contribute to the S2R standardisation rolling development plans wherever relevant.

The action shall actively contribute to the S2R KPIs development. This shall lead to publicly available deliverable, quantified indicatively on a semi-annual basis.

The planned activities of the action should take into account the revised MAAP part A.

The S2R JU will only fund one proposal under this topic.

EXPECTED IMPACTS

Benefits of adoption of a System Architecture and Conceptual Data Model, in general, are:

- System of Systems approach integrating digitalization and automation
- Increase scalability and extensibility of existing systems
- Reduce development effort and consequently time to market for new applications
- Improve system maintainability
- increased cooperation between systems by making use of integrated data
- Provide a foundation for innovative new services, e.g. making use of analytics technologies on integrated data

Adopting a S2R-CDM, at S2R level, will alleviate ongoing and upcoming projects from the need to reinvent another different way to represent common objects but to concentrate only to extensions.

Furthermore, the adoption of a common language between projects will foster data integration across projects and across IPs.**Type of Action: Research and Innovation Action (RIA)**

4.2 ANNEX II – 2019 Calls for non-JU members – Topic descriptions

4.2.1 S2R-OC-IP1-01-2019: Advanced Car body shells for railways and light material and innovative doors and train modularity

SPECIFIC CHALLENGE

Specific challenges for the different topics are:

Car Body Shell

Cost is one of the key factors impeding entry to the market for composite technologies. An investigation on new technologies able to address this challenge is needed, e.g. 3D additive technologies that allows quick and cheap tool manufacturing to successfully introduce the composite in the Rail Industry, especially for large dimensions tools. 3D printer technology is considered very promising, although any other technology covering the same requirements could also be considered.
The potential benefits that structural health monitoring systems could offer are the cost reductions regarding maintenance and operation, Reduction of inspection time, early damage detection to enhance safety and allow for less drastic and less costly repairs.

Doors

Also for doors, cost is one of the key factors impeding entry into the market for composite technologies. Special emphasis is needed on cost reduction technologies to make the composite technologies affordable for Rail industry. For that purpose, a specific focus on manufacturing tools is necessary.
Due to the characteristics of door leaves which shall have low thickness (mainly between 32 mm till 50 mm), low weight, relatively low tightness, they are on the weak point to allow important comfort in the vestibule or in the vicinity of the door. As a consequence, other solutions than strictly door solutions should be studied in order to improve passenger comfort and allow phone conversation in the door vicinity.
Solutions have to be provided for the accessibility of trains to all users. A significant challenge is to improve train services and create a real universal service, allowing independent and easy access to all passenger categories, including passengers with reduced mobility.

Interiors

The challenge is to propose new low cost, modular and aesthetic interiors designs (passengers room) matching the concepts of new fixation systems developed during the S2R-CFM-IP1-01-2019 call.

A further challenge is to be able to decide which interiors and cabin layout use before building a mock-up demonstrating the modularities allowed by the new concept of plug&play fixation systems.

Cost is one of the key factor preventing the entry into the market of composite technologies. For that purpose, a specific focus on manufacturing tools is necessary.

Following the results of PIVOT (S2R-CFM-IP1-01-2017) work around innovative driver cabin and new HMI are one of the challenges to address. Gesture, sound and voice control are the new technologies to master in the cabin of the future. For this, human factors, cognition and cultural differences impacts have to be taken into account to design the most efficient cabin commands.

One of the most interesting could be the integration of the low volt circuit as a way to reduce assembly time and the associated cost. Currently, an industrial application with this functionality does not exist.

SCOPE

Proposals addressing S2R-OC-IP1-01-2019 is part of the Car body shells, innovation doors and train modularity developments and activities within the Shift2Rail (S2R) programme (respectively TD1.3, TD1.6 and TD1.7) and is complementary to the S2R-CFM-IP1-01-2019. These activities are described in the S2R Multi-Annual Action Plan (MAAP) – TD1.3, TD1.6, TD1.7 and the S2R-CFM-IP1-01-2019 topic description. The detailed information about the scope of the Open Call (OC) contribution is mentioned in the following work streams.

1. New tooling for composite car body manufacturing
2. Car body Structural Health Monitoring Systems for Composites and for Metal-Composite Interfaces
3. Process automation concepts for Composite Car body Manufacturing
4. Process integrating joint concepts and modular concepts for Composite Car body Manufacturing
5. New tooling for Composite Door Leaves manufacturing
6. Solutions for thermal and noise reduction in the neighbourhood of the door
7. Accessibility to passenger trains (ramps, thresholds, gap filler)
8. Modular Interior's concepts and virtual immersive interior design configurator tool
9. New tooling for Composite interiors manufacturing
10. Innovative Driving cabin: European survey to define new human-machine interactions
11. Integrated low voltage circuits in a wall/roof/floor panel .

Proposals should address all work-streams described below, in line with the Shift2Rail Multi-Annual Action Plan (MAAP) – TD1.3, TD1.6, TD1.7:

Car Body Shell

Worstream 1 : New tooling for composite car body manufacturing

Proposals should provide the necessary tools in the selected technology in order to manufacture the car body prototype defined in PIVOT (S2R-CFM-IP1-01-2017) project[31]. To test the technology adequately, the partners should be ready to develop the tool´s technologies specifically for the selected different manufacturing processes defined during PIVOT (S2R-CFM-IP1-01-2017) project[32]. The test of the technology should provide relevant parameters in order to evaluate costs, vacuum integrity, surface roughness, manufacturing time, in different sizes and complexity. Large size panels, roof panels, beam parts and frame parts tools including complex geometries should be considered. The size of the tools should allow production of standard carbody parts and should be focused on High Speed and Urban carbodies defined during PIVOT (S2R-CFM-IP1-01-2017) project.[33] Activites are expected to reach TRL5/6.

Workstream 2 : Car body Structural Health Monitoring Systems for Composites and for Metal-Composite Interfaces

[31] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

[32] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

[33] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

Identification and implementation in the Car body demonstrator specified in PIVOT[34] that will be produced by S2R-CFM-IP1-01-2019 of the most suitable technologies of structural health monitoring systems for railway carbodies. The proposals should apply health monitoring in different components (e.g. main frame, lateral panel, roof). Locations and types of potential failure (both globally and locally) should be defined. Activites are expected to reach TRL5/6.

Workstream 3 : Process automation concepts for Composite Car body Manufacturing

Proposals should address process automation technologies in manufacturing of composite components for the rail industry. The proposed technologies should reduce the cost and the time needed to manufacture the composite structures in the different process steps involved. The proposal should investigate flexible automated concepts with limited investments costs.

The following processes should be considered:

- Process automation concepts based on competitive OOA (Out of Autoclave) processes with special interest on liquid moulding processes and OOA low temperature curing pre-preg. These process automated solutions should address the main process steps and especially fibre/ fabrics cutting (and stacking- kitting if needed), laying over different geometries (either complex double curvature or simple longitudinal profiles), 3D preforming, resin impregnation and curing.

- Process automation concepts based on low cost composite materials like dry fibre reinforcements in various formats, e.g. NCF (Non Crimp Fibre) materials.

- Process automation concepts with potential to be applied to the car body structures including mainly big size structures (main car body structure including big panels and beams) both monolithic and sandwich, also some smaller and more repetitive parts (like ribs or similar) and some specific parts like doors.

- Process automation concepts providing reduced amount of material scrap.

Activites are expected to reach TRL5/6.

Workstream 4 : Process integrating joint concepts and modular concepts for Composite Car body Manufacturing

The Proposal should provide tooling which integrates the joint before curing process in the preforming phase (joining of preforms, inserts integration in the preforms, etc.). The parts to be integrated are coming from Car body integration concept defined in Pivot (add footnote). 2 areas should be considered:

- New methods to integrate the joints concepts in the current manufacturing processes. The proposal should deliver a physical demonstrator compatible with the Car body demonstrator specified in PIVOT[35] that will be produced by S2R-CFM-IP1-01-2019 validating the new methods.
- Propose new technologies as for example 3D additive technologies, allowing quick and cheap tool manufacturing. The proposed technology should reduce the cost and

[34] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

[35] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

the time needed to manufacture the tools. The technology should contemplate the easy modification of the tools in order to permit the re-use of the tools from one project to another as a way to reduce the non-recurring cost. 3D printer technology is considered very promising, although any other technology covering the same requirements could be also considered. The proposal should deliver a physical demonstrator compatible with the Car body demonstrator specified in PIVOT[36] that will be produced by S2R-CFM-IP1-01-2019 validating the new identified technologies.

Activites are expected to reach TRL5/6.

Doors

Workstream 5 : New tooling for Composite Door Leaves manufacturing

Proposals should provide the necessary manufacturing tools in thetechnology selected in PIVOT[37] to S2R-CFM-IP1-01-2019 project in order to manufacture the door prototype defined during PIVOT project[38]. The aim will be to test the technology in order to evaluate it in terms of cost, vacuum integrity, surface roughness, manufacturing time, etc. Proposals should consider a regional train as a target. The activity is expected to reach a TRL5-6.

Workstream 6 : Solutions for thermal and noise reduction in the neighbourhood of the door

Proposals should develop active solutions to reduce the noise in the vestibule in the vicinity of the doors, with the target to allow easy phone conversation and improved acoustic comfort. In addition, recommendations and development of passive solutions that could increase noise absorption are expected. Proposals should apply solutions to reduce the feeling of "hot" and "cold" surfaces.

The developed solutions will be tested within S2R-CFM-IP1-01-2019 project. A regional train should be considered for the further integration of the developed solutions. The activity is expected to reach a TRL5-6.

Workstream 7 : Accessibility to passenger trains (ramps, thresholds, gap filler)

Proposals should evaluate the demonstrator and solutions developed within S2R-CFM-IP1-01-2019 action selected for funding with a representative panel of persons with reduced mobilities. Potential updates of the specifications to S2R-CFM-IP1-0 1-2019 project in order to manufacture the interiors mock-up defined during PIVOT (S2R-CFM-IP1-01-2017) project[39] and the necessary development test. The testing of the technology should be performed in order to evaluate it in terms of cost and feasibility. This technology will be used to manufacture the interiors mock up in the action timeframe. Special care it should be taken to solve technical and fundamentals aspects such as as curing conditions, drape ability, repair technologies, joint technologies, and plug & play technologies to connect the panel in between and the equipment. The technology should support the easy

[36] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

[37] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

[38] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

[39] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

modification of the tools in order to allow the re-use of the tools from one project to another as a way to reduce the non-recurring cost. 3D printer technology is considered very promising, although other technologies covering the same requirements could also be considered. These activities are expected to reach a TRL 5-6.

Interiors

Workstream 8 : Modular Interior's concepts and virtual immersive interior design configurator tool
Proposals should develop several modules for ambiances, lighting and accessories (e.g. electric sockets) to demonstrate the attractiveness and the modularity of the proposed design. The activities should include the development of new interiors design adapted with the concept of quick fixation system developed in PIVOT[40]. The studies have to include competitive cost validated by an economic study.
Proposals should perform design studies and deliver physical mock-ups scale 1 for integration in the functional mock up developed in the complementary action S2R-CFM-IP1-01-2019. An associated virtual mock-up compatible with the configurator tool should be provided.

Proposals should develop a configurator tool using new immersive technologies to enhance several layouts (INTERIORS and driver's CABIN) in a virtual passenger/cabin room. The purpose of the tool is to help decision before building a mock-up to finalise the studies and the potential of a full plug&play interiors. A high quality of visual appearance is expected in term of design. Fluidity and user friendly design is expected in term of use. The specifications and/or design brief are indicatively supposed to be provided by the complementary topic S2R-CFM-IP1-01-2019 at M4.
These activities are expected to reach a TRL 5-6.

Workstream 9 : New tooling for Composite interiors manufacturing

Proposals should provide the necessary manufacturing tools technology selected in PIVOT[41] to S2R-CFM-IP1-0 1-2019 project in order to manufacture the interiors mock-up defined during PIVOT (S2R-CFM-IP1-01-2017) project[42] and the necessary development test. The testing of the technology should be performed in order to evaluate it in terms of cost and feasibility. This technology will be used to manufacture the interiors mock up in the action timeframe. Special care it should be taken to solve technical and fundamentals aspects such as curing conditions, drape ability, repair technologies, joint technologies, and plug & play technologies to connect the panel in between and the equipment. The technology should support the easy modification of the tools in order to allow the re-use of the tools from one project to another as a way to reduce the non-recurring cost. 3D printer technology is considered very promising, although other technologies covering the same requirements could also be considered. These activities are expected to reach a TRL 5-6.

Workstream 10 : Innovative Driving cabin: European survey to define new human-machine interactions

[40] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)
[41] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)
[42] Relevant information can be found on the PIVOT website (http://projects.shift2rail.org/s2r_ip1_n.aspx?p=pivot) in particular with the published document "*PIVOT project factsheet*" (direct link: http://projects.shift2rail.org/download.aspx?id=e1d80a5c-a383-4820-8d85-ecb55ac71bd9)

The aim of this topic will be to realise a European survey to define a common new HMI using gesture, sound, voice, etc. Drivers and non-driver member of staff (e.g. controllers in control room) from European operators (from minimum 3 Countries) must be included in the analysis to enlarge the panel. Return on experience in different industries (aeronautics, car, etc.) must be take into account. This topic will receive specifications from the complementary topic S2R-CFM-IP1-01-2019 indicatively at M4.

Proposal should deliver a bank of sounds and gestures to build the test and propose the first analysis of the survey.

Work stream 11 : Integrated low voltage circuits in a wall/roof/floor panel

Porposals should work on new technologies to integrate new functionalities in the composite parts, especially low volt circuits, to provide electricity to the passenger lights or to the speakers or other functionalities.

- The circuit should be presented as a ply to be mould during the lay-up process.
- The ply should be compatible to the current resin families (epoxy, phenolic, etc.).
- The system should provide the adequate plug systems to connect the circuit to the equipment
- The technology should consider repair aspects in order to restart the functionality during the manufacturing process or in service.
- The technology should consider aspects of heating to avoid the risk of fires in the cabin.

The activity is expected to reach a TRL5-6.

An indicative scheduling of the deliverables is suggested below[43]:

- Deliverables under work stream 6 are expected by month 12
- Deliverables under work stream 1, 2, 4, 5 and 9 are expected by month 16
- Deliverables under work stream 10 are expected by month 18
- Deliverables under work stream 7 are expected by month 22
- Deliverables under work stream 3, 8 and 11 are expected by month 24

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-IP1-01-2019: Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Car body, Running Gear, Brakes, Doors, Modular interiors and HVAC.

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- PIVOT (GA 777629).

EXPECTED IMPACT

[43] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling

Car Body Shell

Development of new skills in the Railway Industry: These technologies will have an impact on the way railway vehicles are produced and maintained, keeping the value added by the conventional metal constructions and adding the new value coming from industries that are already producing systems for the aerospace and automotive industry.

Workstream 1: Improvements in manufacturing technologies: the replacement of some composite parts within the car body could be quicker and less costly than welded metallic parts (repairing of certain metallic structures can be complex). Depending on the chosen raw materials, processes used for forming composites can compete with those use for metals.

Positive side-effects for suppliers and research institutes: The need for physical characterization of composite material systems, together with the knowledge gained from the application of modern manufacturing processes, will bring activity for industries and research centres specialized in composite materials that are already working for other sectors, now gaining experience in composite railway structural applications.

Workstream 2: Integrating functions in the parts made of new materials: Train functions, such as, e.g. thermal isolation, can be integrated in a carbodies made of several materials - mainly composites, thus saving space and weight. Additionally, integrating functions such as air conduction, piping, etc., can make the whole car body system less prone to corrective maintenance. In this case, monitoring physical properties directly in the car bodies will help to gain knowledge about the behavior of the design throughout the life cycle of the structure and will make redesigns possible or even eliminate the monitoring system in the future.

Workstream 3: Improvements in composite manufacturing technologies of the composite car body to provide competitive manufacturing routes both in terms of process cost and capacity. Especially in terms of big composite structures, the process automation solutions to be developed to meet the lower cost railway industry requirements, could be applicable in the future to other sectors like aeronautics, public road transportation, wind mill sector, etc. In terms of smaller and more repetitive composite components, the process automation solutions to be developed to meet the lower cost railway industry requirements, could be applicable in the future also to other sectors like automotive, aeronautics, public road transportation, etc.

Workstream 4: Improvements in composite manufacturing technologies of the composite carboy to provide competitive manufacturing routes, reducing the need for additional joints after the manufacturing of the cured component. Integrating joint solutions to be developed to meet the railway industry requirements could be applicable in the future to other sectors like aeronautics, public road transportation, automotive, wind mill sector, etc... Process integrated joints concepts will help providing modular concepts which will be of interest especially for large structures from many sectors that can be divided in modules for easier transportation and/ or faster and more competitive production of the modules.

Doors

Workstreams 5 To 7: Once the technologies developed are fully implemented and deployed at Shift2Rail level, the actions will contribute to the four top levels Shift2Rail KPI.

Specific metrics and methods to measure and achieve impacts should be included in the proposals, with the objective to achieve by the end of the S2R Programme the quantitative and qualitative targets defined in the S2R MAAP related to TD innovative doors in line with the relative Planning and Budget.

Interiors

Workstreams 8 to 11: A reduction of the LCC and increase in attractiveness will be achieved with the new interior concepts. Testing of a new real-scale layout without the need to be inside a train will reduce time to market and therefore reduce LCC costs.

Knowledge in multimodal interactions taking into account cognition will contribute to design future cabin commands with high levels of operational efficiency and safety. For this task, expertise in cognitics (cognition and automation), human factors in complex systems and psychoacoustic is required.

Type of Action: Research and Innovation Action (RIA)

4.2.2 S2R-OC-IP1-02-2019: Tools, methodologies and technological development of next generation of Running Gear

SPECIFIC CHALLENGE

Universal Cost Model 2.0

The penetration of innovative running gear solutions into the market has often been limited by the lack of evidence of economic benefits. What is missing is a cost modelling methodology which is valid and accepted widely throughout Europe and which can reflect and quantify the global impact of running gear performance on the rail system economics. This issue was tackled during the development of the Universal Cost Model (UCM) in the ROLL2RAIL (GA 636032) project in providing a methodology to quantify the value of a global life cycle cost by innovative vehicles and ultimately ensuring the market uptake of the newly developed running gear technologies.
The challenge is to improve the UCM, which targets the development of a user friendly and public UCM2.0 software tool for the use of European rail stakeholders.

Contribution of high-end solutions to develop Running Gear Innovations

This topic seeks to address the challenge linked to developing novel and ground-breaking tools, methodologies and technology for running gear applications. Historically, it has not been easy to introduce innovation in running gear because often preference was given to technology which has proved to be robust enough to survive the heavy loads, but not innovative enough. New technological solutions for running gear need to have sufficient durability to operate between overhauls or even through the entire vehicle design life of up to 40 years.

The challenge is to develop and combine suitable technologies to produce light, silent, track-friendly, reliable, low life-cycle-cost costs (LCC) running gear. This multi-technology approach will have to address several functions (comfort, curving, structural function, rolling components, health monitoring, etc.).

Wheel set of the future

The challenge is to inspire and convince the rail stakeholders to open a path for non-conservative approach in wheelsets, having a regard to the framework (loads, life time, etc.) described in the current standards and regularitions.

SCOPE

Proposals should complementing the running gear developments and activities within the Shift2Rail (S2R) programme, especially within the S2C-CFM-IP1-01-2019. These activities are described globally in the S2R Multi-Annual Action Plan (MAAP) – TD1.4 and the S2R-CFM-IP1-01-2019 topic description.

Proposals should address all work-streams described below, in line with the Shift2Rail Multi-Annual Action Plan (MAAP) – TD1.4:

Work-Stream 1: Universal Cost Model 2.0

The results of the activities carried out in the lighthouse project ROLL2RAIL (GA 636032), to which the below activities needs to start from, are described in the public deliverables D4.1 to D4.6[44].

The UCM2.0 has to build on the ROLL2RAIL outcomes and provide user friendly solutions for the all modules described below. Even though this activity fit under the IP1 running gear work (TD1.4), the action is linked with the action stemming from the topic S2R-CFM-CCA-01-2017 and the results shall

[44] http://www.roll2rail.eu/Page.aspx?CAT=DELIVERABLES&IdPage=45291e18-8d8f-4fd6-99f8-5d4b7a519b9c

be open to be integrated in a wider system cost model approach in S2R. The action stemming from this action will therefore be complementary to IMPACT-2 (GA 777513)).
The following should be developed:

Infrastructure Module:

The focus of future development of the UCM within S2R should be on demonstrating the infrastructure cost savings by using innovative bogies in operation.

- Detailed analysis between physical variables and deterioration rate must be proposed for different infrastructure problematics (ballast settlement, switches and crossings deterioration etc.). The influence of different constructive parameters must be analysed.
    - A more thorough methodology should be developed for damage to switches and crossings. A proposal for the development of this methodology is given in ROLL2RAIL D4.6 Appendix B.
    - Vertical settlement model needs to be improved to include the effect of bad substructure conditions. It is recommended to use the experiences and available results of the EU Mainline project (Mainline, 2014)[45].
- Cost related to infrastructure unavailability due to maintenance work caused by the vehicles must be considered in the UCM.

Energy Module:

- CO_2 emission must be calculated and considered when calculating the LCC.
- The methodology to calculate energy consumption must be analysed in order to include phenomena not previously taken into account like the efficiency of traction system.
- Energy Consumption of auxiliary bogie components like air springs or active elements within the bogie is not considered in the UCM up to now. Either an energy calculation method or a reliable estimation method should be implemented in the energy module of the UCM.

Noise Module:

- Vibrational noise is important in several European countries (e.g. Germany). A standardised methodology to calculate this noise should be developed and its influence on the LCC must be considered.
- An analysis about how to include comfort issues should be done.

Vehicle Maintenance:

- For the wheel maintenance procedure, a description about how to determine the wheel diameter reduction due to re-profiling should be included.
- For wheel maintenance, the re-profiling of the wheels is set by limit values from standards, for example the flange thickness. But these limit values are not the most efficient values regarding LCC. It should therefore be mentioned in the procedure that the optimal limit values for wheel re-profiling should be obtained by the user instead of taking them from the standards. The limit values in the standards should be considered, but in general the optimum limit values are below the limit values from standards which are safety values and the procedure should reflect it.
- Include in the procedure for wear calculations that for the 'simple method', where the wheel profile won't be updated during the wear calculation process, the accumulated wear should be distributed on the flange area and tread area of the wheel. Otherwise, most of the wear

[45] http://www.mainline-project.eu/Results,7.html

will be applied on the same position of the wheel, resulting in reaching the wheel wear limits (flange thickness etc.) too fast.
- Include the ''one procedure for wear and RCF calculations" (ROLL2RAIL D4.6 Appendix A) in the procedures.

Overall Model:

- Analyze the necessity of a hard check. Create a hard check if required, setup a basic vehicle model together with basic track parameters and use the UCM to calculate the output for some predefined cases in order to validate the different damage models (wear model, RCF model etc.) with the basic model. If the results of the user are the same, then the user can 'safely' use the model for the real application.
- For the calculations with the UCM in S2R, only one physical model for each module and with the same input parameters (friction coefficient, infrastructure parameters, etc.) should be proposed and used for all calculations. Otherwise, the results can't be compared. In case there are different users, it is recommended to use the proposed ''one procedure for wear and RCF calculations'', since it is a simplified and detailed description which reduces the emergence of different interpretations between the users.
- An analysis of the variability of the parameters (due to manufacture process or with time) and its influence on the LCC must be considered.
- In practice, not all calculation parameters will be at hand for all of the users. For that case, reliable default values should be available.

- Open software algorithm is espected to be delivered to address open points of UCM using conventional state of the art computer language including the program documentation

Finally, the proposals should comprise the organisation of a joint advisory group (including the required funding for at least quarterly meetings), including experts from S2C-CFM-IP1-01-2019 and other rail stakeholders (operators, manufacturer, infrastructure managers, regulatory body, etc.)

Work Stream 2: Contribution of high-end solutions to develop Running Gear Innovations
The work should include tools, methodologies and technological development in the following areas:

Optimised & Composite materials:

- New light materials suitable to running gear components with activities expected to reach TRL 4-5.
    - New light materials suitable to manufacture running gear components with this combination of properties shall be developed:
        - High ratio strength/density, improving in this regard the current technology for bogies based on metallic materials (steel and aluminium alloys).
        - Good impact resistance to maintain structural integrity under the typical impact of ballast stones.
        - Appropriate electrical conductivity to allow the typical functions in this regard or alternative solutions.
        - Adequate heat resistance generated by conventional brake systems, maintaining structural integrity and mechanical properties during the complete lifetime.
    - Cost study: a life cycle cost and a life cycle assessment analysis should be performed in order to cover all the aspects from manufacturing to operation.

- New technology for mechanical joints between metal and composite suitable for running gear components with activities expected to reach TRL 4-5.
- Health monitoring systems are applicable to composite parts in running rear with activities expected to reach TRL 4-5.

Control technology:

- Active Suspension systems with enhanced reliability and LCC with activities expected to reach TRL4-5

Inside PIVOT project it has been detected that the current technologies for active and semi active actuators are not sufficiently cost-effective, providing low reliability and LCC to be implemented extensively. This applies more specifically for primary suspended and non-suspended systems.

  - Development of the appropriate technology of active and semi active suspension systems focusing on the improvement of the reliability and LCC to the level of existing conventional passive systems.
  - The developed technology shall be designed capable to withstand the requirements derived from suspension level assembly focusing on primary stage.

Work Stream 3: Wheel set of the future

A development of a wheel set with composite axle or even a combination of axle and wheel body with a steel wheel tire that improves existing Running Gear maintainability and LCC (TRL3). The proposed research has to cover the following activities:

- Specify the safety and material requirements of the wheel set, espcecially by taking into account vibrations issues.
- Analyse the state- of- the- art (composite manufacturing procedures).
- Define developing scope and design concept of axle or wheel set based on previous points and subsequently define functional specification.
- Define industrial, light and secure solution for the interface between composite axle and the wheel (wheel tire). Given that one of the most important Running Gear maintenance cost is related to the worn wheel replacement, propose also a cost optimised and secured maintenance procedure of the new solution.
- Cost Analysis: the performance of a life- cycle cost and a life- cycle assessment analysis is necessary in order to cover all the aspects from manufacturing to operation.
- Benchmark and define manufacturing procedure related to the functional specification.
- Propose new wheel concepts with optimized maintainability, reduced Running Gear LCC (e.g. a wheel with removable rim by means of a detachable joint) and low noise emission
- Functional specification of the wheel set of the future (with composite and LCC focus) covering the points above.

The outcome of this workstream, especially the functional specification, will be fundamental for further development in future S2R activities, therefore the outcome should be publicly available so that design and manufacturing of a wheel set or at least parts can be performed at later stage.

An indicative scheduling of the deliverables is suggested below[46] :

- Deliverable under workstream 3 is expected by month 12
- Deliverable under workstream 1 and 2 are expected by month 24

[46] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-IP1-01-2019: Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Car body, Running Gear, Brakes, Doors, Modular interiors and HVAC.

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- PIVOT (GA 777629).
- IMPACT-2 (GA 777513).

EXPECTED IMPACT

Universal Cost Model 2.0

The model is setting the foundations for a holistic economic assessment of the rail system from different perspectives and from different rail system stakeholders. Limitations of financial calculations need be assessed to achieve appropriate rating of future savings in maintenance of infrastructure. The UCM will be maintained, improved and used to validate the impact of innovative running gear solutions developed within the S2R Programme.

Contribution of high-end solutions to develop Running Gear Innovations

Activities are expected to contribute to the running gear work streams according to the MAAP:

- A robust assessment of the suitability of standard sensors for monitoring component conditions is possible. Using standard sensors will bring the perceived high current costs of such equipment for the railway environment down and closer to that of other industries.
- Developing an understanding of the opportunities and risks presented by new materials with a focus on increasing the lifetime and reducing the LLC. Detailing the conformance testing required during initial manufacture and the possibilities for maintenance and repair of unusual railway sector materials (which have not been routinely used) should help to unlock some of the entry barriers for innovative materials for running gear.

Furthermore, the activities are also expected to contribute to the following key Shift2Rail objectives:

- Vehicle weight reduction through the use of new concepts based on lighter materials is possible. This weight reduction will have several side effects such as:
    - Reduction of the energy consumption of the vehicle
    - Increase in track friendliness
    - Additional freedom for vehicle design
- Reduction of the LCC of the vehicle and the whole railway system, derived from the reduction of track damage due to the reduction of mass and the improvement of guidance ability of running gear, and improved health monitoring supported by new running gear sensor systems.
- Increase in operational reliability and composite material acceptance supported by better performing health monitoring and sensor systems.

Wheel set of the future

This topic should boost high innovative developments on rail wheel sets. The aim is to reduce (un)sprung mass by using composite wheel set components and reduced maintenance costs. Furthermore, the activities are also expected to contribute to the S2R TD1.4 Running Gear progress and to the key Shift2Rail objectives.

Type of Action: Research and Innovation Action (RIA)

4.2.3 S2R-OC -IP1-03-2019: Support to the development of technical demonstrators for the next generation of brake systems

SPECIFIC CHALLENGE

In the first phase of Shift2Rail, the projects PINTA (GA730668), CONNECTA (GA730539) and PIVOT (GA777629) put their focus on the analysis of the status quo and approaches to cope with the new development challenges and comply with the new requirements for the railway subsystems and components. These activities resulted in specifications, design of new and more standardised brake components, as well as new methods and tools to improve maintenance and certification processes.

Based on this, the challenge of the technical demonstrator brake system (TD1.5) is to perform the development and implementation of brake systems with higher brake performance (e.g. in low adhesion condition), lower life cycle costs and noise levels. The development of the new generation of more compact and environmentally friendly brake components with enhanced diagnosis systems and electronics requires considerable analysis and test work.

SCOPE

Proposals should complement the brake developments and activities within the Shift2Rail (S2R) programme and especially within the S2C-CFM-IP1-01-2019. These activities are described globally in the S2R Multi-Annual Action Plan (MAAP) and the S2R-CFM-IP1-01-2019 topic description.

Proposals should address all work-streams described below, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

Work Stream 1: Improved adhesion management

To cope with the challenge of insufficient adhesion conditions, additional data shall be collected on a running train under real field test conditions. In this regard, the results of the action stemming from the topic S2R-CFM-IP1-01-2016 - D8.1 Adhesion Modelling Specification shall be considered. The data collection has to be aligned with the partners of the action stemming from the topic S2R-CFM-IP1-01-2018 to ensure sufficient results and support. One of the main aspects is the conditions of collection of adhesion data from trains on tracks, in sliding condition.

The data collection runs should be done with trains on tracks under real field test conditions. The data should be transferred into a format that will be defined in the action stemming from the topic S2R-CFM-IP1-01-2018.

Proposals shall provide adhesion curves acquired during rolling stock wheels sliding caused by degraded adhesion conditions. The preferred rolling stock shall be a Multiple-Unit. Measurements shall be done by using different types of contaminants, in order to better understand the phenomenon. Measurement shall be done by properly instrumenting the train under test. These measurements will be inserted into a database that will be proposed by the complementary action stemming from the topic S2R-CFM-IP1-01-2018 to allow a comprehensive approach of the interpretation of the influence of the environmental conditions on the adhesion coefficient.

Proposals partners shall provide the train and the test track, the instruments for acquisition and shall collaborate with the complementary action stemming from the topic S2R-CFM-IP1-01-2018 partners for the tests setup and execution definition. Activites are expected to reach TRL4.

Work Stream 2: High safety relevant brake control functions in an advanced brake component HW-SW architecture

The objective is to support the safety analysis of brake subsystems with well-defined, easy to apply and efficient processes and methods. This requires a close cooperation with the partners of the complementary action stemming from the topic S2R-CFM-IP1-01-2018 - brakes part . The main aspect is the definition of user-friendly safety processes and methods.

Proposals should define a user-friendly safety process and methods which allow system engineers to execute safety analysis activities in their daily engineering exercise for railway subsystems, especially as concerns brakes. Modern model based system engineering methods and artefacts shall be used to allow system engineers to handle the complexity of the system using an integrated system- and safety engineering. Activites are expected to reach TRL3.

Work Stream 3: Innovative lightweight brake discs.

Ceramics disks are currently used in automotive industries, especially in sport or luxury cars. The use of this material provides a tremendous saving of weight and LCC costs. This technology shall now be investigated for the use for brake disks. Proposals should evaluate the usability of ceramics combined with conventional material in brake disks. The action shall be performed in close coordination with the complementary action stemming from the topic S2R-CFM-IP1-01-2018, especially the working area Friction Pairing. This working package includes the evaluation of ceramic layers for brake discs.

Proposals should perform activities to better understand the capability of a ceramic layer for braking applications. In particular proposal should evaluate if combined brake discs from metal based materials and a ceramic layer ceramic applications can be used for the railway industry.

The evaluation should be based on already existing standards for type testing, as the EN 14535. Scaled dynamometer testing is preferred. Activites are expected to reach TRL4.

An indicative scheduling of the deliverables is suggested below[47] :

- Deliverable under workstream 1, 2 and 3 are expected by month 24

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-IP1-01-2019: Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Car body, Running Gear, Brakes, Doors, Modular interiors and HVAC

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- PIVOT (GA 777629).

[47] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling

EXPECTED IMPACT

The most significant benefits from the action as a result of the new technology developments, methodologies and simulations besides the continues qualification of the brake related KPI's are:

- Optimisation of adhesion conditions to reduce braking distances in low adhesion conditions and to reduce the LCC and overall train safety
- LCC reduction due to better diagnostics, lower energy consumption and introduction of life time brake components due to an advanced SIL3/4 compliant electronic hardware and software architecture for brake components

Reduction of weight and LCC costs by developing innovative friction pair solutions such as ceramic disks for lifetime operation.

Type of Action: Research and Innovation Action (RIA)

4.2.4 S2R-OC-IP2-01-2019: Demonstrator development for the use of Formal Methods in railway environment - Support to implementation of CSIRT to the railway sector

SPECIFIC CHALLENGE

Shift2Rail has identified the use of **formal methods** and standard interfaces as two key concepts to enable reducing the time it takes to develop and deliver railway signalling systems, and to reduce high costs for procurement, development and maintenance. Formal methods are needed to ensure correct behaviour, interoperability and safety, and standard interfaces are needed to increase market competition and standardization, reducing long-term life cycle costs.

To widen industry take-up of these key aspects, Shift2Rail plans demonstrating technical and commercial benefits of formal methods and standard interfaces, applied on select applications.

The industry survey performed in TD2.7 has identified the learning curve and uncertain cost/benefit ratio as obstacles: the decision to start using formal methods is deemed too risky by management. Shift2Rail proposes to define and prototype a demonstrator of state-of-the-art formal methods, including the use of standard interfaces, to address obstacles of learning curve and lack of clear cost/benefit analysis.

The dramatic rise in the cybercrime targeting Industrials Control Systems (ICS) over the past years and the development of Intelligent Public Transport requiring a high level of integration of transport systems highlighted the need of cyber-security coordination between railway operators. Such coordination will require, in most of the cases, system integrator and railway manufacturer involvement.

In order to face such challenge, a network of cyber security experts dedicated to railway sector is to be developed.

In order to create and coordinate this network, Shift2Rail proposes to define and prototype a CSIRT (Computer Security Incident Response Team) collaboration tool fulfilling the specific needs of the railway sector.

The need of such collaborative tool has been emphasised over the time by the publication of the NIS Directive that requires coordinated cyber security incident reporting for critical infrastructures.

SCOPE

The activities shall cover:

- Defining of formal development demonstrator with measured cost/benefit ratio and assessed level of learning curve for industrial application;
- Defining and prototyping the CSIRT collaborative environment devoted to railway.

The proposals should address all work-streams described below, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

1. In the framework of the introduction of Formal Methods in railway environment (linked with TD2.7 of the MAAP) the activities are expected to:
    a. Describe and specify cost/benefit ratio and learning curves required, based on already developed use cases in Shift2Rail;
    b. Create formal development demonstrator for railway signalling sub system using standard interfaces, exemplifying cost/benefit ratio and learning curves.

Foreseen achievable Technology Readiness Level: TRL 4

An indicative scheduling of the deliverables is suggested below[48]:

- "Specification of formal development demonstrator" 1st draft: by M6;
- "Formal development demonstrator prototype" 1st draft: by M12;
- "Specification of cost/benefit analysis and learning curves" 1st draft: by M16;
- "Formal development demonstrator prototype final release: by M20;
- "Specification of cost/benefit analysis and learning curves" final version: by M24.

2. In the framework of the introduction of the Cyber Security in the railway sector (linked with TD2.11 of the Multi Annual Action Plan) the activities are expected to cover the following points:
   - To capture and specify the information sources, workflows and data flows required for the implementation of the CSIRT dedicated to railway sector, based on input to be provided by complementary activity;
   - To specify, implement and validate prototype of the CSIRT collaborative environment dedicated to railway, based on the CSIRT workflow model and on the recommendations from the complementary activity.

The proposals should address all work streams described below, in line with the Shift2Rail Multi-Annual Action Plan (MAAP).

In the framework of the standardisation of the cyber-security approach for railway (TD2.11), the activities are expected to liaise with the following member activities:

a. "TD2.11.8 CSIRT: Combining expertize – Designing a holistic knowledge base": Shift2Rail will provide to the Open Caller a common "ontology" and a description of the current incident management workflows at operator, system integrator and manufacturer levels.
b. "TD2.11.9 CSIRT: Validation of CSIRT model dedicated to railway": Shift2Rail will review and validate the Open Caller proposition for the definition of CSIRT workflows inside and between each organisation.
c. "TD2.11.10 CSIRT: Validate CERT collaborative environment »: Shift2Rail will review and validate the Open Caller proposition for CSIRT collaborative environment.

Foreseen achievable Technology Readiness Level: TRL4

An indicative scheduling of the deliverables is suggested below[49]:

- For "CSIRT model dedicated to railway" 1st draft: by M7;
- For "CSIRT model dedicated to railway" final release: by M11;
- For "CSIRT collaborative environment prototype" 1st draft: by M16.
- For "CSIRT collaborative environment prototype" final release: by M20.

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- S2R-CFM-IP2-01-2018: Advanced signalling, automation and communication system (IP2 and IP5)

[48] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling.
[49] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling.

- X2RAIL-2 (GA 777465).

EXPECTED IMPACT

Regarding the work stream 1 the activities are expected to contribute to:

- Reduction of cost and time-to-market for software-based railway signaling systems;
- Increased market competition and standardization;
- Impact management levels to widen use of formal methods and standard interfaces:
    - Demonstrator for formal development, using standard interfaces
    - Clear cost/benefit analysis for applied formal methods
    - Clear description of learning curve required

Regarding the work stream 2 the activities are expected to contribute to:

- Sustainability in degraded situation by increasing in a significant way the cooperation reaction time and quality between all stakeholders in case cyber threat occurrence;
- Security significant increase by :
    - building a common and up-to-date threat landscape for railway
    - sharing threat prevention or mitigation means
    - increasing the cooperation between operators in the area of cybersecurity

Type of Action: Research and Innovation Action (RIA)

4.2.5 S2R-OC-IP2-02-2019: Support to development of demonstrator platform for Traffic Management

SPECIFIC CHALLENGE

Innovation Programme 2 includes, as a key innovation, the specification and design of a communication platform (Integration Layer) using standardized data structures and processes to manage the Communication/Data exchange between different services/clients and supporting TMS applications connected to other multimodal operational systems.

This Integration Layer links in a first step, Traffic Management, Traffic Control, Asset and Energy Management systems and signaling field infrastructure. It also provides a gateway for the communication with external clients such as traffic status update and management of traffic demands from external services.

Public documents describing the proposed architecture, interfaces and the data model are available as deliverables from the project IN2RAIL[50]. X2RAIL-2 is continuing to enhance the specifications and will supply updated drafts for the action.

It is required that consortia applying for this call include an Infrastructure Manager (IM) to host the installation and provide real data from trackside assets and trains to be integrated into the communication network allowing the test and validation of business service application for Traffic Management and Traffic Control developed from different partners of the S2R program. It is preferable that the involved IM is actively performing Traffic management and traffic Control in dedicated Control centers.

SCOPE

The proposals should address all work streams described below, in line with the public deliverables from the project "IN2RAIL" (Grant agreement number 635900).

- D7.3 Specifications of the standard operator workstation
- D8.1 Requirements of the Integration Layer
- D8.2 Requirements for Interfaces
- D8.3 Description of the Integration Layer and constituents
- D8.4 Interface Control Document for Integration Layer Interfaces, external/Web interfaces and Dynamic Demand Service
- D8.5 Requirements of an Application framework
- D8.6 Description of the Application Framework
- D8.7 Interface Control Document (ICD) for Application-specific Interfaces
- D9.1 Appendix 1 "Canonical Data Model"

The proposals shall include activities covering the following scope:

- Delivery of HW and System SW (RHE Linux) needed for Integration Layer, Application Framework and Operators Workstation both connected to the Integration Layer;
- Configuration of the middleware of the Integration Layer to support the Conceptual Data Model, and all specified communication and data management processes for Integration Layer, Application Framework, Operators Workstation and WEB-IF.
- Integration (Interface to Integration Layer, function and data mapping of specific formats to Conceptual Data Model, all necessary administrative processes to manage the clients/services) of the following clients/services:
    a. At least two interlockings;

[50] http://www.in2rail.eu/Page.aspx?CAT=DELIVERABLES&IdPage=69d2e365-3355-45d4-bb3c-5d4ba797a3ac

b. Preferably 2 Radio Block Centers (RBCs) for ETCS Level 2 operations (if not available, a simulation tool for the RBC is required);
c. Web-IF to exchange data with external clients for weather forecast and passenger information systems;
d. Three operator workstations linked with Integration Layer and being able to manage and display Traffic Management Traffic Control functionalities, Energy (Grid) and Asset (infrastructure) status. It shall also be able to present data coming from external clients/services via WEB-IF to the operator;
e. Application Framework to host applications for Traffic Management and Traffic Control;
f. Maintenance Service Management System to the level to subscribe to traffic status and to publish asset fore and now cast information;
g. Preferable Energy (Grid) Management Control System.

- Configuration of 3 Databases attached to the Integration Layer:

  a. Geographical Database:
     - supporting position representation in LRBG (Balise based), GNSS and Kilometer format;
     - providing the "translation" of the different data formats;
     - carrying all necessary infrastructure elements needed for Traffic Control, Automated Train Operation, Moving Block Operation, Maintenance services, and Traffic Management ;
     - Data structure shall be according the Conceptual Data Model.

  b. Time Table Database:
     - Supporting now – and forecast traffic status;
     - Supporting Sandbox operations;
     - Data structure shall be according the Conceptual Data Model.

  c. Vehicle Database:
     - Supporting all relevant data for single vehicles e. g. Locomotive and Train consist needed for Traffic Control, Traffic Management, Automated Train Operation, Moving Block, Fleet Management services including Maintenance;
     - Data structure shall be according the Conceptual Data Model.

  d. Implemented Data:
     - Infrastructure Data related to the network operated from the IM of the consortia shall be implemented into the Geographical Database in the required Data structure;
     - Data representing the vehicles operation on the network shall be implemented into the Vehicle Database in the required Data structure
     - Data representing the operational Timetable (now-and fore-cast status) for the train services carried out on the network of the IM of the consortia shall be implemented into the Time Table Database in the required Data structure.

- First level support for 12 months during installation, commissioning and testing phase of the prototypes of the S2R X2RAIL2/4 prototypes.
- Project Plan to be agreed with TD2.9 activities to be included in the action to be funded under the topic S2R-CFM-IP2-01-2019 and with CCA WA4.2 activities to be included in the action to be funded under topic S2R-CFM-CCA-01-2019, to integrate the activities carried out under these topics;
- Project Management tools/structure to link closely linked with TD2.9 and CCA WA4.2;

- Validation of the system including Modules from TD2.9 activities/work package of S2R-CFM-IP2-01-2019 and CCA WA4.2 activities work package of S2R-CFM-CCA-01-2019 as agreed in the Project Plan.

An indicative scheduling of the deliverables is suggested below[51]:

- Deliverables of work stream 1 are expected to be available by M6;
- Deliverables of work stream 2 are expected to be available by M9;
- Deliverables of work stream 3 expected to be available by M15;
- Deliverables of work stream 4 expected to be available by M21;
- Deliverables of work stream 5 to start by month M21 and end in month 33;
- Deliverable of work stream 6 is expected to be available by M3;
- Deliverable of work stream 7 is expected to start in Month 2 and end in month 30;
- Deliverable of work stream 8 is expected to be available by M30.

The activities are expected to reach TRL 6/7.

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-IP2-01-2019: Completion of activities for enhanced automation systems (including Freight ATO GoA4), train integrity, object controller.
- S2R-CFM-CCA-01-2019: Integrated mobility management (I2M), Energy and Noise & Vibration.

EXPECTED IMPACT

The activities are expected to contribute to:

- Achieving the basic knowledge and experience of the best system architecture for the targeted communication platform. Application such as automated Train Operation and automated Traffic regulation processes will be one of the main key element to improve European industries competitiveness also in markets currently dominated by other systems;
- Defining and validating the basic architecture able to power the deployment of this new communication structure. The new structure will have impact reducing OPEX and CAPEX of Rail operations for mainline and regional;
- Reducing time to market for such a system, the test & commissioning phase under life operations integrating the activities of TD2.9 and CCA WA4.2 is a key success factor. It will also have significant impact on the signaling system at a enabling different and simplified operational procedures;
- Specific metrics and methods to measure and achieve impacts should be included in the proposals, with the objective to achieve by the end of the S2R Program the quantitative and qualitative targets defined in the S2R MAAP related to TD2.9 and CCA WA4.2, in line with the relative planning and budget.

Type of Action: Innovation Action (IA)

[51] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling.

4.2.6 S2R-OC-IP3-01-2019: Future traction power supply for railways and public transport

SPECIFIC CHALLENGE

The currently running projects under TD3.9 "Smart Power Supply Demonstrator" explore Rail Power Supply Systems by optimizing the existing solutions for traction power supply for maximum capacity and minimum losses with limited investments.

Demand for increasing railway network capacity, in combination with a change to electric traction also for other transport modes, makes it necessary to rethink railway power supply under future requests, reflecting the status of different systems. Finally this requires integrated electric power systems connecting the different transport modes.

For the power supply system this brings up new requirements:

- Efficiency and environmental impact of electric transport systems become more important requiring integration of "green" energy sources
- Energy grids become more and more decentralised with new possibilities and requirements for interaction
- The limited capacity of existing power supply systems, especially for the DC Rail Power systems, requires for step changing improvements
- Electrical traction will become standard also for no rail bound systems, requiring for combined traction power systems integrating permanent supply by contact lines and punctual supply for charging points.
- More complex power grids require for proper operation faster reaction for control of the systems e.g. by digital twins.

The extended targets for future solutions ask for a wider view to the rail power supply systems.

Specific challenges are:

- Improvement of capacity of Railway Power Supply System for future transport demand
- Upgrade of DC power supply systems for increase of capacity
- Use of renewable ("green") energy sources in the Railway power supply
- Interaction between Railway power grids and feeding networks under the view of decentralised power systems
- Integration of other transport modes as energy and power consumer in Railway Power Grids (E-Bus, E-Car, …)
- Fast and easy adjustability of Railway Power Grids for the volatile demand of power and energy

Consideration of all challenges requires a wider approach for the Railway Power Supply System. This call aim to challenge the traditional rail approach with innovative and breakthrough concepts from a non-linear approach to existing technological evolution.

SCOPE

In order to address the challenges described above the proposed research shall address all of the following tasks described below, in line with the Shift2Rail MAAP:

- Grid Interaction between Railway power supply system and Public grids
    - Smart Railway Power Grid control and interaction with the connected feeding grids considering the different grid codes
    - Defining the optimum split of Functionalities between Railway Power Grid and Feeding Grid; Defining methods and measures to transfer functionality between the grids.
- Integration of renewable energy sources and storages in rail power supply systems
    - Usability of decentral power generators (Photovoltaics, Wind-Energy) in Railway Power Supply

    - Integration of charging systems (Rail + Public)
- Solutions for upgrading of DC power systems for higher capacity and multiple use
    - Defining methods to upgrade DC power supply systems for higher capacity; e.g. higher system voltages, voltage control, boosting systems.
    - Interaction with other DC systems like charging systems
- Digital twins for modelling and control of rail power supply systems
    - Analysis of existing models
    - Methods for automatic adaption of models for changing configurations.

For all these activities, the project should cover and report the following aspects:

- state of the art and best practices analysis, including economic evaluation for EU conditions;
- definition of performance targets with KPI-model;
- implementation of proof of concept;
- specifications for development and adjustment of elements and systems of the Railway Power Supply System
- definition of demonstrators for further development of the identified elements

The project is expected to reach TRL 3-4.

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- IN2STEMPO (GA 777515).

EXPECTED IMPACT

Research results are expected to contribute to future S2R exploratory research and in general to open new possibilities and ideas for the S2R stakeholders and rail research community for future developments in the Railway Power Supply System. Results shall specify the next work steps for the Future Railway Power supply system and allow for direct start of further innovation steps for implementation.

Type of Action: Research and Innovation Action (RIA)

4.2.7 S2R-OC-IP4-01-2019: Complementary Travel Expert Services

SPECIFIC CHALLENGE

People are traveling around daily for business trips, on holiday, weekend travel or other private purposes. They want to get a large choice of multi-modal offers adapted to their preferences, and they need additional information to make an informed choice before selecting a proposal.

One of the specific challenges of this call is to classify complete itineraries with respect to different categories, including but not restricted to, the environmental impact (e.g. energy consumption, NOx emission, carbon footprint), the waiting time between legs, the accessibility of the modes for disabled people, the overcrowded legs in peak hours.

The second challenge, contributing also to the environmental impact, is to to facilitate access to rail transport, for example by increasing the occupancy rate of private cars when used in combination with public transport. This is specifically the case for the first and last mile in rural areas.

SCOPE

In order to address the above mentioned challenges, the awarded project should conduct the following activities:

(1) Choice criteria for travel planning

Investigate how relevant categories can be defined for the whole trip or for legs of the trip, investigate what is already available and develop algorithms to propose quantitative estimates. Categories could include:

- Environmental aspects :
  - Carbon footprint;
  - Noise and vibration emission;
  - Total energy consumption;
  - NOx,Sulphur oxide (SO2), other type of emission;
- Comfort aspects: waiting time, stress, number of interchanges, etc.
- Specific needs for disabled people: access, walking time and distance, etc.
- other, traffic conditions, etc.

It should be studied and defined by the awarded project, how these different categories could be combined in clusters.

In addition, the action should investigate the factors that could influence a consumer decision based on the categories provided and propose the best way how this information should be used (to help consumers towards choosing more sustainable transport modes).

These categories shall be provided to the travellers while planning their trip, as one of the decision factors. It could also be used by the transport authorities to propose incentives for when the traveller respects specific targets in the multimodal journey (e.g. emission threshold per km).

Activities are related to TD4.2 and TD4.5.

(2) Ride Sharing in a multi-modal journey context for incorporation in the Shift2Rail IP4 ecosystem

In order to achieve a full seamless multimodal travel experience and make “door-to-door” multimodal journeys a reality, access to the rail mode for the first and last mile of a multimodal trip, especially in the rural areas, will have to be facilitated. Since most of car riders travel alone between their home and the station, they can offer some available car seats between the station and the surrounding area.

Problems in the past have always been the difficulty of finding users making identical trips and the reluctance of passengers to share their cars. These problems tend to be particularly severe in rural areas. Thus the first stage should be behavioural studies to understand the key for a successful system, taking a sample of existing passengers and examining the degree to which they could be persuaded to ride-share.

The principle is that when dealing with an intermodal trip, some of the travellers will use their own car for the first or last mile. They can propose to share/offer some seats through the Travel Companion, and this option will become visible to potential passengers. Country specific legal aspects in conveyance of passengers should be taken into consideration.

The information will be the base of a so-called crowd-based Transport Service Provider (TSP), and will be accessible thanks to the Interoperability Framework. Development will divided into two parts:

- An Application that runs "as a service", acting as a crowd-based TSP

  Aim of this topic is the development of algorithms and proof of concept to allow travellers to share their (car) rides, incl. offering, ticketing, settlement, validation and tracking. This TSP will be considered in the trip planning phase of other travellers.

- An Application that runs as part of the Travel Companion through integration of specific modules

  Allowing the traveller offering the car seats to manage their offers, and to check the validity of the Entitlement/Token generated for the other travellers.

The objective is first and foremost to improve the connection with rural areas thus facilitating access to the rail and increasing its attractiveness as part of a multi-modal travel experience. Moreover, this action will help reducing the number of single-occupants car trips. It should also investigate algorithms for the optimal synchronization of sharing mobility solutions and other transportation modes with the rail service, as well as algorithms for the optimal matching between drivers and riders within a ridesharing system, which can represent the last mile solution of a rail-based multimodal journey. Those activities are meant to be incorporated in the S2R IP4 ecosystem, enlarging its capabilities and enabling new Transport Service Providers towards the use of the Shift2Rail Interoperation framework.

Activities related to TD4.1, TD 4.2, TD4.3, TD4.4 and TD 4.5 of the S2R MAAP.

For these activities, the project should cover the following aspects: state of the art, passenger survey and best practices, realistic target performances and definition of KPIs, but also implementation of proof of concepts (including tests and validation), and finally recommendations.

The proposed options must remain compatible with the approach currently developed within IP4[52], and must allow for the adaptation of the interoperability framework mechanisms.

The project is expected to reach TRL 5 by the end of the project.

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for

[52] information on how a TSP can integrate the IP4 eco-system can be found on the S2R website in the IP4 page (direct link: https://shift2rail.org/wp-content/uploads/2019/01/Integration-of-a-TSP-in-the-IP4-eco-system.pdf)

the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- S2R-CFM-IP4-01-2018: Passenger service platform specifications for an enhanced multi-modal transport ecosystem including Mobility as a Service (MaaS).
- COHESIVE (GA777599).
- CONNECTIVE (GA 777522).

EXPECTED IMPACT

S2R-IP4 "IT Solutions for Attractive Railway Services" has the main goal of increasing the attractiveness of rail transport by providing a radical improvement to the current lack of capacity to perform a door-to-door journey as a seamless multimodal journey. Developing reliable information about relevant characteristics of the multi-modal journey and specifically about the environmental impact of all legs of a trip is a way to encourage the use of more sustainable modes, and specifically the rail. Moreover, besides a reliable rail system and easy to use ecosystem, the connection of the rural areas will be enhanced by taking into account the first and last mile.

The expected impacts are then:

- Increase the number of passengers using public transport.
- Improve the rail connection with the rural areas.
- Minimise environmental pollution while traveling.
- Propose additional criteria for informed decision making when planning a trip.

Type of Action: Research and Innovation Action (RIA)

4.2.8 S2R-OC-IP5-01-2019: Condition-based and preventive maintenance for locomotive bogie

SPECIFIC CHALLENGE

The development of intelligent tools and methods for predictive maintenance are needed to optimize the availability of rolling stock, the quality of service, maintenance costs and return of investment. Condition-based and Predictive Maintenance means predicting when a fault is likely to occur and issuing a warning if the component reaches its lifetime limit or even if an overhaul is required. This information will be distributed automatically to fleet and workshop management systems and trigger actions in accordance to maintenance. Condition-based and Predictive Maintenance requires sensors and communication boxes for data transmission, but more importantly, data analytics and monitoring tools, an asset management centre and a database with maintenance program and rules. The main driver for current maintenance costs is the locomotive bogie. Therefore, the main focus of this proposal shall be given to the condition-based and predictive maintenance of the locomotive bogie (i.e. motor bogie and trailing bogie), which is at the top of the material costs.

SCOPE

Proposals should address an in-depth analysis and practical testing and evaluation of freight-specific use cases monitoring critical components, as input to the overall approach of CBM in IP5. This includes the analysis of component data, especially but not limited to the bogie, as well as the development of rules and a maintenance program for Condition-based and Predictive Maintenance dedicated to bogies. The scope comprises the following:

- Definition of the monitoring impact for unplanned maintenance events and the prevailing planned maintenance intervals;
- Definition of the right data which are relevant to monitor the condition of the locomotive bogie;
- Identification of existing or development of new sensors to monitor the condition of the bogie in order to replace the current maintenance regime which is based on kilometres and calendar days or use technics to simulate the condition;
- Integration of these sensors in existing On-board Units with special focus on interoperability;
- Definition - based on the required data – of a condition-based and predictive maintenance regime for bogies to overcome the current maintenance regime. More concretely:
    - Define rules to monitor the condition (e.g. technical parameter) and threshold values (Entity in charge of Maintenance (ECM) 2 process);
    - Define maintenance program for maintenance workshops in order to understand which maintenance task is required depending on the condition/prediction (ECM 4 process);
    - Define instructions for fleet management to manage unplanned maintenance events (ECM 3 process).

The activity is expected to finish with a demonstrator in TRL 5/6.

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- FR8HUB (GA 777402).
- FR8RAIL (GA 730617).

EXPECTED IMPACT

The expected impact related to bogie condition-based maintenance concept will be the increased attractiveness and competitiveness of the rail freight transportation, especially for high cost items which have a main impact on operational costs.

Condition-based and predictive maintenance for bogies is expected to lead to improved operations, as the railway undertakings will be able to detect the impending failures much earlier and to recover quickly from service outages. Customer service levels are expected to improve and maintenance costs are expected to decline – especially planned maintenance activities. Asset lifecycles will be extended, and the state of good repair backlog will be steadily decreased.

Type of Action: Research and Innovation Action (RIA)

4.2.9 S2R-OC-IP5-02-2019: Advanced obstacle detection and track intrusion system for autonomous freight train

SPECIFIC CHALLENGE

The future of rail freight will be fully automated. For the operation in automation grade GoA 3/4 (attended and non-attended operation), all activities and responsibilities of today's train drivers needs to be taken over by several systems.

Among other things, the GoA 3/4 system must be able to:

- Sense the environment to overlook the scene;
- Detect potentially dangerous objects on the train's path;
- React accordingly and in the right way.

The obstacle detection system will need to monitor an environment according to freight specific and general use cases e.g. EN62267 and/or relevant projects working in the field of automation.

Example for challenging situation:

- System should have the ability to detect very long ranges e.g. up to 2 km;
- Encountering troubling weather conditions, including heavy winter and desert-like situations;
- Being able to detect pathways;
- At large speed ranges from 0km/h up to 180 km/h;
- In line with the achievement of SIL 4 for the entire GoA 3/4 system.

SCOPE

The project should provide with in-depth analysis, practical testing and evaluation of freight specific use cases. This shall be provided as input to running and upcoming freight ATO projects within Shift2Rail.

The scope of this call, as described below, is to focus on novel approaches for obstacle detection and track intrusion systems, including trackside, on-board and airborne systems with dedicated interfaces to the GoA 3/4 wayside and on-board systems.

The activities shall start with an in-depth analysis of freight specific use cases followed by requirement specification and the development, practical testing and evaluation of stationary and on-board systems**.** The result of this project should deliver proposals for on-board and trackside units.

In order to address the challenges described above, the proposals should consider in detail:

- Review and assessment of the safety requirements on obstacle detection and track intrusion system delivered by the user (IM, RU) and industry from S2R Members on IP2 and IP5;
- Review and assessment to the Reliability, Availability and Maintainability (RAM) requirements on obstacle detection and track intrusion system delivered by the user (IM, RU) and industry from S2R Members on IP2 and IP5
- Review and assessment to the Diagnostic System requirements on obstacle detection and track intrusion system delivered by the user (IM, RU) and industry from S2R Members on IP2 and IP5
- Review and assessment of the test-, use- and operational-cases on obstacle detection and track intrusion systems delivered by the user (IM, RU) and industry from S2R Members on IP2 and IP5
- Review and assessment to the Classification and Detection requirements on obstacle detection and track intrusion system delivered by the user (IM, RU) and industry from S2R Members on IP2 and IP5
- Review and assessment of the open interface requirements for obstacle detection and track intrusion system to the GoA 3/4 System delivered by the user (IM, RU) and industry from S2R Members on IP2 and IP5

Based on this, the project should:

develop a “state of the art” prototype of stationary obstacle detection and track intrusion system e.g. by using laser scanners, radars, fiber optic sensing or drones.

- Deliver an assessment of the test results of the prototype to understand the expected
  - Reliability, Availability, Maintainability of the system
  - Quality on Safety and Security of the system
  - Quality on detection and classification of objects and track intrusion of the system.
- Identify the necessary effort and steps to achieve a safe product according the requirements and specifications mentioned above.

This activity should consider the work carried out in previous/ongoing research projects/initiatives in the field of obstacle detection, e.g. ARCC, SMART, GoSAFE RAIL, X2Rail-1. Moreover, the consortium should bring innovative experiences in the field of both hardware and software.

The activity is expected to finish with prototype(s) demonstration at TRL 6.

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-IP2-01-2019: Completion of activities for enhanced automation systems (including Freight ATO GoA4), train integrity, object controller.

EXPECTED IMPACT

The foreseen research activities are expected to contribute to

- Reduction of the complexity of the requirements for the proposed system
- Improvement of reliability and availability of the GoA 3/4 operation thanks to:
  - the generated know-how of the ideal set-up of systems,
  - reduced number of fault positives,
  - increased detection area (e.g. behind a curve, slope, tunnel), etc.
- Proposed platform should be flexible and open for future technologies

Type of Action: Innovation Action (IA)

4.2.10 S2R-OC-CCA-01-2019: Noise & Vibration

SPECIFIC CHALLENGE

Noise and vibration (N&V) represent one of the biggest environmental challenges for the railway. The target of this work area is to reduce the exposure to noise and vibration related to the railway sector in Europe. Population in the vicinity of railways do not accept the increasing N&V annoyance while on the other hand a shift to rail-traffic is important for environmental reasons.

Exterior Noise: In order to ease vehicle certification and reduce the associated cost and time expenses without penalising the real vehicles noise performance, virtual certification can play an important role in the future. Thus, current exterior noise simulation tools require further research and validation in order to ensure that the procedures and methodologies applied, and the results obtained represent the noise performance the real train will have.

Additionally, current noise measurement procedures lack the possibility to accurately separate noise sources on pass-by noise tests, and do not cover the common vehicle scenarios including different track types. Source separation is relevant both for vehicle validation and for source ranking prior to mitigation measure implementation, and the improvement of separation techniques shall finally lead to more flexibility, better comparability and hence a better vehicle characterization in current homologation procedures.

New Technologies: Noise control of railways is a challenge also from a comfort point view of the passenger. New and innovative solutions are required to match and exceed the development of passenger comfort and acoustic performance in other modes of the transport such as cars, busses and aircraft, in the future.

SCOPE

In order to address the challenges described above, the proposed research shall address the work-streams described below, in line with the Shift2Rail Multi-Annual Action Plan (MAAP).

Exterior Noise

Work stream 1: Exterior noise simulation tools

The objective of this work stream is to improve exterior noise at standstill and pass-by simulation capabilities based on existing tools developed in the complementary action and results achieved in the European projects ACOUTRAIN [53], Roll2Rail [54] and FINE1's[55] .

Proposals should provide modelling of exterior noise adding together noise sources placed on different parts of the train to simulate the resulting noise levels. The activities in this work stream are expected to focus on the following areas:

- Definition of the strength and directivity of each source: Measure or simulate sound power and directivity or use existing data from measurements and/or simulations data base for 5 different noise sources of a rail vehicle. These sources shall include sources located on the vehicle roof, on its underframe and on its bogie (traction motor). Noise sources contributing to the exterior noise of a standstill and a pass-by vehicle (except rolling noise) shall be considered (a vehicle with a maximum speed, lower or equal to 160 km/h, on a free field and ballasted track shall be considered for the pass-by scenario).

[53] http://www.acoutrain.eu/?page_id=883
[54] http://www.roll2rail.eu
[55] https://shift2rail.org/projects/fine-1/).

- Represent the strength and the directivity of the source as an equivalent source improving the methodology from ACOUTRAIN (superposition of simple sources [56]) or with new modelling techniques and validate the representation. Note that the noise generating phenomena of the equipment itself does not have to be modelled. The modelling shall follow requirements proposed by the complementary Members project. Basic requirements for source characterization and ranking of relevant source types can be found in FINE 1 Deliverable D8.1 "Characterisation and specification requirements" [57].
- Define integration effects due to installation of the source on the train by measurement and/or calculation. Integration effects are changes of effective sound power, radiation characteristics or operating condition once the sources are installed on the vehicle in comparison to e.g. a test bench or a pure source simulation (integration effects shall consider equipment mounted on the vehicle roof, on its underframe and on its bogie, as well as the presence of skirts and fairings). Simulation methodologies for integration effects shall be developed and it is of special interest to have a general method and avoid relying on costly measurements that represent only one case. All simulation results need however to be validated by measurements. For the validation of the integration effects of bogie-mounted equipment, a standstill vehicle can be considered and either real equipment or known noise sources (such as omnidirectional loudspeakers) can be used.
- Simulate the added effect of all the sources together for a vehicle at standstill and on a pass-by. Propose a methodology to estimate the uncertainties of a complete simulation process (input data, source model and propagation model uncertainty) for constant speed pass-by and standstill cases. This uncertainty assessment methodology shall be applied to reference cases proposed by complementary Members project.

Knowledge and experience of the ACOUTRAIN [58] type of approaches, of exterior noise modelling according to standard ISO3095:2013 and of the state of the art of exterior noise modelling and installation effects are hence required.

An indicative scheduling of the deliverables is suggested below [59]:

- State of the art, strategy for improved exterior noise modelling and source representation - M9;
- Description of improved equivalent source models based on sound power and directivity including integration models and validation testing campaign proposal - M18;
- Conclusions and validation test results for the models developed - M30;
- Uncertainty analysis - M33.

Work stream 2 - *Pass-by noise source separation*

The objective of this work stream is to develop novel and innovative techniques to get the sound power level and directivity of the different types of noise sources during pass by at constant speed of a train.

[56] http://www.acoutrain.eu/wp-content/uploads/2015/08/D3.1_Source_model_for_cooling_fans_suitable_for_integration_in_the_global_simulation_model_Final.pdf

[57] https://shift2rail.org/projects/fine-1/).

[58] http://www.acoutrain.eu/?page_id=883

[59] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling.

- The techniques proposed shall present improvements and benefits in comparison to separation techniques used in the past. The type of sources to be considered shall include aerodynamic sources, traction noise sources as well as rolling noise (rolling noise can be considered as an entity, with no need to separate track noise from wheel noise). Any methodology proposal shall be capable of providing the sound power and directivity of the each of the separated sources at least in 1/3 octave band resolution and may include improved beamforming technologies. The complementary member project will define two vehicle scenarios and the methods proposed should be agreed with the complementary Members project
- The techniques developed shall be validated and assessed for uncertainties for each vehicle scenario separately on test campaigns to be organised by this open call. The complementary Members' project will define and give access to vehicles and tracks to be used for this purpose. An analysis to quantify the uncertainties of the techniques developed shall be included. A detailed theoretical background and the validation test results shall be provided to the complementary project for their analysis.

Knowledge and field experience of state of the art of source separations techniques and methodologies types from Roll2Rail project is required [60]

An indicative scheduling of the deliverables is suggested below [61]:

- State of the art, strategy for new separation techniques, M9
- Innovative separation techniques: theoretical description and validation testing campaign proposal, M18
- Innovative separation techniques: validation test results, M27

Work stream 3: Separation of track noise versus vehicle noise

The objective of this work stream is twofold: simplify and enhance methodologies for separation of rolling noise with the track versus vehicle part and extend their validation and data collection to several vehicle scenarios.

- The most promising separation techniques analysed in the project ROLL2RAIL[62] are to be taken as a starting point for further development (e.g. ATPA, PBA, TWINS based transfer function methods, improved beamforming and/or hybrid methods[63]). The most promising methods available should be analysed to clarify strengths and weaknesses for simplification and define uncertainties in view of using them for authorisation procedures in the future as well as from a scientific point of view to assure increased knowledge of the basic physics involved in rolling noise generation and separation. Roughness separation between wheel and rail is expected.
  Furthermore, the method shall allow transposing pass-by data obtained on one track to another track of different roughness and track decay rates. The method should provide track noise in parts of vertical and lateral rail vibration with high accuracy. Specification of requirements for the development together with three vehicles scenarios to be considered will be provided by the complementary project.

[60] http://www.roll2rail.eu
[61] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling.
[62] http://www.roll2rail.eu
[63] Roll2Rail Deliverable 7.4 http://www.roll2rail.eu/Page.aspx?CAT=DELIVERABLES&IdPage=45291e18-8d8f-4fd6-99f8-5d4b7a519b9c

- The separation techniques developed shall be validated for each vehicle scenario separately on test campaigns. The complementary project will define and give access to vehicles and tracks to be used for this purpose. An analysis to quantify the uncertainties of the techniques developed shall be included. A detailed theoretical background and the validation test results shall be provided to the complementary project for their analysis.

Knowledge and field experience of state of the art of rolling noise separations techniques and methodologies types from Roll2Rail project is required [64]

An indicative scheduling of the deliverables is suggested below [65]:

a) State of the art, strategy for enhancing separation techniques - M9;
b) Track versus vehicle separation and transposition techniques including theoretical description and proposal for full scale validation test campaign - M15;
c) Track versus vehicle separation and transposition techniques conclusions, recommendations and validation test results - M30.

New Technologies

Work stream 4 – New Materials and Concepts

The objective of this work stream is to use new and innovative approaches to improve the acoustic design for the interior noise on future rolling stock.

The activities in this work stream are expected to focus on the following areas:

- Initial feasibility studies on a number of innovative ideas and approaches for future noise abatement and sound quality improvements in the compartment of trains e.g. new materials and methods for transmission loss and absorption or sound quality control or other novel concepts. The feasibility study shall consider the current state of the art methods and needs of the complementary project and shall be based on agreed criteria assessment between the two complementary projects;
- Select two of the most promising design approaches from above in agreement with the complementary project;
- Acoustic performance characterisation by simulation for the baseline design of the selected concepts;
- Acoustic performance characterisation by simulation for new design concepts (including new materials simulation and/or measurement characterisation);
- Validate new concept by measurement (measurement/test specification in agreement with the complementary project).

An indicative scheduling of the deliverables is suggested below [66]:

a) Initial feasibility study of new concepts and approaches - M8;

[64] http://www.roll2rail.eu
[65] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling.
[66] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling.

b) Acoustics performance characterization of baseline and new design variants (simulation) - M 14;
c) Validation of acoustics performance characterization of new design variant (measurement/test) - M 30.

Foreseen achievable Technology Readiness Level: TRL 3 / 4

COMPLEMENTARITY

As specified in section 2.3.1 of AWP 2019, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-CCA-01-2019: Integrated mobility management (I2M), Energy and Noise & Vibration.

The action stemming from this topic will also be complementary to actions carried out within the following projects:

- FINE-1 (GA 730818).

All technical results from all the work streams of this topic should be provided to the complementary action.

EXPECTED IMPACT

Exterior Noise

- Reduction on rail vehicles noise validation lead time and cost;
- Reduction of requirement non-compliances at product delivery;
- More precise and better-founded requirement definition for equipment suppliers, reducing time (and cost);
- Lower operators' track occupation for testing;
- Better understanding of noise contributors exterior noise;
- Higher comparability and reproducibility of pass-by measurements;
- The new assessment method will allow silent vehicles to show up and will stimulate low noise vehicle design;
- A better basis for possible noise dependent track access charges;
- Reduce the need of a TSI-compliant test track (e.g. slab track is also possible without high risk);
- Detection of main noise contributors to pass-by noise.

New Technologies

- Availability of new, innovative and validated design solutions for interior noise control.

Type of Action: Research and Innovation Action (RIA)

4.2.11 S2R-OC-IPX-01-2019: Artificial Intelligence (A.I.) for the railway sector

SPECIFIC CHALLENGE

Arising and promising disruptive technologies (e.g. A.I., robotics) will contribute to shaping the way how future rail automation and maintenance will be organised and the subsequent strategic industrial developments on rolling stock and infrastructure. The more advanced aspects of this approach and technologies can be developed in a potential continuation of the current S2R activities.

Rail is a network, is a system, is predictable, is supervised and the Shift2Rail Joint Undertaking can become the test bed for some A.I. developments.

A.I. could become for example an "add on" for existing and future management systems providing suggestion/action for real time problem solving in order to comply with the basic safety and performance requirements, as well as it can guide the design process (e.g. data preparation and configuration).

SCOPE

In order to address the challenges described above, the proposals should foresee PhD research for indicatively a period between 12 to 36 months on the following thematic.

The research activity should investigate ways to transfer existing Artificial Intelligence developed in other sector, in particular the transport one, which can support a fast take up of this technology in railways.

For this the following activities should be undertaken at least, more can be added within a TRL2/3 limit:

- State of the art of algorithms, machine learning techniques, datasets and available neural networks and experience from the rail and from other relevant sector.
- Analysis on the transferability into the rail sector of existing tools/methods/initiatives and datasets
- Recommendations for implementation in different railways domains for assets managements, decision tool support, increased automation, etc.
- Identification of challenges, limitations, and new opportunities
- Migration strategies for the AI integration.

The work should analyse and consider the current ongoing work in S2R and see in which areas S2R can be used as test bed and the current innovation results used for AI training in some AI applications.

In addition the research should identify the necessary innovation or work that could enable the AI to be used and useful; this could include the creation of rail network digital twin, enhancement of data driven process, creation of autonomous operation, simplification and systems interoperability, etc. Such identification should be followed by a state of the art and recommendations.

The technical results of this action are expected to be open-access in case of publications or in case of software/(source) code/etc. distributed through a non-viral open source license which guarantees royalty-free usage, modification and (re)-distribution to projects within the Shift2Rail programme. The results are expected to be publicly disseminated. Only exceptionally could a (non-essential) deliverable be declared confidential under the condition that this would not call into question the initial grant awarding decision.

The area(s) of A.I. of which the above activities can cover are free, as an indication only here some possible domains relevant in rail:

- A.I. for enhanced safety in self-driving vehicles (e.g. learning machine from obstacle detection to inferring the state of the infrastructure linked to multiple variables)
- A.I. to mine Big Data in Rail (e.g. predictive maintenance, BIM and optimisation processes)
- A.I. to detect Cybersecurity intrusion (e.g. based on exchanges with a multiplicity of IP-connected smart objects)
- A.I. for flexible capacity allocation across the network
- A.I. for real-time provision of innovative flexible services (e.g.: to combine the full capacity provided by long block trains along the freight routes - starting from the Rail Freight Corridors - , with flexible services - stop-and-go in automated terminals)
- A.I. for crew schedule management for optimising the use of available/ suitable rolling stock and existing crew in a given network and on a given service offer. (e.g. to find a way through A.I. to minimise the number of require duties and consequently the operational costs with automatisation of crew scheduling and crew rostering – taking into account physical and operational, legal and any other constrains)

EXPECTED IMPACT

Research results are expected to contribute to future S2R exploratory research and in general to open new possibilities and ideas for the S2R stakeholders and rail research community.

At the same time, the PhD researchers who are part of the S2R activities, are expected to become European ambassadors of the possible bright and innovative future that the rail sector has in the year to come.

The initial concept investigations should look forward the possible achievement of the following future impacts:

o Increased capacity

o Reduced LCC

o Reduced errors (human, in the processes, etc.)

o High efficiency / increased performance

o High automation and auto-adaptive systems

o Simplified supervision and fast problems resolution

o Reduced complexity, simplified and interoperable interfaces

o Improved flexibility

Type of Action: Research and Innovation Action (RIA)

4.2.12 S2R-OC-IPX-02-2019: Breaking language barriers

SPECIFIC CHALLENGE

The current language requirements for train drivers are not considered to be the most effective means of ensuring a high level of safety while allowing efficient operation of the network. In this respect, The European Commission prepared a proposal to amend Annex VI to the Directive 2007/59/EC on language requirements, with the aim of exploring alternative options to the current language requirements, which should allow for greater flexibility and ensure an equivalent level of safety with the current requirements. These alternative options should be explored in day-to-day operations in the framework of pilot projects.

SCOPE

This action aims at facilitating the emerge of technological solutions that would help to harmonise the specific terminology (digital language) or support effective communication and possibly enable translation in various languages. The technological digital sulutions should demonstrate the ability to support a safe, effective and efficient communication under normal operation, but also in degraded and emergency situations.

The action should benchmark relevant activities in other industries as well as current initiates in the rail sector, including possible future pilot porjects condussed on the base of the revised Annex VI to Directive 2007/59/EC.

The action should foresee a demonstration at least at TRL5 and in accordance with the S2R JU if there is a possibly to implement with a railway undertaking in a European Corridor (TRL7).

The involvement of Start-ups and SMEs is strongly recommended.

In accordance with art9.3(d) of the HORIZON 2020 Rules for Participation, in this specific topic the minimum condition shall be the participation of one legal entity established in a Member State or Associated Country. The reason of this approach is justified by the nature of the expected activity that would require an agile short-term solution for possible early testing and deployment.

EXPECTED IMPACT

The technological digital solutions should result in demonstrating the ability to support the driver in communicating actively and effectively in routine, degraded and emergency situations, without negative impact on safety.

Type of Action: **Research and Innovation Action (RIA)**

4.3 ANNEX III – Indicators and Scoreboard of KPIs

4.3.1 TABLE I - Horizon 2020 Key Performance Indicators[67] 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. [new approach 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. [new approach under H2020]	to be developed based on FP7 ex-post evaluation and /or first H2020 project results	Yes
SOCIETAL CHALENGE	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	H2020 beneficiaries through project reporting; Responsible Directorate/Service (via	n.a. [new approach under H2020]	[On average, 20 publications per €10 million funding (for	Yes

[67] (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
				commercially available bibliometric databases.	access to appropriate bibliometric databases)		all societal challenges)]	
	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. [new approach under H2020]	On average, 2 per €10 million funding (2014 - 2020) RTD A6	Yes
	16	Number of prototypes testing activities and clinical trials[68]	Number of prototypes, testing (feasibility/demo) activities, clinical trials	Reports on prototypes, and testing activities, clinical trials	H2020 beneficiaries through project reporting	n.a. [new approach under H2020]	[To be developed on the basis of first Horizon 2020 results]	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. [new approach under H2020]	[To be developed on the basis of first Horizon 2020 results]	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. [new approach under H2020]	[To be developed on the basis of first Horizon 2020 results]	Yes

[68] 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) all applicants 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) successful applicants 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 [69]	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

[69] 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	Automated
	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.

4.3.2 TABLE II - Indicators for monitoring H2020 Cross-Cutting Issues[70] 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

[70] (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 [71]	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[72] 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

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

[72] 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[73]s and Universities in PPPs (Art 187 initiatives)	Number of participations of RTOs to funded projects and % of the total Number of participations of Universities to funded projects and % of the total % of budget allocated to RTOs and to Universities	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)[74]	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
*Services -Executive Agencies and other external bodies in charge with H2020 activities

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

[73] RTO: Research and Technology Organisation

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

4.3.3 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

4.3.4 TABLE IV – Initial Estimation – Release 1.0 - of the Key Performance Indicators of the Shift2Rail Programme

System Platform Demonstrator (SPD)	Life-Cycle Cost (LCC)	Capacity*	Punctuality
Overall Target	-50%	+100%	+50%
Overview by Segment			
High speed	-18%	74%	19%
Regional	-24%	49%	15%
Urban	-18%	28%	11%
Freight	-30% / -45% / -44%*	91%	71%

SPD: High speed	LCC	Capacity	Punct.*
Vehicle / IP1	-5%	16%	11%
Signalling / IP2	-37%	50%	24%
Infra./ IP3	-38%	**	42%

SPD: Urban	LCC	Capacity	Punct.*
Vehicle / IP1	-5%	7%	15%
Signalling / IP2	-58%	20%	5%
Infra./ IP3	-38%	**	45%

SPD: Regional	LCC	Capacity	Punct.*
Vehicle / IP1	-9%	14%	15%
Signalling / IP2	-47%	30%	12%
Infra./ IP3	-39%	**	45%

SPD: Freight	LCC	Capacity	Punct.*
Freight / IP5	-16% -42% -40%	21%	81%
Signalling / IP2	-20%	50%	28%
Infra./ IP3	-38%	5%	45%

* Punctuality: Reduction of Unpunctuality of rail services

** Major impact on Capacity per day but not on Capacity at Peak Hour

The data contained in the table here above provide the initial figures of how the different TDs are contributing to the achievement of the S2R target KPIs. **Nevertheless, at this stage**

- **the input values discounts the low TRL R&I activities still performed in some S2R Projects**
- **the interdependencies require further refinenments**
- **IP2 value are under reassessment as well as the Urban value with particular regard to the concept of punctuality.**

+9% LCC decrease because of load factor increase

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

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

NAME OF MEMBER	CONSTITUENT ENTITIES OF CONSORTIA	COUNTRY
	Polskie Koleje Państwowe S.A. (PKP)	PL
	PRORAIL B.V.	NL
	Schweizerische Bundesbahnen (SBB)	CH
	Slovenske zeleznice (SZ)	SI
	Türkiye Cumhuriyeti Devlet Demiryollari (TCDD)	TR
Faiveley Transport		FR
HaCon Ingenieurgesellschaft mbH		DE
INDRA SISTEMAS S.A.		ES
Kapsch CarrierCom 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	*Strukton Rail BV*	NL
	ACCIONA INFRAESTRUCTURAS SA	ES
	Deutsches Zenttrum für Luft-und Raumfahrt e.V. (DLR)	DE
	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.	DE
	Centro de Estudios de Materiales y Control de Obra S.A	ES
Smart Rail Control (SmartRaCon) consortium	*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)*	DE
	Centro de Estudios e Investigaciones Técnicas (CEIT)	ES
	FONDATION DE COOPERATION SCIENTIFIQUE RAILENIUM	FR

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

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