



# **Shift2Rail Joint Undertaking (S2R JU)**

## **Annual Work Plan 2018 & Budget**

**ANNEX to GB decision no 6/2017**

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<b>Shift2Rail Joint Undertaking – Annual Work Plan 2018</b>		
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# 1 INTRODUCTION

The Annual Work Plan 2018 (AWP 2018) of the Shift2Rail Joint Undertaking (S2R JU) outlines the scope of the Research and Innovation (R&I) activities that will be performed as from 2018, implemented through call(s) for proposals and/or call(s) for tenders open to its Members and third parties. It also details the governance structure of S2R JU and the underpinning 2018 Budget.

The AWP 2018 shall be read in conjunction with the previous AWP's and AARs and the work planned in the S2R MAAP, as revised by the MAAP Part A adopted by the Governing Board on 27 October 2017<sup>1</sup>. It is constructed with the objective to accelerate the R&I activities performed and maximize the resources available in order to bring to the market railway innovative solutions addressing passengers' mobility and freight railway's logistic shortcomings.

In the introduction (Section 1), S2R JU's background, mission and objectives are described. Section 2 outlines the activities planned for 2018 including the support to operations, S2R JU governance and internal control framework. Section 3 explains the S2R JU 2018 Budget.

*NB: The present document is based on the template provided by the Commission Services and it has minor adaptation to allow dealing with the specific need of the JU 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. ERRAC and ERA consultation 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 addressing the challenges faced by the rail sector, through a comprehensive and coordinated approach to research and innovation focusing on the needs of the rail system and of its users, including in Member States that do not currently have a railway system within their territory.

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

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<sup>1</sup> Decision 6/2017 of 27 October 2017

<sup>2</sup> 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

<sup>3</sup> Commission Decision N° C(2014) 7084 final

<sup>4</sup> AERFITEC consortium, Amadeus IT Group SA, AZD Praha s.r.o., CFW consortium, Deutsche Bahn AG, DIGINEXT, EUROCC consortium, Faiveley Transport, HaCon Ingenieurgesellschaft mbH, Indra Sistemas S.A., Kapsch CarrierCom, Knorr-

## 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, 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 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<sup>5</sup>, further detailed in the S2R Multi-Annual Action Plan (MAAP)<sup>6</sup> and its evolutions. Overall, the S2R JU shall:

- to establish and 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 H2020 Regulation and in particular part of the Smart, Green and Integrated Transport Challenge under the Societal Challenges pillar of Decision No 2013/743/EU;
- contribute to the achievement of the Single European Railway Area, to a faster and less costly transition to a more attractive, user-friendly (including for persons with reduced mobility), competitive, efficient and sustainable European rail system, and to the development of a strong and globally competitive European rail industry;
- play a major role in rail-related research and innovation, ensuring coordination among projects within its overall Programme. It provides all stakeholders with relevant and available information on R&I activities funded across Europe. It shall also manage all rail-focused research and innovation actions co-funded by the Union;
- actively promote the participation and close involvement of all relevant stakeholders from the full rail value chain and from outside the traditional rail industry. In particular, it fosters the involvement of small and medium sized enterprises (SMEs), as defined in Commission Recommendation 2003/361/EC (8);
- develop demonstration projects in interested Member States including those that do not currently have a railway system established within their territory.

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

- a 50 % reduction of the life-cycle cost of the railway transport system, through a reduction of the costs of developing, maintaining, operating and renewing infrastructure and rolling stock, as well as through increased energy efficiency;
- a 100 % increase in the capacity of the railway transport system, to meet increased demand for passenger and freight railway services;
- a 50 % increase in the reliability and punctuality of rail services (measured as a 50 % decrease in unreliability and late arrivals);
- the removal of remaining technical obstacles holding back the rail sector in terms of interoperability, product implementation and efficiency, in particular by endeavouring to

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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+

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

<sup>6</sup> [http://www.shift2rail.org/wp-content/uploads/2013/07/S2R-JU-GB\\_Decision-N-15-2015-MAAP.pdf](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

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 Joint Undertaking 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 H2020 Regulation<sup>7</sup> and its Rules of participation<sup>8</sup>. 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, encompassing therefore R&I activities beyond the programmatic period of S2R JU. It proposes a holistic approach of the rail system that takes into consideration all the relevant railway subsystems and actors, as well as their complex interaction (system demonstrators).

Given this whole-system approach, the S2R Master Plan established a R&I Programme structured around five integrated Innovation Programmes (IPs). Transversally, five cross-cutting themes and activities (CCA) are analysed independently from the specific IP:

#### 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 back 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 define 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

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

<sup>8</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/legal\\_basis/rules\\_participation/h2020-rules-participation\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/legal_basis/rules_participation/h2020-rules-participation_en.pdf)

- Train Control and Monitoring System
- Carbodyshell
- Running Gear
- Brakes
- Doors and Intelligent access systems
- Train interiors.

### 1.3.2 Innovation Programme 2: 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 ERTMS has 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/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, decrease traction energy consumption and carbon emissions, reduce operational costs, enhance safety and security, and provide 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.

### 1.3.3 Innovation Programme 3: 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 modal infrastructures (including multimodal hubs, changing 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: 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 transportation. 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 GNSS based location, the advances in cloud computing, Open Data and Big Data Analytics and the propagation 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 the 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 and purchase door-to-door journeys. Ticketless or multi-application solutions that guarantee interconnectivity no matter where the traveller roams 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, 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.

#### 1.3.5 Innovation Programme 5: 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<sup>9</sup> 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 that helps to take freight away from the already-congested road network, to become the backbone of the Union inland integrated logistic system.

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

Different market segments with specific technical and operational characteristics and needs have to be identified in order to direct research and innovation projects towards present and future market needs. The first segment is the intermodal segment, which mainly relies on the use of containers/trailer trains and where continued growth can be expected. Reliability, service characteristics and cost competitiveness in this segment can progress significantly with an increase in train length, better length utilisation, innovative rolling stock features for value-added services, progress in the terminal operations, improved real-time customer information to customers and better data exchange between involved parties in the intermodal transport chain. 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 single wagonload 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, tagging of all wagons with RFID tags automatically readable 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.

The Other Members involved in IP5 are already looking at how this IP should be better focused to the challenges of the sector.

#### **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 (hereinafter also CCA) relevant to each of the different sub-systems and taking into account the interactions between these sub-systems.

These cross-cutting 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 eliminating the aforementioned barriers, the new solutions will be supported by cost-benefit analyses. The overall S2R activities will embed, when applicable, suitable works to prepare for future technical standardisation/regulation related to the proposed innovations.

On 27 October 2017, the Governing Board adopted the new MAAP Part A 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 it identifies the associated set of twelve new capabilities S2R will help the railway develop and bring to market. It describes the S2R Programme as a whole, summarising its purpose, structure, methodology and content and focus on the series of intermediate steps by 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 business. 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.

It explains how the MAAP and its detailed activities (as set out in Part B), within the framework of the original S2R MP, 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.

## 2 ANNUAL WORK PLAN 2018

### 2.1 Executive Summary

The S2R JU has been building on the activities started since it was first set-up. The R&I projects and activities which began in 2015-2016 started to bring in their first results and they were continued in 2017 with the launch of 17 new projects, as part of the AWP 2017.

The S2R JU's 2018 AWP describes the R&I activities to be executed by its Other Members and beneficiaries of Open Calls in the next years building upon the results coming from the Lighthouse Projects and the expected outcome of the 2015-2016 Projects.

The 2018 AWP foresees the following operational activities:

- launch of calls for proposals and calls for tenders for a total foreseen value of the action of 157,8 M€:
  - competitive calls for proposals (RIA and IA) for S2R JU Members with a total foreseen value of the actions of 134,1 M€ (max S2R co-funding 59,6M€);
  - open calls for proposals (RIA), where the S2R JU Members are excluded from participation, with a total foreseen value of the actions of 21,1 M€ (max S2R co-funding 19,1 M€);
- calls for tenders with a maximum value of 2,3 M€;
- other activities include: monitoring and review of the R&I activities (including the finalisation of Lighthouse Projects, subject to the final agreement of the Commission Services).

In the domain of stakeholder management and external relations, 2018 will see the continuation of the close collaboration established between the S2R JU and:

- ERRAC (the European Railway Research Advisory Council),
- the European Union Agency for Railways (ERA)
- different International and European organizations and associations (including CEN/CENELEC and ETSI)
- different associations representing the key stakeholders of the rail sector and beyond, in different areas.

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

The S2R JU will also continue to participate in specific activities, workshops and events in order to advertise, communicate and disseminate worldwide the successful achievements of its Partnership.

The S2R JU will in particular organise and coordinate its participation, together with its Members and projects, to two major events in 2018:

- the Transport Research Arena (April in Vienna, Austria)
- InnoTrans, the largest Railway Trade Fair in the world (September in Berlin), during which key demonstrations about the first results stemming from the R&I work undertaken in the different Innovation Programmes and Technology Demonstrators will be showcased.

In addition, the S2R JU will:

- continue to raise awareness about R&I in railway as instrument of industry sustainability and competitiveness, growth and jobs;
- promote stakeholders' 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;
- manage the S2R JU website;
- continue to lead a coherent dissemination strategy.

At a corporate level, the S2R JU will continue to forecast and maintain an accurate baseline for workloads, costings and staffing levels needed to ensure successful delivery of the Programme. The relevant processes within S2R JU will be configured and managed effectively throughout 2018 to ensure continuity of service delivery.

The 2018 AWP aims to provide a detailed view of all activities to be undertaken and objectives to be achieved during 2017 to meet these goals, drawing from S2R JU's MAAP.

## 2.2 Operations

### 2.2.1 Objectives & indicators

The overall objectives for the S2R programme in 2018 are the following:

- To progress in the R&I in line with the global programming laid down in the current and future MAAP and, 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 2018 wave of calls for proposal and/or tenders takes due considerations of the relevant results achieved by the first wave of projects relating to the first call 2015/2016, the initial progress of the call 2017 and the 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 as for the relevant agreements and/or contracts;
- To contribute to the preparation of R&I beyond the present Programme, possibly along the following three main R&I axes:
  - Blue Sky and fundamental Research,
  - applied R&I (TRL 3 to 7), including relevant demonstration activities to reduce the time to market of innovative solutions explored in the current Programme,
  - deployment coordination and management, paving the way already in the current Programme supporting the Commission Services in the deployment of ERTMS;
- To analyse the current administrative processes and procedures and introduce simplifications in line with the underpinning objectives which drove the establishment of the Joint Undertaking, starting with the lump-sum grants for some R&I activities;
- To assess the recommendations coming from the Interim Review of the Joint Undertaking and, where necessary, propose to the Governing Board possible ways to implement them if and when relevant.

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<sup>10</sup> common to all JTI JUs;
- Indicators for monitoring H2020 Cross-Cutting Issues<sup>11</sup> common to all JTI JUs;

<sup>10</sup> Based on Annex II to Council Decision 2013/743/EU

<sup>11</sup> Based on Annex II to Council Decision 2013/743/EU

- Key Performance Indicators specific for S2R JU. Considering the work currently ongoing within the CCA on KPIs, it can be expected that the indicators will be reviewed during 2018 to the new ones better designed to detect the internal performance of S2R Programme and its innovative solution results and that the AAR 2018 will measure achievements against the new indicators.

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

### 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. It results from a Risk Management exercise performed within the JU during Q2 and Q3 2017.

Risk identified	Action Plan
Adequacy of the MAAP to the evolving needs of the users and stakeholders' expectations	During 2017, a revised version of Part 1 and 2 of the MAAP (now called Part A) will be finalized and Part 3 (now call Part B) maintained taking into consideration the new top down approach.
In accordance with the H2020 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 railway integrated, connected and automated system. This may result on questioning the sound financial management of the implementation process through grants, especially with regards to Members 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. During 2017, the sound financial management risks will be further assessed and possible adequate measures implemented accordingly.
Delays or inadequacies in the completion of activities in grants that are complementary or prerequisites to grants to be awarded under the AWP 2018 may result in an inability to implement activities under AWP 2018.	Ensure, through program management, regular activity the 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 projects collaboration to achieve the programme objectives at risk because of "silos" projects or IP approaches	significant implication of SIWG + decoupling IP structure from AWP topics + further fostering use of common S2R Cooperation Tool and sharing functionalities
S2R JU members fail to deliver on additional activities.	Additional activities plan is contained in the membership agreement. Work with the members on preparation and implementation of the certification and reporting requirements.
Lack of adequate dissemination of result may develop in vague information to the end-user/interested parties and could compromise the JU impact.	The JU is working towards a joint dissemination plan, monitoring the dissemination actions and promoting project results.
There is a risk of the projects underspending the resources available.	Together with the Other Members, the JU has put in place a reporting and monitoring systems that should detect any risk of underspending and take the necessary corrective measures.

<b>Risk identified</b>	<b>Action Plan</b>
TDs not/partially achieved because of: - lack of resources (staff, money, assets etc.) - Members priorities/merge/stepping out - insufficient or late delivery/input from the projects	Proper planning and regular follow up at IPSteCo/SIWG + Projects control gates + regular reporting to GB.
Demonstrations non interoperable because representing a single company solution	Collaborative approach in GA + Projects control gates + regular reporting to GB.
Projects development not aligned with S2R Programme	Programme perspective in GA + regular follow up at IPSteCo/SIWG + regular reporting to GB.
Operational demonstrations not/partially achieved because of difficulties in obtaining Authorisation(s)	Planning anticipation and regular follow up at IPSteCo/SIWG + ERA involvement + regular reporting to GB.
S2R solutions not reaching the market due to lack of coordination and resources at deployment level	investigate possible instrument to support deployment at EU level and implement JU strategy/support
Partial or limited stakeholders (including Members) acceptance of S2R solutions	decision made on consensus based approach in IP SteCo/SIWG/GB + involvement of URID-WG (how the S2R solutions are accepted - develop strategy)
Significant cut in EU budget	The JU Membership shall put in place all the measures to provide all the elements to the budget authority to reduce such a risk
Governance: organisation complexity that impacts S2R JU global objectives	On the one hand, the S2R JU shall focus on delivering the Programme results and, on the other hand, assess and put in place measures that can make its governance more effective and efficient
Turnover of staff and Insufficient number and/or qualitative of applications due contract conditions	Within the budget constraints prepare a career plan for staff. Ensure business continuity
Lack of back-up for JU key function	Replacement plan (back-up) where possible including through external support (interim, expert, outsourcing)

### 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 2018 and are reflected in the topics included in the 2018 calls for proposals and/or for tenders.

The S2R JU published its first calls for proposals on 17 December 2015, combining budgets of 2015 and 2016, thus ensuring a meaningful start of activities in all Innovation Programmes and CCAs; this took duly into account the work planned in the Lighthouse Projects already awarded by the Commission while S2R did not have yet its financial autonomy. A second call for proposals, Call 2017, was published in November 2016. The activities are now engaged in all Innovation Programmes to warrant that the work starts in all relevant Technology Demonstrators at the same pace enabling the timely completion of TDs, and their further incorporation into integrated Technology Demonstrators.

In 2018, the S2R JU on the basis of the results of the first wave of projects relating to the call 2015/2016, 2017 and 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 2018

Following thorough analysis with the contribution of the IP Steering Committees and the SIWG, after having consulted the Scientific Committee, the States Representatives Group and ERA, the AWP 2018 includes integrated topics to further enhance the synergies between IPs and CCA. Overall, the following types of activities have been identified:

- projects progressing up TRL 7 by 2024 which build on the work conducted in the Lighthouse Projects and the first S2R calls;
- projects achieving lower TRL by 2022, which embed some flexibility and may result and readjusted innovative solutions more adapted to the evolving medium terms needs;
- "blue sky" and fundamental research projects (mostly Open Call Projects) which may offer the opportunity to put the seeds on 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 on which to build upon S2R Innovative solutions, such as those needed to support the implementation of the European Deployment Plan related to ERTMS and related.

The table below identifies the topics related to the call that the S2R JU is planning to launch in 2018.

Activity	Type of call	Value of the actions (*)	Maximum S2R co-funding (*)	In-kind contribution (*)	Indicative publication date
Call for Proposals and/or Call for tenders	JU members eligible only	134.1	59.6	74.5	Q4 2017
Call for Proposals	Open, JU Members excluded	21.1	19.1	2.0	Q4 2017
Call for Tenders	Open	2.3	2.3	N/A	Q4 2017
Operational Experts	Open, including through REA	0.3	0.3		
<b>Total</b>		<b>157.8</b>	<b>81.3</b>	<b>76.5</b>	

(\*) indicative figures in million EUR

##### 2.2.4.1 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 2018, the S2R JU is planning to issue calls for proposals and/or call for tenders addressed to JU Members only. The budget for this call is estimated at EUR 59.6 mln (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 134.1 million (the difference, EUR 74.5 million, corresponds to the indicative minimum value of the net in-kind contributions of the Other Members).

Detailed topic descriptions are provided in the Annex I to this AWP 2018.

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 Q4 2017, with activities expected to start towards year end 2018.

Proposals should be invited against the following topics:

<b>Topic number - IP</b>	<b>Topic name</b>	<b>Type of action and expected Technical Readiness Level (TRL)</b>	<b>Value of the actions (*)</b>	<b>Maximum S2R co-funding (*)</b>	<b>In-kind contribution (*)</b>
S2R-CFM-IP1-01-2018	Development of technology demonstrators for the next generation of traction systems and adhesion management systems	RIA , TRL 5 to 6	28,534,203	12,680,600	15,853,603
S2R-CFM-IP1-02-2018	Implementing new technologies for the TCMS	RIA, TRL 5	10,576,058	4,700,000	5,876,058
S2R-CFM-IP2-01-2018	Advanced Signalling, Automation and Communication System (IP2 and IP5)	IA, TRL6	38,900,540	17,287,400	21,613,140
S2R-CFM-IP3-01-2018	Research into optimized and future railway infrastructure	IA, TRL 6	30,153,015	13,400,000	16,753,015

<b>Topic number - IP</b>	<b>Topic name</b>	<b>Type of action and expected Technical Readiness Level (TRL)</b>	<b>Value of the actions (*)</b>	<b>Maximum S2R co-funding (*)</b>	<b>In-kind contribution (*)</b>
S2R-CFM-IP4-01-2018	Passenger service platform specifications for an enhanced multi-modal transport eco-system including Mobility as a Service (MaaS)	IA, TRL 6	11,701,170	5,200,000	6,501,170
S2R-CFM-IP5-01-2018	Technology demonstrators for competitive, intelligent rail freight operation	IA, TRL 6	12,376,238	5,500,000	6,876,238
S2R-CFM-CCA-01-2018	Virtual certification & smart planning	RIA TRL 3	1,894,689	842,000	1,052,689
<b>TOTAL</b>			<b>134,135,914</b>	<b>59,610,000</b>	<b>74,525,914</b>

(\*) indicative figures in EUR

#### **2.2.4.2 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 2018, 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 19,1 mln (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 21,1 million (the difference, EUR 2,0 million, corresponds to the indicative minimum value of the net in-kind contributions of the Other Members).

Detailed topic descriptions are provided in the Annex II to this AWP 2018.

It is planned that the call for proposals will be launched in Q4 2017, with activities expected to start towards the end of the year 2018.

Proposals should be invited against the following topics:

Topic number - IP	Topic name	Type of action and expected Technical Readiness Level (TRL)	Value of the actions (*)	Maximum S2R co-funding (*)	In-kind contribution from non Members (*)
S2R-OC-IPX-01-2018	Paradigm shifts for railway	RIA, up to TRL 2	2,200,000	2,200,000	n.a
S2R-OC-IPX-02-2018	Transversal exploratory research activities and knowledge transfer	CSA	500,000	500,000	n.a
S2R-OC-IPX-03-2018	Innovative/breakthrough mobility concepts (with rail as backbone)	CSA	500,000	500,000	n.a
S2R-OC-IP1-01-2018	Technical solutions for the next generation of TCMS	RIA, up to TRL 4/5	4,000,000	4,000,000	n.a
S2R-OC-IP2-01-2018	Analysis for Moving Block and implementation of Virtual Coupling concept	RIA, up to TRL 3	1,300,000	1,300,000	n.a
S2R-OC-IP2-02-2018	Modern methodologies and verifications for GNSS in Railways and virtual test environment.	RIA, up to TRL 3	1,020,000	1,020,000	n.a
S2R-OC-IP2-03-2018	Communication environment assessment and validation	RIA, up to TRL 5/6	750,000	750,000	n.a
S2R-OC-IP3-01-2018	Measuring and monitoring devices for railway assets	IA up to TRL 6	6,785,714	4,750,000	2,035,714
S2R-OC-IP4-01-2018	Semantic framework for multimodal transport services	RIA up to TRL4	2,000,000	2,000,000	n.a
S2R-OC-IP4-02-2018	Supporting the implementation of the IP4 multi-modal transport ecosystem	RIA up to TRL4	1,500,000	1,500,000	n.a
S2R-OC-IP5-01-2018	Radio communication and simulation of train dynamics for Distributed Power within long trains	RIA up to TRL5	600,000	600,000	n.a
<b>TOTAL</b>			<b>21,155,714</b>	<b>19,120,000</b>	<b>2,035,714</b>

(\*) indicative figures in EUR

### 2.2.5 Call planning

In Q4 2017 the S2R JU plans to launch a call for proposals and/or call for tenders addressed to JU Members and an open call for proposals addressed to non-JU Members. The key activities for the management of the foreseen 2018 calls for proposals are presented in the table below:

<b>2018 Management process for the call for proposals addressed to JU Other Members</b>	<b>Indicative timing</b>
Preparation of the call for proposals	Q4 2017
Publication of the call for proposals	Q4 2017
Deadline for the submission of proposals	Q2 2018
Selection of the experts and evaluation of proposals	Q2 2018
Preparation and signature of S2R Model Grant Agreement for JU members (*)	Q3 and Q4 2018
<b>2018 Management process for the open call for proposals addressed to non-JU members</b>	<b>Indicative timing</b>
Preparation of the call for proposals	Q4 2017
Publication of the call for proposals	Q4 2017
Deadline for the submission of proposals	Q2 2018
Selection of the experts and evaluation of proposals	Q2 2018
Preparation and signature of S2R Model Grant Agreement for non-JU members (*)	Q3 and Q4 2018

(\*) *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 V of the General Financial Regulations.

### 2.2.6 Call for tenders

In 2018, the S2R JU is planning to issue the following call for tenders relevant within the IP2 and IP3 scopes and within framework of the S2R JU MAAP.

The calls for tenders are scheduled not later than Q3 2018; 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	Study on alternative communication bearers in the railway environment	The activity shall assess the railway environment and identify new alternative bearer beyond established cellular technologies (UMTS/HSPA, LTE, LTE-A, etc.) or other access technologies (WiFi/802.11, SatCom, etc.), which are or expected to become available for on-board to trackside communication needs. The availability of the alternative bearers might be restricted to certain	€ 150,000

Number	Subject of tender	Indicative scope	Maximum budget
		<p>areas (for example train stations, shunting yards, high-speed lines, different terrains, etc.). The alternative bearers could rely on or leverage already available infrastructure or equipment alongside the railway tracks. Some potential candidates include but are not limited to data over power lines, free space optical communications, etc.</p> <p>The results of the study are expected to enrich the set of access network options for infrastructure managers, when they deploy their new adaptable communication system and leverage the benefits of alternative bearers to address specific needs of their planned rollout of advanced services and applications.</p>	
2 - contract	Study on railway bridge dynamics and the interface with rolling stock	<p>Under supervision of the JU, in collaboration with the ERA, the study should collect bridge and train data, as well as calculation and validation methods, including:</p> <ul style="list-style-type: none"> <li>• calculation methods to describe the dynamic interface vehicle – bridge;</li> <li>• vehicle design assessment method;</li> <li>• validation of calculation methods;</li> <li>• load models and vehicle design limits;</li> <li>• proposal and suggestions for standardisation and regulation.</li> </ul>	€ 250,000
3 - contract	Support to ERTMS European Action Plan to pave the way for the deployment of the future S2R Innovative Solutions	<p>This activity aims at supporting the implementation of the ERTMS European Action Plan, published by the European Commission in June 2017.</p> <p>Under the supervision of the JU and together with 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</p>	€ 1,600,000

Number	Subject of tender	Indicative scope	Maximum budget
		the appraisal of the impact on interoperability of its roll-out.	
4 - contract	Study on use of fuel cell hydrogen in railway environment	This activity aims at analysing the business case of hydrogen and fuel cell usage in the rail environment, both in passenger train and freight. The investigation could for example include analyses on the CO2 performance (through Life Cycle Analysis techniques) of current rail powertrain solutions and demonstrate the specific emissions saving that can be achieved by replacing conventional technologies.	€ 270,000
<b>TOTAL</b>			<b>€ 2,270,000</b>

### 2.2.7 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 as a platform for Railway R&I, press releases, presentations at internal (EC, Governing Board, Scientific Committee, States Representatives Group) and external (conferences, Info days, etc.) stakeholder events, Twitter, as well as other medias.

In addition, during 2018 major dissemination events will take place such as TRA 2018 in Vienna, InnoTrans 2018 in Berlin where demos of the initial results of the S2R R&I activities will be shown in different types of environments.

## 2.3 Call management rules

The S2R JU follows the rules of the European Union's Horizon 2020 framework programme (H2020) and in particular the Horizon 2020 Rules for participation<sup>12</sup> 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.

<sup>12</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/legal\\_basis/rules\\_participation/h2020-rules-participation\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/legal_basis/rules_participation/h2020-rules-participation_en.pdf)

Following the simplification provisions introduced by the Commission on the implementation of H2020, the 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 will be implemented fixing an overall ceiling per topic and leaving the candidates submitting proposals defining 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.

The implementation of lump sum will be subject to the final readiness of the necessary underpinning documents by the launch date of the Call 2018.

In addition, as already foreseen in previous years calls, also in 2018 the S2R Grant Agreements will include the options regarding 'complementary grants' of 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 complementarity of the activities performed in the calls in the interest of the Programme and independently from the nature of the beneficiary. In this respect, 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 2018.

A number of results produced are expected to contribute to European or international standards; hence the standard wording regarding '*results that could contribute to standards*' is included in relevant topic descriptions in Annexes I and II and the corresponding option will be enabled in the relevant S2R JU Agreements.

Similarly, standard wording obliging beneficiaries to 'disseminate any technical specifications of the results that are needed for interoperability' and to 'disseminate the deliverables relating to cross-border interoperability' are included in relevant topic descriptions in Annexes I and II, and the corresponding options will be enabled in the relevant S2R JU Agreements.

### 2.3.2 List of countries eligible for funding

Part A of the General Annexes to the EC Horizon2020 Work programme applies.<sup>13</sup>

### 2.3.3 Standard admissibility conditions and related requirements

Part B of the General Annexes to the EC Horizon2020 Work Programme applies.<sup>14</sup>

### 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 H2020 Rules for Participation and Article 17.1(a) and (b) of S2R JU Statutes, will restrict the type of beneficiary to JU

<sup>13</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf) this reference will need to be updated once document available

<sup>14</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf) this reference will need to be updated once document available

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 H2020 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 EC Horizon2020 Work Programme – General Annexes applies<sup>15</sup>.

Within the call for proposal for JU Members, in the case of S2R JU Members comprised of several legal entities, such legal entities shall be deemed not independent<sup>16</sup> 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 EC Horizon2020 Work Programme – General Annexes applies.<sup>17</sup>

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)<sup>18</sup>.

### 2.3.6 Evaluation rules

Part H of the General Annexes to the EC Horizon2020 Work Programme applies.<sup>19</sup>

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 S2R Regulation in its Article 17.2. The evaluation of award criteria will take into account the coherence of the proposal with the S2R Multi-Annual Action Plan.

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<sup>15</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf) - this reference will need to be updated once document available

<sup>16</sup> Art.8 of the H2020 Rules for Participation

<sup>17</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf) - this reference will need to be updated once document available

<sup>18</sup> 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.

<sup>19</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf) - this reference will need to be updated once document available

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 Horizon2020 Work Programme applies.<sup>20</sup>

### 2.3.8 Financial support to third parties

Part K of the General Annexes to the EC Horizon2020 Work Programme applies for actions performed by non-JU members, supported by the JU.

Part K of the General Annexes to the EC Horizon2020 Work Programme applies for actions performed by JU members, supported by the JU.<sup>21</sup>

### 2.3.9 Consortium agreement

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.

### 2.3.10 Dissemination and information about projects results

Part L of the General Annexes to the EC Horizon2020 Work Programme applies for actions performed by non-JU Members, supported by the JU.

Part L of the General Annexes to the EC Horizon2020 Work Programme applies for actions performed by JU Members, supported by the JU.<sup>22</sup>

In addition to the dissemination of the results already foreseen in the H2020 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 to make available the necessary resources in a manner to facilitate and accelerate dissemination. On the other hand, the S2R JU will provide the necessary material sufficiently in advance. Dissemination success is the result of a strong commitment towards innovation.

These channels will also be used to disseminate and communicate about significant results of on-going S2R JU 'Lighthouse' projects co-funded following H2020 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.

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<sup>20</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf) this reference will need to be updated once document available

<sup>21</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf) this reference will need to be updated once document available

<sup>22</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf) this reference will need to be updated once document available

## 2.4 Support to Operations

### 2.4.1 Communication and events

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

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.

Globally, the communication activities of the S2R JU aim 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 endeavour.
- **Promote stakeholders' engagement** along and across the value chain in order to facilitate cooperation and knowledge exchange. This objective will require the organisation of fora, 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 audience for this objective includes the European Parliament and/or the Council and policy makers in EU Member States. This objective will require the organisation of events inside the European Parliament, the participation in visibility events such as exhibitions, Open Days, publications/presentations of key achievements.
- **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 for providing visibility to the publication of press releases and specific articles related to S2R JU's activity.
- Pro-actively **publish communication material** in regards 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.
- **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 stakeholders' groups. It will also include organisation of the S2R Research Info Days, in Brussels, once S2R calls for proposals are open.
- **Manage the S2R JU website and social media platforms** in order to stimulate the public interaction on key issues and improve public awareness on S2R JU activities.
- **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.
- **Promote the S2R vision and the new MAAP Part A**, around which to build the long term vision of the sector beyond S2R Membership.
- **Support and promote the recognition of results at global level**, including through standards, to contribute to the competitiveness of the European railway industry.

Further to the above, S2R will rely on multipliers and ambassadors:

- S2R Members, including S2R project coordinators and participants, who will communicate the success of S2R to various audiences;
- ERRAC (European Rail Research Advisory Council) reaching out to policy makers and decision makers inside ERRAC.
- Scientific Committee;
- Local multipliers in the Member States such as States Representative Group reaching out to local stakeholders;
- Information days
- Major stakeholders being present at key events, within and outside the Union.

At the beginning of 2017, the JU launched a framework contract for communication services which was awarded during the 2<sup>nd</sup> quarter of the year. The implementation of the communication activities will be realised through the existing S2R framework contract as well as the 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, 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 SLAs (Service Level Agreements) concluded with relevant Commission Services and inter-institutional framework contracts available to them.

In 2018, the S2R JU foresees to run several tenders of low-value.

Indicative Title	Indicative expenditure (EUR)	Type of procedure	Indicative schedule
Team Building Event	<15 000	Negotiated procedure for low-value contracts	1Q2018
Specific Contracts implementing the Communication FWC	300,000	Specific Contracts	First half 2018
Health and safety equipment	<15,000	Negotiated procedure for low-value contracts	2Q2018
Support to events, stands at conferences & exhibitions	<60,000.00	Negotiated procedure with three tenderers	2Q2018
Dissemination and communication activity plan	<60,000.00	Negotiated procedure with three tenderers	1Q2018
Subscriptions to journals & periodicals	Max. 10,000.00	Negotiated procedure for low-value contracts	2Q2018
Framework contract for basic office furniture	<60,000.00	Negotiated procedure with three tenderers	3Q2018
Multiplier events	< 60,000.00	Negotiated procedure with three tenderers	2Q2018

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 on the Governing Board about the procedures put in place as part of the AAR 2018.

#### 2.4.3 IT and logistics

S2R has implemented common ICT tools designed and offered by the European Commission on the financial management and H2020 call management. These tools are updated and maintained on regular basis by the European Commission (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 the multiple and repetitive mistakes. The follow up of these processes absorb multiple resources of the JU.

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 2018 the H2020 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.

S2R JU is participating to 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 and it is expected that during 2018 the rationalization process will continue to maximize the limited resources available.

#### **2.4.4 JU Programme Team – HR matters**

By 2018, the JU shall be fully staffed with 21 members. No additional recruitment of statutory staff members is therefore to be foreseen.

Please refer to Section 3 for more details, provided in budget, and Staff Establishment Plan.

In addition to statutory staff Members and the SNE's already in place, the S2R JU will also make recourse to European Commission's Bluebook trainees.

The Shift2Rail JU HR function will ensure 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. It also makes an explicit reference to the possibility that this function could be attributed to the Accounting Officer of the European Commission (EC).

The Governing Board of the S2R JU has appointed the Accounting Officer of the EC also as the Accounting Officer to the JU. This appointment is not expected to be revised in 2018. In addition, the Governing Board has examined at different stage 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. The role of data protection officer is exercised by the S2R JU's Legal Adviser. During 2018, the notification process of relevant procedures to the EU Data Protection Supervisors will be continued.

## 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 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 being nominated by the IP Steering Committees and appointed by the Board. Following this process, the final composition of the Governing Board was reached in the beginning of 2016. The JU 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 European Agency for Railways 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 tasks are discussed, but has no voting rights.

In 2018, the Governing Board is planning to hold three ordinary meetings.

The key activities are listed below:

<b>Key activities in 2018 – timetable</b>	
Adopt 2017 Annual Activity Report	Q1
Discuss draft 2019 Annual Work Plan	Q3
Discuss draft budget 2019	Q3

Decision on proposal for funding from call 2018	Q3
Adopt the key documents for the S2R JU's operations in 2019: 2019 Annual Work Plan, 2019 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 2018, two meetings of this body are planned

The tentative key activities are listed below:

<b>Key activities in 2018 – timetable</b>	
7 <sup>th</sup> Meeting of the SC. The SC would: <ul style="list-style-type: none"> <li>– Provide advice on the draft 2019 Annual Work Plan.</li> <li>– Provide advice on the planned calls for proposals and/or for tenders.</li> <li>– Provide advice on the results achieved in the previous years and the alignment with the MAAP.</li> </ul>	Q2
8 <sup>th</sup> Meeting of the SC. The SC would: <ul style="list-style-type: none"> <li>– 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</li> <li>– Provide advice to the GB on the programme progress of the S2R and other strategic issues</li> </ul>	Q4

### 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, 30 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 ESIF;
- 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 2018, two meetings of the States Representatives Group are planned (Q2 and Q4). The tentative key activities are listed below:

<b>Key activities in 2018 – timetable</b>	
<p>8<sup>th</sup> Meeting of the SRG. The SRG would:</p> <ul style="list-style-type: none"> <li>– Provide advice on the draft 2019 Annual Work Plan.</li> <li>– Provide advice on the planned calls for proposals.</li> <li>– Provide advice on the results achieved in the previous years and the alignment with the MAAP.</li> </ul>	Q2
<p>9<sup>th</sup> Meeting of the SRG. The SRG would:</p> <ul style="list-style-type: none"> <li>– 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</li> <li>– Provide advice to the GB on the programme progress of the S2R JU and other strategic issues</li> <li>– 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.</li> </ul>	Q4

## **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.

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.

During 2017, the processes and procedures have been further reinforced with the introduction of the S2R Cooperation Tool, the Programme Handbook, different specific procedures that enhance the sound financial management in the implementation of the activities. The S2R intends to have the different elements of the Internal Control System in place by the end of 2017.

In 2018, 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.

## **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.

During 2018, 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 H2020 common Audit Strategy. The strategy has been developed and implemented by the Common Audit Service of the Commission.

## **2.6.4 Risk Management**

During 2018, in accordance with the relevant S2R Policy, the JU will perform twice 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 MP and MAAP.

# **3 BUDGET 2018**

## **3.1 Budget information**

The S2R JU 2018 Budget is subject to the adoption of the EU General Budget for 2018.

The present Budget is based on the initial amounts submitted to the Commission Services in view of the preparation of the Union Draft Budget 2018 early this year, 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 the 2017 Economic Outturn and any other unexpected element. 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 2018:

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

The revenue includes EUR 273 403 relating to the Expert Evaluators; this amount although included to the S2R Budget is managed by the REA Services. Unused amounts will be returned to the S2R JU.

## **Expenditure**

The amount included in the 2018 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 (1 1 0) and Contract Agents, Interim Staff, trainees and SNEs (1 1 1);
- Mission Costs (1 3 0);
- Training (1 5 0);
- Other Staff Expenditure (1 9 0), such as medical service, recruitment, mobility costs and other social expenses.

The estimated expenditure under Title 1 amounts to EUR 2,305,000 and represents 66.2 % 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 (2 0 0)  
Amongst which: Rents; Provisions for other charges in relation to the housing
- IT Expenditure and technical facilities (2 1 0)  
Amongst which: Hardware purchases; Software development & purchases; Day-to-day maintenance
- Movable property and associated costs (2 2 0)  
Amongst which: The purchase / maintenance of office equipment and furniture
- Current Administrative Expenditure (2 3 0)  
Amongst which: Stationery and office supplies; Petty expenditure; Documentation and library expenditure, subscriptions; Translation, interpretation

- Postage and telecommunications (2 4 0)  
Amongst which: postage, telephone, internet and mobile communication expenses
- Administrative Board Expenditure (2 5 0)  
Amongst which: Governing Boards, SRG meetings, SC meetings
- Administrative support services (2 6 0)  
Amongst which: Experts other than ones related to evaluations and project reviews under operational budget, Beneficiary portal.
- PR and Events (2 7 0)  
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 (2 9 0)  
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 273 403 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 2018 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.

Shift2Rail Joint Undertaking Budget 2018

STATEMENT OF REVENUE

Title Chapter	Heading	2016 Executed Budget		% of Budget 2018		2017 Adopted Budget		2017 Amendment 1 <sup>23</sup>		2018 Budget		CA Variance 2017/2018 <sup>24</sup>		PA Variance 2017/2018	
		CA	PA	CA	PA	CA	PA	CA	PA	CA	PA	EUR	%	EUR	%
9	REVENUE														
9 0	CONTRIBUTIONS														
	CONTRIBUTION FROM THE EUROPEAN UNION	46,869,535	49,083,650	59%	63%	63,126,601	53,657,939	63,126,601	32,857,939	79,227,979	77,503,543	16,101,378	25.5%	23,845,604	44.4%
9 0 0	Administrative Budget	1,620,687	1,992,142	98%	120%	1,618,419	1,618,419	1,618,419	1,618,419	1,661,839	1,661,839	43,420	2.7%	43,420	2.7%
9 0 1	Operational Budget	45,248,848	47,091,508	58%	62%	61,508,182	52,039,520	61,508,182	31,239,520	77,566,140	75,841,703	16,057,958	26.1%	23,802,183	45.7%
	CONTRIBUTION FROM MEMBERS OTHER THAN THE EU	2,353,105	2,353,105	142%	142%	1,618,419	1,618,419	1,618,419	1,618,419	1,661,839	1,661,839	43,420	2.7%	43,420	2.7%
9 0 2	Administrative Budget	2,353,105	2,353,105	142%	142%	1,618,419	1,618,419	1,618,419	1,618,419	1,661,839	1,661,839	43,420	2.7%	43,420	2.7%
9 3	UN-USED APPROPRIATIONS PREVIOUS YEARS*	1,009,328	887,390	26%	42%	2,831,968	1,683,120	3,807,718	9,618,168	3,866,664	2,108,067	1,034,696	36.5%	424,947	25.2%
9 3 0	Un-used appropriations previous years Administrative	1,009,328	887,390	74%	42%	1,683,120	1,683,120	1,749,563	3,325,073	1,359,401	2,108,067	(323,719)	(19.2%)	424,947	25.2%
9 3 1	Un-used appropriations previous years Operational			0%		1,148,848		2,058,155	6,293,095	2,507,263	0	1,358,415	118%	0	
	<b>TOTAL REVENUE</b>	<b>50,231,968</b>	<b>52,324,145</b>	<b>59%</b>	<b>64%</b>	<b>67,576,988</b>	<b>56,959,478</b>	<b>68,552,738</b>	<b>44,094,526</b>	<b>84,756,482</b>	<b>81,273,449</b>	<b>17,179,494</b>	<b>25.4%</b>	<b>24,313,971</b>	<b>42.7%</b>

<sup>23</sup> An Amendment (1) of the Budget 2017 is proposed for adoption to the S2R Governing Board

<sup>24</sup> Variance shown towards the Budget 2017 as currently adopted

STATEMENT OF EXPENDITURE															
Title Chapter	Heading	2016 Executed Budget		% of Budget 2018		2017 Adopted Budget		2017 Amendment 1 <sup>25</sup>		2018 Budget		CA Variance 2017/2018 <sup>26</sup>		PA Variance 2017/2018	
		CA	PA	CA	PA	CA	PA	CA	PA	CA	PA	EUR	%	EUR	%
<b>1</b>	<b>STAFF EXPENDITURE</b>														
1 1	STAFF IN ACTIVE EMPLOYMENT	1,086,039	928,569	55%	47%	1,760,000	1,760,000	1,760,000	1,917,471	1,969,000	1,969,000	209,000	11.9%	209,000	11.9%
1 1 0	Temporary Agents	356,285	356,285	47%	47%	750,000	750,000	605,000	605,000	752,000	752,000	2,000	0.3%	2,000	0.3%
1 1 1	Contract Agents, Interim Staff, trainees and SNEs	729,754	572,284	60%	47%	1,010,000	1,010,000	1,155,000	1,312,471	1,217,000	1,217,000	207,000	20.5%	207,000	20.5%
1 3	MISSION COSTS	45,000	35,709	82%	65%	50,000	50,000	70,000	74,000	55,000	55,000	5,000	10.0%	5,000	10.0%
1 5	TRAINING	16,640	0	24%	0%	67,000	67,000	47,000	63,640	70,000	70,000	3,000	4.5%	3,000	4.5%
1 9	OTHER STAFF EXPENDITURE	130,470	120,802	62%	57%	205,000	205,000	205,000	253,447	211,000	211,000	6,000	2.9%	6,000	2.9%
<b>TITLE 1 TOTAL</b>		<b>1,278,149</b>	<b>1,085,080</b>	<b>55%</b>	<b>47%</b>	<b>2,082,000</b>	<b>2,082,000</b>	<b>2,082,000</b>	<b>2,308,558</b>	<b>2,305,000</b>	<b>2,305,000</b>	<b>223,000</b>	<b>10.7%</b>	<b>223,000</b>	<b>10.7%</b>
<b>2</b>	<b>ADMINISTRATIVE EXPENDITURE</b>														
2 0	RENTAL OF BUILDINGS AND ASSOCIATED COSTS	345,000	273,154	108%	85%	315,000	315,000	355,000	426,846	320,000	320,000	5,000	1.6%	5,000	1.6%
2 1	IT EXPENDITURE AND TECHNICAL FACILITIES	588,004	75,283	370%	47%	165,000	165,000	165,000	358,190	159,000	159,000	(6,000)	(3.8%)	(6,000)	(3.8%)
2 2	MOVABLE PROPERTY AND ASSOCIATED COSTS	25,538	49,917	128%	250%	40,000	40,000	40,000	77,272	20,000	20,000	(20,000)	(100.0%)	(20,000)	(100.0%)
2 3	CURRENT ADMINISTRATIVE EXPENDITURE	17,823	14,689	45%	37%	61,000	61,000	25,000	25,000	40,000	40,000	(21,000)	(52.5%)	(21,000)	(52.5%)
2 4	POSTAGE AND TELECOMMUNICATIONS	6,500	2,177	22%	7%	30,000	30,000	30,000	35,000	30,000	30,000	0	0.0%	0	0.0%
2 5	ADMINISTRATIVE BOARD EXPENDITURE	24,031	17,692	40%	29%	100,000	100,000	60,000	68,605	60,000	60,000	(40,000)	(66.7%)	(40,000)	(66.7%)
2 6	ADMINISTRATIVE SUPPORT SERVICES	500,500	193,728	585%	227%	500,000	500,000	120,000	51,091	85,500	85,500	(414,500)	(484.8%)	(414,500)	(484.8%)
2 7	PR AND EVENTS	272,299	185,843	91%	62%	300,000	300,000	600,000	768,166	300,000	300,000	0	0.0%	0	0.0%
2 9	OTHER INFRASTRUCTURE AND OPERATING EXPENDITURE	195,117	10,000	119%	6%	150,000	150,000	150,000	335,117	163,579	163,579	13,579	8.3%	13,579	8.3%
<b>TITLE 2 TOTAL</b>		<b>1,974,811</b>	<b>822,484</b>	<b>168%</b>	<b>70%</b>	<b>1,661,000</b>	<b>1,661,000</b>	<b>1,545,000</b>	<b>2,145,286</b>	<b>1,178,079</b>	<b>1,178,079</b>	<b>(482,921)</b>	<b>(41.0%)</b>	<b>(482,921)</b>	<b>(41.0%)</b>
<b>TOTAL ADMINISTRATIVE EXPENDITURE (Title 1 and Title 2)</b>		<b>3,252,961</b>	<b>1,907,564</b>	<b>93%</b>	<b>55%</b>	<b>3,743,000</b>	<b>3,743,000</b>	<b>3,627,000</b>	<b>4,453,844</b>	<b>3,483,079</b>	<b>3,483,079</b>	<b>(259,921)</b>	<b>(7.5%)</b>	<b>(259,921)</b>	<b>(7.5%)</b>

<sup>25</sup> An Amendment (1) of the Budget 2017 is proposed for adoption to the S2R Governing Board

<sup>26</sup> Variance shown towards the Budget 2017 as currently adopted

STATEMENT OF EXPENDITURE															
Title Chapter	Heading	2016 Executed Budget		% of Budget 2018		2017 Adopted Budget		2017 Amendment 1 <sup>25</sup>		2018 Budget		CA Variance 2017/2018 <sup>26</sup>		PA Variance 2017/2018	
		CA	PA	CA	PA	CA	PA	CA	PA	CA	PA	EUR	%	EUR	%
STATEMENT OF EXPENDITURE															
Title Chapter	Heading	2016 Executed Budget		% of Budget 2018		2017 Adopted Budget		2017 Amendment 1 <sup>27</sup>		2018 Budget		CA Variance 2017/2018 <sup>28</sup>		PA Variance 2017/2018	
		CA	PA	CA	PA	CA	PA	CA	PA	CA	PA	EUR	%	EUR	%
3	OPERATIONAL EXPENDITURE														
3 0	OPERATIONAL EXPENDITURE	44,100,000	40,798,413	54%	53%	61,508,182	52,039,520	61,059,074	37,532,615	81,273,403	77,041,703	19,765,221	24.3%	25,002,183	32.5%
<b>TITLE 3 TOTAL</b>		<b>44,100,000</b>	<b>40,798,413</b>	<b>54%</b>	<b>53%</b>	<b>61,508,182</b>	<b>52,039,520</b>	<b>61,059,074</b>	<b>37,532,615</b>	<b>81,273,403</b>	<b>77,041,703</b>	<b>19,765,221</b>	<b>24.3%</b>	<b>25,002,183</b>	<b>32.5%</b>
4	UNUSED APPROPRIATIONS NOT REQUIRED IN CURRENT YEAR														
4 0	ADMINISTRATIVE BUDGET	1,730,159	3,325,073		444%	1,176,958	1,176,958	1,359,401	2,108,067	0	748,666	(1,176,957)	0.0%	(428,292)	(57.2%)
4 1	OPERATIONAL BUDGET	1,148,848	6,293,095			1,148,848		2,507,263	0	0	0	(1,148,848)	0.0%	0	0.0%
<b>TITLE 4 TOTAL</b>		<b>2,879,007</b>	<b>9,618,168</b>		<b>1285%</b>	<b>2,325,806</b>	<b>1,176,958</b>	<b>3,866,664</b>	<b>2,108,067</b>	<b>0</b>	<b>748,666</b>	<b>(2,325,805)</b>	<b>0.0%</b>	<b>(428,292)</b>	<b>(57.2%)</b>
<b>TOTAL EXPENDITURE</b>		<b>50,231,968</b>	<b>52,324,145</b>	<b>59%</b>	<b>64%</b>	<b>67,576,988</b>	<b>56,959,478</b>	<b>68,552,738</b>	<b>44,094,526</b>	<b>84,756,482</b>	<b>81,273,449</b>	<b>17,179,494</b>	<b>0.0%</b>	<b>24,313,971</b>	<b>29.9%</b>

<sup>27</sup>An Amendment (1) of the Budget 2017 is proposed for adoption to the S2R Governing Board

<sup>28</sup> Variance shown towards the Budget 2017 as currently adopted

### **Contributions overview**

<b>CONTRIBUTIONS OVERVIEW</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>
CONTRIBUTIONS FROM THE UNION (incl EFTA)	46,869,535	63,126,601	79,227,979
Title 1 and Title 2 (financial)	1,620,687	1,618,419	1,661,839
Title 3 (financial)	45,248,848	61,508,182	77,566,140
CONTRIBUTIONS FROM MEMBERS OTHER THAN THE UNION	81,415,274	53,252,712	78.223.467
Title 1 and Title 2 (financial)	2,353,105	1,618,419	1.661.839
Title 3 (in-kind)	79,062,169	51,634,293	76.561.628
TOTAL CONTRIBUTIONS	128,284,809	116,379,313	157.451.446

It should be noted that EUR 2.0 million coming from non-Members are considered by analogy IKOP but they cannot be accounted for the Other Members.

**Schedule of payments**

	Commitment Appropriations		Payment Appropriations		
	RAL from earlier years	Budget 2018	Budget 2018	Estimated Budget 2019	Estimated Budget 2020 and after
2015 Work Plan	22,494,010		15,882,510	6,611,500	
2016 Work Plan	21,778,993		15,691,347	6,087,646	
2017 Work Plan	27,429,011		5,569,293	19,114,970	2,744,748
2018 Work Plan Administrative		3,483,079	3,483,079	-	
2018 Work Plan Operational		81,273,403	39,898,553	8,843,361	32,531,488
<b>Total</b>	<b>71,702,014</b>	<b>84,756,482</b>	<b>80,524,782</b>	<b>40,657,477</b>	<b>35,276,236</b>

## 3.2 Staff Establishment Plan

### Establishment plan posts

#### Temporary Agents

Function group and grade	2016				2017		2018	
	Authorised under the EU Budget		Actually filled as of 31/12/2016		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		1		2		2
AD 8								1
AD 7				1		1		1
AD 6						1		
AD 5		1		1				
AD TOTAL		4		4		5		5
AST 1-11								
AST TOTAL								
AST/SC 1-6								
AST/SC TOTAL								
TOTAL		4		4		5		5
GRAND TOTAL		4		4		5		5

#### Contract Agents

Contract agents	Authorised 2016	Recruited as of 31/12/2016	Authorised 2017	2018 Request of the Agency
Function Group IV	7	8	11	11
Function Group III	3	3	3	3
Function Group II	3	2	2	2
Function Group I				
TOTAL	13	13	16	16

#### Seconded National Experts

Seconded National Experts	Authorised 2016	Recruited as of 31/12/2016	Authorised 2017	2018 Request of the Agency
TOTAL			2	2

## 4 LIST OF ACRONYMS

Abbreviation	
<b>ABAC</b>	Accrual Based Accounting
<b>ATO</b>	Automatic Train Operation
<b>AWP</b>	Annual Work Plan
<b>AAR</b>	Annual Activity Report
<b>CA</b>	Commitment Appropriation
<b>CAPEX</b>	Capital Expenditure
<b>CBM</b>	Condition-Based Maintenance
<b>CCA</b>	Cross Cutting Activities
<b>CEN</b>	European Committee for Standardization
<b>CENELEC</b>	European Committee for Electrotechnical Standardization
<b>CFM</b>	Call for Members
<b>CSA</b>	Coordination and support action
<b>DOI</b>	Digital Object Identifier
<b>DRIMS</b>	Dynamic Railway Information Management System
<b>EC</b>	European Commission
<b>ED</b>	Executive Director
<b>EN</b>	European Norm
<b>ERRAC</b>	European Rail Research Advisory Council
<b>ERTMS</b>	European Rail Traffic Management System
<b>ETCS</b>	European Train Controlling System
<b>EU</b>	European Union
<b>EUAR</b>	European Union Agency for Railways
<b>FACTs</b>	Flexible AC Transmission Systems
<b>FFFIS</b>	Form Fit Functional Interface Specifications
<b>FIS</b>	Functional Interface Specifications
<b>GA</b>	Grant Agreement
<b>GIS</b>	Geographic Information System
<b>GNSS</b>	Global Navigation Satellite System
<b>GoA</b>	Grade of Automation
<b>H2020</b>	Horizon 2020, EU framework programme for Research and Innovation
<b>IA</b>	Innovation Action
<b>ICT</b>	Information and Communications Technology
<b>IEC</b>	International Electrotechnical Commission
<b>IKAA</b>	in-kind contributions to additional activities
<b>IP</b>	Innovation Programme
<b>IPR</b>	Intellectual Property Rights
<b>ISO</b>	International Standardisation Organisation
<b>IT</b>	Information Technology
<b>ITD</b>	Integrated Technology Demonstrator
<b>JTI</b>	Joint Technology Initiative
<b>JU</b>	Joint Undertaking
<b>KPI</b>	Key Performance Indicator

<b>LCC</b>	Life Cycle Cost
<b>LIDAR</b>	Light Detection and Ranging
<b>LTE</b>	Long-Term Evolution (standard for wireless communication)
<b>MAAP</b>	Multi-annual Action Plan
<b>MB</b>	Moving block
<b>NLOS</b>	non-line-of-sight
<b>NTP</b>	Network Time Protocol
<b>OC</b>	Open Call
<b>ODM</b>	Operational Data Management
<b>OPEX</b>	Operating Expenditure
<b>PA</b>	Payment Appropriation
<b>R&amp;I</b>	Research and Innovation
<b>PPP</b>	Public Private Partnership
<b>PRM</b>	Persons with Reduced Mobility
<b>PTC</b>	Positive Train Control
<b>PTI</b>	Platform Train Interface
<b>RAL</b>	Unpaid amount
<b>RAMS</b>	Reliability and Maintainability System
<b>RBC</b>	Radio Block Centre
<b>RFID</b>	Radio Frequency Identification
<b>RIA</b>	Research and innovation action
<b>RoI</b>	Return of Investment
<b>S2R</b>	Shift2Rail
<b>SC</b>	Scientific Committee
<b>SME</b>	Small and Medium Enterprise
<b>SNE</b>	Seconded National Expert
<b>SPD</b>	System Platform Demonstration
<b>SRG</b>	States Representatives Group
<b>SWL</b>	Single Wagon Load
<b>TAF</b>	Telematic Application for Freight
<b>TAP</b>	Telematic Application for Passengers
<b>TCMS</b>	Train Control and Monitoring System
<b>TC</b>	Tender Call
<b>TD</b>	Technology Demonstrator
<b>TL</b>	Train Load
<b>TMS</b>	Traffic Management System
<b>TRL</b>	Technology Readiness Level
<b>TSI</b>	Technical Specifications for Interoperability
<b>UAV</b>	Unmanned Aerial Vehicle
<b>WA</b>	Work Area

## 5 ANNEXES

### ANNEX I - 2018 Call for proposals for the JU members – Topic descriptions

#### S2R-CFM-IP1-01-2018 Development of technology demonstrators for the next generation of traction systems and adhesion management systems

##### Specific Challenge:

There are two main specific challenges concerning traction systems and management of wheel/rail adhesion.

##### **1. Traction systems**

The Traction Drive sub-system is one of the main sub-systems of a train as it moves the train converting energy from an electrical source (directly or via a chemical source) into a mechanical one.

The physical domains to master are multiple: electrical, mechanical, thermal, and control. A large number of norms and regulations have to be taken into account for traction systems design, manufacturing, validation and certification. The challenges, at this point, are:

- to master technologies breakthrough developments like Silicon carbide (SiC) semi-conductors applied to different railways traction applications and wheel independent rotating wheels for high-speed trains (HST);
- to develop and contribute to implementing new methodologies, tools, norms & standards of noise, reliability, virtual validation and certification, smart maintenance.

These challenges were preliminarily undertaken by previous projects ROLL2RAIL<sup>29</sup> and PINTA<sup>30</sup> at low TRLs. In the AWP 2018, the developments shall reach higher TRLs.

##### **2. Adhesion**

The wheel-rail contact is normally not only a great source of uncertainty in the prediction of braking distances, but it can constitute a general bottleneck for the achievable braking effort of the train – and to a substantial degree for the tractive effort as well. Due to environmental as well as technical issues, the properties of this rail-wheel contact are highly variable. This affects a large number of rail traffic characteristics, like headways, punctuality and especially safety. The challenge is to develop a proper mapping of different adhesion conditions occurring in rail traffic, and the investigation of the effect of methods to modify basic adhesion, in order to achieve optimal traction and braking effort in the future.

This challenge was preliminarily undertaken by previous project PINTA (S2R-CFM-IP1-01-2016) at low TRL. In the AWP 2018, the developments shall reach higher TRLs.

##### Scope:

The ongoing work in PINTA is expected to deliver by the start date of the present Research and Innovation activities the following expected results:

- specifications on five applications (tramway, metro, sub-urban, regional and high-speed trains (HST)) both for new solutions and refurbishment markets, including traction spare parts obsolescence management. The update of marketing needs on all five targeted applications (tramway to HST);

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<sup>29</sup> [www.roll2rail.eu](http://www.roll2rail.eu)

<sup>30</sup> [http://projects.shift2rail.org/s2r\\_ip1\\_n.aspx?p=PINTA](http://projects.shift2rail.org/s2r_ip1_n.aspx?p=PINTA)

- new hardware and software traction components and sub-systems (especially Silicon Carbide based but also independently rotating wheel architecture for HST) customised for different market segments.
- methodologies and tools for noise emission prediction and reduction (noise levels and tonal noise, electromagnetic, aerolic and EMI noise) for traction sub-system, components and parts (ex.: fans) in all phases of vehicle use including parking mode.
- methodologies and tools to increase traction system reliability and smart maintenance.
- methodologies for virtual validation and certification of traction systems, as well as tools for Traction KPIs and Traction local performance indicators quantification by simulation of energy consumption.
- pre-standardisations for new solutions & new technologies-adhesion
- adhesion management tools and solutions for braking to map different adhesion conditions occurring in rail traffic. The activities contribute to the formulation of new performance specifications for Adhesion Recovery Systems. Requirements for Wheel Slide Protection (WSP) test procedures followed by new specifications for Automatic Test benches.

In order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP:

1. Traction (TD1.1)

- **Traction solution developments** : Based on experienced gained in and the expected results achieved by the start of the present activities in PINTA , the development of new hardware and software traction components and sub-systems (especially Silicon Carbide based but also independently rotating wheel architecture for HST) customised for different market segments (urban, regional, HST) should reach TRL5 to6. The Independently rotating wheel architecture should focus on low floor solutions.

The Traction solution developments will include the development of solutions for energy savings as well as specific maintenance solutions for train applications (Condition Based Monitoring of traction components, remote diagnostic, on-board and/or off-board software, etc.), leading up to the preparation of “smart-maintenance of traction systems” application to be implemented into the S2R Traction demonstrators.

The LCC definition and KPIs quantification will require cooperation between consortium partners and in particular between manufacturers and operating companies.

Identify and –propose measures to address possible barriers to innovation implementation (norms, cultural habits, etc.). Continue test bench tests and assess their results on the S2R and PINTA defined KPIs (Capital cost, maintenance cost, energy cost, reliability, weight, volume, noise of traction system and/or traction components).

The work should include the development of prototypes of inverter blocks in SiC-technology for Urban AC- and DC-lines, with improved high reliability and prepare propulsion system tests to validate the results on the KPIs.

The work should also be the continuation of the development of the SiC Traction on Regional train application and HST motor wheel completion.

- **Traction Noise** : Based on experienced gained in PINTA and FINE-1 (S2R-CFM-CCA-02-2015), continue to develop and implement methodologies and tools for acoustic noise emission prediction and reduction (noise levels and tonal noise, electromagnetic, aerolic and EMI noise) for traction sub-system, components and parts (e.g. fans) in all phases of vehicle use including parking mode.

Realize a traction motor cooling prototype design for low & optimized acoustic noise with a target of verifying the new design in lab environment (TRL4).

Continue further improvements on EMI emissions of urban traction systems with SiC converters. Validate traction converter EMI noise simulation compared to prototype measurement.

- **Traction Reliability/availability:** Based on the results of the first phase of PINTA, Continue to develop methodologies and tools to increase traction system reliability, availability, in particular, use real operator data and return of experience as much as possible.  
 Continue further improvements in converter reliability concerning SiC modules, reduction of traction failure, smart maintenance and generic approach due to digitalized system features.  
 Implement a proof of concept for a “data observation system”, dedicated to gather Traction system and components variables (ex : current, voltage, operating temperature, vibration, etc.) and process them by specific algorithms to point out failures before they could happen.(TRL3). Extend it from propulsion related components also to train control components.
- **Traction virtual validation & certification:** Based on the experience gained in PINTA (like requirement specifications for virtual validation tools and concept specification for simulations; first proposals of new methodologies for validation), continue to develop the methodologies & tools for virtual validation and certification of traction systems, with the ambition to apply SIL tests (Software in the Loop) to cover the complete traction control system and combine with vehicle level TCMS.
- **Pre-standardisation:** Based on the experience gained in PINTA (first progress towards more standardization on –for example- virtual certification, virtual validation , predictive maintenance data transmission, Traction Life Cycle cost validation) continue to perform pre-standardisations task for new solutions & new technologies (e.g. new insulation material, sensors network, etc...), prepare normative evolution via cooperation with S2R Cross Cutting Activity Area “Standardisation” and all needed normative bodies.

## 2. Adhesion (TD1.5) :

The work should include the further continuation of adhesion data collection with an innovative method/ device (search for available methods/ devices has been done in PINTA) that could be developed and/or tested, expected low TRL level like laboratory prototype (TRL2-3). This would be a continuation of PINTA.

Development of adhesion management product and/or system prototypes up to TRL5-6 for braking and traction in order to handle different adhesion conditions occurring in rail traffic, e.g. by positively influencing the wheel/rail contact. Basis for these developments are the proposals for normative changes defined in PINTA.

These could for example comprise real-time adaptive algorithms of the wheel slide protection system (friction brake/ ED-brake) improving the control dynamically based on the experience gathered within PINTA. The adhesion related knowledge also gathered during the previous PINTA project should be used for the development in order to optimise operational cycles in future rail traffic (e.g. by guaranteeing reduced braking distances).

In order to benefit from the shorter braking distances, an analysis of the impact on rail operation (TRL2-3) should be done. The developed solutions for handling of challenging adhesion conditions could be also assessed concerning their compliance to performance specification for Adhesion Recovery Systems defined in the project PINTA (S2R-CFM-IP1-01-2016).

- In view of the above, available results of the Shift2Rail project PINTA (S2R-CFM-IP1-01-2016) shall be the basis for the following research and innovation activities.

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-01-2018. Virtual certification & Smart Planning

As specified in section 2.3.1 of S2R AWP for 2018, 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 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 previous S2R Lighthouse project Roll2Rail and PINTA project (S2R-CFM-IP1-01-2016) have defined seven Traction KPIs (capital cost, maintenance cost, energy cost, reliability, noise, weight, volume of traction sub-system) directly linked with S2R KPIs. The long-term quantified performance targets have been described.

The most significant quantitative benefits of the present Action brought by new technologies, methodologies and simulation tools developed within this action will include the regular quantification of Traction & Adhesion KPIs improvements progress toward previously described targets:

- A reduction of the traction system validation/certification duration and costs through simplification, harmonization of rules and replacing very expensive "on site" certification tests through more cost efficient simulations and/or static bench tests;
- A reduction in maintenance costs, thanks to high reliability and "maintenance oriented design" components and traction sub-system hardware completed by smart maintenance;
- A potential increase of line capacity thanks to low noise traction & improved adhesion management systems shortening braking distances of trains.
- A reduction in traction energy consumption thanks to the use of higher energy efficiency technologies, significant weight reduction.
- Traction & Brakes Noise reduction thanks to the application of methodologies of noise emission prediction, new low noise solutions on Traction components and new brakes solutions on adhesion management;
- Further important impacts can also be expected in the domains of train capacity thanks to traction components volume savings.
- Finally, the Life Cycle Cost will be reduced thanks to a specific focus –in complement with energy and maintenance- on the reduction of capital cost of the Traction & Adhesion management systems.

The research and innovation activities results shall be brought in the form of a demonstrator in the context of InnoTrans 2020 that it should be specified in the answer to the call, including on the S2R JU stand.

Type of Action: Research and Innovation Action

## **S2R-CFM-IP1-02-2018 Implementing new technologies for the TCMS**

### Specific Challenge:

Shift2Rail's CONNECTA project (S2R-CFM-IP1-02-2016) together with its complementary action SAFE4RAIL (S2R-OC-IP1-02-2016) have been researching on new technologies to shape the next generation of train control and monitoring systems (TCMS).

By the start of the present research and innovation activities, CONNECTA is expected to deliver:

- Implementation and validation of a number of use cases for the new train-to-ground standard communication based on the IEC61375-2-6;
- Assessment of the performance in the field of the wireless train backbone network based on the LTE communication technology under real operational conditions;
- Development of the high level network architecture supporting the "Drive-by-Data" concept, to allow the integration of safety-critical functions within the TCMS;
- Definition of a number of application profiles and its general methodology;
- Architecture and communication principles of the functional open coupling, together with applicability studies to a certain number of functions;
- High-level functional architecture of the "Functional Distribution Framework" middleware to allow the integration of functions in reduced number of on-board CPUs;
- ETB and ECN conformance test definition and a proof-of-concept implementation; Development of the needed architecture for the TCMS simulation framework and tools to deploy the virtual homologation, and;
- Specifications and high level architectures for the new safe brake control electronics, ensuring consistency with the requirements for the safe TCMS networks.

In order to progress towards the expected radical change in the TCMS paradigms, the proposed technologies have to be implemented in a relevant environment, so that they could be validated in a later and final stage.

### Scope:

In order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP (TD 1.2 and TD 2.1). :

The Action should implement two laboratory demonstrators (TRL 4/5), one for mainline application and the other one for urban application. Both demonstrators should be the basis for their future validation and later deployment on real vehicles within the following and final stage of the MAAP.

The following technologies should be implemented in at least one preferably in both laboratory demonstrators:

- Drive-by-data concept (i.e. SIL4 capabilities for TCMS) including the integration of at least one on-board safety related function (TRL 4).
- Functional distribution framework, through an integrated modular platform, including the integration of third party's functions by the Complementary Grant (TRL 4).
- Functional Open Coupling in the mainline demonstrator, including a heterogeneous networks environment (TRL4).
- Interoperability tests for the wireless Ethernet train backbone, with the support of the Complementary Grant, in the mainline demonstrator (TRL 5).
- Completion of the virtual homologation's simulation framework, its tools and the train virtualisation, including remote hardware-in-the-loop. Application of the simulation framework in both demonstrators (TRL 4).

To support the implementation of both demonstrators, the virtual homologation's simulation framework, its tools and the train virtualisation, including remote hardware-in-the-loop, will be completed.

In parallel, the following activities should be carried out, and when possible, integrated in the laboratory demonstrators:

- Development of new application profiles (TRL 4).
- Evolution studies of the IEC 61375-2-6 (TCN train-to-ground standard) for merging the link with the new signalling communication technologies developed within X2RAIL-1 (S2R-CFM-IP2-01-2015) and its successors (TRL 2/3).
- With the support of the new TCMS technologies, concepts, architectures and interfaces for the driver machine interfaces (DMI), including safety related ones, will be developed and prototyped. A starting point will be the technical report CENELEC TR 50542-1 Railway applications - Driver's cab train display controller (TDC) and the related documents, which should be completed and complemented (TRL 3/4).

The project results will support the evolution of related IEC 61375 standards to integrate the drive-by-data network architecture, integrated modular platform interfaces, new application profiles and any other technology part of the Action.

- The results of the Shift2Rail projects CONNECTA (S2R-CFM-IP1-02-2016), SAFE4RAIL (S2R-OC-IP1-02-2016) and X2RAIL-1 (S2R-CFM-IP2-01-2015) shall be the basis for the following research and innovation activities.

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-IP1-01-2018: Technical solutions for the next generation of TCMS
- S2R-OC-IP2-01-2018 - Analysis for Moving Block and implementation of Virtual Coupling concept
- S2R-CFM-IP2-01-2018: Advanced Signalling, Automation and Communication System

In particular, this action shall closely work with the action stemming from the complementary open call, to ensure integration of projects' results into S2R solutions.

As specified in section 2.3.1 of S2R AWP for 2018, 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 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 Action will contribute to the implementation in a relevant environment, for mainline and urban railway applications, of:

- The Functional Open Coupling to improve capacity, flexibility and to reduce LCC;
- The Drive-by-Data concept, including the elimination of train lines, the integration of safety-critical functions (like signalling) and therefore obtaining a LCC reduction and operational reliability improvement;
- The Functional Distribution concept, together with the Integrated Modular Platform, leading to a reduction of LCC and improvement of operational reliability;

- The Virtual homologation simulation framework and its supporting toolbox to enable further reductions in LCC.
- The interoperability of the proposed wireless Ethernet Train Backbone, to reduce LCC, increase operational reliability and capacity, by adding flexibility to the system.

As a consequence, the Action will implement technologies to support the Virtual Coupling concept, and provide inputs to concerned standards (e.g. IEC 61375, CENELEC TR 50542-1).

The research and innovation activities results shall be brought in the form of a demonstrator, if available, in the context of InnoTrans 2020, including on the S2R JU stand.

The overall final objective is to ensure convergence/consistency in the solutions adopted in the S2R programme.

Type of Action: Research and Innovation Action

## **S2R-CFM-IP2-01-2018 - Advanced Signalling, Automation and Communication System (IP2 and IP5)**

### Specific Challenge:

Technological developments foreseen under the Innovation Programme 2, building on the results obtained in the project X2Rail-1 (S2R-CFM-IP2-01-2015), require to assess and initially demonstrate how new technologies challenge the traditional signalling principles for a drastic change in railway operations. This covers innovation built around Communications, Moving Block, Testing Methodologies and Cyber Security as well as investigation of the application of new Advanced Signalling concepts such as Virtually Coupled Train Sets. Additionally, The Freight ATO demonstration activities of WP1 in ARCC (IP5) and of WP4 in X2Rail-1 (IP2) requires engineering and planning support to realise the planned GoA2 demonstrator.

### Scope:

In order to address the challenges described above, the proposals should address one or all of the following main work streams (main work stream 1 and/or main work stream 2), in line with the S2R MAAP:

#### Main work stream 1

1. **TD2.1 - adaptable communication:** Demonstrate, via the integration of the different prototypes into dedicated demonstrators, that a new Communication System will be able to overcome the shortcomings in current ETCS and CBTC communications and deliver an adaptable communications system usable for train control applications in all market segments. The solution will use IP-based technologies as convergence for all the radio access technologies (GPRS, EDGE, LTE, Satellite, Wi-Fi, etc.) into a bearer independent solution. It should demonstrate the multi-bearer access capabilities of the system that will enable an easy migration from legacy systems, providing enhanced throughput, safety and security functionalities to support the current and future needs of signalling systems, and be resilient to interference and open to radio technology evolution. The demonstrator will take into account the specifications and guidelines coming from X2Rail-1. As such, it will support the business case study enabling the potential shift from “network as an asset” to “network as a service” model vision for all railways. It will validate via the lab testing activities the potential of communication layer for all communication needs and combines different access networks into a unified communication system.
2. **TD2.3 - Moving Block:** the scope is to move beyond the laboratory demonstrations undertaken in the framework of the X2Rail-1 project, to create technical demonstrators in representative railways environments. The action will also include the investigation of the processes required for testing Moving Block systems, in collaboration with the action to be funded under S2R-OC-IP2-01-2018. Finally, the action will also maintain the results stemming

from X2Rail-1, as more information will be made available from the application of Moving Block in representative railway environments.

3. **TD 2.6 - zero on-site testing:** In the context of the simulation and testing framework integrating new functionalities such as moving block/satellite positioning, the action should finalise the general architecture, the communication model and will a well perform validation in a testing environment. The objective is to reach a simulation environment able to support automated laboratory testing, which will reduce dramatically the need to perform them on the trackside. The work will also take forward the activities started in X2Rail-1.
4. **TD 2.8 - Virtual Coupling:** the action should perform a comprehensive study focusing on the new concept of “Virtual coupling”, which foresees that trains will be able to run much closer to one another (within their absolute braking distance) and to dynamically modify their own composition on the move (virtual coupling/uncoupling of train convoys). This should be achieved while ensuring at least the same level of safety currently provided. The action has for objective to define the behaviour, the system, the architecture, the functions, the real feasibility & applicability, the potential performance increase to be achieved as well as the safety level.
5. **TD 2.11 - Cybersecurity:** In the context of Cyber Security, the main objectives are:
  - to define a “Cyber-Security” System dedicated to railway to ensure high availability, authentication and integrity of the railways system by preventing attacks or errors;
  - to contribute to a “Security-by-Design” standard applicable to railway application to reduce the infrastructure and maintenance costs of railways operators and improving time to market, compatibility and interoperability;
  - To develop a network of Railway Cyber Security Experts as basis of a CSIRT (Computer Security Incident Response Team) dedicated to railways (R-CSIRT).

Benefits from the implementation of the results generated by these activities cover cost reductions, security improvement, integration on IT systems network across Europe, cost reductions linked to maintenance, reduction of the time to market.

## Main work stream 2

6. **TD5.6 - Autonomous train operation:** in the context of freight Autonomous train operation (, the main objective is:
  - To support the Freight ATO demonstration activities of WP1 in ARCC (IP5) and of WP4 in X2Rail-1 (IP2) which requires engineering and planning support to realise the planned GoA2 demonstrator.

The Main work stream 2 activities are expected to request a contribution of indicatively 11% of the total topic activities

The proposals should address more in particular with reference of the workstream mentioned above:

1. In the framework of the introduction of new Communication technologies in railways (TD2.1) the activities are expected to cover the following points:
  - a. Finalize all the prototypes development based on the specifications developed in X2Rail-1.
  - b. Integrate them in order to develop the Main line/High-Speed line, Urban/Suburban line, Regional/freight line demonstrators, supporting signaling data, voice services and EIRENE functionalities.
  - c. Validate, with the support of the radio access emulator tool to be developed by the action to be funded under the call S2R-OC-IP2-03-2018, the multi-bearer capability of the Adaptable Communication System via lab testing activities.

- d. Validate the capability of the Adaptable Communication System to support all type of application (i.e.: ETCS, CBTC, Voice etc.)
- e. Perform validation of the demonstrators via early lab test and provide associated report prior engaging into the last phase, the field test.

Foreseen achievable Technology Readiness Level: TRL5.

2. In the framework of the introduction of Moving Block technologies (TD2.3) the activities are expected to cover the following points:
  - a. Creation of a Moving Block Technical Demonstrator for Urban/Suburban Railways;
  - b. Creation of a Moving Block Technical Demonstrator for Moving Block Overlay Systems;
  - c. Creation of a Moving Block Technical Demonstrator for High Speed Lines;
  - d. Creation of a Moving Block Technical Demonstrator for Low Traffic and Freight Lines;
  - e. Work to create a testing strategy for Moving Block signalling systems;
  - f. Work to maintain the results from X2Rail-1 for Operational and Engineering Rules, and for System Specifications, based on feedback from the Technical Demonstrators;
  - g. The work on a Testing Strategy for Moving Block signalling systems will be done in collaboration with the action to be funded under the topic S2R-OC-IP2-01-2018.

Foreseen achievable Technology Readiness Level: TRL6.

3. In the framework of the introduction of new testing and simulation technologies (TD2.6), the activities are expected to take further the activities started X2Rail-1. In this respect, the work stream should cover the following points:
  - a. completion of the general architecture, including the integration of the open call results;
    - i. Align defined high-level architecture based on the first results and requirements from the actions started in X2Rail-2 (S2R-CFM-IP2-01-2017), i.e. the Traffic Management Integration Layer;
    - ii. Include available results and definitions from previous projects (e.g. VITE).
  - b. communication model definition in line with the communication environment defined in TD2.1;
    - i. Specification of test scenarios and test cases;
    - ii. Specify higher levels of communication protocols;
    - iii. Standardized interfaces and collaborative definition of inter-application for end-to-end data exchange.
  - c. developing and validating the testing environment taking independent assessment and continuous update / upgrade of the test environment into account;
    - i. Integrated simulation capabilities including the simulation of operational scenarios, production plans and infrastructure data;
    - ii. The test environment shall support distribution and virtualization as well as test automation for conducting and evaluating tests.

Foreseen achievable Technology Readiness Level: TRL6.

The work stream should foresee a close collaboration with system integrators, assessors and with ERA.

Due to the methodologies to be used, a strong link to the project X2Rail-2 and specifically focusing on Formal Methods, is expected.

4. In the framework of the introduction of the Virtual Coupling concept (TD2.8), the activities are expected to cover the following points:
  - a. Definition of the concept: The activity should address the concept of Virtual Coupling in terms of basic principle, system behaviour, system boundary, system architecture,

according to the different operating scenarios to be chosen and developed. Taking into account the results of the related Open Call, the analysis should cover new ideas and insights for the needed infrastructure for Train-to-Train (T2T) and Train to Wayside (T2W) communication.

- b. Safety and performance analysis:
  - i. The activity should analyse the hazards linked to the Virtual Coupling concept. For each market segment (Main Line, High-speed line, Regional, Urban/Suburban, Freight), the analysis has to take into account the new risks introduced by the new concept. Those risks can be technical (e.g. train characteristics, braking rate, delay of communications, etc.), they can be linked to the infrastructure (e.g.: impact of gradients, curves, tunnels etc.) or on operational procedures of the staff and the behaviour of the end-users behaviour, all of which can have an impact on the safety of the system. Specific attention should be paid to analysing the occurrence rate of potential events like derailment of a train part of a Virtually Coupled convoy or of cars jailed in the level crossing area. In addition, a detailed analysis should be performed in order to identify the risks associated to degraded situations (e.g.: failure impeding the use of all the necessary functions).
  - ii. The activity should also focus on the performance, the capacity improvement and the risks involved for a set of common operational/traffic scenarios. The analysis should investigate the application of VCTS in all the market segments (Main Line, High-speed line, Regional, Urban/Suburban, Freight) taking also into account scenarios in which different trains can run on the same line, controlled by different signalling systems (mixed traffic). The objective is to identify the operational scenarios where VCTS is effective and to is the real potential capacity improvements VCTS can bring. A clear identification of the pros/cons for each operational/traffic scenarios in terms of performance and associated risk(s) is also expected to be performed. The impact on performance and safety of variations in parameters like communications delays, brake performance and differences in brake performance, location accuracy, track data accuracy and weather conditions must be considered in all the safety and performance analysis. Performance analysis could also take advantage from the application of simulators/emulators that can help understanding the system and dynamics behaviour.
- c. Feasibility analysis. Based on the Safety and Performance Analysis, the action should investigate the technical feasibility, the applicability of some aspects and parts of the system, which have been assessed as critical for the accomplishment of the project (e.g. what radio system / network could be used, its availability, including those of frequencies, as well as the cost of installation and operation). The action should measure the reasonable trade-off between safety and performance in order to reach the necessary capacity improvement (e.g.: definition of the minimum number of trains to be upgraded to VCTS in order to improve the line capacity; identification of the impact on both operational rules and capacity if only a few or no trains have VCTS). The way to foster and introduce VCTS should also be analysed; specific and potential obstacles to the introduction of VCTS also have to be identified (e.g.: difficulties to accept the new signalling paradigm by the Railway Undertakings and Infrastructure Managers).
- d. Functional Architecture, SAS and FRS. Given the previous analyses, the action has to provide the System Architecture Specification and the Functional Requirement Specification in order to outline the functional behaviour and the potential architectural structure.
- e. Functional Architecture FIS. Based on the SAS and FRS, the action has to provide the Functional Interface Specification for the main defined interfaces identified in the architecture.

- f. Impact analysis. Given the full definition of the system architecture, the action must identify the major impacts on the existing signalling system due to the application of VCTS. It is essential to quantify the necessary technical modifications/adaptations and the related expected cost the introduction of VCTS will bring (e.g.: on Interlocking, Radio Block Centre, Traffic Management System, Automatic Train Protection, Automatic Train Operation, Communications, infrastructure, etc.) in addition to changes linked to operational and engineering rules, maintenance, training and public education.

Foreseen achievable Technology Readiness Level: TRL3.

5. In the framework of the introduction of Cyber Security (TD2.11) the activities are expected to cover the following points:
  - a. Take further and finalise the tasks started in X2RAIL-1 regarding the final specifications of the “Security-By-Design” and “Cyber-Security Management System” standards. The specific assessments of the security and safety impacts issued X2Rail-1, as well as the procedures identified in order to apply the chosen standard for the railway protection profile requirements. Finally, a consultation with competent organisations (e.g. CENELEC) safety and security aspects should be foreseen to ensure consistency of the chosen approach for railways at European level. The deliverable should specify:
    - i. The architectures, protocols, interfaces and procedures to be applied to all communicating assets across the networks dedicated to signalling systems and railway infrastructure to ensure the security level of the railway system;
    - ii. The common security assessment guidelines and methodologies for Operators, National bodies, System integrators and Providers. In addition, a global taxonomy and common methodology for impact assessment agreed and approved by all stakeholders should be included;
    - iii. A set of requirements and/or guidelines as result of the application to railway signalling and communication context of the selected “Security-by-Design” standard.
  - b. Take further and finalise tasks started in X2Rail-1 by completing the design and first integration of both the “Cyber-Security System” and the “Security-by-Design” demonstrators. The proposed technical demonstrators will illustrate how the “Cyber-Security System” shall manage threats and incidents during operation after implementation in a railway signalling environment. The “Security-by-Design” demonstrator will show how to fulfil the protection profile requirements defined in X2Rail-1 with the expected level of maturity. Future IP2 projects will further develop the demonstrators implementing the selected functions delivered in the scope and functional specifications provided by X2Rail-1.
  - c. Specify the Railway CSIRT which implies:
    - i. The creation of a group of experts from all needed disciplines which will develop the dedicated model and glossary for a railway CSIRT able to communicate under a common terminology and taxonomy;
    - ii. Specification of CSIRT demonstrator environment to gather a holistic view on the incorporated systems and their interdependencies by including specifically tailored workflows and knowledge on the subject, merging thus the know-how of the group of experts from previous task;
    - iii. Identification of information sources, network architecture and participate to the analysis of the sub-system dependencies which will be the basis of a collaborative tool for CSIRT security information exchange. This multiple environment of CSIRTs will be able to share their findings in an easy and comprehensive way. The result of this activity is a demonstrator of a

collaborative CSIRT environment with at least two to three existent CSIRT-partners interacting between each other.

Foreseen achievable Technology Readiness Level: TRL4.

6. In the framework of “Freight ATO demonstration” (TD 5.6), the activities are expected to support the implementation of the planned (ARCC, WP4) ATO demonstration with GoA2 through:
  - a. Development of a “converter solution” to connect available ATO modules to ETCS baseline 2
  - b. Necessary adaptation of locomotive control for optimized mainline running
  - c. Planning for tests
  - d. Making available of an interoperable HMI
  - e. Integration of different ATO modules

Foreseen achievable Technology Readiness Level: TRL6.

Most of the activities of this work area will need to set up a collaboration with ERA in order to evaluate the potential impacts of the work streams on the current ERTMS/ETCS specifications, included in the CCS TSI.

- 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-IP1-02-2018: Validation of new technologies for the TCMS.
- S2R-CFM-IP5-01-2018: Technology demonstrators for competitive intelligent rail freight.
- S2R-OC-IP2-01-2018: Analysis for Moving Block and implementation of Virtual Coupling concept.
- S2R-OC-IP2-02-2018: Modern methodologies and verifications for GNSS in Railways and virtual test environment.
- S2R-OC-IP2-03-2018: Communication environment assessment and validation.
- S2R-OC-IP2-04-2018: Study on alternative communication bearers in the railway environment.

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

- S2R-CFM-IP2-01-2015: Start-up activities for Advanced Signalling and Automation System.
- S2R-CFM-IP2-01-2017: Enhancing railway signalling systems thanks to applying satellite positioning; developing an on-board safe train integrity; applying formal methods approach and standardised interfaces, and enhancing traffic management system (TMS) functions.

As specified in section 2.3.1 of AWP 2018, 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 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, the actions are expected to contribute to:

- LCC reduction (through sharing of the communication network and possibility using public network);
- additional service performance and support of capacity increase where the performances of the currently-deployed telecom system is creating a bottleneck;
- demonstrate the possibility to integrate a number of heterogeneous radio access technologies and communication networks into one solution, showing how the concept of radio bearer independency allows a smooth and low cost migration between successive generations of radio technologies, and can be completely transparent for the signalling application within the different railways segments.

Regarding the work stream 2, the actions are expected to contribute to:

- An increase in the Technology Readiness Level (TRL) for Moving Block signalling systems on main line railways;
- Enabling the demonstration of the potential benefits of Moving Block systems;
- Enhancement of the Operational and Engineering Rules and System Specifications for Moving Block Systems, based on feedback from Technology Demonstrators.

Regarding the work stream 3, the actions are expected to contribute to:

- Increasing of operational efficiency;
- Reducing the effort spent and time consumed for (system) testing as well as tests related to upgrades brought to the system;
- Optimizing the installation cycles decreasing the impact on service operation while upgrading the system.

Regarding the work stream 4, the actions are expected to contribute to:

- Increasing line capacity without the need to change and expand the infrastructure. VCTS can increase line capacity with more than 100%, possibly 300%.
- Introducing “Flexible signalling” which will allow dynamic approach of train control whereas on board systems will become even “smarter”. That must also be seen in a network in which each signalling element will exchange the rights and the information to perform functions with other signalling elements of the network;
- Open new horizons where signalling system would move to a Train Centric solution in which the traditional signalling logic (e.g. interlocking) could be shared and activated by on-board subsystems, when needed.

Regarding the work stream 5, the actions are expected to contribute to:

- Common an standardised architecture, interface and protocol specifications for interoperable railway network;
- Common up-to-date Cyber Security approach for railway systems, including common security and impact assessments, threat landscape and security-by-design guidelines;
- Investigation and monitoring tools dedicated to the railway Cyber Security System;
- Setting up of Railway CSIRT;
- Model of collaborative environment dedicated to the Railway CSIRT;
- Prototype of Railway products/applications using the Cyber Security System, applying the security profiles and implementing the security-by-design guidelines dedicated to railway.

Regarding the work stream 9, the actions are expected to bridge the activities of ARCC and X2Rail-1 and to eliminate unforeseen obstacles on the way to the planned Freight ATO demonstrator with GoA2. Hence, the impact of the work stream will facilitate the impact of ARCC towards increased efficiency on the main railway lines and nodes, reducing lead time and costs:

- 20% energy saving thanks to automatically optimised acceleration and braking patterns for rail freight profiles;
- 50% increase in production capacity, doubling the throughput through infrastructure by reducing required headway (the distance between trains on the network);

- 50% reduction in costs for operating systems.

The research and innovation activities results shall be brought in the form of a demonstrator in the context of InnoTrans 2020, including on the S2R JU stand.

The overall final objective is to ensure convergence/consistency in the solutions adopted in the S2R programme.

Type of Action: Innovation Action

## **S2R-CFM-IP3-01-2018 - Research into optimised and future railway infrastructure**

**Specific Challenge:** In the coming years, we can expect a strong growth in rail transport demand, accompanied by aging infrastructure and growing effects of climate change.

With respect to the rail infrastructure, in order to face these demands, this call consists of research work aiming at enhancing, optimising and developing switches & crossings (linked to TD 3.1 Enhanced switch & crossing system demonstrator and to TD3.2 Next generation switch & crossing system of the S2R MAAP) as well as track systems (linked to TD 3.3 Optimised track system and TD3.4 Next generation track system of the S2R MAAP) including drainage management, in order to ensure optimal line usage and capacity.

The call also includes research on extending the life of bridges and tunnel assets (directly linked to TD 3.5 Proactive bridge and tunnel assessment, repair and upgrade demonstrator of the S2R MAAP) through better approaches for assessing, maintaining, repairing and upgrading these structures. The focus should be on proactive maintenance and operation of all these assets, considering the needs and costs across their whole life including disruption of service.

### **Scope:**

In order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP:

- Further improve, develop and implement the whole system modelling approaches for track & S&C, to gain an understanding of how alternative asset designs, materials, etc. affect the overall performance of the railway system. The whole system modelling approach will be validated by simulations, which will enable faster implementation of new technologies by reducing timely and expensive physical testing. A hybrid testing approach will be taken, meaning that state-of-the-art simulation tools, laboratory and field tests will work collectively to provide a whole system assessment (up to TRL 6). In this context the action will make use of developments from earlier S2R IP3 complimentary projects in order to deliver the required tools for the track and S&C demonstrator implementation based on the design for reliability concept. These will use the following principles: Performance, Reliability, Availability and Maintainability and change managed through the Common Safety Method approach.
- Continue development of Track and S&C Technology Demonstrators (up to TRL 6) to meet functional requirements and establish efficient maintenance procedures. This includes modular track and S&C systems, non-ballasted Track Support solutions (*i.e.* slab and Asphalt Track), control of track stiffness variations in transition zones, advanced welding and repair technologies (e.g. induction welding) and the innovative use of materials and advanced manufacturing techniques (e.g. new rail material, additive manufacturing of crossings and other S&C components.) New rail concepts will also be considered, in addition to improving the performance of the current design. These concepts should reduce the environmental footprint such as noise and vibration from traffic as well as other pollution from the life cycle of the railway system.
- Develop proof of concept (TRL3) for a bespoke, localised automatic tamping operation (road-rail type vehicle) to enable localised repair of track geometry deterioration, going beyond the current state-of-the-art techniques, which include the use of large tamping machines that result in the disturbance of 'good' ballast during the treatment of localised track faults.
- Develop proof of concept for ability to monitor European-wide track stiffness in a more efficient way & establish thresholds for maintenance alerts & interventions. This will then be considered

alongside the measuring and monitoring techniques developed in the wider S2R IP3 programme (TRL 3). Current state-of-the-art monitoring techniques can only be deployed on a site by site basis therefore a means of monitoring infrastructure is required to enable predictive and preventative maintenance in Europe, taking into account the relative outcome of the project SMARTE (GA H2020-777627). This will also enable track renewals to be optimised through site prioritisation based upon degradation rates and associated risk.

- Service life extension of bridges and tunnels by a combination of deterioration monitoring, proactive maintenance and upgrading technologies for enhanced performance (up to TRL 6). This includes technology for assessing fatigue consumption, methods to increase bearing and fatigue capacity, ways of mitigation of clogged tunnel drainage pipes, technologies for enhanced optical methods for tunnel inspection, and development of partly autonomous monitoring networks with on-site processing capabilities;
- Continue developing requirements for railway bridges for high speed lines. This includes enhanced understanding of dynamic effects based on tests or simulations in a relevant environment, for example, on a bridge not intentionally built for high speed traffic (up to TRL 5). This will include development of proposals for a modernised design approach including design limits for bridges and the interface with rolling stock, and enhanced knowledge to improve the potential of virtual testing and the tools for compatibility checks between the existing infrastructure and the rolling stock. It is expected that the results will pave the way for the closure of the related open points in the INF TSI. This particular workstream entails collaboration with the European Union Agency for Railways.
- Develop detailed specification including cost benefit and root cause analysis of the importance of effective drainage management within the track system; the impact on track geometry; and methodologies to identify drainage assets across the infrastructure (up to TRL 2). This will assess the true cost of ineffective water management across the industry.
- Develop process for identifying all drainage assets (buried assets); carry out horizon scanning for inspection techniques deployed in other industries for buried assets, to support development of a specification for pro-active inspection of the drainage system. This will involve data gathering, data analysis; and a specification for identification of drainage assets and pro-active inspection techniques for the rail industry to support effective water management (up TRL 3).

This action will build upon the successes and available results of existing and finalised projects, such as In2Track (GA H2020-730841) and S-Code (GA H2020-730849.) This action will take validated and available past projects outputs through to an early system prototype stage. This will run in parallel to incorporating further innovations and technology developments i.e. drainage management. A physical prototype of an enhanced S&C solution will be evaluated and installed for preparation of the final Technology Demonstrator. As part of the installation preparations, safety validation of the final system will be undertaken using the Common Safety Method – Risk Assessment (CSM-RA) process. European railway sites and test facilities will be assessed for hosting the final Integrated Technology Demonstrators (ITD) within future S2R activities.

The action expected to be funded from this topic will be complementary to actions carried out within the following topic:

- S2R-CFM-IP3-01-2016: Research into enhanced track and switch and crossing system (In2Track)
- S2R-CFM-CCA-01-2017 “Improving Railway Services for Users and Operators” (Impact-2)

As specified in section 2.3.1 of S2R AWP for 2018, 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 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 action will result in specifications, the start of Common Safety Method Risk Assessment activities to support deployment of the demonstrators, and production of performance indicators to assess demonstrator performance. The innovative technology developed will enable a change in building and operating railway infrastructure compared to present practised methods. With successful prototypes, capacity and reliability should increase together with reduction of costs for railway transports. Substantial contribution is expected in the following areas:

- Development of a framework for virtual assessment and approval with enhanced prediction capabilities;
- Improved LCC, RAMS and environmental aspects through enhanced design of track and S&C components;
- Design of next generation track and S&C components in order to enhance LCC, RAMS and environmental aspects;
- LCC and RAMS improvements through assessment and management of track and S&C status focusing on key parameters and relevant limits on operational conditions;
- Improved RAMS through monitoring solutions to obtain reliable and objective measures of the asset status;
- Improved RAMS and LCC through advanced maintenance and repair technologies;
- Reduced LCC through service life extension technologies including upgrading solutions for bridges and tunnels;
- Reduced delay costs from ineffective water management (flooding); reduced costs associated with track geometry faults; improved resilience to climate change; improved attractiveness of railway;
- Reduced costs for railway bridges on high speed lines.

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 TD3.1 to TD3.5 in line with the relative Planning and Budget.

The research and innovation activities results shall be brought in the form of a demonstrator and prototype(s) as mentioned here above in the context of InnoTrans 2020, including on the S2R JU stand, to show the impacts intended to be achieved.

**Type of Action:** Innovation Action

## **S2R-CFM-IP4-01-2018 - Passenger service platform specifications for an enhanced multi-modal transport eco-system including Mobility as a Service (MaaS)**

### **Specific Challenges:**

The topic addresses two IP4 Research and Innovation areas described in the S2R Master Plan: the “Multimodal Travel Services” (TD4.2 and TD4.3) and the “Customer Experience Applications” (TD4.4 and TD4.5). Previous research activities focussed on co-modal journeys using the main transport modes such as airways, railways, coach and ferry, and the related business rules. This action must enhance and complement the set of passenger services, integrating other transport modes and their related business rules and more specifically must answer the following challenges:

- Integrate a compatible approach to including Mobility as a Service (MaaS).
- Integrate On-Demand Transport modes (in addition to the modes already addressed: scheduled modes, shared transport modes, some aspects of the personal transport modes) covering the following main aspects: shopping, booking, ticketing, trip-tracking, settlement services, and after-sales/re-accommodation services.
- Validate the entitlement of the traveller throughout the multimodal transportation networks, providing downward compatibility to existing legacy systems for operators joining the eco-system, supporting different payment schemas (pay-as-you-go, card-centric, account-based) and promoting front-end technologies such as NFC (Near Field Communication), EMV (EuroCard MasterCard and Visa) and the use of smartphone.
- Complement the current end-to-end processes focused on a single adult passenger, by integrating Multi User Travel and Group Travel.
- Validate the potential contributions of the most up-to-date technologies of human-machine interfaces for innovative traveller experiences and services.
- Complement the activities already started in previous projects on Business Model/ Contractual requirements/specifications, with respect to Intermodal Travel.
- Ensure continuity by addressing the reuse of all technology contributions developed within the past and current projects falling into IP4 environment, further listed in the present document.

### **Scope**

The action will develop new features starting from the previous business application projects dedicated to TD4.2 Travel Shopping, TD4.3 Booking & Ticketing, TD4.4 Trip Tracking, TD4.5 Travel Companion, and will prepare the inputs for the second release of the IP4-ITD7 demonstration project, scheduled for end of 2020.

In order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP:

- Adopt the IP4 engineering guidelines produced by ITD7 to guarantee the IP4 continuity
- Integrate adequate mechanisms in the IP4 eco-system to take into account the Mobility as a Service (MaaS)
- Develop On-Demand Transport mode(s) aspects, for demand driven public transport and self-driving vehicles
- Develop Shared Transport modes aspects (e.g. shared Car Rides)

- Integrate Multi-User and Group Travel aspects with enhanced customer management.
- Complete contractual and business agreement specifications for Inter-modal travel (with a single contract for several transport legs)

The action must also address all the following aspects impacting specific TDs:

- TD2 – Travel Shopping
  - Develop Complementary Services (e.g. additional luggage, extra seat, change of the ticket class), from a Shopping perspective, to an already existing itinerary / booked offer
  - Developing additional services for demand driven transportation including planning and disposition capabilities
- TD3 – Booking and Ticketing (and settlement)
  - Develop Complementary Services for the booking, ticketing, settlement and after-sales to an existing itinerary / booked offer
  - Provide customer management functionalities for after sales transactions that trigger cancellation, refund, exchange, and where necessary, semi-automated re-accommodation
  - New validation schemes, using new front-end equipment optimizing equipment maintenance and supervision
- TD4 – Trip Tracker
  - Advanced Tracking Services for new modes (e.g. demand driven transport, ride sharing) taking into account alternative source of data and events
  - Better Prognosis of Expected Time of Arrival (ETA) including real-time operational information
- TD5 – Travel Companion
  - Capabilities of sharing data with other stakeholders
    - Other users / travellers, e.g. to be informed about their journey (planned and tracked)
    - Operators, e.g. for a (semi) automated complaint management
  - Make the traveller experience more adaptive to the context evolution by using new technologies:
    - to gather information about the user (e.g. better indoor positioning, deeper integration with cloud services)
    - to communicate information to the user (e.g. augmented reality glasses, Internet of Things devices)
  - Management of entitlements: storage, retrieve, security and fraud prevention, allowing tapping and validation using the travel companion.

The action is expected to reach TRL up to 6.

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

- S2R-CFM-IP4-01-2015: CO-modal journey re-ACcommodation on associated Travel services (Co-Active)
- S2R-CFM-IP4-02-2015: Advanced Travel Companion and Tracking Services (ATTRACTIVE)
- S2R-CFM-IP4-01-2017: Connecting and Analysing the Digital Transport Ecosystem (CONNECTIVE)
- S2R-CFM-IP4-02-2017: COHErent Setup and Demonstration of Integrated Travel Services (COHESIVE)

As specified in section 2.3.1 of S2R AWP for 2018, 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 planned activities of the action should take into account the revised MAAP part A.

Expected Impact:

The most significant benefit of the present Action will be the integration in the urban area thanks to the MaaS approach and complete multimodal and customer-centric services for co-modal journey covering all categories of transport mode: Scheduled, Shared, Private, and On-Demand (long distance and urban).

The action will benefit to the travellers but also to the transport actors. The level and the coverage of the services provided to the travellers will be increased with more modes, extensive set of services in the different TDs, up to date technologies to interact with the user: traveling will become more easy, efficient and pleasant and therefore should indirectly increase the number of travellers. Moreover, thanks to the enriched set of services accessible on the “web of transport”, every transport actor can get an unprecedented visibility on the market place for its co-modal travel offer.

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 TD4.1 and TD4.6 in line with the relative planning and budget.

Expected Type of Action: Innovation Action

## S2R-CFM-IP5-01-2018: Technology demonstrators for competitive, intelligent rail freight operation

### Specific Challenge:

Within the 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. New **Automatic Couplers**, provided with electrical and data transmission functionalities, need to be implemented. The specific challenges of this call are to complete the detailed design, build up a unitary demonstrator and test it on the innovative wagons developed in TD5.3.
2. **Telematics and Electrification** will enable Condition Based Maintenance (CBM). Telematics should contribute to collect, transmit and use the necessary information required by CBM strategy. Electrification should be responsible for supplying the required energy to the telematics by means of the Energy Management System (EMS).
3. **Improved methods for annual and short term timetable planning** and in traffic operations should increase overall capacity and raise punctuality by developing methods and processes in this direction.
4. The work stream of **Real-time network management** aims at reducing or even eliminating inefficiencies by integrating medium to short-term and operational planning at yards/terminals and in the railway network,.
5. Future **freight wagon design** for the core and extended markets as defined in the S2R - MAAP shall contribute to increased reliability of the freight transport while increasing the payload per meter of train.
6. Future main line electric freight locomotives must feature highly flexible **freight propulsion** systems with reduced operational costs. The challenge in this call is to merge all results from the projects FR8RAIL (S2R-CFM-IP5-01-2015) and FR8HUB (S2R-CFM-IP5-01-2017) and demonstrate the performance as well as to evaluate, specify and design the required systems and processes.
7. The freight sector needs to find ways to rapidly decrease unit costs to improve its competitiveness against the road sector. Major boundaries are the readiness of infrastructure for longer trains and the maximum load on the coupling hook, which limits the maximum weights of trains. **Distributed Power** in freight trains could solve this problem by distributing the traction and braking forces **for long freight trains up to 1,500 m**.
8. In order to achieve the advantages with ATO/DAS, the integration with the TMS-system is of importance. **Automated Train Operation (ATO) and Driver Advisory Systems that are connected (C-DAS) to the Traffic Management Systems** in the train control centres of the IM provide means to enhance capacity, improve punctuality and optimize energy consumption of the railway system.

### Scope:

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 “Automatic Coupling” (TD 5.1) should:

- Complete the mechanical and electric design of the Automatic Coupler Demonstrator, based on the concept design developed in FR8RAIL project (S2R-CFM-IP5-01-2015).
- Calculate an estimation of the production costs for an industrialization of the technical solution in Europe.
- Manufacture and assemble the Automatic Coupler Demonstrator.
- Test the Automatic Coupler Demonstrator, in a test bench, to assure that the maximum specified forces are reached without damaging the system. This is a prototype demonstrator operating in a traction-compression test bench, in normal laboratory conditions.

The activity is expected to finish with prototype demonstration in a TRL6 level.

The work expected in work stream 2 concerning “Telematics and Electrification” (TD 5.1) should be based on the results obtained in the projects FR8RAIL (S2R-CFM-IP5-01-2015) and FR8HUB (S2R-CFM-IP5-01-2017) and should cover (TD5.1.3) the integration of the different components and processes defined prior to the validation:

- Telematics integration
  - Specification of the integration of the telematics (WMS, wOBU, FTSMS) within the new wagon (TD5.3) design including new wheels and axles (TD5.3) and within the currently available wagons.
  - Specification of the integration of the telematics with other systems such as Automatic Coupler (TD5.1), Access and Operation (TD5.2) and Novel Terminal, Hubs, Marshalling yards, Sidings (TD5.4).
  - Definition of test scenarios with research vehicles in combination with other systems from Access and Operation (TD5.2) and Novel Terminal, Hubs, Marshalling yards, Sidings (TD5.4).
- CBM integration
  - Specification of a target process including an approval process for diagnosis-based maintenance and a migration-process for all relevant stakeholders.
  - Aggregation of data from locomotive and wagons, comparison actual values and threshold values (system based) and deduction of specific maintenance tasks if threshold value is reached (system based).
  - Integration of the web-interface for train data visualization, incl. a standardized interface for existing external and maintenance systems.

The activities concerning telematics and CBM are expected to validate – proof of concept –the integration of the different components and processes in a laboratory (TRL 4).

The work expected in work stream 3 concerning “Improved Methods for time table planning” (TD 5.2) should:

- Improve methods for timetable planning including aspects of decision support for operational traffic and traffic information that improves both capacity utilization and customer satisfaction of rail freight systems.
- Further develop concepts from the project ARCC (S2R-CFM-IP5-02-2015) into a demonstrator with shared information about ad-hoc planning and daily timetable.
- Testing the concept and impact to rail freight in a demonstrator.

The activity is expected to provide a demonstrator of the proposed concepts in infrastructure management with at least TRL 5..

The work expected in work stream 4 concerning “Real-time network management” (TD 5.2) should:

- Improve interaction between Railway network and yards/terminals including aspects of decision support for operational traffic and traffic information that improves capacity, efficiency and punctuality especially for freight trains.
- Testing the concept and impact to rail freight in a demonstrator.

The activity is expected to provide a demonstrator of the proposed concepts in infrastructure management with at least TRL 5.

The work expected in work stream 5 concerning “Core and Extended Market Wagon” (TD 5.3) should include:

- Structural, aeroacoustical & aerodynamical drag optimized wagon design concept and proof of concept for core and extended market wagon 2020 Optimized (wheel-rail interface, Life Cycle Costs, higher speed, track degradation, noise reduction) running gear design concept and proof of concept for core and extended market wagon 2020
- Standard interfaces definition and integration towards electrification, telematics, CBM as well as autonomous coupling & train operation

The activities for the core and extended market wagon are expected to validate – proof of concept – the impact of the design and the fit with CBM (TRL 4)

Complementary to and building on the results of the work done in the projects FFL4E (S2R-CFM-IP5-03-2015) and FR8HUB (S2R-CFM-IP5-01-2017), the following work is expected in the work stream 6 concerning “Freight Propulsion Systems” (TD 5.5):

- Develop and manufacture functional prototypes for hybrid propulsion systems.
- Validation and measurement of the performance of the hybrid propulsion system prototypes defined, designed and partially developed in the projects FFL4E (S2R-CFM-IP5-03-2015) and FR8HUB (S2R-CFM-IP5-01-2017).

Complementary to the work being done in ARCC, the following work is expected in the work stream 6 concerning “Freight Propulsion Systems” (TD 5.5):

- Define all actions required and performed for a train composition
- Study how these actions can be automated
- Develop a concept for automating the whole process
- Define the systems and process requirement specification
- Develop and construct some selected technologies

The activities concerning Freight Propulsion Systems are expected to validate selected technologies in the laboratory or in a relevant environment with at least TRL 4.

Complementary to and building on the results of the work done in the project FFL4E (S2R-CFM-IP5-03-2015) the work expected in work stream 7 concerning “Long Trains with Distributed Power (DP)” (TD 5.5) should include the following activities:

- Further development of DP-technology for usage in trains up to 1500 m
- Demonstration of DP-technology in 740 m and 1500 m trains

The activity is expected to provide a DP-technology demonstration in a 1,500 m train with at least TRL 6.

The work expected in work stream 8 concerning “ATO/DAS” (TD 5.6) should:

- Analyse the requirements of TMS-users and railway undertakings for real-time data for usage in a Connected DAS and ATO module, making sure that requirements of TMS-users will be taken up by IP2.
- Integrate requirements in the definition of standard interfaces in alignment with other ongoing projects like ARCC and X2-Rail-1 (S2R-CFM-IP2-01-2015), making sure that requirements for the standard DAS/TMS interface will be taken up by IP2 to analyse and utilise them in the design of ATO/TMS interfaces for live data, to create maximum synergies
- Realize first concept and simulation of connected DAS
- Evaluate the impact C-DAS can have on the performance of rail freight

The activity is expected to provide a technology for the exchange of real-time data and its demonstration with at least TRL 4.

Due to the strong link of this work stream with the current and future activities in IP2 and the input that the results of this topic will provide, the succeeding proposal will set up an advisory board with representatives of IP2.

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-IP5-01-2018: Radio communication and simulation of train dynamics for Distributed Power within long trains

This action shall closely work with the action stemming from the complementary open call, to ensure integration of projects' results into S2R solutions.

The action expected to be funded from this topic will also be complementary to actions carried out following the topics:

- S2R-CFM-IP5-01-2015: Development of functional requirements for sustainable and attractive European rail freight
- S2R-CFM-IP5-02-2015: Start-up activities for freight automation
- S2R-CFM-IP5-03-2015: Freight propulsion concepts
- S2R-CFM-IP5-01-2017: Real-time information applications and energy efficient solutions for rail freight
- S2R-CFM-IP2-01-2015: Start-up activities for Advanced Signaling and Automation System
- S2R-CFM-IP2-01-2017: Enhancing railway signaling systems thanks to applying satellite positioning; developing an on-board safe Train Integrity; applying formal methods approach and standardised interfaces, and enhancing Traffic Management System (TMS) functions

As specified in section 2.3.1 of S2R AWP for 2018, 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 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 "Automatic Coupling" are expected to:

- Enable longer trains lengths (up to 1,500m), operating at higher speeds, as a result of increased coupler load transmission capacity.

- Lead to reduced train composition times (up to 30%), and lower operation costs.
- Data and electrical transmission will allow the installation of sensors in the trains, required for an enhanced Condition Based Maintenance, and the possibility to monitor the status of the goods remotely.

The foreseen research activities in work stream 2 “Telematics and Electrification” are expected to contribute to:

- Further advancement of the reliability and efficiency of rail freight based on the results of the projects FR8RAIL (S2R-CFM-IP5-01-2015) and FR8HUB (S2R-CFM-IP5-01-2017);
- A significant reduction of derailments through furthering CBM implementation;
- Reaching a 10% reduction of maintenance operational expenses to increase rail freight business competitiveness.

The foreseen research activities in work stream 3 “Improved Methods for time table planning” are expected to:

- Provide methods that acknowledge the specific needs and opportunities of the rail freight system.
- Provide methods to timetable planning that increase the competitiveness of the rail freight system, while also considering the performance of the total rail system.
- Improve operational capacity utilization, robustness and punctuality by 10-15%.

The foreseen research activities in work stream 4 “Real-time network management” are expected to:

- Provide methods that improve the efficiency of the network as a whole including decision support for railway network, marshalling yards and terminals.
- Conclude the requirements on other supporting activities and systems (e.g. data availability, planning methods, integration between yard operation and line management) that are necessary for improved performance.

The foreseen research activities in work stream 5 “Core and Extended Market Wagon” are expected to contribute to the overall MAAP Impacts by:

- Reducing the weight of freight wagons, to maximise the payload/ deadweight ratio.
- Significantly contributing to the improvement of reliability
- Reducing total operating costs for the vehicle and infrastructure by up to 30% combining novel design of running gears, predictive maintenance methods and improved aerodynamics
- Analysing of possible improvements on the acoustical behaviour of wagons
- Providing standard mechanical and electrical interfaces for modular, scalable wagon design for operational interoperability

The foreseen research activities in work stream 6 “Freight Propulsion” are expected to:

- Improve energy efficiency and operational flexibility
- Significantly reduce time requirement of train composition
- Optimize train composition process, thus a cost reduction
- Make automated processes available

The foreseen research activities in work stream 7 “Long Trains” are expected to:

- deliver a Distributed Power technology ready for market entrance, and
- enable operators to increase train lengths up to twice the current train lengths and therefore increase their competitiveness rapidly.

The foreseen research activities in work stream 8 “ATO/DAS” are expected to:

- Eliminate obstacles that prevent rail freight from reaching the potential of ATO/DAS systems
- Increase robustness of the system

- Proof the value of C-DAS for optimizing energy consumption, increasing punctuality and capacity in the rail freight system

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 TD5.1, TD5.2, TD5.3, TD5.5 and TD5.6 in line with the relative planning and budget.

**Type of action:**

Innovation Actions (TRL 6)

## **S2R-CFM-CCA-01-2018. Virtual certification & Smart Planning**

### Specific Challenge:

#### *Virtual Certification*

The big challenge is a reduction of the duration and cost of the process for an appropriate authorisation to put a new train into service. Technically, the way to make a breakthrough in performance is to introduce progressively numerical simulations in a mixed virtual/experimental authorisation process, resulting in less field tests.

Virtual certification raises many technical issues which are to be studied in the different TDs of IPs. However, there is still a need of:

- An appropriate coordination among relevant TDs to share generic technical methods when possible and to define, at the end, a comprehensive practical industrial process for validation of rolling stock sub-systems and systems.
- A common interface with standardisation and regulatory bodies (ERA, CEN, CENELEC...)

The project shall aim, in collaboration with the connected activities within the CFM projects, at creating a very lean structure to handle these two roles in order to steer the projects outcomes in the standards and guidelines.

#### *Smart Planning*

In PLASA (S2R-CFM-CCA-03-2015 Integrated Mobility and Safety Management), the concept and a first prototypical implementation for an integrated Smart Planning simulation is being developed. The planning horizon addressed by PLASA is from tactical to daily capacity planning. One challenge here is to enhance and extend the concepts developed in PLASA to incorporate strategic capacity planning, to support investment and reinvestment decisions.

For a practical simulation concept that is able to describe the real world in railway traffic properly, further improvements (more detailed models) must be incorporated in the system to exploit the full potential of such a Smart Planning approach.

The aim for strategic capacity planning is to enable railway stakeholders to make the best decisions for the overall system, leading to an optimal allocation of funds to promote the best possible use of existing capacities.

This extension of the concepts developed in PLASA will require the development of methods for planning with incomplete data, e.g. capacity planning without precisely defined timetables, or yearly timetable planning without knowledge about minor construction sites and on demand freight traffic.

An additional challenge lies in increasing the level of automation of the model calibration process. Especially if the methods are to be applied in practice for daily capacity planning, extensive manual effort for calibrating the model to the specific task and question is not feasible. The R&I activities carried out under the present proposal should thus evaluate the possibilities for automation of the methods developed from the very beginning.

### Scope:

In order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP:

## *Virtual Certification*

The project will be expected to:

- make a state-of-the-art (results from previous research projects, such as Dynotrain, Pantotrain, Aerotrain, Acotrain, Euremco... and bibliography work on the best practices in other industrial domains), a gap analysis and a barriers identification for the virtual certification in the different domains (traction, TCMS, running gear, braking system, etc.), including coordination with IP coordinators, TD leaders and other railway experts in order to share knowledge and new results obtained by the different TDs, as well as coordinating the dissemination activities
- make an overview of :
  - possible synergies with the activities on TD2.6 “zero on-site testing”;
  - the generic scientific methods that are developed during the Shift2Rail initiative (advanced methodologies for numerical models validations, taking account of physical variabilities and modelling uncertainties ; methods to characterize properly the input parameters ; statistical approaches for reliability assessments ; mixed experimental/numerical approaches ; Hardware-In-the-Loop (HIL) techniques for bench tests ; validation criteria ; standardisation of software framework... ) ;
  - solutions found to overcome the non-technical barriers ;
  - defined procedures, consistent with a V-model used for the pre-design, design and validation of sub-systems and systems
- define a dissemination plan targeting the relevant standardisation bodies:
- the work will consist in identifying the relevant CEN/CENELEC/ETSI/ERA WGs and their conveners, determining when official communication should be organised by synchronisation between the projects timelines and the ERA, CEN and CENELEC timelines. The participation of the European Union Agency for Railways in this activity as advisory body is requested, in order to guarantee that the outcomes are applicable and could be regulated. Additional support could be provided on all relevant areas coming from railways, infrastructure managers and industry.
- In addition, available results of the Shift2Rail projects PINTA (S2R-CFM-IP1-01-2016), Mat4Rail (S2R-OC-IP1-01-2017) and RUN2RAIL (S2R-OC-IP1-02-2017) should be considered.

The work will be organised around three phases/tasks:

- State of the art, gap analysis and barriers identification
- Overview of the generic methods and the processes which are proposed by the IP1 TDs
- Dissemination – Liaison with the standardisation bodies

*Smart Planning*, the objective is to reach a Smart Planning simulation concept (based on the previous results of PLASA) that is able to reproduce the real world railway situation and, in addition, that is able to forecast the effect of certain changes (disturbances, timetable changes, construction sites, ...).

Proposals should include:

- Development of methods for simulation with incomplete data (e.g. long term capacity planning with not precisely defined timetables, yearly timetable planning without knowledge about minor construction sites, infrastructure availability, and on demand freight traffic)
- Modelling of the impact of resource plans (e.g. vehicle scheduling, staff planning) for proper simulation of delay propagation between consecutive train runs

- Case studies for a large national network and parts of the TEN-T corridors; case studies should address time perspectives between 30 years ahead for strategic investment decisions on the one hand, and daily capacity planning on the other
- In addition, the available results of the Shift2Rail projects GoSafeRail (S2R-OC-CCA-04-2015) and PLASA (S2R-CFM-CCA-03-2015) should be considered.

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-IP1-01-2018 Development of technology demonstrators for the next generation of traction systems and adhesion management systems
- S2R-OC-IP1-01-2018 Technical solutions for the next generation of TCMS

The action expected to be funded from this topic will also be complementary to actions carried out following the topics:

- S2R-CFM-IP1-01-2017 Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Carbody, Running Gear, Brakes, Doors and Modular interiors (PIVOT)

As specified in section 2.3.1 of S2R AWP for 2018, 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 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 Action will contribute to:

#### *Virtual Certification*

The authorisation process for putting new rolling stock into service is largely based on full-scale field and line tests, which is long, expensive and capacity consuming. Moreover, it can only be performed at the end of the design process, which does not help to reduce the time-to-market.

The project brings the impact of clearly defining a new overall industrial mixed experimental/virtual certification process in order to support the competitiveness of the EU industry by:

- harmonising and simplifying Traction/braking/TCMS/train dynamics assessment processes to decrease cost and duration via introduction of virtual tools
- bringing proof tangible benefits for the end user through LCC reduction

The degree of maturity of the envisaged solutions will depend on the domain, but the final results could reach TRL3. Also, recommendations for the revision of relevant standards could be provided.

### *Smart Planning*

Actions are expected to help to deliver precise railway network simulation to support railway operational planning. A conservative estimate based on the current causes of delays in long-distance traffic showed that more than 40% of the overall delay time could be addressed by the research carried out under Shift2Rail project PLASA (S2R-CFM-CCA-03-2015). The research proposed here will bring these potentials closer to practical application.

In addition, the extension of the methods to long-term simulations with incomplete data will allow the support of strategic investment planning.

The action is expected to reach TRL3 by the end of the timeframe.

Type of Action: Research and Innovation Action

## ANNEX II - 2018 Calls for non-JU members – Topic descriptions

### *Open call for proposals*

#### **S2R-OC-IP1-01-2018 Technical solutions for the next generation of TCMS**

##### Specific Challenge:

The Train Control and Monitoring System (TCMS) is the brain and the communications backbone of the train, which has some essential roles on vehicle performance. The next generation of TCMS should include wireless capabilities, should provide seamless coupling, enhanced interoperability, throughput and reliability, should be built on a new architecture based on distributed functions with standardised interfaces, while supporting safety-critical and security functionalities, and should offer easier certification procedures and self-configuration.

##### Scope:

In order to address the challenges described above, the proposals should address all the following domains, in line with the S2R MAAP (TD1.2)

As a result of the activities carried out in the lighthouse project ROLL2RAIL (GA 636032) described in the public deliverables D2.5 and D2.7<sup>31</sup>, in CONNECTA<sup>32</sup> (S2R-CFM-IP1-02-2016), SAFE4RAIL<sup>33</sup> (S2R-OC-IP1-02-2016) and X2RAIL-1 (S2R-CFM-IP2-01-2015) projects described in their public deliverables published so far, the following further research activities, reaching TRL 3-4, should be carried out for the wireless TCMS, based on LTE communication technologies:

- a) Specification, implementation and validation of railway mobile LTE equipment (based on release 14<sup>34</sup>), supporting multicast transmission. This should include the impact analysis on the IEC61375-2-5 Ethernet Train Backbone Nodes (ETBN) and proposals for their modification.
- b) Analysis of mobility and dynamic aspects of LTE equipment for wireless TCMS and the interaction of multiple cells in busy scenarios (e.g. main stations, depots etc).
- c) Proposal for technical solutions to merge all on-board radio links (incl. signalling) taking advantage of the LTE equipment.
- d) Participation in the interoperability wireless ETB tests of S2R-CFM-IP1-02-2018 in the laboratory demonstrator, by providing the required LTE expertise and hardware and technical support.
- e) Exploratory work on the applicability of 5G and the seamless transition between LTE and 5G in the railway TCMS domain.
- f) Evolution studies on how CONNECTA's Drive-by-Data concept (i.e. SIL4 TCMS) could be deployed through a wireless Ethernet Train Backbone.

The complementary action S2R-CFM-IP1-02-2018 will continue CONNECTA's activities so the proposals also should participate in the set-up of two laboratory demonstrators and in particular address the following activities (TRL4/5):

- i. Provide train subsystem to be integrated in the virtual homologation's simulation framework and participate in combined tests including remote with hardware-in-the-loop for both demonstrators around
- ii. Provide the implementation of network devices (i.e. modified EBTN and car switches) for integration into the Drive-by-Data concept based demonstrator architectures and participate in validation activities for both demonstrators around

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<sup>31</sup> <http://roll2rail.eu/Page.aspx?CAT=DELIVERABLES&IdPage=45291e18-8d8f-4fd6-99f8-5d4b7a519b9c>

<sup>32</sup> [http://projects.shift2rail.org/s2r\\_ip1\\_n.aspx?p=CONNECTA](http://projects.shift2rail.org/s2r_ip1_n.aspx?p=CONNECTA)

<sup>33</sup> <https://safe4rail.eu/news/deliverables>

<sup>34</sup> Based on release 14 developed by 3GPP <http://www.3gpp.org/release-14>

- iii. Provide the implementation of a real train subsystem function to be integrated in CONNECTA (i.e. wireless TCMS, drive-by-data, functional open coupling)<sup>35</sup> functional distribution framework (i.e. Integrated Modular Platform) for both demonstrators around

In addition, proposals should carry out applicability studies (TRL 2) of the proposed technologies developed through CONNECTA for supporting the Virtual Coupling concept.

- Finally it is expected that the proposals include the organisation (including the required funding for two meetings) of a joint advisory group, which should include experts from 3GPP and 5G PPP amongst others. In addition, available results of the Shift2Rail projects ROLL2RAIL (GA 636032), CONNECTA (S2R-CFM-IP1-02-2016), SAFE4RAIL (S2R-OC-IP1-02-2016) and X2RAIL-1 (S2R-CFM-IP2-01-2015) should be considered.

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-IP1-02-2018 Implementing new technologies for the TCMS
- S2R-CFM-IP2-01-2018: Advanced Signalling, Automation and Communication System
- S2R-CFM-CCA-01-2018: Virtual certification & Smart Planning

As specified in section 2.3.1 of the S2R AWP for 2018, 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.

An indicative scheduling of the deliverables is suggested below<sup>36</sup>:

- Deliverable under item d) is expected by month 20
- Deliverables under item i), ii) and iii) are expected by month 24

#### Expected Impact:

Actions will support S2R-CFM-IP1-02-2018 to validate in a relevant environment (TRL4/5) and for two representative railway applications (i.e. mainline and urban), the following technologies:

- The Functional Distribution concept, together with the Integrated Modular Platform, leading to a reduction of LCC and improvement of operational reliability;
- The Virtual homologation simulation framework to enable further reductions in LCC.
- The interoperability of the proposed wireless Ethernet Train Backbone, to reduce LCC, increase operational reliability and capacity, by adding flexibility to the system.

In addition, activities on LTE equipment should close identified open points (TRL3/4) and bring enough maturity for allowing full scale demonstrators of the wireless TCMS from 2020.

#### Type of Action: Research and Innovation Action

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<sup>35</sup> CONNECTA technical proposals relevant to virtual coupling will be published through the public deliverables D2.4 (08.2018), D3.5 (08.2018) and D4.2 (03.2018).

<sup>36</sup> 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.

## **S2R-OC-IP2-01-2018 - Analysis for Moving Block and implementation of Virtual Coupling concept**

### Specific Challenge:

In the framework of the technological developments foreseen within the Innovation Programme 2 of Shift2Rail Master Plan, the application of the most advanced Train Separation systems like Moving Block or other new systems based on Train Centric solutions, are seen being one of the most effective and promising technologies to increase line capacity reducing the trackside life cycle costs due to less train detection systems to be installed.

The challenge is to boost innovative and cost-efficient technologies and systems for railway signalling while, at the same time, achieving a level of safety consistent with methods and standards to be applicable in all railway segments.

### Scope:

The aim of the work should be:

- To identify and assess the most suitable methodology in order to test and bring into service Moving or Fixed Virtual Block contributing to the definition of the Operational Procedures and highlighting the differences with the traditional signalling systems.
- To analyse the potential business and market response thanks to the application of the Virtual Coupling concept identifying pros/cons in terms of performance and cost. To investigate new kind of Train-to-Train (T2T) communication solutions, getting ideas from other domains (e.g.: automotive), in order to perform the needed functions required by Virtually Coupled Train Sets project.

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 Moving Block technologies (linked with TD2.3 of the Multi Annual Action Plan) the activities are expected to cover the following points:
  - a. Starting from the current signalling architecture (with a particular focus on trackside detection system), define approaches to the testing of Moving Block signalling systems, including consideration of how much testing must be performed on site, and how much testing can be performed in the office.  
This work should be performed in collaboration with work within the Action stemming from the call S2R-CFM-IP2-01-2018, addressing TD2.6 and S2R-CFM-IP2-01-2015 (X2RAIL-1).
  - b. Provide feedback on the Moving Block Operational and Engineering Rules, to highlight differences from traditional signalling systems, and propose changes, which might result in easier application of Moving Block “signalling systems” or their evolution to a different traffic management approach.
2. In the framework of the introduction of the Virtual Coupling concept (linked with TD2.8 of the Multi Annual Action Plan) the activities are expected to cover the following points:
  - a. Produce the Business Case analysis for the application of the Virtually Coupled Train Sets VCTS concept. The activity has to identify:
    - i. The potential markets, which can be interested to introduce VCTS (Main Lines, High Speed Lines, Urban/Suburban, Regional Lines, Freight).
    - ii. For each of the above market segments is requested to provide the cost/effective analysis assessing the potential benefits of VCTS application, from the point of view of an Operator, highlighting pros/cons in terms of performances (e.g.: line capacity improvement, passengers increase, CAPEX

- and OPEX reduction) compared with the traditional train separation system (Fixed and Moving Block).
- iii. For each of the above market segments is required to provide the expected roadmap for the introduction of VCTS focusing the main business and market actions, which are deemed necessary in order to foster the application of VCTS. The activity should make assumptions in terms of cost identifying the foreseen trade-off between the start-up cost of R&D and of the potential implementation vs the positive returns thanks to the application.
  - iv. For each of the above market segments to identify the potential risks in terms of business due to the introduction of VCTS providing also the related actions, suggestions, mitigations in order to overcome the potential obstacle and achieving the objective.
- b. Investigate the use of new communication structure in agreement with IP2 and IP1 CFM complementary actions for allowing the communication between trains within the train convoy. The activity has to:
    - i. Analyse the up to date radio communication wayside and/or on board infrastructures able to provide the full data exchange between trains. The activity has to analyse pros/cons of each communication technology in terms of real time domain, throughput, reliability, availability, cost, applicability to the specific domain in relation with the requirements that will be defined by the complementation Action stemming from the call S2R-CFM-IP2-01-2018.
    - ii. According to the above analysis and for each market segment, select the most suitable communication structure providing the evidence (with a theoretic but rigorous approach) of the goodness of the choice. The analysis has to provide an in depth study for demonstrating the real effectiveness of the solution with regards the compliancy of the requirements that will be defined by the complementation Action stemming from the call S2R-CFM-IP2-01-2018.
  - c. Investigate the application, solutions and dynamics of automated car driving currently in order to evaluate the applicability in the railway field. The study has to analyse similarities between automotive and railway fields and to provide insights highlighting the part of the railway system that can take advantage from the application of systems, sensors, functions, procedures coming from the automotive domain.

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

- S2R-CFM-IP2-01-2018: Advanced Signalling, Automation and Communication System and Automated Freight Train Operation
- S2R-CFM-IP1-02-2018 Implementing new technologies for the TCMS
- S2R-CFM-IP2-01-2015 Start-up activities for Advanced Signalling and Automation Systems (X2RAIL-1).

As specified in section 2.3.1 of S2R AWP for 2018, 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.

An indicative scheduling of the deliverables is suggested below<sup>37</sup>:

- Deliverables of work stream 1 are expected to be available as specified below:
  - Moving Block signalling system test strategy – M12

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<sup>37</sup> 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.

- Moving Block signalling system test methods – M18 (This to include specification of any tools required)
- Report on Moving Block Operational and Engineering Rules – M24
- Deliverables of work stream 2 are expected to be available as specified below:
  - For item a(i): by M6;
  - For item a(ii): by M9;
  - For item a(iii): by M12
  - For item a(iv): by M15
  - For item b(i): by M9
  - For Item b(ii): by M12
  - For item c: by M9

Expected Impact:

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

- Understanding of the test processes required in order to bring a Moving Block signalling system into use.
- Enhancement of the Moving Block Operational and Engineering Rules, including highlighting differences from traditional signalling systems to the future ones.

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

- Refining the knowledge of the market to accept and request also very innovative and potentially disruptive transportation solutions.
- Understand the real feasibility for applying VCTS according to the different characteristics of the lines, of the railway structure and of the Railway Undertakings and Infrastructure Managers needs or constraints.
- Identify the potential application roadmap for the introduction of VCTS taking into account the switch over from the traditional systems and the possible transition issues.

Type of Action: Research and Innovation Action

**S2R-OC-IP2-02-2018 - Modern methodologies and verifications for GNSS in Railways and virtual test environment**

Specific Challenge:

In the framework of the technological developments foreseen within the Innovation Programme 2 of Shift2Rail Master Plan, the application of the new technologies for train localisation using GNSS are seen being one of the most promising technologies able to increase line capacity reducing the trackside life cycle costs. The main challenge is to identify and assemble the basic data necessary to accomplish and apply the GNSS in the Railway environment.

The call also aims to study new methodologies and assessment procedures for maintaining the simulation environment, in line with the introduction of new functionalities in the system. It is important to perform tests of innovative products and services using up-to-date simulation environment in order to support new (type) approval processes or even a harmonised European approval process in the context of control, command and signalling systems.

### Scope:

Regarding the activities related to the GNSS application in railway (TD2.4) of the Multi Annual Action Plan) the main scope is to achieve a realistic characterization of the environment, in terms of railway and GNSS infrastructures, able to evaluate performances and properties of some Fail-Safe Train Positioning components with respect to normal and specific failure conditions. The activity also aims to lay down a geographical and distributed infrastructure able to verify and take advantage from the results of the existing laboratories.

Regarding the activities linked to TD2.6, it is important to remark that any simulation environment has to be aligned with the evolution of the system and of the configuration of the track / station. In addition, the obsolescence of different parts of the system needs to be taken into account while improving the test environment. The main scope is to find out a technical solution which can reduce the need for re-assessments due to the upgrade so maintaining the simulation and testing environment in line with the latest evolutions such as:

- changing the hardware due to obsolescence or product enhancements;
- changing the software due to new functionality, upgrade of specifications.

For supporting these activities the test environment as well as the simulation, needs to show the following capabilities:

- Automated upgrade of the simulation environment including the automated repetition of already available test cases including automated evaluation of the test results to fulfill the requirements of system integrators and assessors;
- Ease of upgradeability in terms of limited effort for approving the test environment;
- Support physical as well as virtual test and simulation environments.

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 GNSS technologies (linked with TD2.4 of the Multi Annual Action Plan) and in collaboration with the project X2Rail-2 (S2R-CFM-IP2-01-2017) and subject to the available results of related projects as STARS and ERSAT, the following activities are expected to contribute to the Fail-safe train positioning (satellite) (TD2.4):
  - a. Identify and develop a Simulation Environments able to characterize the Railway and the GNSS infrastructures and to evaluate the performance of the GNSS application. The characterization has to at least include the following features:
    - Railway infrastructure peculiarities according to the application of GNSS into the different market segments (e.g.: Main Lines, Regional Urban/Suburban and Freight lines);
    - Characterization of the Satellite Constellation availability and coverage (related to the position and the date/time);
    - Capability to define test cases and evaluate impact and performance reproducing normal and failure modes of parts of the modules: related to Railway and/or GNSS infrastructure.
  - b. Develop a comprehensive methodology able to:
    - Characterize the GNSS into Railways Application domains;
    - Carry out the models able to verify the properties of some Fail-Safe Train Positioning components with respect to specific faults (e.g. due to multipath, radio frequency interference, spoofing, ...)
  - c. Setup of a geographically distributed verification infrastructure able to exploit the features of existing complex and expensive laboratories.

2. In the framework of the evolution of the simulation environment technologies (linked with TD2.6 of the Multi Annual Action Plan) the activities are expected to cover the following points:
  - a. Develop a concept for the automated update of test environments due to multiple changes;
  - b. Develop a concept for continuous integration as well as automated test repetition and automated evaluation of these tests, taking the safety aspect into account. The concept shall support the safety approval of the overall system as well as the changed function taking into account the requirements of representative bodies (Notified Bodies, Designated Bodies and Assessment Bodies).
  - c. Ensure that the concept for upgrading the test environment as well as the test candidate can be approved by an independent safety assessor.
  - d. The proposed solution shall contain as a minimum:
    - i. Methodologies and tools feasible for continuous update and integration of the test environment as well as the test candidate; The proposal shall not be limited to Software;
    - ii. Methodologies and tools for test automation and automated analysis of test results giving the necessary KPIs for safety approval;
    - iii. Concept for improving assessors tasks and linking testing to approval;
    - iv. The proposed solution shall support multiple sites for testing;
    - v. The proposed solution can be based on representative examples.

The action that is expected to be funded under this topic will be complementary to the action that is expected to be funded under the topic S2R-CFM-IP2-01-2018: Advanced Signalling, Automation and Communication System and Automated Freight Train Operation.

The action expected to be funded under this topic will also be complementary to action carried out in the project funded under S2R-CFM-IP2-01-2017 (X2RAIL-2).

As specified in section 2.3.1 of S2R AWP for 2018, 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.

An indicative scheduling of the deliverables is suggested below<sup>38</sup>:

- Deliverables of work stream 1 are expected to be available as specified below:
  - For item a; by M12
  - For item b; by M18
  - For item c; by M24
- Deliverables of work stream 2 are expected to be available as specified below:
  - Overview over today's approval processes in different countries; by M9
  - Set of common requirements for NoBo approval of a test environment and the necessary upgrades; by M12
  - Agreed update and approval process for system simulation and test environment; by M22

#### Expected Impact:

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<sup>38</sup> 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.

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

- The development of the GNSS architecture as planned in the Multi Annual Action Plan;
- Simplify the analysis of the pros/cons for the GNSS application according to the different lines characteristics and market segments;
- Help the characterisation of the architecture in order to achieve the optimised balance between the constraints due to the lines and the railway environment and the maximisation of the performances.

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

- the development of a Zero on-Site Testing (TD2.6) environment. As more and more test are transferred from the field to the lab, the needs of enhancing and increasing the efficiency of the test environment becomes fundamental.
- Reduce costs and improve efficiency. The positive results thanks to the definition of a dedicated process for upgrading the lab environment as well as the system in the field are expected to yield direct benefits in terms of:
  - Reduction of costs of lab resources due to the reduction of real lab equipment needs (acquisition, obsolescence, maintenance, use of energy and space, etc.) and introduction of 'state of the art' technology;
  - Increase of the efficiency of test resources management;
  - Full accessibility to the test environment available from different locations;
  - Support of the necessary safety integrity level.

Type of Action: Research and Innovation Action

## S2R-OC-IP2-03-2018 - Communication environment assessment and validation

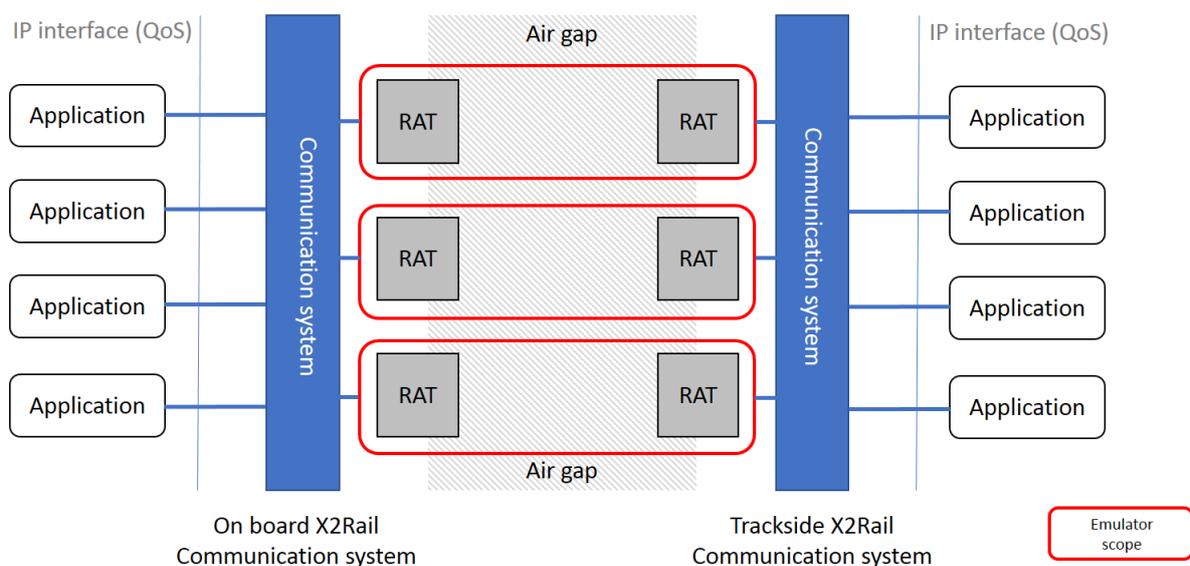
### Specific Challenge:

In the context of the IP2 adaptable communication technology demonstrator the development of the prototypes relies on comprehensive testing and validation activities. These activities shall also cover test scenarios to verify the functionality and capabilities of the adaptable communication system with multiple radio access systems and reproduce the railway environment including radio link perturbations, overload scenarios and other events, which impact the communication bearer and ultimately the applications.

To avoid the complex and expensive installation and operation of various real radio access equipment in the development labs the outlined test campaigns shall rely on a radio access emulation, which can act as flexible, configurable and programmable laboratory tool supporting the end-to-end validation and verification activities.

Scope: The proposed activity should address the following domains and functional areas in line with the goals of the adaptable communication system technical demonstrator defined in TD2.1 of the Shift2Rail Multi-Annual Action Plan (MAAP):

The radio access emulator shall support multiple emulation instances of one or more access networks, including but not limited to LTE, LTE-Advanced, GSM-R, 5G, WiFi/802.11, SatCom networks.



The emulation of each bearer (marked red in the diagram above) shall support configurable and programmable parameters for typical communication perturbations perceivable at the radio system interfaces, including packet delay, packet error, average/maximum/guaranteed throughput, latency, jitter and packet loss. The emulation of each channel shall support programmable sequences of parameter changes over time (1s granularity) to validate the communication for specific environment use cases or railway scenarios (train in tunnel, train passing hilly terrain ...) and differentiate between uplink and downlink transmission in both nominal and degraded mode.

It is required to have support for QoS profile requests by different applications per radio channel, in order to verify behaviour with multiple concurrent applications at the same time.

The interface to the adaptable communication system (network/terminal) should be based on the relevant standardized interfaces (at a minimum and plain IP interface, for 3GPP access emulators the IP bearer should be offered by the Gi network interface and other relevant 3GPP control interfaces).

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

- a. Analysis of communication characteristics perceivable by the applications and services using the communication bearer (like throughput, packet loss, jitter etc.).
- b. Assessment of communication capabilities of existing radio access networks (including LTE, LTE-A, 5G, GSM-R, WiFi/802.11, SatCom etc.) and how these could be emulated.
- c. Investigation of communication scenarios covering degraded modes, outages, overload scenarios, interferences and other perturbations with occur in the railway environment or can be expected in the future.
- d. Definition of elements which should be variable, configurable and programmable in the radio access emulation tool.
- e. Design and implementation of the radio access emulation tool.
- f. Support for integration of the radio access emulation tool in the verification labs.

For the avoidance of doubt, it is not required to simulate the internal functions of the radio access networks and related air gap specifics, including but not limited to resource management, prioritization, hand overs or interferences, distortion, other radio perturbations. Only the resulting implications perceivable at the external interfaces of the emulation should be covered by the test & validation tool. In other words, the action should provide a fully functional and comprehensive radio access emulation tool in line with the aforementioned functional requirements and not a radio access simulation tool.

The activity is complementary and closely linked to the work of the Action stemming from the call S2R-CFM-IP2-01-2018 "Advanced Signalling and Automation System". The main deliverable of this activity provides a radio access emulator and is expected to be used during the test and validation tasks within the Action stemming from the call S2R-CFM-IP2-01-2018. Hence, the radio access emulator should become available for the project related to S2R-CFM-IP2-01-2018 latest 12 month after start of the activity, as per indicative scheduling here below.

As specified in section 2.3.1 of S2R AWP for 2018, 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.

An indicative scheduling of the deliverables is suggested below<sup>39</sup>:

- Deliverable of work stream "a" are expected to be available by M3;
- Deliverable of work stream "b" are expected to be available by M4;
- Deliverable of work stream "c" are expected to be available by M5;
- Deliverable of work stream "d" are expected to be available by M5;
- Deliverable of work stream "e" are expected to be available by M12;
- Deliverable of work stream "f" are expected to be available by M15;

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<sup>39</sup> 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:

Actions will contribute to the development and testing activities for the adaptable communication system for all railway technology demonstrator (TD2.1) in IP2. In detail it will help to

- Reduce the complexity and linked costs during testing and validation of the communication prototypes within the TD2.1 activities with the usage of emulation instead of installing and operating real radio equipment
- Deliver radio access emulation to simplify the testing and contribute to the cost reduction targeted by the TD2.6 zero on-site testing activities.
- Support the development and help to deliver more reliable and robust prototypes with the ability to emulate various critical conditions, even ones which occur very rarely

Type of Action: Research and Innovation Action

## **S2R-OC-IP3-01-2018 – Measuring and monitoring devices for railway assets**

### Specific challenge:

One of the objectives of the S2R Master Plan Innovation Programme 3 (IP3) “Cost efficient and reliable infrastructure” is to enable the development of a set of cutting-edge on-board and wayside asset-specific measuring and monitoring devices. These will collect and deliver the status data of the railway system (infrastructure and rolling stock). The information collected by such devices will be then processed to generate relevant maintenance infrastructure-related information to support asset management decisions.

The main challenge of this call is to identify specific monitoring and upgrading solutions addressed to bridges and tunnels (TD 3.5) and to develop monitoring solutions for trains and track geometry monitoring as well as data collection from fail-safe systems (TD3.7)

### Scope:

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

1. Research on monitoring of bridges and tunnels including upgrading solutions, to support the aims of TD 3.5:

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

- Railway tunnel examination technologies for subsurface defect detection;
- Non-traffic disturbing methods for cleaning long tunnel drainage pipes. This is specifically to remove precipitate calcium products;
- Development of contactless measurement technology to detect and monitor noise emissions from train passage over bridges as well as the development of noise dampers for significant noise reduction;
- Bridge and tunnel information modelling systems able to import digital data in various formats (such as numerical data, 3-d models and photos) as well as capable of interpreting and filtering data and reporting current asset status compared to previous condition history;
- Algorithms for bridge information model module.

The following main deliverables are expected:

- i. Description of novel technology including hardware and software to detect subsurface tunnel defects of significance, validated in a relevant environment (TRL5);
- ii. Description of a method for cleaning tunnel drainage. This method should be validated in a relevant environment (TRL5) within an existing tunnel without disturbing traffic nor damaging the pipes;
- iii. Description of hardware and software for noise monitoring, demonstrated in a relevant environment on existing bridges during train passage (up to TRL6.) Measurements should be possible from a distance approximately within the range of 5m and 30m. Areas with resonance frequencies between 40Hz and 800Hz are of particular interest. In addition, the deliverables should include specifications of noise dampers for further development and a prototype as well as the development of noise dampers, which should be validated in a relevant environment on an existing bridge (TRL5). The noise dampers should reduce peak noise by approximately 5 dB.

- iv. Code for bridge and tunnel information modelling system, which should be demonstrated in a relevant environment (up to TRL6) such as sensor data and structural 3D-models with geometries.
- v. Bridge information model module with capability of merging traffic management data, on-board monitoring data, structural influence lines and limited structure sensor data, to store fatigue consumption for individual structural components demonstrated on relevant data (up to TRL6.)

An indicative scheduling of the deliverables is suggested below<sup>40</sup> :

- Deliverables under points (i), (ii) and (iii) are expected by month 24.
- Deliverables under points (iv) and (v) are expected by month 30.

The above work stream 1 activities are expected to request a contribution of indicatively € 2.9 million in order to perform technology validation in the corresponding to TRLs, as mentioned above.

## 2. Research on railway measuring and monitoring systems, to support the aims of TD 3.7:

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

- Train monitoring solutions: in this context the research activities will focus on:
  - o Development of “stereo images” systems for measurements of defects on rolling stock;
  - o Development of on-track image-based systems for underframe measurements;
  - o Automatic features measurement configuration tools and processes;
  - o Read/write RFID tags: study, design and development of possible different solutions based on “Read/write RFID tags” for passenger and freight trains;
  - o Definition of precise models that quantify the impact of a given measured defect on the infrastructure.
- Development of a system/sensor to measure the transversal position of the wheel in relation to the rail: system to be installed on in-service trains fulfilling the following requirements:
  - o Reliable measurements for vehicle speeds between 60 and 200 km/h;
  - o Insensitive to dust, rain, snow and waste along the track;
  - o Installable on different railway bogies taking into account the railway loading gauge;
  - o low power consumption.
- Collection of data from fail-safe systems: Study and development of new diagnostic data collection solutions (HD and SW) designed to achieve seamless safety approval prior to implementation in the field e.g.:
  - o signalling systems or train diagnostic collection not interfering with brakes or steering system in the train (no interference with safety systems);
  - o a serial connector with a special cable cut for transmission (i.e. only possible to listen to data).

The following main deliverables are expected:

- a. Specification of requirements for the collection of data for train monitoring solutions, track geometry monitoring and data collection from fail-safe systems

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<sup>40</sup> 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. Proof of concept for train monitoring solutions, track geometry monitoring and data collection from fail-safe systems
- c. Validation/demonstration of the above mentioned concepts in relevant environment (TRL5/6)

An indicative scheduling of the deliverables is suggested below<sup>41</sup> :

- Deliverables under point a are expected by month 6
- Deliverables under point b are expected by month 18
- Deliverables under point c are expected by month 24

The above work stream 2 activities are expected to request a contribution of indicatively € 1.85 million in order to perform technology validation in the corresponding to TRLs, as mentioned above.

The proposed research activity will generate data/information to feed both the TD3.6 “Dynamic Railway Information Management System (DRIMS)” and TD3.8 “Intelligent Asset Management Strategies Demonstrator (IAMS)” models/algorithms to support maintenance and asset management processes.

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-IP3-01-2018: Research into optimised and future railway infrastructure

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

- S2R-CFM-IP3-01-2016: Research into enhanced track and switch and crossing system
- S2R-CFM-IP3-02-2016: Intelligent maintenance systems and strategies

As specified in section 2.3.1 of S2R AWP for 2018, 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.

#### Expected impact:

The technologies to be under this action are expected to have a significant impact on the S2R objectives concerning costs, reliability and capacity. In particular:

#### Workstream 1:

- a) Enhanced inspection and monitoring of bridges and tunnels facilitating proactive maintenance, which will contribute to increased capacity and reliability and reduced costs;

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<sup>41</sup> 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) Prolonged technical and economical use of structures, leading to less total disturbance, reduced costs and reduced environmental impact;
- c) Reduction of noise and vibration levels;
- d) Improved capacity by reducing or eliminating existing restrictions in bridge and tunnel monitoring/maintenance.

Workstream 2:

- a) Train monitoring solutions: increase train monitoring to achieve a better evaluation of their performance and their impact on the infrastructure;
- b) Monitoring systems to support track geometry measurements: increase the precision of track geometry monitoring to provide reliable measurements of transversal position of the wheel in relation to the rail;
- c) Collection of data from signalling systems: increase the status monitoring of signalling systems by making their diagnostic data available to data analysts to perform specific data analysis

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 TD3.5 and TD3.7 in line with the relative Planning and Budget.

**Type of Action:** Innovation Action.

## S2R-OC-IP4-01-2018: Semantic framework for multimodal transport services

### Specific Challenge:

The topic addresses the IP4 “interoperability framework”, one of the key research and innovation areas of IP4 described in the S2R Master Plan. The challenge for the interoperability framework is to provide seamless connectivity (using open semantic web standards and technologies), in order to address the diversity and variability of standards and protocols of different transport modes managing data coming from different environments<sup>42</sup>.

The IP4 transport ecosystem is expanding the scope through different complementary projects, and new services, modes, operators, providers and functionalities are incorporated; accordingly the ontologies are enriched, and the reliability of the interoperability framework mechanisms must be reinforced. The specific challenges of this call are the following:

- Improving performance and scalability of the interoperability framework to sustain a large deployment.
- Support the market uptake by simplifying/automating all the necessary steps (e.g. creation of ontologies, discovery, annotation, mapping) which are needed to integrate new services and sub-systems in the IP4 ecosystem.

### Scope:

In order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP:

#### 1) Performance :

Optimize performance and scalability of the interoperability framework<sup>43</sup>, exploiting new techniques developed over the last few years in semantic architectures and standards. The project will explore different options, such as: alternative architecture, new software paradigms (such as application containers, dynamic resizing, in-memory processing), parallel computing mechanisms, etc.

#### 2) Automation for an easy integration of new services or sub-systems :

Propose mechanisms to automate the generation of ontologies (esp. lightweight ontologies), the annotation, the mapping and translation between different systems, etc.

For all these activities, the project should cover the following aspects: state of the art 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 (as much as possible) with the approach currently developed within IP4<sup>2</sup>, to allow the adaptation of the interoperability framework mechanisms developed in the parallel complementary project CONNECTIVE (S2R-CFM-IP4-01-2017).

The project is expected to reach TRL up to 4.

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<sup>42</sup> Information on previous S2R activities on the interoperability framework, including public deliverables and brochures, can be found on the S2R website.

<sup>43</sup> Please check the latest IP4 documentation available on the Shift2Rail website at <http://.....>

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

- S2R-CFM-IP4-01-2017: Connecting and Analysing the Digital Transport Ecosystem (CONNECTIVE)

As specified in section 2.3.1 of S2R AWP for 2018, 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.

Expected Impact:

The overall objective of the Interoperability Framework is to maximize the development of new products and services by removing technological or standardization barriers, reducing integration costs and time to market and allowing new market players to participate in the ecosystem. It would then shield travelers and service providers from the complexity and fragmentation of the transport market. This project will contribute to this objective with two specific impacts:

- The improvement of the Interoperability framework will ensure that it can reach the requested performance and scalability to become a viable technical backbone for the IP4 multi-modal web of transport
- Automating some of the underlying mechanisms will reduce efforts and costs for the integration of new systems/services/actors in the transport ecosystem.

Type of Action: Research and Innovation Action

## **S2R-OC-IP4-02-2018: Supporting the implementation of the IP4 multi-modal transport ecosystem**

### Specific Challenge

IP4 is defining a consistent array of services covering all the steps of multi-modal journeys and providing a seamless passenger experience. The long-term CFM project COHESIVE (S2R-CFM-IP4-02-2017) started in 2017 is consolidating incrementally the various building blocks developed in the IP4 projects and then demonstrating the end-to-end set of services with relevant use-cases. To be effective and to pave the way of an easy deployment, the demonstration made by COHESIVE (end of 2020) must take into account the constraints of a real environment. One of the specific challenges of this Open Call is to develop an even deeper operational perspective and an active collaboration on the definition and description of this real environment, and to deliver the necessary support to the COHESIVE project to implement a successful demonstration.

Moreover, the new IP4 ecosystem is changing the business rules, with the creation of global services and data transport market place. A specific challenge for this project will be to assess the influence of IP4 on the transport ecosystem, with new roles, new business models, and new behaviour for the passengers (socio-economic impact).

### Scope:

The action addresses the “non-technical” part of the ITD4.7 in the Shift2Rail Multi-Annual Action Plan (MAAP). The overall integration of various travel services and modes all over IP4 is the only way to demonstrate added value on the market. The technical part (complex sub-systems integration) of ITD4.7 is developed by the CFM project COHESIVE (S2R-CFM-IP4-02-2017), but performing a meaningful and relevant demonstration requests the involvement of additional stakeholders which will support the demonstration. Experiences, perspectives and functions will be wider with the participation, for instance but not restricting to: operators (urban rail, main line, others transport modes), transport authorities, passengers, cities, retailers, airlines, etc.

In order to address the challenges described above, the proposals should address all the following work streams, in line with the S2R MAAP:

- Propose relevant scenarios, and support COHESIVE project to transform them in valid use-cases, compatible with the developments made in the others IP4 projects.
- Support the demonstration of these use-cases by the COHESIVE project, with non-technical contributions, for instance but not restricting to:
  - Access to data to execute the use-cases
  - Alert on implementation constraints and business logics
  - Give access to the interfaces of the legacy systems, with associated support, allowing their mapping in the IP4 ecosystem.
  - For real life pilot testing, provide a realistic and adequate environment to integrate and run the demonstration done by COHESIVE project.

The second set of actions is related to the careful analysis of the impact of the IP4 ecosystem on the passenger’s behaviour and their response to the technological changes, and the transport business rules at large. The action should look at the impact on the technical and regulatory aspects of the IP4

multimodal transport services market place on the business logics, on the creation of new business models, on the behavioural response of passengers, etc.; utilising as far as they are available public results from previous projects as GOF4R project<sup>44</sup> (S2R-OC-IP4-01-2016).

This action could benefit from surveys conducted during the S2R-CFM-IP4-02-2017 - COHESIVE demonstration.

The project is expected to reach TRL up to 4 (even if the project members are supporting the COHESIVE demonstration, they will not perform any technical activities).

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

- S2R-CFM-IP4-02-2017: IP4 overall integration and demonstration (COHESIVE)

As specified in section 2.3.1 of S2R AWP for 2018, 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.

#### Expected Impact:

The action will bring the following:

- Ease and promote the market acceptance by bringing various and complementary stakeholders proposing realistic scenarios to build the demonstration use-cases.
- Enrich the content of the COHESIVE demonstration, by providing realistic business rules, real data and realistic environment.
- Demonstrate that the IP4 eco-system is versatile, able to cope with legacy systems.
- The assessment of the business and socio-economic impacts of the IP4 ecosystem will clarify the pros and cons, and accelerate the market uptake

Type of Action: Research and Innovation Action

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<sup>44</sup> <http://www.gof4r.eu/home.aspx>

## **S2R-OC-IP5-01-2018: Radio communication and simulation of train dynamics for Distributed Power within long trains**

### **Specific Challenge:**

Long trains up to 1,500 m with distributed traction units enable operators and infrastructure managers to increase competitiveness and capacity of railway system rapidly. Distributed Power Systems (DPS) steering multiple traction units within 1,500 m trains need:

1. efficient and reliable technologies to transmit traction and braking commands between locos, and
2. simulation-driven traction and braking regimes which optimize upcoming in-train-forces and follow an integrated safety management.

Within the 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. The challenge in **Radio communication for long trains** is to develop and implement a GSM-R-based radio communication system for Distributed Power systems (DPS) in freight trains and to demonstrate it in trial runs up to 1,500 m train-length.
2. The challenge in **train dynamics simulation** is to identify upcoming and tolerable in-train-forces in different operational scenarios and to integrate this into a safety assessment of the operation of long trains.

The consortium should bring experience in the field of both hardware and software for both work streams.

### **Scope:**

The activities should address the following elements, in line with the Shift2Rail MAAP:

The work expected in work stream 1 concerning **Radio communication for long trains** should include:

- Design and standardisation of a GSM-R-based signal transmission technology for DPS in long freight trains up to 1,500 m
- Development and testing of a GSM-R-based radio communication system integrated in DPS for long freight trains incl. Hardware and Software components
- Integration of the radio system on two locos for the demonstration of the DPS in 740 m trains in 2019
- Integration of the radio system on up to four locos for the demonstration of the in 1,500 m trains in 2020

This work stream should consider the work carried out in previous research projects.

The work expected in work stream 2 concerning **train dynamics simulation** should include:

- Simulation of upcoming and tolerable in-train-forces within trains up to 1,500 m and up to four distributed locos
- Deduction of optimal traction and braking behaviour of DPS within dynamic operational scenarios of 1,500 m trains
- Execution of an integrated safety assessment of in-train-forces

The consortium shall be able to:

- Demonstrate the integration of the radio system into existing locos of industry partners of the project FFL4E (S2R-CFM-IP5-03-2015)
- Demonstrate a fast and reliable communication between two locos within one 740 m train and up to four locos within one 1,500 m train
- Demonstrate the compliance of the radio system with reliability and availability requirements derived from train dynamics simulation
- Standardise and homologate the used radio protocols in a way that communication of radio systems of different suppliers within one train is ensured
- Make use of TrainDy for simulation which is validated and certified to ensure the acceptance of simulation results by Railway Authorities (this is an advice in order to maximise the compatibility of results with the complementary projects).

The proceeding of S2R-OC-IP5-01-2018 must continue the outcomes of the project FFL4E (S2R-CFM-IP5-03-2015). The results of S2R-OC-IP5-01-2018 must be aligned – regarding timing and content – with the corresponding work and targets of S2R-CFM-IP5-01-2018 in order to achieve the overall goals of IP5. The Open Call consortium shall design its planning according to the long-term roadmap of the running consortium FFL4E (S2R-CFM-IP5-03-2015).

The expected result of both work streams to provide a system integration in a relevant environment (TRL 5).

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-IP5-03-2015: Freight propulsion concepts
- S2R-CFM-IP5-01-2018: Technology demonstrators for competitive, intelligent rail freight operation

As specified in section 2.3.1 of S2R AWP for 2018, 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 S2R JU considers that proposals requesting a contribution from the EU of around €0.5 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

**Expected Impact:**

The research activities shall contribute to:

- The development of new business cases through doubling of train lengths in rail freight up to 1,500 m based on Distributed Power technology
- Efficiency gains and strengthening of the modal competitiveness through unmanned operation of one or multiple slave locomotives in the train consist

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 TD5.5 in line with the relative planning and budget.

**Type of action:**

Research and Innovation Actions (TRL 5)

## S2R-OC-IPX-01-2018 - Paradigm shifts for railway

### Specific Challenge:

Current activities in S2R are developing the fundamental building blocks that will allow in the future producing **interoperable and autonomous passenger or freight trains** that can run at a short distance from each other and have the ability to virtually couple and decouple as they travel on existing infrastructure.

Arising and **promising disruptive technologies** (e.g. A.I., robotics) will also 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.

Once this technology is available, the **operational aspects** and the use of vehicles in general will change radically. It will be necessary to take a critical look at rolling stock and signalling/control-command and adapt them to the new needs, possibly creating many different concepts that may cover the wide range of needs that may arise, and also reviewing which new technology will need to be created and deployed.

New operational principles and industrial concepts that will be **digital and service oriented** ("railway 4.0") have the potential to radically transform the railway value and supply chain and ultimately benefit the final user, being the passenger or freight forwarder.

Even if these paradigm changes represent an apparently longer-term scenario for the railway sector, it is necessary to evaluate to the needs and feasibility of technologies/operations projected to play a major role in this potential future.

### Scope:

The study (up to TRL 2) should formulate technological concepts tackling all of the following work-streams and their interconnection:

#### **a) Concepts for the future autonomous railway vehicles "train-centric"**

Here below some few possible technological points to look at (but not limited to) in the "train-centric" concepts (automatically running in existing railway infrastructure) the study should develop:

- Technology towards the "all electric" train (No pneumatics or hydraulics)
- Mechanical functions transferred to Electric / Electronics / Communications when possible (e.g. crash elements vs collision avoidance)
- State-of-art of technologies from other sectors to simplify and make manufacturing cheaper
- On-Board signalling intelligence moving to on-board the Interlocking and the Train Separation functions. Signalling system becomes Train-Centric based
- New structure and algorithms in order to achieve the train self-driving

The pre-identified aspects above should also be investigated in collaboration with the S2R-CFM-IP1-02-2018 and S2R-CFM-IP2-01-2018 and other relevant projects stemming from the CFM topics calls (in particular IP1 and IP2).

#### **b) Promising disruptive technologies impacting automation systems and maintenance concepts**

Here below some possible technological points to look at (but not limited to) in the formulation of concepts making use of arising disruptive technologies :

- A.I. could become 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).
- The new technologies today applied in robotics could be used for performing repetitive actions in checking infrastructure status and repairing/replacing devices. Also different and new concepts usage of robotics in the entire railway field could be part of this investigation (up to TRL2).

The pre-identified aspects above should also be investigated in collaboration with the S2R-CFM-IP2-01-2018 and other relevant projects stemming from the CFM topics calls (in particular IP2 and IP3).

#### **c) Railway 4.0**

Full system and life-cycle analysis on concepts as mobility as a service (MaaS), industry 4.0 (automated industry and industry as a service), railway clouds and decentralised ownership are among the ones this exploratory research should look at, providing a picture of the Railway 4.0.

In addition to considering the two previous work streams (but not limited to), here below some possible technological points to look at in the overall “Railway 4.0” concept:

- Machine to machine communication for Maintenance, Production, e.g.:
  - Axle counter knows it will soon have a failure,
  - Axle counter directly sends this diagnostic data to the supplier factory
  - Supplier factory builds spare part and delivers just in time
  - Digital supply-chains concepts and solutions
- Cloud centralised or decentralised services shared between transport companies for flexibility/scalability as well as service resiliency/availability, e.g.:
  - Investigation on future architecture that would leverage a service centric and self-organizing approach to minimize operational overhead and maintenance efforts.
  - Building blocks, which include but are not limited to software-defined networks, network function virtualization while embracing fog computing and edge computing for real-time critical applications.
  - Passenger and freight information systems integrated in a traffic and operation management of the railway system that is interconnected with other transport modes
  - Set up of a full railway IT ecosystem and connected business models that would ensure interoperability using advanced semantic technology independent from a unique standard for the entire railway value chain.

- Asset digitization, using IoT and big and open data processing and usage for the entire railway value chain

The aspects above and any more operational principle/industrial concept (up to TRL2) should also be investigated in collaboration with the other relevant projects stemming from the CFM topics calls (in all IPs).

Approaches to be incorporated in the proposal methodology:

- Comprehensive review of previous blue-skies EU/national funded projects related to this topic that did not find a way to the track/market, and critical evaluation of future applicability
- Trends in automotive, air and waterborne industry and analysis of transferability to railway rolling stock
- Forecast of evolution of key fundamental technologies, identification of technical risks and of potential blocking points
- Identification of key aspects for business feasibility
- Analysis of the current safety requirements and how the introduction of “train-centric” automated concept, the introduction of disruptive technologies and the digitalisation affect and change the railway safety approach
- Analysis of how the results the S2R running projects, planned from this AWP and in the MAAP directly contribute in the different work streams and concepts identified, and clarification of the missing components for their achievement

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-IP1-02-2018: Implementing new technologies for the TCMS
- S2R-CFM-IP2-01-2018: Advanced Signalling, Automation and Communication System
- S2R-CFM-IP3-01-2018: Research into optimised and future railway infrastructure

This do not preclude further necessary complementarity with other S2R projects related to other IPs.

As specified in section 2.3.1 of S2R AWP for 2018, 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 S2R JU expect proposals of requesting up to 1.15M and plan to finance at least up to two projects.

#### Expected Impact:

The initial concept investigations should look forward the possible achievement of the following future impacts:

- Increased capacity
- Reduced LCC

- Reduced errors (human, in the processes, etc.)
- High efficiency / increased performance
- High automation and auto-adaptive systems
- Simplified supervision and fast problems resolution
- Reduced complexity, simplified and interoperable interfaces
- Reduced wayside architecture
- Reduced efforts for V&V and further bug fixing
- Improved flexibility

Type of Action: Research and innovation Action

### **S2R-OC-IPX-02-2018 – Transversal exploratory research activities and knowledge transfer**

Specific Challenge:

Current activities in S2R are developing the fundamental building blocks that will allow the creation of the future railway interoperable system, but new disruptive technology can accelerate the pace or deviate the path.

This topic aim to strengthening the effectiveness of consensual exploratory research building in Europe, through continuous cooperation among the rail community, including decision-makers, to provide an orientation on the future needs and possible collaborative research on future and emerging innovative ideas.

This action will assist the rail-related European technology platforms (ETP) and will foster the creation of expertise and knowledge for the benefit of the future evolution of the rail system while supporting the competitiveness of the European rail sector.

This topic should stimulate the learning and exchange of knowledge from academia, research community and industrial partners build upon the S2R R&I results and also stimulating the transfer of new knowledge from other disciplines.

The challenge of this topic is also to consider, incorporate and further elaborate on the results of the complementary topic S2R-OC-IPX-03-2018: Innovative/breakthrough mobility concepts (with rail as backbone), in order to leverage the effect from a broad community of rail stakeholders (represented in the ETP) with transfer of knowledge and specialised PhD research activities.

Scope:

In order to address the challenges described above, the proposals should address the following workstream and coordination actions:

- Delivery of a Rail Sector observatory and roadmap:
  - monitoring, identification and analysis of new opportunities for innovative research of relevance to the evolution and attractiveness of the rail system and
  - development of a long-term perspective by focusing on innovative and interdisciplinary intermodal and multi-modal concepts considering rail as backbone beyond S2R scope and timeframe;

The roadmap should contain information on the S2R Capabilities and its Building Blocks (described in the S2R Multi Annual Action Plan) in the long-term period for S2R concepts

evolution. It shall integrate emerging trends and recent existing strategic documentations on rail transport and research produced at European (e.g. STRIA) or national level.

- Delivery of compiled and analysed data and statistics on the rail advantages/benefits in Europe, as for example:
  - Statistics of GDP influence growth that rail provide as contribution in each Country
  - Statistics of employments in the sector, in manufacturing industry, service industries/mainline, urban and local operating companies and infrastructure managers, research centre, etc.
  - Comparative studies of rail (long distance, regional and urban) passenger/freight demographics in the different Countries and overall usage of rail/local/urban public rail transport
  - Impact of rail on climate change and comparative study with other transport modes, including emerging trends as electric cars and taking into account S2R foreseen results
  - Study on how rail can better serve multimodality supported by case studies
  - Rail capacity and bottlenecks in the different Countries
- Benchmarking activities and support to the creation and organization of innovative rail initiatives in close cooperation with the S2R JU coupled with the rail R&I funded at EU level under H2020 such as S2R Science Awards, S2R Hackaton events, TRA.

Additionally, specifically addressing event/marketing activities of rail S2R funded innovations towards EU citizens.

The Scientific community of the European rail Technology Platform should be involved.

Strong and focused consortia must be made-up of leading European experts for transport technologies from both sector and research providers. The implementation of this action requires close collaboration with the ETPs dealing with rail transport research and innovation. Cooperation with the S2R JU will be an essential element in this coordination and support action.

**Note:** The project must not subsidise any direct or indirect costs (e.g. secretariat) of the ETP organisations. In kind contributions from additional stakeholders are welcome.

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

#### Expected Impact:

The expected impacts from these activities will be cross-fertilization of knowledge from other disciplines or of disruptive technology and innovation not yet fully applicable to rail, that will encourage the exploration of innovative and unconventional ideas and research directions in rail.

Other expected impacts are the kick-starting of new ideas through dedicated S2R events and overall contributing to the evolution of the S2R activities. Additionally, gathering all relevant stakeholders around a common forward-looking activity that include also dissemination and communication activities, aim as well to create strong engagement of scientists, citizens, innovators and policy makers and non-rail stakeholders.

#### **S2R-OC-IPX-03-2018: Innovative/breakthrough mobility concepts (with rail as backbone)**

#### Specific Challenge:

Current activities in S2R are developing the fundamental building blocks that will allow the creation of the future railway interoperable system, but new disruptive concepts can accelerate the pace or deviate the path.

This topic 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 broad challenges described above, the proposals should foresee PhD research for indicatively a period between 12 to 24 months on the following thematic: Innovative/breakthrough mobility concepts that keep rail as backbone of a sustainable European Transport system.

The PhD researchers are expected regularly to liaise with the S2R JU and to present their research findings to the S2R events, including those organized with the European rail Research Technological Platform and submit scientific papers to relevant conferences (e.g. TRA, WCRR, etc. but also non-rail related).

This action may be requested to provide relevant inputs to the European rail Technology Platform.

The S2R JU expect to finance four proposals from universities or similar high level institutes covering each at least one PhD student activities.

#### 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.

## ANNEX III Indicators and Scoreboard of KPIs

**TABLE I - Horizon 2020 Key Performance Indicators<sup>45</sup> common to all JTI JUs**

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

<sup>45</sup> (based on Annex II to Council Decision 2013/743/EU)

	Correspondence to general Annex 1	Key Performance Indicator	Definition/Responding to question	Type of data required	Data to be provided by	Baseline at the start of H2020 (latest available)	Target at the end of H2020	Automated
							<u>all societal challenges]</u>	
	15	Patent applications and patents awarded in the area of the JTI	Number of patent applications by theme; Number of awarded patents by theme	Patent application number	H2020 beneficiaries through project reporting; Responsible Directorate/Service (via worldwide search engines such as ESPACENET, WOPI)	n.a. [ <u>new approach</u> under H2020]	On average, 2 per €10 million funding (2014 - 2020) RTD A6	Yes
	16	Number of prototypes testing activities and clinical trials <sup>46</sup>	Number of prototypes, testing (feasibility/demo) activities, clinical trials	Reports on prototypes, and testing activities, clinical trials	H2020 beneficiaries through project reporting	n.a. [ <u>new approach</u> under H2020]	<u>[To be developed on the basis of first Horizon 2020 results]</u>	Yes
	17	Number of joint public-private publications in projects	Number and share of joint public-private publications out of all relevant publications.	Properly flagged publications data (DOI) from relevant funded projects	H2020 beneficiaries through project reporting; Responsible Directorate/Service (via DOI and manual data input-flags)	n.a. [ <u>new approach</u> under H2020]	<u>[To be developed on the basis of first Horizon 2020 results]</u>	Yes
	18*	New products, processes, and methods launched into the market	Number of projects with new innovative products, processes, instruments, methods, technologies	Project count and drop down list allowing to choose the type processes, products, instruments, methods, technologies	H2020 beneficiaries through project reporting	n.a. [ <u>new approach</u> under H2020]	<u>[To be developed on the basis of first Horizon 2020 results]</u>	Yes

<sup>46</sup> Clinical trials are IMI specific

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

	Correspondence to general Annex I	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 <sup>47</sup>	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

<sup>47</sup> 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.

**TABLE II - Indicators for monitoring H2020 Cross-Cutting Issues<sup>48</sup> 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
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

<sup>48</sup> (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
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 <sup>49</sup>	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 <sup>50</sup> 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

<sup>49</sup> This indicator (9.2) is initially intended to monitor the Digital Agenda (its applicability could be only partial)

<sup>50</sup> 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 <sup>51</sup> 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) <sup>52</sup>	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

<sup>51</sup> RTO: Research and Technology Organisation

<sup>52</sup> Data relates to pre-granting ethics review. This time span runs in parallel to granting process.

**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
<b>S2R</b>						
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
6	Number of Integrated Technology Demonstrators (ITDs) and System Platform demonstrations	Improve market uptake of innovative railway solutions through large-	JU	tbd in the Multi-Annual Action Plan		Yes

#	Key Performance Indicator	Objective	Data to be provided by	Baseline at the start of H2020	Target at the end of H2020	Automated
		scale demonstration activities				
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

## ANNEX IV List of Members of S2R JU other than the Union

NAME OF MEMBER	CONSTITUENT ENTITIES OF CONSORTIA	COUNTRY
AERFITEC Consortium	<i>AERNNOVA AEROSPACE S.A.U.</i>	ES
	<i>FIDAMC</i>	ES
	<i>FUNDACION TECNALIA RESEARCH &amp; INNOVATION</i>	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)	<i>Contraffric GmbH</i>	DE
	<i>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)</i>	DE
	<i>Waggonbau Niesky GmbH</i>	DE
	<i>Centro de Estudios e Investigaciones Técnicas (CEIT)</i>	ES
	<i>Verband der Bahnindustrie in Deutschland (VDB)</i>	DE
Construcciones y Auxiliar de Ferrocarriles		ES
Deutsche Bahn AG		DE
DIGINEXT		FR
EUropean Rail Operating community Consortium (EUROC)	<i>Infraestruturas de Portugal, S.A.</i>	PT
	<i>BLS AG</i>	CH
	<i>CP</i>	PT
	<i>Finnish Transport Agency</i>	FI
	<i>ÖBB-Infrastruktur AG</i>	AT
	<i>Polskie Koleje Państwowe S.A. (PKP)</i>	PL

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

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

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