Shift2Rail Joint Undertaking (S2R JU)

Annual Work Plan 2017
&
Budget Figures

ANNEX to GB decision no 25/2016

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1 INTRODUCTION

The Annual Work Plan 2017 (AWP2017) of the Shift2Rail Joint Undertaking (S2R JU) outlines the scope of the research and innovation activities that S2R JU will perform in 2017, implemented through call(s) for proposals open to its Members and third parties as well as specific calls for tenders. It also details the governance structure of S2R JU and the underpinning 2017 Budget.

Section 1 - Introduction describes S2R JU's background, mission and objectives. Section 2 describes more the activities planned for 2017 including the support to operations, call management rules, S2R JU governance and internal control framework. Section 3 explains the S2R JU 2017 Budget.

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 Annexe 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. Inter alia, S2R JU shall manage all rail-focused R&I actions co-funded by the Union.

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[1] 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[2] [3].

1.2 Mission and Objectives

The mission of the S2R JU is to coordinate and manage the Union research and innovation investments in the European rail sector.

In this respect, its main objective is to implement the S2R Programme, research and innovation activities in the railway sector in Europe, through the collaboration between stakeholders in the entire railway value chain, also outside the traditional rail sector, with particular attention to SMEs, research and technology centres and universities.

[1] 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

[2] Commission Decision N° C(2014) 7084 final

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

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[4] and more detailed in the S2R Multi-Annual Action Plan (MAAP)[5]. Overall, the S2R JU shall:

- 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 and providing all stakeholders with relevant and available information on projects 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, the involvement of small and medium sized enterprises (SMEs), as defined in Commission Recommendation 2003/361/EC (8), shall be ensured;
- 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 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[6] and its Rules

[4] http://ec.europa.eu/transport/modes/rail/doc/2015-03-31-decisionn4-2015-adoption-s2r-masterplan.pdf
[5] http://www.shift2rail.org/wp-content/uploads/2013/07/S2R-JU-GB_Decision-N-15-2015-MAAP.pdf
[6] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0104:0173:EN:PDF

of participation[7]. 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[8] 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 is structured around five Innovation Programmes (IPs) and five cross-cutting themes and activities (CCA):

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 compete more effectively with other modes and attract more passengers 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, reliable, safe and affordable travel experience for all passengers.

The S2R Master Plan identifies seven priority research and innovation areas in which activities should be undertaken with a view to achieving the ambition of IP1:

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

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

[8] Nor constituent entities of Industry Members in the form of consortia or groupings, nor their affiliated entities.

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 traffic management and automation 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), automation, as well as innovative real-time data collection, processing and communication systems, which have the potential to considerably enhance traffic management (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.

In order to be competitive with other modes but also integrated with them, 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[9] in terms of developing rail freight; almost doubling the use of rail freight compared to 2005, achieving a shift of 30% of road freight over 300 km to modes such as rail or waterborne transport by 2030, and more than 50% by 2050. Rail freight must be in a position to offer a cost-effective, attractive service to shippers that helps to take freight away from the already-congested road network.

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,

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

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.

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 that are related to non-technical issues such as product acceptance; development of a business case; 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.

2 ANNUAL WORK PLAN 2017

2.1 Executive Summary

2016 has been a year of transition for the S2R JU: it obtained its autonomy and started the R&I activities as a result of its own calls. The S2R JU's 2017 Annual Work Plan describes the research and innovation activities to be executed by its Other Members and beneficiaries of Open Calls in the next years.

The 2017 AWP foresees the following operational activities:

- launch of two calls for proposals and a call for tender for a total foreseen value of the action of 113,1M€:
- a competitive call for proposals (RIA and IA) for S2R JU Members with a total foreseen value of the actions of 92,9M€ (max S2R co-funding 41,3M€);
- an open call for proposals (RIA), where the S2R JU Members are excluded from participation, with a total foreseen value of the actions of 19,5M€ (100% funded);
- an open call for tenders, where the S2R JU Other Members are excluded from participation, with a maximum value of 0.7M€;
- other activities include: the organisation of the CCA activities, the establishment of a Project Management Handbook, the review of the MAAP, the oversight and monitoring of the R&I activities (including the lighthouses projects expected to be transferred to the S2R JU)

In the domain of stakeholder management and external relations, 2017 will see a closer collaboration between the S2R JU and the European Union Agency for Railways (EUAR) in different areas, as well as with the different International and European organizations and associations. 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 and communicate worldwide the successful achievements of the S2R JU Partnership.

In particular, the communications activities of the S2R JU will be revamped in 2017, with the following key activities:

- raise awareness about the S2R JU;
- promote stakeholders' engagement;
- promote the S2R JU within the EU Institutional arena;
- establish and develop 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;
- 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 2017 to ensure continuity of service delivery. The above intent has been summarised in the following goals: a. ramp up of the Programme; b. effective stakeholder engagement; c. continued provision of an effective organisation to support delivery of S2R JU's mandate.

The 2017 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 objectives of the S2R JU Programme in 2017 are the following:

- To progress in the R&I activities in line with the global programming laid down in the MAAP and in this respect prepare, launch a second open call for proposals (in accordance with the eligibility principles described in Section 1.2 and criteria in Section 2.3) and proceed to the award of the related grants and co-funding. In this respect, the participation of SMEs and railways stakeholders will be further promoted;
- To define and implement an appropriate process for each cross-cutting area and horizontal theme that allows for the transversal coordination to be executed and technical synergies to be extracted from all technical activities;
- To establish and implement a Project Management Handbook reflecting a highly automated, efficient and coherent work-flow, with the relevant support tools, to ensure the sound management of the R&I activities in compliance with S2R Regulations, Statutes and any other relevant rules. Within the regulatory framework, S2R JU with its Members will endeavour to minimize the administrative and bureaucratic burden to implement process innovation in a complex cooperation environment;
- To review the MAAP to ensure that, in line with the S2R Master Plan, it would reflect the level of ambition of the S2R initiative in a coherent and consistent manner, further refine the requirements for Integrated and System Demonstrators, including schedule and scope; ensure this will adequately be incorporated in the S2R AWPs, in the IP Steering Committee annual implementation plans and the Grant Agreements;
- To perform the oversight and monitoring of the R&I activities in accordance with the S2R rules and the aforementioned Programme Management Handbook, with particular regard to the Lighthouse Projects – expected to be transferred from the EC to S2R JU by year end 2016 and the activities awarded as a result of the 2015-2016 calls.

An indicative list of Key Performance Indicators (KPIs) was already elaborated by the Commission services last year aiming at the establishment of 3 groups of indicators, namely:

- Horizon 2020 Key Performance Indicators[10] common to all JTI JUs;
- Indicators for monitoring H2020 Cross-Cutting Issues[11] common to all JTI JUs;

[10] Based on Annex II to Council Decision 2013/743/EU.
[11] Based on Annex II to Council Decision 2013/743/EU.

- Key Performance Indicators specific to the S2R JU.

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

It should be noted that within the CCA "Long-term needs and socio-economic studies", more specific KPIs to assess S2R technology developments are under development.

2.2.2 **Risks & mitigations**

The table below indicates the main risks associated with the implementation of the Programme, as well as mitigation actions, ownership and deadlines.

Risk identified	**Action Plan**	**Ownership and deadline**
Unclear translation of strategic objectives as defined in S2R Master Plan and S2R MAAP into Annual Work Plans (i.e. selection of grant topics)	The Annual Work Plans are submitted to the Governing Board for approval, together with the opinion of the State Representative Group and scientific/technical advice of the Scientific Committee respectively. The System Integration Working Group may submit to the Executive Director for his consideration proposals for further enhancing strategic links.	ED - Annually in view of the preparation of the AWP By year end 2016
Conflicts of priorities may happen within S2R JU Members, when providing to Programme Office the technical input for the development of the calls. Such conflict could hinder the identification by the JU of objectives and priorities of the AWP2017.	The Programme Office should consist of staff with the necessary skills and competences to assess the IPs input to avail itself of with the necessary external expertise, including, but not only, from EUAR, State Representative Group and Scientific Committee.	ED – Annually in the preparation of the AWP
Change of specific JU Members R&D internal strategy or priority.	Identify the issue at early stage through close contact with Members. In this respect, the ED has started meeting bilaterally with the Members in order to maintain an open dialogue, with a view to escalate to the GB where a need would arise.	ED – regular bilateral meetings with the Members
Failure of Members to submit successful proposals in the calls for Members leading to a risk that they may not fulfil their Membership Agreements'	The Programme Office shall organise information meetings for Members on the process and procedure to submit proposal under H2020 Rules for participation. The Programme	S2R Programme Office in preparation of the AWP and during the calls process

Risk identified	Action Plan	Ownership and deadline
commitments to the S2R JU.	Office shall be alert at IP Steering Committee meetings too.	
Low participation in RIA actions by non-JU Members.	S2R JU Annual Work Plans to include topics that are of meaningful size and of interest to wide groups of stakeholders, with particular regards to SMEs and the railway community at large. Organisation of communication and partnering events, like information day.	S2R Programme Office in preparation of the AWP and during the calls process
Time to grant is delayed due to disputes within the consortium or failure of beneficiaries to provide relevant information. Collaboration does not happen because of disputes between consortia on the term of the collaboration agreement, in case of complementary grants.	Availability and promotion of existing guidelines material on S2R/H2020 and use of IPR Help desk. Put at the disposal of the complementary consortia and the Members a S2R collaboration agreement template and provide mediation also using existing guidelines material on H2020 and IPR Help desk.	S2R Programme Office in preparation of the AWP and calls A first draft collaboration agreement was made available to S2R beneficiaries in June 2016. Based on the experience of its initial implementation it might be revised.
Time to grant is delayed due to bottlenecks in the S2R JU due to insufficient staff resources	Staff establishment plan is fulfilled in 2017, and or further revised if need be.	ED to ensure that the recruitment procedure is in line with the S2R needs. 1st Semester 2017
Delays or inadequacies in the completion of activities in grants, especially those that are complementary or prerequisites to other grants to be awarded.	The Programme Office shall implement the processes and procedures that will be developed in the Project Management Handbook, supported and facilitated by a highly automated, efficient and coherent work-flow to monitor and report on projects.	S2R Programme Office. First exercise during the first half 2017.
S2R JU Members fail to deliver on in kind contribution to additional activities (IKAA).	Additional activities plan is contained in the Membership agreement. Organise information meetings for Members on the specificities derived from the S2R JU Regulation, and clarify in particular through guidelines for Members the certification and reporting requirements.	S2R Programme Office. Three meetings organized till July 2016; need to maintain at least yearly meetings with the Members on broad Financial Programme aspects.

Risk identified	Action Plan	Ownership and deadline
Lack of adequate dissemination of result may result in vague information to the end-user/interested parties and could compromise the JU impact.	Provide a platform where the dissemination plans could converge towards a coherent set of actions. Monitor the dissemination actions and actively promotes the projects' results.	S2R is assessing the best platform to ensure the communication and dissemination of results, as well as the set-up of appropriate tools to support the Programme. End of December 2016

2.2.3 **Scientific priorities & challenges**

The S2R Programme should cover all the levels of R&I and it is essential to ensure a coherent progression from lower Technology Readiness Levels (TRL) towards higher ones, fostering the development and use of cutting-edge technologies with participation of the whole rail value chain (including the users, operators, infrastructure managers, research centre/universities and suppliers). At the same time, through open calls particular attention should be maintained to exploratory research to ensure the adequate input in the innovation cycle of new ideas and leveraging R&I performed in other sectors.

The initial results of the Lighthouse Projects will have to be considered in the ongoing R&I activities within S2R. At the same time, the R&I activities to be initiated in 2017 as a result of the calls for proposals shall ensure, together with the activities stemmed from the S2R calls 2015-2016, a coherent start of the development of all Technology Demonstrators, in order to enable the timely completion and their further incorporation into Integrated Technology Demonstrators, covering different rail market segments.

The Scientific Committee will be a key partner of the Programme Office to ensure the necessary oversight and monitoring of the scientific challenges faced by S2R.

Finally, the S2R JU has the intention to launch during 2017 the "S2R Innovation Days" which could take the form a biennial event where to promote railway R&I and to create an open platform to prize exploratory research too. The S2R Innovation Days would be organised the years when the WCRR is not taking place.

2.2.4 **Calls 2017**

The S2R JU will launch in 2017 the following calls for proposals and tenders. The main means of implementation of the activities foreseen in the Annual Work Plan are grants that will be signed following the calls for proposals (relevant information is provided in sections 2.2.4.1-2.2.4.2) and contracts that will be signed following call for tenders (relevant information is provided in sections 2.2.4.5).

Activity	Type of call	Value of the actions (*)	Maximum S2R co-funding	In-kind contribution	Indicative publication date	Indicative dates of GA / contracts
Calls for	Open to	92,9	41,3	51,6	Q1 2017	Jul-Sep

Activity	Type of call	Value of the actions (*)	Maximum S2R co-funding	In-kind contribution	Indicative publication date	Indicative dates of GA / contracts
Proposals	S2R Other Members only					2017
Calls for Proposals	Open[12]	19,5	19,5	n/a	Q1 2017	Jul - Sep 2017
Call for Tenders	Open[13]	0,7	0,7	n/a	Q2 2017	Sept – Oct 2017
Total		113,1	61,5	n/a		

(*) Indicative amounts in Million EUR

2.2.4.1 Competitive call for proposals for S2R JU Other Members

In 2017, the S2R JU is planning to issue one call for proposals addressed to JU Other Members. Detailed topic descriptions are provided in Annex I.

Proposals should be invited against the following topics:

Topic number	Topic name	Type of action and expected Technical Readiness Level	Value of the actions (*)	Maximum S2R co-funding (*)	In-kind contribution (*)
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	RIA, up to TRL 3/4	18 901 890	8 400 000	10 501 890
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	RIA, up to TRL 5	30 153 015	13 400 000	16 753 015

[12] Open to non Other Members
[13] Open to non Other Members

Topic number	Topic name	Type of action and expected Technical Readiness Level	Value of the actions (*)	Maximum S2R co-funding (*)	In-kind contribution (*)
S2R-CFM-IP3-01-2017	Smart system energy management solutions and future station solutions	RIA, up to TRL 5/6	13 501 350	6 000 000	7 501 350
S2R-CFM-IP4-01-2017	Technical framework for attractive railway services	IA, up to TRL 6	9 225 923	4 100 000	5 125 923
S2R-CFM-IP4-02-2017	IP4 overall integration and demonstration	IA, up to TRL 6	4 050 405	1 800 000	2 250 405
S2R-CFM-IP5-01-2017	Real-time information applications and energy efficient solutions for rail freight	RIA, up to TRL 4/6	9 900 990	4 400 000	5 500 990
S2R-CFM-CCA-01-2017	Improving railway services for users and operators	RIA, up to TRL 4/5	7 200 720	3 200 000	4 000 720
TOTAL			**92 934 293**	**41 300 000**	**51 634 293**

(*) indicative amounts in EUR

2.2.4.2 Open call for proposals[14]

In 2017, the S2R JU will issue one open call for proposals dedicated to co-fund R&I activities. The S2R JU Other Members[15] are not eligible to participate. The S2R budget for this call is estimated at EUR 19 700 000. Detailed topic descriptions are provided in Annex II.

Proposals should be invited against the following topics:

Topic number – IP	Topic name	Type of action and expected Technical Readiness Level (TRL)	Maximum S2R co-funding (*)
S2R-OC-IP1-01-2017	Innovative materials & modular design for rolling stock applications	RIA, up to TRL 4/5	3 500 000
S2R-OC-IP1-02-2017	Tools, methodologies and technological development of the next generation of Running Gear	RIA, up to TRL2	2 800 000

[14] Open to non Other Members

[15] Nor constituent entities of Industry Members in the form of consortia or groupings, nor their affiliated entities , etc.

Topic number – IP	Topic name	Type of action and expected Technical Readiness Level (TRL)	Maximum S2R co-funding (*)
S2R-OC-IP2-01-2017	Operational conditions of the signalling and automation systems; signalling system hazard analysis and GNSS SIS characterization along with Formal Method application in railway field	RIA, up to TRL3	1 800 000
S2R-OC-IP2-02-2017	Energy harvesting methodologies for trackside and on-board signalling and communication devices. Adaptation of already existing technologies for developing a purely on-board Train Integrity	RIA, up to TRL 4	1 700 000
S2R-OC-IP3-01-2017	Smart metering and asset management of railway systems	RIA, up to TRL 5	2 200 000
S2R-OC-IP3-02-2017	Future stations and accessibility (IP1 and IP3)	RIA, up to TRL 3	1 200 000
S2R-OC-IP3-03-2017	Satellite and autonomous monitoring systems' solution	RIA, up to TRL5	600 000
S2R-OC-IP4-01-2017	Smart technologies for trip tracking and improved travel companion and trip tracking	RIA, up to TRL 4-5	3 500 000
S2R-OC-IP5-01-2017	Real-time yard and network management	RIA, up to TRL 4	1 500 000
S2R-OC-CCA-01-2017	Smart maintenance and human capital	RIA, up to TRL 4	700 000
TOTAL			**19 500 000**

(*) indicative amounts in EUR

2.2.4.3 Call management

As already mentioned, S2R JU plans to launch the aforementioned calls for proposals during Q1 2017 and in accordance with this indicative calendar

	Indicative timing (**)
Publication of the AWP 2017	Q4 2016
2017 call for proposals addressed to S2R JU Members only	
Publication of the AWP 2017	Q4 2016
Publication of the call for proposals (*)	Q1 2017
Deadline for the submission of proposals	Q2 2017

	Indicative timing (**)
Selection of the experts and evaluation of proposals	Q2-Q3 2017
Award, preparation and signature of S2R Grant Agreement	Q3 2017
2017 open call for proposals (***)	
Publication of the AWP 2017	Q4 2016
Publication of the call for proposals (*)	Q1 2017
Deadline for the submission of proposals	Q2 2017
Selection of the experts and evaluation of proposals	Q2-Q3 2017
Award, preparation and signature of S2R Grant Agreement	Q3 2017

* The possibility of an earlier publication of the call will be explored, to happen in Q4 2016.
** Maximum Time to Grant of 8 months from the deadline for the submission of proposals.
*** No participation of S2R Other Members (see previous sections too)

2.2.4.4 Prizes

As already mentioned in Section 2.2.3, the S2R JU is considering to establish some events such the "S2R Innovation Days" to be combined to the award of a prize to PHD Thesis and innovative ideas to be assessed as a result of a Prize Contest in accordance with Part F of the EC Horizon2020 Work Programme 2016-2017 - General Annexes.

The total amount dedicated to such Prize Contest will not exceed cumulatively EUR 15 000 to be allocated to the best three works in a railway field to be identified together with the Scientific Committee.

The Contest is expected to be launched in Q1 2017 with an award during Q4 2017.

2.2.4.5 Open call for tenders for non-JU members

In 2017, the S2R JU is planning to issue one call for tenders on "Pantograph - overhead contact line interaction (Dynamic behaviour and quality of the current collection)" relevant within the Cross-Cutting Activities (CCA) scope and within framework of the S2R JU MAAP.

The work stemming from this tender would serve as an input in particular to the European Union Agency for Railways (EUAR). The maximum budget allocated to this call for tenders will be of EUR 700 000.

The call for tenders addressed to non-JU members is scheduled not later than Q2 2017; it 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	CCA - Pantograph - overhead contact line	– Produce an input for both standardization bodies and EUAR to	€ 700 000

	interaction (Dynamic behaviour and quality of the current collection)	improve in terms of costs, time, and technical difficulty both the requirement (chapter 4 of TSI) and the assessment method (chapter 6 of TSI) of this parameter: ○ ENE [16] and LOC&PAS [17] technical specifications for interoperability (TSI) set out dynamic behaviour and quality of current collection as a basic parameter to make sure the proper interface between the pantograph and the overhead contact line for the current collection. This is a key parameter because it includes several phenomena (uninterrupted current collection, wear, temperature, elasticity and uniformity of elasticity, wave propagation speed, contact point movement, etc.) in one single parameter.	
Total			€ 700 000

2.3 Call for proposal management rules

In line with Article 2(e) of the S2R Statutes, the S2R JU shall financially support R&I actions through grants awarded as a result of calls for proposals in accordance with Horizon 2020 Rules for participation[18]. Unless specified otherwise, the provisions in all sub-sections of this Section apply to both aforementioned calls for proposals.

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*".

[16] Technical specifications for interoperability relating to the 'energy' subsystem of the rail system in the Union. More information on : http://www.era.europa.eu/Document-Register/Pages/Energy-Subsystem-ENE-TSI.aspx

[17] Technical specification for interoperability relating to the 'rolling stock — locomotives and passenger rolling stock' subsystem of the rail system in the European Union. More information on: http://www.era.europa.eu/Document-Register/Pages/RST-TSI.aspx

[18] Regulation (EU) no 1290/2013 of the European Parliament and of the Council, hereinafter also H2020 Rules for Participation.

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 two distinguished aforementioned calls.

In addition, as already foreseen in the 2015-2016 calls, also in 2017 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), will be enabled in the S2R JU Grant Agreements. This should ensure the complementary 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 Annual Work Plan.

A number of results produced within certain grants 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 S2R JU Grant 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 S2R JU Grant Agreements.

2.3.2 List of countries eligible for funding

Part A of the General Annexes to the EC Horizon2020 Work programme 2016-2017 applies. [19]

2.3.3 Standard admissibility conditions and related requirements

Part B of the General Annexes to the EC Horizon2020 Work Programme 2016-2017 applies.[20]

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 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;

[19] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf

[20] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf

- and open, competitive calls for proposals (or tenders) 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 2016-2017 – General Annexes applies[21].

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[22] 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 the EC Horizon2020 Work Programme 2016-2017 – General Annexes applies.[23]

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) [24].

2.3.6 **Evaluation rules**

Part H of the EC Horizon2020 Work Programme 2016-2017 - General Annexes applies.[25]

Selection criteria shall include 'financial capacity' and 'operational capacity'. Award criteria shall 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 each respective call shall be evaluated by independent experts, in accordance with Article 17.2 of the S2R Regulation. The evaluation of award criteria shall take into account the coherence of the proposals with the S2R Multi-Annual Action Plan.

Details on the submission and evaluation process are described in the Grants Manual - Section on: Proposal submission and evaluation. [26]

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[21] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf

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

[23] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf

[24] 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.

[25] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf

2.3.7 **Budget flexibility**

Part I of the General Annexes to the EC Horizon2020 Work Programme 2016-2017 applies.[27]

2.3.8 **Financial support to third parties**

Part K of the General Annexes to the EC Horizon2020 Work Programme 2016-2017 applies for actions performed by non-JU Members, supported by the JU.

Part K of the General Annexes to the EC Horizon2020 Work Programme 2016-2017 applies for actions performed by JU Members, supported by the JU.[28]

2.3.9 **Consortium agreement**

The legal entities wishing to participate in a project shall form a consortium and appoint one of its consortium 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 2016-2017 applies for actions performed by non-JU Members, supported by the JU.

Part L of the General Annexes to the EC Horizon2020 Work Programme 2016-2017 applies for actions performed by JU Members, supported by the JU.[29]

In addition to the dissemination of the results already foreseen in the H2020 portals, the results of the 2015/2016 and 2017 calls for proposals will be disseminated by the S2R JU in accordance with the Communication Strategy adopted by the Governing Board (via 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 the S2R website (e.g. the ”Solutions’ results” part of the website).

Tother with the Scientific Committee S2R 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

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[26] http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/pse/h2020-guide-pse_en.pdf

[27] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf

[28] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf

[29] http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf

Challenge “Smart, green and integrated transport”, call “Mobility for Growth”, topic 2. Rail, that should be transferred under the responsibility of S2R by year end 2016.

2.4 Support to Operations

2.4.1 Communication and events

One of the main objectives of communication activities is to ensure public awareness about the S2R JU's activities, in order to gain acceptance and support from various audiences at European and national level. For that reason, the role of the stakeholders will be essential, especially the State Representatives Group, as an interface towards Member States, national and regional policies and programmes.

It is equally important to promote the programme outputs, its R&I achievements and the culture of innovation that S2R is building within the sector. 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 S2R, to be performed in strict coordination and with the support and cooperation of its Members and in line with a Communication Strategy adopted by the Governing Board in 2016, 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 gaining 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, participation to regional and national events.
- **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, brochures will enhance the visibility of S2R JU towards other stakeholders, including the general public.
- **Mobilise applicants for S2R JU Open calls for proposals** 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**, on the one hand, in order to stimulate the public interaction on key issues and improve public awareness on S2R JU activities and, on the other hand, to disseminate the activities, progress, results, etc. of the projects performed by S2R Members.
- **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.

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

- S2R Members, in particular S2R project coordinators and participants, who will communicate the success of S2R to various audiences;
- Scientific Committee;
- S2R management and staff;
- ERRAC (European Rail Research Advisory Council) reaching out to policy makers and decision makers inside ERRAC
- Local multipliers in the Member States such as States Representative Group reaching out to local stakeholders.

In June 2015, the S2R JU signed a specific contract for Communication with RETELL consortium, under the Framework contract № RTD-L05-2010-INFORMATION PRODUCTS LOT 1 of DG RTD, expiring in July 2016.. Follow up contract for Communication Services was foreseen in the Annual Work Plan 2016, so that the work can continue in 2017, after the expiry of the previous contract.

During 2017, the S2R JU will participate to key events and, as already mentioned will assess the possibility to design and finance the "S2R Innovation Days".

The 2017 Budget includes an amount of EUR 300.000 for Communication and Events Activities under the title "PR AND EVENTS".

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, the S2R JU makes use of SLAs (Service Level Agreements) concluded with relevant Commission Services or other interinstitutional framework contracts with Union's Agencies and Bodies with the objective to reduce the administrative burden of ad hoc procedures.

Nevertheless, where such contracts would not be available and within the limits of the budgetary availabilities, the S2R JU will launch the necessary procedures in accordance with Article 33 of the S2R Decision No 21/2015 of 15 December 2015 of the Governing Board on the revised financial rules (S2R Financial Rules).

The indicative planning for the open calls for tenders is

Indicative Title	Indicative expenditure (EUR)	Type of procedure	Indicative schedule
Communication and event services and supplies	250,000.00	Open Call Framework Contract	Q1-Q3 2017

2.4.3 **IT and logistics**

S2R has implemented common ICT tools and related services (training, etc) provided by the European Commission on the financial management and H2020 call management, in accordance with the relevant underpinning agreements and costs.

In addition, the S2R JU is participating to the joint strategic ICT plan of the Joint Undertakings located in the White Atrium building.

With particular regard to Programme Management, during 2016 the S2R JU has launched a call for tender to procure and make available a cooperation and support tool to ensure the adequate monitoring and sound management of the S2R resources. The objective is to have the tool in place early 2017.

The S2R JU will assess the current ICT set up and consider the next steps in compliance with the principle of sound financial management, its Internal Control Framework and the budget availabilities.

2.4.4 **S2R JU Programme Office – HR matters**

In accordance with Article 10.5 of the S2R Statutes, the ED shall set up a Programme Office execution of all tasks arising from S2R activities and functioning. In order to implement the present AWP 2017 and following the decision of the Budgetary Authority of the Union to grant the JU 4 additional posts (see section 3.2 Staff Establishment Plan), the JU intends to fill in the new positions in a manner to ensure full staffing as from early 2017.

In addition to statutory staff Members, the JU also intends to recruit seconded national experts (SNE) in order to benefit from high level of professional knowledge in particular in areas where such expertise is not readily available. In addition, the S2R JU will participate to the Traineeship Programme of the European Commission.

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

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).

Considering that as from 2017 some S2R staff members may be eligible for reclassification, the necessary exercise 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**

As from the S2R JU financial autonomy in May 2016, the Commission provides to the JU the financial tools ABAC and SAP.

Furthermore, the S2R Financial Rules define powers and responsibility of the S2R JU Accounting Officer. In this respect, the Governing Board has appointed the Accounting Officer of the EC also as the Accounting Officer to the JU.

In terms of financial management, during the first years of life of the S2R JU and before the autonomy, the provisions of Article 16.2 of the S2R Statutes were not complied with. As a result, the

S2R JU will ensure the adequate balancing of the financing of the Administrative Costs between Union and Industry Members during 2017.

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.

2.5 Governance

In accordance with the S2R Statutes, 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.

In 2017, the Governing Board is planning to hold three ordinary meetings.

The key activities are listed below:

Key activities in 2017 – timetable	
Adopt 2016 Annual Activity Report	Q1
Discuss draft 2018 Annual Work Plan	Q2- Q3
Discuss preliminary draft budget 2019	Q2 - Q3
Adopt the key documents for the S2R JU's operations in 2018: 2018 Annual Work Plan, 2018 budget and staff establishment plan	Q4

2.5.2 **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 2017, two meetings of the Scientific Committee are planned (Q2 and Q4).

The tentative key activities are listed below:

Key activities in 2017 – timetable	
5th Meeting of the SC. The SC would: – Provide advice on the draft 2018 Annual Work Plan. – Provide advice on the planned calls for proposals.	Q2
6th Meeting of the SC. The SC would:	Q4

– Provide advice on the scientific priorities to be addressed in the 2019 Annual Work Plan, including links with similar research activities carried out for example in Horizon 2020 – Provide advice to the GB on the programme progress of the S2R and other strategic issues	

2.5.3 **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.

During the year 2017, two meetings of the States Representatives Group are planned (Q2 and Q4).

The tentative key activities are listed below:

Key activities in 2017 – timetable	
6th Meeting of the SRG. The SRG would: – Provide advice on the draft 2018 Annual Work Plan. – Provide advice on the planned calls for proposals.	Q2
7th Meeting of the SRG. The SRG would: – Provide advice on the scientific priorities to be addressed in the 2019 Annual Work Plan, including links with similar research activities carried out for example in Horizon 2020 – Provide advice to the GB on the programme progress of the S2R JU and other strategic issues – Provide updated information and discuss initiatives on: regional and national research and innovation programmes to allow synergies; dissemination and communication activities; and deployment activities in relation to S2R JU.	Q4

2.5.4 **Other Groups**

The Governing Board has established the following Working Groups in accordance with Article 5 of the S2R Statutes:

- S2R System Integration Working Group and its sub groups, “MAAP Tiger Team”, “CCA sub-group” and “IP coordination”;
- User Requirements/Implementation and Deployment Working Group.

2.6 Internal Control framework

In May 2016, the Executive Director has adopted the Internal Control Framework of the S2R JU which is based on the model currently in force with the Commission Services. The Internal Control Framework contains the key elements to ensure the sound management of the JU in accordance with Article 11 of the S2R Financial Rules.

Financial procedures

In view of the financial autonomy, as already mentioned, the S2R JU has implemented the financial systems provided by the Commission Services, as well as the key processes and procedures to ensure the adequate management of the financial resources, in accordance with the S2R Financial Rules budgetary and financial principles.

The Manual of Financial Procedures has been designed to guarantee a segregation of duties and to apply the four eyes principle in S2R JU financial transactions. During 2017, the work to improve the sound management of S2R processes and procedures will continue.

2.6.1 **Ex-ante and ex-post controls**

The S2R JU's ex-ante and ex-post controls aim to ensure that the actions financed from the budget are effectively carried out and implemented correctly.

The overall objective of the ex-ante controls is to ascertain that the expenditure is in order and complies with the provisions applicable and that the principle of sound financial management has been applied: The finance and operational teams will continue to work closely together in their day to day activities of initiation, verification and payments of invoices and cost claims, creation of commitments, recovery orders, validation of financial and technical reports and following-up on other financial and administrative aspects of the projects. These activities will be conducted in a timely manner that will be monitored through the defined set KPIs, in particular, the time to pay, the budget and work plan execution.

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 Services. Considering that during 2016 there will be only pre-financing payments and some limited interim payments in 2017, it is not expected that ex-post audits will take place in 2017. The approach will be discussed with the Common Audit Service early 2017, based on their initial estimated activities. When necessary, the S2R JU intends to make use of the provisions of Article 10 of the Delegation Agreement signed with the Commission on ad hoc ex-post audit activities.

2.6.2 **Audits**

In accordance with the Article 26 of the S2R Financial Rules, the Commission's Internal Auditor shall act as S2R Internal Auditor and in this respect report to the Governing Board and Executive Director.

With regard to External Audits, the provisions of Article 46 of the S2R Financial Rules shall apply. The annual accounts of the S2R JU shall be verified by an independent external auditor; the selection process was launched in June 2016, making use of the relevant Commission Services

Framework Contracts, and it is expected to be finalized for the first audit 2017 by year end 2016. In addition, the European Court of Auditors shall prepare on a yearly basis an Special Annual Report, taking into consideration the work performed by the aforementioned independent external auditor.

3 BUDGET 2017

3.1.1 **Budget information**

The S2R Budget 2017 contains as revenue appropriations the contributions of its Members and in particular those of the Union; as a consequence, the S2R Budget 2017 is largely dependent on the adoption of the EU General Budget for 2017 (expected by the end of December 2016) before being adopted by the S2R Governing Board.

The present Budget reflects the amounts submitted to the Commission Services in view of the preparation of the Union Draft Budget 2017. It might be subject to adjustments considering the appropriations made available by the Union and to amendments to take into account the 2016 Economic Outturn and any other unexpected element. Any 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 2017:

- 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 463 500 relating to the Expert Evaluators. This amount is included to the S2R Budget but will be managed by the REA Services.

Expenditure

Staff Expenditure (Title 1)

S2R JU details its staff expenditure into following Chapters to cover:

- 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 2,082,000 and represents 55.6 % 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: All expert and meeting costs for evaluations and project reviews, Beneficiary portal. This chapter also includes EUR 463 500 relating to the Expert Evaluators. This amount is included to the S2R Budget but will be managed by the REA Services.
- 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 costs of the JU as detailed earlier in the document.

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

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 2017

STATEMENT OF REVENUE

Title / Chapter	Heading	2015 Executed Budget CA	2015 Executed Budget PA	% of Budget 2017 CA	% of Budget 2017 PA	2016 Adopted Budget CA	2016 Adopted Budget PA	2017 Budget CA	2017 Budget PA	*CA Variance 2016/2017 EUR*	*CA Variance 2016/2017 %*	*PA Variance 2016/2017 EUR*	*PA Variance 2016/2017 %*
9	**REVENUE**												
9 0	**CONTRIBUTIONS**												
	CONTRIBUTION FROM THE EUROPEAN UNION	**46,686,379**	**1,230,305**	**74.0%**	**2.3%**	**46,869,535**	**47,283,650**	**63,126,601**	**53,657,939**	***16,257,066***	***34.7%***	***6,374,289***	***13.5%***
9 0 0	*Administrative Budget*	*1,352,212*	*1,230,305*	*83.6%*	*76.0%*	*1,620,687*	*1,992,142*	*1,618,419*	*1,618,419*	*(2,268)*	*(0.1%)*	*(373,723)*	*(18.8%)*
9 0 1	*Operational Budget*	*45,334,167*	*0*	*73.7%*	*0.0%*	*45,248,848*	*45,291,508*	*61,508,182*	*52,039,520*	*16,259,334*	*35.9%*	*6,748,012*	*14.9%*
	CONTRIBUTION FROM MEMBERS OTHER THAN THE EU	**887,390**	**887,390**	**54.8%**	**54.8%**	**2,353,105**	**2,353,105**	**1,618,419**	**1,618,419**	***(734,686)***	***(31.2%)***	***(734,686)***	*(31.2%)*
9 0 2	*Administrative Budget*	*887,390*	*887,390*	*54.8%*	*54.8%*	*2,353,105*	*2,353,105*	*1,618,419*	*1,618,419*	*(734,686)*	*(31.2%)*	*(734,686)*	*(31.2%)*
9 3	**UN-USED APPROPRIATIONS PREVIOUS YEARS**			**0.0%**	**0.0%**	**1,009,328**	**887,390**	**2,831,968**	**1,683,120**	***1,822,640***	***180.6%***	***795,730***	*89.7%*
9 3 0	*Un-used appropriations previous years Administrative*			*0.0%*	*0.0%*	*1,009,328*	*887,390*	*1,683,120*	*1,683,120*	*673,792*	66.8%	*795,730*	*89.7%*
9 3 1	*Un-used appropriations previous years Operational*			*0.0%*		*0*	*0*	*1,148,848*	-	*1,148,848*		*0*	*0.0%*
TOTAL REVENUE		**47,573,769**	**2,117,695**	**70.4%**	**3.8%**	**50,231,968**	**50,524,145**	**67,576,988**	**56,959,478**	***17,345,020***	***34.5%***	***6,435,333***	***12.7%***

STATEMENT OF EXPENDITURE

Title Chapter	Heading	2015 Executed Budget		% of Budget 2017		2016 Adopted Budget		2017 Budget		*CA Variance 2016/2017*		*PA Variance 2016/2017*	
		CA	PA	CA	PA	CA	PA	CA	PA	*EUR*	*%*	*EUR*	*%*
1	**STAFF EXPENDITURE**												
1 1	STAFF IN ACTIVE EMPLOYMENT	357,942	357,942	20.3%	20.3%	1,100,000	1,100,000	1,760,000	1,760,000	*660,000*	*60.0%*	*660,000*	*60.0%*
1 1 0	*Temporary Agents*	*120,682*	*120,682*	*12.5%*	*12.5%*	*400,000*	*400,000*	*750,000*	*750,000*	*350,000*	*87.5%*	*350,000*	*87.5%*
1 1 1	*Contract Agents, Interim Staff, trainees and SNEs*	*237,260*	*237,260*	*30.0%*	*30.0%*	*700,000*	*700,000*	1,010,000	1,010,000	*310,000*	*44.3%*	*310,000*	*44.3%*
1 3	MISSION COSTS	5,519	5,519	11.0%	11.0%	40,000	40,000	50,000	50,000	*10,000*	*25.0%*	*10,000*	*25.0%*
1 5	TRAINING	0	0	0.0%	0.0%	20,000	20,000	67,000	67,000	*47,000*	*235.0%*	*47,000*	*235.0%*
1 9	OTHER STAFF EXPENDITURE	99,718	49,398	48.6%	24.1%	130,000	183,558	205,000	205,000	*75,000*	*57.7%*	*21,442*	*11.7%*
	TITLE 1 TOTAL	**463,179**	**412,859**	**22.2%**	**19.8%**	**1,290,000**	**1,343,558**	**2,082,000**	**2,082,000**	***792,000***	***61.4%***	***738,442***	***55.0%***
2	**ADMINISTRATIVE EXPENDITURE**												
2 0	RENTAL OF BUILDINGS AND ASSOCIATED COSTS	169,778	194,748	53.9%	61.8%	320,000	320,000	315,000	315,000	*(5,000)*	*(1.6%)*	*(5,000)*	*(1.6%)*
2 1	IT EXPENDITURE AND TECHNICAL FACILITIES	62,664	18,965	38.0%	11.5%	400,000	443,699	165,000	165,000	*(235,000)*	*(58.8%)*	*(278,699)*	*(62.8%)*
2 2	MOVABLE PROPERTY AND ASSOCIATED COSTS	257,599	361,559	644.0%	903.9%	38,000	84,040	40,000	40,000	*2,000*	*5.3%*	*(44,040)*	*(52.4%)*
2 3	CURRENT ADMINISTRATIVE EXPENDITURE	2,420	406	4.0%	0.7%	55,000	57,014	61,000	61,000	*6,000*	*10.9%*	*3,986*	*7.0%*
2 4	POSTAGE AND TELECOMMUNICATIONS	0	0	0.0%	0.0%	25,000	25,000	30,000	30,000	*5,000*	*20.0%*	*5,000*	*20.0%*
2 5	ADMINISTRATIVE BOARD EXPENDITURE	24,690	20,953	24.7%	21.0%	80,000	83,737	100,000	100,000	*20,000*	*25.0%*	*16,263*	*19.4%*
2 6	ADMINISTRATIVE SUPPORT SERVICES	109,378	109,378	21.9%	21.9%	450,000	450,000	500,000	500,000	*50,000*	*11.1%*	*50,000*	*11.1%*
2 7	PR AND EVENTS	109,807	28,097	36.6%	9.4%	242,000	323,710	300,000	300,000	*58,000*	*24.0%*	*(23,710)*	*(7.3%)*
2 9	OTHER INFRASTRUCTURE AND OPERATING EXPENDITURE	30,759	83,340	20.5%	55.6%	400,000	418,759	150,000	150,000	*(250,000)*	*(62.5%)*	*(268,759)*	*(64.2%)*
	TITLE 2 TOTAL	**767,095**	**817,446**	46.2%	49.2%	**2,010,000**	**2,205,959**	**1,661,000**	**1,661,000**	***(349,000)***	***(17.4%)***	***(544,959)***	***(24.7%)***
	TOTAL ADMINISTRATIVE EXPENDITURE (Title 1 and Title 2)	**1,230,274**	**1,230,305**	32.9%	32.9%	**3,300,000**	**3,549,517**	**3,743,000**	**3,743,000**	***443,000***	***13.4%***	***193,483***	***5.5%***

STATEMENT OF EXPENDITURE

Title Chapter	Heading	2015 Executed Budget		% of Budget 2017		2016 Adopted Budget		2017 Budget		*CA Variance 2016/2017*		*PA Variance 2016/2017*	
		CA	PA	CA	PA	CA	PA	CA	PA	*EUR*	*%*	*EUR*	*%*
3	**OPERATIONA EXPENDITURE**												
3 0	OPERATIONAL EXPENDITURE	45,334,167	0	73.7%	0.0%	44,100,000	45,291,508	61,508,182	52,039,520	*17,408,182*	*39.5%*	*6,748,012*	*14.9%*
TITLE 3 TOTAL		**45,334,167**	-	73.7%	0.0%	**44,100,000**	**45,291,508**	**61,508,182**	**52,039,520**	***17,408,182***	***39.5%***	***6,748,012***	***14.9%***
4	**UNUSED APPROPRIATIONS NOT REQUIRED IN CURRENT YEAR**												
4 0	ADMINISTRATIVE BUDGET			0.0%	0.0%	1,683,120	1,683,120	1,176,958	1,176,958	*(506,162)*	*(30.1%)*	*(506,162)*	*(30.1%)*
4 1	OPERATIONAL BUDGET			0.0%	0.0%	1,148,848	0	1,148,848		*0*	*0.0%*	*0*	*0.0%*
TITLE 4 TOTAL				0.0%	0.0%	**2,831,968**	**1,683,120**	**2,325,806**	**1,176,958**	***(506,162)***	***(0)***	***(506,162)***	***(30.1%)***
TOTAL EXPENDITURE		**46,564,441**	**1,230,305**	68.9%	2.2%	**50,231,968**	**50,524,145**	**67,576,988**	**55,719,958**	***17,345,020***	***34.5%***	***5,195,813***	***10.3%***
BUDGET OUTTURN		**1,009,328**	**887,390**			-	-	-	-				

Contributions overview

CONTRIBUTIONS OVERVIEW	2015	2016	2017
CONTRIBUTIONS FROM THE UNION	**46,686,379**	**46,869,535**	**63,126,601**
CONTRIBUTIONS FROM MEMBERS OTHER THAN THE UNION	**887,390**	**81,992,439**	**53,252,712**
Title 1 and Title 2 (financial)	887,390	2,353,105	1,618,419
Title 3 (in-kind)		79,639,334	51,634,293
TOTAL CONTRIBUTIONS	**47,573,769**	**128,861,974**	**116,379,313**

A summary statement of the schedule of payments due in subsequent financial years to meet budget commitments entered into in earlier financial years

	Commitment Appropriations		Payment Appropriations		
	Unpaid Amount (RAL) from earlier years	**Budget 2017**	**Budget 2017**	**Estimate Budget 2018**	**Estimate Budget 2019 and after**
2014 Work plan (1)	26,000,000		20,800,000	5,200,000	
2015 Work Plan	22,384,444		1,492,119	13,664,217	4,167,084
2016 Work Plan	22,907,064		1,087,401	15,949,980	2,804,424
2017 Work Plan Administrative		3,236,838	3,236,838		
2017 Work Plan Operational		61,508,182	28,660,000	5,774,331	27,073,851
Total	**71,291,508**	**64,745,020**	**55,276,358**	**46,714,811**	**34,045,359**

(1) Assuming that the "Lighthouse" projects (resulting from H2020 2014 MG.2 call under the Horizon 2020 Transport Work Programme 2014-2015, and currently managed by the European Commission) will be taken over by S2R JU in 2016.

3.2 Staff Establishment Plan

Function group and grade	2015				2016		2017	
	Authorised under the EU Budget		Actually filled as of 31/12/2015		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
AD 13								
AD 12								
AD 11								
AD 10								
AD 9		2				2		2
AD 8		1						
AD 7				1				1
AD 6								1
AD 5				1		1		
AD TOTAL		4		2		4		5
AST 1-11								
AST TOTAL								
AST/SC 1-6								
AST/SC TOTAL								
TOTAL		4		2		4		5
GRAND TOTAL	4		2		4		5	

Contract Agents

Contract agents	Authorised 2015	Recruited as of 31/12/2015	2016	Budget 2017
Function Group IV	5	4	7	11
Function Group III	3	2	3	3
Function Group II	2	2	3	2
Function Group I				
TOTAL	10	8	13	16

Seconded National Experts

Seconded National Experts	Authorised 2015	Recruited as of 31/12/2015	2016	Budget 2017
TOTAL				2

4 ANNEXES

ANNEX I 2017 Call for proposals for the JU Members – Topic descriptions

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

Specific Challenge: A range of key rolling stock technologies oriented at achieving the overall S2R Master Plan objectives (high reliability, high capacity, low cost and improved performance) need to be developed to a point that enables the future development of the demonstrators foreseen in S2R. These high level objectives are influenced by many functional elements of the vehicle, so the fundamental challenge to be addressed is to define the specific solutions at sub-system level which will work together to produce the desired benefits at system level. The following individual challenges placed at the different rolling stock subsystems can contribute to these objectives:

- *Carbodyshell*: The challenge is to develop lighter carbodyshells which make full use of the possibilities of composite materials including integration of functions. This is linked to identifying the specific design principles, materials and manufacturing processes that fulfil the requirements set in previous activities[30], in terms of material properties, manufacturing cost and certification.
- *Running Gear*: The challenge is to develop and combine adequately suitable technologies to produce light, low noise, track friendly, reliable, low LCC running gear.
- *Brakes*: The challenge is to develop the future brake system concept based on complementary technologies and considering both adhesion-dependent and adhesion-independent approaches, leading to a full system approach with efficient brake force generation and reduced noise emissions.
- *Accessibility and Doors*: The challenge is to provide seamless and flexible access to the train to persons with reduced mobility, while reducing the weight and the cost, improving the comfort features (noise, thermal, etc.), and adding functionalities of door and access systems.
- *Modular interiors*: The challenge is to identify and define modular, flexible approaches for the design of train interiors including driver's desk, taking into account new generation of driver´s simulators. This approach search to increase/adapt seating capacity, to improve/adapt passenger flow in and out the train and to increase passenger comfort.

The completion of all these challenges, along with the activities already started in the areas of TCMS, Traction and Brakes as a result of the S2R JU 2016 calls for proposals, will contribute to the achievement of the objectives set out for IP1 in the S2R MAAP, as described here below.

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

[30] FP7 Refresco project, H2020 Roll2Rail project

- *Carbody Study (TD1.3)*: Building on the work carried out towards the creation of a regulatory framework for the use of composite material in structural applications in trains and the activity carried out in the REFRESCO project, and on the definition of the technical specification of the prototypes to be built in S2R which is already being carried out in H2020 ROLL2RAIL project, the work should focus on the selection and benchmarking of material and manufacturing alternatives, the definition of material characterization and the certification process associated. The activity is expected to prepare conceptual design solutions up to TRL3.
- *Development of concepts & technologies towards future running gear (TD1.4)*: A multi-technology approach will have to address several functions of running gear (comfort, curving, structural function, rolling components, health monitoring, etc.). Proposals should address the following aspects: technical specification of future running gear; innovative sensors for condition monitoring; new or improved materials for bogie frames and wheelsets; methodologies for the prediction of running gear noise & vibration; concepts for noise reduction; and certification and safety methods/tools for active and passive control systems; and address possible certification issues for all such potential technologies developed. The Universal Cost Model methodology being developed in the Roll2Rail project will be used to evaluate the benefits of the proposed developments. The activities are expected to prepare specific conceptual design solutions up to TRL3.
- *Development of future noise-reduced brake system solutions (TD1.5):* the work should focus on a full system approach with efficient brake force generation based on complementary technologies (innovative friction pair solutions, electro-mechanic solutions & adhesion independent frictionless low-noise brake system solution (e.g. next generation Eddy current brakes)), incl. the development of proposals for the technical standardisation of the assessment of brake system and virtual certification. The activities are expected to reach TRL3, including the development of specific conceptual design solutions.
- *Development of innovative concepts towards new generation of door system (TD1.6):* The proposals are expected to address the following aspects:
    - Adaptable gap filler for easier and independent access for Persons with Reduced Mobility (PRM) compatible with the 2 standard European station platforms (550 mm and 760 mm) and vertical gaps up to 200/250 mm compatible with existing and future station platforms.
    - Integration and utilization of new technologies for door entry surveillance and passenger information.
    - Selection of metallic, plastic or composite materials, material characterization, architecture and integration of new metallic and composite technologies of the leaves for weight, comfort and energy optimization.

  The activities are expected to reach TRL3, incl. development of specific conceptual design solutions.

- *Development of concepts towards new generation of interiors modularity (TD1.7):* Activities are expected to start with an analysis of the state of art of technical possibilities for a modular design interior including for example seats, tables, interiors ambiances, screens and driver's desk from different transport modes (railway, aircraft interiors, etc.).

Both for new generation of drivers' cab and ultra-light seats, this topic call will feed specifications to the complementary topic S2R-OC-IP1-01-2017 in September 2018 at the latest. As a result, the opportunities of Modularity In Use will be identified and will lead to the development of a range of specific conceptual ideas. The activities are expected to reach TRL 3 or 4, including the development of conceptual design solutions.

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

The implementation of this action requires close collaboration with ROLL2Rail project ('lighthouse' project resulting from H2020 call MG2.3-2014) [31].

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-IP1-01-2017: Innovative materials & modular design for rolling stock applications
- S2R-OC-IP1-02-2017: Tools, methodologies and technological development of the next generation of Running Gear
- S2R-OC-IP3-01-2017: Future stations and accessibility
- S2R-CFM-IP3-01-2017: Smart system energy management solutions and future station solutions
- S2R-CFM-IP5-01-2017: Real-time information applications and energy efficient solutions for rail freight

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

- S2R-CFM-IP1-01-2016: Development of concepts towards the next generation of traction systems and management of wheel/rail adhesion
- S2R-CFM-IP1-02-2016: Development of new technological concepts, standard specifications and architectures for train control and monitoring, with specific applications in train-to-ground communications and high safety electronic control of brakes
- S2R-CFM-CCA-02-2015: Energy and sustainability, including noise and vibrations baselines assessment

As specified in section 2.3.1 of S2R AWP for 2017, 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 will only fund one proposal under this topic.

Expected Impact: The most significant benefits expected from these actions, once the technologies developed are fully implemented and deployed, are:

- Significant weight reductions in major sub-systems of railway vehicles, such as car-bogies, running gear, doors and train interiors. This weight reduction will have several side effects such as:
    - Reduction of the energy consumption of the vehicle

[31] However, as the EC Work Programme 2014-2015 does not contain sufficiently detailed requirements, the provisions on complementary grants in the S2R MGA are not mandatory for the beneficiaries of Roll2Rail project , who may accept them on a voluntary basis, subject to their explicit agreement.

    - Increased track friendliness
    - Additional freedom for vehicle design
- Reduction of the Life Cycle Cost of the vehicle and the whole railway system, reduction of track damage and improved health monitoring
- Increase in passenger comfort, improved access systems and insulation, reduction in noise emission and transmission in running gear and brakes and additional flexibility for the interiors
- Increase in components reliability
- Improved passenger experience and accessibility.
- Increase in passenger capacity by new kinds of comfort seat for high density train and by innovative compact and flexible driver's desks.

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

Type of Action: Research and Innovation Actions

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

Specific challenge: ERTMS/ETCS is evolving and is requiring incorporating new technologies and functionalities with the aim of improving the capability of tackling new markets and new railway segments. Satellite and moving block applications are one of the key aspects of ERTMS/ETCS evolution. The challenge is to contribute, as defined in the S2R Master Plan, with technological advancement, to the rapid and broad deployment of new technologies and systems for railway signalling, control systems and supervision, by offering improved functionalities and standardized interfaces, based on common operational concepts, facilitating the migration from legacy systems, decreasing overall costs, adapting applications to the needs of the different railway segments.

A full system approach within the Shift2Rail programme will require, from the very beginning, synchronizing the development of required technological solutions, e.g. Fail-Safe Train Positioning (through satellite technology), On-board Train Integrity, Traffic Management Evolution, Formal Methodology and standardisation progress in method and content for application in railway.

In order to preserve both the short-term stabilisation of the specifications, and the long-term evolution of ERTMS, a key objective is to maintain backward compatibility of ERMTS technologies. With this respect the role of the European Union Agency for Railways (EUAR), will be instrumental, acting as the system authority for ERTMS. S2R will oversight, together with EUAR substantial contribution, over the IP2 system roadmap related to ERTMS.

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

1. Regarding *Fail-Safe Train Positioning (including satellite technology),* the proposed R&I activities should include Phase 1, 2 and partially 3 of the TD2.4 planning as described in the S2R MAAP. Specifically the work stream has the aim to:
   - Acquire information and analyse the state-of-the-art of the GNSS technologies (coming from results of the test campaign and the review of the statistical characterisation of the GNSS SIS done in the context of STARS project, or coming from H2020 ITS related call) of possible supporting technologies based on kinematic multisensory platforms and radio localisation. In addition, the performances achievable with such technologies should be quantified. Finally, the SRS (which includes functional and non-functional requirements), and the System Architecture documents of the new Fail-Safe Train Positioning subsystem will be defined and delivered.
   - Identify different possible GNSS solutions[32] and their application in railway environment, develop proof of the concepts and identify preliminary new processes to be used for performing the verification, validation and certification of new ERTMS systems based on the new Fail-Safe Train Positioning.
   - Test and verify behaviour of the developed components of the new Fail-Safe Train Positioning performed by means of laboratory tests using the GNSS based localisation devices and the simulators. Different verification methods will be used such as modelling, early horizontal and/or vertical prototypes. The validation of components will lead to the preparation of the development of prototypes as described in the S2R MAAP.

[32] Considering multi constellation and multi frequency approaches

- Provide a business model for GNSS application in Railway which takes into account the outcomes and results from other relevant projects and the specific requirements of the different Railway Market Segments.

2. As far as *On-Board Train Integrity is concerned* (TD2.5), the proposed R&I activities should include:
   - Studying, through market investigation and Cost Benefit Analysis, the existing Train Integrity technologies & related products, analysing their technical suitability for the detection of the train interruption and the train completeness monitoring. The study should investigate different technologies and devices (e.g. wireless sensors, transponders, radio, GNSS solution) analysing safety and security aspects in the defined target scenarios and associated product classes (with particular focus on freight&low traffic lines and taking into account the developments done in the IP5 for new freight wagons).
   - Defining the requirements and functional specifications of the On-Board Train Integrity taking into account the different train characteristics and dependencies due to the specific Railway Segments and application. Furthermore, the architectures and related test scenarios, the test cases and the procedures should be specified (with particular focus on freight & low traffic lines and regional lines).
   - Identification and development of the candidate new technologies to be adopted for On-Board Train Integrity. Mock-ups and performance tests in laboratory are to be foreseen.
   - Adaptation of the existing solutions in order to fulfil the OTI requirements. The activities should include tests in laboratory and the preliminary safety assessments.
   - Analyse the OTI solutions in order to harmonize them with interoperability.
3. Regarding *Formal methods and standardisation for smart signalling systems* (TD2.7), the activities, should include:
   - Analysis of the state of the art, search and take up of results from previous projects like Cesar, NeGST, Eurointerlocking, INESS, EULYNX.
   - Identification of the most suitable methodology, language and tool to apply in the railway environment.
   - Application of the methodical approaches of the selected formal methods for specification, design, verification and validation in the railway environment.
   - For the defined architecture to develop a set of specifications, on FIS and FFFIS level, on selected interfaces which refer to the main signalling subsystems (e.g.: Interlocking, RBC (Radio Block Centre), TMS (Traffic Management System), On Board Subsystems (EVC/ATO).
   - Produce the test specifications and identify the interfaces to be tested.
4. *Traffic Management Evolution* (TD2.9) activities are innovative for the integration of status information of different assets categories (e.g. Wayside objects, Energy Infrastructure, Fleet and Staff, weather conditions….) in Rail business service processes (e.g. TMS, Asset Management, Energy management….), enhancement and automation of processes resulting in an increase of performance of rail operations and reduction of cost through standardization. Therefore the activities are expected to include:
   - Integration Layer providing standardized Data Structure, Data Management and interfaces able to integrate real-time status and performance data from the network from the train and external sources (e.g. signalling, passenger information, fleet management, staff management and weather monitoring systems)
   - Building on IN2Rail project deliverables, the activities should enhance specifications, and architecture of the Integration Layer.
   - Furthermore, the work should include the definition of middleware and detailed data structure for Integration Layer.

    - Finally the proposals should start the development and testing of prototypes of the constituents of an Integration Layer and necessary interfaces.
- Application Framework
    - Building on IN2Rail project deliverables, the activities should enhance specification of functional requirements, and architecture for the Application Layer.
    - Furthermore, the work should start the development and testing of the constituents of an Application Framework.
- Advanced Traffic Management Principles
    - Research and development of specification of system requirements for new Train/Traffic Control Management functions integrating energy and trackside asset status and automated Push-Notification Management between Business Services.
    - Specification of advanced Business Rule Management, Conflict Detection and Resolution, USE-Cases to demonstrate new functionalities, Optimizer-Principles including Maintenance and Energy.
    - The proposals should also start the development and testing of prototypes for new Train Control Management System.
- TMS Business Service Applications
    - The proposals should cover specifications and development of prototypes for Business Applications for Traffic Management.
- Standardized Operators Workstation
    - Building on IN2Rail project deliverables, the activities should enhance the specification of Operators Workstation.
    - The proposals should also include the development and testing of prototype of a Standardized Operator Workstation incl. General Display Rules, Alarm-Management for new functionalities, disabled staff.
    - Develop Workload Analysis for Operators.
- Functionalities and Interfaces for Dynamic Demand and Information Management to and from external clients
    - Building on IN2Rail project deliverables, the activities should enhance the specification of dynamic demand and information management.
    - The proposals should also start the development and testing of prototype of WEB IF.
    - The work should include the development of a specification of a Data-Silo and an interface to integrate Freight Operation Services

Most of the activities of this work area will need to interfaces with ATO, RBC and Interlocking, while defining harmonized processes in collaboration with EUAR.

The implementation of this action requires close collaboration with IN2Rail project ('lighthouse' project resulting from H2020 call MG2.1-2014)[33].

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-IP2-01-2017: Operational conditions of the signalling and automation systems; signalling system hazard analysis and GNSS SIS characterization along with Formal Method application in Railway field.

[33] However, as the EC Work Programme 2014-2015 does not contain sufficiently detailed requirements, the provisions on complementary grants in the S2R MGA are not mandatory for the beneficiaries of In2Rail project , who may accept them on a voluntary basis, subject to their explicit agreement.

- S2R-OC-IP2-02-2017: Energy harvesting methodologies for trackside object controllers and on-board devices for Train Integrity. Characterization of a suitable language for formal methods application in the railway field.
- S2R-CFM-IP5-01-2017: Real-time information applications and energy efficient solutions for rail freight.

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-IP3-02-2016: Intelligent maintenance systems and strategies.
- S2R-CFM-IP5-02-2015: Start-up activities for Freight Automation.

As specified in section 2.3.1 of S2R AWP for 2017, 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 will only fund one proposal under this topic.

The activities are expected to reach TRL5.

Expected impacts: The completion of the S2R R&I Programme is foreseen by 2024. The activities included in the scope of this call topic address the first stage of IP2, which is planned in the MAAP in four different streams, regarding Advanced Traffic Management & Control Systems. In line with the S2R MAAP, a significant impact is expected from the technologies developed in this research and innovation action:

- The new technology based on GNSS and fail-safe train positioning system should allow increasing opportunities of application of ERTMS to new railway segments e.g. to low traffic regional and freight lines that are placed in rural areas, where the reduction of installation (CAPEX) and maintenance costs (OPEX) is one of the most significant key aspects.
- Moving Block is expected to bring a significant reduction of CAPEX and OPEX needs the On Board Train Integrity to perform basic train separation functions.
- Formal Method application in railway sector is envisaged to support competitiveness of the EU industry in compliance with the EU strategic objectives.
- Traffic Management System evolution is expected to improve reliability of train operations in terms of punctuality and availability of wayside assets.
- Standardisation of the frameworks, data structures and interfaces within the Integration Framework and Application Layer will deliver a reduction of the investment for new integrated installations
- An additional benefit will arise by deploying the specified structures within this project to other services management facilities e.g. Maintenance Services, Energy Management (cooperation with IP3), Passenger Information (cooperation with IP4) and Freight Management (cooperation with IP5).

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 TD2.4, TD2.5, TD2.7 and TD2.9 in line with the relative Planning and Budget.

Type of action: Research and Innovation Actions.

S2R-CFM-IP3-01-2017: Smart system energy management solutions and future station solutions

Specific Challenge:

Within the challenges highlighted in the IP3 part of the S2R Master Plan, the delivering smart systems for energy management and enhancing the customer experience in stations share a lot of similar approaches. Achieving both of these goals would require physical changes and enhancements to occur within the railway subsystems. The dynamic nature of rail traffic implies that solutions must be adaptable, reacting readily to changing transport demand and emerging technologies; and operators and managers require real-time information to improve their decision making, both in terms of controlling passenger experience and sustainably using resources.

Power supply systems for railways are feeding highly flexible loads, able to recuperate and moving through the network. These networks can be optimized with the methods and measures of smart grids. This covers the measurement, the control and the action insides the networks. Elements and methods to optimize this for railways are covered by this call.

With regard to stations the challenge is to develop station design concepts optimising station management, creating cost effective solutions and technologies so they can be applied in a variety of scenarios. The primary ambition is for customer experience at stations to be significantly improved, increasing the number of customers that will use rail as their preferred transport mode.

Scope: The proposals should address all the following elements, in line with the S2R MAAP:

1. Smart Metering for Railway Systems (TD3.10)

The objective of the Smart Metering Demonstrator is to achieve a fine mapping of different energy flows within the entire Railway System, as the basis of any energy management strategy is built on a detailed and clear knowledge of the dynamics of energy flows of both consumers and generators. The proposals shall address the following expected R&I activities:

a. Railway System Smart Metering Demonstrator implementation and testing.

- implementation studies and procedures for a Smart Metering System physical integration in both trackside and on-board;
- on-site installation of sensors, gateways and telecommunications, as well as data processing software applications and data servers;
- development of the Demonstrator Integrated Test Plan, functional test methods and procedures for Smart Metering components and sub-systems and conformity validation with the Technical Specifications.

b. Development of technologies for Railway Smart Metering data acquisition and processing.

- development of smart metering and data acquisition and transmission solutions, applicable both on board and at ground;
- development of specific software applications for energy data acquisition, error correction, synchronization and aggregation.

c. Development of Railway Systems Smart Metering user applications

- development and demonstration of specific case studies based on collected data correlation and using advanced data processing algorithms for energy management decision making;
- development of user applications linking the railway system physical modelling with data from measurements in order to allow better energy forecasting, better assets ROI evaluation, losses evaluation, etc.

The proposal covering a, b and c is expected to provide a technology validated in relevant environment (TRL5).

d. Technological assessment and railway certification preparation

- investigations in view to ensure conformity with the European regulations(TSI compatibility), including improvement proposals regarding requirements and assessment methods, whenever applicable;
- long and medium term technical and economic impact studies regarding a Smart Metering implementation in real railway environment.

The activity is expected to provide certification preparative studies, impact assessments and evaluations (TRL3).

2. Smart Power Supply (TD3.9)

The proposals should address the R&I needed to develop and validate innovative control and protection system(s), which would allow additional signals, interfaces and parameters sets to interact with the feeding grid. In particular the R&I activities should comprise:

a. control procedures and integration rules for implementation of elements of Flexible AC Transmission Systems (FACTS)in 50 Hz-traction substations and capabilities for digital data processing and transfer established;
b. virtual models and parameter sets for optimised use cases, including interfacings with 3 Phase power grids and train operation requirements, specified and tested within virtual demonstrators;
c. active power equipment development to enable energy flow control and power balance in the rail power network together with the control system mentioned before.

The activity is expected to provide specifications, evaluations and proof of concept under virtual conditions of a relevant implementation systems for the technologies (TRL 3-4) and a demonstration/validation in the relevant environment for control and protection concepts (TRL 5-6).

3. Future Station Solutions (TD3.11)

In this area, the R&I activities aim at optimising station management, creating cost effective solutions and developing technologies. The aim is for the customer experience at stations to be significantly improved, resulting in increased number of customers using railway.

The proposal should address the following:

a. crowd management in high capacity stations: the main deliverable will be a modelling tool that will enable congestion/emergency management, seamless end-to-end journey and improved accessibility. In this respect, the work should also deliver operational features and

strategies. Deliverables will be validated through modelling of an existing station (corresponding to TRL5/TRL6);

b. Improved Station Designs and Components: Develop standard designs for small stations that will enable low energy impact, use of sustainable materials and that will address the evolving needs of passengers. The design should also contribute to autonomous smart solutions that will support digital and web-based services. The activity should deliver a catalogue of specifications and design prototypes based on station components validated at TRL5 or possibly higher;
c. Improved Accessibility to Trains:
    - New ticketing technologies to facilitate seamless journeys whilst maintaining revenue protection should be investigated. This should be analysed in cooperation with the activities of IP4, where the various technologies are expected to be identified;
    - Address issues related to Platform-Train Interface and improve ease-of-transfer and customer experience. This should be completed in collaboration with the activities under the complementary topics S2R-CFM-IP1-01-2017 and S2R-OC-IP3-02-2017. This work should deliver tested platform-train interface strategies, at TRL5/TRL6, for typical conditions in existing stations.
d. Blast resistant Glass Specification for glass in stations: The work should aim at establishing a strategy for assessing risk of glass in case of explosions and the development of appropriate specifications where glass has to be used in areas of high risk. The relevant material and also relevant various models should be tested in laboratory (or outdoor explosion) environment at TRL4.

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-IP3-01-2017: Smart metering and asset management of railway systems ;
- S2R-OC-IP3-02-2017: Future stations and accessibility;
- 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;
- S2R-CFM-IP4-01-2015 – Shopping, booking and ticketing of multimodal travel solutions.

As specified in section 2.3.1 of S2R AWP for 2017, 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 will only fund one proposal under this topic.

Expected Impacts:

Actions should contribute to:

- reduced LCC for the traction power supply system by up to 20% less equipment to install for same functionality and by up to 30% reduction of transmission losses for traction energy;
- a reduction in asset deterioration through more robust and reliable products, procedures and processes;

- improvements in passenger safety and their exposure to risks with improvements expected from new station designs;
- optimized Return of Investment (RoI) allowing optimal investments and asset management;
- increased power supply quality and optimized line capacity;
- better identification of electric infrastructure losses;
- detailed knowledge of energy flows and consumers behaviour inside the railway system;
- energy profile provision improvement. Refined knowledge of the traffic disturbances consequences on system's energy profiles;
- better identification of auxiliary, maintenance facilities and stations energy consumption and of opportunities for savings.

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 TD3.9, TD3.10 and TD3.11 in line with the relative Planning and Budget.

Type of Action: Research and Innovation Actions

S2R-CFM-IP4-01-2017: Technical framework for attractive railway services

Specific Challenge:

The topic addresses the completion of one of the key research and innovation areas of IP4, as described in S2R Master Plan, namely the Technical framework which is composed of the interoperability framework and the business analytics framework.

The interoperability framework will provide seamless connectivity to enable the deployment of the full IP4 ecosystem using open semantic web standards and technologies. As IP4 evolves and the transport ecosystem is extended with new services, modes, operators, providers and functionalities, the interoperability framework should be correspondingly extended to facilitate interoperability among business applications and the creation of added value services for achieving a seamless multimodal door-to-door experience.

The specific challenge consists in coordinating the incorporation of new ontologies and resolvers corresponding to the various eco-system extensions, and to coordinate their intelligent interaction for efficient integration in successive ITD releases.

A similar challenge applies to the extension of the business analytics framework, which should address an increased variety and complexity of data in order to support business decision-making for operators, with a potential application for customers where operational information can be anonymously aggregated across modes. The specific challenge will be to develop an open, shared and universal toolkit, which can profit the entire industry.

An additional challenge will be to explore clear and sustainable governance for the deployment of the technical framework taking into account the recommendations of the project stemming from the topic S2R-OC-IP4-01-2016. The European Union Agency for Railways (EUAR), which oversees the implementation of the TAP TSI, will be involved as necessary.

Scope**:**

Proposals should address the following elements, in line with the S2R MAAP:

With regard to the interoperability framework (TD4.1) the work should include:

- Integration of current and new ontologies (specified in the complementary projects) and development of appropriate resolvers based upon semantic web technologies.
- Extension and improvement of the mechanisms for new service providers to join the eco-system via the publication of their annotated services in the Service Registry.
- Provision of intelligent data access capabilities to locate, access, infer, map, translate, convert, fuse and link data assets distributed anywhere, extending the number of modes and of standards which can be addressed.

With respect to business analytics (TD4.6), the proposals should address the following aspects:

- Provision of business analytic capabilities via the interoperability framework in connection with the activities of the IP4 transport ecosystem.
- Integration of gradually new data sources and improved techniques to achieve better accuracy, prediction capabilities and near real time analysis.

The project aims at the development of an open, shared and universal toolkit software toolkit which is expected to reach at least TRL6 by the end of the project timeframe. In addition, guidelines fostering the market uptake of the technical framework should be provided.

The implementation of this action requires close collaboration with IT2Rail project ('lighthouse' project resulting from H2020 call MG2.2-2014)[34].
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-IP4-01-2017: Smart technologies for trip tracking and improved travel companion, in order to achieve consistency and ensure integrated system level delivery of IP4 concepts.
- S2R-CFM-IP4-02-2017: IP4 overall integration and demonstration

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

- S2R-CFM-IP4-01-2015 – Shopping, booking and ticketing of multimodal travel solutions,
- S2R-CFM-IP4-02-2015: Travel companion and tracking services,

As specified in section 2.3.1 of S2R AWP for 2017, 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 will only fund one proposal under this topic.

Expected Impacts:

Actions will consolidate the IT backbone supporting IP4 developments, and will prepare a larger scale deployment of new, innovative technologies. The expected impacts which are expected to be quantified in the answer to the call, can be listed as follow:

a. Transform the European transportation ecosystem into a global services and data market place.
b. Steer free from technological barriers, enabling an easy emergence of new actors and business models.
c. Contribute to a more attractive rail system and a better experience for customers.
d. Promote the development of transport services, applications, devices and systems by reducing the overhead and financial associated costs.
e. Decreasing the time-to-market of advanced customer experience applications.
f. Contribute to lower the costs of operations.

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.

Type of Action: Innovation Actions

[34] However, as the EC Work Programme 2014-2015 does not contain sufficiently detailed requirements, the provisions on complementary grants in the S2R MGA are not mandatory for the beneficiaries of IT2Rail project , who may accept them on a voluntary basis, subject to their explicit agreement.

S2R-CFM-IP4-02-2017: IP4 overall integration and demonstration

Specific Challenge:

The IP4 of the S2R Master Plan focuses on developing innovative IT services for rail and other transport modes in order to increase the attractiveness of greener transport modes to passengers. The backbone for offering new services to users will be the establishment and growth of a sustainable travel and transport eco-system characterised by a seamless access to new technologies and functionalities. This will significantly enhance the communication and integration of the full range of transport modes, their offers and services, to the travelling public. The specific challenge is to develop the IP4 Integrated Technologies Demonstrator (ITD) by proceeding to the progressive integration of the various technological innovations developed in IP4.

The results of intermediate steps of this integration should demonstrate the value added by the technological developments accumulated from the different IP4 projects, in terms of sustainability and attractiveness features, and the final integration should pave the way for a large scale deployment in the market place ranging from urban and suburban (commuter transport) subsystem to long distance subsystem, beyond the official project end.

Scope**:**

Proposals should address the following elements, in line with the S2R MAAP (ITD4.7).

By using an agile development life-cycle, the integration of current and future IP4 projects should enrich progressively the IP4 content with new business services and technologies, addressing the end-to-end aspects of a journey. The scope of the ITD is to develop a stepwise integration of the individual technological developments on shopping, booking, ticketing and settlement, travel companion and trip tracking concepts, using all the potential of the interoperability framework and the business analytics environment.

The action will provide a demonstrator of the integration of all IT services to provide a seamless travel experience to the passengers. Based on a smart platform, taking into account all the necessary security measures, the integration will run several use cases with increasing complexity (number of modes, variety of payment schemes, different business models, additional functionalities), and representativeness (from simulated mock-up to real-life implementation) to reach at least TRL6 by the end of this project timeframe.

The implementation of this action requires close collaboration with IT2Rail project ('lighthouse' project resulting from H2020 call MG2.2-2014)[35].

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-IP4-01-2017: Smart technologies for trip tracking and improved travel companion
- S2R-CFM-IP4-01-2017: Technical framework for attractive railway services

[35] However, as the EC Work Programme 2014-2015 does not contain sufficiently detailed requirements, the provisions on complementary grants in the S2R MGA are not mandatory for the beneficiaries of IT2Rail project , who may accept them on a voluntary basis, subject to their explicit agreement.

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

- S2R-CFM-IP4-01-2015 – Shopping, booking and ticketing of multimodal travel solutions,
- S2R-CFM-IP4-02-2015: Travel companion and tracking services,

As specified in section 2.3.1 of S2R AWP for 2017, 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 will only fund one proposal under this topic.

Expected Impacts:

The activities are designed to demonstrate the seamlessness of overall IP4 concepts, developed to respond to the policy objectives formulated in the White paper on transport 2011 "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system"[36] and further operationalised in the S2R Master Plan.

The main expected impact will be to present the passenger with a single access to the multimodal market-place in a way which eliminates or reduces the risk, effort and cost associated to navigating the current silo transport markets.

At the same time, the activities are expected to provide a sustainable environment for operators in which they can more easily extend the marketing reach of their services both competitively and collaboratively with other eco-system players.

Most passengers are today digitally connected, and expect this same level of connectivity when they travel, in particular automating the parameterisation of their personal preferences (e.g. for people with reduced mobility, or aiming at reducing their carbon footprint…), driving their travel search and planning activities and acquiring their right to travel.

In the case of multimodal journey, the activities are expected to allow a smooth integration for the provision of alternatives in the case of service disruptions affecting multimodal itineraries.

Moreover the activities should provide operators an effective environment for better monitoring and adaptation of their transport offers to customers' actual demand.

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 ITD4.7 in line with the relative planning and budget.

Type of Action: Innovation Actions

[36] COM/2011/0144 final

S2R-CFM-IP5-01-2017: Real-time information applications and energy efficient solutions for rail freight

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. Future freight locomotives must reach the maximum possible energy efficiency - alone, in the train consist, or within a fleet – in order to improve the cost-competitiveness of rail freight. Also they need to serve complex logistics concepts. The challenge is to identify and test innovative technologies for further customer benefit in a demonstrator, including freight specific propulsion concepts, energy recuperation and storage systems, clever energy management systems and mission managers.
2. Hybridization of the legacy shunting fleets should be sought in order to quickly react to the competitive pressure from other modes, by reducing lifecycle cost and defending rail freight's position as the most environmentally friendly mode of transport. The challenge is to use already existing, reliable and owned shunting fleets as a basis for an environmentally friendly, energy- and cost-efficient second life. The expected study should lay the foundation for a demonstrator.
3. The realisation of an optimised network management is expected to lead to centralized information about the traffic conditions, available capacity, train composition and infrastructure characteristics. The challenge is to optimize the driving profile of the freight trains in operation and to give advice for the network dispatching system to obtain better line utilisation, based on existing applications and TAF TSI.
4. In yard management there are still a lot of physical checks and processes relating to single wagon-load transport. For a higher degree of automation the challenge is to design, build and test a novel terminal with Intelligent Video Gate technology to optimize train in- and outbound detection, including automatic identification of train consist and characteristics (length, loading gauge, structural data, etc.). Projects should search for synergies with existing TAF TSI platforms.
5. Maintenance of bogie components is one of the major operational expenses. The challenge is to reduce maintenance cost and hazard probability associated to the bogie, for bogies of freight wagons existing in IP5, in practical tests. The project must be synchronized and align the output with the overall approach of the Condition Based Maintenance strategy of IP5.

A common challenge for the innovations that will be developed when addressing the challenges described above, is to foresee an ambitious but also reasonable timeline for the European market uptake to take place. The European Union Agency for Railways (EUAR), which oversees the implementation of the TAF TSI, will be involved as necessary.

Scope:

Proposals should address all the following elements, in line with the S2R MAAP:

The work expected in the work stream 1 concerning **"**future freight locomotives" (TD5.5) should:

- Analyse and select different state-of-the-art propulsion technologies for testing, such as e.g. hybridization concepts, powerful energy storage systems;
- Testing of selected technologies, complimentary to the activities started in IP5
- validate power peak shaving concepts for a complete fleet, using fleet wide real-time information on energy consumption, intelligent auxiliary management and powerful mission managers, (TRL 4).

The activity is expected to provide recommendations for the selection of components for testing, and results from the testing of components in the loop, on a test bench or in simulation and validation.

The research in the work stream 2 concerning the “hybridization of shunting legacy fleets” (TD5.4) should include the following items:

- development of basic guidelines for assessment of the suitability of selected shunting fleets for a second life refit based on technical, economic and ecological analyses;
- development of a standardized, modular, hybrid concept for suitable legacy shunting fleets for given load cycles and fields of usages incl. lithium-ion technologies;
- development of technical concepts and design studies for implementation of the modular hybrid concept on a prototype shunting locomotive including technical validation concepts.

The activity is expected to provide the analysis of the legacy fleet, the specification and simulation of a target design (TRL 4)

“Network Management” will develop methods for improved interaction between network management and yard management including:

- development of a data exchange platform for inter-modal hubs for connecting rail freight stakeholders, facilitating operation of mixed traffic (passengers and freight);
- specification of integration layers for real-time yard management and real-time network management applications. Evaluation of the effect that a technological upgrade of one hub, will affect other hubs and nodes in the network;
- simulation of operational scenarios on freight corridors to increase the average speed improving train dynamics with the aim to optimize time-tabling systems.

The activity is expected to provide a simulation of real-time network management based on the developed data exchange platform in a test environment. (TRL 5)

The scope of the work stream 4 “Intelligent Video Gate” (TD5.4) is expected to include the following elements:

- analysis of the design of the terminal and specification of how the information flow can proceed and be gathered amongst the different stakeholders involved;
- assessment of IVG technology including necessary developments, integrating different complementary image-based and non-intrusive technologies and sensors, able to gather dynamically relevant data and features from freight train compositions;
- selection and testing of technologies and definition of services for automatic rolling stock identification and train classification.

The activity is expected to provide a validated prototype of an intelligent video gate technology designed and ready for integration and in an existing terminal. (TRL 6)

The scope of work in the work stream 5 consisting in “defining sensors for wagon bogies, for integration in condition-based maintenance” (TD5.3) will be:

- specification of sensors for wagon bogies, and development of corresponding algorithms, efficient from a computational point of view, to obtain key performance indicators of the evolution of relevant variables which will trigger condition based maintenance (CBM) tasks;

- Thorough interpretation of sensor data, assigning patterns to specific failures and provision of reliable diagnosis of the state of the bogie, including prediction of the possible next failure of the bogie;
- investigation of methods for the compression of information and reliable synchronization, taking into account communication channel constraints for providing sensor data in real-time.

The activity is expected to provide prototype sensors and software algorithms covering the wagon bogie, tested in the framework of the overall approach of Predictive Maintenance in IP5 (TRL 5).

The scope of the work stream 6 related to "migration plan" should include the:

- development of technological paths, migration plans and market uptake scenarios for key technologies and solutions, which will be developed in IP5;
- identification of short-term wins for shippers, customers and operators, building on the available results of the Smart Rail project.

The activity is expected to provide a compilation of migration plans that describe the ideal roll out of key technologies in the European rail freight market (TRL 3).

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-IP5-01-2017: Real-time yard management.
- 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

The action that is expected to be funded under this topic will also be complementary to the actions funded within the following 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.

The implementation of this action also requires collaboration with Smart Rail project ('lighthouse' project resulting from H2020 call MG2.2-2014)[37].

As specified in section 2.3.1 of S2R AWP for 2017, 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 will only fund one proposal under this topic.

[37] However, as the EC Work Programme 2014-2015 did not contain sufficiently detailed requirements, the provisions on complementary grants in the S2R MGA are not mandatory for the beneficiaries of Smart Rail project , who may accept them on a voluntary basis, subject to their explicit agreement.

Expected impact:

The expected impacts, which are expected to be quantified in the answer to the call, are:

- enhance the environmental friendly performance through high energy efficiency propulsion systems by 10%;
- increase energy efficiency by recuperation and on-board storage of braking energy;
- reduce the peak power request by peak shaving;
- increase the operational efficiency through upcoming propulsion systems both in the main line and marshalling yards

The foreseen research activities in the work stream 'hybridization of shunting legacy fleets' are expected to:

- reduce the implementation time and enhancing the cost competitiveness for environmentally friendly innovation;
- improve the ecological footprint and lifecycle cost of Diesel shunters ;
- increase the flexibility and freight operational efficiency.

The expected impact of activities resulting from the work stream on 'network management' will be to:

- optimise the decisions and the resulting operational processes in real-time and be able to respond to any scenario including unforeseen incidents e.g. delays of trains, technical failures, new construction requirements;
- increase the capacity of mixed traffic .

The work within the work stream **'**Intelligent Video Gate' is expected to lead to:

- an optimization of terminal design and operations together with better data exchange, between involved parties along the intermodal transport chain;
- improvement of reliability, service characteristics and cost competitiveness of intermodal rail transport;
- a significant reduction of dwell times in terminals;
- ensuring interoperability with existing rolling stock, therefore avoiding constraints and limitations, minimizing investments and fostering market uptake.

The work stream defining 'sensors for wagon bogies', for integration in condition-based maintenance is expected to deliver:

- an increased rail freight reliability and efficiency;
- a significant reduction of freight train derailments through the real-time prevention of bogie failures and condition-monitoring;
- a reduction of 10% of maintenance operational expenses related to bogie components and increase rail freight business competitiveness.

The work stream related to the development of 'migration plan' should deliver logical steps for the market uptake of the new solutions which could become a guideline for these innovations to happen throughout the European freight sector.

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 TD5.2, TD5.3, TD5.4 and TD5.5 in line with the relative planning and budget.

Type of action: Research and Innovation Actions (TRL 4-6)

S2R-CFM-CCA-01-2017: Improving Railway Services for Users and Operators

Specific Challenge:

Socio-Economic Effects

The potential of rail in contributing to European transport policy and wider societal objectives is substantial. However, today figures from the railway sector show that in most countries around Europe there is a low level of railway usage in general. A modal shift to rail for both passengers and freight is a major challenge in realising the potential of rail. How can rail/shift to rail be used as an active factor in societal building? Which are the key factors for a modal shift to rail and which are the obstacles? Which ones reside within the railway system and which ones relate to other parties? What factors are addressed by S2R targets and activities? Which other factors, activities of actors and sectors are needed for realising the full potential of rail for customers and society?

System Platform Demonstrators (SPDs) and Integrated Assessment

The challenge is to develop approaches and tools to enable the evaluation of the impacts of key technology developments within Shift2Rail. In particular, the objective of the Integrated Assessment (IA) of the System Platform Demonstrators (SPD) is to evaluate to which extent the results of the Shift2Rail Programme are reaching the expected key targets detailed in the Master Plan. The SPDs are the basis for the IA, the latter being expected to measure their specific effects on each Key Performance Indicator (KPI). The specific challenge is linked to the definition of the SPDs in order to identify the right scenarios of the future railway system(s) and model the inter-dependencies of the KPIs between each other as well as between low-level functional and technical parameters and high-level socio-economic objectives. The result will be a KPI model for the overall railway system, able to demonstrate the influences of all IPs and TDs on the Shift2Rail key targets. This model is to be validated by external data and finally used throughout the project runtime of the TDs in order to monitor the achievement of the key targets.

Standardisation

Standardisation is an efficient way to ensure the best and most rapid exploitation of the validated results of the research and innovation activities within Shift2Rail program. Although standardisation can sometimes be a lengthy and expensive process, the improvement of identified critical processes and enabling a fast and easy transfer of research results into both the European and world markets should be sought. New and innovative approaches need to be streamlined to facilitate and make more efficient the transformation of the research results into standards to cope with novel technologies never used before.

Smart Maintenance

The current maintenance system is characterised by a combination of scheduled pre-emptive maintenance (predictive maintenance with service activities at defined intervals and replacement/reconditioning of parts before they fail) and unscheduled maintenance (corrective maintenance with repair/replacement of failed parts). The introduction of digitalisation presents significant opportunities for reducing maintenance costs, while also having a strong positive impact on reliability and availability. In the future many important railway subsystems and components will implement Condition-Based Maintenance (CBM) , expecting a reduction of maintenance costs and increase of components reliability and availability. Research activities will be carried out for infrastructure components within the topic S2R-CFM-IP3-02-2016 and for freight trains within the topic S2R-OC-IP5-03-2015. This topic will address the challenge of integration of CBM developments for all subsystems and consider CBM for passenger trains investigated in the complementary topic S2R-OC-CCA-01-2017.

Integrated Mobility Management

Integrated mobility management shall be smart and based on a real-time seamless exchange of information between rail operation business services and achieve an increased level of standardisation of interfaces, processes and data structures on such a level to ensure interoperability between supplier´s subsystems and modules.

Integrated processes shall provide intelligent, automated and flexible rail traffic operations, but also support an integrated approach to the optimization of railway architecture and operational systems at network, route and individual train service level. These will reconcile business and operational requirements (namely customer service, capacity, speed, timekeeping, energy, asset management) with real-time field and asset condition monitoring and intelligent traffic planning. Integrated Mobility Management requires expertise from IP2, IP3 and IP5.

Human Capital

The challenge is to bridge the gap between the changes in railway and other industrial sectors imposed by rapid technological advances such as automation and digitization and the substantial demographic change in the “Human Capital” of railways expected in the near future.

The specific challenge is to be able to derive a concept on the management of these changes on the human capital side (e.g. change in job profiles, skills, organization and their relationships with safety, simplified/user designed devices and services) of the sociotechnical system “railway” imposed by the introduction of technical innovations.

Scope:

Proposals should address all the following work streams in line with the Shift2Rail MAAP:

Socio-Economic Effects (WA1):

All activities under this topic will be based on four use cases. These cases are based on the System Demonstrator Platforms (SPDs) and the activities will be performed in close connection to the SPDs and Integrated Assessment work. This work will be an input to the SPDs work and should achieve:

- Societal building by transportation: based on the available deliverables of the actions funded under S2R-CFM-CCA-01-2015 and S2R-OC-CCA-01-2015, the scope of this action is to investigate how rail, within the transport system, can be used as a design tool for societal building, in ways that contribute to European transport policy and wider societal objectives.

The Shift2Rail targets and results should be investigated from this societal building perspective.

- Key success factors for a modal shift to rail: the scope of this action is to investigate what factors that are the most important for a modal shift to rail (passenger and freight) and to what extent S2R targets and activities include these factors and promote such shifts. Results should include a research map, which shows possible measures for urban, regional, long-distance and freight transport that will attract more customers.
- S2R Society effects: based on the available deliverables of the actions funded under S2R-CFM-CCA-01-2015 and S2R-OC-CCA-01-2015, the scope of this action is to investigate obtained and potential societal effects of S2R results (towards the end of project duration) through a Socio-economic Impact Assessment Study.
- Preparation and finalisation of guidelines to describe chances, risks, strategies to attract more customers (passenger + freight) targeted for Railway Undertakings, Infrastructure Managers Government and the industry. It will analyse trends, user requirements, obstacles, socio-economic-effects, technology evolution, mobility competition and needs from different user groups.

System Demonstrators and Integrated Assessment (WA2)

The scope of this work is to detail the baseline and SPD scenarios focusing on the integration of KPIs, based on available deliverables of the actions funded under S2R-CFM-CCA-01-2015 and the S2R-OC-CCA-01-2015. The following four activities should be performed, taking into account the work done already on KPI monitoring and socio-economics:

- Today's SPDs scenario: the SPDs will be specified from wider transport policy and societal objectives. The current transport market state of play should be described, so that it can be the baseline on which the Shift2Rail achievements could be measured. The continuous change of Railway operation modalities should also be addressed here. The model that will be developed should also be flexible enough to take into account changes e.g. market, technology or other changes from the overall mobility domain..
- SPDs within Shift2Rail: the work should assess and predict how the four SPD (high speed, regional, urban/suburban, freight) segments would look like once the Shift2Rail results are incorporated. The TDs objectives and expectations should be taken into account. In addition the work should also show how those SPDs segments would have looked like without Shift2Rail and its R&D results/innovations. A limited mid-term view should be developed.
- Future SPDs: The identification and detailed description of the future SPDs will lead to detection of some shortcomings in the Shift2Rail planned activities. The work should draw conclusions on how these shortcomings should be handled.
- Segmentation and interaction of the market segments in the KPI model contains the model structure which is segmented into several sub-models. Those are separately validated by using existing data as well as used to set up the different models for the SPD scenarios. The target is to re-use as much of the generic KPI-model for all SPD scenarios and have only specific adaptation per segments. The validity has to be shown for all SPD scenarios.

Standardisation (WA3)

The action should address the process of transformation of the S2R research results into standards and the way it can be speeded up with decreased costs. Innovative and accepted processes need to be investigated based on the participant experience and a state of the art analysis.

This action should support the Shift2Rail JU in managing the standardisation activities related to:

- Disseminating the S2R programme value in contributing to the EU and international standards with the results from the R&I activities
- Definition of innovative more efficient and effective processes for standards developments from S2R R&I results

The proposal should address the following elements:

- prepare the strategic analysis of the Shift2Rail research activities in terms of standardisation potential
- propose a standardisation deployment plan based on the analysis of the S2R R&I and provide a prioritisation process based on a state of the art analysis of the different ongoing and planned standardisation process at EU and international level
- propose innovative standardisation processes and tools to speed up market uptake of the R&I results from the S2R activities
- provide return on experience and background information on the normative process with the European standardisation bodies (CEN/CENELEC), the regulation body European Union Agency for Railways and other professional organisations that define international specifications in the railway domain in order for the JU to be able to develop guidelines.
- help in developing a proper template to support TD leaders in harmonising how standards are written within the JU processes
- develop a mapping and roadmap for closing TSI open points in coordination with the European Union Agency for Railways
- monitor the European standardisation processes of the Shift2Rail activities to prevent overlaps

Smart Maintenance (WA3)

The activities of the proposed action should:

- Define the scope of cooperation with sub-system Shift2Rail Smart Maintenance activities (within IP1, IP3 and IP5) for sharing information and data
- Develop of an overall maintenance concept for all CBM activities within Shift2Rail programme
- Analyse and integrate different data sources (comprehending vehicle and wayside) that can be used for CBM of passenger trains
- Develop a CBM model that suggests necessary maintenance activities in advance
- Propose optimised procedures for passenger trains and integrate them into a management process
- Develop semantics of CBM data and requirements for standardisation concerning in/outputs and related to physical interfaces, data flow and format, physical data transmission and on-board rolling stock software and databases

Integrated Mobility Management (WA4)

The activities of the proposed action should include:

- Upgrading the specification of the Data structure of the Integration layer to meet freight operation requirements and the development of prototypes representing the enhanced status. These activities address the specification and development of additional Information packets required for high efficient freight operations and their integration into the Integration and Implementation into the Integration Layer specified under IN2RAIL and IP2 TD2.9. This will link Traffic Management System (IP2), Asset Status Presentation (IP3) and Freight Operations (IP5)
- Specifying and developing advanced business application modules applied in TMS enabling the increase of performance of Rail Freight Operations.

Human Capital (WA6)

The content of the member call comprehends the collaboration with the open call (OC S2R-OC-CCA-01-2017) and tender call (S2R/2016/OP/02) related to "Human Capital". The four different topics of the open calls and tender calls include:

1. Analysis of the change of job profiles in future railway systems (TC)
2. Skills and qualifications: analysis of the effects of new technologies on the skills of the system operators and the requirements for qualification (TC)
3. Creating agile organisations for increased flexibility and autonomy for blue collar workers (TC)
4. Customer-oriented design of mobility: simplification of a system will attract more customers. (OC)

The work includes the following activities:

- Definition of requirements and future needs to be taken into account in the future development of the railway system and making sure that the railway-specific goals of the CCA-Human Capital are met
- Providing the perspective of the operator to assure that the specific requirements are taken into account and the results of the work of the OC and TC are valid
- Providing data and return on experience
- Defining the implications of the research of the OC/TC and the path of transformation for the application of the research results for the future railway system

The implementation of this action requires close collaboration with IN2Rail project ('lighthouse' project resulting from H2020 call MG2.1-2014)[38].

The action that is expected to be funded under this topic will be complementary to the action(s) that are expected to be funded under the topic:

- S2R-OC-CCA-01-2017: Standardisation, smart maintenance and human capital

[38] However, as the EC Work Programme 2014-2015 does not contain sufficiently detailed requirements, the provisions on complementary grants in the S2R MGA are not mandatory for the beneficiaries of In2Rail project , who may accept them on a voluntary basis, subject to their explicit agreement.

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

- S2R-CFM-CCA-01-2015 – Start-up activities for System Platform Demonstrator Integrated Assessment and socio-economic effects
- S2R-CFM-CCA-02-2015 – Energy and sustainability, including noise and vibrations baselines assessment
- S2R-CFM-CCA-03-2015 – Integrated Mobility and Safety Management
- S2R-CFM-IP3-02-2016 – Intelligent maintenance systems and strategies.

As specified in section 2.3.1 of S2R AWP for 2017, 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 will only fund one proposal under this topic.

Expected Impact:

The activities are expected to contribute to the achievement of Shift2Rail objectives by:

Socio-Economic Effects, System Platform Demonstrators & Integrated Assessment

- specifying socio-economic effects and future options to which S2R targets and activities need to be compared;
- analysing the factors to increase the attractiveness of the railway system based on the extended and prioritized knowledge about customer obstacles, customer requirements and future needs to use the railway system, railway undertakings get the scientific based knowledge for new activities to attract additional customers
- delivering a validated KPI Model for the railway system
- delivering baseline and Shift2Rail project scenarios for future railway systems

Standardisation

The proposal will contribute to deliver innovative and faster processes for standardisation activities in order to accelerate the market deployment of the overall Shift2Rail results.

It will contribute to improve the achievement of the Shift2Rail objectives by:
- giving advice on the way of drafting standards
- providing the best market up-take to the results with ready to use standards
- helping in the definition of the best methods and processes to be used in S2R guidelines for standardisation

Smart Maintenance

- increasing availability of vehicles and infrastructure by reducing unplanned fails and outage

- reducing maintenance costs by 10%

Integrated Mobility Management

- enabling a capacity increase of 10% of Freight Rail Traffic through the integration of dynamic Asset status update developed under IP3 and freight specific business logic applied in a future for TMS developed under IP2 in TD9
- enabling cost improvements by integrating different new functional applications and modes that will lead at least a 10% cumulated savings.

Human Capital

The proposed activity will contribute to overcome the challenges imposed by demographic change and to balance the benefits and risks for the human capital in the system imposed by comprehensive and radical technological innovations through increasing:

- job profiles, skills and life-long development of new skills
- flexibility for employer and (blue collar) employees, also considering safety requirements
- attractiveness of the railway system through customer-oriented design.

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 in line with the relative planning and budget.

Type of Action:

Research and Innovation Actions

ANNEX II - 2017 Open call for proposals for non-JU Members – Topic descriptions

S2R-OC-IP1-01-2017: Innovative materials & modular design for rolling stock applications

Specific Challenge: The challenge is two-fold tackling materials and modular design for rolling stock applications:

- The use of *composite materials* is nowadays frequent in many sectors, notably structural applications in the aerospace and automotive industries, as well as in interiors, where they are vastly used in the current railway vehicles. One of the advantages of using composite materials is that they can be configured in multiple shapes and combinations, depending on the function that they are intended for. Additionally, this ability makes them suitable for integrating several functions within the vehicle system at the same time. *For railway vehicle carbodies* fully or partially made of composite materials, several issues regarding compatibility with the special railway environment have been identified in previous European R&D projects (e.g. Refresco and Roll2Rail). Those issues affect both constituent and also combination of materials that need further adaptation for the railway industry. As a consequence, further research is needed in order to define the most adequate materials available for primary vehicle structures. Therefore, the challenge is to create new constituent and composite materials adapted to the special railway environment requirements. For *access door systems*, the challenge is to make a breakthrough related to cost, weight, acoustic and thermal performances of door leaves by looking for new materials, innovative door leaves architecture, assembly solutions and processes and protection technologies against corrosion.

- With regard to the *modular design*, the current rolling stock is not flexible enough to meet the changing passenger demand during the in-service operating life-cycle of a train (40 years): it is not possible to easily change the interior layout or add services (wall outlet, etc.).The challenge is to develop new technologies and products which could increase the capability and flexibility of rolling stock throughout its lifetime.

Scope**:** The proposed research should address all the following work-streams described below, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

1 *Materials*:

- *Carbodyshell* (TD1.3): These activities are related to the task 1.3.2 “Carbody Study” indicated in the MAAP:
  In the FP7 project REFRESCO[39], the need of creating new resins for railway structural applications was identified because the fire & smoke behaviour of the current state-of-the-art structural resins used in the industry is not compatible with their use in railway vehicles. Also in REFRESCO, a benchmark of joint types and uses was made, further complemented with the joint technologies related work in the lighthouse project Roll2Rail. As a consequence of both activities, it has been concluded that joints used for carbody structural applications

[39] http://www.refresco-project.eu/deliverables/

must be compatible with the type of maintenance and reparability demanded for such structures in a railway environment. Additionally, high performance composite materials, such as carbon fibre-based laminates, use joining methods that are not in the scope of cost expected in the railway sector. For the abovementioned reasons, the proposals should include the following activities:

- Research on new base constituents and selection of joints regarding cost and quality: Railway structural applications require specific materials able to cope with the railway environment requirements. Those are:
  - Base constituents fire and smoke compliance: Resins commonly used for structural applications in the aeronautical industry do not meet fully the railway standards. New formulations of resins are needed that are able to provide both sufficient strength and fire & smoke resistance.
  - Structural joints for railway applications: Despite the fact that joint technology for composite materials is widely known in industries such as the aeronautic, some specific requirements regarding quality and cost must be met in the railway environment. The quality levels must be adapted to the new use of the composites, with respect to maintenance and reparability. Thus, proposals should explore an affordable way to join high-tech composite materials. In addition, adhesive joints for structural railway applications should be studied in order to find complementarities with the traditional riveted or bolted joints.

The activity is expected to request a contribution of indicatively € 2.5 million in order to perform technology validation in laboratory environment corresponding to TRL4.

The REFRESCO project[40] has also identified the apparent lack of a standard or a certification concept for manufacturing structural composites dedicated to railway vehicle carbodies, as well as for the joints used for the same purpose. As a consequence, a first work to sketch both manufacturing and joint concepts must be performed via basic research without the backup of a standard. For this reason, the activities should include:

- Defining manufacturing alternatives regarding material and joints: for the above proposed materials and joints, it will be necessary to develop proof-of-concept. The activities should include the development of the first batch of material characterizations, and the subsequent validation of a number of samples of the proposed materials and joints.
- Especially for the static and fatigue strength assessments, a lack of applicable loads was identified. To fill this gap additional work should be performed on:
  - Concept for static strength and fatigue assessments based on material independent load spectra and commonly accepted strength standards and regulations (such as IIW-Regulations, FKM-Guideline, EN1993, EN1999 etc.)
  - Strategy to derive these load spectra from measurements or simulations
  - Performing exemplary measurements and simulations
  - Combination of these sources (i.e. measurements and simulations) to a complete set of load spectra
  - Static and fatigue strength assessment based on the exemplary load spectra
  - Detailed specification of the measurement, analysis and verification process for the validation of the calculations with on field measurements.

The activities in this work stream are expected to perform technology validation in laboratory environment, corresponding to TRL4.

- *Access door systems* (TD1.6): To reach improvements in term of weight, acoustic attenuation, thermal performances and cost, the work should cover the following activities:
  - characterize, benchmark and choose metallic or plastic materials, by taking into account market price requirements, door leaf weight, railway constraints such as fire and smoke (EN45545), fatigue, pressure waves, passenger efforts, door leaf stiffness, shocks and punching, environmental constraints (e.g. temperature), standards and regulation (ISO, IEC, EN, TSI, EuroSpec, etc), welding (EN15085), gluing (DIN6701) and calculation rules (Eurocode);
  - study, benchmark and choose door leaves architecture and assembly solutions for their manufacturing;
  - perform specific tests of both materials and architectures. Eventually, the work could also suggest standards and design rules evolutions.

  The activity is expected to request a contribution of indicatively € 0.35 million in order to perform proof of concept in laboratory environment, corresponding to TRL3.

2 *Interior design*

- *Innovative Plug and play systems* (TD1.7):The research on new technologies for innovative modular electric and mechanic plug and play systems adapted to railways requirements: current and future (2020) technologies should cover new functionalities and demonstrate them by proofs of concepts:
  - Improving the passengers' comfort: investigate technologies and applications (railway industry or not) which can facilitate to move the position of the thermal sensor or add a thermal sensor for better regulation, move screen information, move electric plugs, change decors, atmosphere and lighting inside a passenger area;
  - Contactless power: technologies and applications (railway industry or not) of:
    - local energy harvesting on passenger equipment (seat, table, screen, etc.) and a specific focus of inductive power (seat, table, screen, etc.);
    - analysis of strengths and weaknesses of each technology and selecting the most adapted one for future application in the railway sector.

The activities are expected to perform technology validation in laboratory environment corresponding to TRL4 (studies and mock-up).

- *Innovative seats* (TD1.7): The research activities should include the development of innovative seats which combine ultralight weight, competitive cost, eco-design approach, modularity of comfort and of diagram (diagram understood as the distribution of the equipment and spaces in a train i.e. mainly the seat distribution and technical equipment in a top view). The target is to increase passengers comfort, as well as provide high density and modular interior arrangement (high density to be understood as regional train with a maximum of capacity needing a minimal comfort i.e. seats, and having a time travel of more than 30 minutes). The proposals should include the following elements and demonstrate them by proofs of concepts:
  - Ultralight weight concept validated by technical studies to allow increase of capacity without global weight impact. The weight target is 10 kg by place with a double seat equipped (electric plugs, personal light, armrest, shelf, goblet support) and 5kg by place with a double seat non-equipped.

- New kind of high density comfort validated by ergonomic studies to combine very strong seating capacity with an acceptable comfort. The target is to demonstrate that an innovative and at the same time comfortable seat arrangement can be used for high density train journey.
- Competitive solutions validated by an economic study to ensure that the capital cost (fixed and variable costs[41]) is competitive compared to the cost of a classic railway seat (regional travel seat).
- Sustainable development validated by eco-design studies to demonstrate a global environmental quality of design.
- Modularity in use validated by technical studies to change easily the diagram or the comfort. Possibilities to adapt the seat (add functions for example) or to adapt the diagram easily (face to face or uni-directional seat) should be developed.

The activities are expected to perform technology validation in laboratory environment corresponding to TRL 4-5 (studies and primary mock-up).

- *Innovative driver's desk (TD1.7)*: the research activities should include the development of innovative driver's desk which combines a compact cab driver's space, easy evolutive desk and modularity of diagram (diagram understood as the distribution of the equipment and spaces in a train i.e. mainly the seat distribution and technical equipment in a top view). The proposals should be demonstrated by proofs of concepts:
  - Ultralight weight concept validated by technical studies to allow integrating the desk "on demand" even the configuration of the train
  - Compact driver's desk validated by technical studies to allow to increase seat passengers capacity
  - Easy evolutive desk and modularity validated by technical studies to allow the train in order to adapt quickly and effectively to new requests during the life of the train
  - Competitive cost validated by an economic study: ensure the Return on Investment. Combine weight and cost and compare it to drivers desk equipments currently used.

  Both for new generation of drivers' cab and ultra-light seats, the activity(ies) stemming from this topic will receive specifications from the complementary topic S2R-CFM-IP1-01-2017 in September 2018 at the latest.

  The activities are expected to perform technology validation in laboratory environment corresponding to TRL 4-5 (studies and primary mock-up).

  The activities in work-stream 2 are expected to request a contribution of indicatively € 0.65 million in order to cover the 3 activities mentioned.

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-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.

As specified in section 2.3.1 of S2R AWP for 2017, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model

[41] variable costs understood as the cost of the equipment without engineering cost, validation cost or investment i.e. only the cost of the product itself

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 Impacts: Once the technologies developed are fully implemented and deployed at Shift2Rail level, the actions will contribute to:

- Allow avoiding metals in areas of the carbody where electromagnetic radiations are critical for the correct functioning of the train. This action will help to reach the forecasted 15-30% weight reduction in the primary structure.
- Enable composite materials to be used in the same way as steel or aluminium by using structural resins with equal or better mechanical performance than the ones used in aerospace industry, for example, that are fully compliant with the current railway fire and smoke standards. This action will help to reach the forecasted 15-30% weight reduction in the primary structure.
- Reduce time and cost in maintenance and repair operations by using joints for structural members of the carbody that are more economical and more adapted to the manufacturing rates for railway vehicles than in the aeronautical industry.
- Significant weight reductions of door leaves through the use of new concepts based on new lighter materials, process or architecture. This weight reduction will have several side effects such as:
  - Reduction of the energy consumption of the vehicle
  - Increased track friendliness
  - Additional freedom for vehicle design
  - Decrease of the dwell time in station
- Increase in passenger comfort, as a result of improved thermal and acoustic insulation of door leaves
- Evolve or adapt capacity of passenger seating by the use of technologies that help reducing the weight or increase modularity. This action will help to validate technical opportunities to adapt interiors design to the mass-transit need.
- Evolve or adapt comfort/services on board using technologies that allow facilitating modularity. This action will help to validate technical opportunities to offer more flexibility of interiors design.

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 TD1.3, TD1.6 and TD1.7 in line with the relative Planning and Budget.

Type of Action: Research and innovation actions

S2R-OC-IP1-02-2017: Tools, methodologies and technological development of the next generation of Running Gear

Specific Challenge: This topic seeks to address the challenge linked to developing novel and ground-breaking tools, methodologies and technology for running gear applications in line with the S2R Master Plan. Historically, it has not been easy to introduce innovation onto running gear because often preference was given to technology which has proved to be robust enough to survive the heavy loads, but not innovative enough. New technological solutions for running gear need to have sufficient durability to operate between overhauls or even through the entire vehicle design life of up to 40 years.

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

Scope**:** The proposed research should address all the following work streams, described below, in line with the S2R MAAP which relates to TD1.4:

The work should include tools, methodologies and technological development in the following four areas:

- *Innovative sensors & condition monitoring*: The work should include researching system architectures and specifying sensors with all the equipment directly related to these sensors. The focus should be on verifying the suitability of standard sensor equipment (i.e. as deployed in sectors such as aerospace, automotive, renewable energy, oil & gas and power generation) to the railway environment. The activities should also define the capability of a sensor to indicate the condition of a particular component. The work should analyse the requirements and benefits at the higher system level, by considering the (potentially wireless) signal transmission equipment and the signal processing hardware and software with the associated secure plug and play protocols. This part of work should take form of case studies based on the successful deployment of condition monitoring technology in other sectors, with a comprehensive explanation of the relevance for rail applications. Note that running gear condition monitoring sensors do not necessarily have to be vehicle mounted;
- *Optimised materials*: Proposals should focus on the analysis, testing and selection of new lightweight materials and manufacturing processes for running gear. Materials that already are in use in other applications should also be taken into account. Proposals should therefore include a comparison of different challenges posed by running gear design and manufacture. The impact of new materials on existing products should be explored as new materials may well dictate different compliance challenges, design solutions and manufacturing processes. Similarly, the opportunity for 3D printing or near net shape manufacturing of components should be investigated. The assessment of manufacturing processes should include the validation testing requirements for initial manufacture. A new methodology for conformity testing might be required for materials where the physical properties are more sensitive to the manufacturing process than the materials used historically for running gear. A thorough understanding of through life maintenance and repair activities is key to unlocking the entry barriers for such innovative materials. Non-destructive / non-invasive damage detection techniques for composites and other lightweight materials should be investigated;
- *Active suspension & control technology*: The scope of this research area is to develop new dynamic control systems for running gear. Physically, these systems include actuators and other hydraulic / electro-mechanical components. The work should explore the suitability of

off-the-shelf equipment and the similarities and differences between how the equipment is likely to be deployed in running gear and its application elsewhere. Where there is no suitable technology available, the work should identify further development needs. Equally important are the secure plug and play protocols, failure and damage tolerant data buses, (wireless) communication and control architectures. The authorisation strategy for the system as a whole should be explored, with reference to the acceptance process and requirements for other industries;

- *Noise & Vibration*: The activities with regards to this work stream should include prediction of the transmission of noise from the running gear into the carbody. The starting point may be the tools and techniques used to analyse noise transmission outside the rail sector. The work should focus on developing, validating and implementing simulation models for prediction of running gear noise. Such models should enable to formulate a methodology and a virtual test for the prediction and evaluation of new Noise & Vibration measures. These virtual tests would be for both interior noise and structure-borne noise transmission. To prove the methodology, a variety of existing and new materials for reducing Noise and Vibration transmission should then be assessed. These new materials may be used in other applications to limit noise transmission or they may be promising materials whose Noise and Vibration properties may prove to be beneficial in future.

The activity should end at TRL2 with the formulation of technology concepts for all four work streams.

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-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.

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

- S2R-CFM-CCA-02-2015: Energy and sustainability, including noise and vibrations baselines assessment

As specified in section 2.3.1 of S2R AWP for 2017, 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 Impacts: Activities are expected to contribute to:

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

- Creating an understanding of where off-the-shelf technology can be used for active suspension and beginning to define an authorisation process for such systems which guarantees safe operation.
- Improving methodologies for predicting the transmission of noise and vibration from the Running Gear to the carbody.

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

- Vehicle weight reduction through the use of new concepts based on lighter materials. This weight reduction will have several side effects such as:
  - Reduction of the energy consumption of the vehicle
  - Increased track friendliness
  - Additional freedom for vehicle design
- Reduction of the Life Cycle Cost of the vehicle and the whole railway system, derived from the reduction of track damage due to the reduction of mass and the improvement of guidance ability of running gear, and improved health monitoring supported by new running gear sensor systems
- Increase in passenger comfort, as a result of the improved suspensions, reduction in noise emission and transmission in running gear
- Increase in operational reliability supported by better performing health monitoring and sensor systems.

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 TD1.4 in line with the relative Planning and Budget.

Type of Action: Research and Innovation Actions

S2R-OC-IP2-01-2017: Operational conditions of the signalling and automation systems; signalling system hazard analysis and GNSS[42] SIS characterization along with Formal Method application in railway field

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

In the framework of the technological developments foreseen within the Innovation Program 2 of Shift2Rail Master Plan, the specific challenge is to apply GNSS in safety railway applications, new train separation system (Moving Block) and automatic driving (ATO).

Scope: The aim of the work will be to improve technologies for signalling and automation investigating new applications and solutions that must be carefully analysed in terms of safety and in terms of performances. Insights from other fields, such as avionics or automotive, will also be necessary to exploit cutting edge technologies, scientific approaches and methodologies also in the railway environment.

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 the GNSS technology into the ERTMS Signalling System, the activities are expected to cover the following points (linked to TD2.4):
   a) Identification and description of the main navigation RTCA (Radio Technical Commission for Aeronautics) assumptions that might not be valid in railways application domains;
   b) Identification and description of the main navigation RTCA parameters that are applicable as they are or might be extended for being applied in railways application domains (e.g. Horizontal Position Accuracy, Navigation System Error, Satellite Residual Error for the Worst User Location, User Differential Range Error, Protection Level);
   c) Quantitative analysis of the diagnostic capability of Standard Augmentation Subsystems (e.g. EGNOS) with regards to detection and mitigation of feared events originating from GNSS subsystem only (excluding local railways environment);
   d) Hazard Analysis aimed at supporting the identification of the ERTMS hazards associated with GNSS faults, including possible mitigation strategies both in the GNSS domain and in the railways domain with specific investigation on the application of GNSS in the different Railway Market Segments due to their particular characteristics;
   e) Execution of a Quantitative Comparative Analysis of different GNSS algorithms;
   f) Verification of different GNSS algorithms by means of modelling both in nominal and abnormal conditions (e.g. in presence of specific fault injections);
   g) Modelling of Multipath and Radio Frequency Interferences and identification / description of the main parameters that affects such local phenomena;
   h) Definition of the GNSS Minimum Performance Requirements suitable for the Railways Domain also based on different railways mission operational profiles.
2. Perform the Hazard Analysis of the railway system (technical and operational) in view of the application of the Moving Block functionalities (linked to TD2.3). Specifically the activities should include:

[42] For multi constellation and multi frequency approaches

a) The examination of the safety level of a Moving Block signalling system operating without trackside train detection;
b) The identification of the hazards in the most significant system operative conditions defined through use cases (e.g. initialization of the system, normal and failure operative conditions, recovery of the system from failure situations, mixed traffic, operational procedures to be applied in normal or degraded conditions according to the Grade of Automation (GoA) of the system, operational maintenance activities).

3. Identify the most suitable technology to be implemented in the railway field for performing automated driving (linked to TD2.2) coming from the automotive sector; specifically the activities should include:
   a) Autonomous cars analysis: identification of technologies implemented on the trackside and on-board for performing automated driving. The analysis should include insights from automotive sector and assess the cutting edge technologies present on the market or coming from developments for application fields which can be different from the railway market. Identify the basic characteristics from the automotive sector that can be assumed valid for implementation in the railway field;
   b) Assessment of the reusability of these technologies in railway field and identification of the types of applications (Operation Conditions) which are required in driverless or unattended operation.
4. Identify the most suitable semi-formal and/or formal language and formal method to be applied in the railway field (intended as the overall wayside and on board railway signalling system) (linked to TD2.7); specifically, referring to the results from previous projects (e.g.: Cesar, NeGST, Eurointerlocking, INESS, EULYNX), the activities should include:
   a) Benchmarking of the languages and of the formal methodologies present on the market in terms of flexibility, usability, capability to provide system modelling, facilitate RAMS activities and testing;
   b) Identify the ranking of the above languages and formal methods in the application in the railway field for all the main steps of the work process (e.g.: development, engineering, test and commissioning, operation and maintenance, training, update);
   c) Provide the proof of the effectiveness of the selected set of formal method(s) and language(s) by means of using them for a defined application (e.g. IXL or on-board system design, configuration and testing);
   d) Validate the capability of the selected set of formal method(s) and language(s) for supporting the evolution of ETCS/ERTMS respecting the basic requirements of interoperability.

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-IP2-01-2017: 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.

The action expected to be funded from this topic will also be complementary to action carried out following the topic S2R-CFM-IP2-01-2015: Start-up activities for Advanced Signalling and Automation System.

As specified in section 2.3.1 of S2R AWP for 2017, 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[43]:

- Deliverables of work stream 1 are expected to be available as specified below:
  - For items a. and b.: by M6;
  - For items c. and d.: by M9;
  - For item e.: by M12;
  - For item f: by M18;
  - For items g. and h.: by M24.
- Deliverables of work stream 2 are expected to be available by M6.
- Deliverables of work stream 3 are expected to be available by M6.
- Deliverables of work stream 4 are expected to be available by M30.

The activities are expected to reach TRL3

Expected impacts: The activities are expected to contribute to:

- Improving the basic knowledge in the field of GNSS, new signalling system (Moving Block) and automation. These fields are the key points in the evolution of signalling and automation in view of a full compliancy with ERTMS/ETCS standards and its future enhancement with new functionalities and with the application of new technologies.
- Enhancing optimisation of the train control according to the real needs of traffic through automatic driving features, especially for the highest grade of automation (GoA4) whose application would lead to line capacity improvement, headway reduction, reduction of traction energy consumption and carbon emissions.
- Standardise processes for system, product and standards' development through well-defined formal languages, thus contributing to reduce overall CAPEX cost, improving interoperability and reliability of the 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 TD2.2, TD2.3, TD2.4 and TD2.7 in line with the relative planning and budget.

Type of Action**:** Research and Innovation Actions.

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

S2R-OC-IP2-02-2017: Energy harvesting methodologies for trackside and on-board signalling and communication devices. Adaptation of already existing technologies for developing a purely on-board Train Integrity

Specific challenge: Evolution on signalling needs to be accompanied by an investigation of new technologies to be applied in the traditional environment and framework. The challenge is to develop competitive solutions for enhancing train integrity functionalities and for trackside object controller deployment.

Considering the different application in the Railway Segments one of the challenges is to find out solutions that will enable to overcome communication issues and provide the suitable energy supply for on board train integrity devices also in those cases where trains (especially freight trains) do not have any power supply available on the wagons.

Similar issue is present for trackside signalling object controllers which are laid down close to the track or the signalling equipment; hence a specific solution is necessary in order to minimize cables and trackside infrastructure. Subsequently, the objective will be to identify the best technical system (communication network, devices, antenna, energy generation and harvesting, etc.) to be used for achieving the On Board Train Integrity feature and to identify the best engineering solution for energy feeding of the trackside object controller.

Scope: The proposals should address all work streams described below, in line with the SS2R MAAP:

- Regarding the On-board Train Integrity (complementarity with TD2.5), the activities should include:
  a) the identification of solutions and the development of devices focusing on radio communication, energy harvesting technologies, antennas suitable to be installed in the queue of a very long train, optimizing its characteristics, also in non-line-of-sight (NLOS) conditions;
  b) the exploration of new solution or adaptation of existing technologies of energy generation for feeding on-board Train Integrity devices (for application on trains where power supply is not available) considering both the most appropriate source and the best way to store and distribute it.
  c) Validation in relevant environment of the developed solution regarding suitable antennas, power supply and harvesting.
- Regarding the trackside energy harvesting systems for object controller (complementarity with TD2.10) the activities should include:
  a) The analysis of the economic models of the energy harvesting systems focusing notably on regional and freight lines;
  b) The identification (in terms of components, circuits, engineering rules, redundancy, cabling) of the most suitable energy harvesting solution taking into account existing signalling standards as the essential input for ensuring safety and security.
  c) Provide the proof of the effectiveness of the solutions in terms of efficiency of the energy harvesting and safety.

This topic will be complementary with the topic 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.

The action stemming from this topic will also be complementary to action carried out following the topic S2R-CFM-IP2-01-2015: Start-up activities for Advanced Signalling and Automation System.

As specified in section 2.3.1 of S2R AWP for 2017, 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[44]:

- Deliverables of work stream 1a and 1b are expected to be available by M12;
- Deliverables of work stream 1c are expected to be available by M20;
- Deliverables of work stream 2a are expected to be available by M8;
- Deliverables of work stream 2b are expected to be available by M12;
- Deliverables of work stream 2c are expected to be available by M30.

The activities are expected to reach TRL4.

Expected impact: The activities are expected to contribute to:

- Achieving the basic knowledge of the best system architecture for further Train Integrity development and on board integration. Train Integrity is essential for the application of the Moving Block and it will be one of the main key element to improve European industries competitiveness also in markets currently dominated by other systems and technologies like PTC (Positive Train Control) (e.g. American market in the application of freight and regional lines).
- Defining the basic architecture (made up of components and interfaces) able to power the new Object Controller deployment. The new structure will have impact reducing installation cost (reducing quantity of cables to be laid down) and time to market reducing test & commissioning phase. It will also have significant impact on the signalling system at a whole using radio communications not only between object controllers and interlocking but also directly with trains.

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 TD2.5 and 2.10 in line with the relative planning and budget.

Type of Action**:** Research and Innovation Actions

[44] 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-IP3-01-2017: Smart metering and asset management of railway systems

Specific Challenge:

In the framework of the S2R Innovation Programme 3 (IP3) "Cost efficient and reliable infrastructure", of the S2R Master Plan, there are, inter alia, two Technological Demonstrators (TDs) in the S2R MAAP aiming at generating knowledge from data:

- "*Smart Metering for Railway Distributed Energy Resource Management System*" (TD3.10), where the specific challenge relies on the technology development and demonstrator implementation in order to realise:
  - A non-intrusive Smart Metering sensor networks at Railway System level.
  - An open system and interface for data collection, aggregation and analysis in an open source Operational Data Management (ODM) Platform.
  - A set of User Applications design and specifications. The Applications will exploit the energy analysis process with the aim of enhancing the energy decision making and the line operation patterns, as well as other possible improvements such as preventive maintenance.
- *"Dynamic Railway Information Management System (DRIMS)"* (TD3.6) where the challenge is to generate knowledge from data and/or information – driven whenever necessary by the available domain knowledge - valid for life cycle management and intelligent asset maintenance planning including automatic detection of anomalies, discovering and describing the maintenance workflow processes and implement predictive models of decaying infrastructural assets.

Scope:

The proposed research and innovation activities should address both work streams described below, in line with the Shift2Rail Multi-Annual Action plan (MAAP):

- Work-stream 1: Management of energy related data

The activities regarding this work stream should cover all following elements:

1. Development of sensors for railway systems energy data collection and transmission from the field, as well as technical support for the aims of TD 3.10 installation. This should include:
   - Analysis of existing components, systems and solutions that can be adapted to the railway environment for the measurement of energy and environmental related values. For example, analysis of smartphone or other low cost communicating sensors for on-board and track side energy measurements.
   - Technological development of programmable smart sensors ready to be adapted in railway environment, on-board and trackside.
   - Development of technologies for underground train geographical location and accurate train kinematic parameters measurements. These measurements will be integrated in a Geographic Information System (GIS) solution and synchronised with energy related measurements.
   - Development of advanced methods for underground equipment cartography, such as ground LIDAR (Light Detection and Ranging) combined with GIS.
   - Development of data recorders, relays and concentrators to be used on-board or at ground.

The activity is expected to finish with a technological proof of sensors and data transmission components, validated in relevant environment (TRL5). The sensors and the associated electronic modules to be delivered at the end of the project should have the following properties/characteristics:

- Be self-powered, low energy, with wireless transmission capabilities and able to be used in tunnels, accompanied by detailed technical specifications for their physical installation in the railway environment.
- Be able to perform measurements of energy (voltage, current), motion, localization and environmental parameters (temperature, CO2, pollution, noise).
- Support Network Time Protocol (NTP) for data time stamping.
- Have resilient telecommunications capabilities adapted to railway environment in tunnels and at surface.
- Support intelligent algorithms for data prioritization and data transmission management.

2. Energy data management architecture research for the TD3.10 data collection, processing and storage, including the following software specifications and developments:

    - Analysis of existing frameworks, systems and solutions that can be adapted to the railway applications environment for the management of energy related data, including GIS.
    - Specification and application of the most appropriate data distribution strategy within the data infrastructure, stating how data is acquired by the system, where is it processed, and how it is aggregated.
    - Develop scalable solutions for the data processing architecture for handling large, heterogeneous data volumes in short times, such as data compression algorithms, etc.
    - Develop adapted Data Storage solutions for a distributed and rapid data access, able to process streams of continuous data, as required by real-time sensing applications.
    - Develop techniques for securing data such as encrypted databases and the associated secured analytic engines.
    - Develop interfaces with railway control systems such as SCADA, etc. dedicated to railway operational data integration in the overall processing flow.
    - Develop the software for human machine interface for operational purposes such as data visualization and big data management.

The activity is expected to finish with a prototype of an Operational Data Management (ODM) Platform and the associated software validated in relevant environment (TRL5). The data management software to be delivered at the end of the project should have the following properties/characteristics:

- Continuous data collection from meters and installed sensors as well as associated streaming data processing.
- Non-intrusive and loosely-coupled data transmission protocols such as message-oriented middleware.
- Ability of processing data provided by heterogeneous sources and in large volumes.
- Data formatting and reconciliation for ensuring the synchronization of captured data at different times.
- Data processing capability for removing non-relevant data (odd-blank-inconsistent).
- Analytics capabilities and specific algorithms for data-knowledge extraction.
- Elasticity of the data management architecture in order to be incremented by new nodes when the current configuration needs more performance.

- Open source framework.
- Be able to interface with other possible data collection platforms such as GIS platforms, etc. and other possible data analytic engines.

3. Energy user applications development and associated modelling research applied to the TD3.10. The following Application domains should be investigated:

   - Data extraction and data visualization applications and integration in a GIS framework. Data coherence algorithms development.
   - Public portal applications for enhanced customer experience: dedicated portals or applications will provide specific energy data and contribute to energy savings by highlighting travel energy footprint, proposing customer travel habits changes, etc..
   - Railway system modelling application development in conjunction with measurement inputs. Embedded learning algorithms for energy estimation from train kinematic parameters.
   - Predictive maintenance applications using energy measurements.
   - Demonstrator specific energy market interface applications such as demand response, frequency regulation, or any other specific applications.
   - Railway asset management applications.

The activity is expected to finish with a prototype of the user applications described above, validated in relevant environment (TRL5).

The activities under work stream 1 are expected to request a contribution of indicatively € 1.4 million.

- Work-stream 2: Management of asset related data

The activities regarding this work stream should address the necessary IT solutions and related methodologies for business security, economic sustainability and decision support in the field of big data and analytics railway applications in the field of asset management, covering:

a. IT solutions for data and transactions security and safeguarding data ownership rights.
b. Methodologies and related IT solutions for the extraction of (visual or rule-based) explicit knowledge from data-driven models, exploitable by decision makers to interpret phenomena underlying analytics algorithms.
c. Study and proof-of-concept on the metrics and methods/tools to measure the accuracy of analytics algorithms.
d. Study and proof-of-concept on the railway specific structural contract mechanisms for information and knowledge exchange in order to guarantee a proper management of the value of the information dealt with, and the exploitation of general accounting services.

The activity is expected to request a contribution of indicatively € 0.8 million in order to deliver a validation of the activities described in points a and b above in relevant railway environment (corresponding to TRL5) and to provide an experimental proof of concept (corresponding to TRL3) of the studies described in points c and d above.

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-IP3-01-2017: Smart Systems for Energy Management and Future Stations Solutions

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

- S2R-CFM-IP3-02-2016: Intelligent maintenance systems and strategies.

As specified in section 2.3.1 of S2R AWP for 2017, 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[45]:

- Deliverables of work stream 1 are expected to be available as specified below:
  - For element nr 2.: by month 18;
  - For elements nr 1. and 3.: by month 24;
- Deliverables of work stream 2 are expected to be available by month 24.

Expected Impacts:

An analysis of the positive impacts of smart metering for energy management purposes can be highlighted for several cases specific to the main rail transportation energy consumption profiles, for example:

- Detailed knowledge of energy flows and consumers behaviour inside the railway system.
- Energy profile prevision improvement. Refined knowledge of the traffic disturbances and consequences on system's energy profiles.
- Continuous supervision of power supply equipment status. Improved reliability and LCC based on predictive maintenance by continuous supervision of energy consumption and early identification of the abnormal variations.
- Optimized return of investment (ROI) and ability for developing a better business plan, allowing optimal investments and asset management.
- Better identification of electric infrastructure losses.
- Better identification of auxiliary, maintenance facilities and stations energy consumption and of opportunities for savings and for demand-response.
- Increasing the power supply quality and optimizing the line capacity.
- Better coordination between the energy hourly variation prices and the traffic operation.
- Valorisation of braking energy
- Better management of train lighting and air conditioning/heating when not in revenue service.

A significant impact is expected from the methodologies and tools for business security, economic sustainability and decision support in the field of big data and analytics railway applications on the following areas:

[45] 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.

- Improvement of capacity – a large improvement in line capacity due to a more effective asset maintenance management;
- Improved Reliability: failure modes of current systems will be reduced/eliminated due to the new “intelligent asset management”;
- Improved safety – as a consequence of the improved reliability, the number and magnitude of incidents will be reduced;
- Significant LCC savings should be possible, due to new asset management approach.

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 TD3.6 and TD3.10 in line with the relative Planning and Budget.

Type of Action: Research and Innovation Actions

S2R-OC-IP3-02-2017: Future stations and accessibility (IP1 and IP3)

Specific Challenges:

High capacity stations have become destinations in their own right and dynamic places of commercial, retail and social activities. They are likely to have issues with congestion, guidance and security that are not experienced in more remote stations. The challenge is to improve security in large stations with the use of big data, digital analysis and technologies providing models for human behaviour. Another challenge is to improve the customer experience at high capacity stations with regard to boarding the train with ease and safety, in particular for persons with reduced mobility (PRM).This has to be achieved giving due consideration to the safe integration of the proposed solutions in the infrastructure subsystem.

Scope**:**

The proposed research activities should address all of the following work streams, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

1. Crowd flow analysis in large train station areas (TD3.11)

The activities are expected to provide an in-depth technical review of best practices and latest research in order to:

- Study the crowd flow in large stations and describe the main behaviours and characteristics in the movement of people.
- Develop the modelling of multiple people flows in large stations and the ways to manage crowds particularly in emergency situations which are causing evacuation.
- Identify available enabling technologies to analyse crowd management and people's movement in stations.

The activity is expected to request a contribution of indicatively € 0.4 million in order to develop an analysis, specification and demonstration of concept up to TRL3 (experimental proof of concept).

2. Improved Accessibility to Trains
    a. Platform-based design solutions for Platform-Train Interface (TD3.11)

The activities should focus on developing and evaluating new designs for platform-based solutions to resolve issues related to the Platform Train Interface (PTI). These solutions should:

- be consistent with the requirements and approaches developed within work streams 2.b and 2.c (see below)
- support the need for accessibility of PRM
- support the needs of passengers currying heavy luggage.
- support the handling of light-cargo (Bikes, Parcels, etc.) and train supply logistics.

The activity is expected to request a contribution of indicatively € 0.4 million in order to finish with design solutions for platform based PTI, up to TRL3 (experimental proof of concept).

    b. Train Access Door System for an independent and easy access (IP1-TD1.6)

The activities should focus on the following elements, complementary to the activities expected to be developed following the topic S2R-CFM-IP1-01-2017:

i. Define the exact needs (admissible slope, cant, vertical and horizontal gaps, thresholds, warning signals, passenger information, functionalities...) for independent and easy access of persons with reduced mobility. Consider application to existing infrastructure for the short term and innovative infrastructure for the long term.
ii. Support and validate the overall specification of the future Train Access Door System equipped with its adaptable gap filler.
iii. Support and validate the adaptable gap filler specifications with a detailed analysis of the needs of all passengers including persons with reduced mobility
iv. Evaluate the preliminary design of the adaptable gap filler that is expected to be developed following the topic S2R-CFM-IP1-01-2017, with a representative panel of users.

The activity is expected to request a contribution of indicatively € 0.2 million in order to finish with a validation of the access door and adaptable gap filler by a representative panel of users up to TRL3 (experimental proof of concept).

c. Research on platform detection technologies for station platform height and position determination (IP1-TD1.6)

The activities should focus on the following elements:

- Develop/upgrade sensors, detection systems and/or SDO (selective door operation) system, in order for the door system to detect the platform position and to reduce the thresholds and the gaps. Identify the best compromise between cost, precision and reliability.
- Perform specific tests of the developed solutions.

The activity is expected to request a contribution of indicatively € 0.2 million in order to finish with technology validation up to TRL3 (experimental proof of concept).

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 topics:

- S2R-CFM-IP3-01-2017: Smart Systems for Energy Management and Future Stations Solutions
- S2R-CFM-IP1-01-2017: Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Car-body, Running Gear, Brakes, Doors and Modular interiors.

As specified in section 2.3.1 of S2R AWP for 2017, 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[46]:

- Deliverables under points 1 and 2a are expected by month 18

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

- Deliverables under point 2b, as follows:
  - Deliverables under point “i” are expected by month 6
  - Deliverables under points “ii” and “iii” are expected by month 12
  - Deliverables under point “iv” are expected by month 18

Expected Impacts:

The most significant benefits expected from these actions, once the technologies developed are fully implemented and deployed, are:

- Increased passenger flow and station capacity, reducing the passenger related incidents and impacts on service reliability and punctuality;
- Increased safety and security in stations through improved crowd management;
- Improved travel experience by station users through the usage of better communication and reduction of physical barriers;
- Improved passenger experience thanks to independent accessibility for PRM and new access systems functionalities.

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 TD1.6 and TD3.11 in line with the relative Planning and Budget.

Type of Action: Research and Innovation Actions

S2R-OC-IP3-03-2017: Satellite and autonomous monitoring systems

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 autonomous and unmanned vehicles for railway network monitoring, by processing data captured by those devices in order to generate relevant maintenance infrastructure-related information. The specific challenge of such a concept relies on the technology development and demonstrator implementation in the field, to assess operational interests and feasibility in terms of which elements/parameters can be measured via unmanned aerial monitoring, and with which accuracy, to fulfil requirements of the specific applications.

Scope**:**

The proposed research and innovation activities should address all the following elements, in line with the S2R MAAP (TD.3.7):

- Analysis of the monitoring performances determined in other industrial fields, of various measuring systems based on satellites and/or Unmanned Aerial Vehicles (UAVs) implementation;
- Identification, by using KPIs, of the key assets to be monitored and their related parameters and variables to be measured, for which the use of satellites and/or UAVs are particularly suited;
- Selection of the most relevant monitoring system for each of the key assets to be monitored with satellites and/or UAVs;
- Identification of the relevant methods for data processing and post-processing, required to monitor the relevant parameters and generate the required information;
- Identification of gaps and/or barriers to be overcome for the usage of satellites and/or UAVs for asset monitoring, e.g. legal and security issues, technology improvement, etc.

The expected final output will include a technological proof in relevant environment (corresponding to TRL5) of aerial unmanned monitoring (satellites, UAVs, etc.) of key railway-related assets for which there is a clear and sustainable return of investments (to be developed). The prototype demonstration will have to generate maintenance infrastructure-related information for the railway maintenance processes, taking into account the application cases, which is planned to be developed under the activities of the complementary topic S2R-CFM-IP3-02-2016: Intelligent maintenance systems and strategies (*In2Smart* project). In particular, these application cases will include:

- Monitoring of the ground movements nearby the infrastructure (due to human activities – working area nearby – or due to natural movements – landslides, mudflow). This use case will allow satellite monitoring and LIDAR measurements to be mixed.
- Monitoring of hydraulic activities nearby the track (watershed, hydraulic gutter, track platform humidity level, etc.). This will allow multispectral, LIDAR and satellite monitoring to be mixed.
- Identification of natural hazards (barrier, vegetation, etc.) which allow a global supervision of the infrastructure to be settled.
- Electrical systems: monitoring device to be developed for hot spots localisation, corona effect, de-stranding detection, geometry control, etc.

- Civil engineering structures (bridges) monitoring: maybe a radar interferometry technic with drone equipped with radar photo and multispectral analysis for cracks or movements detection
- Safety monitoring (for maintenance impacts): identification of infra modification / deterioration due to human activities that could impact trains operation.

The prototype will also have to demonstrate which sensor performances, geo-referencing capabilities, costs, post-processing and analytics methods are used, to collect such maintenance infrastructure-related information

This work should be carried out considering that automation for acquisition but also for analysis of raw data obtained from UAVs and/or satellites is a critical issue: a large proportion of the acquired data will correspond to digital imaging, requiring dedicated post-processing methods that have to be completely automated to ensure effectiveness for the maintenance supervision. In this case, sensors and post-processing methods should be specifically worked out, notably for:

- multispectral and hyperspectral optical imagery;
- thermal imagery;
- lidar imagery;
- radar measurement (i.e. interferometry).

Moreover, in a context of multi-scale data acquisition the analysis process should propose optimal combinations of vehicles, sensors and post-processing methods to extract the most reliable and precise indicators for the studied application cases. The work should focus on:

- permanently improving default identification;
- automatically creating anomalies/faults/degradations databases;
- enabling cross analysis (different kind of data) to improve anomalies/faults/degradations detection;
- improving railway digital asset management.

The action expected to be funded from this topic will also be complementary to action carried out following the topic S2R-CFM-IP3-02-2016: Intelligent maintenance systems and strategies.

As specified in section 2.3.1 of S2R AWP for 2017, 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 Impacts:

The activities are expected to contribute to:

- Improvement of railway reliability and capacity thanks to a more effective maintenance management supported by the here developed monitoring solutions;
- Improvement of the railway maintenance by the development of a highly integrated automatic system;
- LCC reduction (lower physical complexity of systems, increased reliability and the like).

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 T.D.3.7 in line with the relative Planning and Budget.

Type of Action: Research and Innovation Actions

S2R-OC-IP4-01-2017: Smart technologies for improved travel companion and trip tracking

Specific Challenge:

In the Shift2Rail Master Plan, IP4 is focusing on proposing a new seamless approach for door to door journeys, with all services from all transport modes easily accessible to the passenger. This seamless access will be enabled by a "travel companion", using advanced human-machine interface features, adapted to the services to be displayed, the environment, and the passenger preferences. Real-time information addressing all the steps of the journey needs also to be proposed to the passenger, including a special focus on foreseen delays and/or disruptions, and real-time re-accommodation of the remaining part of the passenger's journey (rerouting and rescheduling) when necessary.

Starting from an existing but simplified mock-up of travel companion, already developed in the initial phase of IP4, the challenge remains to radically enrich the end-user experience, by improving the interaction of the passenger with the companion. Another challenge is to enhance the tracking of a journey using smart mechanisms, for instance developing prognosis of possibly upcoming disruptions, using decision making process to define when and how the journey of users can be affected.

Scope**:**

The proposed research should address all the elements described below, in line with the S2R MAAP (TD4.4 and TD4.5). The proposals should cover the following R&I activities:

- Development of new tools allowing better interaction between the passenger and each of the services (shopping, booking-ticketing, tracking and business analytics) provided by the IP4 environment[47].
- Development of enhanced human-machine interaction, complementing those developed by on-going IP4 activities[49].
- Ensure that novel and accurate/robust scalable positioning techniques for localising travellers in various transport modes, including within stations, can be interfaced with the travel companion.
- Additional mechanisms to track a journey, based on the collection, elaboration and integration of real time and historical data from diverse sources will be developed.
- Development of forecasting mechanisms able to predict the remaining part of the trip of a passenger will be developed. To improve the forecasting accuracy, the models could take into account (e.g. based on a correlation analysis) external variables including but not limited to environmental conditions (e.g. weather forecast, time and traffic, seasonal and periodic peaks, events spotting) and their presumable effects.
- Complete existing ontologies and define open interfaces and open specifications which support the development of these new functions.

The activity is expected to provide specifications and interfaces, and a software toolkit with prototype demonstration at TRL4-5. Further integration in operational environment will be achieved within the activities led following the topic S2R-CFM-IP4-02-2017: IP4 overall integration and demonstration.

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 topics:

[47] Please check the latest IP4 documention available on the Shift2Rail website at http://shift2rail.org/research-development/ip4/#updates

- S2R-CFM-IP4-02-2017: IP4 overall integration and demonstration
- S2R-CFM-IP4-01-2017: Technical framework for attractive railway services, in order to achieve consistency and ensure integrated system level delivery of IP4 concepts.

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

- S2R-CFM-IP4-01-2015 – Shopping, booking and ticketing of multimodal travel solutions
- S2R-CFM-IP4-02-2015: Travel companion and tracking services

As specified in section 2.3.1 of S2R AWP for 2017, 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 Impacts:

Activities are expected to contribute to the social acceptance of the overall IP4 eco-system. Innovative new interaction concepts should enhance the passenger experience by turning any journey into a seamless and enjoyable experience, adapted to the user's profile and the evolving situation, easily accessible to those with disabilities and reduced mobility, thus contributing to a larger adoption of the public transport.

Robust mechanisms to analyse, qualify and quantify potential delays, variations and/or disruptions and their impact on the passenger journey, together with precise and individualised guidance will provide a smoother multimodal experience, and a real alternative to private transport modes.

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 TD4.4 and TD4.5 in line with the relative planning and budget.

Type of Action: Research and Innovation Actions

S2R-OC-IP5-01-2017: Real-time yard and network management

Specific challenge:

Within the challenges highlighted in the IP5 part of the Shift2Rail Master Plan, the following specific challenges should be addressed by the proposed action for this topic:

Real-time yard and network management will guarantee on-time delivery and operational efficiency in particular in single wagon transport. The challenge however consists in providing a consistent set of data describing the processes and resource allocation in the yard and the surrounding railway network in real-time. An essential requirement of this call will thus be the modelling of the yard in a relevant network eco system, and an intelligent real-time simulation which generates the optimal disposition decisions and recommendations for resource utilisation in real time.

Innovation in real-time network management, as an extension of real-time yard management, will rely on improved decision support in ad-hoc timetable planning to optimize operational processes that connect freight traffic in yards and terminals with timetable slots to and from the network. A challenge of this call therefore is to model the data management processes of an existing network in appropriate simulation systems and to develop optimization algorithms. Processes incl. interaction between infrastructure manager and railway undertakings, need to be simulated for disturbances, sensitive freight, priority freight, dangerous goods etc.

The flow of data towards the terminals must fulfil the requirements defined in TAF TSI regulation and profit of the existence of a standardised set of messages in place, the TAF TSI XML catalogue. Moreover, new developments for tracking wagons and loading status shall take into account existing platforms at EU level implementing TAF TSI (ISR – RAILDATA).

Scope:
The activities should cover both work streams described below, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

Within the work stream 1 (TD5.2) related to “real-time yard management” proposals should address all the following elements:

- definition and selection of suitable methods for data analytics and data management;
- design and selection of a suitable simulation environment for real-time yard management in marshalling yards;
- development of detailed functional and technical specifications of selected simulation environment including interfaces with real-time network management and IT production fulfilment system (in the IT domain modal for rail freight, following the sales of a service, production planning is followed by production disposition, which is then realized in production fulfilment);
- development of framework conditions and algorithms for disposition of resources in yards in real-time and adaptation of existing simulation systems according to the results of specification;
- testing of simulation system in a production-like test and training environment focussing on one up to three existing complex European marshalling yards;
- performing feasibility test of real-time capabilities of the simulation system according to defined test cases, applicable to today’s operation in single-wagon load and block train transport.

The activity is expected to provide a fully functional software module, running successfully as a technical demonstrator in a production-like test environment and providing concrete and validated optimal decision support for dispatchers in yards, with a link to network management. The optimization module and algorithms must be proven for large and complex yard infrastructures, and integrate well with activities towards yard automation, e.g. intelligent assets and automated shunting in yards.

The scope of activities of the work stream 2 (TD5.2) regarding "real-time network management" should build upon real-time yard management activities described above and include:

- describing strategies how to follow up the roll-out of real-time yard management by means of optimization of Traffic Management up- and down-stream of these yards to cover end-to-end traffic information and traffic management in the network in real-time;
- modelling of an existing network including the simulation of yards managed in real-time to develop algorithms that can improve decision support and increase automation in ad-hoc timetable planning and operational train traffic for freight traffic between departure terminals/ nodes and arrival terminals/nodes covering the whole transport chain;
- specifying improved information and communication channels between infrastructure managers, railway undertakings and entrepreneurs responsible for infrastructure work;
- building on the results of past EU projects (RNE tools) and in accordance with the existing regulations TAF TSI and TAP TSI, development of an improved decision support in ad-hoc timetable planning to optimize operational processes that connect freight traffic in yards and terminals with timetable slots to and from the network. In this respect, the activities should develop appropriate simulation systems and optimization algorithms;
- processes need to be developed for dealing with minor perturbations and also for bigger disturbances.

The activity is expected to provide an extended, fully functional simulation model where beyond real-time yard management, interactions with the network and ad-hoc timetable planning will be simulated in real-time. The optimization module and algorithms must be proven for large and complex freight transport networks, and integrate well with IP5 activities towards automation, e.g. intelligent assets and automated shunting and mainline operations.

The following topic is expected to be complementary to this topic: S2R-CFM-IP5-01-2017: Real-time information applications and energy efficient solutions for rail freight.

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

- S2R-CFM-IP5-02-2015: Start-up activities for Freight Automation

As specified in section 2.3.1 of S2R AWP for 2017, 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 impacts:

The foreseen research activities are expected to contribute to the development of automation and digitalization of monitoring and decision processes along the supply chain of single wagon transport

(wagon load system). Based on an advanced simulation approach the expected impacts of a real-time yard management in combination with an interaction real-time network management would lead to improved punctuality, system efficiency and competitiveness of single wagon transport.

Moreover the activities are expected to lead to:

- improved automation in decision support for ad-hoc timetable planning and operational traffic;
- more flexible and competitive freight traffic by reduced travel times and reduced dwell times in yards, terminals and nodes of the system;
- improvement of punctuality of deliveries and most accurate estimated time of arrival due to real-time forecast and automation of disposition processes in yards and nodes of the system;
- increased flexibility and cost competitiveness for single-wagon load and block train transport;
- optimized traffic management and traffic flow due to ad-hoc timetable planning based on real-time information from yards and from the network;
- safer operation of dangerous goods in yards.

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 TD5.2 in line with the relative Planning and Budget.

Type of action: Research and innovation actions

S2R-OC-CCA-01-2017: Smart Maintenance and Human Capital

Specific Challenge:

Smart Maintenance

The current maintenance system is characterised by a combination of scheduled pre-emptive maintenance (predictive maintenance with service activities at defined intervals and replacement/reconditioning of parts before they fail) and unscheduled maintenance (corrective maintenance with repair/replacement of failed parts).

In the future in many of the most important railway subsystems and components will implement Condition-Based Maintenance (CBM) techniques and systems, expecting a reduction of maintenance costs and increase of components reliability and availability.

CBM is pushed by digitalisation, in particular more and more modules of modern vehicles provide diagnostic data that can be used for CBM without the installation of additional sensors and there is a growing possibility of gathering and processing huge volumes of various data. However, up to now there is very little knowledge concerning data analysis applied to the prediction of maintenance activities required to prevent component failures.

This topic aims at carrying out CBM research activities for the part related to passenger trains, while the others regarding infrastructure components will be covered within S2R-CFM-IP3-02-2016 and freight trains within S2R-OC-IP5-03-2015.

CBM presents a significant value potential for:

- Maintenance strategies, for faults prevention (i.e. early detection) and troubleshooting
- Asset Management strategies, for adapting and optimising maintenance activities to diverse clusters of similar assets.

Human Capital

The challenge of this action is to cover the future needs of the railway sector in terms of human capital focusing on customer-oriented design of mobility, with an overall objective to bridge the gap between the massive changes in the railway and other industrial sectors imposed by rapid technological advances (e.g. automation and digitization, comprehending the use of planning apps by customers on their own devices) and the substantial demographic change expected in the near future.

The specific challenge is manage these changes impacting on human capital.

Another specific challenge is place the human rather than technology at the centre of the mobility design process (“human-centred design”, “design thinking”). In particular, digitization and automation should have a good potential of improving and simplifying the customer experience in the use of the railway system, which complexity poses challenges to many passengers and could be a reason not to choose the train for a trip. Passengers need information (e.g. about the next bus stop, alternatives in case of disruption, ticketing information, planning information, railway station access, platform information, interchange information) and a support to manage mobility while at their destination. In comparison with the use of one´s own car, this appears substantially more complex and complicated. From a customer´s perspective, the travel chain is not designed with respect to usability.

Scope:

Proposals should address all the following work streams, in line with the CCA Work Areas (WA) of the Shift2Rail Multi-Annual Action Plan (MAAP):

Smart Maintenance (WA 3.3):

The activities should focus on the development and application of CBM of 2 – 4 specific modules of 2 – 4 passenger trains classes (motor train sets, locomotives and coaches). The work has to be carried out in close cooperation with the complementary action stemming from the topic S2R-CFM-CCA-01-2017 "Improving railway services for users and operators", as diagnostic and maintenance data of the trains mentioned above will be supported and integrated by the complementary action. The scope of this topic is therefore limited to data analysis and identification of statistical insights, clusters, trends and hidden patterns in huge sets of condition data. The work should be based on explicit experience of the applicant in reliability engineering in different industrial sectors. The proposal should address all the following elements:

- Investigation of CBM applications that could be applicable to railways from other technical systems, e.g. moving stairways, elevators, airlines and aircraft industry, industrial machinery, wind turbines, power plant engineering
- Statistical analysis of the failure mechanism of the modules incl. root-cause-analysis and fault clarification under operational conditions (in cooperation with vehicle, module and maintenance experts from the participants to the action stemming from the complementary topic S2R-CFM-CCA-01-2017)
- Development of semantics for CBM
- Identification of the parameters of the modules and their components that have an influence on reliability and maintenance
- Testing existing and developing new methods of failure prediction, both in the Supervised as well as the Unsupervised Learning mode, i.e. with historical failures in a well-structured database as well as based on purely probabilistic reasoning evaluating the likelihood of a prevailing system state under the normality assumption.
- Connecting the various methods of pattern recognition.
- Development of a forecasting model for CBM for the defined modules and components (Required input data, output data, fault forecasting (time horizon, justified warning rate and overlooked events and faults), and description of the model)
- Cooperation with maintenance and workshop experts from the participants to the action stemming from the complementary topic S2R-CFM-CCA-01-2017 concerning fault hypothesis generation and validation.
- Application and validation of the CBM-model with real data of specific train modules.

The smart maintenance activity is expected to request a contribution of indicatively € 0.47 million.

Human Capital (WA 6):

The work has to be carried out in close cooperation with the complementary action stemming from the topic S2R-CFM-CCA-01-2017 "Improving railway services for users and operators".

Customer-oriented design of mobility: successful systems and services are mostly linked to simple and intuitive solutions (e.g. anyone can use a device or service without reading an instruction manual). These systems and services are based on usability design, keeping things as simple as possible for the user.

The activities should focus on analysing the complexity of each part of the passenger journey from door to door, comprehending knowledge about relevant bus stops, access information for journey planning and ticketing, behaviour options in the case of delays, interchange conditions.

As a first step, an overview of the most critical factors (conscious and unconscious) negatively affecting the use of train from a customer perspective should be analysed.

Then each critical/complex activity should be compared through diverse transport modes (rail and road, air, etc.) and related services, for all the journey phases. It has to be assessed if one activity could be simplified, combined with another activity or eliminated.

The work should include surveys on a representative number of passengers to define the influence of each aforementioned factor on the choice of a transport mode, including railway.

Finally the work proposals should address the simplification of the journey and consider how digitization, automation and technical evolution in combination with the customer focus could decrease the number of necessary customer activities and, hence, increase the physical and psychological comfort.

In addressing the simplification of the journey, the work should in particular:

- Specify all activities from thinking about a trip to the planning, preparation and travelling phases, the mobility at the destination and the way back. For each activity clarify where they would stand from an usability perspective (i.e. subconscious, very easy, easy, complicated, very complicated) regarding to railways and also to other means of transport in competition to trains (comprehending at least airlines, long distance buses and cars).
- Describe the potential of customer tolerance/acceptance to their efforts to pass from one step of a journey to the next one (e.g. to get information about the next bus stop, to get information about options in the case of delays, to optimise travel costs). Develop a diagram with each of the steps of a journey and provide estimation on the level of possible customer resistance at each step related to personal attitudes for homogeneous group of target customers and on the percentage of customers lost in each step due to unfulfilled usability requirements (percentage of not retained customers). Provide an explanation on the main reasons of the diverse attitudes to public transport
- Do as described above also for other means of transport in competition to trains (comprehending at least airlines and cars) and with respect to other services related to the travel journey (i.e. online shopping).
- Provide conclusions and suggestions on what should be simplified and how.

The S2R JU considers that proposals requesting a contribution from the EU of up to € 0.23 million would allow this specific challenge, and all its elements, to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

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 topic:

- S2R-CFM-CCA-01-2017: Improving railway services for users and operators

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

- S2R-CFM-IP4-01-2015 – Shopping, booking and ticketing of multimodal travel solutions,
- S2R-CFM-IP4-02-2015 – Travel companion and tracking services,

As specified in section 2.3.1 of S2R AWP for 2017, 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 activities are expected to have the following impacts:

Smart Maintenance

The activities are expected to contribute to:

- increased availability and reliability of passenger vehicles and components and of infrastructure
- reduced maintenance costs.

Human Capital

The work will develop a concept on how to achieve a number of benefits and overcome the challenges imposed by the introduction of radical technological innovations through the customer-oriented design of mobility, in particular defining specific possibilities to improve usability, in order to increase the attractiveness of the railway 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 “Specific Achievements” quantitative and qualitative defined in the S2R MAAP related to the CCA Work Areas (WA) 3 Safety, Standardisation, Smart Maintenance, Smart Materials & Virtual certification and WA 6 Human capital in line with the related Planning and Budget.

Type of Action: Research and innovation action

ANNEX III Indicators and Scoreboard of KPIs

(annexes to be added later, once the document is finalised)

TABLE I - Horizon 2020 Key Performance Indicators[48] common to all JTI JUs

	Correspondence to general Annex 1	Key Performance Indicator	Definition/Responding to question	Type of data required	Data to be provided by	Baseline at the start of H2020 (latest available)	Target at the end of H2020	Automated
INDUSTRIAL LEADERSHIP	12	SME - Share of participating SMEs introducing innovations new to the company or the market (covering the period of the project plus three years);	Based on Community Innovation Survey (?). Number and % of participating SMEs that have introduced innovations to the company or to the market;	Number of SMEs that have introduced innovations;	H2020 beneficiaries through project reporting	n.a. [new approach under H2020]	50%	Yes
	13	SME - Growth and job creation in participating SMEs	Turnover of company, number of employees	Turnover of company, number of employees;	H2020 beneficiaries through project reporting	n.a. [new approach under H2020]	to be developed based on FP7 ex-post evaluation and /or first H2020 project results	Yes
SOCIETAL CHALENGES	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. [new approach under H2020]	[On average, 20 publications per €10 million funding (for all societal	Yes

[48] (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
							challenges)]	
	15	Patent applications and patents awarded in the area of the JTI	Number of patent applications by theme; Number of awarded patents by theme	Patent application number	H2020 beneficiaries through project reporting; Responsible Directorate/Service (via worldwide search engines such as ESPACENET, WOPI)	n.a. [new approach under H2020]	On average, 2 per €10 million funding (2014 - 2020) RTD A6	Yes
	16	Number of prototypes testing activities and clinical trials[49]	Number of prototypes, testing (feasibility/demo) activities, clinical trials	Reports on prototypes, and testing activities, clinical trials	H2020 beneficiaries through project reporting	n.a. [new approach under H2020]	[To be developed on the basis of first Horizon 2020 results]	Yes
	17	Number of joint public-private publications in projects	Number and share of joint public-private publications out of all relevant publications.	Properly flagged publications data (DOI) from relevant funded projects	H2020 beneficiaries through project reporting; Responsible Directorate/Service (via DOI and manual data input-flags)	n.a. [new approach under H2020]	[To be developed on the basis of first Horizon 2020 results]	Yes
	18*	New products, processes, and methods launched into the market	Number of projects with new innovative products, processes, instruments, methods, technologies	Project count and drop down list allowing to choose the type processes, products, instruments, methods, technologies	H2020 beneficiaries through project reporting	n.a. [new approach under H2020]	[To be developed on the basis of first Horizon 2020 results]	Yes

[49] Clinical trials are IMI specific

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

	Correspondence to general Annex 1	Key Performance Indicator	Definition/Responding to question	Type of data required	Data to be provided by	Baseline at the start of H2020 (latest available)	Target at the end of H2020	Automated
AUDITS	NA	Error rate		% of common representative error; % residual error	CAS	n.a. [new approach under H2020]		Yes
	NA	Implementation of ex-post audit results		Number of cases implemented; in total €million; ´of cases implemented/total cases	CAS	n.a. [new approach under H2020]		Yes
PAYMENTS	NA	Time to pay (% made on time) -pre-financing - interim payment -final payment	To optimize the payments circuits, both operational and administrative, including payments to experts	Average number of days for Grants pre-financing, interim payments and final payments; Average number of days for administrative payments; Number of experts appointed	Joint Undertaking	FP7 latest know results	-pre-financing (30 days) - interim payment (90 days) -final payment ((90days)	Yes
HR	NA	Vacancy rate (%)		% of post filled in, composition of the JU staff [50]	Joint Undertaking	n.a. [new approach under H2020]		

[50] 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
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
	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[51] 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

[51] (based on Annex III to Council Decision 2013/743/EU)

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

Correspondence in the general Annex 2	Cross-cutting issue	Definition/Responding to question	Type of data required	Data to be provided by	Data to be provided in/to	Direct contribution to ERA	Automated
9	Bridging from discovery to market [52]	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[53] 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

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

[53] 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
		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
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	14.2 Proposal evaluators by country	Nationality of proposal evaluators	Responsible Directorate /Service/Joint Undertaking in charge with the management of			

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
				proposal evaluation			
		14.3 Proposal evaluators by organisations' type of activity	Type of activity of evaluators' organisations	Responsible Directorate /Service/Joint Undertaking in charge with the management of proposal evaluation		YES	
NA	Participation of RTOs and Universities	Participation of RTO[54]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)[55]	Responsible Directorate /Service/Joint Undertaking	JU AAR RTD Monitoring Report		

Notes:

[54] RTO: Research and Technology Organisation

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

*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

TABLE III - Key Performance Indicators specific for the S2R JU

#	Key Performance Indicator	Objective	Data to be provided by	Baseline at the start of H2020	Target at the end of H2020	Automated
S2R						
1	% reduction in the costs of developing, maintaining, operating and renewing infrastructure and rolling stock and increase energy efficiency compared to "State-of-the-art"	Reduce the life-cycle cost of the railway transport system	JU	"State-of-the-art" 2014	> 50 %	No
2	% increase the capacity of railway segments to meet increased demand for passenger and freight railway services compared to "State-of-the-art" 2014	Enhance the capacity of the railway transport system	JU	"State-of-the-art" 2014	100%	No
3	% decrease in unreliability and late arrivals compared to "State-of-the-art" 2014	Increase in the quality of rail services	JU	"State-of-the-art" 2014	> 50%	No
4	Reduce noise emissions and vibrations linked to rolling stock and respectively infrastructure compared to "State-of-the-art" 2014	Reduce the negative externalities linked to railway transport	JU	"State-of-the-art" 2014	> 3 - 10 dBA	No
5	Addressing open points in TSIs, compared to "State-of-the-art" 2014	Enhance interoperability of the railway system	JU	"State-of-the-art" 2014		No
6	Number of Integrated Technology Demonstrators (ITDs) and System Platform demonstrations	Improve market uptake of innovative railway solutions through large-scale demonstration	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
		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	*AERNNOVA AEROSPACE S.A.U.*	ES
	FIDAMC	ES
	FUNDACION TECNALIA RESEARCH & INNOVATION	ES
ALSTOM Transport SA		FR
Amadeus IT Group SA		ES
ANSALDO STS S.p.A.		IT
AZD Praha s.r.o.		CZ
Bombardier Transportation GmbH		DE
Competitive Freight Wagon Consortium (CFW)	*Contraffic GmbH*	DE
	Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)	DE
	Waggonbau Niesky GmbH	DE
	Centro de Estudios e Investigaciones Técnicas (CEIT)	ES
	Verband der Bahnindustrie in Deutschland (VDB)	DE
Construcciones y Auxiliar de Ferrocarriles		ES
Deutsche Bahn AG		DE
DIGINEXT		FR
EUropean Rail Operating community Consortium (EUROC)	*Infraestruturas de Portugal, S.A.*	PT
	BLS AG	CH
	CP	PT
	Finnish Transport Agency	FI
	ÖBB-Infrastruktur AG	AT
	Polskie Koleje Państwowe S.A. (PKP)	PL
	PRORAIL B.V.	NL
	Schweizerische Bundesbahnen (SBB)	CH
	Slovenske zeleznice (SZ)	SI
	Türkiye Cumhuriyeti Devlet Demiryollari (TCDD)	TR
Faiveley Transport		FR
HaCon Ingenieurgesellschaft mbH		DE
INDRA SISTEMAS S.A.		ES
Kapsch CarrierCom AG		AT
Knorr-Bremse Systems für Schienenfahrzeuge GmbH		DE
MER MEC S.p.A		IT
Network Rail Infrastructure Limited		UK
Siemens Aktiengesellschaft		DE
Smart DeMain (SDM) consortium	*Strukton Rail BV*	NL
	ACCIONA INFRAESTRUCTURAS SA	ES
	Deutsches Zenttrum für Luft-und Raumfahrt e.V. (DLR)	DE
	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.	DE

NAME OF MEMBER	CONSTITUENT ENTITIES OF CONSORTIA	COUNTRY
	Centro de Estudios de Materiales y Control de Obra S.A	ES
Smart Rail Control (SmartRaCon) consortium	*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)*	DE
	Centro de Estudios e Investigaciones Técnicas (CEIT)	ES
	FONDATION DE COOPERATION SCIENTIFIQUE RAILENIUM	FR
	Nottingham Scientific Ltd	UK
Société Nationale des Chemins de Fer Français Mobilités (SNCF Mobilités)		FR
Swi'Tracken consortium	*FONDATION DE COOPERATION SCIENTIFIQUE RAILENIUM*	FR
	UNIVERSIDADE DO PORTO	PT
	TATASTEEL	FR
	UNIVERSIDAD DEL PAIS VASCO	ES
	UNIVERSIDADE DO MINHO	PT
	VOSSLOH-COGIFER	FR
	INSTITUT FÜR ZUKUNFTSSTUDIEN UND TECHNOLOGIEBEWERTUNG	DE
	EGIS RAIL	FR
	GROUPE EUROTUNNEL SA	FR
	TRONICO ALCEN	FR
Patentes Talgo S.L.U.		ES
THALES		FR
Trafikverket		SE
Virtual Vehicle Austria consortium+ (VVAC+)	*Kompetenzzentrum - Das virtuelle Fahrzeug, Forschungsgesellschaft mbH (Virtual Vehicle)*	AT
	FCP Firtsch, Chiari & Partner ZT GmbH	AT
	Getzner Werkstoffe GmbH	AT
	Kirchdorfer Fertigteilholding GmbH	AT
	Plasser&Theurer GmbH	AT
	voestalpine Schienen GmbH	AT
	voestalpine VAE GmbH	AT
	Wiener Linien GmbH & Co KG	AT
	AVL List GmbH	AT
	PJM Messtechnik GmbH	AT
	TATRAVAGONKA a.s.	SK
	AC2T research GmbH	AT
	Materials Center Leoben Forschung GmbH	AT

5 LIST OF ACRONYMS

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

IPR	Intellectual Property Rights
ISO	International Standardisation Organisation
IT	Information Technology
ITD	Integrated Technology Demonstrator
JTI	Joint Technology Initiative
JU	Joint Undertaking
KPI	Key Performance Indicator
LCC	Life Cycle Cost
LIDAR	Light Detection and Ranging
LTE	Long-Term Evolution (standard for wireless communication)
MAAP	Multi-annual Action Plan
MB	Moving block
NLOS	non-line-of-sight
NTP	Network Time Protocol
OC	Open Call
ODM	Operational Data Management
OPEX	Operating Expenditure
PA	Payment Appropriation
R&I	Research and Innovation
PPP	Public Private Partnership
PRM	Persons with Reduced Mobility
PTC	Positive Train Control
PTI	Platform Train Interface
RAL	Unpaid amount
RAMS	Reliability and Maintainability System
RBC	Radio Block Centre
RFID	Radio Frequency Identification
RIA	Research and innovation action
RoI	Return of Investment
S2R	Shift2Rail
SC	Scientific Committee
SME	Small and Medium Enterprise
SNE	Seconded National Expert
SPD	System Platform Demonstration
SRG	States Representatives Group
SWL	Single Wagon Load

TAF	Telematic Application for Freight
TAP	Telematic Application for Passengers
TCMS	Train Control and Monitoring System
TC	Tender Call
TD	Technology Demonstrator
TL	Train Load
TMS	Traffic Management System
TRL	Technology Readiness Level
TSI	Technical Specifications for Interoperability
UAV	Unmanned Aerial Vehicle
WA	Work Area