Shift2Rail
Joint Undertaking
(S2R JU)

ANNUAL WORK PLAN 2015

Version N°3

Annex to GB Decision N° 2/2016

Adopted by the S2R JU Governing Board on 29 February 2016

Shift2Rail Joint Undertaking - Annual Work Plan 2015		
Version N°	***Issue date***	***Change***
1	*11 December 2015*	*Adoption of AWP 2015 by the S2R JU Governing Board*
2	*28 January 2016*	*Editorial correction of topic S2R-OC-IP5-03-2015*
3	*29 February 2016*	*Amendment: Clarification of eligibility conditions to participate in S2R JU calls for proposals, regarding JU members in the form of a consortium or grouping.* *Addition of Annex IV listing all JU members (founding and associated) other than the Union*

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2 Introduction

2.1 Shift2Rail Joint Undertaking - background information

The Shift2Rail Joint Undertaking (S2R JU) was established by Council Regulation (EU) No 642/2014 of 16 June 2014 (S2R Regulation) until 31 December 2024. The S2R Regulation is accompanied by the S2R Statutes, in its Annex I.

S2R JU is a new public-private partnership in the rail sector established under Article 187 of the Treaty on the Functioning of the European Union, providing a platform for the rail sector as a whole to work together with a view to driving innovation in the years to come. The S2R JU fulfils the criteria for public-private partnerships (PPP) listed in Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020[2] ("Horizon 2020 Regulation") and Council Decision (EU) No 2013/743/EU of 3 December 2013 establishing the specific programme implementing Horizon 2020 (2014-2020)[3]. Rail research conducted within 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.

The S2R JU has nine founding members: the European Union, represented by the European Commission, and eight members from the rail industry, consisting of rail equipment manufacturers Alstom, Ansaldo STS, Bombardier, Construcciones y Auxiliar de Ferrocarriles (CAF), Siemens AG, Thales and infrastructure managers Trafikverket and Network Rail. Besides the founding members, S2R JU will also have associated members.

In accordance with S2R Regulation, and Article 4 of S2R Statutes in particular[4], the Commission launched a call for expression of interest to become associated member of the S2R JU, on 6 October 2014[5].

The call document (Ref. S2R JU/AM/01/2014[6]) listed the conditions and procedures for applications, as well as a detailed list of selection and evaluation criteria.

The first stage of the selection procedure for associated members was finalised on 31 March 2015 with a decision of the S2R JU Governing Board approving the results of the evaluation conducted by independent experts, as well as a decision approving the guidelines and template for the second stage submissions. The second stage of the call was launched on 7 April with a deadline of 21 May 2015.

The evaluation of the second stage applications was conducted by independent experts. Each time, the experts first assessed and scored the applications individually (between 22

[2] OJ L 347, 20.12.2013, p. 104
[3] OJ L 347, 20.12.2013, p. 965.
[4] OJ L 177, 17.6.2014, p. 9.
[5] Commission Decision N° C(2014) 7084 final
[6] http://ec.europa.eu/transport/modes/rail/news/doc/2014-10-06-shift-to-rail-call/2014-10-06-call-associated-member-s2rju.pdf

May and 20 June 2015), before coming together within their respective panels to form a consensus score and a consensus report. The consensus week took place from 29 June to 3 July 2015.

The candidates who were positively evaluated and met the required financial thresholds were invited by the Decision of the S2R JU Governing Board to further consultations and negotiations. It is expected that the process of selection of associated members will be concluded in Q4 2015. Then, each member will be expected to sign its individual membership agreement with the S2R JU, defining its legal, operational and financial commitment to the JU.

The completion of membership of the S2R JU constitutes a crucial milestone that must be achieved in order for the JU to launch its first call for proposals for members and the first open call for proposals for non-JU members.

According to Article 19 of the S2R Regulation, the Commission shall be responsible for the establishment and initial operation of the S2R Joint Undertaking until it has the operational capacity to implement its own budget. It is foreseen that the S2R JU will achieve this operational autonomy by Q2 2016.

2.2 Shift2Rail's mission and objectives

The objective of the S2R JU is to implement an ambitious programme of research and innovation activities in the railway sector in Europe. Those activities should be carried out through collaboration between stakeholders in the entire railway value chain, also outside the traditional rail sector, including SMEs, research and technology centres and universities.

The rail research performed within the S2R JU will prioritise the following overall objectives for the duration of the S2R JU, in line with the S2R Regulation and S2R Master Plan:

- Achieve the Single European Railway Area through the removal of remaining technical obstacles holding back the rail sector in terms of interoperability and through the transition to a more integrated, efficient and safe EU railway market, guaranteeing the proper interconnection of technical solutions.
- Radically enhance the attractiveness and competitiveness of the European railway system to ensure a modal shift towards rail through a faster and less costly transition to a more attractive, user-friendly (including for persons with reduced mobility), efficient, reliable, and sustainable European rail system.
- Help the European rail industry to retain and consolidate its leadership on the global market for rail products and services by ensuring that Research & Innovation activities and results can provide a competitive advantage to EU industries and by stimulating and accelerating the market uptake of innovative technologies.

The objectives of the S2R JU should be achieved by means of supporting research and innovation activities by using resources from the public and private sectors. To this end, the

S2R JU will organise calls for proposals for supporting research, demonstration and deployment activities.

As specified in Article 17 of the S2R Statutes, up to 70% of the S2R JU budget will be implemented directly by the members of S2R JU (founding and associated members) and their affiliated entities following calls for proposals accessible to members only. At least 30% of the S2R budget will be implemented through open, competitive calls accessible 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.

In accordance with Articles 1(4) and 2(a) of S2R Statues, the Governing Board of the S2R JU adopted, on 31 March 2015, a strategic Master Plan[7], which identifies the key priorities of S2R R&I activities and indicates the main operational and technological innovations that are required to achieve the objectives of the JU. The S2R Master Plan is a living document that may be updated by the Governing Board of the S2R JU, in accordance with the procedure set out in the S2R Regulation.

2.3 Shift2Rail's Annual Work Plan

This document establishes the Annual Work Plan (AWP) of the S2R JU for 2015.

The Annual Work Plan 2015 is based on the draft Annual Work Plan 2015 adopted[8] in accordance with Article 19 of the S2R Statutes, which foresees that the Executive Director must draw up and submit for adoption to the Governing Board a draft annual work plan, on the basis of the S2R Master Plan. The draft Annual Work Plan included a detailed plan of the research and innovation activities, the administrative activities and the corresponding expenditure estimates for the coming year, as well as the estimated value of the in-kind contributions to be made by members other than the Union and their affiliated entities in implementing indirect actions, in accordance with point (b) of Article 16(3) of the Statutes. The Annual Work Plan 2015 follows the adoption of the Financing Decisions of the S2R JU by the European Commission[9].

The AWP of the S2R JU indicates IPs and research and innovation areas foreseen in the Master Plan in which the work would be led in priority within a given year, and a plan for their effective and efficient implementation. In order to ensure that the AWP for any given

[7] This S2R Master Plan was developed by the Commission services in close cooperation with the 8 Shift2Rail founding members other than the Union and incorporates comments received from stakeholders during numerous individual meetings with sector representatives and a public consultation meeting held on 20 June 2014, to which close to 200 stakeholders took part. The document was first approved by the Governing Board of the S2R JU on 24 September and consequently endorsed by the Council on 10 February and is available at: http://ec.europa.eu/transport/modes/rail/shift2rail_en.htm

[8] Decision n°12/2015 of the S2R Governing Board.

[9] The Commission Decision for 2015 for the contribution of the European Union to the administrative costs of the Shift2Rail Joint Undertaking (C(2015) 1275 final) was adopted on 26 February 2015 and the Commission Decision (C(2015) 7778 final) on the Union financial contribution to the operational activities of the Shift2Rail Joint Undertaking for 2015 was adopted on 13 November 2015.

year is anchored in a long-term approach that guarantees the continuity and synchronicity of all S2R JU R&I activities, in accordance with Article 2(c) of the S2R Regulation, the S2R JU Governing Board will also develop a long-term investment plan, the S2R 'Multiannual action plan' (hereinafter "MAAP").

The MAAP will identify the concrete actions, milestones and deliverables to be undertaken and produced during the lifetime of the S2R JU and it will provide a framework for the long-term cooperation between all members of the S2R JU and the other participants in S2R JU actions.

It is on the basis of this MAAP that the S2R JU members' long-term individual contributions to the JU will be defined in their membership agreements.

2.4 Shift2Rail's research and innovation priorities

The S2R Master Plan identifies the key strategic priorities of S2R initiative, looking at a 2030 horizon, encompassing therefore research 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.

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. **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, more energy and cost-efficient while at the same time providing a comfortable, 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

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 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

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 a 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 research and innovation areas in which activities should be undertaken with a view to achieving the ambition of IP3:

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

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, big, linked and open data 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, 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

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 in terms of developing rail freight[10]; 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 can be identified. The first segment is the intermodal segment, which mainly relies on the use of containers / trailer trains and where continued growth can be expected. Reliability, service characteristics and cost competitiveness in this segment can progress significantly with an increase in train length, better length utilisation, innovative rolling stock features for value-added services, progress in the terminal operations, improved real-time customer information to customers and better data exchange between involved parties in the intermodal transport chain. A second market segment is the wagon load / block train activity segment, which relies on the use of specific freight wagons. This segment has 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

[10] WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system /* COM/2011/0144 final, Goal N°3.

6. Cross-cutting themes and activities

In addition to the five Innovation Programmes, the work of S2R R&I activities will include cross-cutting activities (CCA) relevant to each of the different sub-systems and taking into account the interactions between these sub-systems.

These 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 research 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

3 Governance

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

3.1 Governing Board

The 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[11].

The Governing Board of the JU was established after the 8 Founding Members of the S2R JU other than the Union listed in Annex II to the S2R Regulation endorsed the S2R Statutes and once all founding members, including the Union, nominated their representatives and alternate representatives to the Board.

In accordance with the S2R Regulation, the JU Governing Board is currently composed of two representatives from the Commission and one representative from each of the founding members of the S2R JU other than the Union. Once the procedure for selecting associated members is completed, the number of representatives in the Governing Board will be extended to include representatives from the associated members, in accordance with Art. 6 of the S2R Statutes.

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

In 2015, the Governing Board is planning to hold four ordinary meetings.

The key activities are listed below:

Key activities in 2015 – timetable	
Adopt/discuss the key documents for the S2R JU's operations: 2014 Annual Report, 2015 draft Annual Work Plan, and draft budget 2016.	Q1
Adopt draft 2015 Annual Work Plan and draft 2016 Annual Work Plan	Q3
Adopt the model Rules of Procedure for Innovation Programme Steering Committees	Q3
Adopt the practical arrangements for implementing Regulation (EC) No 1049/2001 regarding transparency and access to EU documents	Q4

[11] Annex to the Council Regulation (EU) No 642/2014 of 16 June 2014 establishing the Shift2Rail Joint Undertaking ("S2R Regulation").

Adopt the Code of Conduct for staff and appropriate implementing rules as regards the Staff Regulations and the Conditions of Employment	Q4
Approve Membership agreements	Q4
Approve the launch of the call for proposals for members, and of the open call for proposals for non-JU members	Q4
Set up the IP Steering Committees and working groups, when appropriate	Q4
Adopt further key documents for the S2R JU's operations in 2016: 2015 Annual Work Plan; 2016 Annual Work Plan, 2016 budget and staff establishment plan	Q4
Discuss draft budget 2017	Q4
Discuss draft 2017 Annual Work Plan	Q4
Interview and appoint the Executive Director of the S2R JU and delegate the appointing authority	Q4

3.2 Executive Director

According to Article 10 of the S2R JU Statutes, the Executive Director is the chief executive responsible for the day-to-day management of the S2R JU in accordance with the decisions of the Governing Board. The Executive Director is the legal representative of the S2R JU. The Executive Director is accountable to the Governing Board. He is supported by the JU staff.

In accordance with Article 19 of the S2R Regulation, the Commission is responsible for the establishment and initial operations of the S2R JU until it has the operational capacity to implement its own budget. The Commission will carry out, in accordance with Union law, all necessary actions with the involvement of the competent bodies.

The European Commission appointed an Interim Executive Director on 09 July 2014. The Interim Executive Director will fulfil the functions of the Executive Director until he/she takes up his/her duties.

The recruitment process for the position of Executive Director was launched on 25 July 2014 (vacancy notice COM/2014/10363), in line with Article 9 of the S2R JU Statutes. The vacancy notice was published on the website of EPSO and the website run by the S2R promoters. The deadline for applications was 22 September 2014. 44 applications were received. The Commission concluded the selection process without proposing any short list of candidates to the Governing Board. The vacancy notice was consequently republished on 27 May 2015 with the deadline to submit applications of 26 June 2015.

The appointment of an Executive Director is a pre-requisite for the S2R JU to obtain its budgetary and financial autonomy, as, in accordance with Art. 19.4 of S2R Regulation, the JU will reach the capacity to implement its own budget at a date determined by the Interim Executive Director in common accord with the Executive Director, subject to the approval of the Governing Board.

Selection of the Executive Director – key elements	
Re-publication of the Vacancy notice	27 May 2015
Deadline for submission of applications	26 June 2015
Set up of a preselection panel, screening of applications with regard to the selection criteria, and interviews of the short-listed candidates with the European Commission's Consultative Committee on Appointments (CCA)	Q3 2015
Interviews with the Commissioner for Transport and with the S2R JU Governing Board, decision on appointment	Q4 2015
Taking office	March 2016 (at latest)

3.3 Scientific Committee

According to Article 13 of the S2R Statutes, the Scientific Committee is an advisory body to the Governing Board.

The Scientific Committee shall carry out the following tasks:

- advise on the scientific and technological priorities to be addressed in the annual work plans;
- advise on the scientific and technological achievements described in the annual activity report;
- suggest possible areas of advanced research that could be subject to further developments;
- suggest possible synergies with national and international research and innovation activities in the rail technical domain, in particular via the European Rail Research Advisory Council (ERRAC) Technology Platform, as well as with those in other domains, as identified in Article 2(k) of the S2R Statutes.

The S2R JU launched the selection procedure of its Scientific Committee on 21 October 2014 through the publication of an open call for expression of interest.[12] The call document (Ref. S2R JU/SC/01/2014[13]) listed the eligibility conditions, evaluation and selection criteria and procedures for applications. The deadline for applications was 22 December 2014.

The call was published on the website of DG MOVE and the website of the S2R promoters (www.shift2rail.org). In accordance with the S2R Regulation, the call was also advertised through the ERRAC technology platform, the European Railway Agency and the States Representatives Group, who were invited to nominate potential candidates.

[12] http://ec.europa.eu/transport/modes/rail/news/shift-to-rail-call-members-scientific-committee_en.htm

[13] http://ec.europa.eu/transport/modes/rail/news/doc/2014-10-22-shift-to-rail-call/call-members-scientific-committee.pdf

The selection panel completed the evaluation of the applications in February 2015 and the Governing Board decided on 31 March 2015 on the final selection of the successful candidates to appoint in the S2R Scientific Committee as well as on the constitution of a reserve list. The S2R Scientific Committee was established further to this decision and held its first meeting on 28 May 2015. The tentative key activities are listed below:

Key activities in 2015 - timetable	
1st Meeting of the SC. The SC would: – Be formally established, elect the chairperson and adopt the rules of procedure – Provide advice on the draft 2015 Annual Work Plan, which was adopted for budgetary purposes, and the plan of the research and innovation activities for 2016. – Provide advice on the planned calls for proposals.	Q2
2nd Meeting of the SC. The SC would: – Provide advice on the scientific priorities to be addressed in the draft Multi Annual Action Plan – Be informed and provide advice on the final draft of the 2015 Annual Work Plan and the Annual Work Plan for 2016 – Provide advice to the GB on the programme progress of the S2R and other strategic issues	Q4

3.4 States Representatives Group

Following the entry into force of the S2R Regulation, Members States and countries associated to the Horizon 2020 framework programme were asked to nominate their representatives to the States Representatives Group, in accordance with Article 14 of the S2R Statutes. To date, the 28 countries have nominated representatives to the Group.

A first meeting of the States Representatives Group was organised on 16 October 2014 in Brussels. During that meeting the States Representatives Group adopted its rules of procedures and proceeded with the election of the Chair and Vice-Chair persons.

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

1. updating of strategic orientation and of the S2R Master Plan and progress towards achievement of its targets;
2. the S2R JU Annual Work Plans;
3. links to Horizon 2020 and to other Union and Member State funding instruments, including the Connecting Europe Facility, and the ESIF;
4. links to the Union rail transport legislation and the goal of achieving a Single European Railway Area;

5. involvement of SMEs and relevant actors from outside the traditional rail sector.

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

a) the status of relevant national or regional research and innovation programmes and identification of potential areas of cooperation, including deployment of relevant technologies to allow synergies and avoid overlaps;

b) specific measures taken at national or regional level with regard to dissemination events, dedicated technical workshops and communication activities.

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

During the year 2015, at least two meetings of the States Representatives Group are planned (Q2 and Q4). The first meeting of SRG in 2015 took place on 29 April 2015.

The tentative key activities are listed below:

Key activities in 2015 - timetable	
2nd Meeting of the SRG. The SRG would: – Provide advice on the draft 2015 Annual Work Plan, which was adopted for budgetary purposes, and the plan of the research and innovation activities for 2016. – Provide advice on the planned calls for proposals.	Q2
3rd Meeting of the SRG. The SRG would: – Be informed about the results of the Call for Associated Members; – Provide advice on the scientific priorities to be addressed in the draft Multi Annual Action Plan; – Be informed and provide advice on the final draft of the 2015 Annual Work Plan and the Annual Work Plan for 2016; – Provide opinion to the GB on the programme progress of the S2R R&I activities and other strategic issues; – Provide updated information and discuss initiatives on: regional and national research and innovation programmes to allow synergies with similar research activities carried out for example in Horizon 2020; dissemination and communication activities; and deployment activities in relation to S2R R&I activities.	Q4

4 Operational activities 2015

As mentioned previously, the activities of the S2R JU will be based on the priorities set out in the S2R Master Plan and further developed in the framework of the Multi-Annual Action Plan.

In accordance with Art. 2 of S2R Statutes, the S2R JU will financially support research and innovation indirect actions, mainly through grants to its members and to participants through the most appropriate measures, such as procurement or the award of grants following calls for proposals to achieve the programme objectives, in accordance with Regulation (EU) No 1290/2013.

Consequently, the S2R activities will be implemented either directly by the members of S2R JU following calls for proposals that are accessible only to JU members (founding and associated), and their affiliated entities[14], pursuant to Article 9.5 of Regulation (EU) No 1290/2013, or through open, competitive calls for proposals or calls for tenders accessible 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 S2R JU plans to launch its first calls for proposals and calls for tenders in Q4 2015, following the completion of the selection of associated members. More details on the planned calls that will be launched in 2015 can be found in section 4.2.

Prior to this, a number of projects were launched by the Commission under the general Horizon 2020 Transport Work Programme for 2014, within the Challenge “Smart, green and integrated transport”, call “Mobility for Growth”, topic 2. Rail. These projects kicked off their activities on 1 May 2015 and are expected to contribute to the achievement of the objectives and goals of the JU. It is also foreseen that the Commission transfers the management of these projects to the JU once it will have reached its operational and financial autonomy. More details on these projects, which will lay the foundations for future work under the S2R JU, can be found in section 4.1.

4.1 Activities within projects from HORIZON 2020 – WORK PROGRAMME 2014-2015 – 2014 call "Mobility for Growth"

In 2014, there was no call for proposals launched specifically by the S2R JU. However, the Work Programme 2014-2015 of Horizon2020, and specifically the Challenge “Smart, green and integrated transport”, call “Mobility for Growth”, topic 2. Rail specified that “the selected proposals will contribute to the objectives of the initiative to be implemented under

[14] 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 their affiliated entities, are eligible to participate in the restricted calls for JU members.

a public-private partnership (Shift2Rail) as they will later be integrated into the activities of this partnership".[15]

The 2014 call included the three following topics:

- MG.2.1-2014.I²I – Intelligent Infrastructure
- MG.2.2-2014. Smart rail services
- MG.2.3-2014. New generation of rail vehicles

The first stage of the 2014 MG.2 call was closed on 18 March 2014. A total of 33 proposals were received, of which two were ineligible. The proposals were evaluated remotely, by independent experts, from 14 April until 23 May 2014.

Following the first stage evaluation, a total of 13 proposals were invited to stage 2. The deadline for second stage submissions was 28 August 2014. All 13 proposals were successfully submitted by the applicants by this deadline and were deemed eligible. The proposals were evaluated by independent experts from 15 September to 14 October 2014, first remotely, then centrally in Brussels. A decision of the Commission on the list of projects to be funded and reserve lists was adopted at the beginning of the year 2015.

7 proposals were retained for funding for a total value of € 67,153,627. 3 of these projects are currently managed by DG MOVE, 1 by DG RTD and 3 by INEA (the Innovation & Networks Executive Agency). The Grant Agreements for all 7 projects were prepared and signed in late April 2015.

In accordance with Article 3.1(b) of the S2R Regulation, it is foreseen that the management of the 4 projects currently managed by DG MOVE and DG RTD (hereinafter the 'lighthouse projects'), for a value of € 51,997,759, may be taken over by the S2R JU once it achieves the operational capacity to implement its own budget (i.e. towards Q2 2016, once the Executive Director has been appointed). These four projects started on 1 May 2015 and will run for 30 months (2 projects) or 36 months (2 projects). The take-over of the management of the projects by the JU would require an amendment of the relevant grant agreements, signed by the European Commission. As the EC Work Programme 2014-2015 does not contain sufficiently detailed requirements, the provisions on complementary grants in the S2R MGA will not be mandatory for the beneficiaries of these projects following the take-over, who may accept them on a voluntary basis, subject to their explicit agreement.

Finalisation of the 2014 call management process	
Deadline for proposals submission (2nd stage)*	28/08/2014
Finalisation of evaluations (information on outcome of the evaluation)	Q1 2015
Preparation and signature of the grant agreements for the selected proposals	Q1/Q2 2015
Pre-financing payments	Q2 2015 (the kick off date of projects

[15] https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-transport_en.pdf, p.22.

	is 1 May 2015)
Follow-up implementation of projects	2015-2018
Take-over of the management of the 2014 call projects by S2R JU	Q2 2016

(*) Time to grant of maximum 8 months from 28/08/2014 according to Horizon 2020 rules

The JU with help of the Commission established an overview of the activities that will be undertaken under the four lighthouse projects resulting from H2020 2014 MG.2 call that are foreseen to be integrated into S2R R&I activities.

This mapping exercise aims to help the S2R JU to determine the priorities for the first calls for proposals to be launched in Q4 2015, taking into account the following constraints:

- avoid a duplication of research work and/or any double-funding between the activities covered by the lighthouse projects and future calls for proposals or tenders launched by the JU;
- ensure sufficient synergies and continuity, and fill in the possible gaps between the activities being carried out under the lighthouse projects and the future calls for proposals launched by the JU.

4.2 Overview of 2015 planned operational activities

The table below identifies the calls that the S2R JU is planning to launch in 2015, in order to launch its operational activities. 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 4.2.1-4.2.5). However, a number of activities will be performed through public procurement, following call for tenders (cf. section 4.2.6).

Actor	Activity	Type of call	Indicative EU contribution	Indicative minimum in-kind contribution of JU members	Indicative publication date
JU members	Call for Proposals	Closed - Restricted to JU members	€ 34.6 mln	€ 43.3 mln	Q4 2015
Non-JU members	Call for Proposals	Open	€ 10 mln	N/A	Q4 2015
Non-JU members	Call for Tenders	Open	€ 700 000	N/A	Q4 2015
TOTAL			€ 45.3 mln	€ 43.3 mln	

4.2.1 S2R JU's calls 2015 – general information

Art. 25 of H2020 Regulation, regarding public-private partnerships states that "public-private partnerships shall make public funds accessible through transparent processes and mainly through competitive calls, governed by rules for participation in compliance with those of Horizon 2020. Exceptions to the use of competitive calls should be duly justified."

In the case of S2R JU, as specified in Article 17 of the S2R Statutes, up to 70% of the Union financial contribution to the S2R JU may be allocated to the members of S2R JU (founding and associated members), and their affiliated entities, following calls for proposals that are accessible to members only. At least 30% of the S2R budget must be implemented through open, competitive calls for proposals or calls for tenders accessible to non-members of the S2R JU. The aforementioned ratio applies to the overall budget implementation for the duration of the S2R JU, and does not necessarily need to be respected on an annual basis.

In light of this, and in order to fulfil the aforementioned allocation of the Union financial contribution, the JU will distinguish between:

- calls for proposals, which, pursuant to art. 9.5 of Regulation 1290/2013 and art. 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 their affiliated entities, are eligible to participate in the restricted calls for JU members;
- and open, competitive calls for proposals (or tenders) that, pursuant to art. 9.5 of Regulation 1290/2013, 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 JU plans to launch its first call for proposals for JU members in Q4 2015, following the signature of the membership agreements with founding and associated members.

The JU plans to launch its first open, competitive call for proposals addressed to non-JU members in Q4 2015.

More details of the management process of the calls for proposals are presented in section 4.2.5 below.

The JU also plans to launch its first open call for tenders addressed to non-JU members in Q4 2015 (cf. section 4.2.6 for more information).

4.2.2 S2R JU's calls 2015 – strategic priorities

On the basis of the mapping exercise explained in section 4.1, the S2R JU considers that its first call for proposals should focus on ensuring a meaningful start of activities under IP 2 and IP 5, which are covered only to a very limited extent by the four lighthouse projects resulting from H2020 2014 call. It will be also crucial to extend the activities in IP4, in order to fully cover co-modal travel solutions, leading towards intermodal solutions.

Starting a number of cross-cutting activities (CCA) is also considered a priority in order to guarantee a coherent approach and alignment of technological developments across the IPs. The CCA will identify where additional research activities need to be performed in order to achieve the S2R objectives and enable the emergence of a genuine systems approach achieving overall environmental, economic and societal benefits.

The first calls for proposals will also take into account the need to make steady, coherent and meaningful progress from lower Technology Readiness Levels to higher TRL[16], enabling the completion of all Technological Demonstrators in time, and their convergence into integrated Technological Demonstrators and System Demonstration Platforms. This is why the first call for proposals will mostly take the form of Research and Innovation actions (RIA)[17], corresponding to lower TRL activities, and will then lead to development of further Innovation Actions (IA)[18], corresponding to higher TRL levels. Cross-cutting activities, corresponding to accompanying measures, might take form of RIA or Coordination and Support Actions (CSA)[19], as appropriate.

4.2.2.1 Innovation Programme 2: Advanced traffic management and control systems

The research and innovation areas of IP 2 are the least covered by the lighthouse projects. Consequently, launching activities within IP2 will be among priorities in 2015. It is expected that the work would start on most of research and innovation areas of IP2, as described in the S2R Master Plan.

4.2.2.2 Innovation Programme 4: IT Solutions for Attractive Railway Services

Within the scope of IP4 the initial activities within all Research and Innovation areas described in the S2R Master Plan are covered by activities of one of the lighthouse projects. However, the solutions developed will mostly be co-modal in nature, combining different transport modes, but not bringing them into one intermodal chain of travel shopping, booking and integrated ticketing. For this reason, further activities are needed in order to pave the way towards a fully multimodal integration, mainly by completing the work on ontologies and specifications with regards to intermodal solutions. Consequently, launching further activities within IP4 will be among priorities in 2015.

4.2.2.3 Innovation Programme 5: Technologies for sustainable and attractive European Rail Freight

In IP5, only a limited number of start-up activities in the R&I areas "Implementation Strategies and Business Analytics" and "Access and operation" (provision of real-time data)

[16] General Annexes to H2020 Work Programme 2014-2015, Part G. https://ec.europa.eu/research/participants/portal/doc/call/h2020/common/1617621-part_19_general_annexes_v.2.0_en.pdf

[17] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-d-ria_en.pdf

[18] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-d-ia_en.pdf

[19] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-d-csa_en.pdf

of the S2R Master Plan are covered by the lighthouse projects. Consequently, launching further activities within IP5 will be among priorities for 2015. It is expected to start activities in further research and innovation areas of IP5 described in the S2R Master Plan.

4.2.2.4 Cross-Cutting Activities

The medium- and long-term objectives of S2R R&I activities include the increase of railway capacity, the reduction of noise, the minimisation of energy consumption and of emissions and the reduction of life-cycle costs. The achievement of these objectives should be assessed, monitored and evaluated throughout the JU duration. Such an integrated assessment of newly developed technologies can only be tackled through an integrated approach and creation of synergies between the different technical subsystems. Thus, the Cross-Cutting Activities will help to ensure that the R&I activities within different IPs and the results of the Technical Demonstrators (TDs) related to the specific cross-cutting themes are closely aligned.

As a first step, the work performed within cross-cutting activities will contribute to the development of methodologies for evaluating and assessment of improvement that are required in different TDs. Secondly, it will also provide technical and scientific support within all IPs to monitor the progress and results achieved within different Technological Demonstrators, and evaluate them.

4.2.3 Call for proposals for S2R JU members

This section presents the list of topics that will be included in the call for proposals for JU members, in line with the priorities defined in the previous section.

In 2015, the S2R JU is planning to issue one call for proposals addressed to JU members, in Q4. The budget for this call is estimated at EUR 34.6 million (in EU contribution). The indicative minimum value of the in-kind contributions to be made by members other than the Union and their affiliated entities in implementing indirect actions pursuant to the call for proposals for members is EUR 43 257 786.

Detailed topic descriptions are provided in the Annex I to the Annual Work Plan 2015.

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

It is foreseen that the call for proposals will be launched in Q4 2015, with activities expected to start in Q4 2016.

Proposals should be invited against the following topics:

Topic number - IP	Topic name	Expected TRL	Type of action	Indicative Union contribution	Indicative in-kind contribution from members other than the Union
S2R-CFM-IP2-01-2015	Start-up activities for advanced signalling and automation system	Up to 4	RIA	€ 20 000 000	€ 25 004 501
S2R-CFM-IP4-01-2015	Shopping, booking and ticketing of multimodal travel solutions	5-6	IA	€ 3 750 000	€ 7 501 350
S2R-CFM-IP4-02-2015	Travel companion and tracking services	3-6	IA	€ 2 250 000	
S2R-CFM-IP5-01-2015	Development of functional requirements for sustainable and attractive European rail freight	3-5	RIA	€ 3 500 000	€ 8 251 485
S2R-CFM-IP5-02-2015	Start-up activities for freight automation	3-5	RIA	€ 1 600 000	
S2R-CFM-IP5-03-2015	Freight propulsion concepts	3-5	RIA	€ 1 500 000	

S2R-CFM-CCA-01-2015	Start-up activities for System Platform Demonstrator Integrated Assessment and socio-economic effects	Up to 3	RIA	€ 300 000	€ 2 500 450
S2R-CFM-CCA-02-2015	Energy and sustainability, including noise and vibrations baselines assessment	3-5	RIA	€1 350 000	
S2R-CFM-CCA-03-2015	Integrated Mobility and Safety Management	3-5	RIA	€ 350 000	
TOTAL				€ 34 600 000	€ 43 257 786

4.2.4 Open call for proposals for non-JU members

This section presents the indicative list of topics, in line with the priorities defined in section 4.2.2, that will be included in the open call for proposals for non-JU members, addressing the broader research and innovation community.

In 2015, the S2R JU is planning to issue one call for proposals addressed to non-JU members, in Q4. The budget for this call is estimated at EUR 10 million (in EU contribution).

Detailed topic descriptions are provided in the Annex II to the Annual Work Plan 2015.

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

It is foreseen that the call for proposals will be launched in Q4 2015, with activities expected to start in Q4 2016.

Proposals should be invited against the following topics:

Topic number - IP	Topic name	Expected TRL	Type of action	Indicative Budget (EU contribution)
S2R-OC-IP2-01-2015	Threat detection and profile protection definition for cyber-security assessment	3	RIA	€ 1 500 000
S2R-OC-IP2-02-2015	IT virtualisation of testing environment	3	RIA	€1 000 000
S2R-OC-IP2-03-2015	Technical specifications for a new Adaptable Communication system for all Railways.	2-3	RIA	€ 500 000
S2R-OC-IP5-01-2015	Freight Automation on lines and in yards	3-5	RIA	€ 1 000 000
S2R-OC-IP5-02-2015	Improved vehicle/train dynamics	2-4	RIA	€ 1 000 000
S2R-OC-IP5-03-2015	Intelligent freight wagon with predictive maintenance	3-5	RIA	€ 1 500 000
S2R-OC-CCA-01-2015	Long-term needs of different actors in the railway sector	1-3	RIA	€ 400 000
S2R-OC-CCA-02-2015	Energy usage, generation and saving approaches	3-5	RIA	€ 800 000
S2R-OC-CCA-03-2015	Noise reduction methodologies	3-5	RIA	€ 1 000 000
S2R-OC-CCA-04-2015	Safer infrastructure – improved object detection and prevention of safety critical events and	3-5	RIA	€ 1 300 000

	integrated mobility			
TOTAL				€ 10 000 000

4.2.5 Management rules for calls for proposals

The S2R JU follows the rules of the European Union's Horizon 2020 framework programme (H2020) and in particular the Horizon 2020 Rules for participation[20]. Unless specified otherwise, the provisions in all sub-sections of the section 4.2.5 apply to both calls for proposals addressed to JU members and open calls for proposals addressed to non-JU members.

4.2.5.1 Types of calls for proposals

The calls for proposals that will be launched by the JU may be: calls for proposals restricted to JU members (as explained in section 4.2.1), or open, competitive calls for proposals for non-JU members.

In Q4 2015 the S2R JU plans to launch one call for proposals addressed to JU members and one open call for proposals addressed to non-JU members. The key activities for the management of the foreseen 2015 calls for proposals are presented in the tables below:

2015 Management process for the call for proposals addressed to JU members	**Indicative timing**
Preparation of the call for proposals	Q3-Q4 2015
Publication of the call for proposals	17 December 2015[21]
Deadline for the submission of proposals	17 March 2016
Selection of the experts and evaluation of proposals	Q1-Q2 2016
Preparation and signature of S2R Model Grant Agreement for JU members (**)	Q2-Q3 2016
2015 Management process for the open call for proposals addressed to non-JU members	**Indicative timing**
Preparation of the call for proposals	Q3-Q4 2015
Publication of the call for proposals	17 December 2015[22]
Deadline for the submission of proposals	17 March 2016
Selection of the experts and evaluation of proposals	Q1-Q2 2016
Preparation and signature of S2R Model Grant Agreement for non-JU members (**)	Q2-Q3 2016

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

As specified in section 2.4, the S2R research and innovation programme is organised into five Innovation Programmes (IP1-IP5), together with one area of Cross-Cutting Activities (CCA). In order to facilitate the contribution of indirect actions towards the achievement of S2R

[20] Regulation (EU) No 1290/2013 of the European Parliament and of the Council of 11 December 2013 laying down the rules for participation and dissemination in "Horizon 2020".
[21] Date subject to the approval of the S2R Governing Board.
[22] Date subject to the approval of the S2R Governing Board.

objectives, 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.

Specifically, the following grants will be considered complementary in order to allow for the overall achievement of the objectives of the IP/CCA in question:

- Certain grants to S2R JU members and non-members supporting actions within each IP and within the areas of CCA, stemming from the 2015 calls for proposals for S2R JU members (S2R-CFM-IPX/CCA-XX-2015) and the open calls for proposals (S2R-OC-IPX/CCA-XX-2015), which are established by this Annual Work Plan 2015, and
- Certain grants to S2R JU members and non-members supporting actions within each IP, stemming from the call for proposals for S2R JU members (S2R-CFM-IPX-XX-2016) and the open call for proposals (S2R-OC-IPX-XX-2016), which may be established by S2R JU Annual Work Plan 2016.

Grants to S2R JU members and non-members supporting actions within the IPs and/or within the area of CCA, which may be established by future S2R JU Work Plans for years 2017 and beyond, may be rendered complementary to the grants identified above insofar as they relate to similar topics and/or rely on some of the results of those grants.

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 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 Grant Agreements.

4.2.5.2 List of countries, and applicable rules for funding

Part A of the General Annexes to the EC Horizon2020 Work programme 2014-2015 applies.[23]

4.2.5.3 Admissibility conditions for grant proposals, and related requirements

Part B of the General Annexes to the EC Horizon2020 Work Programme 2014-2015 applies[24].

[23] https://ec.europa.eu/research/participants/portal/doc/call/h2020/common/1617621-part_19_general_annexes_v.2.0_en.pdf

[24] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-ga_en.pdf At the time of the adoption of the Annual Work Plan 2015, the new version of General Annexes to EC H2020 Work Programme 2016-2017 was already available:

4.2.5.4 Eligibility criteria

In line with the objective of combining public and private sector funding to ensure the development and implementation of a long-term investment plan for rail research and innovation, Articles 17(1)(a) and (b) of the S2R Statutes foresee that up to 70% of the Union financial contribution to the S2R JU may be allocated to the S2R JU members (up to 40% for Founding Members and up to 30% for Associated Members). At the same time, is in line with Article 2(1)(e) of the S2R Regulation, which states that the S2R JU should pursue the objective of promoting broad stakeholder participation in the activities of the S2R JU, Article 17(1)(c) of the S2R Statutes foresees that at least 30 % of the Union financial contribution to the S2R JU shall be allocated by way of competitive calls for proposals and calls for tenders.

In light of this, and in order to fulfil the aforementioned allocation of the Union financial contribution, the JU will distinguish between:

- calls for proposals, which, pursuant to art. 9.5 of Regulation 1290/2013 and art. 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 their affiliated entities, are eligible to participate in the restricted calls for JU members;
- and open, competitive calls for proposals (or tenders) that, pursuant to art. 9.5 of Regulation 1290/2013, will be addressed only to entities that are not members of the S2R JU (founding or associated), nor constituent entities of members in the form of consortia or groupings, nor affiliated entities either to the S2R JU members or to the constituent entities of members in the form of consortia or groupings.

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

Furthermore, Part C of the General Annexes to the EC Horizon2020 Work Programme 2014-2015 applies[25].

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

4.2.5.5 Types of action: specific provisions and funding rates

Part D of the General Annexes to the EC Horizon2020 Work Programme 2014-2015 applies[26].

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

[25] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-ga_en.pdf

[26] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-ga_en.pdf

This means that the funding rate for grants will be 100% of the total eligible costs for research and innovation actions and coordination and support actions, and 70% of the total eligible costs for innovation actions (except for non-profit legal entities where a rate of 100% applies)[27].

4.2.5.6 Evaluation

Part H of the General Annexes to the EC Horizon2020 Work Programme 2014-2015 applies[28].

Selection criteria include 'financial capacity' and 'operational capacity'.

Award criteria include 'excellence', 'impact' and 'quality and efficiency of the implementation'.

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

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

Details on the submission and evaluation process are described in the Grants Manual - Section on: Proposal submission and evaluation.[29]

4.2.5.7 Budget flexibility

Part I of the General Annexes to the EC Horizon2020 Work Programme 2014-2015 applies[30].

4.2.5.8 Financial support to third parties

Part K of the General Annexes to the EC Horizon2020 Work Programme 2014-2015 applies for actions performed by non-JU members, supported by the JU[31].

Part K of the General Annexes to the EC Horizon2020 Work Programme 2014-2015 applies for actions performed by JU members, supported by the JU[32].

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

[28] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-ga_en.pdf

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

[30] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-ga_en.pdf

[31] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-ga_en.pdf

[32] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-ga_en.pdf

4.2.5.9 Consortium agreement

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

4.2.6 Call for tenders for non-JU members

The activities described in this section will be implemented by call for tenders (i.e. public procurement).

In 2015, the S2R JU is planning to issue one call for tenders, including two benchmarking studies, relevant to a number of Cross-Cutting Activities (CCA). These studies will be instrumental to frame the work of the S2R JU, in particular in terms of monitoring and evaluation of the activities undertaken by the S2R JU. The budget for the call for tenders will be of EUR 700 000 (in EU contribution).

A first call for tenders addressed to non-JU members is scheduled for Q4 2015. The usual rules for open tender procedures, defined in Title 5 of the Financial Regulation, will be respected. Following the evaluation of submitted offers, the specific contracts with relevant consortia would be signed in Q2 2016.

Number	Subject of tender	Indicative scope	Indicative budget
1	CCA - Long-term needs and socio-economic research	– Contribute to developing a common methodology for evaluating the economic, safety and environmental impacts, costs and benefits of the different R&I actions and their contribution to the S2R objectives; – Development of implementable tools and methodologies to establish operational KPIs for assessment and support to project management; Provide KPI methodology, theory and experience of practical applications; Develop implementable tools for KPI assessment, including a model for the relation of KPIs towards the overall targets of S2R programme and models for the SPD base scenarios; – Support the market uptake of past research, its future implementation and potential benefits.	€ 500 000
2	CCA - Human capital	Analyse the skills that the railway sector will need in the future, which links to the question of long-term transport needs. Assess the skills that will be needed, and analyse the gaps. Propose adapted strategies and tools (incl. training) to fill these gaps, and ensure increased flexibility of railway staff.	€ 200 000
Total			€ 700 000

4.3 Key Performance Indicators (KPIs)

An indicative list of KPIs has been elaborated by the Commission aiming at the establishment of 3 groups of indicators, namely:

- Horizon 2020 Key Performance Indicators[33] common to all JTI JUs;
- Indicators for monitoring H2020 Cross-Cutting Issues[34] common to all JTI JUs;
- Key Performance Indicators specific for S2R JU.

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

Further S2R specific Key Performance Indicators, together with a proper baseline to assess S2R technology developments, and their methodology, will be developed within the study performed under CCA "Long-term needs and socio-economic studies", starting in early 2016.

[33] Based on Annex II to Council Decision 2013/743/EU.
[34] Based on Annex III to Council Decision 2013/743/EU.

5 Horizontal and support activities

5.1 Communication activities

One of the 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&D achievements and the culture of innovation that S2R JU 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.

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. The value of the contract is 98.929,57 over 12 months, and the contractor will provide support to S2R JU in Web and Print Communication.

Once S2R JU will reach its autonomy, the dissemination of information on the progress of actions and its results will also be included in the overall communication strategy. This strategy, which will be developed in late 2015/early 2016 will include specific actions in order to ensure outreach to both stakeholders and public.

> *Nota bene: A specific Communications Officer and Stakeholders' Relations Project Officer will be recruited in order to ensure a successful communication about S2R JU, publicize and disseminate information about its programmes and activities, and foster a strong stakeholders' network.*

Globally, the communication activities will 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.

- **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 etc. 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 Infodays, in Brussels.
- **Manage the S2R JU website** in order to stimulate the public interaction on key issues and improve public awareness on S2R JU activities.
- **Lead a coherent dissemination strategy** regarding projects' activities and achievements, notably via coordinating web, documents and event management of the projects, and their presence on the S2R website.

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

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

5.2 Budget and Finance

5.2.1 2015 Annual budget

The annual budget for 2015 has been adopted by the Governing board on 15 October 2014.

The Commitment Appropriations (in EUR) in the budget are set to:

	2015
Title 1 - Staff expenditure	861 014
Title 2 - Infrastructure and operating expenditure	1 843 410
Title 3 - Operational expenditure*	45 334 167
Total	**48 038 591**

*The expected in-kind contribution from JU members to indirect actions that will be launched following 2015 call for proposals for JU members is at minimum € 43 257 786. It is accounted for in 2016 budget, as the grants will be signed in 2016. The individual commitments from members will be made at the moment of grant signature.

The Payment Appropriations (in EUR) in the budget are set to:

	2015
Title 1 - Staff expenditure	861 014
Title 2 - Infrastructure and operating expenditure	1 843 410
Title 3 - Operational expenditure*	0[35]
Total	**2 704 424**

*According to the call schedule, the grants resulting from 2015 calls for proposals for members and open call for non-JU members will be signed in 2016. The pre-financing will take place in 2016. The expected minimum in-kind contribution from JU members to indirect actions (€ 43 257 786) is accounted for in 2016 budget, as the grants will be signed in 2016. The individual commitments from members will be made at the moment of grant signature.

5.2.2 Financial Management

During 2015, the budget of the S2R JU will be executed by the Interim Executive Director of the S2R JU and the European Commission in accordance with Article 19 of the S2R Regulation. This approach will continue until the JU gains the full autonomy to execute its own budget.

In the meantime the JU will establish the Internal Controls and adopt a Manual on Financial Procedures.

5.2.3 Staffing

In accordance with the staff establishment plan, the JU foresees to recruit in 2015 three (3) Temporary Agents, including the Executive Director, and six (6) Contract Agents.

In 2016, the JU foresees to recruit one (1) more temporary agent (Head of Administration and Finance) and five (5) more Contract Agents.

[35] Pending the adoption of the amended budget 2015.

5.2.4 Learning and professional development

The JU promotes learning and development among its staff also with respect to functions outside their initial job descriptions. This will guarantee the JU more flexibility during the peak periods of work load on task sharing and create back-up functions for the moments of absence. The current organisational chart foresees a single jobholder per function of the JU. This may be seen as a risk in respect of the contingency.

A budget transfers will be applied to the adopted budget 2015 to allow the recruited JU staff to attend training already in 2015.

5.3 Other support activities

5.3.1 IT tools

For the 2015 calls for proposals, it is planned that the Commission H2020 IT systems will be used for the publication of the call, as well as for the submission and evaluation of proposals and grant preparation.

A Cooperation tool to facilitate the work on Multi-Annual Action Plan has been set up by the S2R JU Programme Office.

5.3.2 Accounting system – Accounting Officer

The European Commission's Accrual Based Accounting system (ABAC) will be used for accounting purposes. The accounting system will be put in place with the assistance of DG BUDGET. A formal request to DG BUDGET was made in this context. The setting-up of the S2R JU legal entity in ABAC will be finalized once the procedure of selection of the Executive Director will be completed.

Then, the Governing Board of the S2R JU will be expected to appoint its Accounting Officer.

5.3.3 Procurement and Contracts

In order to reach its objectives and adequately support its operations and infrastructures, S2R JU will allocate funds to procure the necessary services and supplies. In order to make tender and contract management as effective and cost-efficient as possible, S2R JU makes use of the SLA (Service Level Agreements) with relevant Commission services, multi-annual framework contracts available to it and inter-institutional tenders.

In 2014, S2R JU entered into a SLA with PMO (Pay Masters Office of the Commission) to cover the calculation of the entitlements and to assure the insurance coverage of its staff.

In early 2015, the S2R JU also completed SLA agreements with further Commission services to benefit from the already designed mechanisms and tools in its administration:

- SLA with DG HR covering the medical services and training for staff;

- SLA with DG BUDG covering the IT tools used for the financial management of the JU (ABAC).

In addition to these two SLAs, the S2R JU will assess whether any additional services are required by the S2R JU. Based on this assessment, the S2R JU may conclude SLA agreements with EPSO on the recruitments, DGT on the translations of the official documents, DG HR and DG DIGIT for the roll-out of human resources management tool, and OPOCE on the publications. To secure the S2R JU's usage on the H2020 grant management tools, the Delegation Act with REA is foreseen sufficient and no SLA will need to be completed for this purpose.

In addition to the SLAs, in 2015 the S2R JU will enter into a contract on housing and various works and services accompanying it. The contract on the housing will cover the leasing of office space in White Atrium building, when a number of other Joint Undertakings have their offices. The S2R JU joined the already existing contract with other JUs, covering the full lifespan, until 2024. In connection to this contract, some works were conducted in the premises.

The S2R JU participates to the joint effort with other JUs on the networks, ICT back office and other support functions. To this purpose, S2R JU concluded a number of Memoranda of Understanding (MoUs) with other JUs and contributes to the cost on the basis of consumption or partition key defined. The tendering of these services has been completed by the signing party, other than the S2R JU, in each MoU. Further services and goods, which are not covered by either already existing Framework Contract directly open to S2R JU or via MoUs as detailed above, will be tendered out by the S2R JU. The indicative planning for these tenders for services and goods in 2015 is following:

Indicative title indicative	**Indicative expenditure (EUR)**	**Type of procedure**	**Indicative schedule**
Purchase of S2R logo, web address and trademark, developed by S2R promoters before the creation of S2R JU	11 000	Negotiated procedure for low-value contracts	1Q2015
Basic Office Furniture	15 000	Negotiated procedure for low-value contracts	3Q2015
Executive Office Furniture	15 000	Negotiated procedure for low-value contracts	3Q2015
Banking Services	< 50 000	Open procedure	3Q2015
Cooperation tool for the creation of Multi Annual Action Plan	2 000	Negotiated procedure for low-value contracts	3Q2015
Voip telephony equipment	4 000	Negotiated procedure for low-value contracts	4Q2015
Voip Licenses	2 000	Negotiated procedure for	4Q2015

		low-value contracts	
Coffee Machine(s)	5 000	Negotiated procedure for low-value contracts	4Q2015

5.4 Annual Activity Report

The Annual Activity Report (AAR) presents the progress made by the S2R JU in each calendar year, in particular in relation to the Annual Work Plan for that year.

It includes information on the performed activities, the costs and the contribution of the S2R JU for any individual project, the participation of SMEs and any other activities during the previous year, with the corresponding expenditure.

The first AAR for 2014 was presented in 2015 to the Governing Board by the Interim Executive Director. It was approved in the Governing Board's meeting on 31 March 2015 and subsequently made public.

2015 AAR will be presented to the Governing Board by the Interim Executive Director by the end of February 2016. It will be approved in the Governing Board's meeting in Q1 2016 and subsequently made public.

5.5 Management control and internal control procedures

The S2R JU and its bodies shall avoid any conflict of interest in the implementation of the activities.

According to Article 26 of the Financial Rules, the internal audit function shall be performed by the Commission's internal auditor. The internal auditor shall advise the S2R JU on dealing with risks, by issuing independent opinions on the quality of management and control systems and by issuing recommendations for improving the conditions of implementation of operations and promoting sound financial management.

The S2R JU shall protect the financial interests of the members and implement anti-fraud measures. In particular, the S2R JU shall ensure that the financial interests of its members are adequately protected by carrying out or commissioning appropriate internal and external controls.

Furthermore, the Internal Control Standards from the Commission will be adapted for the purpose of the S2R JU and a Manual of Procedures will be drafted.

6 2015 Milestones

In 2015, the S2R JU operations will focus on:

- Completion of the selection procedure for associated members;
- Preparation and conclusion of the membership agreements;
- Preparation of the S2R Model Grant Agreement, for members and participants of open calls;
- Development of the 'Multi-annual action plan' ("MAAP"), by the Governing Board;
- Preparation of first calls for proposals, to be launched in Q4 2015;
- Establishment of the IP Steering Committees, after the completion of the membership;
- Establishment of the working groups, when appropriate;
- Adopting a 2016 Annual Work Plan;
- Preparing the draft 2017 Annual Work Plan;
- Recruiting the Executive Director;
- Recruiting and training staff members;
- Adopting staff implementing rules;
- Organising the set-up of the JU in its new premises in Brussels;
- Establishing the accounting system and the necessary IT tools, including for actions internal management;
- Concluding additional Service Level Agreements with relevant services of EU bodies in relation to administration and procedures that need to be implemented by the JU;
- Concluding the necessary procurement procedures and contracts to support the administration of the JU;
- Putting in place the internal control framework and the staff committee.

ANNEX I

2015 Call for proposals for the JU members – Topic descriptions

S2R-CFM-IP2-01-2015 – Start-up activities for Advanced Signalling and Automation System

Specific challenge: Although ERTMS has already become a worldwide dominant solution for railway signalling and control systems, it still has the potential to incorporate new functionalities and thereby improve the overall system efficiency and effectiveness and tackle a wider railways market. Today, ERTMS specifications do not cover all interfaces, and only cover engineering and operational rules to a certain extent. Thus, different railways and suppliers continue to design specific solutions and lose the chance to foster interoperability and decrease costs.

The challenge is to contribute with technological advancement to the rapid and broad deployment of technologies and systems for railway signalling, control systems and automation, by offering improved functionalities and standardized interfaces, based on common operational concepts, facilitating the migration from legacy systems, decreasing overall costs, adapting it to the needs of the different railway segments.

Achieving a full system approach at the end of S2R programme will require, from the very beginning, synchronizing the development of different aspects of required technological solutions, e.g. on-board automation systems, high-capacity radio communications systems, safe train separation systems, cyber security systems, testing processes, etc.

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 Railway Agency, ERA, will be instrumental, acting as the system authority for ERTMS. ERA's oversight over the IP2 system roadmap related to ERTMS will ensure that a proper configuration management will be followed.

Scope: The research and innovation activities should evolve within the following six interdependent work streams, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

- Regarding *Adaptable Communication system for all Railways,* the research and innovation activities should start with the collection of the user requirements for the next generation of technology to be applied into the several railway environments (Urban/Mass Transit, Suburban/Commuters, Freight and Regional/Main Lines). The output of this investigation represents the main input for developing a subsequent business model for the proposed evolution.

Therefore next step should deal with the specification of the communication system, by completing the following specifications: an overall architecture specification should be prepared and be the basis for the 'interface' specification. Detailed specifications for 'addressing', for 'services' to be provided, for 'quality of service' and about 'security' should also be prepared. Furthermore an activity for investigating safety related voice services should be foreseen as well.

- As far as *Automatic Train Operation (ATO) up to Grade of Automation (GoA) 4* is concerned, a step by step approach should be adopted, starting with activities dealing with ATO for GoA2, in particular, based on the inputs from the TEN-T 3rd call (Technical Interoperability Requirement for GoA2ATO over ETCS) and the Operation Concepts updated according to the results of the European NGTC project, the following task are foreseen:
  - Delivery of a complete set of specification dedicated to GoA2 application for several railway market (Main lines, Regional and Freight lines), including:
    - System Requirement Specification;
    - ATO on-board/ATO trackside Interface Specification;
    - Specification of the off-site and on-site tests to be executed in order to demonstrate the interoperability of the GoA2 features;
  - Development of ATO on-board and trackside prototypes;
  - Reference Test Bench Demonstration, for interoperability assessment of the GoA2 prototypes delivered by the different suppliers;
  - Setup of GoA2 pilot line demonstration (preliminary description of Pilot Line and Pilot trains selected for GoA2 tests).

  Furthermore, based on the final deliverables of the NGTC project and the experience gained with GoA2 activities, the research on GoA levels 3/4 should also start with a feasibility study (mainly addressing Urban/Mass Transit applications) including:

  - the consolidation of Users Requirements;
  - the identification of the hazards (PHA);
  - the establishment of a simplified model of system architecture with the identification of all internal and external subsystems.

  The following step should deal with the start-up of the specification phase for GoA3/4 application; in particular a draft of System Requirements Specification should be delivered.

- Regarding *Fluid Moving Block* the research and innovation activities should start with a full investigation of Moving Block (MB) Operational and Engineering Rules specification. The objective of this task should be to capture the user requirements in order to identify the changes required to existing Operational and Engineering Rules. Some examples of areas where new Operational Rules are required include:
  - transition into a MB Signalling System area;
  - transition out of a MB Signalling System area;

- mixed operation of fitted and unfitted trains;
- shunting operations within MB Signalling System areas.

Engineering Rules should also be analysed in accordance with the specific implementation and behaviour required of Moving Block Signalling Systems.

On the basis of these inputs, the work on Moving Block System Specifications will analyse the deliverables from the "Next Generation Train Control" (NGTC) project. The NGTC project includes work on Moving Block Principles, and work on the architecture of signalling systems. This information will be used to define Application Specifications and Interface Specifications for the different market segments:

- Urban/Suburban;
- High Speed Main Line;
- Low Traffic and Freight.

Such System Specifications will establish the requirements for setting up Product Specifications. The work should also identify the additional product requirements relevant to an Overlay Moving Block Signalling System. This part of the work is important to understanding the feasibility of migration to a Moving Block Signalling System and also the potential for switching between Moving Block and conventional signalling.

Safety and Security Analysis will also be carried out in order to perform the safety risk analysis of a Moving Block Signalling System. Specifically the feasibility of removal of any dependence on trackside train detection should be analysed.

The research and innovation activities should also define the basic set of specification of Moving Block signalling, including:

- definition of the Operational Rules for Moving Block Signalling;
- definition of the Engineering Rules for Moving Block Signalling;
- identification of the safety arguments for railways without trackside train detection;
- the System Requirement Specification for Moving Block Signalling, as applied to the following applications:
    - Low Traffic and Freight;
    - Overlay (to migrate from current fixed block to overlaid MB);
    - Urban/Suburban;
    - High Speed Line.

The analysis, across the different applications, should lead to the definition of practical prototype demonstration systems to be applied in the above mentioned market segments (e.g.: System Architecture Specification).

– As far as *Zero on site testing framework* is concerned, the very first aim of this work stream should be to assess the current field test activities and to identify work packages which can be shifted to lab testing. The objective will be to, on the one hand, identify areas where lead time and cost of field testing can be reduced, and on the other hand,

to improve further on the quality of delivered solutions. A benchmarking of Rail Signalling activities with other safety critical industries like avionics, medical, automotive should be a strong element of this task. Special contribution from the above industries should be expected on:

- knowledge of specifications in the Southern, Central and Eastern Europe railway networks,
- telecomm assessment based on previous experiences,
- benchmarking with automotive, aviation and other sectors.

On that basis the research and innovation activities should also define and agree on a common test process framework and identify a standard method to derive and describe test specifications.

Furthermore the work should focus on defining a general architecture for test environment. The task should target the creation of a new architecture of a test environment where many activities, which are currently done during field testing, can be executed in lab. It needs to support different technologies but also products of different suppliers. Beside the architecture of this future test environment there should be a clear definition of which elements need to be real (HW, hardware, and SW, software), where is real SW sufficient (HW virtualized) or where simulators are needed. The definition of virtualisation should also be proposed.

– Regarding *Smart radio-connected all-in-all wayside objects* the research and innovation activities should start with the analysis of the existing railway lines and economic models focusing on Regional and Freight lines. On the basis of the reported economic models the activity should identify the System Functional Requirement Specification, mainly focusing on the safety and availability aspects, and the System Architecture. The overall scope is to contribute to developing an autonomous, complete, intelligent, self-sufficient smart equipment (“box”) able to connect with any signalling wayside object and communicating device in the area (by radio or satellite) in order to foster overall reduction both of installation and maintenance costs. In this context the work should include the following activities:
  - Analysis of existing lines and economic models: with a special focus on requirements for Regional and Freight lines. The analysis will include the state of the art of communication techniques as well as technical possibilities within power supply area.
  - Analysis of railway requirements / standards with regard to safety and security issues.
  - Definition of system architecture: The interfaces between object controller, communication network and adjacent systems (e.g. interlocking) will be defined as well. Based on the requirements and standards evaluated in precedent tasks, the communication network(s) will be pre-designed accordingly. Pending on the requirements those networks are based on (adapted) existing components or new developments.

- Regarding *Cyber Security* the research and innovation activity should start focusing on the security assessment of the existent railway operational systems in order to determine the needs and the context. On that basis, the work should include the first iteration of the threat and risk analysis of the transport networks and interfaces. The objectives should be to find out the most appropriate standard framework for the "security by design" application in railway along with the definition of "protection profile" (first iteration) applicable in railway. These activities should contribute in achieving the optimal level of cyber-security against any significant threat for the signalling and telecom systems in the most economical way, as well as protection from cyber attacks and advanced persistent threats coming from outside.

This action will be complementary to the actions carried out in the S2R-OC-IP2-01-2015: Threat detection and profile protection definition for cyber-security assessment, S2R-OC-IP2-02-2015: IT virtualisation of testing environment, and S2R-OC-IP2-03-2015: Technical specifications for a new Adaptable Communication system for all Railways. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €20 million would allow this specific challenge, and all its streams, to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

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

Expected impacts: The completion of the S2R research and innovation programme is foreseen for 2024. The scope of this topic addresses the first stage of the work in six different streams of the Innovation Programme 2, regarding Advanced Traffic Management & Control Systems.

A significant impact is expected from the technologies developed in this research and innovation action:

- the improvement of the overall line capacity should result from the activities performed within *ATO up to GoA4* thanks to train traffic optimisation and *Fluid Moving Block* thanks to reducing headway between trains.
- the reduction of CAPEX is expected to result from *Adaptable Communication system for all Railways* work, contributing as well to a wider use of commercial and low cost communication networks; from *Fluid Moving Block* thanks to reducing wayside signaling train detection devices; from *Zero on site testing framework* thanks to reducing time to market and overall cost of the commissioning phase and from *Smart radio-connected all-in-all wayside objects* by reducing the need of cables and therefore the overall cost.

- the reduction of OPEX will result from *ATO up to GoA4* thanks to an optimisation of staff utilisation; *Fluid Moving Block* due to a reduction of the overall maintenance cost of the trackside, and *Smart radio-connected all-in-all wayside objects* thanks to a reduction of the overall cost of the trackside;
- the reduction of traction energy consumption, and carbon emissions, notably by means of improvement of automatic train operation and train control; the contribution of *ATO up to GoA4* is expected to lead to the optimisation of the train control according to the real needs of traffic;
- the enhancement of the overall reliability, safety and security - major effects are expected from *Fluid Moving Block* by means of reducing the global number of trackside devices and applying advanced signalling system also in railway markets sometimes covered by ATP systems and from *Cyber Security*.

Type of action: Research and Innovation Actions

S2R-CFM-IP4-01-2015 – Shopping, booking and ticketing of multimodal travel solutions

Specific challenge: The White Paper Transport 2011 suggested as one of its ten main goals: "By 2020, establish the framework for a European multimodal transport information, management and payment system". It has given impetus to a number of initiatives in the field of transport digitalisation, and fostering multimodality.

One of the overall major challenges of door-to-door seamless travel concerns a one-stop-shop capability for the advance purchase of separately marketed multimodal products and services: i.e. 'comodality'. Market acceptance of this capability is however compromised by the risks attached to: individual transaction(s) failure in the orchestration of multiple booking, payment and ticketing processes; insufficient automation of the processing of contractual elements in ticketing post-sales processes; and, to the contractual consequences of missed connections caused by service disruption when actually travelling.

The specific challenge is to enrich and optimise the contribution of technology towards the reduction of these risks in the case of rail segments retailed co-modally with other transport modes. Beyond co-modality, the focus on post-sales and re-accommodation will benefit any future solutions for integrated ticketing across modes.

Scope: Proposals should address the following scope, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

The proposed work should aim at enriching the suite of support facilities for the 'one-stop shop' sale and use of transport products and ancillary services across multiple transport modes.

Additional guarantees for the passenger should be provided, linked in particular to the risks coming from the simultaneous purchase of multi-tickets, multi-vendors' products: the up-front identification of the contractual nature of the associated purchase for customer-awareness and enriched roll-back features for partially booked/purchased/ticketed itineraries.

Furthermore, it is expected that the work will develop a complete set of after-sales functions and associated financial reporting to enable full re-accommodation facilities in the case of service disruption(s) and, the provision of the relevant settlement infrastructure required to support the co-modal type of product/service retailing and after-sales business functions. To support this capability, the associated ticketing systems must rely on harmonized orchestration of dematerialized entitlements enriched by post-sales processes. Furthermore, this will require a novel approach to business, operational and tickets inspection/validation processes and software to support this new capability. Particular emphasis should be put on developments which support robust business models capable of guaranteeing the economics of these e-services in the long-term, with special focus put on the railway sector.

The implementation of this action requires close collaboration with IT2Rail project ('lighthouse' project resulting from H2020 call MG2.2-2014)[36].

This topic is complementary with topics S2R-CFM-IP4-02-2015: Travel companion and tracking services, S2R-OC-IP4-01-2016: Interoperability Framework governance, ensuring its market uptake and sustainability and S2R-OC-IP4-02-2016: Interoperability Framework Converters in order to achieve consistency and ensure integrated system level delivery of IP4 concepts. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €3.75 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

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

Expected impact: In the field of shopping, booking and ticketing of multimodal travel solutions, the actions will aim at increasing the market-take-up potential for solutions promoting the advance purchase of co- modally bundled rail, and other transport modes, products and services, by increasing the technology contribution to the mitigation of the associated risk factors.

Type of action: Innovation Actions

[36] 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 following take-over of the project by the JU, who may accept them on a voluntary basis, subject to their explicit agreement.

S2R-CFM-IP4-02-2015 – Travel companion and tracking services

Specific challenge: Travellers have high expectations about transport reliability, minimal tolerance for mobility restrictions and also a need for fast information handling and propagation. This represents a major challenge currently limiting the larger adoption of transport solutions composed of different travel segments, and it requires significant improvement in the attractiveness and user-friendliness of the rail transport in particular, in order to maintain the current customer base, and attract new users.

For that purpose a new generation of intuitive and seamless travel services, ubiquitously accessible to the customers is needed to shield them from the heterogeneity and complexity of door-to-door journeys encompassing different modes of transport. The challenge is to develop systems enabling user friendly re-accommodation and enhancing customer experiences. These complementary services must offer real-time and easily accessible information and assistance to travellers and must adapt to the passengers' preferences, profiles, abilities, behaviour as well as to the evolving transport situation and traffic.

Scope: Proposals should address the following scope, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

The work should aim at consistently designing, prototyping, and integrating both innovative multimodal travel companion and travel tracking, which will enable the delivery of next-generation traveller experience. These will include the support in case of disruptions for all modes, other relevant events and advanced user interfaces and experience concepts exploiting the multiple devices populating the traveller's environment.

The proposed travel companion will offer a modular and extensible architecture designed to support multiple traveller profiles that will be used to dynamically adapt the user experience along multimodal travels while supporting disruptions; scalable and open cloud based platform for the storage and processing of traveller's data, including wallets and tickets; enhanced seamless indoor and outdoor navigation using novel forms of interfaces, such as mixed reality. Moreover, additional tools will be prototyped to rapidly and cost-effectively create or extend, debug, animate and evaluate traveller's experiences concepts. The proposed multimodal trip tracker will offer a scalable and open framework to collect and fuse static and dynamic data about travel and traffic data and other relevant information, like weather or events and will introduce a complex event processing method to handle all kind of real time information across modes, services providers and geography.

The implementation of this action requires close collaboration with IT2Rail project ('lighthouse' project resulting from H2020 call MG2.2-2014).[37]

[37] 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 following take-over of the project by the JU, who may accept them on a voluntary basis, subject to their explicit agreement.

This topic is complementary with topics S2R-CFM-IP4-01-2015: Shopping, booking and ticketing of multimodal travel solutions, S2R-OC-IP4-01-2016: Interoperability Framework governance, ensuring its market uptake and sustainability and S2R-OC-IP4-02-2016: Interoperability Framework Converters in order to achieve consistency and ensure integrated system level delivery of IP4 concepts. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €2.25 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

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

Expected impact: In the field of travel companion and trip tracker, the activities will aim at significantly improving the attractiveness of the traveller's experience, by offering a seamless access to all travel services, and a continuous personalized information and assistance specifically in case of disruption. It is also expected that such services will improve railway products attractiveness to customers.

Type of action: Innovation Actions

S2R-CFM-IP5-01-2015 – Development of functional requirements for sustainable and attractive European rail freight.

Specific challenge: In order to meet the key challenges in rail freight, it is important that the innovations brought forward are affordable, cost effective and have a quick market uptake. The challenge is to use the knowledge from earlier research projects and to put forward a migration plan for a cost-efficient market uptake of the foreseen innovations that will bring the desired development to the rail freight market. It is important to collect, transmit and make use of information within the overall rail freight transportation, as well as to develop new technological solutions for improving global performance of freight train compositions, control and management.

Scope: Proposals should address all the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

- Develop business analytics of freight market segments, KPIs for freight, and a migration plan with implementation strategies that will provide the starting point for further activities.
- The wagon design with new running gear concepts will be developed including the intelligent coupling, the electrification, telematics and monitoring. The telematics should contribute to collect, transmit and use the necessary information.
- Specifications for the wagon will be developed, focusing on optimising aerodynamics and on lightweight design. The framework for condition based maintenance, real time yard management and automated train operation (ATO) will guide the desired actions to be taken. The single wagon load system should be improved by the development of better organisational rules in the marshalling yards as well as by increased automated processes and will also include preparations for a management system by defining the desired input and outcome from various subsystems.
- The processes in terminals will be defined and streamlined with input in design for enhancing the intelligent video gate potential within information and operational improvements.
- Hybridisation of legacy fleet in the terminals will be developed, leading to higher reliability and better environmental impact.

This topic is complementary with topic S2R-OC-IP5-01-2015: Freight Automation on lines and in yards. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €3,5 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

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

Expected impact: The foreseen research activities are expected to contribute to the creation of a framework for an effective railway for freight as a part of the supply chain/logistical value chain in a more automated way via intelligent equipment and railway terminals enabling the provision of accurate information to end customers and operators. The automated processes are expected to lead to higher quality of services and cost savings. Improved rail freight for the next generation should also ensure the safe transportation of dangerous goods.

Type of action: Research and Innovation Actions

S2R-CFM-IP5-02-2015 – Start-up activities for freight automation

Specific challenge: The challenge is to automate the chain of processes including equipment, nodes, lines, leading to developing/testing an autonomous freight train in a test ring and/or in a corridor, which will also include real-time interaction with traffic management systems and other supporting processes and systems. The need for increased capacity with harmonisation of freight and passenger traffic and a better stability and reliability in the system should thus be met.

Scope: Proposals should address all the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

In order to reduce lead time, increase reliability and improve cost-efficiency of rail freight, a progress in various automated processes is key. Also automated processes within the nodes are very important. The connection/information between different nodes in real-time and network management systems, supporting eco- and overall energy-efficient driving in combination with targeting meeting points/bypasses for better punctuality will reduce the waste of time in unnecessary stops and the overall waiting time. Faster and more flexible freight trains on saturated lines can also increase the capacity.

The research and innovation activities will include:

- Defining automation processes in marshalling yards and terminals;
- Defining efficient business processes for in a real time network management system;
- Defining efficient processes for interaction between network management and energy-efficient train driving
- Time table simulation of the effects with faster and more flexible freight trains.

A stepwise approach will start at a GoA2 (Grade of Automation, level 2) demonstration and end with a GoA3/4 cross-border demonstration.

This topic is complementary with topics S2R-OC-IP5-01-2015: Freight Automation on lines and in yards and S2R-OC-IP5-03-2015: Intelligent freight wagon with predictive maintenance. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €1,6 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

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

Expected impact: On-going digitalisation can act as an enabler for the process of the automation in railway. The automation of rail freight operations is expected to lead to more

reliable and cost efficient solutions. Increasing the cost-competitiveness of rail for freight forwarders will also contribute to bringing more freight transport to the rail sector.

Type of action: Research and Innovation Actions

S2R-CFM-IP5-03-2015 –Freight propulsion concepts

Specific challenge: The challenge is to further develop the freight locomotive in order to enable autonomous driving, yield improvements regarding last mile freight distribution concepts and continue previous developments in order to enable longer freight trains, up to 1500 meters. Also the development of driver advisory systems (DAS) supporting efficient driving is an important challenge within freight propulsion concepts.

Scope: The research and innovation actions should evolve within the following four interdependent work streams, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

- *Future freight locomotives*: The aim of this work stream is to specify, design, develop subsystems and systems for the future freight locomotive, including dual power hybrid variants, the use of lightweight materials, two or three axle track friendly, low noise bogies, energy storages for the recuperation of braking energy, etc.
- *Full electric last mile systems based on Li-Ion batteries* including state-of-the-art mission management systems: The aim of this work stream is to specify, design, develop, commission and authorise a full electric last mile system based on state-of-the-art Li-Ion batteries. Beside technical issues, focus should be put on the certification part, which is seen as a challenge due to missing standards and norms.
- *Long freight trains up to 1500m with distributed power and brake capabilities*: The aim of the work stream Longer Trains (LT) is to fully develop a technical solution for the regular operation of 1,500 m long freight trains. The project is meant to identify the actual market potential, a technically secure and operational reliable realisation of longer freight trains, the needs for a European authorisation and certification for longer trains with distributed power and no driver on the second locomotive, necessary measures to infrastructure, operations and rolling stock and the economic effects for Railway Undertakings (RU) and Infrastructure Managers (IM) in a business case. The technological progress will be shown in different technology demonstrators within the project. The work should take into account the deliverables of MARATHON project, which showed the general reasonability and practicability of this approach of 1,500 m long freight trains. The next step would be to clear the remaining open points to prepare an European regular traffic of LT.
- *DAS connected to the various traffic management systems*: The aim of the work stream on driver advisory systems is to develop and implement a European standardised electronic interface for exchanging driving advices between IMs and RUs and to prepare interoperable real life trials on the core network and develop a roadmap for a European Implementation of the system.

This topic is complementary with topic S2R-OC-IP5-02-2015: Improved vehicle/train dynamics. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard

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

The S2R JU considers that proposals requesting a contribution from the EU of around €1,5 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

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

Expected impact: The developed concepts should provide:

- Greater flexibility for operation;
- Interoperability, including ERTMS and national ATP systems;
- Environmental friendly performance, with an optimized traction system for every line;
- Less wheel / rail efforts, which will diminish wear rates and hence maintenance costs;
- Less operating costs by various means, including energy efficiency, track access costs, integration of driver assistant systems (DAS) and autonomous train operations (ATO);
- Capability of operating longer as well as faster trains;
- Minimize the volume of locomotive fleet of the operator.

Type of action: Research and Innovation Actions

S2R-CFM-CCA-01-2015 – Start-up activities for System Platform Demonstrator Integrated Assessment and socio-economic effects

Specific challenge: There are two main specific challenges concerning socio-economic effects and System Platform Demonstrators (SPDs):

1. Socio-economic effects

The rail system is not an end in itself but a means to support the development of an attractive, sustainable society, which is prosperous and cohesive. Free movement of goods and people is also one of the "four freedoms" of the internal market. The value of S2R lies in its potential to enable a better accessibility and connectivity through the delivery of a high capacity and cost effective rail system seamlessly interconnected with other modes and embedded in a local, regional and cross border context.

The challenge is to define the socio-economic factors that can contribute to an attractive railway system. It is important to better understand in what way safe, reliable, comfortable and attractive train services can be beneficial for the interactions between European regions, enlargements of daily commuting areas and foster integration of major conurbations. It also needs to be analysed in what way the customers and the society are affected by the rail system in general and how in particular the innovations that will be achieved in the S2R programme will change this situation.

2. System Platform Demonstrators

Another interlinked challenge is to develop tools and approaches to enable the evaluation of impacts of new technologies which will constitute an essential element of the activities within the S2R JU, in line with the Shift2Rail Multi-Annual Action Plan. The objective of the Integrated Assessment (IA) of the System Platform Demonstrators (SPD) in particular will be to evaluate whether the results of the S2R program are fulfilling the expected key targets in line with the Master Plan (MP): improved services for users and customer quality, reduced system costs, simplified business process and enhanced interoperability.

Here, the specific challenge is linked on the one hand to the definition of the SPDs in order to identify the right application scenarios for the future railway system(s), and on the other hand to the modelling of the inter-dependencies of the KPIs horizontally between each other as well as vertically between low-level functional-technical parameters and high-level socio-economic objectives.

Scope**:** Proposals should address all the following elements in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

With respect to *socio-economic factors*:

- *Socio-economic factors and targets*: The needs of target groups, such as customers, users and other affected, should be systematically specified and analysed from the societal view, but also from the S2R system perspective. In combination with possible

future trends up to 2022, 2030, 2040, first results for relevant challenges which also could influence S2R targets will be available, including implementation aspects. It should be also analysed what kind of influence a strengthened rail system could have on the society and its function to increase the support for the rail system.

- *Successful key factors*: In addition the key factors for a successful railway system will be collected from existing and available research studies, looking also at future preferences, values, and perception of rail as something more than just an A to B mode of transport.

With respect to *System Platform Demonstrators*:

- *First iteration of the scenarios for system platform demonstrators (SPD)*: define the reference evaluation/assessment scenarios that can be used to measure the Technical Demonstrators' (TD) and Innovation Programmes' (IP) contribution to the achievement of the top level S2R objectives by applying them to the SPDs. Relevant characteristics for the SPDs will be identified. This element should be linked to the key factors and socio-economic factors/targets.
- *First iteration of the KPI model*: The objective is to set up a KPI model or, if necessary, different instantiations of the model depending on the SPD-scenarios, consisting of the low-level KPIs for the evaluation of the individual TDs, the top level objectives of S2R (expressed in KPIs), as well as their inter-dependency. The objectives which are partly already set in the Master Plan have to be collected and evaluated against the adequate baseline. In case of not quantified or not quantifiable goals, an assessment method and a performance indicator have to be defined. Hence, railways as a system consisting of sub-elements like rolling stock, infrastructure, time-tables etc. must be structured in order to cover all TDs' synergies. This forms the basis for the transformation of the KPI model and inter-dependencies into a KPI tool which is to be delivered by the work of a specific study.
- *Concept for the validation of the KPI-model*: the concept for the evaluation of partial models should be proposed to ensure that the KPIs and their interdependencies are modelled and parametrized correctly. The model should be evaluated by using real operational data stemming from the railways.

This topic is complementary with topic S2R-OC-CCA-01-2015: Long-term needs of different actors in the railway sector. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €0,3 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 S2R JU will only fund one proposal under this topic.

Expected impact**:** Actions will contribute to improve the achievement of the S2R objectives by:

- specifying relevant societal values, target groups and implementation factors to which they need to be compared;
- analysing the obstacles of the current railway system to attract more passengers and as far as possible to isolate the single and combined influence of different factors, which will be a quick-win starting point to customer attractiveness;
- presenting which customer requirements and future needs have to be taken into consideration in any further activities of the railway system to get a success story today and in the future;
- delivering the reference scenarios for the SPDs which will be used for the assessment of the S2R achievements;
- developing an initial KPI model that will show the TDs' and IPs' contribution to the achievement of top level S2R targets;
- developing the concept for the evaluation of partial KPI models by real railway data.

Type of action: Research and Innovation Actions

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

Specific challenge: There are two main specific challenges concerning energy and noise:

1. The challenge regarding *energy* is linked to the need to reduce energy consumption within the railway sector in order to ensure that the environmental advantage of railways is matching the improvements in other means of transportation. Another challenge is linked to the need to reduce energy costs as an important part of the total Life-Cycle Cost in order to contribute to the general S2R objective "Reduced operating costs". Furthermore, it is also necessary to develop a standardized methodology for estimation of energy consumption in the railway sector, since up to now it is not available.
2. *Noise and vibration (N&V)* represent one of the biggest environmental challenges for the railway. To facilitate effective noise and vibration management, it is crucial to apply an overall system approach and enable efficient mitigation actions. To achieve this it is essential to have commonly agreed and validated simulation tools to be able to e.g. rank the sources correctly before deciding on costly measures for N&V mitigation. For the S2R programme it will also be important to set and follow up N&V targets within different Innovation Programmes and their Technical Demonstrators and define a number of traffic and N&V scenarios to propose a proper system level analysis. Also new technologies should be considered to reduce N&V.

Scope**:** Proposals should address all the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

1. The work regarding *Energy* work stream should cover the following elements:

A CCA Energy Group should be established that will consist of the energy experts of the participants of this working area. The group should provide support to all IPs and TDs, notably with an energy calculation methodology with agreed boundary conditions. Once the energy related tasks have been identified for each IP, they should be analysed with respect to their potential contribution to energy saving. The CCA Energy Group should carry out the following work:

- Develop a common approach on eco-labelling, using inputs from previous European R&D projects;
- Analyse the energy requirements for passenger and freight trains resulting from existing specifications and guidelines. Carry out Pre-standardisation work. Energy efficient technologies and strategies from a whole life cycle approach should be analysed;
- Develop an energy baseline as a reference for the evaluation of energy savings of new S2R technologies;

- Define operational scenarios for the four traffic segments (high speed, regional, urban and freight traffic) with regards to estimating the energy saving of S2R innovations;
- Develop an energy calculation methodology to allow the monitoring of all TDs with respect to energy saving in different traffic segments.

2. *Noise*: Proposals should include the following activities:

- *Technical assessment and integration:* Identification of all N&V relevant components in the demonstrators included in S2R TDs to set and follow up N&V targets for each contributor for an optimal results on system level. Initially this will be based on existing methods and estimates.
- *Evaluation and monitoring of impact on traffic noise of S2R research and innovation activities:* Definition and evaluation of different traffic scenarios and combinations of rolling stock, infrastructure and running conditions with respect to N&V. Such scenarios can be used during the entire project as reference cases for calculation of noise emissions and interior levels. These calculations should monitor and evaluate effects of proposed N&V mitigation measures in S2R compared to a base line that will be defined in the start-up phase of this activity.
- *Interior noise simulation model:* Specification of a modular framework to handle sources, transmission paths and results from existing simulation tools should be carried out. The framework should be able to handle the interior noise modelling based on new and existing methods and also to analyse relevant parts of the N&V scenarios as defined above. Work should include definition of validation schemes for interior noise and application of such schemes for the simulation models as gradually available. Also the development of improved methods should be supported by providing relevant modelling targets, as well as specification of sources and sub-assemblies important for interior noise.
- *Sources and sub-assemblies characterisation methodologies:* Definition of relevant input data for simulation models and an accurate procedure for specifying standardised characteristics of the N&V sources should be proposed. Methodologies for specification are required for different type of sources including their different transmission paths (air-borne and structure-borne). The proposals should also take methods for the specification of train sub-assemblies into account (floors, gangways, doors, etc.). From a state of the art analysis a SWOT study will be obtained to point out the necessary improvements. Proposals should include the application and validation of the methods to be industrially standardized at both component and train sub-assembly level by either numerical/analytical models and/or tests. Collection of information from sources and train sub-assemblies available in different Technical Demonstrators should be performed. The proposed acoustic characteristics specifications should be implemented in the requirement setting for the different TDs.
- *New Technologies*: Definition and support to auralisation and visualisation of noise scenarios for the public of progress in the N&V areas in S2R, start with defining and

support to demonstrate baseline before mitigation. Specify and support feasibility of active and other new noise control technology on e.g. noise proof windows.

The implementation of this action requires close collaboration with Roll2Rail project ('lighthouse' project resulting from H2020 call MG2.2-2014).[38]

This action will be complementary to the actions carried out in S2R-OC-CCA-02-2015: Energy usage, generation and saving approaches and S2R-OC-CCA-03-2015: Noise reduction methodologies. As specified in section 4.2.5 of S2R AWP for 2015, 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.

For grants awarded under this topic for research and innovation actions it is expected that results contribute to European or international standards. Therefore, the respective option of Article 28.2 of the Model Grant Agreement will be applied.

The S2R JU considers that proposals requesting a contribution from the EU of around €1.35 million would allow the specific challenges to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

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

Expected Impact**:** The expected impact of the research and innovation action in the field of energy will be linked to the determination of the potential energy improvement of technical innovations in order to decide which innovations should be applied when new trains or infrastructure assets are purchased. Further the reduced energy consumption thanks to new technologies should contribute to the reduction of the environmental impact of the railway sector and help to increase the competitiveness of rail transport due to reduced energy cost. The standardisation of the simulation methodology and parameters as well as measurement procedures for the estimation and verification of energy consumption supports the general S2R objective of "simplified business processes".

A significant impact is expected from the technologies developed in this research and innovation action on noise including:

- Improved attractiveness and comfort for rail users and reduced exposure to noise and vibration;
- Improved virtual design and testing methods for simulation with a focus on system level rankings, N&V source characterisation and improved interior noise prediction models;
- Investment costs should be reduced;
- Significant LCC savings should be targeted.

[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 Roll2Rail project following take-over of the project by the JU, who may accept them on a voluntary basis, subject to their explicit agreement.

Type of action: Research and Innovation Actions

S2R-CFM-CCA-03-2015 – Integrated Mobility and Safety Management

Specific challenge**:** The challenge is two-fold, concerning both safety and integrated mobility.

1. *Safety*

Ensuring and enhancing the safety of rail operations is of high importance for the EU since past rail accidents have shown that they may come with high costs in terms of loss of life, environmental damage, economic impact, and the overall image and public perception of the rail sector.

In what concerns the railway system, safety is one of the major inherent advantages over other means of transportation according to the official international accident records. In this context, a specific challenge for railway undertakings is to focus on safety in order to maintain and increase the railway's share in the transportation market.

2. *Integrated Mobility (Smart Planning)*

An integrated approach for a quality-oriented operational railway planning is a key challenge to create a reliable and robust railway system. It is needed for ensuring trains' punctuality, to minimise operational disruptions and to render the system able to respond quickly to any disruptions so normal operation can resume as quickly as possible. Digitalisation with smart data, open interfaces and enhanced IT capabilities offer potential to expand detailed operational analyses from local focus to larger areas and entire complex railway networks, while at the same time can be based on an increasing level of detail.

Scope: Proposals should address all the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

1. With respect to *Safety* the work should tackle the following aspects:

Proposals should focus on developing an integrated approach to deal with the safety of the railway system. Starting from the state of the art, previous studies and daily operation experience, the work should propose safety dedicated indicators and methods such as:

- potential severity measurements,
- severity scale,
- weakness fields system identification (human behaviour, suitable process, including management method).

2. With respect to *Integrated Mobility (Smart Planning)*:

Proposals should cover the initial identification of all relevant parameters that need to be taken into account in micro-level railway simulation for integrated planning and to collect information on existing analyses on interdependencies in the railway system. Requirements should be set for an implementation of a micro-level simulation model for test purposes. Furthermore, proposals should cover a first analysis of the planning processes of the

different railway stakeholders (RU, IM) in order to identify interfaces to the simulation model.

The main disturbances of railway operation should be identified, prioritized, and the foundation for a stochastic model, based on past operational data, should be laid. Based on these results, first requirements should be derived for an integrated simulation tool for quality planning going beyond current status of micro-level railway simulation. This includes the development of a simulation model for test purposes under consideration of results of various existing simulations and their results, e.g. in major railway hubs.

This topic is complementary with topic S2R-OC-CCA-04-2015: Safer infrastructure – improved object detection and prevention of safety critical events and integrated mobility. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €0,35 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

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

Expected impact: Regarding *Safety*, the expected impact will be to help taking the good decisions to manage the safety of the railway system at a global level. This integrated approach to deal with the safety of the railway system will also enable taking the best decision, every day, in operation.

Regarding *Integrated Mobility (Smart Planning)*, actions are expected to help to deliver precise railway network simulation to support railway operational planning. A conservative estimate based on the current causes of delays in long-distance traffic shows that more than 40% of the overall delay time could be addressed (e.g. from planning, operations and secondary sources such as train connections).

Type of action: Research and Innovation Actions

ANNEX II 2015 Open call for proposals for non-JU members – Topic descriptions

S2R-OC-IP2-01-2015 – Threat detection and profile protection definition for cyber-security assessment

Specific challenge**:** Although ERTMS has already become a worldwide dominant solution for railway signalling and control systems, it still has the potential to incorporate new functionalities and thereby improve the overall system efficiency and effectiveness and become even more competitive.

The challenge is to boost innovative and cost-efficient technologies and systems for railway signalling, traffic control and automation, while at the same time achieving the highest possible level of safety and security of all lines. With ever increasing reliance on communications technologies and automation of rules and operation, the need for protecting the integrity of infrastructure, rolling stock, staff and passengers against physical and cyber attacks is crucial.

In the framework of the development of the Smart Cities and Communities (SCCs), the deployment of interconnected Intelligent Public Transport (ITP) systems will play a key role in improving the quality level of citizens' life through an increase in service levels and efficiency. In this framework, transport by rail will play a major role for international, inter-city and suburban connections, requesting a wide and efficient exchange of information with the other transport modes and with the final user.

The coordination of different public transport modes on both local and national levels, and the interconnection of the networks dedicated to public transport with the public internet network, to provide to passenger supports and services anywhere at any time, represents a huge challenge in terms of cyber security for ensuring the continuity and quality of public transport under all conditions.

Scope: Proposals should address all the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

- Security assessment of railway systems in service taking into account the complete operational context;
- Identification and analysis of the different cyber-attack threats applicable to different railway segments (Urban/Mass Transit, Suburban/Commuters and Main Line) and interfaces with other modes. For each identified threat the work should include the development of identification and specification of countermeasures or mitigation strategies;
- Selection of the standard framework to be applied for the development of cyber secure railway applications in order to reach “security by design”. The work should include the

development of a specification of the Protection Profiles applicable to signalling railway applications. Evaluation Assurance Level should also be identified.

This topic is complementary with topic S2R-CFM-IP2-01-2015: Start-up activities for advanced signalling and automation system. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €1,5 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected impact: Action will contribute to:

- Improving the operational security level of the different rail segments by allowing early detection of incidents due to network supervision, a better network protection due to threat and risk assessment and the standardisation of a cyber-secure interfaces and protocols;
- Improving the robustness of the railway information, control and signalling sub-systems by the standardisation and application of secure-by-design development process;
- Improving the inter-modal transport coordination and the communication with the end users by allowing a secure interconnection between the railway dedicated networks (e.g.: Railway Lines and Urban Metro) and the networks allocated to other transport modes or to the public use.

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

S2R-OC-IP2-02-2015 – IT virtualisation of testing environment

Specific challenge: Currently, due to the complexity of the signalling systems and the differences between sites and applications, a large amount of tests must be carried out on-site. On-site tests take a lot of effort in terms of time and cost (about 5 to 10 times the effort compared to similar tests done in the lab). The challenge is to reduce on-site tests for signalling systems, leading to reducing overall testing costs.

The main technical aspects for system testing in the lab basically need:

- to sufficiently model the reality by identifying parts of the system that need to be virtualized in order to perform the majority of the system functional and integration tests,
- to identify the valid and effective certification and authorisation process in order to minimize the processes to be performed on-site.

This implies improving lab testing capabilities by broadening the test scope as well as decreasing the number of on-site test cases and maintaining the respect of normative and legislative rules. The strategy is to make lab tests strictly focused on real needs, making the commissioning phase less costly, both in financial terms (CAPEX) and overall time to market. The main challenges include:

- The definition of a dedicated system test architecture for the lab tests;
- Specification of a standardised method to derive and describe test cases;
- Fixing a common test process framework.

Scope: Proposals should address all the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

- Develop the concept of virtualisation for holistic railway testing environments. The IT virtualisation capabilities should include communication systems, performance and processing tests reporting, Quality of Service (QoS) management, etc.;
- Develop an IT virtualisation of hardware (HW) and software (SW) platform that allows deploying, integrating and testing of any legacy and future railway system:
  - This platform should support the implementation of the railway system, whether in real form, virtually or simulated (depending of the availability and needs) and any combination of these alternatives;
  - This platform should be cloud-based to allow to have distributed locations. This platform should be open to existing and future systems (different operating systems, protocols, programing languages, etc.);
  - The IT virtualisation platform shall be generic and open to support the architecture for test environment and communication model.
- Propose different scenarios (railway system combinations and configurations) that could be deployed at the same time but running separately (scenario by scenario);
- Develop a demonstrator with the selected parts of the testing environment.

This topic is complementary with topic S2R-CFM-IP2-01-2015: Start-up activities for advanced signalling and automation system. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €1 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected impacts: Actions will contribute significantly to the development of a Zero on-Site Testing environment. As more and more test are transferred from the field to the lab, the needs of enhancing and increasing the efficiency of the test environment becomes fundamental.

The impact of the definition of dedicated system test architecture for lab tests, including remote tests, is expected to yield direct benefits in terms of:

- Reduction of costs of lab resources due to the reduction of real lab equipment needs (acquisition, obsolescence, maintenance, use of energy and space, etc.) and introduction of ‘state of the art’ technology;
- Increase of the efficiency of test resources management;
- Full accessibility to the test environment available from different locations;
- Support to the full interoperability in terms of open accessibility independently of the providers and the technology.

Type of Action: Research and Innovation Actions

S2R-OC-IP2-03-2015 – Technical specifications for a new Adaptable Communication system for all Railways.

Specific challenge: In light of the programmed end of GSM-R, on the one hand, and the increasing need for data communication to support enhanced signalling systems, on the other hand, the challenge is to provide an adaptable train-to-ground IP communication system with enhanced throughput, safety and security functionalities to take advantage of new technologies. Backward compatibility for ERTMS (including for EIRENE voice services), easy migration and capability to be resilient to radio technology evolution are part of this challenge.

Even if some radio technologies have to be chosen for real implementation, first for technical demonstrators and then for the interoperability specification, the architecture has to stay as much as possible bearer independent.

Currently the radio communication system is "owned" by the signalling application due to its impact on the general availability and safety (network as an asset). Better independence and possibilities of business models would be achieved if radio communication was only "used" (network as a service) by the signalling application, so long as an assessment on some quality of service parameter is agreed.

Scope: Proposals should address the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP) and with the work currently performed by ETSI T CRT NG2R and UIC FRMCS:

- Definition of new business model scenarios for the use of the more advanced radio technologies in the railways domain, as identified in NGTC, to support the shift from "network as an asset" to "network as a service" model vision;
- Analysis and definition of conditions in which the use of public radio communication network instead of dedicated networks could be possible.

This topic is complementary with topic S2R-CFM-IP2-01-2015: Start-up activities for advanced signalling and automation system. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €0,5 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected impact: A significant impact is expected from the technologies developed in this research and innovation action notably:

- Optimisation of the Life Cycle Cost for the railway wayside to train communication system, thanks to use of most updated radio technologies broadly applied on public network;
- Possibility to offer new services or to enhance the signalling applications thanks to increase capacity of data transmission.

Type of action: Research and Innovation Actions

S2R-OC-IP5-01-2015 – Freight Automation on lines and in yards

Specific challenge: In the domain of automation of rail freight, the challenge is twofold. There is a need to focus both on automated driving and on automation of processes in the marshalling yard. Combining automation of these different processes would contribute to increasing competitiveness in comparison to road freight:

- Automated driving of freight trains on main-line: Automated Guided Vehicles (AGVs) can carry shipping containers and operate in warehouses. Auto-pilots are already standard on air and ocean carriers, allowing for increased efficiencies with less personnel. Whereas other transport modes have been quick to automate certain operations, rail runs the risk of lagging behind. One key challenge, which has so far prevented automation of rail freight is the lack of a safe and reliable on-board obstacle detection system for freight trains within existing infrastructure. Obstacle detection will be a key requirement for freight trains on mixed mainlines running 100 km/h, also for trains beyond 5000 t still going 80 km/h, and in all conditions.
- Automation of disposition processes in marshalling yards: Operators face significant costs for operating the shunting activities in marshalling yards. Planning, disposition and operations in yards are critical for cost efficiency of rail freight supply chains. However, the daily operations management in yards requires multiple optimisations in real-time and multi-dimensional decisions, which are often too complex for the staff. The solution to this problem would be the “Real-time Yard Management”, which will include a real-time decision support system for optimized planning and disposition of resources in yards. The work should contribute to tackling the challenge of the development of a real-time simulation of yard processes in existing infrastructure.

Scope**:** The research and innovation activities should evolve within two interdependent work streams, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

1. *Automated driving of freight trains on European main lines*: The work should include the development of a complete, safe and reliable prototype solution for obstacle detection, for automated short distance shunting onto buffers, and long distance forward-looking braking, based on full requirements analysis and technology transfer. The activities should also include the development of hardware and software for coverage of the identified relevant space ahead, optical/sensor data fusion, complex pattern diagnostics relevant for rail application, and a rail-specific safety framework. The obstacle detection solution resulting from these activities should be ready for a later integration in the automated freight train described in the MAAP (TD5.6).

   Research and innovation activities should aim at:

   - Analysis of the requirements for obstacle detection for targeted autonomous (Grade of Automation 4) trains with E-locomotive on European mainlines in existing infrastructure;

- Analysis of technologies available for transfer and adaptations and interfaces;
- Specification of requirements for an integrated obstacle detection system including positioning and distance measurement (+/- 5 cm) for automated driving onto vehicle buffers and automated braking when detecting an obstacle ahead;
- Development of the obstacle detection system prototype including software and hardware (camera and sensors), data fusion and pattern detection;
- Development of a safety framework, testing and validation in lab.

  The work will requires knowledge of optical and/or sensor solutions for a range of minimum 600 - 1,000m, and data fusion from multiple sources such as radar lidar (light detection and ranging) and stereo camera systems. Experience from obstacle detection both in the automotive and the aviation sector, and pattern diagnostics should also be involved.

2. *Automation of disposition processes in marshalling yards.* The work should include the development of a real-time simulation system of processes in local marshalling yards. The simulation system should be able to run on an IT platform available at the market and should offer open interfaces to be integrated in an IT production system for real time management of yards.

   Research and innovation activities should aim at:

   - Analysis of requirements of a real-time simulation towards the modelling of local marshalling yards and the modelling techniques;
   - Detailed modelling of all assets, resources and processes based on requirements analysis;
   - Advancement of existing simulations platform to provide optimisation of decisions in real-time (which resources to use how, which wagons handle when);
   - The preparation of the simulation system for integration in an IT production system and the pilot testing of real-time management of a given large marshaling yard.

   The work will require detailed knowledge of rail operations and process, of single wagon load transport and interaction of RUs and IMs in large marshalling yards. It needs a proven simulation system for detailed simulation of rail processes in yards and knowledge with software based planning and optimisation and optimisation concepts of single wagonload transport.

This topic is complementary with topics S2R-CFM-IP5-01-2015: Development of functional requirements for sustainable and attractive European Rail Freight and S2R-CFM-IP5-02-2015: Start-up activities for Freight Automation. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €1 million would allow this specific challenge, and both of its streams (automated driving of freight trains on main-line and automated driving of freight trains on European main lines), to be addressed appropriately. Proposals should address both described work streams with an indicatively equal split of the budget (€0.5 million each). Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected impact: The expected impacts of automation of rail freight operations shall be:

- To improve the quality of rail freight in terms of punctuality, reliability and flexibility;
- To reduce the operating costs maximizing energy savings and resource efficiencies;
- To increase transport capacity on lines and hubs of the European TEN-T network;
- To boost rail freight competitiveness in comparison to road freight according to 2011 EU White Paper Transport;
- To make an important contribution to the vision of a fully automated rail freight system.

Type of action: Research and Innovation Actions

S2R-OC-IP5-02-2015 – Improved vehicle/train dynamics

Specific challenge: The EU White Paper on Transport 2011 states that, by 2030, a shift of 30% of road freight over 300km to rail, or a doubling of the freight transport by rail compared to 2005, should be achieved. Future models of locomotives might strongly contribute to achieving this challenge, supporting the achievement of the goal by providing more attractive rail freight services to the final customer, with competitive rail solutions, maximizing flexibility and efficiency while reducing the operating and maintenance costs.

Consequently, future freight locomotives should be able to:

- Provide sufficient flexibility for operation in non-electrified and in electrified lines, allowing private and public operators to offer a broad range of rail freight services according to demand without the need of changing the locomotive;
- Feature remote control for distributed power, thus, allowing the increase of the train length up to 1500m and consequently improving the cost efficiency of rail freight transport;
- Recuperate braking energy as much as possible, store it on-board and reuse it whenever required, for traction purposes, for peak shaving, to supply auxiliaries and for other purposes;
- Minimize the energy consumption on their journey, thanks to advanced driver advisory systems (DAS) that will be connected to traffic management systems of infrastructure managers (IMs);
- Provide improved traction force, while being more reliable and simultaneously reducing life cycle costs. This includes track friendliness and low noise emission.

Scope**:** The research and innovation activities regarding *Advanced Propulsion and train dynamics* should evolve within two interdependent work streams, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

1. *Future freight locomotives*: The aim of this work stream is to specify, design and develop two or three axle track friendly, low noise and low LCC bogies.

The work should involve the following elements:

- Develop and demonstrate new design concepts using lightweight and self-cleaning materials, noise absorbing structures as well as mechatronic systems;
- Analyse, specify, integrate and implement various functions, such as braking, cooling, noise reduction, torque transmission, radial steering and advanced monitoring systems in next generation bogies.

2. *Increase of train length*: The aim of the work stream is to fully develop a technical solution for the regular operation of 1,500 metres long freight trains.

The work should include:

- Developing reasonable solutions for a radio remote controlled traction and braking system, based on the available deliverables of the MARATHON project. Technical solutions should be tested within a prototype and should be ready for certification;
- Higher longitudinal forces within longer trains are one of the main problems while operating trains up to a length of 1500 m. The work should implement methods to determine, simulate and evaluate longitudinal forces within longer trains, based on the available deliverables of the MARATHON project. Analytics and simulations will give the needed inputs for the safety management system and will define the requirements to operate longer trains;
- Trains up to 1500 m will be operated as double trains. For this reason it is necessary to adapt certain infrastructure components, such as stations, where efficient coupling and sharing processes for freight trains can be realized, therefore infrastructure designs should be analysed. It is to show with simulations of the needed processes, whether the new operation concepts are robust for regular operations.

This topic is complementary with topic S2R-CFM-IP5-03-2015: Freight Propulsion concepts. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €1 million would allow this specific challenge, and all its elements, to be addressed appropriately. Proposals should address both work streams described above (Future freight locomotives and Increase of train length) with an indicatively equal split of the budget (€0.5 million each). Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected impact: The activities are expected to lead to achieving the following impacts:

- Improved traction performance;
- Reduced noise emissions;
- Reduced wheel and track wear;
- Reduced LCC thanks to state-of-the-art condition monitoring;
- Higher traffic throughput thank to longer trains;
- Lower operating costs thanks to remote controlled distributed power;
- Higher driving speed of longer freight trains.

Type of action: Research and Innovation Actions

S2R-OC-IP5-03-2015 – Intelligent freight wagon with predictive maintenance

Specific challenge: The challenges related to increased rail freight competitiveness are linked to the development of intelligent freight wagon, where the specific challenge is threefold:

1. *Cargo condition monitoring technologies*

As addressed in several previously funded research project (e.g. Spectrum), the logistic services consider the cargo condition monitoring and traceability as an important feature to be covered by the rail freight operators. With this regard, the cargo identification, weight, integrity, temperature, vibrations, humidity and chemical pollutants exposure are considered the key parameters to be tracked during a door-to-door journey. Since the electrification of freight wagons is not always available, the development of a solution including totally passive sensor (power supply through electromagnetic wave or vibration power harvesting - no external power supply or batteries) and communications is desirable.

2. *Wagon design*

The wagon design of today with a welded steel solution for body and chassis lead to a high tare weight of 1000 kg/m wagon length and above. As a consequence:

- the payload/dead weight ratio is poor;
- the train length with single traction in bulk transport business is limited below the possible train length given by the infrastructure; and
- the dynamics in groupage and intermodal traffic mode is weak.

Therefore the challenge is to reduce tare weight of wagons by approximately 50% in order to improve the competitiveness of the rail freight transport. Part of the intended solution is a change of material selection towards a multi-material approach and along with this a change of the manufacturing and repair technology (e.g. using high strength steels and/or composite materials).

3. *Predictive maintenance*

Rail freight has to increase cost effectiveness and transport performance, to meet economic, environmental and customer requirements. The first step has been an impressive progress in Information and Telecommunication technologies (ICT) leading to improved safety, monitoring and signalling systems. The next step will be the use of ICT for rolling stock maintenance. The development of intelligent tools and methods for predictive maintenance are needed to optimize the availability of rolling stock, the quality of service, maintenance costs and return of investment. Predictive Maintenance means predicting when a fault is likely to occur and issuing a warning if the component reaches its lifetime limit. This information will be distributed automatically to fleet and workshop management systems and trigger actions in accordance to maintenance. Predictive Maintenance requires sensors and communication boxes for data transmission, but more importantly, data analytics and

monitoring tools, an asset management centre and a database with maintenance program and rules.

Scope**:** The research and innovation activities should evolve within three interdependent work streams, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

1. Cargo condition monitoring technologies

Proposals should focus on the development of a set of sensors with communication capabilities totally autonomous (power supply through e.g. electromagnetic wave or vibration power harvesting, without external power supply or batteries). This set of sensors shall cover cargo identification, weight, integrity, temperature, vibration, humidity and chemical pollutants. The communication capabilities are expected to be based in UHF RFID technology but other technologies are also possible provided they are compliant with TAF-TSI. The development will finish with a validation activity involving a freight logistic operator in a TRL5 environment including temperature controlled wagons, and transportation of potentially hazardous cargo (e.g. corrosive, explosive). The information captured by the sensors shall be transmitted to wayside elements in the terminals and during the trip and should be made available to a web-based logistic application.

The work is expected to last 36 months and the deliverables are expected to be submitted as follows: technical specification definition (m0+6), architecture design (m0+12), prototype testing (m0+24), validation (m0+30-36m).

2. *Wagon design*

Proposals should focus on the selection and assessment of different material concepts in the application on the superstructure of wagon chassis including bogies.

The most promising material concepts should be applied in test elements in box and frame design, which should be calculated and tested in a suitable test lab under static and dynamical mechanical stress, with thermo-mechanical loads.

Furthermore the resistance and material integrity in the given operational environment should be proven in test labs regarding given environmental conditions, the resistance against impacts, and effects caused by specific bulk loads (acid, petrochemical products and salt).

3. *Predictive maintenance*

Proposals should address the analysis of on-board devices, as well as the development of rules and a maintenance program for Predictive Maintenance:

- Select the right data coming from propulsion equipment, bogie, brake and auxiliaries in a top down (cost driven) analysis;
- Analyse the data of selected subsystems and components in a bottom up approach (reliability driven):
  - Identify failure mechanism;
  - Root cause analysis;

- Assess quality/quantity of required data.

- Integrating different data sources:
  - Sensor data in real-time (data quantity);
  - Obtain equipment-specific historical data;
  - Analyse historical data and events;
  - Data quality assessment.
- Building, testing and optimizing analytical models:
  - Using technical engineering knowledge to build predictive models, simulation tools for FMEA and fatigue strength analysis;
  - Cost model, maintenance model;
  - Functional model to investigate the relationship of subsystems.
- Integrating analytics in a maintenance organisation:
  - Rules and limit values (ECM 2 process);
  - Maintenance program for workshop (ECM 4 process);
  - Instructions for fleet management (ECM 3 process).

The work should rely on knowledge from the field of condition-based and predictive maintenance, big data infrastructure and analytics, and the development of intelligent algorithms.

This action will be complementary to the actions carried out in the S2R-CFM-IP5-02-2015: Start-up activities for Freight Automation. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €1.5 million would allow this specific challenge, and all its three work streams (cargo condition monitoring technologies, wagon design and predictive maintenance), to be addressed appropriately. Proposals should address all three work streams described above with an indicatively equal split of the budget (€0.5 million each). Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected impact**:** The expected impact related to cargo condition monitoring will be the increased attractiveness and competitiveness of the rail freight transportation, especially for perishable, dangerous or expensive goods by providing traceability of the cargo with a low cost system.

The expected results in wagon design will support the development of lightweight freight wagons with reduced tare weight and increased payload (around 10%) and significantly reduced running gear weight together with considerable cost-efficiency and therefore increased competitiveness of future freight wagons. Approaches for structural health

monitoring and repair procedures will pave the way towards highest reliability and customer experience.

Predictive maintenance is expected to lead to improved operations, as the railway undertakings will be able to detect the impending failures much earlier and to recover quickly from service outages. Customer service levels are expected to improve and maintenance costs are expected to decline. Asset lifecycles will be extended, and the state of good repair backlog will be steadily decreased.

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

S2R-OC-CCA-01-2015 – Long-term needs of different actors in the railway sector

Specific challenge**:** Understanding the users' long-term needs and requirements of the sector´s services and products are the key challenge in order to develop the rail system of the future. Building such understanding will provide the opportunity to develop the railway system based on customer expectations and not the other way round: starting by improve technical solutions and only then trying to secure the acceptance/awareness of customers. Any technological innovations that will be developed within the S2R Programme should take into account the long-term needs of all users of the sector, in order to be attractive, and lead to prospective deployment.

The Transport White Paper 2011 lays down the strategic orientations for rail and it is expected that the introduction of disruptive technologies might lead to users' changes in preferences, behaviours and lifestyles thus creating new rail transport opportunities and challenges. The trends and paradigm shifts e.g. digitalisation, must also be put in the context of the individual and societal value systems and its consequences for the mobility by rail analysed. All of this has to be linked to the concept of social sustainability.

Scope**:** Proposed actions should address all of the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

- Collect and analyse the long-term changes in future needs of actors and users of the railway sector, related to the mobility of the passengers/citizens and to the shipment of goods. Link these needs with the expected technological developments of S2R. Analyse how the expected technological innovation of S2R can be integrated in the transport systems, shaping and structuring the society, and analyse its consequences for social mobility, for the redistribution of revenues and assets.
- Collect and analyse specific knowledge about customer requirements, e.g. which unfulfilled requirements might prohibit the use of a train. The complete knowledge about customer behaviour in relation to mobility before, during and after the journey, from door to door, including the journey planning phase should be taken into account. The analysis should also include a definition of a process to evaluate relevant customer needs for different user groups (e.g. simplicity, usability, comfort, etc.), to score the needs and their fulfilment, to show at which phase they are relevant; before, during, after the journey.
- Analyse mega-trends, scenarios and disruptions to the "landscape of mobility", changing the circumstances for railway, in 2022, 2030 and 2050. Different scenarios concerning the expected changes related to mobility should include questioning of established trends and forecasts with respect to digitalisation, self-driving cars, electric cars, behavioural changes, etc. Propose and assess what sectoral and societal factors can influence the S2R objectives, and what factors can be influenced by the results of S2R.

- Today mobility situation is largely dependent on car usage. Analyse what would happen if the car usage was reduced, by 10% or more. What kind of social change could be expected: more recreational areas, more communication, less traffic, less noise, greener cities, more people friendly areas, more attractive pedestrian and cycling areas? Up to which level the modal share of rail should be increased to get the most beneficial results and from which level of modal share the effects will accelerate by themselves?
- Match the outcome of customer requirements, scenarios and society effects of the aforementioned studies with the objectives of S2R Master Plan.

This topic is complementary with topic S2R-CFM-CCA-01-2015: Start-up activities for System Platform Demonstrator Integrated Assessment and socio-economic effects. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €0.4 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected impact**:** The work is expected to analyse the dynamics of new preferences, behaviours and lifestyles, the main factors that influence them and show their potential market, its potential growth and social impact. It will the basis for long term technical decisions, and it is expected to provide concrete assessments of their impacts on the European rail sector over the long term, facilitating evidence-based decision making (mainly for RU, IM, public and planning sector).

The aggregated knowledge of mega-trends, scenarios and disruptions and all possible customer requirements related to railway based mobility and their attractiveness to the customers will accelerate the development of the rail market, its competitiveness and the work within S2R.

The results shall contribute to the improvement of the sustainability in the transport sector, respecting the differences between the defined user groups, and their needs and requirements. The results are expected to clearly show the market uptake potential.

Work is also expected to contribute to the generation of applicable knowledge about the active and passive Key Factors, i.e. those being possible to affect from the rail sector and those affecting the rail sector. This will facilitate the further analysis of rail research and innovation, within and outside S2R.

Type of action: Research and Innovation Actions

S2R-OC-CCA-02-2015 – Energy usage, generation and saving approaches

Specific challenge**:** The challenge regarding energy within the railway sector is linked to the need to reduce energy consumption in order to reduce LCC and ensure that the relative environmental advantage of railways is matching the improvements in other means of transportation. Energy losses in the traction chain and the application of new technologies for energy saving should be analysed with respect to increased efficiency. Furthermore, it is also necessary to develop a standardized simulation methodology for estimation of energy consumption in the railway sector, since up to now it is not available.

Scope**:** Proposals should address the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

- The energy requirements for urban rail traffic all over Europe should be analysed resulting from existing specifications, guidelines and best practices, notably from other R&D projects.
- An energy simulation model should be developed and a simulation tool should be provided that allows the evaluation of energy consumption. The model should include at least all modules of the propulsion chain including energy management systems that are covered by S2R technical demonstrators, e.g. electronic transformer, converter, battery storage and driver assistant system. Further components that contribute significantly to the energy consumption should be modelled in addition, e.g. the traction motors, the gearbox and the running resistance. The parameters and algorithms of the model have to be provided. In order to avoid the development of a new tool the provided tool should be based on the existing tools developed within the previous European research projects, where appropriate, e.g. Clean-ER-D. The tool should include a trajectory for backward simulation. All activities above should be carried out within the first year of the work. The following activities should start in the second year of the work and should have duration of 1 to 3 years.
- The energy simulation tool should be applied for estimation of the energy consumption for the reference scenarios of the 4 traffic segments (high speed, regional, urban and freight), starting from the state-of-the-art technology (State 0). Further the energy consumption of state 1 (incl. the S2R innovations) should be estimated twice a year over a period of 3 years.
- For the optimisation of driver assistant systems the optimum drive strategies and energy management should be developed for different propulsion systems and traffic segments. Further different driver assistant systems should be compared by means of simulation or “hardware in the loop”.
- A study should be carried out to analyse the losses of energy within the traction chain including their cooling needs for different traction systems in dependence on the operational states like acceleration, steady state, braking and parking. This should be

done by simulation with validated tools. Based on the results, measures for reduction of the losses should be identified.

- The study should include an analysis of the auxiliary consumers, including at least the heating, venting and air conditioning (HVAC) system, the air compressor and the DC loads.
- The switching off of propulsion units at low loads should be analysed with respect to energy saving and gear box wear.
- Based on the results of the previous EU research projects, e.g. Clean-ER-D, the application of the innovative technologies fuel cells, high performance batteries, super caps and permanent magnet motors for electrical drives should be analysed with respect to energy saving and life cycle costs for different traffic segments.
- Finally, a global vision of energy in railways should be developed including smart management of railway networks.

This topic is complementary with topic S2R-CFM-CCA-02-2015: Energy and sustainability, including noise and vibrations baselines assessment. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €0.8 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected Impact**:** The expected impact of this research and innovation action is linked to the determination of the energy improvement of technical innovations in order to decide which innovations should be applied when new trains or infrastructure assets are purchased. Furthermore, the reduced energy consumption should lead to a reduction of the environmental impact and help to increase the competitiveness of rail transport due to reduced energy cost.

Type of action: Research and Innovation Actions

S2R-OC-CCA-03-2015 – Noise reduction methodologies

Specific challenge**:** An important part of the development cost for equipment and train sub-assemblies is due to the vibro-acoustic targets set to fulfil noise requirements. Nowadays, targets for equipment and sub-assemblies are set according to the current level of knowledge and with internal methodologies that are not standard in the industry. Important steps forward to allocate targets in a coherent way for future cost-efficient vibro-acoustic performance improvements include standardisation and validation of methods as well as selection of different approaches for different type of equipment and assemblies.

As noise and vibration represent one of the biggest environmental challenges for the railway sector, it is essential to facilitate effective noise and vibration management. To achieve that it is crucial to apply an overall system approach and enable efficient and optimised mitigation actions. To overcome this challenge the need is to have a system approach, and commonly agreed and validated simulation tools to be able to e.g. rank the N&V sources and transmission paths correctly before deciding on costly measures for their mitigation. A proper ranking of noise sources contribution for relevant combinations of rolling stock, infrastructure and running conditions together with methods for calculating cost effectiveness of mitigation actions will considerably improve the current situation. Cost benefit scenarios of mitigation methods can be optimized, leading also to enhanced attractiveness and comfort for users.

Improved and novel approaches are aimed at for virtual design, testing and introduction of new technologies for handling N&V mitigation in a European context including e.g. multimedia studio illustration of noise scenarios and their reception by the public and for decision makers, and active noise control methods for special cases, since this could also contribute to resolving the N&V challenge.

Scope**:** Proposals should address the main challenge mentioned above, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

- *Evaluation and monitoring of impact on traffic noise scenarios of S2R research and innovation activities:* Evaluating N&V mitigation effects under realistic conditions including their cost benefit ratios for defined traffic scenarios. The work will include a critical review of the end result of current methods applied for calculating cost effectiveness of noise and vibration mitigation cases. Creation and validation of improved models for calculation of cost-efficiency for N&V mitigation for e.g. a freight corridor including infrastructure as well as rolling stock should be proposed.
- *Interior noise simulation model:* Development of interior noise models for virtual design from sources to receivers based on existing numerical, analytical, statistical and experimental methods for air borne and structure borne noise on-board rolling stock should be addressed. The potentials and limitations of existing methods should be analysed. The state of art regarding prediction of sound transmission to the interior in the full audio frequency range should be advanced. Experimental validation of models

on relevant train structures is required whereas numerical benchmarking is promoted as intermediate steps. Modelling tools developed should be suited for parametric and optimisation studies of key design parameters such as weight and space restrictions. Validation schemes should be focused on the correct assessment of key design changes related to noise control. Development work should allow defining a framework to handle relevant sources and accurately predict transmission paths to the interior within the vehicle design process. Focus shall be on methods that can model the space and frequency average of sound levels in relevant passenger positions and correctly assess associated source contributions.

- *Sources and sub-assemblies characterisation methodologies:* Specification of methodologies for different type of sources and train sub- assemblies should be proposed. It is of importance to take into account the current state-of-the-art applied by the industry through an analysis of existing methods. A development of current methodologies towards innovative approaches for determining structure-borne and air-borne noise characterisation of sources and train sub-assemblies is desirable. Validation of the methods in controlled environments and application of the methods together with the industrial partners at component and train sub-assembly level should be proposed.
- *New Technologies*: Develop auralisation and visualisation of noise scenarios in an advanced interactive multimedia studio and strategies to demonstrate to the public the progress in the N&V areas. The work should include the definition and support to demonstrate base line before mitigation methods are applied. A description of current capabilities of existing multimedia studios for this purpose should be compiled.
- Perform and demonstrate feasibility of active and other new noise control technology on noise proof windows. The work should include a study on existing practical results from similar approaches applying active noise control.

This topic is complementary with topic S2R-CFM-CCA-02-2015: Energy and sustainability, including noise and vibrations baselines assessment. As specified in section 4.2.5 of S2R AWP for 2015, in order to facilitate the contribution to the achievement of S2R objectives, the options regarding 'complementary grants' of the S2R Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R Grant Agreements.

The S2R JU considers that proposals requesting a contribution from the EU of around €1 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected impact**:** A significant impact is expected from the technologies developed in this research and innovation action including:

- Improved attractiveness and comfort for rail users and reduced exposure to noise and vibration;

- Improved cost effective methods for analysis and selection of exterior noise mitigation actions;
- Improved methods and tools for simulation of interior noise including source characterisation and specification as well as methodologies for cost effectiveness of exterior noise scenarios.
- The impact of having common specifications can lead to a potential lower weight of the train, energy saving and cost reduction avoiding over- or underspecifying performances of equipment and assemblies.

Type of action: Research and Innovation Actions

S2R-OC-CCA-04-2015 – Safer infrastructure – improved object detection and prevention of safety critical events and integrated mobility

Specific challenge**:** The challenge is two-fold, covering both safety and integrated mobility.

1. *Safety*

Ensuring and enhancing the safety of rail operations is of high importance for the EU since past rail accidents have shown that they may come with high costs in terms of loss of life, environmental damage, economic impact, and the overall image and public perception of the rail sector. In what concerns the railway system, safety is one of the major inherent advantages over other means of transportation according to the official international accident records. In this context, the challenge is to ensure the highest level of safety possible and to enhance a better detection of different objects on the tracks.

2. *Integrated Mobility (Smart Planning)*

Nowadays, insufficiently harmonised planning procedures cause non-optimal planning, disruptions and delay in the railway system. An integrated approach for a quality-oriented operational railway planning is a key to a reliable and robust railway system. It is needed for punctual trains, to minimise operational disruptions and to render the system able to respond quickly to any disruptions so normal operation can resume as quickly as possible. The specific challenge is to improve planning activities of various stakeholders in the railway system by means of precise micro-level railway simulation. Combining Infrastructure Manager (IM) and Railway Undertaking (RU) planning will enable the integration of different parameters of the railway system based on actual data from condition monitoring of vehicles and infrastructure.

Scope**:** Proposals should address both challenges mentioned above to the same extent and include the following elements, in line with the Shift2Rail Multi-Annual Action Plan (MAAP):

1. *Safety*: Improvement of the management of the safety of the railway system based on a risk assessment approach:

- The work should develop the global approach to an integrated management system for the safety of the railway system, based on a global risk assessment model (identification, assessment and hierarchisation of risks). The global approach should identify needed data, events and indicators aiming to build a statistic and predictive model highlighting the trends and potential risks (organisation, processes and procedure). It should also provide the key results to define the following elements:
  - A set of unified railway safety indicators;
  - An integrated system for recording and monitoring the railway incidents;
  - Appropriate prediction models of the number of accidents;
  - Setting criteria to assess the result of the global railway safety management;

- Conception of appropriate decision making tools for the infrastructure managers and the operators specified to different accidents categories.

- Further to developing the global approach, proposals should:
  - Establish a state of the art in the safety management methods based on a global approach. The current effectiveness of those methods should be assessed in order to identify the main drivers, key indicators and further choose the parameters and methods to be used as a common tool. A monitoring study aiming at establishing and progressing beyond the state of the art in the safety management methods, based on a global approach should also be proposed.
  - Quantify the safety improvements carried out in S2R Technology Demonstrators (TDs), with the aim to measure and define the prioritized actions and changes, adapted to the evaluated risks and then commit the stakeholders to obtain a higher level of safety. Define and reach qualitative and quantitative new objectives.

- The proposals should also propose measures to improve vehicle, human and big animal detection on tracks, and specifically on safety-critical sectors of infrastructure, such as level crossings, bridges and tunnels. The objective is to avoid the more severe collisions and consequences of such accidents, and ensure safer conditions with external interfaces from the railway system itself. The work should identify and update the definition and classification of risky zones, steer studies, develop new equipment, proposals, learning, training to reduce the level of risk and consequences of such accidents.

2. *Integrated Mobility (Smart Planning)*

- Proposals should contribute to the improvement of basic micro-level simulation models and should foresee an implementation for test purposes. Specifications methodologies and algorithms including interface descriptions should be developed which could be integrated in existing simulation models to support the connected activities within S2R programme. This should include planning activities like staff planning of vehicle turnaround cycles and dispatching of connections.

- Further to that, proposals should also include the development of a punctuality prognosis based on the developed model parameters including model validation and comparison against actual network operations based on data from IM and RU samples and for comparison to existing simulation results. The results should be tested in two case studies: on a long-distance traffic corridor and in complex partial network in a region.

- Furthermore, proposals should support the development of simulation technology and automation to support project progress and include support regarding fundamentals in terms of data formats (e. g. railML) and future IT-requirements (such as easy handling of interfaces and extensibility). This includes rules for handling large scale disturbances with

significant deterioration of infrastructure capacity and preparation to include results from condition monitoring of vehicles and infrastructure.

- Moreover, developments should be based on existing technology to ensure the preparation of an efficient pilot development and to guarantee the exploitation of the results on the long term. The simulation tools which will be supported by these works should be capable to build and manage a flexible and very detailed microscopic railway infrastructure and timetable model on a very large scale. The model must include the capability to handle customary infrastructure like time stamps for all infrastructure elements and access rules. Furthermore, timetable and operational schedule data should be able to be imported via established interfaces. The tools should provide precise network-wide proven running time calculation, conflict identification and display based on common infrastructure and signalling systems able to consider country-based specific rules (signalling system, running time allowances, buffer times, operational rules, etc.). Based on this data the tool should provide several essential values that characterise a timetable, e.g. capacity calculation according to UIC 406 for lines and nodes.
- In addition, the tools must be able to factor in failures of rolling stock and infrastructure. To investigate and optimize railway operations an integrated network-wide synchronous microscopic simulation based on the above described model approach is essential. Signalling specifications, braking speed supervision and dispatching rules have to be ensured in the simulation. Dispatching rules should take into account the handling from all kind of disturbances and disruptions of the operation, rolling stock and infrastructure elements on lines and in stations including prioritisation, cancellation and re-routing of trains. The tool must have the ability to simulate large networks to provide reliable results regarding punctuality, robustness of a timetable, delay development (initial and secondary delays) and effects of infrastructure failures etc. on a local and network view.

This topic is complementary with topic S2R-CFM-CCA-03-2015: Integrated Mobility and Safety Management. As specified in section 4.2.5 of S2R AWP for 2015, 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 JU considers that proposals requesting a contribution from the EU of around €1.3 million would allow this specific challenge to be addressed appropriately. Proposals should address both described work streams with an indicatively similar split of the budget (€0.7 million for safety and €0.6 million for integrated mobility). Nonetheless, this does not preclude the submission and selection of proposals requesting other amounts.

Expected impact**:** Regarding Safety, the expected impact will be to enable taking the good decisions to manage the safety of the railway system at a global level, in each situation. In the context of S2R programme, the safety level carried out in each Technical Demonstrator

will be assessed. This global approach will help to evaluate the impact of new equipment integrated in the existing railway system.

The expected impact of the improvement of vehicle, human and big animal detection on tracks is a considerable reduction of accidents on safety-critical sectors of infrastructure. Less accidents and their lesser severity, incl. less fatalities, will also contribute to reducing different types of costs related to accidents.

Regarding Integrated Mobility (Smart Planning), actions will help to deliver precise railway network simulation to support railway operational planning. The simulation tools are a core element in order to solve the pressing operational issues on the network, but also to pave the way towards a more integrated approach of railway planning and operation between the many stakeholders of the system.

A conservative estimate based on the current causes for delays in long-distance traffic shows that more than 40% of the overall delay time could be addressed with Smart Planning (e.g. from planning, operations and secondary sources such as train connections). Furthermore, Smart Planning will eventually enable to allocate investments optimally by knowledge of all relevant system parameters and their interactions, in order to reach optimal use of existing capacity and optimal use of limited resources and to provide a basis for a long-term cost-efficient operation of the railway system.

Type of action: Research and Innovation Actions

ANNEX III Indicators and Scoreboard of KPIs

TABLE I - Horizon 2020 Key Performance Indicators[39] 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 challenges)]	Yes

[39] (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
	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[40]	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
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

[40] 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
	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
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

	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
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 [41]	Joint Undertaking	n.a. [new approach under H2020]		
JU EFFICIENCY	NA	Budget implementation/execution: 1. % CA to total budget 2. % PA to total budget	realistic yearly budget proposal, possibility to monitor and report on its execution, both in commitment (CA) and payments (PA), in line with sound financial management principle	% of CA and PA	Joint Undertaking		100% in CA and PA	Yes
	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.

[41] Additional indicators can be proposed/discussed with R.1 and/or DG HR

TABLE II - Indicators for monitoring H2020 Cross-Cutting Issues[42] common to all JTI Jus

Correspondence in the general Annex 2	Cross-cutting issue	Definition/Responding to question	Type of data required	Data to be provided by	Data to be provided in/to	Direct contribution to ERA	Automated
2	Widening the participation	2.1 Total number of participations by EU-28 Member State	Nationality of H2020 applicants & beneficiaries (number of)	H2020 applicants & beneficiaries at the submission and grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes
		2.2 Total amount of EU financial contribution by EU-28 Member State (EUR millions)	Nationality of H2020 beneficiaries and corresponding EU financial contribution	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes
NA		Total number of participations by Associated Countries	Nationality of H2020 applicants & beneficiaries (number of)	H2020 applicants & beneficiaries at the submission and grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes
NA		Total amount of EU financial contribution by Candidate Country (EUR millions)	Nationality of H2020 beneficiaries and corresponding EU financial contribution	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report	YES	Yes
3	SMEs participation	3.1 Share of EU financial contribution going to SMEs (Enabling & industrial tech and Part III of Horizon 2020)	Number of H2020 beneficiaries flagged as SME; % of EU contribution going to beneficiaries flagged as SME	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report		Yes
6	Gender	6.1 Percentage of women participants in H2020 projects	Gender of participants in H2020 projects	H2020 Beneficiaries through project reporting		YES	Yes

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

Correspondence in the general Annex 2	Cross-cutting issue	Definition/Responding to question	Type of data required	Data to be provided by	Data to be provided in/to	Direct contribution to ERA	Automated
		6.2 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
9	Bridging from discovery to market [43]	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

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

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
NA		Scale of impact of projects (High Technology Readiness Level)	Number of projects addressing TRL[44] between…(4-6, 5-7)?	Joint Undertaking	JU AAR RTD Monitoring Report		
11	Private sector participation	11.1 Percentage of H2020 beneficiaries from the private for profit sector	Number of and % of the total H2020 beneficiaries classified by type of activity and legal status	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report		Yes
		11.2 Share of EU financial contribution going to private for profit entities (Enabling & industrial tech and Part III of Horizon 2020)	H2020 beneficiaries classified by type of activity; corresponding EU contribution	H2020 beneficiaries at grant agreement signature stage	JU AAR RTD Monitoring Report		Yes
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

[44] 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
14	Participation patterns of independent experts	14.2 Proposal evaluators by country	Nationality of proposal evaluators	Responsible Directorate /Service/Joint Undertaking in charge with the management of proposal evaluation			
		14.3 Proposal evaluators by organisations' type of activity	Type of activity of evaluators' organisations	Responsible Directorate /Service/Joint Undertaking in charge with the management of proposal evaluation		YES	
NA	Participation of RTOs and Universities	Participation of RTO[45]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)[46]	Responsible Directorate /Service/Joint Undertaking	JU AAR RTD Monitoring Report		

Notes:
*H2020 applicants - all those who submitted H2020 proposals
*H2020 beneficiaries - all those who have signed a H2020 Grant Agreement
*Responsible Directorate - DG RTD Directorates and R&I DGs family in charge with management of H2020 activities
*Services -Executive Agencies and other external bodies in charge with H2020 activities
*Project officer - is in charge of managing H2020 projects in Responsible Directorate/Service including Executive Agencies

[45] RTO: Research and Technology Organisation
[46] Data relates to pre-granting ethics review. This time span runs in parallel to granting process.

TABLE III - Key Performance Indicators specific for the S2R JU

#	Key Performance Indicator	Objective	Data to be provided by	Baseline at the start of H2020	Target at the end of H2020	Automated
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 activities	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
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
	Rede Ferroviária Nacional (REFER)	PT
	Schweizerische Bundesbahnen (SBB)	CH
	Slovenske zeleznice (SZ)	SI
	Türkiye Cumhuriyeti Devlet Demiryollari (TCDD)	TR
Faiveley Transport		FR
HaCon Ingenieurgesellschaft mbH		DE
INDRA SISTEMAS S.A.		ES
Kapsch CarrierCom AG		AT
Knorr-Bremse Systems für Schienenfahrzeuge GmbH		DE
MER MEC S.p.A		IT
Network Rail Infrastructure Limited		UK

Siemens Aktiengesellschaft		DE
Smart DeMain (SDM) consortium	*Strukton Rail BV*	NL
	ACCIONA INFRAESTRUCTURAS SA	ES
	Deutsches Zenttrum für Luft-und Raumfahrt e.V. (DLR)	DE
	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.	DE
	Centro de Estudios de Materiales y Control de Obra S.A	ES
Smart Rail Control (SmartRaCon) consortium	*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)*	DE
	Centro de Estudios e Investigaciones Técnicas (CEIT)	ES
	FONDATION DE COOPERATION SCIENTIFIQUE RAILENIUM	FR
	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