ANNUAL ACTIVITY REPORT 2018

28 June 2019

In accordance with Article 20 of the Statutes of the S2R JU annexed to Council Regulation (EU) No 642/2014 and with Article 20 of the Financial Rules of the S2R JU.

The annual activity report will be made publicly available after its approval by the Governing Board.

Contents

FACTSHEET

Name	Shift2Rail Joint Undertaking (S2R JU)
Objectives	The Shift2Rail Joint Undertaking is a public-private partnership in the rail sector, providing a platform for cooperation that drives innovation in the years to come. The S2R JU pursues research and innovation (R&I) activities in support of the achievement of the Single European Railway Area and should improve the attractiveness and competitiveness of the European rail system. The S2R JU contributes to: • a 50 % reduction of the life-cycle cost of the railway transport system (i.e. costs of building, operating, maintaining and renewing infrastructure and rolling stock), • a 100 % increase in the capacity of the railway transport system, • a 50 % increase in the reliability and punctuality of rail services (measured as a 50 % decrease in unreliability and late arrivals). The S2R JU shall propose innovative solutions to be explored, tested and demonstrated in operational environment and/or "zero on site" to achieve market uptake. Beyond that, with the deployment of its innovative solutions the S2R JU will foster connections between people, regions, cities, and businesses, supporting the socioeconomic objectives of the Union
Founding Legal Act	Council Regulation (EU) No 642/2014 of 16 June 2014 establishing the Shift2Rail Joint Undertaking[1] (S2R Regulation)
Executive Director (ED)	Mr Carlo M. Borghini, as from 16 May 2016
Governing Board (S2R GB)	***European Commission (EC) members (at 31/12/2018)***: • *Henrik HOLOLEI, DG MOVE* • *Elisabeth WERNER, MOVE DDG 2* ***EC alternate (at 31/12/2018):*** • *Ratso SIGNE (RTD.I)* • *Clara DE LA TORRE, DG RTD* ***Industry members (at 31/12/2018):*** • *ALSTOM Nicolas CASTRES-SAINT-MARTIN* • *ANSALDO STS Nadia MAZZINO* • *AZD Praha Vladimir KAMPIK* • *BOMBARDIER TRANSPORTATION Massimo SIRACUSA* • *CAF Imanol ITURRIOZ* • *DEUTSCHE BAHN Hans Peter LANG* • *EUROC Thomas PETRASCHEK* • *HACON Lars DEITERDING* • *INDRA Javier Rivilla LIZANO* • *KNORR - BREMSE Martin DEUTER* • *NETWORK RAIL (Industrial Spokesperson) Andy DOHERTY* • *SIEMENS Roland EDEL* • *SMARTDEMAIN Henk SAMSON* • *SMARTRACON Michael Meyer zu HÖRSTE* • *SNCF Carole DESNOST*

[1] OJ L 177, 17.6.2014, p. 9

	• *THALES Alberto PARRONDO* • *TRAFIKVERKET Bo OLSSON* • *VVAC+ Filip KITANOSKI* ***Industry alternates (at 31/12/2018):*** • *ALSTOM Sophie PERROCHEAU* • *ANSALDO STS Antonella TROMBETTA* • *AZD Praha Michal PAVEL* • *BOMBARDIER TRANSPORTATION Richard FRENCH* • *CAF Jorge DE CASTRO* • *DEUTSCHE BAHN Ralf MARXEN* • *EUROC (to be appointed)* • *HACON Rolf GOOßMANN* • *INDRA Jesus LACOSTA GIMENO* • *KNORR - BREMSE Susanne SCHMIDT* • *NETWORK RAIL Graham HOPKINS* • *SIEMENS Jürgen SCHLACHT* • *SMARTDEMAIN Javier Bonilla DÍAZ* • *SMARTRACON Jaizki MENDIZABAL* • *SNCF Christophe Chéron* • *THALES Yves PERREAL* • *TRAFIKVERKET Christer LOFVING* • *VVAC+ Erik STOCKER* ***Other participants (at 31/12/2018):*** • *Carlo M BORGHINI Executive Director of the S2R JU* ***Observers (at 31/12/2018):*** • *Josef DOPPELBAUER* • *Angela DI FEBBRARO* • *Miroslav HALTUF*
Other bodies	Scientific Committee (SC) States Representatives Group (SRG) Innovation Programmes' Steering Committees (IP SteCos)
Staff	23 (On-going staff recruitment) at 31 December 2018, including 3 Seconded National Experts (SNEs)
2018 Budget	Total voted budget of EUR 84.8 million in commitment appropriations, of which EUR 81.4 million for operational expenditure, EUR 3.4 million for administrative expenditure. In payment appropriations, the total voted budget was EUR 81.6 million in payment appropriations, of which EUR 67.4 million for operational expenditure, EUR 4.5 million for administrative expenditure and EUR 9.7 million of unused appropriations not required in the financial year but needed to meet early 2019 payments. The large amount of unused payment appropriations is due to the delay in the award of the 2018 Call, which was due to causes, legal issues, independent from the Call itself and S2R JU.
Budget implementation	The Budget implementation in terms of commitment appropriations is at 100% and at 82.3% in terms of payment appropriations (in case of payment appropriations, excluding the unused appropriations not required in the financial year). The implementation of Administrative budget was EUR 3.4 million in commitment appropriations and of EUR 3.4 million in payment appropriations. Applying sound financial management, the JU make use of multi-annual framework contracts in particular in Title 2; nevertheless suppliers submit relevant invoices with delays and usually in accordance with their accounting after year-end; this resulted in payment appropriations implementation at 63.4% of the voted budget, which corresponds to

	only 3% to the JU Budget. The Operational Budget was implemented at EUR 81.4 million in commitment appropriations and EUR 55.8 million (82.8%) in payment appropriations. Due to unforeseeable reasons, outside the control of the JU, two of the pre-financing payments resulting from the call 2018 became due in 2019 only and resulted the majority (EUR 83 million) of un-used operational Payment Appropriations for the year.
Grants	In October 2018, the S2R JU awarded 19 grants as a result of the 2018 Call launched on 11 January 2018 based on the amended Annual Work Plan (AWP) 2018. 17 grants agreements were signed between November and December 2018, allowing the timely start of the projects. As indicated earlier, 2 grants agreements will be signed beginning of 2019. In total, the grants will co-fund Research and Innovation activities up to EUR 77.3 million against a total value of EUR 152.6 million. In this respect, it should be noted that the Founding Members other than the Union and the Associated Members (jointly referred to as the "Other Members") agreed to limit their requests for funding to 44.44% of the total project cost. The lowest in overall H2020 Programme.
Strategic Research Agenda	The S2R JU Programme is described in the Multi-Annual Action Plan (MAAP) adopted by the S2R GB in 2015. A new MAAP Executive View (Part A) has been adopted by the S2R GB on 27 October 2017.
Call implementation	The AWP 2018 was implemented already at the beginning of the year, nevertheless due to legal issues beyond the control of the S2R JU and independent from the Call itself, resulted in the award only at a Governing Board meeting on 26 October 2018. With an exceptional commitment and effort, the Other Members and OC together with the JU were able to reach the signature of 17 out of 19 grants, as mentioned, while 2 will be signed early 2019. In accordance with a multi-annual calendar, all the preparatory works of the Call 2019 were realized in 2018 and on 4 December 2018, the S2R GB adopted the AWP 2019 and budget.
Participation, including SMEs	Under the 2018 Call, 76 Small and Medium Enterprises (SMEs) participated to the 2018 Call (23.0%) and 40 SMEs were retained for funding (21.6%). SME's represent 31.5% of the entities selected in the Open Calls projects.

EXECUTIVE SUMMARY

The Shift2Rail Joint Undertaking (S2R JU or S2R) is a public-private partnership under the Horizon 2020 Framework Programme[2] established to manage and coordinate mission-oriented Research and Innovation (R&I) activities for a major transformation in rail systems in Europe.

The S2R JU was officially established on 7 July 2014, following the adoption of Council Regulation (EU) No 642/2014 of 16 June 2014 establishing the Shift2Rail Joint Undertaking (S2R Regulation).

During 2018, the S2R JU has progressed towards achieving its targets, delivering the S2R Programme implementation ensuring an effective and efficient sound financial management.

Programme Status

2018 saw the progress of the R&I activities launched in the previous years. They are now well on track and largely proceeding at cruise speed. A new wave of R&I activities (Call 2018) started at year end. In total, it is estimated that the Total Project Cost of the activities performed in 2018 amounts to EUR 83.4 million.

During the month of April 2018 the S2R JU assessed its R&I activities through its second Control Gate assessment[3]. This exercise took into account the deliverables and reports submitted in the context of the Annual Review of the 2015-2016 Projects coordinated by the other Members than the European Union (hereinafter Other Members). The S2R JU also ensured through this process that the recommendations made during the first Control Gate Assessment where properly applied. Overall the S2R JU noticed an increased understanding of the assessment made both in quality term then in content; such a result is also due to the fact that for the first time the S2R JU was in capacity to assess a significant number of technical deliverables for the reviewed projects. It has to be mentioned, although, that the quality of some submitted deliverables was below standard and the S2R JU requested several re-submission re-opening deliverables and suspending technical reports. This process has been therefore particularly demanding.

In addition, this process is integrated in the overall Programme monitoring realized through the quarterly meetings of the Innovation Programmes (IPs) where it is assessed how the different R&I activities organized in Projects are progressing in a coherent and integrated manner.

The S2R JU decided not to insert the 2017 Other Members Projects in the Control Gate assessment process of 2018 (no Project Review) due to the limited number of results available; those projects will perform their first Control Gate assessment in 2019.

The S2R JU programme team conducted also projects review meetings for non-S2R Members during 2018.

The European Commission tasked also the S2R JU to assess the technical progress from the mid-term report of the four S2R Lighthouse Projects (LP), stemmed from the 2014 H2020 transport call,

[2] Council Decision (EU) No 2013/743/EU of 3 December 2013 establishing the specific programme implementing Horizon 2020 (2014-2020), OJ L 347, 20.12.2013, p. 965.

[3] Accordingly to the procedure set in the S2R Governance and Process handbook, transparently published on the S2R website: https://shift2rail.org/wp-content/uploads/2017/12/S2RJU-Governance-and-Process-Handbook_20171010_v11_Cleanv-nd.v2.pdf

administratively managed by DG Move (IN2Rail (LP), IT2RAIL (LP) and SMART-RAIL (LP)) and by DG RTD (ROLL2RAIL (LP)).

This Programme assessment allowed the S2R JU to confirm that overall the progress of the activities has been in line with the expectations; considering the status of the progress of the TDs reported in Section 1.7. Only few TDs show delays compared to the initial scheduling, mostly due to external factors. In such cases, the JU has requested the concerned Project Teams to put in place the necessary mitigating measures.

- **IP1**

Positive progress has been reported on all TDs that on average have reached around 95% of the estimated work planned in 2018. The initial results in each TDs show that the investment in research and innovation is going to bring the expected results in terms of more efficient, lighter, automated and customer oriented passenger trains.

Most of the TDs are arriving at TRL 4/5 so not yet at the demonstrations' level. During 2018, synergies between IP1 and IP2 have been strengthen in particular with regard to Train Control and Monitoring System (TCMS) and telecoms. The IP1 programme has also contributed with valuable results to Cross Cutting Activities (CCA) work areas (Noise and Vibration, Smart Maintenance, Virtual Certification, etc.).

- **IP2**

This innovation programme is one of the cornerstones of the S2R Programme; only through the achievement of virtual coupling, moving blocks, train integrity new concepts of traffic management enabled by positioning, telecoms, Automated Train Operation (ATO) and digitalization it will be possible to harvest the system benefits of the S2R Programme and meet the capacity objective. Although in line with the planning not all these technologies are expected to reach "demonstrator" level by the end of the present Programme, the work performed in 2018 has contributed to more focused R&I.

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

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

As a result, the aforementioned realignment will contribute to accelerate the delivery approach of IP2 technological enablers. ATO Technology Demonstrator has achieved a major milestone in the summer 2018 with the finalisation and publication of the draft specifications for ATO over European Train Controlling System (ETCS) Grade of Automation (GoA)2. These specifications have been reviewed by the ERA (as ERTMS System Authority) supported by the ERTMS Users Group (EUG) and UNISIG (a working group from UNIFE, the rail manufacturing industry association, that

contribute to the ERTMS/ETCS technical specifications) in order to assess the possible impact on the current ERTMS/ETCS specifications. This was a key milestone to ensure that the uptake of the results of this TD and prepare the integration of this functions and its specifications in the Control Command and Signalling TSI, in the next revision, currently targeted by 2022.

With regard to moving blocks, some demonstrations realized by S2R Members under their national programmes showed the opportunities provided by the introduction of such solutions, although the demonstrations were ring-fenced to a specific context. Some areas of concern are related to the availability of new telecoms technologies and some strategic decisions, where the S2R Programme works in strict collaboration with others, such as FRMCS (UIC project) and ETSI.

Also in the case of IP2, the maturity level of the R&I activities varies between TDs and the completion of the work is estimated at around 90% in 2018.

- **IP3**

The heterogeneous nature of IP3 is developing in relation to funds released to date. Switches and crossings, track and bridges and tunnels activities have achieved early stage research and preparatory work towards operational environment demonstrators.

Good progress has been achieved in the areas contributing to intelligent asset management strategies. The status of the TDs shows the opportunity that would be provided by the implementation of new concepts of intelligent asset management (shifting from reactive to proactive maintenance) in terms of capacity and Life Cycle Cost (LCC).

Also in the field of energy, the scenarios developed in the relevant TDs demonstrated opportunities for the definition of strategies for efficient energy management contributing to the reduction of energy losses and to the reduction of the infrastructure investment costs.

- **IP4**

During 2018, the IP has reported great progress towards delivering, by the end of the Programme, the Integrated Technical Demonstrator. Although legal issues related to the status of HaCon combined with the delays in the input from the Lighthouse Project affected the delivery of some TDs results, the concerned Members showed strong commitment continuing their activities to deliver IP4 TDs, inter alia.

Good progress has been achieved in the Interoperability Framework, showing that the semantic interoperability appear to be sound. The work of IP4 has been evolving also to take into account new services and the integration with other modes of transport and mobility services, approaching the Mobility as a Service (MaaS) concept.

- **IP5**

The Other Members involved in IP5 proposed a reorganization of the IP, as mentioned in the relevant section. During 2018, the links between IP2 and IP5 on ATO have been reinforced.

IP5 progress during 2018 is estimated at 80% compared to the expected targets, although most of the deliverables were met and the projects show good progress towards achieving the results. Although this IP is one of the smallest within the S2R Programme, the JU created opportunities with other IPs building clear synergies.

Great expectations are included in IP5, considering the work performed in 2018 on ATO and automatic couplers.

- **CCA**

The Cross-Cutting Activities showed a slower pace compared to the other IPs, due to the need to establish internal procedures for cooperation with the IPs on which the results rely significantly as well as due to availability of key partners inside the different entities involved.

These cross-cutting activities ensure that the R&I activities within the different Innovation Programmes are closely aligned in order to guarantee consistency within the entire S2R Programme.

The CCA Work Areas (WAs) are largely dependent on the input provided by the rest of the Programme; this process has not been always easy and sometime negatively impacted the progress. The case of the S2R KPI model is a clear example where key effort has been performed but results are not yet at the expected level. In 2018 the S2R JU put in place new cross-IP communication procedures that will support to build the links and to better engage the other IPs in topics of transversal nature.

Initial Programme results have been presented in the Transport Research Arena 2018, while some were showed as Technology Demonstrators quick-wins at the InnoTrans 2018 event. Some 20 demonstrators were presented showing the capacity of the S2R Membership to deliver the system transformation expected and also going beyond. The virtually coupled trams' demonstrator, a combination of different IPs/TDs showed in a specific environment the opportunity offered by telecoms nextgen, positioning, etc.; this flagship demonstrator is part of an overall system of systems approach where all TDs are working together to bring new railway concepts to Europe.

Programme Management and MAAP

In terms of Programme Management, the S2R JU also took some corrective measures for a correct synchronisation of the Programme, resulting in the acceptance of few deliverables submission delays that will not, in principle, affect the overall Programme results. During this process, it clearly appeared that there is not a continuous internal communication process within the Other Members' entities; the current matrix structure of the Programme does not facilitate the implementation due to the fact that often those in charge of projects do not report to those seating in the S2R GB or other key governance bodies.

During the year, the Other Members in coordination with the JU continued to update the technical part of the MAAP, the MAAP Part B, to align it with the vision set in the MAAP Executive View Part A and taking stock of the results of the ongoing Projects, of new technologies/businesses emerging and demonstration and deployment activities. This work is expected to be finalised by mid-2019 and adopted by the S2R GB by year end at the latest.

R&I activities launched in 2018 and prepared for 2019

In June 2018, the S2R JU awarded 19 grants as a result of the 2018 call for proposals launched in January 2018.

17 grant agreements were signed between November and December 2018 normally allowing the start of the projects in December 2018. 2 grant agreements will be signed in early 2019. The value of the R&I activities of this 2018 Call amounts to EUR 151.1 million, to be co-funded by S2R JU up to a maximum of EUR 76.5 million[4]. As in the case of the previous years and for the full duration of the Programme, the Other Members of the S2R JU agreed to a funding rate of maximum 44.44% (this would mean a net 41.44% for an Other Member after having considered its obligations), demonstrating a strong commitment to deliver the most ambitious Railway R&I Programme for a major transformation to rail systems, once deployed.

331 entities, of which 76 SMEs (23.0%), participated to the 2018 Call 2018. They represented 24 States, of which 21 EU Member States and 3 Countries Associated to the Horizon 2020 Framework Programme (See Annex C for details).

To facilitate a future stronger participation from the EU-13 Member States, feedbacks received by the S2R JU suggests that it will be important to integrate successful S2R R&I results with longer-term demonstration and deployment activities, encompassing a wider geographical sector involvement and impact across Europe.
In December 2017, the S2R JU started the process for the preparation of the 2019 Call that was finally published on 15 Jan 2019 in the Horizon 2020 Funding & tender opportunities portal and based on the original version of the AWP 2019 adopted by the S2R JU GB on 4 December 2018. This lengthy process includes the key contribution of the S2R Members, the review and advice at different points of the SC, SRG, ERA and UR-ID and the adoption by the S2R GB, after the overall work was finalized under the responsibility of the Executive Director.

Since its appointment, the Executive Director was requested by the Members to ensure the streamline of the S2R Programme, starting with its administration. The Executive Director, together with the Programme Office, looked at the simplification process introduced by the European Commission through the Lump Sum Grant approach; after extensive internal discussions and analysis decided to propose to the S2R GB, as part of the AWP 2018, the adoption of the Lump Sum Grant approach, which was subsequently implemented through the Lump Sum Pilot in the CFM part of the 2018 Call. This met R&I stakeholders expectations that public international bodies in charge of mission-oriented Programmes, such as the S2R JU, are willing and capable to experiment with both bringing in new expertise (e.g. establishing novel forms of collaboration to pool and share expert knowledge) and changing routines and processes to build dynamic organisational capabilities (including performance management, procurement, grants, etc.). The S2R JU is at the forefront of such processes in a risk management approach.

Other activities

On 7 June 2017, the S2R GB mandated the Executive Director to establish the necessary process to allocate EUR 5.6 million of funding still available within the Union funding available for the Associated

[4] In fact the total value of the funding made available by the S2R JU at the launch of the call was of EUR 77.3 million, which resulted in grants awarded and signed for a total amount of funding of EUR 76.5 million.

Members. An *Invitation to S2R JU Associated Members to submit an answer in view of the realignment of their activities and additional commitment to the S2R Programme* was published in June 2017, ensuring transparency and equal treatment. The Invitation was made public to provide the opportunities to third entities to join existing Associated Members to perform railway R&I. Consultations on the membership agreements were conducted with the eleven associated members who answered the invitation as well as with the Other Members who expressed their need for technical updates. The Membership Agreements with the Associated Members have been revised to take into consideration the "report regarding the outcome of the invitation to Shift2Rail JU Associated Members to submit an answer in view of the realignment of their activities and additional commitment to the Shift2Rail Programme" and the subsequent negotiation process. Subject to the approval of the revised versions of the Membership Agreements by each member, the Executive Director of the S2R JU will transmit the amended membership agreements to the Governing Board for approval by written procedure by beginning of 2019.

In order to provide administrative support to the Programme execution, the JU has progressed in the recruitment of staff filling budgetary open positions; at the end of the year, 23 position were filled, including 3 SNEs. The JU is subject to high turnover mostly due to the fact that other Union JUs and Agencies are in the position to offer Temporary Agent posts (TA) instead of Contractual Agent posts (CA). In fact, contrary to almost all other Union Institutions, Agencies and JUs, the S2R JU has a Staff Establishment Plan with 25% TAs positions and 75% CAs positions; in almost all other cases, these percentages are reversed! During 2018, the recruitment of the Head of Research and Innovation was completed too.

In 2018, the S2R JU enhanced strongly its communication and dissemination activities, including participation to key European and International events (such as TEN T Days, Transport Research Arena (TRA), InnoTrans 2018 and the Politico Connected Transport Summit). At InnoTrans S2R presented more than 20 demonstrators. In 2018, a large coverage has been given to S2R in specialised media such as the Railway Gazette and the International Rail Journal. The Financial Times featured content on S2R goals in February 2018. Four S2R newsletters have been issued. The website has been revamped with a more modern and responsive layout, and the S2R JU has dramatically increased its followers on social media, especially on Twitter.

In addition, the S2R JU signed a cooperation agreement with the South East Europe Strategic Alliance for Rail Innovation (SEESARI) on 18 September 2018.

In parallel the JU improved its internal organisation to provide support to its Members and warrant sound financial management, legality and regularity of its activities through a risk management approach.

With regard to the Discharge in respect of the implementation of the Budget of the S2R JU for the financial year 2017 and the European Parliament resolution, the present report provides in its different sections the answer requested by the Budgetary Authority. All actions have been implemented without delay and reinforcing the internal control management system of the S2R JU.

Suggestions from the SRG and the SC to improve the present report have been taken into account.

It can be concluded that, thanks to the commitment of its Members together with the Programme Office, 2018 has seen the S2R JU accelerating its progress towards delivering the Programme with a clear final users focused approach.

United Nations Sustainable Development Goals (UN SDG)

The R&I work performed by the S2R JU contributes to, at least, 6 out of 17 UN SDG. In particular, the S2R Programme contributes to

- building resilient infrastructure,
- promoting inclusive and sustainable industrialization processes – at manufacturing or operational levels,
- fostering innovation at all levels of the value chain,
- promoting inclusive and sustainable economic growth, tackling also aspects related to human capital opportunities and impact of new technologies on future skills and competences,
- new mobility and transport models towards smart and sustainable cities and regions, connecting people and providing new socio-economic opportunities,
- the urgent actions taken at Union level to combat climate change and its impacts,
- promoting gender equality at all its levels.

During the last three years of activities and more in 2018, S2R shifted from being technology driven to a mission oriented Programme, designed to meet passengers and shippers needs, contributing to achieve sustainable mobility and transport, where railway offers an integrating platform in a multimodal approach, enabled by new technologies, in particular digitalization, automation, telecoms and satellite services.

S2R remains strongly delivery oriented while coupling the need to further explore new solutions to harvest their full benefits.

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INTRODUCTION

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

The S2R JU is a public-private partnership in the rail sector established under Article 187 of the Treaty on the Functioning of the European Union, providing a platform for the rail sector as a whole to work together with a view to driving innovation in the years to come. Inter alia, the S2R JU shall manage all rail-focused R&I actions co-funded by the Union.

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

The Vision of S2R JU is

TO DELIVER, THROUGH RAILWAY RESEARCH AND INNOVATION, THE CAPABILITIES TO BRING ABOUT THE MOST SUSTAINABLE, COST-EFFICIENT, HIGH-PERFORMING, TIME DRIVEN, DIGITAL AND COMPETITIVE CUSTOMER-CENTRED TRANSPORT MODE FOR EUROPE.

The mission statement of the S2R JU is

"*Shift2Rail: moving European railway forward*"

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

This is part of a clear legal framework, where the European Commission, DG MOVE in particular, inter alia defines the transport and mobility policies, the S2R JU contributes to delivering and challenging them through its R&I Programme and ERA acts within its regulatory mandate under the 4th Railway Package.

In addition to the Union, the S2R JU has eight Founding Members other than the Union[5] and nineteen Associated Members. The latter were selected following a call for expression of interest to become Associated Member of the S2R JU[6] [7].

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

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

6 Commission Decision N° C(2014) 7084 final

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

The Union tasked the S2R JU with its Regulation and Statutes, *to manage all rail- focused research and innovation actions co-funded by the Union, ensuring coordination among projects and providing all stakeholders with relevant and available information on projects funded across Europe*.

This task is complemented by the request of the Union to the S2R JU *to establish and develop — and ensure the effective and efficient implementation of — a strategic Master Plan (the 'S2R Master Plan')*, which has been endorsed by the Council[8], and which provides a high-level view of what needs to be done; it explains why and by when. It sets the framework for the research and innovation (R&I) activities to be performed within and beyond the S2R Programme and the deployment activities to be carried out by all operational stakeholders, coordinated to achieve the Single European Railway Area.

S2R JU has developed, together with its Members and advisory bodies, the S2R MAAP, which translates the S2R Master Plan into detailed, result-oriented R&I activities to be performed to start delivering the S2R partnership vision as from 2014 onwards. The S2R MAAP contains two parts: an Executive View developed in 2017[9] and a technical part which is currently under revision[10]. Overall, the S2R JU shall:

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

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

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

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

9 https://shift2rail.org/wp-content/uploads/2017/11/Shift2Rail-MAAP-Part-A_Executive-View_webfinal.pdf

10 http://www.shift2rail.org/wp-content/uploads/2013/07/S2R-JU-GB_Decision-N-15-2015-MAAP.pdf

points which remain open in Technical Specifications for Interoperability (TSIs) due to lack of technological solutions and by ensuring that all relevant systems and solutions developed by the S2R Joint Undertaking are fully interoperable and fitted, where appropriate, for upgrading;
- the reduction of negative externalities linked to railway transport, in particular noise, vibrations, emissions and other environmental impacts.

R&I activities are performed by the Other Members and any other eligible entity. They are co-funded or procured by the S2R JU in accordance with its budget availabilities and in compliance with the H2020 Regulation[11], its Rules of participation[12] and the S2R Financial Rules. To this end, the S2R JU shall organise calls for proposals and/or for tenders for supporting the R&I activities.

As specified in Article 17 of the S2R Statutes,

a. up to 40% of the Union financial contribution to the S2R JU operational budget shall be allocated to the R&I activities performed by its Founding Members other than the Union and their affiliated entities,
b. 30% shall be allocated to the Associated Members and their affiliated entities
c. a minimum of 30% through open and competitive calls .

As for the "open and competitive calls" (point c. here above), also the award of the R&I activities to the Other Members (a. and b. here above) is through competitive calls in compliance with H2020 Rules of Participation and/or calls for tenders, under the relevant eligibility criteria.

1. IMPLEMENTATION OF THE ANNUAL WORK PLAN 2018

1.1. Key objectives 2018 and associated risks

In 2018, the S2R JU activities were driven by the overarching objective to progress the S2R R&I Programme according to the MAAP and detailed in the AWP 2018.

The main operational achievements in 2018 can be summarized as follows:

Delivery of Programme R&I activities

During 2018, the Other Members and the OC Projects continued the implementation of the S2R Programme through 63[13] Projects and some procurement contracts, awarded and signed since 2016, for an estimated R&I Total Value of EUR 428.3 million. Details are provided in Section 1.6.

In addition the Programme supervision and monitoring was implemented through specific 34 Control Gates (project reviews, 14 CFM projects, 16 OC projects and 4 lighthouse projects) executed all along the year, the elaboration of some CCA activities on KPIs and Standards in particular, the review of the technical part of MAAP (MAAP-B), the management of 6 quarterly IP Steering Committees and the follow up of the grant implementation (amendments, reporting, etc.).

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

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

13 4 Light house projects (2015) not included and 1 project closed.

Signature of grants related to the 2018 Call for proposals

During 2018, the S2R JU awarded 19 grants for a Total value of EUR 152.6 million[14]

- topics (RIA and IA) open to S2R JU Other Members with a total value of the actions of EUR 134.1 million (max S2R funding EUR 59.6 million);
- topics (RIA and IA) where the S2R JU Members are excluded from participation, with a total value of the actions of EUR 18.5 million (max S2R funding EUR 17.7 million).

For the first time, the S2R JU implemented the Lump Sum Grant Pilot to the CFM Call 2018.

Signature of procurement contracts related to 2018 Call for tenders (see for more details section 1.8-call for tenders)

- June 2018: direct service contract - Study on use of fuel cell hydrogen in railway environment - for a total value of EUR 569 500;
- October 2018: Service framework contract - Support to the ERTMS Deployment action plan - for a total value of EUR 8 000 000.

Stakeholder management and external relations have been further improved through a closer collaboration with the European Union Agency for Railways (ERA) in different areas, with the European Railway Research Advisory Council (ERRAC), as well as with the different International and European organizations and associations.

In addition, the S2R JU signed a cooperation agreement with SEESARI on 18 September 2018, and a Memorandum of Understanding (MoU) with the Czech Republic in January 2019. An agreement on a MoU with ETSI was reached at the end of 2018.

Communication has been enhanced through the participation in specific activities, workshops and events in order to promote the S2R Programme participation and inform worldwide the achievements of the S2R JU Partnership.

The achievement of the JU operational objectives contributed to finalise the ramp up phase allowing the Programme to proceed at cruise speed with an effective stakeholder engagement.

The following sections describe how these objectives have been achieved, the activities performed and the resources used. In Annex C the performances are measured against the set of agreed KPIs.

Risks

The list below refers to the risks related to the set objectives and is the result of Risk Management activities performed in 2018. Only risks that because of their criticality require continuous ED and where relevant S2R GB, attention and treatment are reported here together with the ongoing and proposed mitigating actions.

[14] Including 2 CFM projects under signature at Q1 2019

For this 2018 annual exercise, it was decided to take into consideration the Other Members' input, when communicated to the JU, and the overall exercise has been performed with the support of an external advisory company. The corresponding risks associated with the Programme activities and the financial administration of the JU, requiring continuous ED (and when relevant GB) attention, as well as the corresponding risk mitigation actions have been communicated via the S2R JU AWP 2019.

The annual risks assessment performed allowed to conclude that the average Shift2Rail risk profile presents a moderate/high net criticality. This is an indication of a higher awareness of Shift2Rail concerning (primarily) the expected higher impact of those risks on the organisation. No risk appears as having a very high or unacceptable net criticality score. This represents a positive element, considering that further actions will be implemented to decrease the risks' net criticality score (a new risk assessment will be performed mid 2019). In addition, it is important to take note that the risks with the highest impact/severity have a medium or low probability to occur.

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

Risk identified	Action Plan
Cross-project collaboration required to achieve the programme objectives may not be achieved due to 'silo-project management' or restrictions related to 'licenses', 'patents', 'IPR Member's sharing policies' or 'accessibility of past OC project results'.	• significant implication of SIWG • decoupling IP structure from AWP topics • further fostering the use of a common S2R Cooperation Tool and sharing functionalities • dedicated cross-IP meeting • IP coordinators meeting • models and guidance from S2R JU • SIWG informal conflict resolutions • simplification of legal structure for collaboration. A S2R JU Common Collaboration Agreement (Common COLA, or 'CCOLA') is under preparation. • in order to ensure connection with national activities, the JU will consider signing specific collaboration agreements with other European and international Organizations, Regions and Member States.
Delays in project execution or other impediments (e.g. staff-resource constraints) might lead to underspending of resources.	• Better monitoring of the consumption • Re-allocation of activities (Revision of activities in the Programme & MAAP) • Monitoring from conception phase of Grant Agreement (GA) until final payment (and multi-annual objective at programme level).
High staff turnover together with difficulties to attract new people (e.g. due to the general 'rivalry for talent') might result in positions being filled in with delays (increased risk during peak moments) and as a consequence leading to difficulties in getting the work done or achieving the JU's objectives; this may include a negative impact on other employees' motivation).	This risk is intrinsic to the S2R JU Staff establishment plan. Nevertheless, within the budget constraints, a career plan for staff has been prepared and business continuity is ensured. In 2018, the Governing Board adopted a revised decision on Learning and Development; implementing policy was adopted in April 2018 by the ED. Enhancing the planning of activities will allow for better risk management. Recruitment of short term resources (interim or trainees) should be aligned accordingly.
Significant cuts in the EU's budget might lead to a decrease in the JU's budget which might result in insufficient (financial) resources to realise the objectives of the JU.	The S2R JU Membership shall put in place all the measures to provide all the elements to the budget authority to reduce such a risk. The S2R JU together with the Other Members are working actively in demonstrating that the S2R Programme is already providing results (TRA, Innotrans, Demo, etc.). Moreover, the available resources will be subject to proper planning and regular follow up with Members and at IPSteCo/SIWG level, Projects control gates level, and subject to regular reporting to the GB.
Lack of adequate dissemination of results may result in suboptimal information reaching the	The S2R JU provided a series of guidelines to the projects and fostered the use of the Horizon

Risk identified	Action Plan
end-user/interested parties, which could compromise the JU's impact.	2020 instrument as the Common Dissemination Booster. Proper planning and regular follow up at IPSteCo/SIWG and projects' control gates' levels are ensured.
Characteristics of the project setup (e.g. the project execution team at a task/sub-task level belongs to one and the same private company without applying a broader scope) might result in a project outcome that represents a single company solution and is therefore non-interoperable on a broader spectrum, and is not in line with the philosophy of the JU.	Demo planning, regular follow up at IPSteCo/SIWG and projects control gates' levels are ensured.
Difficulties in obtaining the necessary authorisation(s) to organise project demonstrations might provoke a significant delay resulting in the inability to organise these demonstrations or in their partial organization.	Planning anticipation (Demo planning) and regular follow up at IPSteCo/SIWG, ERA involvement and regular reporting to GB are ensured.
Impediments during a project (e.g. changes in regulation/ non-achievement of harmonised requirements/unforeseen planning difficulties in resource planning etc.) might lead to the project not being executed in a timely and/or adequate manner, preventing S2R solutions from reaching the market.	Ensure the following actions: • appropriate implementation/exploitation plans in GA and at TD/IP level • national migration strategies • investigate possible instrument to support deployment at EU level and implement S2R JU strategy/support • regular follow up of S2R standardisation roadmaps • coordination with RASCOP, and also directly with ERA, CEN/CENELEC/ETSI • Regular follow up at IPSteCo/SIWG • regular updated with URID WG • Monitoring of the regulatory environment
The rollout of the developed technologies is not taken into account, but should be already considered at the design stage to reach high market acceptance in a short time-frame.	Project design should consider the identification of a proper business case to accelerate market acceptance, within the overall partnership of the S2R JU.
Risk that a lengthy process leading to a possible S2R2 Programme may negatively impact the ongoing R&I activities, with, on the one hand, Members looking at the future instead of investing on current R&I activities, and, on the other hand, de-commitment in case of negative decision	Transparent and timely involvement of the membership in the next Multiannual Financial Framework (MFF) preparation

1.2. R&I activities: the S2R Programme

The S2R MAAP translates the S2R Master Plan into detailed, result-oriented R&I activities to be performed to start delivering the S2R vision as from 2016 onwards.

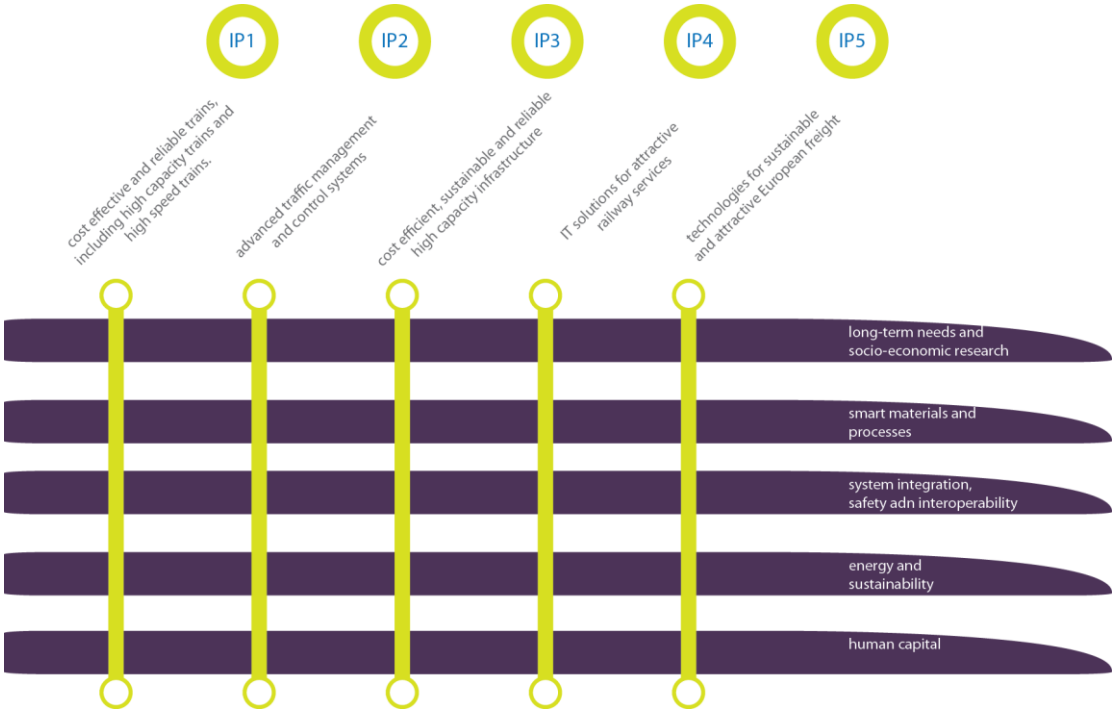
Addressing the challenges opens three opportunities for the railway:

- To become the backbone of current and future mobility concepts (e.g. mobility as a service-MaaS) and on-demand future logistics;
- To identify and establish new market segments for exploitation;
- To enhance the overall competitiveness of the industry, both in Europe and globally.

This is what the Regulation tasks the S2R JU to do when requesting it to manage all rail-focused research and innovation actions co-funded by the Union. Developing the Innovation Capabilities requires a coordinated effort among different rail and non-rail stakeholders to drive innovation at levels in Europe. The S2R JU and its Programme are designed to make a decisive contribution to delivering the essential knowledge and innovation that will provide the building blocks to develop the Innovation Capabilities.

The work conducted within the S2R framework is structured around five asset-specific Innovation Programmes (IPs), covering the different structural (technical) and functional (process) sub-systems of the rail system. These five IPs are supported by work in five cross-cutting areas (CCA) covering themes that are of relevance to each of the projects and which address the interactions between the IPs and the different subsystems:

- IP1: Cost-efficient and Reliable Trains, including high-capacity trains and high-speed trains
- IP2: Advanced Traffic Management & Control Systems
- IP3: Cost-efficient, Sustainable and Reliable High-Capacity Infrastructure
- IP4: IT Solutions for Attractive Railway Services
- IP5: Technologies for Sustainable & Attractive European Freight.



With a holistic approach, the role of the S2R JU is also to ensure that interactions between the various IPs are adequately considered and managed, as technological developments in one part of the system could lead to changes in performance, or even create barriers, in other parts. In addition, cross cutting

activities include research on long-term economic and societal trends such as customer needs and human capital and skills, which must be taken into account by the different IPs.

Different types of activities contribute to the Programme development, including:

- studies, fundamental and "blue-sky" research (TRL 0 – 2),
- scientific/applied research and laboratory demonstrations (TRL 3 – 6)
- operational demonstrations and innovation activities (TRL 6-7)
- other supporting activities.

In addition to these activities that are co-funded by the S2R JU and conducted within the scope of the S2R Programme, the Other Members are required to conduct Additional Activities with a view to leveraging the effect of the overall R&I. These Additional Activities are not eligible for financial support from the S2R JU but must contribute directly to the broader objectives set out in the Master Plan.

1.3. Call for proposals and grant information

Considering the annual budget availabilities and the R&I activities planned in the S2R MAAP, the S2R Programme is implemented through combined and interdependent multi-annual Projects. This structured interdependence of S2R Projects reflects the Technological Demonstrators (TD) and Work Areas (WA) approach set within the Programme and each IP and CCA.

The following table summarises the amounts and topics available under the 2018 Call, against Budget Commitments of 2018. This Call, based on the amended Annual Work Plan 2018, was launched on 11 January 2018 and awarded by the JU following the Decision of the S2R GB of 12 October 2018[15]. It is presented showing the values of the topics open to Other Members (CFM) and those excluding them (OC).

Call	Type	Estimated S2R JU funding	Number of topics
H2020-S2RJU-2018-01	CFM	59.6 M€	7
	OC	19.1 M€	11

The total number of proposals received in response to the call for proposals was 39:

Call	Type	Number of proposals	Number of topics
H2020-S2RJU-2018-01	CFM	7	7
	OC	32	11

The total S2R JU contribution requested by all the submitted proposals amounted to EUR 108.2 million compared to EUR 78.7 million available for funding:

[15] Governing Board Decision No 17/2018 of 12 October 2018 https://shift2rail.org/wp-content/uploads/2018/10/Decision-17-2018-S2R-JU-call-2018.pdf

Call	Type	Requested S2R JU funding	Estimated S2R JU funding available
H2020-S2RJU-2018-01	CFM	59.6M€	59.6 M€
	OC	48.6 M€	19.1 M€

On 12 October 2018, the S2R GB agreed with the proposal of the ED to award grants which resulted in the following data:

Call	Type	Total Project Cost	S2R funding	IKOP	Other contributions to R&I
H2020-S2RJU-2018-01	CFM	134.1 M€	59.6 M€	74.5 M€	
	OC	18.5 M€	17.7 M€		0.8 M€[16]
	TOTAL	**152.6 M€**	**77.3 M€**	**74.5 M€**	**0.8 M€**

The S2R JU Other Members submitted project proposals to cover all the 7 call topics open to them.

The value of activities to be performed by the S2R JU Other Members in the coming years in respect of this call amounts to EUR 134.1 million that will be co-funded by the S2R JU up to EUR 74.5 million. These projects normally started on 1 December 2018, however for some projects an earlier start date was agreed to guarantee continuity; two grants are under signature at the beginning of 2019.

Following the grants awarded form the call 2018 and those in 2016 and 2017, the overall value of Other Members ongoing projects is EUR 367.9 million which are expected to be co-funded by the S2R JU up to EUR 163.5 million.

The applicants to the OC covered the 11 topics open to them. The value of the activities to be performed by the awarded consortia amounts to EUR 18.5 million, EUR 17,7 million to be funded by the S2R JU up to 100% or 70% of the eligible direct costs, subject to respectively being RIA or IA actions. The overall OC amount of ongoing projects, 2016 -2018 Calls, is EUR 62.9 million. The S2R GB on 12 October 2018 approved the list of actions selected for funding proposed by the Executive Director; evaluation result letters were sent to all applicants on 17 October 2018.

Call topics open to S2R JU Other Members and Awarded projects

TOPIC	ACRONYM	TITLE	PROJECT VALUE	GRANT	IN KIND CONTR.	START DATE	END DATE
S2R-CFM-IP1-02-2018	CONNECTA 2	CONtributing to Shift2Rail's NExt generation of high Capable and safe TCMS. PhAse 2.	10.6	4.7	5.9	01/10/2018	31/03/2021

[16] This is the difference between the Research and Innovation activities declared by a beneficiary and the funding received from the JU.

S2R-CFM-IP5-01-2018	FR8RAIL II	Digitalization and Automation of Freight Rail	12.4	5.5	6.9	01/05/2018	30/04/2021
S2R-CFM-IP3-01-2018	IN2TRACK2	Research into enhanced track and switch and crossing system 2	30.2	13.4	16.8	01/11/2018	30/04/2021
S2R-CFM-IP4-01-2018	MaaSive	Passenger service platform specifications for an enhanced multi-modal transport eco-system including Mobility as a Service (MaaS)	11.7	5.2	6.5	01/11/2018	28/02/2021
S2R-CFM-IP1-01-2018	PINTA 2	IP1 Traction TD1 and Brakes TD5 – Phase 2	28.5	12.7	15.8	01/09/2018	30/11/2020
S2R-CFM-CCA-01-2018	PLASA 2	Smart Planning and Virtual Certification	1.9	0.8	1.0	01/09/2018	31/10/2020
S2R-CFM-IP2-01-2018	X2Rail-3	Advanced Signalling, Automation and Communication System (IP2 and IP5) – Prototyping the future by means of capacity increase, autonomy and flexible communication	38.9	17.3	21.6	01/12/2018	30/11/2021
TOTAL			**134.1**	**59.6**	**74.5**		

Open call topics for S2R JU non-Members and awarded projects

TOPIC	ACRONYM	TITLE	PROJECT VALUE	GRANT	START DATE	END DATE
S2R-OC-IP3-01-2018	ASSETS4RAIL	Measuring, monitoring and data handling for railway assets; bridges, tunnels, tracks and safety systems	5.5	4.7	01/12/2018	31/05/2021
S2R-OC-IPX-03-2018	B4CM	Blockchains as a Distributed Ledger for Attribution of RCM Data in Rail	0.1	0.1	01/12/2018	30/11/2021
S2R-OC-IP2-03-2018	EMULRADIO4RAIL	Emulation of radio access technologies for railway communications	0.7	0.7	01/12/2018	31/05/2020
S2R-OC-IPX-01-2018	FLEX-RAIL	Paradigm shifts for railway – Technology uptake strategies for a lean, integrated and flexible railway system	1.1	1.1	01/12/2018	30/06/2021
S2R-OC-IP2-02-2018	GATE4RAIL	GNSS Automated Virtualized Test Environment for RAIL	1.0	1.0	01/12/2018	30/11/2020
S2R-OC-IP5-01-2018	M2O	MAke RAil The HOpe for protecting Nature 2 future OPERATION	0.6	0.6	01/12/2018	30/11/2020
S2R-OC-IP2-01-2018	MOVINGRAIL	MOving block and VIrtual coupling New Generations of RAIL signalling	1.3	1.3	01/12/2018	31/12/2020
S2R-OC-IPX-03-2018	MVDC-ERS	Flexible medium voltage DC electric railway systems	0.1	0.1	01/12/2018	31/11/2021
S2R-OC-IP1-01-2018	SAFE4RAIL-2	Smart Planning and Virtual Certification	4.0	4.0	01/10/2018	30/04/2021
S2R-OC-IP4-02-2018	SHIFT2MAAS	Shift2Rail IP4 enabling Mobility as a Service and seamless passenger experience	1.5	1.5	01/12/2018	31/12/2020
S2R-OC-IP4-01-2018	SPRINT	Semantics for PerfoRmant and scalable INteroperability of multimodal Transport	2.0	2.0	01/12/2018	31/12/2020
S2R-OC-IPX-02-2018	TER4RAIL	Transversal Exploratory Research Activities for Railway	0.5	0.5	01/12/2018	30/11/2020
TOTAL			**18.5**	**17.7**		

For the open call projects, the respective grant agreements were signed in November 2018 and all the activities normally started on 1 December 2018. Two Other Members' Projects were not signed in 2018, although they both requested for an early start date in 2018, due to administrative issues the Other Members' encountered.

1.4. Progress against KPIs / Statistics (Annex C)

The Key performance Indicator results for the year 2018 are presented in Annex C. The JU has taken into its scoreboard all Horizon 2020 indicators, which have been established for the entire Research family by the Commission, to the extent they are applicable to the JU and provide meaningful results.

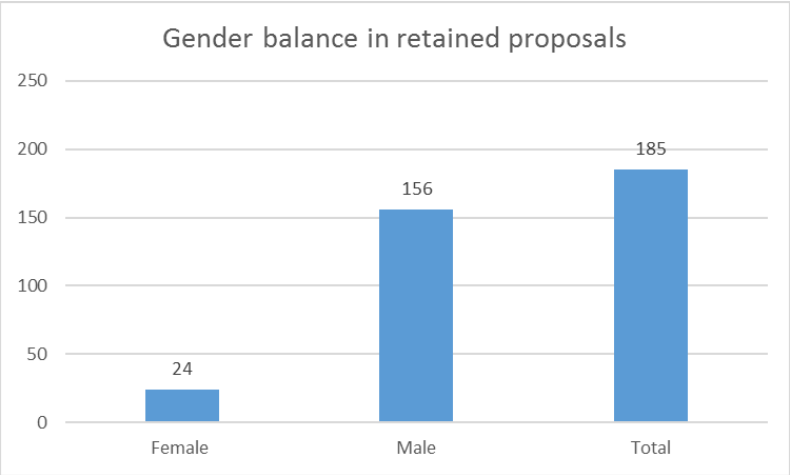
Comments to some individual indicators are provided in the table in the Annex or in the related section of the report, to which the indicators refer. In addition, the S2R JU is presenting more detailed results of its performance monitoring in specific areas, e.g. key figures provided in the section dealing with the call for proposals and the following evaluation process.

Within the context of the CCA activities, during 2018 the S2R JU continued the development of a KPI model to measure the contribution of the R&I activities to its Regulation objectives. This work is still ongoing and the first results of the S2R KPI model have been presented to the Governing Board on 4 December 2018. Refined figures have been annexed to the AWP2019 and are shown in table IV.

1.5. Evaluation: procedures and global evaluation outcome, redress, statistics

The evaluation process took place in April and May 2018. The proposals were evaluated by 29 external experts from 13 different member states (22 men (73%) and 8 women (27%)). They were divided in five different panels, with a dedicated rapporteur for each panel. An independent observer was appointed to monitor the whole process. For the evaluation of the Lump Sum Grant approach three independent financial experts provided support to the experts in charge. The consensus meetings in June 2018 were moderated by staff from the S2R JU with additional observers present.

The total number of proposal evaluated was 39, and 19 were retained for funding with a success rate of 48.7%. The number of participants in the evaluated proposals was 331, represented by 59 female, 267 male and 5 with no gender information provided. 185 participants were retained for funding with a success rate of 55.9%. Out of the retained participants in terms of co-signatory of proposals, 24 were female (success rate 40.7%), 156 were male (success rate 58.4%) and 5 with no gender information provided. Out of the 19 retained proposals for funding with 19 coordinators involved, 4 were female (success rate 57.1%), 14 were male (success rate 45.2%), and 1 not specified. On supported researchers no data are available yet. .



SMEs participating were 76 and 40 were retained for funding, with a very positive success rate of 52.6%. SMEs represent respectively the 23.0% and the 21.6% of total and retained participants for funding. SME's represent 31.5% of the entities selected in the OC projects.

From a geographical perspective, 24 Countries participated to the call, 21 were from the UE and 3 from Associated Countries. After the evaluation, the participating Countries to the retained project for funding were 21 of which 19 from EU and 2 from Associated Countries (see details in ANNEX C).

The majority of the participation to the Call 2018 is from the EU-15 Member States. To facilitate a stronger participation from the EU-13 Member States it is important to integrate R&I activities with demonstration and deployment activities with sector involvement in a future programme agenda.

1.6. Activities carried out in Grant Agreements

In May 2015, while the S2R JU was still in its setup phase, under the Horizon 2020 Transport Programme and its call 2014, EUR 52 million were awarded by the European Commission to the so-called four "S2R Lighthouse Projects", lightening the way towards the Innovation Programmes at the heart of Shift2Rail. One project, ROLL2RAIL (LP), was finalised in 2018.

Project Acronym	Topic from H2020 Call 2014	Linked IP / CCA	Grant (€) million	Start date	Duration	Management [17]
IN2RAIL	MG-2.1	IP3, CCA (IP2)	18.0	01/05/2015	36	DG MOVE
IT2RAIL	MG-2.2	IP4	12.0	01/05/2015	36	DG MOVE
ROLL2RAIL	MG-2.3	IP1, CCA (IP2)	16.0	01/05/2015	30 closed	DG RTD
Smart-Rail	MG-2.2	IP5	6.0	01/05/2015	36	DG MOVE
TOTAL			52.0			

The collaboration between the project Coordinators of the S2R Lighthouse projects and the members of the IP Steering Committees should allow the transfer and the use of the results by S2R Members

[17] The overall management is performed by DG MOVE and DG RTD respectively, while the S2R JU performing a technical oversight and ensuring consistencies between the lighthouse projects and the projects stemming from the S2R calls

Projects. Today the four projects appear to be fully integrated within the S2R Programme. Where there would be any issue on use of results, the S2R JU will make use of the grant provisions in terms of access rights of the Union to the results of the projects for research and policy purposes.

Beside the Lighthouse Projects, by the end of 2018, 60[18] projects were ongoing (25 CFM and 35 OC); 50 projects were distributed on the 5 Innovation Programmes, and 10 projects on the Cross Cutting Activities as follow:

IP1: Cost-efficient and Reliable Trains, including high-capacity trains and high-speed trains

Project Title	Call Reference	Period	Project Value (signed GA)
CONNECTA	S2R-CFM-IP1-02-2016	01/09/2016 - 31/08/2018	€ 12 333 046
PINTA	S2R-CFM-IP1-01-2016	01/09/2016 - 30/11/2018	€ 28 855 184
PIVOT	S2R-CFM-IP1-01-2017	01/10/2017 - 30/09/2019	€ 18 901 895
CONNECTA-2	S2R-CFM-IP1-02-2018	01/10/2018 - 31/03/2021	€ 9 687 622
PINTA-2	S2R-CFM-IP1-01-2018	01/09/2018 - 30/11/2020	€ 28 534 184
Mat4Rail	S2R-OC-IP1-01-2017	01/10/2017 - 30/09/2019	€ 3 495 216
RUN2RAIL	S2R-OC-IP1-02-2017	01/09/2017 - 31/08/2019	€ 2 732 464
SAFE4RAIL	S2R-OC-IP1-02-2016	01/10/2016 - 30/09/2018	€ 6 681 211
SAFE4RAIL-2	S2R-OC-IP1-01-2018	01/10/2018 - 30/04/2021	€ 3 991 632

IP2: Advanced Traffic Management & Control System

Project Title	Call Reference	Period	Project Value (signed GA)
X2Rail-1	S2R-CFM-IP2-01-2015	01/09/2016 - 31/08/2019	€ 45 003 870
X2Rail-2	S2R-CFM-IP2-01-2017	01/09/2017 - 31/08/2020	€ 30 152 828
X2Rail-3	S2R-CFM-IP2-01-2018	01/12/2018 - 30/11/2021	€ 38 728 459
ASTRAIL	S2R-OC-IP2-01-2017	01/09/2017 - 31/08/2019	€ 1 797 307
CYRail	S2R-OC-IP2-01-2015	01/10/2016 - 30/09/2018	€ 1 498 150
ETALON	S2R-OC-IP2-02-2017	01/09/2017 - 31/01/2020	€ 1 699 999
MISTRAL	S2R-OC-IP2-03-2015	01/11/2016 - 31/10/2018	€ 499 282
VITE	S2R-OC-IP2-02-2015	01/11/2016 - 31/10/2018	€ 947 757
EMULRADIO4RAIL	S2R-OC-IP2-03-2018	01/12/2018 - 31/05/2020	€ 748 097
GATE4RAIL	S2R-OC-IP2-02-2018	01/12/2018 - 30/11/2020	€ 1 019 994
MOVINGRAIL	S2R-OC-IP2-01-2018	01/12/2018 - 31/12/2020	€ 1 299 135

IP3: Cost-efficient, Sustainable and Reliable High-Capacity Infrastructure

Project Title	Call Reference	Period	Project Value (signed GA)
IN2SMART	S2R-CFM-IP3-02-2016	01/09/2016 - 31/08/2019	€ 16 405 562
In2Stempo	S2R-CFM-IP3-01-2017	01/09/2017 - 31/08/2022	€ 13 439 981
In2Track	S2R-CFM-IP3-01-2016	01/09/2016 - 28/02/2019	€ 6 366 942
Fair Stations	H2020-S2RJU-OC-2017	01/09/2017 - 31/08/2019	€ 1 199 875
IN2DREAMS	H2020-S2RJU-OC-2017	01/09/2017 - 31/08/2019	€ 2 195 715
S-CODE	S2R-OC-IP3-01-2016	01/11/2016 - 31/10/2019	€ 4 999 771

[18] Four Lighthouse projects (2015) not included. One Open Call project, Dynafreight in IP5, has been finalised.

MOMIT	H2020-S2RJU-OC-2017	01/09/2017 - 31/08/2019	€ 599 172
ASSETS4RAIL	S2R-OC-IP3-01-2018	01/12/2018 - 31/05/2021	€ 5 506 631

IP4: It Solution for Attractive Railways Services

Project Title	Call Reference	Period	Project Value
ATTRACKTIVE	S2R-CFM-IP4-02-2015	01/09/2016 - 31/12/2018	€ 5 256 030
CO-ACTIVE	S2R-CFM-IP4-01-2015	01/09/2016 - 31/12/2018	€ 7 818 365
COHESIVE	S2R-CFM-IP4-02-2017	01/09/2017 - 30/06/2022	€ 4 039 492
CONNECTIVE	SR2-CFM-IP4-01-2017	01/09/2017 - 30/06/2022	€ 7 906 243
GoF4R	S2R-OC-IP4-01-2016	01/11/2016 - 31/10/2018	€ 2 000 000
My-TRAC	S2R-OC-IP4-01-2017	01/09/2017 - 31/08/2020	€ 3 494 476
ST4RT	S2R-OC-IP4-02-2016	01/11/2016 - 31/10/2018	€ 1 000 000
SHIFT2MAAS	S2R-OC-IP4-02-2018	01/12/2018 - 31/12/2020	€ 1 499 906
SPRINT	S2R-OC-IP4-01-2018	01/12/2018 - 31/12/2020	€ 1 999 500

IP5: Technologies for Sustainable & Attractive European Freight

Project Title	Call Reference	Period	Project Value
ARCC	S2R-CFM-IP5-02-2015	01/09/2016 - 31/08/2019	€ 3 600 360
FFL4E	S2R-CFM-IP5-03-2015	01/09/2016 - 31/08/2019	€ 3 375 017
FR8HUB	S2R-CFM-IP5-01-2017	01/09/2017 - 31/08/2020	€ 9 900 990
FR8RAIL	S2R-CFM-IP5-01-2015	01/09/2016 - 31/08/2019	€ 7 826 783
FR8RAILII	S2R-CFM-IP5-01-2018	01/05/2018 - 30/04/2021	€ 12 450 390
INNOWAG	S2R-OC-IP5-03-2015	01/11/2016- 30/04/2019	€ 1 500 562
OptiYard	S2R-OC-IP5-01-2017	01/10/2017 - 30/09/2019	€ 1 499 900
SMART	S2R-OC-IP5-01-2015	01/10/2016 - 30/09/2019	€ 999 599
M2O	S2R-OC-IP5-01-2018	01/12/2018 - 30/11/2020	€ 599,955

IPX:

Project Title	Call Reference	Period	Project Value
B4CM	S2R-OC-IPX-03-2018	01/12/2018 - 30/11/2021	€ 124 951
FLEX-RAIL	S2R-OC-IPX-01-2018	01/12/2018 - 30/06/2021	€ 1 099 230.00
MVDC-ERS	S2R-OC-IPX-03-2018	01/12/2018 - 30/11/2021	€ 125 000
TER4RAIL	S2R-OC-IPX-02-2018	01/12/2018 - 30/11/2020	€ 499 992

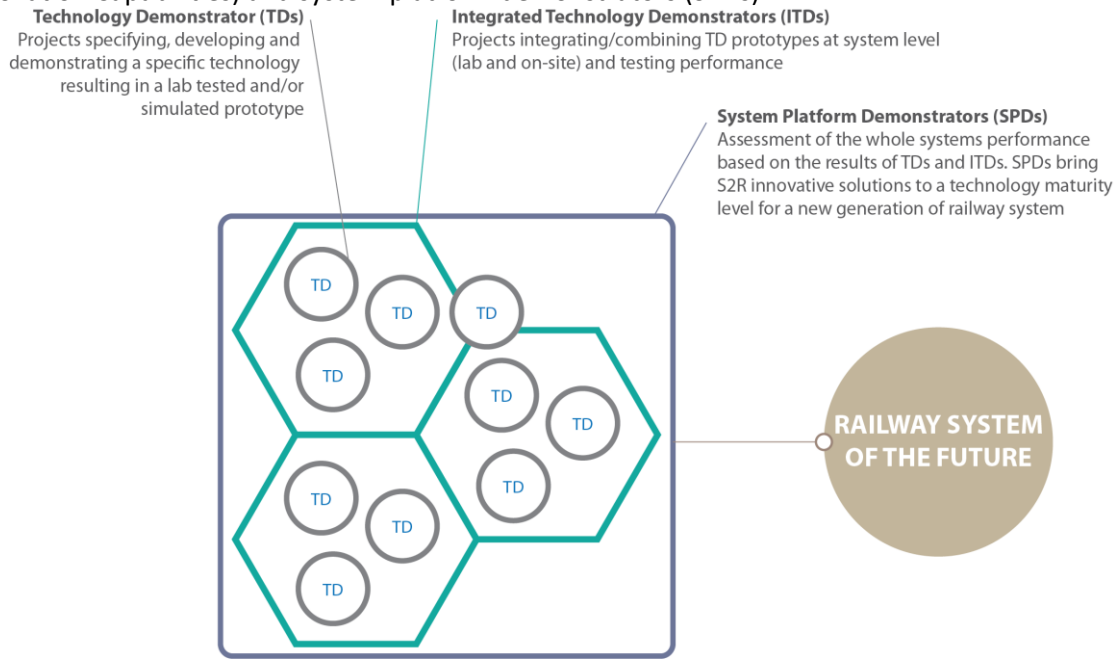
CCA: Cross Cutting Activities

Project Title	Call Reference	Period	Project Value
FINE1	S2R-CFM-CCA-02-2015	01/09/2016 - 31/08/2019	€ 3 017 282
IMPACT-1	S2R-CFM-CCA-01-2015	01/09/2016 - 28/02/2018	€ 674 958
IMPACT-2	S2R-CFM-CCA-01-2017	01/09/2017 - 30/08/2022	€ 7 096 428
PLASA	S2R-CFM-CCA-03-2015	01/09/2016 - 31/08/2018	€ 786 349
PLASA-2	S2R-CFM-CCA-01-2018	01/09/2018 - 31/10/2020	€ 1 853 384
DESTINATE	S2R-OC-CCA-03-2015	01/11/2016 - 31/10/2018	€ 1 271 812
GoSAFERAIL	S2R-OC-CCA-04-2015	01/10/2016 - 30/09/2019	€ 1 298 750
NEAR2050	S2R-OC-CCA-01-2015	01/10/2016 - 31/03/2018	€ 399 891
OPEUS	S2R-OC-CCA-02-2015	01/11/2016 - 30/04/2019	€ 797 130
SMaRTE	S2R-OC-CCA-01-2017	01/09/2017 - 31/08/2019	€ 769 959

Closed Project related to Open call topics for S2R JU non-Members

TOPIC	ACRONYM	TITLE	PROJECT VALUE	GRANT	START DATE	END DATE
S2R-OC-IP5-02-2015	Dynafreight	Innovative technical solutions for improved train DYNAmics and operation of longer FREIGHt Trains	0.9	0.9	01/11/2016	31/06/2018

The practical demonstration of S2R R&I activities is being carried out using a combination of single technology demonstrators (TDs), integrated technology demonstrators (ITDs and resulting into the Innovation Capabilities) and system platform demonstrators (SPDs).



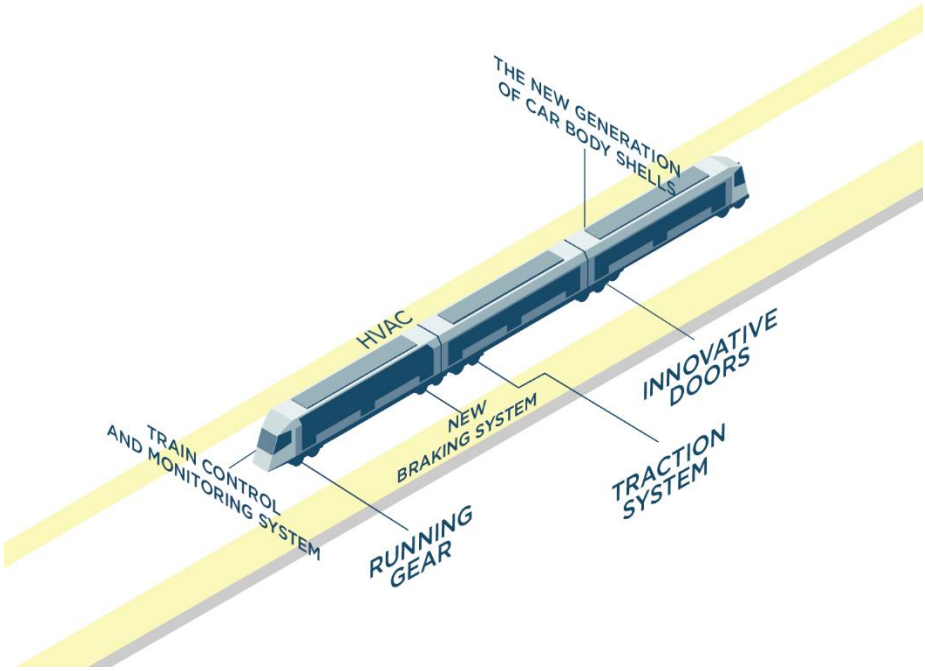
The following sections illustrate the progress achieved in the Technology Demonstrators at the end of 2018. The contributions from the TDs to the delivery of the innovation capabilities (as mentioned in the MAAP (part A) will be elaborated in the MAAP (part B), draft to be published in May 2019.

1.7. Towards delivering the S2R Programme

This section presents by Innovation Program the progress of ongoing projects implementing the R&I activities measured through the achievements in the development of Technology Demonstrators. A market correspondence table per TD will be published in the MAAP (draft Part B) in May 2019.

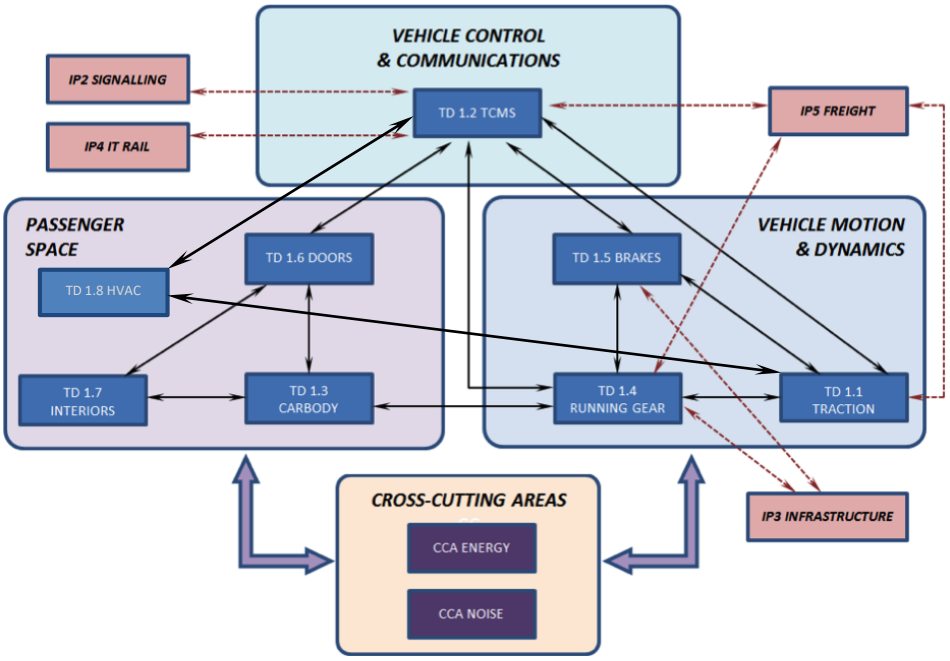
1.7.1. IP1 Cost-efficient and Reliable Trains, including high-capacity trains and high speed trains

The pictures below gives a visual perception on where the TDs will introduce improvements



IP1 will lead to a new generation of passenger trains, lighter, automated, more energy and cost efficient while satisfying customers' needs.
In the review process of IP1 a new area of work is included to research on how to address new legislation on the matter of HVAC.

The picture below shows the TDs connections and dependencies within IP1 and with other IPs and CCA.



TD 1.1. Traction systems Demonstrator

The TD develops new traction components and subsystems using mainly silicon carbide (SiC) technologies leading to new architectures. The work aims at producing Technology Demonstrators (including a traction system based on independently rotating wheels) to implement into a Metro, a Regional train and a High-Speed Train (HST). The SiC application opens up many new opportunities improvements in this key technology area. Besides improved energy efficiency, it gives other optimisation possibilities improving customer value, such as noise reduction and more efficient cooling.

TD progress

TD1.1 builds on the progress made by Pinta project and ongoing action on PINTA2 (CFM projects).

The TD results have reached in 2018 a maturity of TRL 4/5 on traction, they include among others:

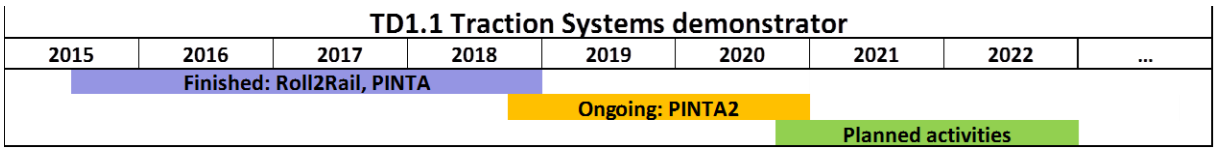
- Prototypes development and test in lab environment of SiC based Traction components for tramways, metro, sub-urban and regional trains, preparing further demonstration on trains (Tramways) or in AWP2020 work (at least Metro and Regional demos). On HST difficulties have been met to find a supplier of Wheel motor prototype.
  The KPIs progress confirms that most of the targets set for the end of S2R are achievable. As an example, the main benefits for Regional platform are the reduction of energy consumption (-9%) at train level, traction maintenance cost (-20%), reliability improvement (+15%), weight/ volume savings (-14%/ -3%). Important noise savings are also reported on 2018 work (on tramway and sub-urban applications).

- On Acoustic noise, the coupling of electrical, magnetic and mechanical models has been done allowing fast and accurate predictions of cooling noise by Computational Fluid Dynamics. On EMI (Electromagnetic Interference) noise, the implementation of a common model and good correlation of the simulation results of currents with the lab testing result are confirming a good potential on cost saving during the validation process in future railways projects.

- On traction reliability, the main achievement is the development of power semiconductor lifetime models for forecasting of device lifetime. That could be used in future predictive maintenance algorithms to reduce maintenance costs. The evaluation of propulsion system architectures for high availability and failure mode detection for high availability have been achieved.

- On virtual validation and certification, the work is on track to save up to 30% of the validation cost. 74 physical traction tests are potentially replaceable by virtualization. Further scientific work and normative effort is needed to make virtual tests replacing physical tests.

The TD is running, in general, according to the schedule despite a slight delay on Wheel motor development for HST application and difficulties to purchase components (high voltage semiconductors).



In 2018, 24 deliverables in PINTA were planned and delivered. No deliverable for PINTA-2 were expected. Next batch of documents will be issued by PINTA-2 at the very end of 2019 (mostly design and test reports). The overall progress is in line with the plan. Since the beginning, TD1.1 has reported having accomplished 95% of the planned work up to the end 2018, which represents 41% of the overall TD. The TD Traction work will continue in 2019 with the project PINTA2 in order to develop and test up to TRL 5/6 components for new traction systems, paving the way for future TRL 7 demonstrations in S2R.

TD 1.2. Train control and monitoring system (TCMS)

The development of a new-generation TCMS (Train Control and Monitoring System) will allow overcoming current bottlenecks caused by physically coupled trains. The new drive-by-data concept for train control, along with wireless information transmission, aims at making new control functions possible; it involves interaction between vehicles and consists, providing high safety and reliability levels with very simple physical architectures.

TD Progress

The TD1.2 builds on the progress made by CONNECTA, CONNECTA-2, Safe4RAIL and Safe4RAIL-2 projects.

In 2018, the TD reached the definition of general specifications for the next generation TCMS, including a comprehensive list of use cases and the corresponding high level system architecture.

In addition, wireless technologies to train communication network solutions have been incorporated with the Specification of the Wireless Train Backbone and contribution to IEC 61375-2-6 for train-to-ground communications.

The Drive-by-Data concept reached a maturity level of TRL 2/3, connecting safety functions up to SIL4 and support of “fail-safe” and “fail-tolerant” principles. A definition of optimal train network for TCMS & OMTS (On-board Multimedia and Telematics Services) as well as ECN/ETB (Ethernet Consist Network / Ethernet Train Backbone) conformance tests has been proposed with a related contribution to the IEC61375-2-8.

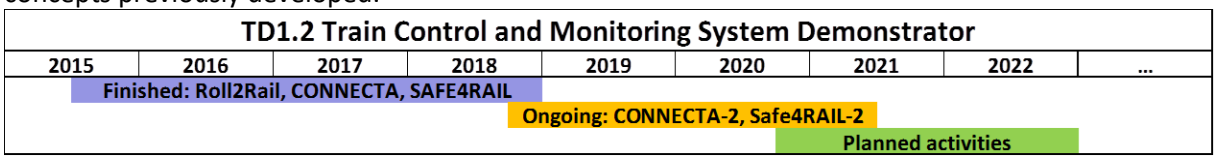
Three application profiles (Doors, HVAC, Bogie Monitoring System) has been defined and the integration of two of these profiles in the TCMS will be brought at higher TRL.

TD1.2 finalized his definition of the Functional Open Coupling concept, its architecture and protocols. This concept will be used as a basis for implementation in the ongoing project.

A successful demonstration of two tramways virtually coupled and moving in a coordinate way has been presented at InnoTrans 2018.

The TD also partially implemented a simulation framework and its tooling in which all subsystems of the train can be simulated, allowing remote and distributed testing including hardware in-the-loop through heterogeneous communication networks.

A joint CONNECTA and Safe4RAIL final conference was held in September 2018. CONNECTA2 and Safe4RAIL2 have started in October 2018 their activities to bring at higher TRL level the proof of concepts previously developed.



In 2018, 15 deliverables in CONNECTA were planned and delivered. 14/15 deliverables have been issued by SAFE4RAIL during this period. No deliverable for CONNECTA2 and SAFE4RAIL2 were expected. Next batch of documents will be issued by CONNECTA2 and SAFERAIL2 Q1/Q2 2019 (New requirements, Lab test specifications). The overall progress is in line with the plan. TD1.2 is estimated having accomplished around 95% of the planned work up to end 2018, which represents 45% of the overall TD progress.

TD 1.3 Car body shell

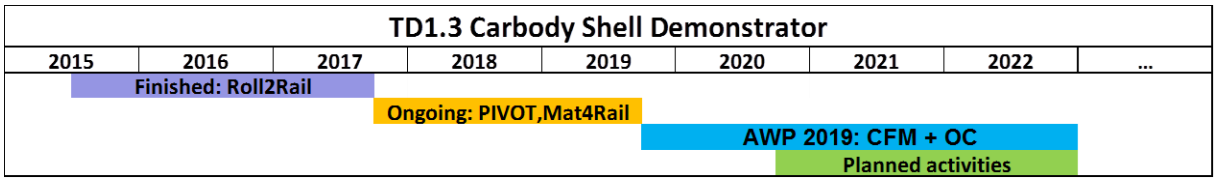
The new generation of car body shells using composite or other lightweight materials will be a step change in the sector, leading to significantly lighter vehicles that carry more passengers within the same axle load constraints, use less energy and have a reduced impact on rail infrastructure.

TD Progress

The TD1.3 builds on the progress made by PIVOT and Mat4Rail projects.

In 2018 the TD has delivered the technical specifications of the different demonstrators taking into account structural criteria, Electromagnetic Compatibility (EMC) requirements, thermal requirements or the maintenance of the future hybrid structures. Four different partial and full demonstrators have been defined (Metro, Tramway, Regional and High Speed), covering different range of products and conditions. The main drivers for the developments was weight and cost reduction, through functional integration and simplification of the assemblies. Finites Elements Analysis (FEA) on the defined models have been conducted, applying different load cases according to the specifications mentioned above. These preliminary models defines the loads paths to provide the engineers with enough information to identified areas to be reinforced and the most adequate way to split the demonstrators using the composite manufacturing processes.

The TD has been working in 2018 on the development of new resins and composites for railway structural application that meet fire, mechanical and cost requirement. 24 different types of composites suitable for car body application were selected, 50% of them being manufactured and tested, providing mechanical characterization of these composites. 3 joint concepts for refitting have been developed and will be evaluated in terms of complexity, industrial readiness, costs and flexibility. Together with the previous activities, risk analysis and methodologies for the introduction of new material in railway car bodies have started to pave the way for the authorization for future testing on track.



In 2018, 3 deliverables in MAT4RAIL were planned and delivered while only 1 deliverable has been issued by PIVOT out of the 2 forecasted during this period. Next batch of documents will be issued by PIVOT and MAT4RAIL early 2019 (Selection of manufacturing process). The overall progress is in line with the plan. TD1.3 is estimated having accomplished around 90% of the planned work up to end 2018, which represents 25% of the overall TD.

TD 1.4 Running gear

TD 1.4 will develop innovative combinations of new architectural concepts, new actuators in new lighter materials leading to new functionalities and significantly improved performance levels with the possibility of vibration energy recovery. A mechatronic bogie able to steer through points and crossings will open huge possibilities for a new design philosophy in collaboration with IP3.

TD Progress

The TD1.4 builds on the progress made by PIVOT and RUN2RAIL.

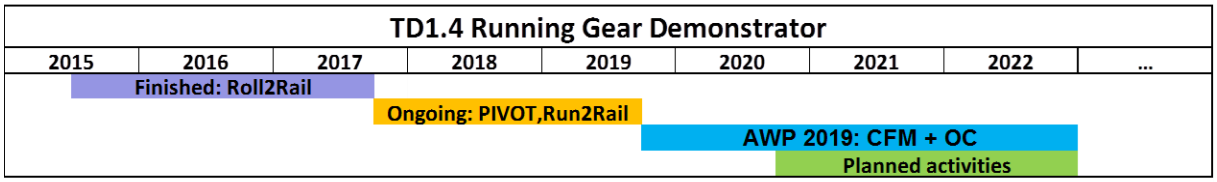
In 2018, the development on a health monitoring system for CBM for running gear & infrastructure has progressed according to the planning. The requirements and the architecture are defined. The hardware is produced. The performance of the different systems and their potential is under analysis. Regarding Active Suspension and Control technology activities some requirements of recent TSI connected with static/dynamic tests, which have to be performed during the certification, are investigated and system requirements, validation process and testing were analysed. Both projects are working on this topic from different perspective.

In 2018 the TD has set the requirements to proceed testing the noise reduction through suspension characterisation. This work stream will provide valuable input to future requirements related to noise and vibrations since the running gear is the major contribution to pass-by noise at most normal running speeds.

State of art of Carbon Fiber Reinforced Polymer materials used in other sectors was analysed. A bogie component (Antenna Beam) out of composite material was produced and presented at the InnoTrans 2018 with significant weight reduction (13 kg vs 60kg for conventional solution).

Furthermore, a wheel prototype for Metro bogie with an innovative design has been manufactured out of conservative material (10% weight reduction + improved mechanical characteristics). The Austempered Ductile Iron (ADI) spoke wheel is bench tested and was also presented at InnoTrans 2018.

The activities linked to Virtual Certification only started at the end of 2018 and did not produce any significant results available so far.



In 2018, 1 deliverable in PIVOT was planned and delivered. 5/6 deliverables have been issued by RUN2RAIL during this period. Next batch of documents will be issued by PIVOT and RUN2RAIL in Q1/Q2 2019 (report on new material/manufacturing process, virtual test method). The overall progress is in

line with the plan. TD1.4 is estimated having accomplished around 95% of the planned work up to end 2018, which represents 25% of the overall TD.

TD 1.5 Brakes

The TD on new braking systems aim is to provide braking systems with higher brake rates and in particular to improve performance.

In IP1, the work on brakes is combined with traction innovations, so that the next generation of passenger rolling stock will be able to offer improvements in acceleration and deceleration rates, leading to greater overall line capacity for trains.

TD Progress

The TD1.5 builds on the progress made by CONNECTA, SAFE4RAIL, PINTA, PIVOT and PINTA-2 projects.

In 2018 the TD defined the high level Electro Mechanical Brake specifications. The use of EM-Brake will lead to a better management of braking forces, an enhanced reliability of the system and LLC reduction in a wide range of railway application.

In the field Friction pairing, analysis of material pairing for brake disks made of steel followed by a test specification as a guideline for further investigations in 2019 has been done. The selection of steel materials and designs for brake disks in combination with the appropriate brake pad was agreed in consideration with the main objectives of S2R, increasing the lifetime of the components, reducing the weight and lower the wear.

Activities on Virtual Certification started with the identification and assessment of fields of application related to the brake. A concept definition of a basic architecture for virtual certification and validation of brake systems and their components has also been produced.

In 2018, the TD focused particularly on the concept definition of a Train Reference Brake Architecture as well as on a Safety assessment for the new braking system. The work was completed with a development of the Electronic Distributor Valve (EDV) hardware device that will contribute to improve brake performance in safety relevant braking functions using High SIL Electronics, and thus to an optimization of the braking distances in safety braking. Initial results show that the defined new train reference brake architecture creates the opportunity to reduce the number of sophisticated pneumatic components which leads, according to the carried out LCC analysis, to a reduction of the maintenance costs by about 27%.

On the Adherence topic, the TD has released adhesion curves for the adhesion catalogue and data to generate requirements for the development of adhesion influencing systems. These data have been used for the Validation of a test rig and the adhesion catalogue has been finalised.

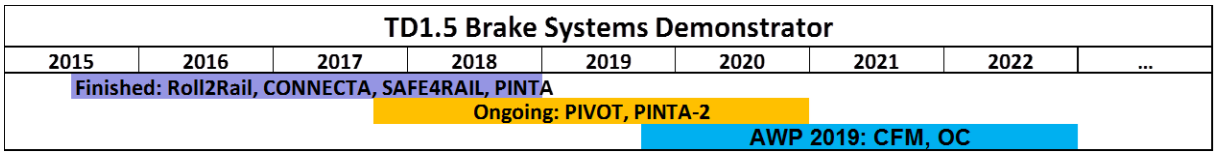
A Wheel Slide Protection (WSP) Test Rig Demonstrators was also built and used for testing. The results were compared in order to check the simulators performance thus ensuring interoperability and equal interpretation of the specifications. The difference in braking distance between the Test Rigs does not exceed 5% for an identical test set up.

Works on proposals for normative changes, focusing on Virtual Validation have been carried on with the identification of field tests that can be replaced by virtual tests in the UIC541-05/EN15595 (up to 50% of the field tests dealing with WSP devices could be virtualized).

During the analysis phase within this TD, it became clear that the development of the next generation of eddy current brake lacked both the (potential) market/business case and the support for broader implementation of such solution in Europe. Main stakeholders and the supplier of the 1st generation of technology have investigated market opportunities, risks and chances for a next generation Eddy Current Brake solution. This investigation showed that Infrastructure Managers are concerned about:

- The temperature increase in rails due to use of Eddy Current Brake and possible resulting track damage;
- EMC of Eddy Current Brake with safety wayside signalling equipment.

Train integrators and train operators want to avoid higher purchasing cost for Eddy Current Brake systems, even at most probably lower LCC costs (compared to a magnetic track brake with wear). The possible noise reduction of an Eddy Current Brake solution (e.g. through frictionless braking and through less needed compressed air) is - under the current regulative/political framework - not compensating for higher initial cost. The work on this activity has been therefore stopped by the end of September 2018.



In 2018, 4 deliverables in PINTA, 2 in CONNECTA and 1 in SAFE4RAIL were planned and delivered while the only deliverable foreseen in PIVOT has not been issued. Next batch of documents will be issued by PINTA2 and PIVOT in 2019 (New test specifications on adherence, test results on high safety components). The overall progress is in line with the plan. TD1.5 is estimated to have accomplished around 90% of the planned work up to end 2018, which represents 35% of the overall TD.

TD 1.6 Doors and Access Systems Demonstrator

The TD aims at moving away from current access solutions based on honeycomb and aluminium or steel sheets reducing their drawbacks on energy consumption, noise and thermal transmission. New lightweight composite structures could be introduced to perform better at existing safety and reliability levels, reducing platform dwell times and increasing overall line capacity. Customer-friendly information systems and improved access for people with reduced mobility using sensitive edges and light curtains are part of this new development.

TD Progress

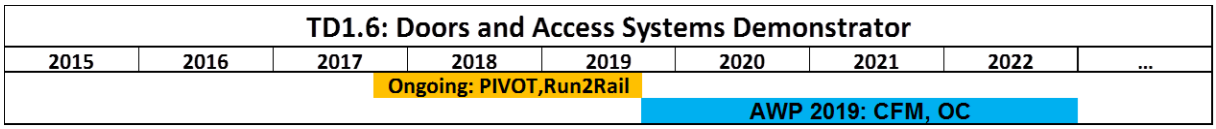
The TD1.6 builds on the progress made by PIVOT and MAT4RAIL Projects.

In 2018, the TD delivered the General Specification of Entrance System, the Specification of Metallic and Composite door leaves, and the specifications of boarding aid. The General Specification has allowed to point the long term for an autonomous and self-managed door in relation of the long term target of Automated Train Operation (ATO) at Go4 level.

More precisely, from the state of the art (use of aluminium profile structure, rigid polyurethane foam or aluminium honeycomb as filling material and aluminium or stainless steel skins to close the door leaves) the TD has defined all the weak elements and proposed development axis like new design of profile, improvement of filling material towards more complex acoustic structure thanks to thermal and acoustic study. Research on materials and manufacturing process on composite solutions for door leaves have been additionally carried on.

With the aim of introducing new materials/multi-materials and innovative manufacturing and joining/assembling techniques, the TD generated 11 door leaves concepts grouped in 4 main blocks (mono-block, structural glass, structural panel and structural profile) and the 3 best candidates in terms of weight reduction, isolation and cost have been selected for further TRL steps.

Among the different concepts of solution that have been produced for boarding aid, 3 have been pre-selected for further assessment. The introduction of new sensors or an innovative use of sensors will allow to improve platform detection and gap measurement, obstacle detection and passenger detection to secure boarding aid movement and door opening request.
Activities on improved passengers comfort and weight and energy optimization were still at an early stage in 2018 with no significant results up to date.



In 2018, 2 deliverables in MAT4RAIL and 1 in PIVOT were planned and delivered. Next batch of documents will be issued by PIVOT and MAT4RAIL early 2019 (Assessment of Conceptual solutions for accessibility and door entry surveillance systems). The overall progress is in line with the plan. TD1.6 is estimated having accomplished around 100% of the planned work up to end 2018, which represents 30% of the overall TD.

The first deliverable from PIVOT on the entrance system specifications is scheduled end of March 2018.

TD 1.7 Train Modularity in Use (TMIU)

The TD will develop new modular concepts for train interiors that allow operators to adapt the vehicle layout to the actual usage conditions, and will improve passenger flows, thus optimizing both the capacity of the vehicle and dwell times.

TD Progress

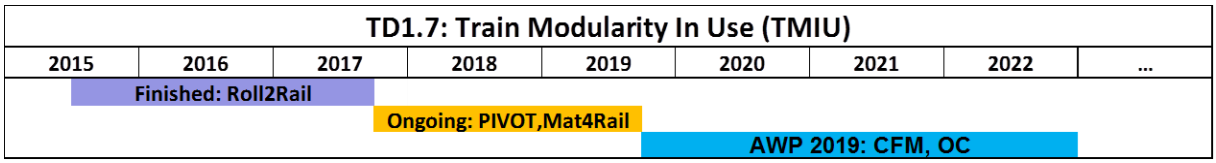
The TD1.7 builds on the progress made by PIVOT and MAT4RAIL Projects.

The TD has performed a technology watch of quick fixations system available on the market and a proposal of a first global concept has been validated.

It has carried on research activities on modularity solutions for services and comfort (lighting, socket, etc…) and issued a proposal of a multi-functions and evaluative electric socket.

An Intermediate report for Cabin and Interiors was released in 2018, including an analysis of the state of the art and definition of needs of the future. Foreseen activities on Interior Design have nevertheless

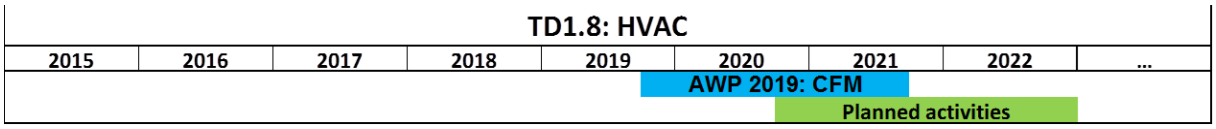
been partially performed due to the need of having a better overview of the Plug and Play system before proceeding with new design of interiors.



In 2018, 4 deliverables in MAT4RAIL were planned and delivered while the only deliverable foreseen in PIVOT has not been issued. Next batch of documents will be issued by MAT4RAIL and PIVOT in 2019 (Physical prototype or virtual mock-up for plug and play system, seat and cabin). The overall progress is slightly behind schedule to compare the initial plan. TD1.7 is estimated having accomplished around 85% of the planned work up to end 2018, which represents 25% of the overall TD.

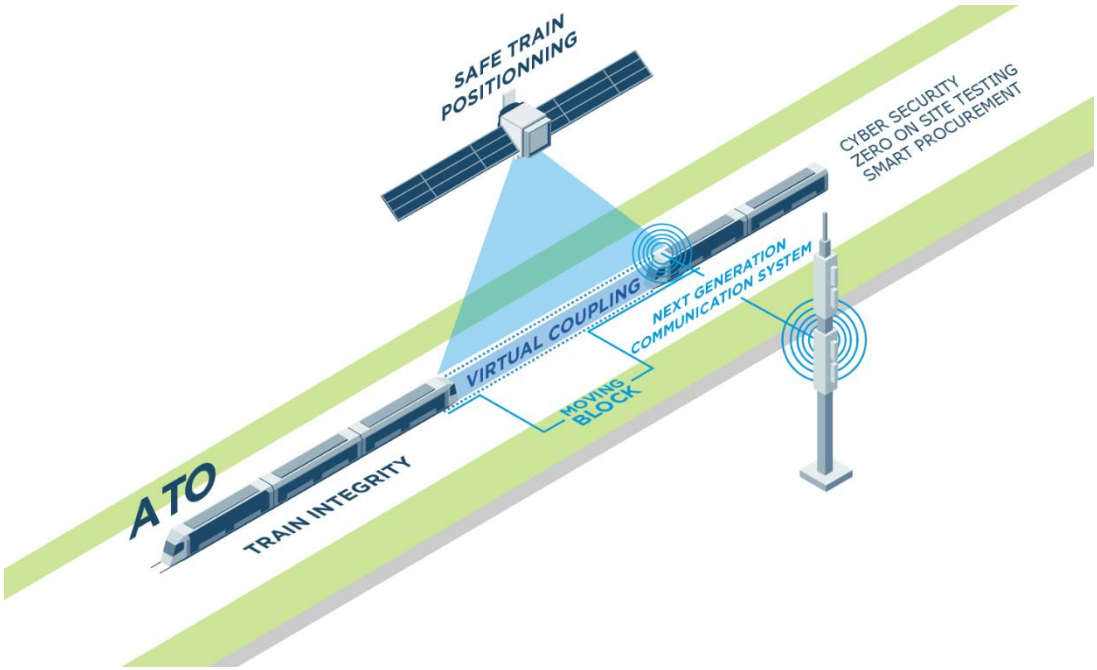
TD 1.8 HVAC

This TD will start its activities in 2019.



1.7.2. IP2 Advanced Traffic Management and Control System

The pictures below gives a visual perception on where the TDs will introduce improvements



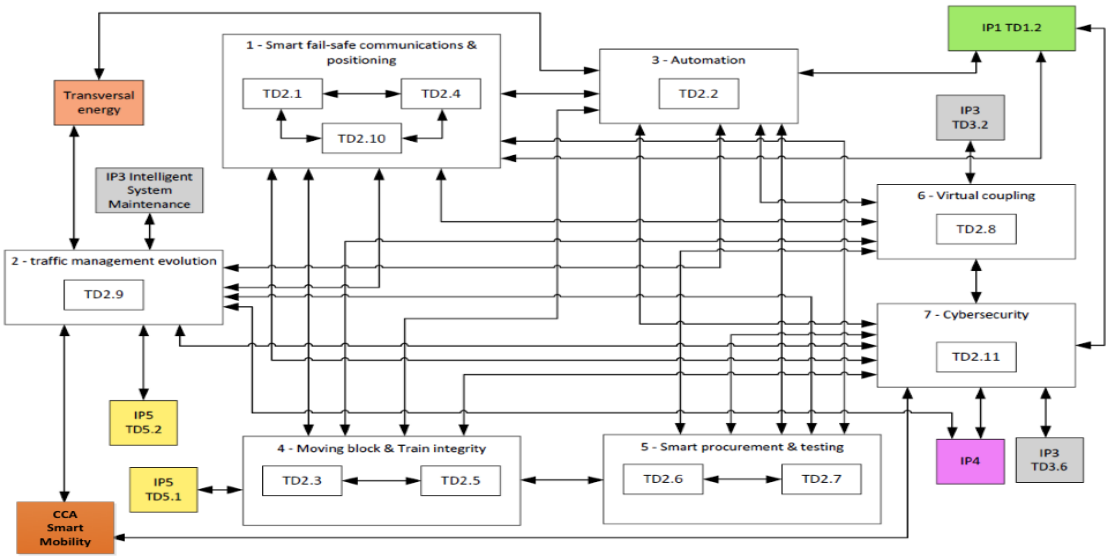
The aim of IP2 is to design and develop a control, command and communication systems that goes beyond being only a contributor to the control and safe separation of trains and becomes a flexible, real-time, intelligent traffic management and automation system.

IP2 builds on ERTMS, that, although limitedly deployed in Europe, including on core rail corridors, appears to be a worldwide dominant solution for railway signalling and control systems, to further develop it exploiting the potential to offer increased functionalities and become even more competitive. Current ERTMS 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. These 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; all in all, the potential for achieving major cost efficiency results for railway operations.

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

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

The picture below shows the TDs connections and dependencies within IP1 and with other IPs and CCA.



TD 2.1: Adaptable communications for all railways

The purpose of this TD is to overcome the shortcomings in the current European Train Control System (ETCS) and Communications-Based Train Control (CBTC) and deliver an adaptable train-to-ground communications system usable for train control applications in all market segments, using packet switching/IP technologies (GPRS, EDGE, LTE, Satellite, Wi-Fi, etc.). The system will facilitate migration from existing systems such as GSM-R, providing enhanced throughput, safety and security functionalities to support the current and future needs of signalling systems and well beyond; it will be resilient to interference and open to developments in radio technology.

TD Progress

This TD currently builds on the following projects: X2RAIL-1, X2RAIL-3 and EMULRADIO4RAIL. The open call project MISTRAL was completed in October 2018.

The main achievement, is the preparation for final delivery of the business model and the specification of the communication of the user and system requirements and Guideline for choice of technology.

The S2R JU launched in 2018 coordination activities with the UIC project “FRMCS” (Future Railway Mobile Communication System). This cooperation led to the update of the User Requirement Specification document, initially delivered in 2017. This cooperation is expected to continue in 2019 in order to ensure full alignment within the sector, ahead of the preparation of integration of the results in the Control Command and Signalling Technical Specifications for Interoperability (CCS TSI). In addition, synergies with the work performed under the umbrella of IP1 (TD1.2 – Wireless TCMS) are also contributing to fostering the system approach across the Programme.

Three major reports were achieved: 1) the validated techno-economic proposition 2) the report on business viability and 3) the report on technical and quality of service viability. These three reports composed the core delivery of the MISTRAL project and will be taken further by the TD.

The techno-economic proposition indicates the conditions for the migration to the next generation communication systems for railways. Three scenarios were analysed:

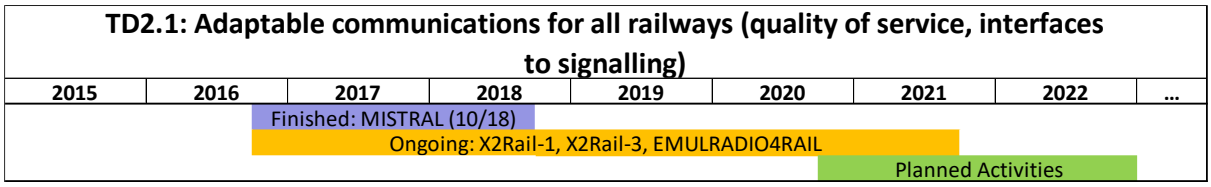
- The Network as an Asset (NaaA) scenario, where the Infrastructure Manager (IM) builds and develops a new 4G*-Mission Critical (MC) network and substitutes the old GSM-R for MC services;
- The upgraded NaaA scenario, where the IM builds and develops a new 4G*-MC network and substitutes the old GSM-R, as in the previous scenario, and the Mobile Network Operator (MNO) deploys a pervasive commercial 4G network along the line, where it could also offer Innovative Services for railways;
- the Network as an Service (NaaS) scenario, where MNO builds and develops a 4G*-MC network, other than its 4G commercial network, and becomes the new owner of the overall railway communication network. The intervention of governments is considered in the present deliverable as incentives and subsidies to MNO to implement the scenario.

Innovative services and costs were investigated for each of the scenario, for three different routes (urban to urban; urban to rural and urban to mountain). Initial findings found that the NaaS scenario seems to be the preferred one in terms of Total Cost of Ownership (TCO) in all the routes, even after a sensitivity analysis, where the variable parameters were 4G and/or 4G*-MC coverage on one hand, and revamping of 4G and GSM-R sites on the other one.

Indeed, lower CapEx and small higher OpEx permits to have a final TCO lower than the TCO for NaaA, when deploying a new infrastructure that can use both 4G-MC and 4G. Also, new business possibilities

can arise from the exploitation of the new network from MNOs. Indicators can be provided to make the NaaS more feasible and viable. Public decision makers should consider also frequency licence scheme and the possibility to introduce some incentives, if the market would be open to MNOs, in the specific railway (communication) domain (should they see an expected high return on investment).

Finally, it was analysed that the comprehensive Quality of Service (QoS) methods for the future communication networks are meeting the requirements of stringent QoS parameters stemming from railway functions. The definition of a QoS vector for railway communication applications for voice and data applications according to the recent 3GPP standardisations have been studied. It has been also proven that 4G enabled networks not only offer the possibility of a very differentiated prioritization of service features, they also use improved cryptographic methods and authentication mechanisms. This will enable higher safety standards to be met in the future.



In 2018, 5 deliverables in MISTRAL were planned and delivered. No deliverable for X2RAIL-1 were expected to be delivered. The next batch will be officially released at the beginning of 2019 (business model, specification and prototype development report). X2RAIL-3 and EMULRADIO4RAIL were officially launched in December 2018. The first deliverables related to TD2.1 are expected by end of 2019.

The overall progress is in line with the plan. TD 2.1 has reported having accomplished 95% of the planned work up to the end 2018, which represent 40% of progress of the overall TD.

TD 2.2: Railway network capacity increase (ATO up to GoA4 – UTO)

ERTMS/ETCS, the current generation of main line signalling, faces a growing challenge to provide the performance improvements and increases in line capacity needed by (European) Main Line operators.

Using Automated Train Operations (ATO) with ETCS is an answer to this challenge. This technology is already vastly deployed in urban transport where different grades of automation are implemented including driverless and unattended operation. The objective of this technology demonstrator is to develop and validate a standard ATO up to GoA3/4 over ETCS, where applicable, for all railway market segments (mainline/high speed, urban/suburban, regional and freight lines).

TD Progress

This Technology Demonstrator currently builds on the following projects: X2RAIL-1, launched in 2016 and ASTRail, launched in 2017. X2RAIL-1 is developing the specifications for ATO GoA2/4 over ETCS while ASTRail focuses on identifying which technologies coming from other application fields could be transferred to the rail sector.

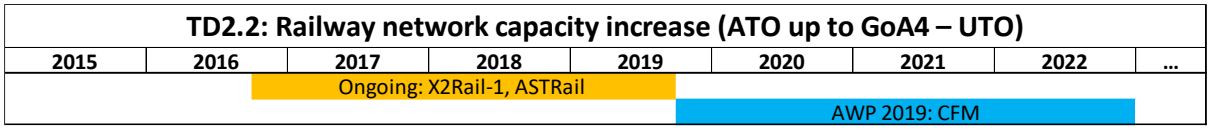
The TD has achieved a major milestone in April 2018 with the finalisation and publication of the draft specifications for ATO over ETCS GoA2. These specifications have been reviewed by the ERA (as ERTMS System Authority) supported by the ERTMS Users Group (EUG) and UNISIG in order to assess the possible impact on the current ERTMS/ETCS specifications. This was a key milestone to ensure that the

uptake of the results of this TD and prepare the integration of this functions and its specifications in the Control Command and Signalling TSI, in the next revision, currently targeted by 2022.

This step came further the definition of the operational requirements and includes the system requirements and the ETCS on-board/ATO on-board interface requirement. The reference test benches will be finalised by beginning of 2019 and the pilot tests are expected to run until middle of the year.

In parallel, the TD has continued working on the use cases and users requirements for Automatic Train Operations up to Grade of Automation 4 (unattended train operations). The work will continue in 2019, as per topics included in the S2R JU Annual Work Plan 2019).

The TD also reviewed the state of the art and identified the technologies used for automated driving in other applications fields (such as automotive, agriculture, maritime or other industrial fields). This formed the basis for the delivery of the analysis of Automatic Train Operations from the point of view of operation conditions and implementation characteristics. It provides the evaluation of the autonomous driving technologies that may be reusable when applying ATO to mainline railways.



In 2018, the two deliverables planned in the TD have been delivered on time. TD 2.2 has reported having accomplished 100 % of the planned work up to the end of 2018, which represents 40% of the overall TD. The overall progress appears to be in line with the plan.

TD 2.3: Moving Block

This TD aims at improving line capacity by decoupling the signalling from the physical infrastructure, and removing the constraints imposed by trackside train detection, thereby allowing the transit of more trains on a given (main) line, especially for high-density passenger services. The system is expected to be compatible with existing ERTMS specifications and will enable progression towards CBTC (Communication Based Train Control) functionalities for urban applications.

TD Progress

This TD currently builds on the following projects: X2RAIL-1, launched in 2016 and ASTrail, launched in 2017. X2RAIL-1 is developing moving block operational and engineering rules, system specifications as well as the application analysis while ASTRail supports the development of the hazard analysis.

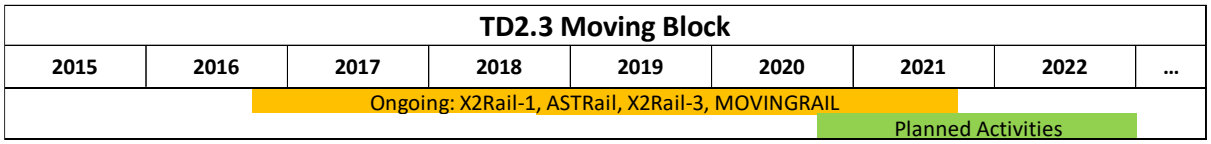
In 2018 the TD prepared the first versions of the system requirements, the operational and engineering Rules as well as the preliminary Safety Analysis, based on sixteen identified scenarios.

The Moving block system Hazard analysis has been performed applying inductive techniques for Preliminary Hazard Analysis, taking into account defined system use cases and assuming that the main positioning system used will be based on GNSS, including the safety requirements.

To perform the Preliminary Hazard Analysis, the Moving Block System (MBS) safety functions have been defined implementing the top-down analysis, which has been derived from the most common type of railway accidents and the scenarios which can lead to these accidents that involve signalling

system. After the determination of the MBS system safety functions, the hazards that can prevent system from performing its safety function have been defined, their plausible causes and consequences have been analysed.

The work in the TD is continuing, developing the Moving Block System Specifications and Interface Specifications (based on the 16 moving block scenarios developed). The specifications will be applicable across all market segments: Urban/Suburban; High Speed Main Line; Low Traffic and Freight. These were showcased during the demonstrator presented at InnoTrans.



The unique deliverable planned in 2018 was delivered on time. The deliverables planned in X2RAIL-1 were slightly delayed and are expected to be ready in the first quarter of 2019. X2RAIL-3 and MOVINGRAIL were officially launched in December 2018. The first deliverables related to TD2.3 are expected by end of 2019.

TD 2.3 has reported having accomplished 80 % of the planned work up to the end of 2018, which represents 40% of the overall TD. The overall progress is slightly delayed but remains globally in line with the plan.

TD 2.4: Fail-Safe Train Positioning (including satellite technology)

This Technology demonstrator aims at developing a fail-safe, multi-sensor train positioning system, applying Global Navigation Satellite Systems (GNSS) technology, as an add-on to the current core of ERTMS/ETCS.

It will enable the use of other new technologies (e.g. inertial sensors) or sensors (e.g. accelerometers, odometer sensors) to boost the quality of train localisation and integrity information, while also reducing the overall life cycle costs, in particular by enabling a significant reduction in all conventional trackside (train) detection systems, such as balises, track circuits or axle counters

TD Progress

This TD currently builds on the following projects: X2RAIL-2, ASTRail (both launched in 2017).

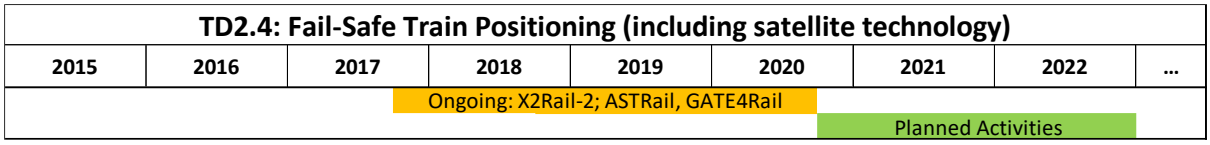
X2RAIL-2 focuses on the development of the architecture and specifications for satellite positioning and start of laboratory testing and process for field tests. ASTRail studies the requirements and possible knowledge transfer from the aeronautical standards regarding application of GNSS to rail signalling.

The key achievement for this TD in 2018 has been the definition and delivery of the first version of the System Requirement Specifications (i.e. functional and non-functional requirements) of the Fail-Safe Train Positioning (including satellite technologies). This activity also included the analysis of different ERTMS Operation Scenarios based on the use of Virtual Balises and the preliminary investigations of technologies GNSS, IMU, Kinematics Sensors and Digital Map. Further activities have been planned (a) to improve the details of the specification and arrive to the specification of the FFFIS interfaces where planned and (b) to collect and taken into account the feedbacks coming from other tasks.

In addition, the TD also defined the Preliminary System Architecture of the Fail-Safe Train Positioning (including satellite technologies) subsystem as the first internal baseline. During the architectural design phase, a preliminary System Functional Hazard Analysis was performed. The first version of the System Architecture along with the related System Hazard Analysis are planned to be delivered by the beginning of 2019.

On-site GNSS performance tests were carried out in Italy, Czech Republic and Germany, in addition to data collected in the framework of the GSA-funded project, STARS (GA 687414). The analysis performed in this task focused on three technologies: GNSS, radio-localization, and kinematic sensor.

The TD performed a review of aeronautical standards, studying the applicability of aeronautical assumptions and requirements to the rail domain. The project made a major contribution to the development of a GNSS propagation channel and the RFI classification for the railway environment. In addition, to focusing on the ERTMS hazards associated with GNSS faults as well as the design of GNSS algorithms.



In 2018, 7 deliverables been delivered out of the 9 expected. Two deliverables are slightly delayed and will be delivered at the beginning of 2019. The open call project GATE4RAIL was launched at the end of 2018 and is expected to provide a GNSS automated virtualized test environment. Its initial results related to TD2.4 are expected by end of 2019.

TD 2.4 has reported having accomplished 78 % of the planned work up to the end of 2018, which represents 30% of the overall TD.

TD 2.5: On-board Train integrity

This Technology Demonstrator aims at specifying and prototyping an innovative on-board train integrity solution, capable of autonomous train-tail localisation, wireless communication between the tail and the front cab, safe detection (SIL4) of train interruption and autonomous power supply functionality without the deployment of any fixed trackside equipment. This functionality will be developed for those market segments (e.g. freight and low traffic lines) lacking such functions.

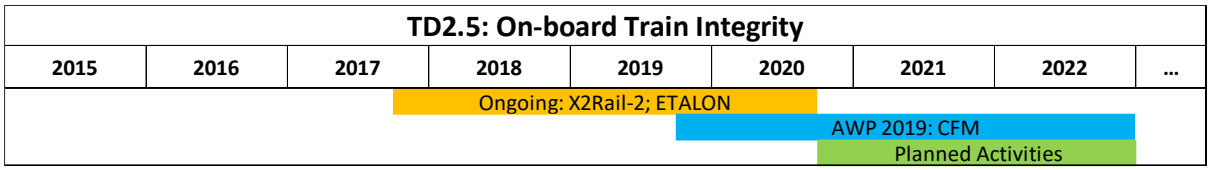
TD Progress

This TD currently builds on the following projects: X2RAIL-2 and ETALON. Both projects started in September 2017.

The main achievement for TD2.5 in 2018 are the activities performed on the state of the art of existing Train Integrity technologies & related products, suitable for train interruption detection and train completeness monitoring. The TD defined target scenarios and product classes for all S2R application domains. It investigated and analysed wireless sensors and/or transponders technologies, analysed the options for installation (considering operational rules). It also performed a feasibility study for the use of GNSS-based solution for train tail localization.

In 2019, the TD will deliver the result of work started in 2018 regarding the functional hazard analysis and the functional requirements specification. Activities also focus on communication and energy harvesting requirements.

The functional architecture and functional interface specification as well as the general approach for test specification are also being considered.



In 2018, the 5 expected deliverable have been delivered. TD 2.5 has reported having accomplished 90 % of the planned work up to the end of 2018, which represents 40% of the overall TD.

TD2.6: Zero on-site testing (control command in lab demonstrators)

The development of a new laboratory test framework comprises simulation tools and testing procedures for carrying out open test architecture with clear operational rules and simple certification of test results. It aims at minimising on-site testing (with the objective of zero on-site testing) by setting-up full laboratory test processes, even when systems comprise subcomponents of different suppliers. The test framework will also allow remote connection of different components/subsystems located in various testing labs.

TD Progress

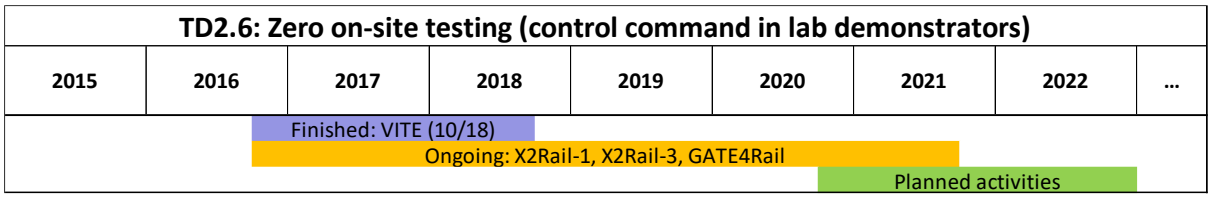
The activities related to this TD were carried out in X2RAIL-1 and VITE. Both VITE and the stream related to TD2.6 in X2AIL-1 were completed at the end of December 2018.

The TD activities in 2018 were to define a dedicated system test architecture for lab testing supporting Zero On-Site Testing, to identify the scope and context of the test architecture, to define requirements for test environment architecture, to adapt system boundaries adapted according identified requirements and finally to detail requirements including use cases identified for the test environment.

The key milestone for the TD was the delivery in 2018 of the full system test architecture for lab testing. To do so, several methodologies have been used to ensure it is as complete as possible:

- A broad, initial architecture was generated based on collected experience from the TD;
- Use Cases were built in order to detail all of the anticipated test scenarios envisaged;
- A set of functional and quality requirements (both mandatory and anticipated) was produced;
- Known constraints from the description of testing process done earlier in the TD and on regulatory/anticipated/experienced constraints.

A possible different approach to the verification and validation processes as well for developing the interface specification was investigated.



In 2018, 13 deliverables were planned in X2RAIL-1 and VITE, of which 5 were delivered on time and 7 delivered with a slight delay by the open call project VITE. The open call project GATE4RAIL was launched at the end of 2018. Initial results related to TD2.6 are expected by end of 2019.
TD 2.6 has reported having accomplished 100% of the planned work up to the end of 2018, which represents 43% of the overall TD.

TD2.7: Formal methods and standardisation for smart signalling systems

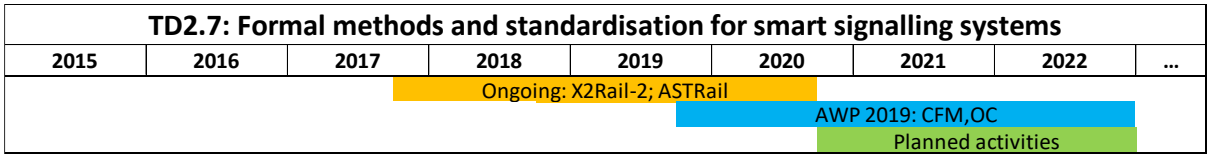
The development of a set of standardised engineering and operational rules aims at contributing to the creation of an open standard interface (if supported by a positive business case) and a functional ETCS description model, all based on formal methods. The objective is to ease the verification, certification and authorisation processes, eventually leading to improved interoperability, while reducing the need for extensive field tests in the future.

TD Progress

This TD currently builds on the following projects: X2RAIL-2 and ASTRail. Both projects started in September 2017.

Key activities include review and assessment of the main formal modelling and verification languages and tools used in other applications, choice of application area(s) in rail and application of formal methods to specification, design, verification and validation.

The main achievement in 2018 is the completion of the taxonomy of Formal Methods and associated survey of formal methods in the railway signalling industry. This document classifies the formal methods based on surveys performed in the railway signalling systems industry, capturing the variety of existing formal methods and tools, their most important aspects as well as industry expectations. It provides a list of specific methods and tools recommendations for different applications, tasks and use cases, including semi-formal methods.



In 2018, all 3 deliverables planned were delivered on time.
TD 2.7 has reported having accomplished 100% of the planned work up to the end of 2018, which represents 40% of the overall TD.

TD2.8: Virtually – Coupled Train Sets (VCTS)

This technology demonstrator targets the enabling of 'virtually coupled trains', capable to operate much closer to one another, within their absolute braking distance, and to dynamically modify their

own composition on the move (virtual coupling/uncoupling of train convoys), while ensuring at least the same level of safety as currently provided.

TD Progress

TD2.8: Virtually – Coupled Train Sets (VCTS)								
2015	2016	2017	2018	2019	2020	2021	2022	…
			Ongoing: X2Rail-3, MOVINGRAIL					

The activities planned in this Technology Demonstrator have started in December 2018 in both the CFM project X2RAIL-3 and the complementary action, MOVINGRAIL. The activities are expected to be performed in full coordination with the work current on going in the framework of IP1 (CONNECTA-2 and SAFE4RAIL-2).

TD2.9: Traffic management evolution

An optimised Traffic Management System (TD 2.9) aims at improving traffic management operations with automated processes for data integration and exchange with other rail business services. The backbone of the new architecture will be a scalable, interoperable and standardised communication structure applicable within an integrated rail services management system. These features will be combined with new business service applications (e.g. advanced driver advisory system, or intelligent, automated and flexible dispatching systems including conflict detection and resolution) to allow for predictive and dynamic traffic management in both regular and degraded situations. It will use and integrate real-time status and performance data from the network and from the train, using on-board train integrity solutions and network object control functions, supported by wireless network communication.

TD Progress

This TD currently builds on the project X2RAIL-2, which started in 2017.

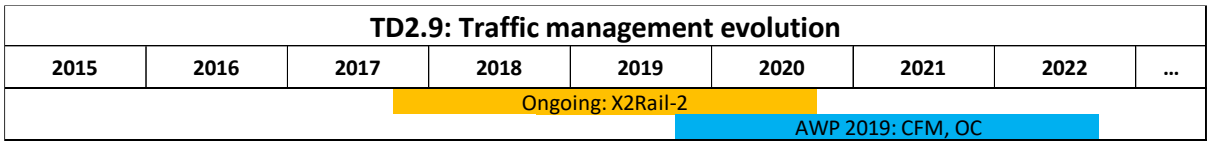
The principal objective of the project is to design a scalable and interoperable Data Layer providing the data exchange between internal Rail Operation Services and external services.

In IN2RAIL2 (LP), a first approach to subscribe and publish information management for all rail business services and has been described and a proof of concept for Integration Layer and Application Framework has been demonstrated. TD2.9 is expected to take this approach further by providing robust system requirement specifications, detailed descriptions of use-cases representing advanced TMS principles.

Business service applications will cover various functionalities executed within a TMS including applications needed to enable ATO and Moving Block Operations.

Regarding the integration layer, the TD has started to elaborate the data structure to create the set of required data elements to be available on the Integration Layer and which shall be represented from the Canonical Data Model (CDM). The evaluation of the available different COTS “Middleware solutions” as operational platform of the Integration Layer was performed to allow Members to start the design of their proposed prototypes of constituents or processes of the Integration Layer.
In addition, the TD also developed the System Requirements Specifications for the Application Framework, which will be officially released in the first quarter of 2019.

The TD also worked on the structure and function of use-cases for advanced TMS principles, elaborated the use-cases as base for functional requirements and system architecture, contributing to the standardised Operator Work Station.



No official deliverables were planned in 2018.
TD 2.9 has reported having accomplished 100% of the planned work up to the end of 2018, which represents 40% of the overall TD.

TD2.10: Smart radio-connected all-in-all wayside objects

This TD has for objective the development of autonomous, complete, intelligent, self-sufficient smart equipment ('boxes') able to connect not only with control centres (e.g. interlocking), other wayside objects and communicating devices in the area (by radio or satellite), but also, with on-board units.

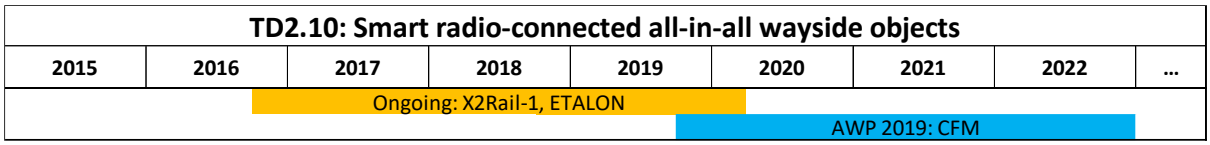
These "intelligent" objects - knowing and communicating their status conditions - would not only provide opportunities in terms of cost reduction and asset management improvement, but also establish new means for management and control of railway network information.

TD Progress

This TD currently builds on the following projects: X2RAIL-1, launched in 2016 and ETALON, launched in 2017.

Moving to 2018, the focus of the TD was put on working on the definition of System Architecture and Interfaces. This include activities related to the operational Capabilities and use Cases, the operational scenarios, the traceability matrix of requirements and finally the operational analysis and system level analysis of architecture and interfaces.

The TD also focused on providing an energy harvesting solution for Smart Radio connected wayside objects, which contributes to the main objective of TD2.10, i.e. to minimize trackside infrastructure.



In 2018, the 6 deliverables planned were delivered on time. The overall progress appears to be in line with the plan.

The TD has reported having accomplished 90% of the planned work up to the end 2018, which represents 45% of the overall TD.

TD2.11: Cybersecurity

The interconnected digital railway network at European level is constantly growing and will keep on growing, which will increase the number of risks associated to security. There is therefore a growing need for handling these cyber-security threats in railway systems. This technology demonstrator aims at achieving the optimal level of protection against any significant threat to the signalling and telecom systems in the most economical way (e.g. protection from cyber-attacks and advanced persistent threats coming from outside).

TD Progress

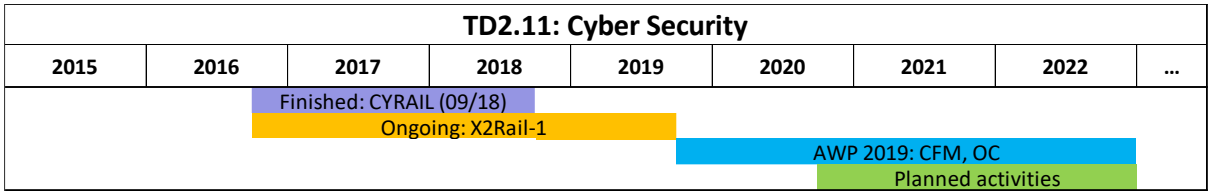
This TD currently builds on X2RAIL-1. The open call project CYRail was completed at the end of 2018.

In 2018, the TD has delivered the risk assessment process defined and delivered for generic architecture. The relevance of the IEC standard 62443 (Security for industrial automation and control systems) as cybersecurity framework for Railway has been performed and delivered for the available subsets of the cybersecurity standard framework for the system integrators and the asset owners. Based on this, the TD also performed the analysis of the coverage of threat detection, prevention and response requirements by the IEC standard 62443.

The TD has started the risk assessment of generic railway architecture for the railway specific zones as well as the definition of the protection profile for main railway signalling equipment.

Significant delays were experience on the drafting of the "draft security by design" standard, due to significant delay mostly triggered by the security risk assessment analysis and the extension of scope of the analysis of the IEC standard 62443. The draft standard will be delivered in the second quarter of 2019.

The work of the TD was complemented by initial deliveries on the security risk assessment, the threat analysis and detection and the protection profile.

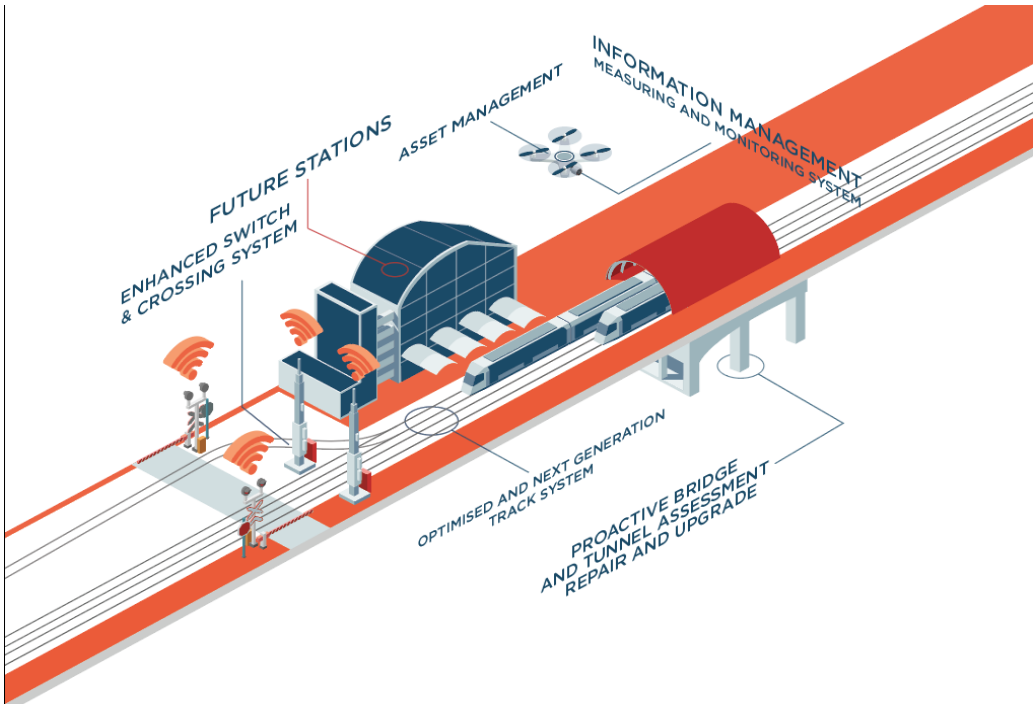


In 2018, the 6 deliverables relating to this TD were planned in CYRail, of which 6 were delivered. The overall progress appears to be delayed compared to the initial plan for X2RAIL-1. However, mitigation measures have been put in place at the beginning of 2018. X2RAIL-3 was officially launched in December 2018. The first deliverables related to TD2.11 are expected by the end of 2019.

TD 2.11 has reported having accomplished 80% of the planned work up to the end 2018, which represents 40% of the overall TD.

1.7.3. IP3 Cost Efficient and Reliable High Capacity Infrastructure

The pictures below gives a visual perception on where the TDs will introduce improvements

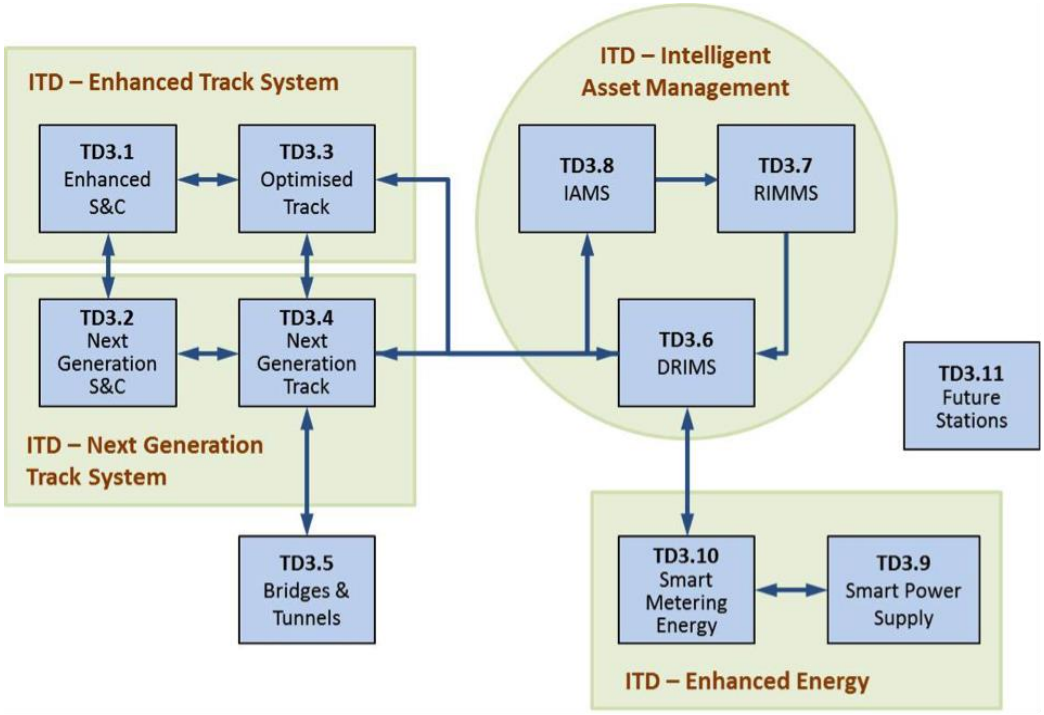


The design, construction, operation and maintenance of rail network infrastructure have to be safe, reliable, supportive of customer needs, cost-effective and sustainable. In order to deliver the benefits of market opening and interoperability and to reduce the life cycle costs of rolling stock and on-board signalling systems, the network diversity needs to be eliminated, notably through a migration towards common high-performing infrastructure system architecture.

Activities that can support the reduction of infrastructure maintenance costs, such as simplified procedures or automation, need to be led in priority. They should propose solutions that can be rapidly and efficiently deployed. Furthermore, the infrastructures have to be managed in a more holistic and intelligent way using lean operational practices and smart technologies that can ultimately contribute to improving the reliability and responsiveness of customer service, as well as the capacity and the whole economics of rail transportation.

In order to be competitive with other modes but also integrated with them, compatibility between different modal infrastructures (including multimodal hubs, changing points and stations) needs to be ensured and based on principles of interoperability and standardisation.

The picture below shows the connections and dependencies within the IP3.



TD3.1 Enhanced Switch & Crossing System Demonstrator

The TD aims at improving the operational performance of existing Switches and Crossings (S&C) designs through the delivery of new S&C sub-systems with enhanced Reliability, Availability, Maintainability and Safety (RAMS), improved Life Cycle Cost (LCC), sensing and monitoring capabilities, self-adjustment, noise and vibration performance, interoperability and modularity.

TD Progress

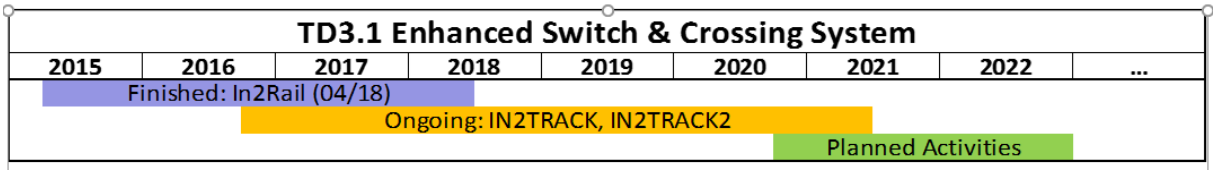
The work on this TD has started with the finished IN2RAIL (LP), with significant results in:

a) Development of novel S&C locking and motion mechanisms including the following concepts that can be used for further evaluation:

- Novel Finite Element Analysis modelling, to demonstrate possible reliability enhancements of existing European switch designs;
- Novel ScrewLock concept enhanced to address conflicts with functional requirements & integration of additional locking and detection capabilities to provide a whole system concept;

b) Embedded & integrated sensors for value-adding S&C monitoring technologies, where a whole system modular architecture concept was developed and was delivered for prototyping during the future activities in this TD.

Building on this work, the TD is expected (at the beginning of 2019) to deliver its final results on the identification of the core S&C issues and missing links between existing failures and root causes identified, and to propose an enhanced design of S&C through a whole system modelling approach including new component design enhancements.



During 2018, 4 deliverables were planned out of which 3 were released. Significant progress is expected during 2019 from IN2TRACK CFM project which is delivering its final results by Q2, and from IN2TRACK2 CFM project which started in November 2018.

TD3.1 has reported having accomplished 75% of the planned work up to the end 2018, which represent only 20% of the overall TD.

TD3.2 Next Generation Switch & Crossing System Demonstrator

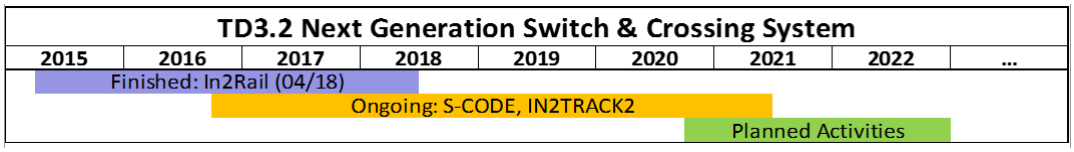
The TD aims at providing radical new system solutions that deliver new methods for directing trains to change tracks with the aim of increasing capacity, while reducing maintenance needs, traffic disturbances and life cycle costs.

TD Progress

The work on this TD within 2018 has started with the finished IN2RAIL (LP), which delivered recommended techniques and approaches for radical S&C concept to be investigated to a higher TRL level in the future activities:

- Improving the kinematic guidance through switch profiles modifications
- Developed S&C solutions for embedded rail sections
- Further assessment of viability of flange back steering at a higher TRL including potential spin-off of the flange back steering actuation to obtuse crossing and testing of new material resistance to abrasive and gouging contact as a possible alternative application of flange back guidance, linking with material research in additive manufacturing
- Development of vehicle based steering
- Development of vertical moving switch blade
- Incremental development of S&C support, in particular the better understanding of long bearers in turnout and their interaction with the ballast bed
- Development of resilient mounted nose concepts.

Definitions and standard operating parameters were reviewed, while a baseline scenario was defined where state-of-the-art of S&C was studied along with RAMS of current S&C. This was then followed by future scenario of traffic demand together with the analysis of the common failure modes and their effect into the overall operation. Radical innovations in S&Cs and technology concepts from other industries were also defined. These concepts were assessed to develop a ranking in order to come up with technology components and solutions for radically new S&C concepts and the associated key technology developments. This ranking proved that the next generation S&Cs would benefit from mechatronic solutions and innovative sensing technologies. It is expected that these solutions will ultimately increase reliability of S&C through the development of fault tolerant designs and support for simplified and preventive maintenance.



During 2018, 3 deliverables were planned and been released. The overall progress appears to be in line with the plan with regards mainly to mechatronics development and to specifications & modelling approach. Further progress is expected during 2019, from the IN2TRACK2 CFM project which started in November 2018, as well as from S-CODE project which is expected to release reports from on-going work.

TD3.2 has reported having accomplished 100% of the planned work up to the end 2018, which represent 30% of the overall TD.

TD3.3 Optimised Track System

The TD challenges track construction assumptions, currently implicit in track design, and explores how innovative solutions in the form of products, processes and procedures can provide higher levels of reliability, sustainability, capacity together with LCC savings. The aim is to derive medium-term solutions thus requiring harmonisation with current solutions and regulations.

TD Progress

The work on this TD has started with the finished IN2RAIL, with significant results in the:

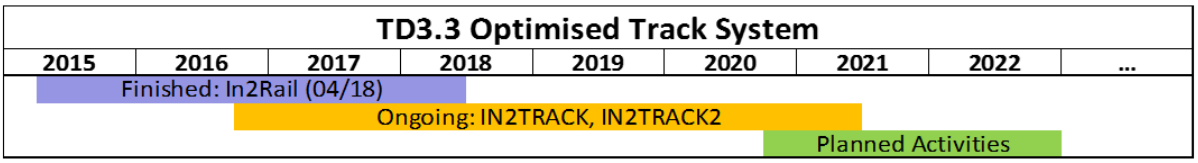
- Investigation of Repair Methods & Welding Techniques, where 3 elements were suggested for further exploitation:
    - Attributes provided to design & build an optimum rail defect repair system. The analysis indicated a large potential of rail repair (namely around 0.2 reparable defects per year, per km of track in the major European IMs) Innovative DDR (discrete defect repair) process to be developed further to TRL6 as it was proven to have the largest potential of the methods investigated,
    - Streamline Approval process for future repair systems, which has the potential to significantly decrease cost and time and enhance the quality for approval of innovative repair weld methods,
- Evaluation of solutions to decrease noise & vibrations, namely squeal noise, impact noise and ground borne vibration where a full finite element model was designed, developed and validated using experimental data allowing to the prediction of vibration propagation and the calculation time. It provides a tool to specify the optimum mitigation solution to reach vibration levels targets required by sensitive equipment in buildings. Parametric studies showed that resilient material (stiffness and loss factor) under the tracks is very efficient but may be costly. Railway pads showed limited positive effects on vibration but increased the radiated noise. The other significant parameter is the mass of the sleepers. Working on a medium to absorb energy can be, from a system perspective, an efficient way to reduce vibration propagation.
- Evaluation of Optimized Track Systems, where an extensive analysis of mechatronics took place including transition zones which require further field verification of the super structure innovations as well as establishing an efficient method to assess stiffness gradient, ballast flight which should test chemical, ballast coating, altering ballast grain properties, and artificial ballast solutions in the field, lateral track stability which has evaluated deflection into

increased temperature to align with stress free temperature management, differential settlement which should pursue unification of the numerous settlement equations by incorporating Vehicle Track Interaction.

Building on this work, the TD delivered at the end of 2018 the analysis on key influencing parameters and prioritised areas of improvement on enhanced track system which includes the investigation on existing failures and root causes as well as the influence on operational parameters, operational failures & related costs.

It is expected that at the beginning of 2019 the TD will deliver its final results on:

- Enhanced track design solutions through predictive analyses, where innovative solutions in the form of continuous supported track structures, new alloys and welding methods, and optimised ballast track will be presented.
- Enhanced inspection, maintenance and operation of track, where highly efficient maintenance practices in terms of improved decision on actions and efficient execution will be presented.



During 2018, 5 deliverables were planned, out of which 3 have been released. Further progress is expected also during 2019, from IN2TRACK2 project which started in November 2018.

TD3.3 has reported having accomplished 60% of the planned work up to the end 2018, which represent around 35% of the overall TD. Further progress is expected at the beginning of 2019 by the release of the final reports of IN2TRACK project which will confirm the reported progress of overall TD.

TD3.4 Next Generation Track System

The TD aims at drastically improving the track system targeting a time horizon of some 40 years beyond present state-of-the art. This implies that step changes in performance are highly prioritized. The TD process follows an integrated chain encompassing initial identification of long-term needs of the railway to the potential solutions to meet these.

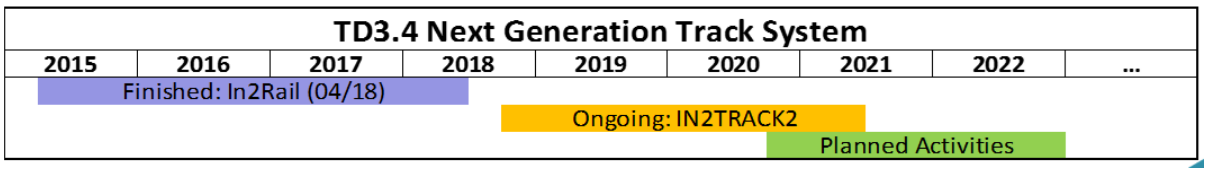
TD Progress

The work on this TD has started with the finished IN2RAIL (LP), with the delivery of a framework & guideline to assess & select innovative track solutions for a user defined specification of a railway corridor. Results of use cases assessments are based on the criteria of: design performance, buildability, safety, environment & maintenance in the form of a 3- evaluation assessments. Of the 13 track systems sampled, the following top 3 scored the highest for each evaluation assessment:

1. Benefits Only:
   a) Embedded Rail
   b) Rhomberg Sersa
   c) PORR Slab Track
2. Installed Cost Only:
   a) Ballast Track
   b) Ballast on Asphalt
   c) Embedded Rail

3. LCC & Benefits
    a) Embedded Rail
    b) Japanese Slab Track
    c) Sleepers on Asphalt

This framework should be utilised to assess any further additional innovative track systems that become available or any hybrids that are developed as a technical demonstrator in S2R.



During 2018, 1 deliverable were planned and released in In2Rail. Further progress is expected during 2019, from the IN2TRACK2 CFM project which should have started in November 2018.
TD3.4 has reported having accomplished 100% of the planned work up to the end 2018, which represent only 10% of the overall TD.

TD3.5 Proactive Bridge and Tunnel Assessment, Repair and Upgrade Demonstrator

The main objective of the TD is to improve inspection methods and repair techniques to reduce costs, improve quality and extend their service life when possible without jeopardizing safety. Reduction of noise and vibrations are also among the prioritised objectives.

TD Progress

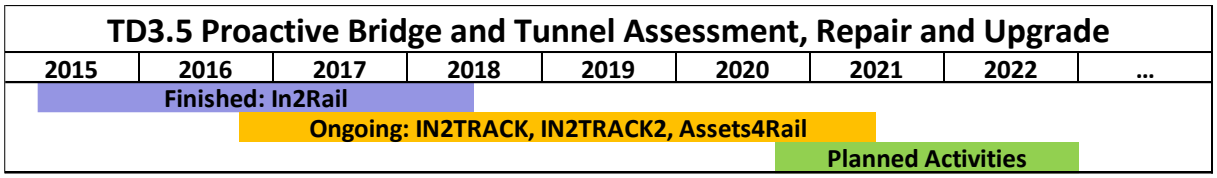
The work on this TD has started with the finished IN2RAIL (LP), with significant results within 2018:

- Identification, benchmark and development of existing technology with respect to defined parameters. The analysis resulted to 6 methods that were studied in detail:
    - Electrical resistivity tomography, suitable for detecting and imaging the amount of pipe clogging due to mineral scale deposits in tunnel drainage
    - Fatigue assessment systems, intended mainly for determining fatigue deterioration of steel bridges
    - Ground penetrating radar, that may be used to evaluate the subsurface properties and condition of tunnels, bridges, foundations and geological layers affecting these structures
    - Image analysis, with possible application in detection of damage, strain and displacement as well as motion and vibration detection from images captured by remote control and robotic vehicle
    - Muon tomography, particularly applicable in tunnels, for early identification of changes in geology below the surface
    - Terrestrial microwave interferometry that can be used in the assessment of bridges.
- Demonstration of the viability, suitability and specifics of these techniques in an operative environment, providing insight as to where would future research effort on the subject be most beneficial, which techniques appear to be sufficiently developed and merely require optimization, and whether any of them represent a potential dead end or still require major advances. The main conclusions are: All of the techniques were proven feasible, cost-effective and able to reduce inspection-caused disturbance on track. The demonstration of Ground

penetrating for sub-surface inspection of concrete elements, be them in tunnels or bridges, has produced disparate results that discourage additional research for the time being. Optical measurement techniques, both for bridges (Laser, Infrared and Photogrammetry) and tunnels (DIFCAM), on the contrary, are highly promising both in the data gathering and data processing aspects. The use of these techniques in combination with UAVs for the inspection of bridges would avoid the need for inspectors on site altogether, while increasing the current working speed of the DIFCAM trolley would significantly reduce tunnel inspection related down-time. The development of Digital Image Correlation software, image processing methodologies and automated defect detection and evaluation would enhance the objectivity and quality of inspection and assessment, while laser scanning of the assets opens the door to multiple digital twin related applications. The use of IM to determine the frequencies of bridges will be key in the mitigation of noise and vibration issues, as well as providing insight to the dynamic behaviour and damping properties of the inspected structures. Finally, the demonstrated technique for fatigue damage inspection and follow-up using hybrid sensing, once fully developed, will unlock the potential for life extension in bridges that have theoretically reached their end of life without compromising safety or requiring major refurbishing.

Building on this work, the TD is expected (at the beginning of 2019) to deliver its final results on:

- Inspection and monitoring techniques for tunnels and bridges including digital image correlation scanning, data base handling and tunnel condition marking index.
- Improvement of tunnels and bridges including repair and strengthening technologies. Methods will be presented for drainage, transition zones and strengthening with Fibre Reinforced Polymers (FRP) under dynamic loads and for fatigue resistance improvement.
- Definition & planning of tunnel and bridge demonstrators including design and feasibility studies for inspection, monitoring, assessment and improvement methods including identification of suitable structures.



During 2018, 3 deliverables were planned out of which 2 were released. Further progress is expected also during 2019, from IN2TRACK2 and Assets4Rail projects which started in November 2018.

TD3.5 has reported having accomplished 66% of the planned work up to the end 2018, which represents only 10% of the overall TD. The progress in this TD is expected to be significantly accelerated at the beginning of 2019, as all relevant reports of IN2TRACK project will be released.

TD3.6: Dynamic Railway Information Management System (DRIMS) Demonstrator

The TD defines an innovative system for the management, processing and analysis of railway infrastructure data obtained from TD3.7 (Railway Integrated Measuring and Monitoring System (RIMMS) Demonstrator). The aim is to provide high-quality input to TD3.8. Intelligent Asset Management Strategies (IAMS).

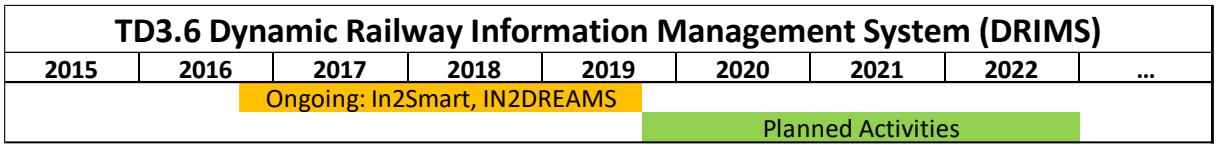
TD Progress

During 2018 period, the S2R projects IN2SMART and IN2DREAMS, have contributed to the related activities of the TD.

In this framework, a focused spotlight on today's most relevant formats and technologies was developed constituting a working resource for data standardization. The list of standards suitable for data representation with respect to the work done in lighthouse project IN2RAIL focused on TMS, was enriched in order to cover maintenance requirements and needs. Based on the study of the relevant open data exchange approaches, a subset was chosen to identify the best data format for data propagation. Moreover, specific use cases has been chosen to validate the work in progress on the Integration Layer and on the Conceptual Data Model.

The work that was accomplished included the definition of the anomaly detection, process mining and predictive analytics approaches suitable for different railway systems along with the presentation of a set of use cases with defined assets and associated data collected from the field. On these datasets, data analysis algorithms were applied and the first results were collected. Two use cases were chosen as scenarios, focusing on relevant railway assets whose malfunction and maintenance policies have an impact on KPIs.

In addition, innovative work on the TD was done with the investigation & adoption of the Distributed Ledger Technologies (DLTs) in railway assets maintenance, including the selection of the right Distributed Ledger Technology that best suits the needs of maintenance and the definition of a preliminary architecture of a relevant prototype. A proof of concept is planned to be accomplished in the next phases of the TD.



During 2018, 9 deliverables were planned and been released. TD3.7 has reported having accomplished 100% of the planned work up to the end 2018, which represent 40% of the overall TD.

TD3.7: Railway Integrated Measuring and Monitoring System (RIMMS) Demonstrator

The TD aims at providing innovative tools and techniques for capturing information on the current status of infrastructure assets in a non-intrusive and fully integrated manner. To this end, the TD focuses on infrastructure asset status data collection in close interaction with TD3.1 Enhanced Switch & Crossing System Demonstrator and TD3.5. Proactive Bridge and Tunnel Assessment, Repair and Upgrade Demonstrator.

TD Progress

The contributing S2R projects to the progress in TD3.7 during 2018 were IN2SMART and MOMIT.

The state of the art of autonomous measurement system based on Unmanned Aerial Vehicle (UAV), Robots and Satellites was developed, while a list of use case has been defined with six main categories. The relevance of these use cases for each type of vector (UAV, robot and satellite) has been evaluated based on criteria such as maturity of the data acquisition, maturity of the data processing, and benefit for the asset manager in order to select the three most relevant use cases to be studied. The use cases that were selected, namely Catenary inspection, Natural hazards, and Asset digitalization. For each use

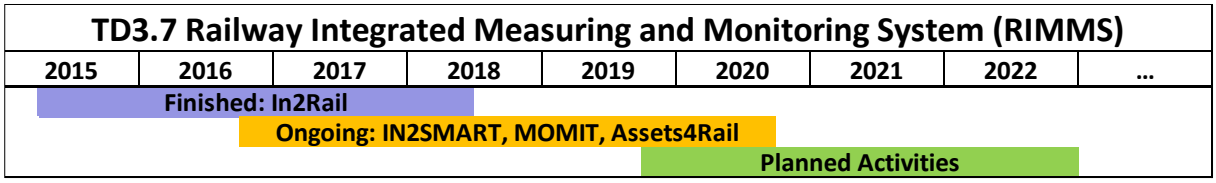
case, the measurement methodology for data acquisition during the planned demonstrations was defined. The parameters and sections on track and S&C that have to be monitored, were analysed, together with the required accuracy and impact on monitoring & maintenance strategies. In addition, the requirements defining the functional, safety and performance criteria applicable to a proxy functionality for collection, configuration and transport of data from sensors relevant to an intelligent asset management system were deployed. The requirements and the methodologies from the Infrastructure Manager point of view in the fiend of rolling stock key parameters identification and measuring were developed. The first testing with images collected from the drones were also performed by using image analysis, deep learning techniques.

The on-board prototype for track and S&C system have been finalized during the first part of 2018, refining parts such as monitoring sensors, system architecture, data collection and processing, results visualization, inclusion in a running train. Data has been collected for several months, both from the new defined system and from an existing homologized one, allowing comparison of results and improvement of analysis approach & algorithms used in the new system.

The architecture of the seamless proxy for extracting data from a signalling system has been finalized and used for starting the definition of the safety case, which has been developed in a first draft.

Methodologies for monitoring rolling stock impact on infrastructure have been defined and led to the definition of several use cases, one based on the visual inspection of the rolling stock, others on the measurement of the wheel impact on the rail and others on the identification of the rolling stock. .

The definition of an overall innovative solution for Rail Thermal Stress Monitoring has been designed and validated up to a TRL5. The solution is composed of on-board components able to monitor track geometry and rail temperature and a mathematical model has been developed that uses this information to estimate rail thermal stress, stress free temperature and buckling probability along the line, which in turn are used in order to define the correct time for maintenance (shifting to a condition-based approach) and to impose operation restrictions (e.g. speed limitations) only if necessary. Validation of rail temperature measurement has been performed in laboratory and in a test line, while validation of track geometry monitoring has been performed on board of a maintenance train, allowing immediate comparison of acquired data. The model has been validated theoretically and via numerical simulation.
The solution is thought to be installed on board of in-operation trains and not only maintenance ones.



During 2018, 15 deliverables were planned out of which 10 were released. Further progress is expected during 2019, from ASSETS4RAIL project which started in November 2018.

TD3.7 has reported having accomplished 66% of the planned work up to the end 2018, which represent 40% of the overall TD. The main delay in accomplishing the planned work was due to the regulatory issues for licensing & using the RPAS platform proposed for Unmanned Aerial Vehicle monitoring. The decision taken to use a commercial – already licensed – platform resolved the issue and the delivery of the planned work is expected to recover by mid of 2019.

TD3.8: Intelligent Asset Management Strategies (IAMS)

The vision of the TD is a holistic, whole-system approach of asset management employing collected and processed infrastructure data provided by TD3.7 Railway Integrated Measuring and Monitoring System (RIMMS) Demonstrator and TD3.6 Dynamic Railway Information Management System (DRIMS) Demonstrator. This includes translating long-term strategies into day-to-day execution of the maintenance and other short term maintenance activities.

TD Progress

Following the work already achieved by the TD through IN2RAIL (LP) in the fields of State of Play and Risk and Asset Management based Strategy, the TD3.8 aimed also at investigating intelligent asset management and execution strategies and new advanced working methods, tools and equipment, logistics solutions, supporting the LEAN execution of maintenance processes[19]. In this framework, work during 2018 was focused on the collection and analysis of use cases for IAMS process which aim to accompany the design of the generic framework, in the sense that they will be used in parallel to derive requirements from concrete decision-making processes to the abstract framework and to validate the applicability of the framework in a broad range of real-world scenarios. A number of use cases have been contributed by user-related partners, covering a broad range of planning problems in Asset Management. The selection and definition of prototypes to support the demonstration of the decision-making within the IAMS process completed this activity.

Significant work undertaken in the development of the prototypes of a LEAN inspection and tamping process which avoids pre-measurements. The “direct” use of inspection data to determine the work of the tamping machines is the key innovation. Since the lean tamping process avoids pre-measurement, one of the most important requirements are the localization accuracy as well as the reliability and accuracy of the inspection system. To this end, significant research was made on localization systems and the related post processing, on comparisons between inspection and pre-measurements and impact of track layout elements on accuracy of inertial inspection system. Comparisons between pre-measurements and measurements from inspection car have shown a very good agreement for longitudinal level and lateral alignment. The reproducibility and repeatability of inspection measurements are very high giving the possibility to use the measured track geometry history for the preparation of the tamping data and to plan future maintenance.

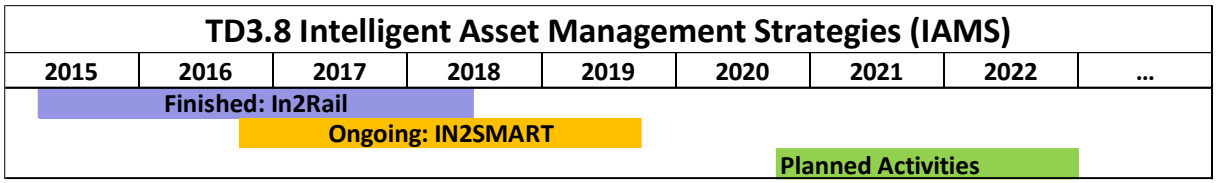
The result of this significant progress in TD3.8 was the successful deployment and presentation of the TD3.8 demonstrator ‘Lean Tamping’ as a S2R quick-win at InnoTrans. The key technological innovations are:

- The track recording car is capable of running at 120 Km/h, and able to accurately measure track geometry, rail profiles and overhead lines.
- It makes continuous digital video recordings of the rail’s surface and the track’s environment.
- Error-free and precise location data (accuracy up to the cm)
- Based on data from track recording car, the tamping machine, been equipped with GPs Real Time Kinematics, knows exactly where corrections should be made

[19] The application of the lean manufacturing concept to maintenance operations. Lean manufacturing makes obvious what adds value, by reducing everything else (which is not adding value). This management philosophy is derived mostly from the Toyota Production System (TPS) and identified as "lean" only in the 1990s

Consequently, the benefits of the proposed methodology are:

- Less need for manual work on the track at night, which increases safety and working conditions
- Eliminating 1 step for tamping work saves time, lowers costs and improves quality, (for example for a 40 Km length track, a 33 hours of premeasurements is avoided)
- Service disruptions can be brought down to a minimum



During 2018, 2 deliverables were planned & released. Further progress is expected during 2019, from ASSETS4RAIL project which started in November 2018.
TD3.7 has reported having accomplished 100% of the planned work up to the end 2018, which represent 35% of the overall TD.

TD3.9: Smart Power Supply Demonstrator

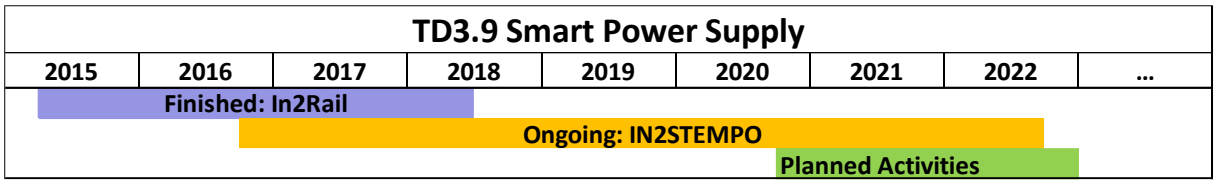
The overarching objective of the TD3.9 is to develop a railway power grid in an overall interconnected and communicating system. This will enable improvements and optimizations regarding train traffic capacity, energy losses and costs, energy supply security and availability for the railway system and environmental impact.

TD Progress

The contributing S2R projects to the progress in TD3.9 during 2018 were IN2RAIL and IN2STEMPO.

The finished IN2RAIL project delivered within 2018 the evaluation of the basic design of Intelligent Substation and its interfaces with Public Grid & with TMS/MMS-systems demonstrator. The most interesting operating scenarios have been identified and analysed. Two scenarios relate to the operation of High Speed Lines with alternating current electric traction system by use of single-phase or autotransformer feeding respectively. One of these scenarios considered a railway line already in commercial operation, in which it is desired to increase traffic density while a sufficiently powerful traction and supply network is not available. The other scenario considered a modern railway line being fed from a high-power short-circuit network. The third scenario evaluated conversion of an existing railway line with DC electrification to an AC system. The simulations results concluded that the new technology offers significant operational and technical advantages for the complete system, namely savings up to 66% of the electric traction losses, reduction of equipment size (25% reduction on the transformer size), increase in traffic, and cost savings based on the billing models. The impact on the public grid was analysed from both technical and economic point of view. Implementation rules and requirements for realisation of double side feeding, static converter and balancer application for an electric traction system were developed. Furthermore, the description of the required data structure and communication pattern structure for the interfaces between TMS/MMS and the Electric Traction System (ETS) was elaborated towards an optimization strategy in terms of energy efficiency. These new interfaces are user to enhance the Conceptual Data Model for interfacing with TMS and MMS.

The new activities started in 2017 within S2R project IN2STEMPO for the finalization & implementation of the intelligent substation demonstrator are expected to deliver first results within 2019.



During 2018, 4 deliverables were planned and released. TD3.9 has reported having accomplished 100% of the planned work up to the end 2018, which represent 40% of the overall TD.

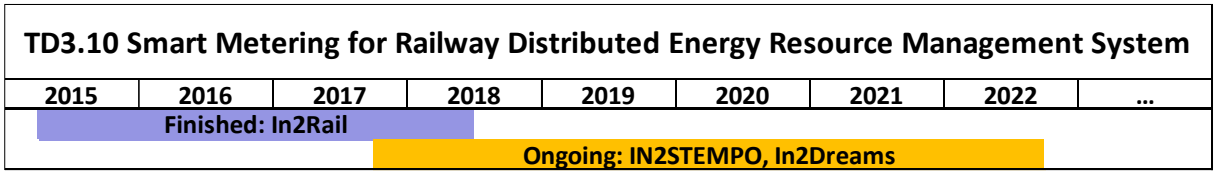
TD3.10: Smart Metering for Railway Distributed Energy Resource Management System Demonstrator

The objective of the TD is to achieve a fine mapping of energy flows within the entire railway system, as a basis of any energy management strategy.

TD Progress

The main achievement in 2018 was the successful deployment and presentation of the TD3.10 demonstrator as a S2R quick-win at InnoTrans, through the work carried out mainly in IN2RAIL lighthouse project. The demonstrator incorporated a smart metering proof of concept in real railway environment, namely in Reims tramway system constituting an innovative solution for railway system energy efficiency measurements both on-board trains and on the electrical infrastructure. Railway system was equipped with sensors for electrical values, acceleration, temperature & CO2 emissions measurements for dynamic and environmental measurements. The proposed system provides benefits such as evaluation & benchmarking of the entire rail system energy efficiency, capabilities for taking operational decisions for energy efficiency improvements, which in turn is expected to improve overall rail system LCC, building accurate business plans for energy efficiency investments & share data with travellers in order to promote energy efficiency improvements on a regular basis.

Moreover, the TD focused on the deployment of an Energy and Asset Management System comprising, i) communication platform offering connectivity between monitoring devices and computational resources, ii) open data management platform allowing scalable data collection and processing and, iii) support of a variety of user applications to enhance energy decision making. It delivered its first results in 2018: The integrated communication platform, including optical wireless communications systems was designed and the main use cases in order for the platform to be assessed were defined. Additionally, the building blocks (data collection, data storage and data analysis) for the open data management platform were developed. The validity of the proposed platform has been tested for the REIMS tramway use case enabling uninterrupted data collection from stations, sub-stations and on-board measurement systems supporting a variety of communication protocols and data sources.



During 2018, 13 deliverables were planned out of which 12 were released. TD3.10 has reported having accomplished 92% of the planned work up to the end 2018, which represent 40% of the overall TD.

TD3.11: Future Stations Demonstrator

The primary objective of the TD is improved customer experience at stations increasing thus the number of customers that will use rail as their preferred transport mode. The TD is organised around four identified key functional demands; two demands relate to improving capacity, safety and security in large stations, one demand relates to the design of small stations with the objective of reducing whole life costs and standardising design where possible and the final demand relates to platform to train accessibility.

TD Progress

The TD builds on the activities of the projects In2Stempo and FAIR Stations which were launched and started in September 2017.

A main achievement within 2018 was the analysis of the passenger needs and expectations at railway stations, for both general public and for persons with reduced mobility, taking into account that passengers and customers at railway stations are a heterogeneous group with different needs and various activities. The analysis resulted to a socio-technical study on perceptions, preferences, needs and expectations on station design, Platform-Train Interface and train egress/ingress. Furthermore, the-state-of-art of a modern rail station, including all applying technologies was defined in order to identify which factors influence more the design of future rail stations (e.g. accessibility, crowd flow, ticketing, information, safety and security, inter-modality and multi-functionality). Finally, based on those inputs, a conceptual design of Platform-Train Interface (PTI) solution was developed together with its specifications, components and functioning logic, keeping into account the needs for accessibility of persons with reduced mobility.

TD3.11 Future Stations								
2015	2016	2017	2018	2019	2020	2021	2022	…
			Ongoing: In2Stempo, FAIR Stations					

During 2018, 7 deliverables were planned out of which 3 were released. TD3.11 has reported having accomplished 42% of the planned work up to the end 2018, which represent 10% of the overall TD. The misalignment with the planned work is mainly due to an extraordinary event in Metro de Madrid (member of Fair Stations project), that affected the finalization of some planned reports. It is expected that during 2019 the TD will have fully recovered by these delays.

1.7.4. IP4 IT Solutions for Attractive Railways Services

The pictures below gives a visual perception on where the TDs will introduce improvements.

IP4 aims at designing and developing a system that respond to customer needs to support seamless door-to-door intermodal journeys encompassing different modes of transportation making the use of rail more attractive. Rail must achieve interoperability with other transport modes and mobility services, within different regions, cities and across borders.

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, following the Mobility as a Service scope. For this reason, the timetables should be increasingly integrated across transport modes to allow better modal integration and minimise travellers' inconvenience.
The IP4 is organised on three priority research and innovation areas as shown in the picture below.

TD 4.1 Interoperability Framework

The aim of the TD is to facilitate multimodal travel in a highly diverse environment and with many transport modes. Interoperability at the semantic level defines formal and explicit models of the transportation domain in an open, standard, machine-readable language that is exchanged automatically by computers, therefore allowing seamless access to all transport data and services in a multimodal and distributed environment. TD4.1 is a key technology enabler for a complete transformation of the European transportation ecosystem.

TD Progress

The TD covered different aspects of the Interoperability Framework, including implementation of components with basic capabilities, definition of architectural principles, analysis of the state of the art of ontology conversion tools and reference ontology, and understanding the current and future demand for the Interoperability Framework.

In 2018 works have continued in all these lines, concluding 3 of the 4 projects (IT2RAIL, ST4RT and GOF4R) that ended their activities in 2018, with relevant achievements and outcomes. Their results are being integrated in SPRINT, which objective is to improve the IF performance and scalability to sustain a large deployment and in CONNECTIVE, as the long term project of TD4.1.

The TD validated the set of concepts and components deployed during the project, allowing the different orchestrators deployed in the project to interoperate with a number of Travel Service Providers. It advanced on building the conceptual design of the converter-generation procedure with annotations for mapping from legacy data models to ontologies, building a technical demonstrator for a bi-directional converter between Full Service Model and TAP-TSI for a pre-booking use case. The main achievements in this period, related to the three initial objectives are:

- *Methodologies for annotation/mapping between legacy data models and ontologies:*

The methodology and tools have been updated to include the capability of annotations and conversion not only of local resources, but also of distributed ones. As a result, it has demonstrated that IP4 approach “semantic interoperability” is sound, and works in practice.

- *Mapping between the IT2Rail reference ontology and legacy data models:*

The implemented converters contribute to the achievement of this objective. Moreover, it should be noted that the semantic processing model and tools of ST4RT have been merged with IT2Rail through the integration of the ST4RT converter in the IT2Rail Interoperability Framework (IF).

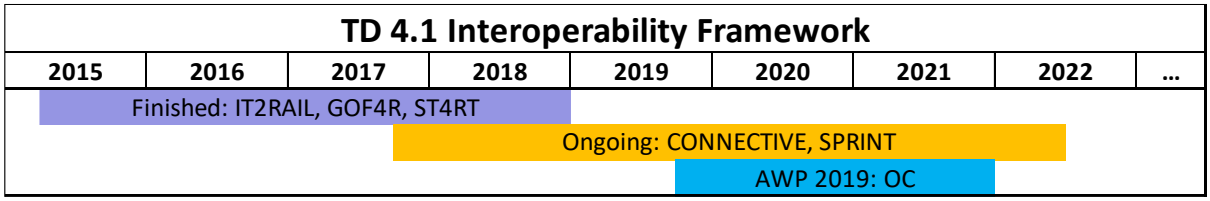
- *KPIs and Metrics for the transformation evaluation:*

A set of KPIs and metrics have been provided for the implementation conversion framework. Evaluation has been performed for different scenarios (4 in total) and different cases.
The list of KPIs covers a wide list of ST4RT outcomes that have been evaluated (e.g. model creation, conversion time, etc.).

The evaluation outcomes (in terms of performance) have not been as expected. Exploitation of REST instead of SOAP could mitigate the performance overheads, since REST allows for scalability (as well as caching that could be utilized if needed). However, TAP-TSI and FSM are in XML formats, thus this had been the only choice at this point to focus on XML and SOAP.

On the other hand, market watch and surveys performed have helped to understand market demand and regulatory environment, with the objective of drafting a roadmap and recommendations for the successful deployment and governance of the Interoperability framework.

Part of the TD´s activities has been oriented towards the integration of individual outputs of R&I in the complete IP4 ecosystem. It included the generation of converters, based on S2R ontologies, to integrate orchestrators with the framework. Components deployed also allow the orchestrators to interact with legacy from a number of TSP in order to perform end to end shopping, booking and ticketing functionalities, including new types of modes not integrated in IT2Rail, such as private cars, and preparing the integration of new capabilities, such as after sales. The project has also started to design the process to allow Travel Experts to join the ecosystem.



During 2018, all pending deliverables of IT2RAIL (LP), GOF4R and ST4RT have been delivered (19 deliverables). During 2018, 3 deliverables were planned in TD4.1 CONNECTIVE project, out of which 2 were released. The overall progress is in line with the plan with regards to MAAP for project CONNECTIVE, with a slight delay of 4 months in the integration with the other CFM projects.
Since the beginning, TD4.1 has accomplished 80% of the planned work up to the end 2018, which represent 25% of the overall TD. This is because most of the work related to the IF will be performed in the project CONNECTIVE, which is a long term project that will last until June 2022.

TD 4.2 Travel Shopping

The concept of TD 4.2 Travel Shopping is both to enable, and to respond to, an emerging single European multimodal transport market place within a Single European Transport Area (SETA). The IP4 approach will promote the integration of distributed travel operators' data and services and the orchestration of services such as expert journey planning and offer building for all modes. It will benefit from the Interoperability Framework that enables applications based upon different standards or coding lists, to communicate meaningfully but without costly application adaptations with the existing legacy systems of all stakeholders.

TD Progress

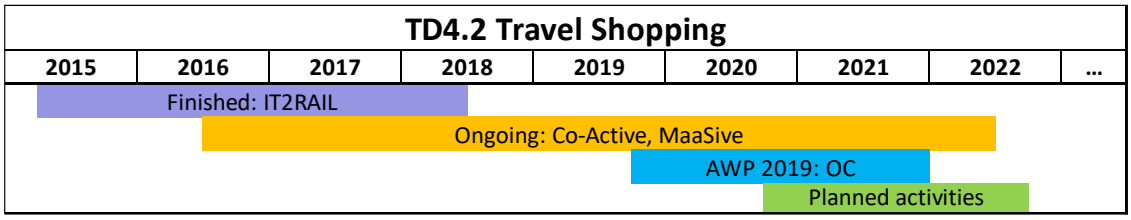
The TD4.2 contribution to the S2R Eco System is to enhance the technical facilitation of a one-stop-shop capability, to enable comprehensive choice of itineraries and offers from modes/operators able to respond to customer mobility requests, especially through the use of existing services from all stakeholders by interfacing their legacy systems.

The basic idea of the travel shopping system has been designed within IT2Rail (LP) using a distributed architecture. After a detailed specification phase in 2017 and in early 2018, which took the outcomes of IT2Rail into consideration, the objective of Travel Shopping in 2018 was to set up a proof of concept system as a starting point for all future developments.

The Cloud Wallet (CW) is one of the core components in the Shift2Rail Eco System. It stores all necessary information of the users travel needs like preferences, itineraries, and corresponding status and so forth. In 2018, the Travel Shopping now interacts with the Travel Experts and the Cloud Wallet by using TRIAS, a German VDV standard. All results of an itinerary search are stored in the CW using this interface. Additionally, the set of user preferences in the Travel Companion is now taken into consideration by requesting itineraries through the Meta Network as well as the Travel Experts.

Two main milestones have been reached in 2018. The first one was the development of the core release (CREL) in April. This version was demonstrated at the TRA 2018. The second milestone was the development of the Quick Win Version for InnoTrans in September in Berlin. On this fair, the IP4 Program demonstrated the whole S2R IP4 Eco System. The development of the Final release (FREL) specification and the update of the Quick Win Version by eliminating necessary integrated shortcuts already started in 2018.

An the interface to the user has been built and through this interface, the user can define his travel needs, receives the results of the Travel Shopping process, and starts the Booking and Ticketing process. The coordination among different funded R&I projects and the effort to achieve system coherence between all projects was more time consuming than expected, hence some overall delay.



The definition of the first ideas of a new Travel Shopping system has started with the LightHouse project IT2Rail. This project it has been finished in 2018. The final and successful presentation was held on the TRA 2018 in April in Vienna.

The overall progress of the TD4.2 Travel Shopping for 2018 shows an estimated completion rate of 80% in relation to the planned tasks. Delivered was the C-Rel specification. The work within the Travel Shopper area will continue until 2020. The Travel Shopper Demonstrator targets TRL 5 and the technical demonstrator TRL 6.

During 2018, 3 deliverables were planned out of which 2 were released. The overall progress is in line with the plan with regards to MAAP for the project CoActive but the activities usage of business rules has been delayed. Additional activities are planned for S2R ongoing and future projects. The Travel Shopper Demonstrator targets TRL 6.

Since the beginning, TD4.2 has accomplished 90% of the planned work up to the end 2018, which represent 75% of the overall TD. The work within the Travel Shopper area will continue during 2019.

TD 4.3 Booking & Ticketing

Today, even within a given mode (air, rail, urban, etc.), the rights to travel have, in the best case, a limited interoperability between the various travel service operators, and this interoperability is almost non-existent between the modes themselves. The aim of this TD is to orchestrate multiple but parallel interactions with several booking, issuing, payment and ticketing engines, including the all-important roll-back activities. This will radically simplify the traveller's life, by abolishing uncertainties and

complexities associated with 'behind-the-scenes' multiple booking, issuing, payment and ticketing processes.

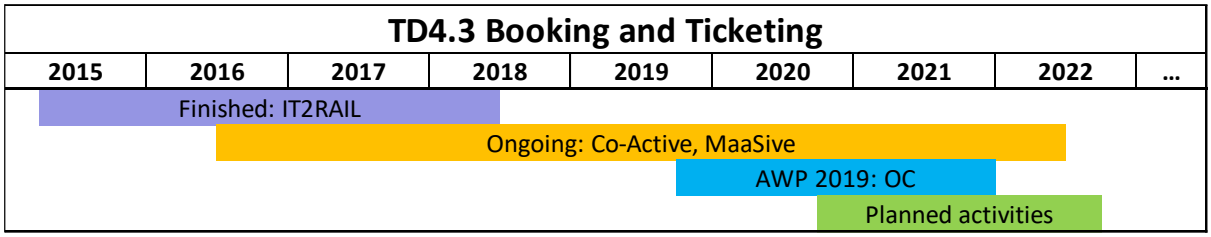
TD Progress

The objective of the TD for 2017 was to develop and integrate a Booking & Ticketing orchestrator able to manage Travel Service Providers (TSP) with booking and ticketing functionalities. During 2018, IT2Rail completed its works, demonstrating the performance of the booking and ticketing flow within the IP4 ecosystem, with a limited scope and capabilities. Co-Active relies on the IT2Rail designs and specifications, but has worked in the redefinition of some of the existing components and the deployment of new orchestrators that can manage interactions (through the Interoperability Framework) with each of the separately contracted TSPs and apply the needed logic to integrate this information.

The new components deployed allow to offer the traveller new functionalities, such as after sales operations (cancellation, refund) or purchase of ancillary services (WiFi, lunch). Orchestrators have also been deployed taking into account new modes not integrated in IT2Rail, such as private cars. Moreover, works have started to support re-accommodation process where alternative itineraries are calculated, in order to take into account the entitlements already purchased.

Important progress has also been made in 2018 concerning issuing, clearing and settlement capabilities, allowing not only the generation of the entitlements and tokens needed for each trip segment, but also the distribution of the corresponding payments to each TSP, through the integration of a Payment Service Provider and the proposal of a Virtual Credit Card solution. Moreover, each TSP is able to check its associated payments through a specific interface deployed. This interface complements the specific platform, deployed within TD4.2, to manage rules for shopping and clearing phases (such as multimodal discounts). These activities are complemented by the analysis on the business and contractual management aspects, which in this year have been extended considering ancillary services, personal and shared transport modes.

One of the main outcomes of the year has been the demonstration of some of the functionalities of TD4.3 at InnoTrans ("quick win"), which required not only deployments on the side of TD4.3 components, but also integration with other projects (for example with the Cloud Wallet and Travel Companion, and with converters and Interoperability Framework). This level of integration that was not initially foreseen in the project has been very useful to test the initial architecture and whole flow in the shopping-booking functionalities. However, the extra effort also had an impact in reaching the FREL complete scope, and for these reason the project is expected to be finalized in the first half of 2019, instead of at the end of 2018, as it was originally planned.



The overall progress of the Booking and Ticketing TD for 2018 is therefore beyond what was initially planned. During 2018, all pending deliverables of IT2Rail (LP) related to TD4.3 were delivered.

During 2018, 4 deliverables were planned in TD4.3 CFM Co-Active project, out of which 2 were released. The overall progress is in line with the plan with regards to MAAP for project Co-Active, but

a number activities experienced delay, such as those related to orchestration and failure cases. Works in the TD will continue during 2019 in the frame of project Co-Active, to finalize the FREL, that will reach TRL 6. Also during next year, the MaaSive project will carry on with the specification and implementation works that will give continuity to the booking and ticketing activities developed in Co-Active

Since the beginning, TD4.3 has accomplished 85% of the planned work up to the end 2018, which represent 60% of the overall TD.

TD 4.4 Trip Tracker

The Trip Tracker will assist a traveller throughout his multimodal journey with technologies which accurately and timely notify travellers of any unforeseen difficulties on their individual trip, and providing alternative routes to limit impacts of delays. When a disruption occurs, the TD will provide assistance by calculating with a multimodal approach both whole new itineraries door to door, and from the current position or even only single legs. Trip Tracker will analyse and correlate available static data (such as timetables, topologies), dynamic data (such as road traffic data, transport real time data, operational feeds, social networks) and passengers' data (such as preferences, itinerary, locations).

TD Progress

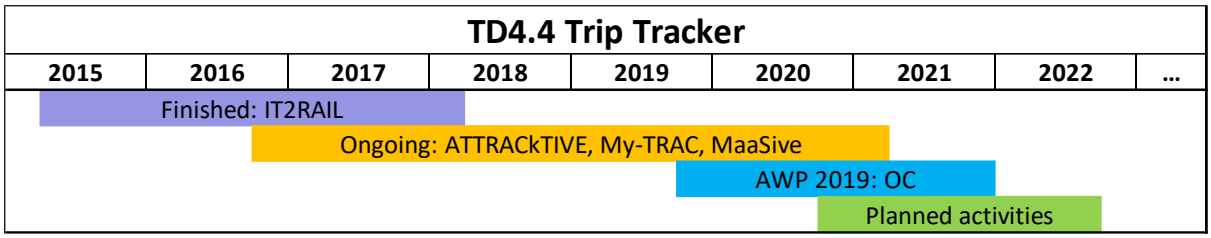
The basic idea of a trip tracking system has been designed within IT2RAIL (LP) comprising the activation, disruption detection and alternative managing of an itinerary. 2017 has been the period to expand the architecture of this trip tracking system to a modular one. The work performed in 2018 aimed to develop this system consisting of the Tracking Orchestrator, different partial Trip Trackers and the corresponding Event Source Management. Development in ATTRACkTIVE has been divided into the CREL, an intermediate Quick Win Release and the FREL.

Work has also started for the development of a mechanism to filter the relevant data and the relevant events to the tracked journeys. Apart from identifying the events per mode (multimodal approach) combining information from multiple modes, it will help to detect and generate new events, as well as to predict the impact they can have in other transport modes.

The modular architecture requires several interfaces. The most important one is the interface between the Tracking Orchestrator and partial Trip Tracker. Originally it was planned to set up a new interface that covers all needs. But it was faced that this bears too many obstacles. It was decided to use TRIAS as the most suitable one. Being a German VDV standard it was translated into English.

Two main milestones have been reached in 2018. One is the specification of the Core Release and its implementation project. The other one is the development of the software for the Quick Win for this project. This release has been demonstrated at InnoTrans. Development of this intermediate system had been much more time consuming than expected. Several functions had been planned for a later stage for the FREL and thus had to be simulated or reduced compared to the final system.

During the whole period technical coordination and system coherence between all projects took place. Among others the aim is to perform the integration of the partial Trip Tracker developed in the project My-Trac into the overall S2R Trip Tracking system, adding new mechanisms to track a journey, based on the collection, elaboration and integration of real time and historical data from diverse sources.



Regarding the progress, three projects have contributed to the development of TD4.4 during 2018: IT2Rail, ATTRACkTIVE and My-TRAC. All deliverables have been finished and delivered in 2018. During 2018, 2 deliverables were planned out of which 2 were released. The overall progress is in line with the plan with regards to MAAP for the project ATTRACkTIVE, but the activities regarding positioning and navigation have been delayed.

The Open Call My-TRAC started in September 2017 and is mainly right on schedule. Extra work has been done on European GDPR, which is important for trip tracker functionalities as well. The work in the Trip Tracker area will continue during 2019 in running and upcoming projects. The Trip Tracker Demonstrator targets TRL 6.

Since the beginning, TD4.4 has accomplished 85% of the planned work up to the end 2018, which represent 65% of the overall TD.

TD 4.5 Travel Companion

The overall objective of the TD is to research, implement and evaluate a seamless and interoperable platform offering new levels of interaction between travellers and transportation stakeholders along with an innovative ubiquitous adaptive front-end to the global transportation service ecosystem.

Thanks to their own personal and secured '*Travel Companion'* travellers will have access to all travel services needed for the journey, shopping and booking as well as novel forms of experiences which extend and transform the journey to a real door to door experience.

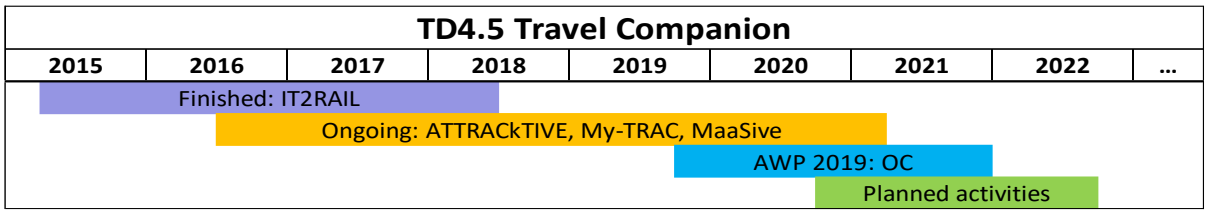
TD Progress

The work carried out throughout 2018 consisted of the completion of CREL implementation as well as the FREL specification and implementation. Indeed, the work that has been done focuses on the specification and implementation of the modules required to produce the final version.
However, the TD progress for 2018 was focussed on preparations for InnoTrans, putting some FREL activities on stand-by until the end of InnoTrans. This is the reason why the TD is running slightly behind schedule planning.

Significant efforts in integration and testing where done in 2018 in view of the Quick-Win demonstrator. While these results are a good bedrock for the FREL, additional developments are needed to achieve the full FREL version of the Travel Companion.

This prototype, including the modules made in 2018, has been successfully tested. During Innotrans visitors could test a preliminary version of the new multi-modal booking system using a smartphone – and experience a simulation on how the system could make a trip between Madrid and Berlin much simpler. The visitor could plan, book, get the different tickets for the multimodal trip, validate the tickets and test the after sales services. The trip tracking could be tested by simulating the trip

This demonstrator is part of the development of transportation as a service, also known as 'Mobility-as-a-Service', a new concept of mobility: A shift from a piecemeal 'individual transport modes' approach towards a world of 'solutions' provided and consumed as a service.



During 2018, 2 deliverables were planned for TD4.5 out of which 2 were released. The overall progress is in line with the plan with regards to MAAP for the project ATTRACkTIVE but the activities regarding positioning and guidance has been delayed.

Since the beginning, TD4.5 has accomplished 85% of the planned work up to the end 2018, which represent 70% of the overall TD.

TD 4.6 Business Analytics

The TD will provide a common business intelligence foundation for all products and services transport providers based on the access to open-ended web of transportation data offered by the Interoperability Framework (TD4.1).

Based on descriptive, predictive and prescriptive analytics using multimodal data sets generated by the services developed in IP4, the TD will help the passenger carriers to better adapt their level of service to the passengers demand and to optimize their operations. TD4.6 will also provide interactive and dynamic visualization capabilities.

Data privacy is also an important issue in transportation: GDPR is effective since May 2018 and before GDPR adoption, other regulations were applied in a transportation context. In this context, anonymization services will be developed to guarantee privacy and confidentiality.

TD Progress

The TD objective for 2018 relies mostly on work performed in CONNECTIVE project. Business Analytics within the CONNECTIVE project aims to give a further step compare to IT2Rail (LP). An issue encountered during the development of the BA module was that IT2Rail was a proof of concept and no real data was available. The KPIs provided were simulated.

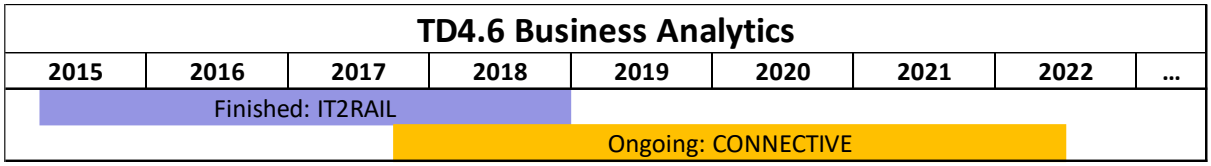
Within the TD, the Business Analitics (BA) wants to make a step forward managing real data from real operators and developing richer algorithms to perform predictive and prescriptive analyses.

Initial use cases have been defined around smart operational control centres, station crowd behaviour, monitoring equipment and maintenance, maintenance activities/assets degradation impacts mitigation. The first two use cases aim to produce data and analyses of mobility (inside a big city like Paris and suburbs or inside a station). The last two use cases focus on how maintenance information can be exploited within the IP4 context in order to meet the dual objective of increasing on one side the Quality of Service and passenger demand by enhancing service availability and efficiency, and on the other side providing operators with techniques to improve the perceived reliability of the whole transport ecosystem. Two use cases are also developed jointly with IP3 project use cases: passenger

flow analysis inside huge stations and predictive maintenance with impact analysis for travellers. For each of these use cases, objectives have been defined, data collected and first implementations and results have been produced.

Algorithmic and technical developments have also been started to enrich later the use cases. These developments concern the implementation of anonymization algorithms, data generation techniques and virtual reality techniques.

Last, a common architecture across the partners has been defined. This choice is determined for being aligned with the developments and for having a common foundation where build up the Business Analytic S2R-IP4. Different implementations have been done by the partners, mostly around the Big Data Hadoop Hortonworks framework or similar. These architectures suffer from some drawbacks (the traditional database computer programming language, such as SQL, may perform badly on Hadoop platforms, data visualization may be quite slow when data to be displayed is important). As Big Data domain is a very fast evolving environment, new promising Big Data architectures appear regularly on the market. Hence, benchmarking is very important task regarding this TD and in 2018, benchmark has been done to answer the two drawbacks described above.



During 2018, 3 deliverables were planned out of which 3 were released. The overall progress is in line with the plan with regards to MAAP for the project CONNECTIVE. Work in this TD will continue until 2022, supported by the activities of project CONNECTIVE.

Since the beginning, TD4.6 has accomplished 80% of the planned work up to the end 2018, which represents 25% of the overall TD.

ITD 4.7 Integrated Technical Demonstrator

At the core of the ITD, lies the objective of opening the transportation ecosystem to new business actors, able to rejuvenate the transportation ecosystem technologies and business models, thus achieving the goals of European leadership in the market. The ITD will release, on a regular basis and for all TDs, successive versions of enriched deliverables, from early conceptual prototypes to the final version. It will act as the orchestrator of other TDs' developments, and will ensure the systems approach to integrate the different TDs' results.

ITD Progress

The ITD objective for 2017 was to address the coordination of technical activities including activity planning and follow-up, definition and production of the technical management documentation used to guarantee effective monitoring and control of activity and its progress.

Activities in ITD4.7 are mainly provided by project COHESIVE that started in September 2017. Practical integration activities started in 2018, taking over similar activities developed in IT2RAIL. The first actions of the project were related to the introduction of the overall technical management and organisation rules to be followed by the other CFM projects, with the aim to offer robust, yet tailored, means of monitoring and control of the integration activities progress. A first set of guidelines has been

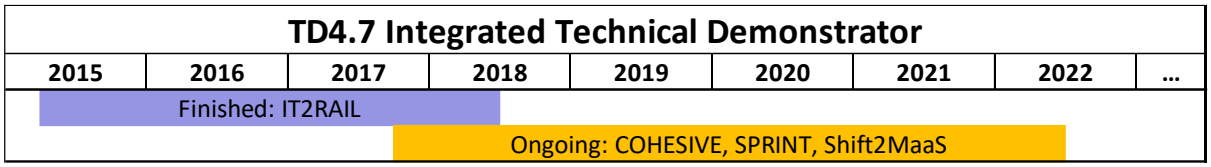
produced, addressing the technical project management and the Work Packages (WPs) internal management which guarantee the project consistency, prescribing methods and procedures to be followed throughout the WPs own lifecycles. A technical principles package included production and delivery of Technical Principles, Data Management Plan, Generic Test Plans, Guidelines, and Configuration management Plan, published in 2018. The Project Management and Quality Plan and Risk management have been also issued in the first and second quarter of 2018.

Most of the initial, preparatory and setup activities undertaken in COHESIVE were based on and supported by the experience acquired and lessons learnt from running projects, ensuring efficient communication, information sharing, interfacing and synchronization among a set of projects, each having their own programs, planning and objectives. Although targeting a common objective, the formal separation stemming from specific Contractual and Grant Agreements needs to be overcome to ensure overall target, consistency and fluidity required by the ITD.

During 2018, IT2Rail project was finished, finalising all integration activities and submitting all pending deliverables. The COHESIVE project submitted 6 deliverables and has at this stage 4 under preparation. Activities and deliverables related to the Alfa release are on-going.

The documentation and integration activities undertaken in the IT2RAIL were similar to those in Cohesive and were sometimes done in parallel, supporting both projects.

One of the main achievements of the year has been the integration and the demonstration of specific use-cases for InnoTrans 2018.

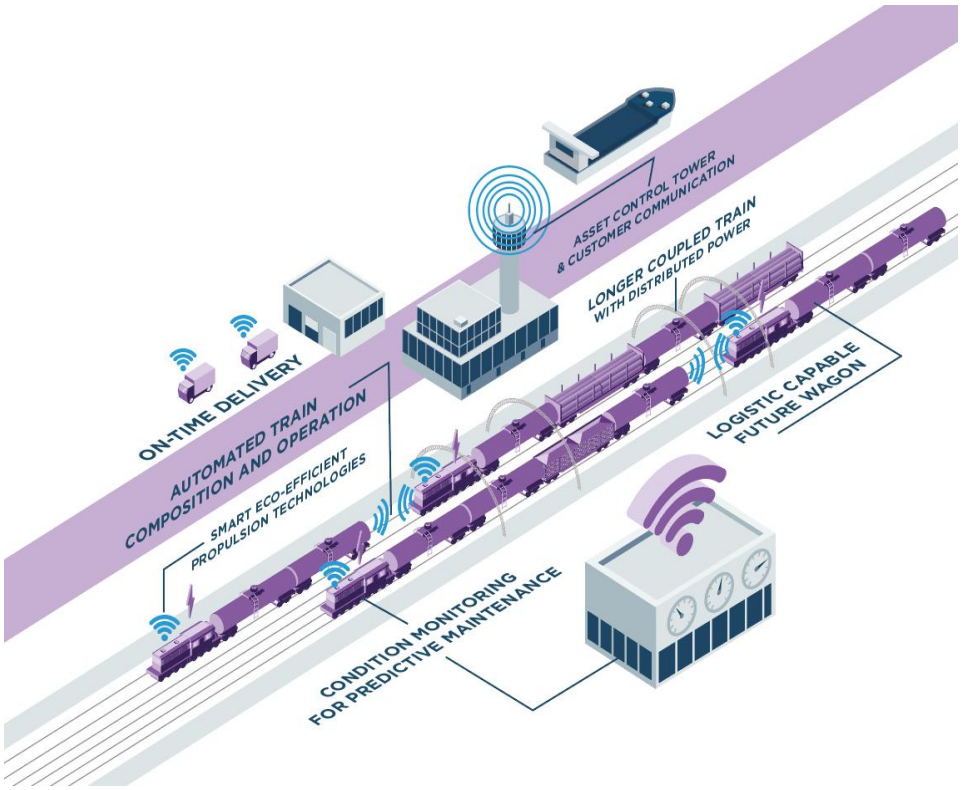


During 2018, 13 deliverables were planned out of which 7 were released. 3 were planned for a later stage to align with a slight adjustment of the Alfa release. The overall progress is in line with the plan with regards to MAAP for the project COHESIVE and the activities related to synchronization with the remaining CFM projects. Since the beginning, iTD4.7 has accomplished 80% of the planned work up to the end 2018, which represent 23% of the overall TD.

Work in this ITD will continue until June 2022, mainly with the support of project COHESIVE. The TRL is expected to be higher than 6 for the final release in 2022.

1.7.5. IP5 Technology for Sustainable and Attractive European Rail Freight

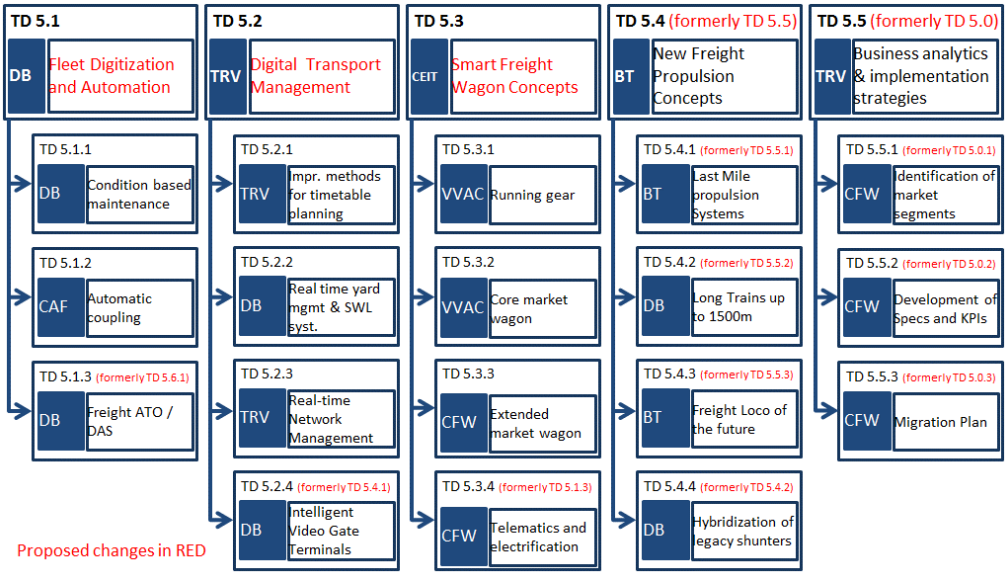
The picture below gives a visual perception on where the TDs will introduce improvements. Please note that the TD structure presented in this Report do not yet reflect the upcoming IP5 structure improvement which is currently ongoing with the MAAP Part-B update.



This IP aims at improving the cost competitiveness and the reliability of freight services of the rail sector in order to meet the ambitious objectives of almost doubling the use of rail freight compared to 2005. This will allow achieving the White Paper objective of 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. Work focus on different market segments with specific technical and operational characteristics and needs.

During 2018, IP5 has progressed very well in the re-prioritization of its Technology Demonstrators (TDs). While in terms of content no much difference shall be reported, the reorganization of the TDs allows for a more focused and prioritized series of R&I activities, with clear targets towards digitalization, automation and sustainability.

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



TD5.1 Fleet Digitalisation and Automation

This TD targets the adoption of two global megatrends for freight rolling stock: the automatic coupling for freight trains, which is an important enabler for reliable data connections through the train, and digitisation of rolling stock, which leads to smart, connected assets that offer the necessary information for improved services. Therefore, the TD focuses on areas such as condition-based and predictive maintenance of locomotives and wagons and wagon monitoring systems, automatic coupling and freight ATO/DAS.

TD progress

This TD currently progress through the work performed in FR8RAIL, ARCC, FR8HUB, INNOWAG, SMART and FR8RAIL II projects. Further inputs are expected from the project stemming from the call CFM.

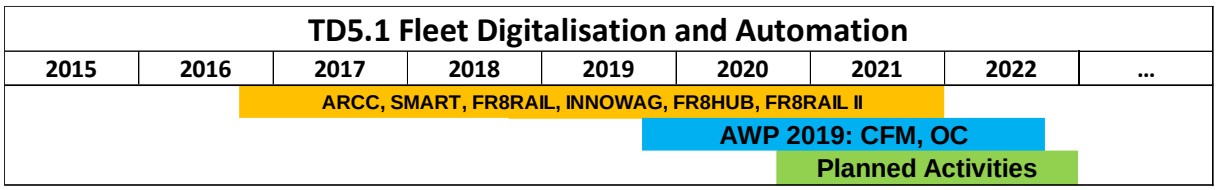
In the area of CBM, the work continued with the identification of the variables which assess the condition of a component (such as temperature, wear and condition of operating material), as well as the identification of the threshold of these reference variables in which a maintenance task is required. Since in 2017 the focus was rather to classify the top components and feedings. In 2018, the aim was to analyse the data of these components, which is one of the most essential task within CBM. With this information, condition based and predictive maintenance will be enabled by knowing which parameter needs to be monitored to detect malfunctions and abrasions of these components. By knowing which signals are required, Big Data/Analytics can be used to identify algorithms and patterns and data analytics to develop maintenance rules. In doing so, any necessary maintenance measures can be scheduled in separate downtimes, which have a much smaller effect on the operation. As a result, the technical availability of the locomotives will be significantly affected in a positive way.

On the other hand, the TD has designed, prototyped and tested in the lab and in relevant railway environment the sensor focussing on two applications: container wagon with sensitive goods, and tank wagon carrying hazardous goods. It delivered the definition of scenarios for CBM on wagon bogies and the definition of subsystem architecture to determine the prerequisites for CBM on wagon bogies. Additionally, laboratory stress tests to acquire data of the failure of selected wagon bogie components (e.g. spring) to be monitored have been carried out. One of the most relevant results is that the higher frequency of the dynamic response is around 270Hz, which sets a lower limit for the sampling frequency of the sensors to be used in the on-board system of 540Hz. Finally, initial activities have been done regarding CBM. An Assessment of current maintenance regime of relevant locomotive types and the definition and specification of a target process for diagnostics-based maintenance in both locomotives and wagons has started. This work continues previous activities in Shift2Rail projects and aims to a reduction of the total operational cost of rail freight i.e. in maintenance.

In the area of automatic coupling, the TD has collected all the technical requirements list that should be complied by the new automatic coupler. A competitive solution that covers the main needs detected in the current couplers and in the target market segments is being designed based of these requirements. A new automatic coupling concept has also been developed. This solution will form the basis for the new European-wise solution that will lead to the project demonstrator, to be tested in further steps of the project. Moreover, the interfaces of electrification and telematics for the wagon with automatic coupler are been defined and integrated.

For ATO the goal was to have a well-established demonstrator so that the test run could be performed in early 2019. A strong coordination between ARCC, X2RAIL-1, X2RAIL-3 and SMART was required and it was more time consuming than foreseen; today the lab tests are planned for 2019, while the

demonstrator will be tested in 2020. Nonetheless, the discussion regarding the coordination was also used to agree on the test locomotive (BR185.1). Moreover, the discussion regarding test cases was initiated and the overall documentation was taken one-step further, this includes the description of work, schedule, technical description, etc. On the other hand, the TD has concluded the requirements and specifications for obstacle detection and presented at Innotrans2018 the obstacle detection system prototype. The work goes on with the development of software algorithms for obstacle detection on railway tracks. The topic DAS started in late 2018.



During 2018, 18 deliverables were planned out of which 8 were released. The overall progress appears to be in line with the plan with regards to CBM and automatic coupling, while the ATO activities have been delayed for the above mentioned reasons.
Since the beginning, TD5.1 has reported having accomplished 60% of the planned work up to the end 2018, which represent 50% of the overall TD.

TD5.2 Digital Transport management

This TD is targeting the digitisation of processes to optimise service planning and operation thanks to real-time data gathering, steering, operation and coordination of intermodal transport at higher speed. This supports better utilisation of available capacity, by optimising access and operation of local hubs which are essential but cost-intensive subsystems for rail freight business. The TD is looking into improvement of effectiveness in marshalling yards and terminals with the introduction of innovations in real time information management (e.g. intelligent video gate). The key challenge is to improve the interaction between yards/terminals and the network, thus reducing the lack of information and adding new decision tools that will increase the punctuality and capacity.

TD progress

This TD builds on the following projects: ARCC, SMART, OPTIYARD, FR8HUB and FR8RAIL II. Further input is expected from the project stemming from the call CFM in 2019.

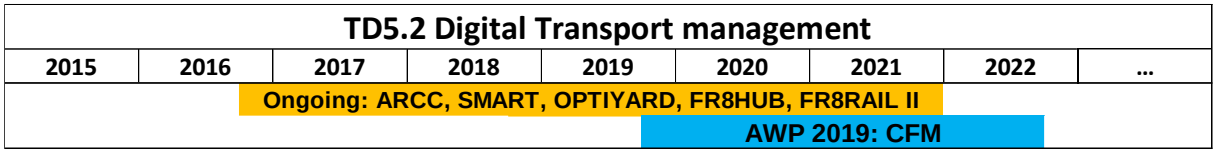
The 2018 TD's goal was to move ahead on the development of the solutions identified for reducing the gap between planning and operation and developing methods for improving real time yard and network management.

In the area of real time yard/network management and timetabling, the TD has developed a good understanding of yard-line interaction by providing a detailed analysis of the biggest marshalling yard in Germany and Sweden and the interaction between a freight company, a yard manager and an infrastructure manager. Here, the main deficiency to study is the low connection between freight traffic and timetables. For example, currently the terminal operator cannot know the accurate ETA of neither freight trains nor trucks during disturbances. Albeit there is normally an ETA for arriving freight trains, it is not automatically passed on by the terminal operator to road hauliers, and in case of deviations trucks arrive at the Terminal without any pre-arrival notification. Due to the various non-standardised IT systems and manual routines for information exchange (telephone, email, etc.) among the involved stakeholders, the terminal operator cannot always be informed in advance regarding the

sequence of unit loads on the trains, thus making the decisions regarding the planning of transhipments and pick-ups cumbersome. As the information chain is long and the digitalisation status is on a low level, the information flow is prone to disruptions and when it is disrupted trucks will experience idle times at the Terminal or empty returns from the Terminal. Moreover, requirements for real-time decision processes were collected and summarised in order to present demonstration scenarios for a Real-time Yard Management System in 2019/20.. The description of modelling requirements for a real-time decision support system both for yard and for yard-line operations was delivered and how the use of artificial intelligence methods will contribute to an appropriate decision support system was analysed. On the other hand, the TD provided a full mapping of functional requirements and technical characteristics for real-time data management; the identification of yard processes, and the definition of strategies for improving real-time yard operation in relation to the relevant real-time information obtained from the network; a validated simulation environment. Furthermore, a first concept of General Architecture of Multimodal Freight Data Exchange Platform have been described.

Regarding timetable planning, an improved methodology was provided and the state of the art in practice was described for timetable planning in Sweden, UIC 406 method and AnsaldoSTS Traffic management systems. The main focus is to close the gap between planning and operational traffic in order to raise automation, effectiveness, capacity and punctuality. The TD provided specifications of the functionalities in real time network management. The main functionalities in data-driven future operative and strategic decision support systems are in 1) tactical data driven timetable planning, 2) operative traffic control adjustment for a single train, and 3) tactical planning, analysis and models of yard and network interaction. Moreover, initial studies on faster freight trains were carried out, categorising those trains and analysing railway lines in Germany for evaluation of faster freight traffic. Optimization processes as well as static and dynamic parameters of the marshalling yard management system were well considered and the project uses TAF TSI as basis of the activity. The TD analysed information from six selected European marshalling yards for the integration into a unique database. This will be used as an input for modelling, simulation and optimization of marshalling processes and for validation of real-time optimization algorithms. The TD has delivered the architectural design of a web-based information system for supervision and management of marshalling yards. The general concept of a machine learning decision system which will be trained to provide the optimal or near-optimal solution of marshalling operations in real time, based on data of optimization from heuristic or meta-heuristics optimization algorithm, was also conceived.

In the area of IVG, the TD presented at InnoTrans 2018 a scale model/demo of their system to scan wagons at terminals after studying the prerequisites for the technology and the market study to ensure that appropriate components are selected. The target is to reduce the processing time down to 15 min per train, to increase the terminal capacity/throughput by 15% and to achieve a 75% reduction of complains and disputes for damages/losses with customers Further work on this area is ongoing with the aim of delivering a proof of concept for the system and a test on terminals.



During 2018, 14 deliverables were planned out of which 11 were released. The overall progress appears to be in line with the plan.

Since the beginning, TD5.2 has reported having accomplished 75% of the planned work up to the end 2018, which represent 60% of the overall TD.

TD5.3 Smart freight wagon concepts

This TD has the objective of delivering technical demonstrations of next generation running gear and wagons for freight. The next generation freight wagons will improve the competitiveness of rail freight logistics by providing more flexible and reliable high-capacity assets at competitive costs. This will be achieved by means of the technological outputs to be delivered by this TD consisting of low-noise, lightweight, high speed & track friendly freight running gear, intelligent freight wagon 2020 for core market share increase & extended markets able to provide information such as status and location.

TD progress

This TD builds on the following projects: FR8RAIL, INNOWAG, FR8HUB and FR8RAIL II. Further input is expected in the future from the projects stemming from the calls in 2019 and 2020.

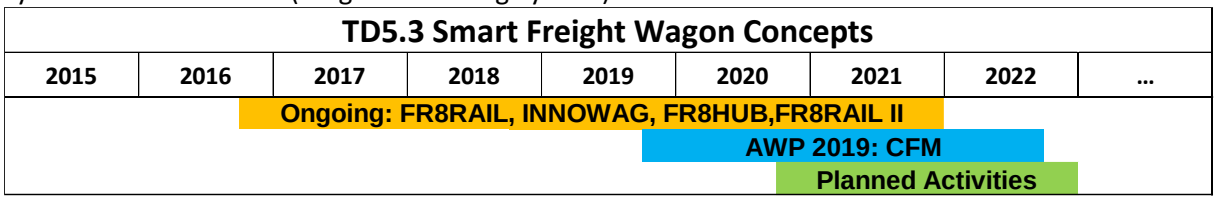
The 2018 TD's goal was to progress on the specification and design of the elements that compose this technology demonstrator.

This TD has been working on the areas of running gear, wagon design (core and extended market) and telematics & electrification. It has completed design, defined components and manufactured the running gear and completed the pre-studies for extended market wagon design. The design of the wagon structure describes the coupling system, the adjustable end carriages, as well as the buffer compensation and it includes a structural analysis with different load schemes and boundary conditions. On the other hand, for the bogies and wheelset concepts, the use of break disks as a breaking system was defined in order to reach an overall reduction of 6 dB, and investigations focused on novel wheelset design and materials.

In addition, the core market wagon design was completed. the TD has focussed on three case studies/concept designs: Y25 bogie concept which achieved an overall mass reduction: 17% (mass reduction of bogie frame: 30%); intermodal flat wagon concept which achieved an overall mass reduction: 22.4% (mass reduction of wagon underframe: 28.5%); and Cereals hopper wagon concepts which achieved an overall mass reduction: 27.2% (mass reduction of hopper body: 50.7%).

The TD has also initiated the activities of definition of components and wagon manufacturing. In the area of telematics and electrification, all the running projects has contributed to the advancement on the high level specification definition, the feasibility analysis and the preliminary testing of telematics.

This activity will be conclude once the safety analysis and gap analysis is delivered since it might bring new requirements that can modify the architecture. Finally, the conceptual preliminary design has been completed based on wagon On-Board-Unit (wOBU - Comm. and Pos.), Wagon Monitoring systems WMS and CMS (Cargo Monitoring System).



During 2018, 13 deliverables were planned out of which 9 were released. The overall progress appears to be in line with the plan.
Since the beginning, TD5.3 has reported having accomplished 80% of the planned work up to the end 2018, which represent 40% of the overall TD (even though some activities are have covered a higher percentage).

TD5.4 New freight propulsion concepts

The target of this TD is to provide more attractive rail freight services to the final customer, with competitive rail solutions maximizing flexibility and efficiency while reducing the operating and maintenance costs. The focus of this TD is on improving the overall performance of today's locomotives by adding and integrating additional functionalities and technologies. Future locomotives will provide extreme flexibility for operation in non-electrified and in electrified lines, allowing private and public operators to offer broaden rail freight services according to demand without the need of changing the locomotive or allowing the new production concepts. Future locomotives will 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 transport. Moreover, other areas of work include: reduced LCC, braking energy recuperation, operational efficiency increase by automating various activities such as train start-up, train preparation, start of mission, stabling and parking, generally shunting.

TD progress

This TD builds on the progress made with the project FFL4E, FR8HUB, DYNAFREIGHT and M2O.

The 2018 TD's goal was to finalize the specification and getting close to conclude the development of the activities of FFL4E in order to successfully implement the demonstrators in Q1 2019; to finalize all activities in DYNAFREIGHT an close the project, to continue with the specification and analysis work in FR8HUB; and to start organizing the work to be done in FR8RAIL II and M2O.

In the area of last mile, the TD continued the development of the Full Electric Last Mile Battery Building Block with a state-of-the-art water cooled 25kWh Li-ion battery. The electrical integration (complete electrical schematics), including the protection concept has been developed allowing a safe integration into the traction converter of the locomotive. The cubicle will be built and tested (demonstrator) in Q1/2019. An overview with requirements and assessment criteria about the possible drive types (e. g. combustion engines, battery, fuel cell) for a last mile has been created. The preliminary result indicate that technically the Diesel engine is a fit for purpose solution for short-term and mid-term, while for the long-term solution fuel cell drive seems more appropriate. For Diesel engines, last mile Diesel with engine power 230kW (existing one) and 300kW were modelled, simulated and compared. The performance increase of 70kW (30%) has benefits for the customer concerning the increase of tractive effort, tonnage and acceleration. Based on that, a feasibility study for the integration of a Diesel engine EU Stage V with an engine power 300kW in the existing last mile diesel frame (pre-requisite) has been executed. Three different Diesel engines EU Stage V with after-treatment system have been examined in the 3D. The examination has been made in collaboration with engine suppliers.

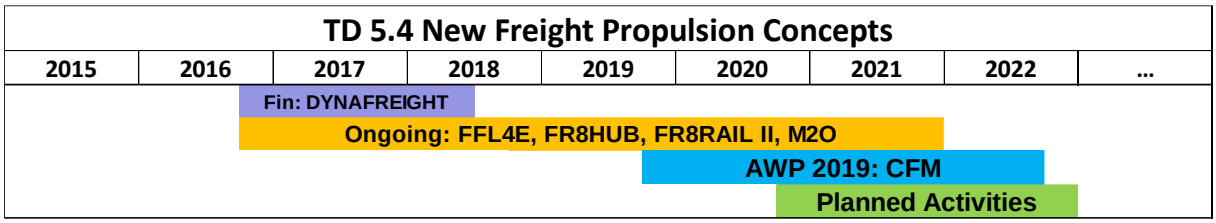
In the area of long trains, the TD continued the development of the radio remote control for distributed power. After having decided to proceed for the demo purposes with GSM-R as communication mean, ensuring therefore an open communication standard, detailed development has begun. Components were integrated into two DB BR 147 locomotives (BT) and static commissioning done. In addition, dynamic tests with low speed were done on in the shunting yard in Mannheim. The tests were successfully and the planning for the dynamic commissioning and the final demonstration, both to be done in Q1/2019 has started. Functional requirements of radio remote control systems for distributed power in mainline freight operations was delivered, taking into account the deliverables of the Marathon Project together with the requirements defined by OPE TSI, CCS TSI, EN50126, EN50129 and CSM (Common Safety Methods). It was concluded that radio and traction components of the Distributed Power System must at least achieve SIL2 for the analysed radio and traction functions whilst higher SIL may be required for braking functions. Furthermore, a new standard is needed to fix the radio technology, communication protocols, control requirements, operational procedures and

restrictions. Safety precautions in train configuration and brake application was also delivered, including definition of traction and braking actions at various scenarios, simulations of brake pressure propagation and wheel braking forces for different cases. Regarding the adaptations in rail infrastructure, the project concluded that the operation of freight trains longer than 750 m would be a significant challenge. Moreover, it highlighted the impact on the safety of the infrastructure and the rolling stock. Two new projects started working in this area at the end of 2018: FR8RAIL II and M2O, focussing on operation of Distributed Power System in demonstrator trains.

In the area of freight loco of the future, the TD also investigated new concepts to be applied on freight locomotive bogies. This included work on noise reduction, analysis of passive and mechatronic steering bogie solutions and a final integration and implementation into a three axle bogie virtual model to demonstrate the final feasibility of the proposed new design concepts. A concept development for hybrid propulsion technology and a demonstrator for the radial steering system was developed.

The TD has been also working on the simulation for smart train operation using peak power shaving, showing that with smart driving peak power demand can significantly be reduced without having the need to install HW like energy storage systems on-board. Optimizing the speed profile (thus the driving style) is challenging if focus is placed on peak power demand, as real-time information from the substations is required. The use of energy storage system facilitates this, however, introduces HW and maintenance costs. First attempt to set-up a business case has been performed.

In the area of hybridisation of legacy shunters, the TD advanced in the testing of first built-up Diesel-hybrid shunting prototype. Unfortunately, due to an accident it was not possible to perform track tests. However, the advanced bench tests already validate the operability of the locomotive. In 2018, the main outcome of the project is an evaluation and assessment report of the tests, which will be handed in as deliverable in 2019. Also, the data gathered during the tests will lay the ground for further optimization.



During 2018, 10 deliverables were planned out of which 7 were released. The overall progress appears to be in line with the plan, with some deviations.
Since the beginning, TD5.4 has reported having accomplished 70% of the planned work up to the end 2018, which represent 50% of the overall TD.

TD5.5 Business analytics and implementation strategies

This TD ensures that IP5 develops technologies in line with the market needs and with sound plans for introductions into the market. This is provided by migration plans for implementing new technology solutions on a large scale, identifying market segments and developing specifications and Key Performance Indicators for freight.

TD progress

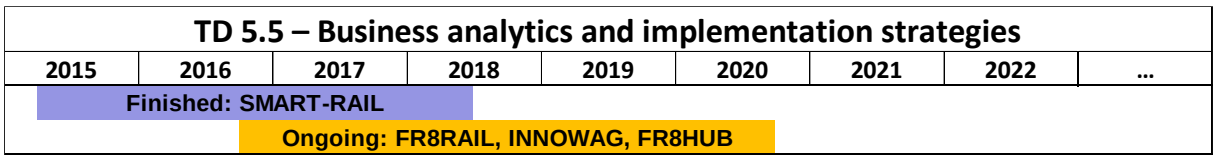
This TD builds on the following projects: SMART-RAIL (lighthouse project), FR8RAIL, FR8HUB and INNOWAG. Cooperation have been established with IMPACT II about KPIs.

The 2018 TD's goal was to establish KPIs for freight and for that, cooperation have taken place with the CCA IMPACT II project and top-level requirements have been one target to reach. Efficient work with business analysis and migration have also played an important role.

The TD works in areas of identification of market segments, development of specifications and key performance indicators (KPIs), and in the area of migration plans. The SMART-RAIL project finished in April 2018, closing three years of work to improve the freight rail services offered to the shippers, focussing on the five key performance indicators: reliability, lead-time, costs, flexibility and visibility. Its activities built on existing scientific research already available and utilised a broad range of innovative solutions. The project very well followed the issues of the international data and information exchange between railway actors, namely between Railway Undertakings and Infrastructure Managers both vertically and horizontally, i.e. between each other. It also well identified and analysed data flows between other stakeholders in the railway transport business and proposed a viable long-term solution that could be utilised by all stakeholders while fulfilling the requirements of all stakeholders in terms of timeliness and quality of data as well as its high level of security. The project, its conclusions and recommendations could contribute to some unresolved procedures envisaged by the TAF TSI.

The TD also worked in quantifying the estimated benefits of new technologies in the form of KPIs based on model calculations. This activity covers novel wagon versus typical UIC standard wagons, running gear and automatic coupler, locomotive propulsion systems and technical specification on new propulsion last mile applications and locomotive boogie. Moreover, the project also worked on Cost Benefit Analysis and migration plan in the specific solution of automatic coupling in order to support the market uptake.

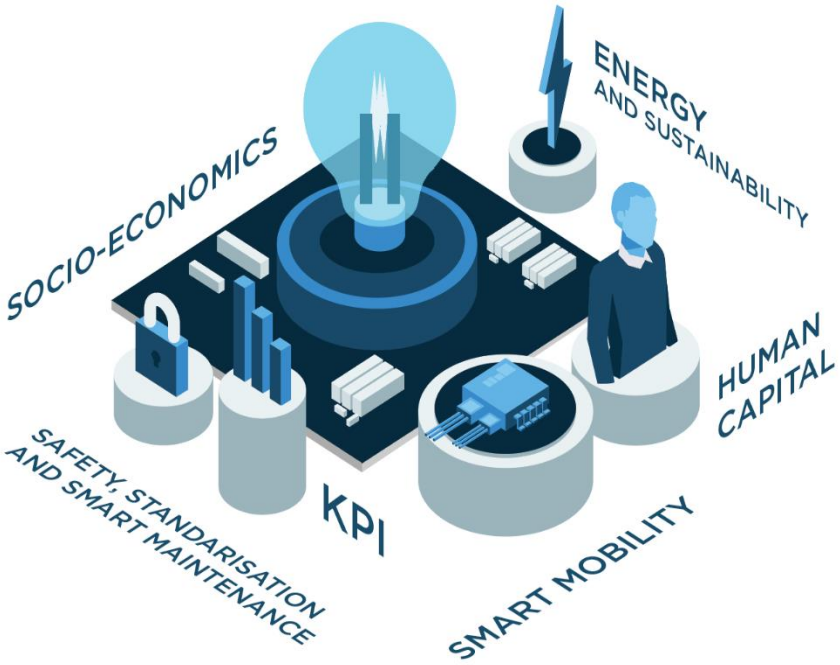
The TD gave the first steps towards the preparation of the IP5 migration plan by developing a report on key technologies, further evolutionary steps and their interrelations. This work is depending on input from other projects in the form of deliverables that have been screened. This work will be finalized in the first quarter of 2019.



During 2018, 41 deliverables were planned out of which 37 were released. The overall progress appears to be in line with the plan some exception of some delays reported in FR8RAIL. Since the beginning, TD5.5 has reported having accomplished approx. 85% of the planned work up to the end 2018. After the accomplishment of the remaining deliverables, the TD will be concluded.

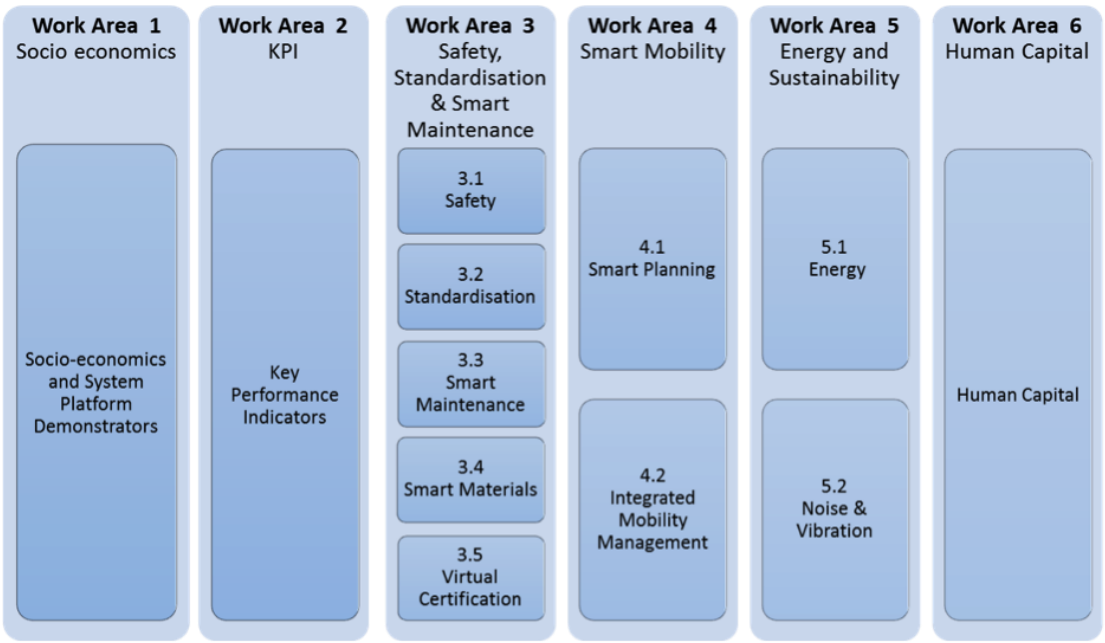
1.7.6. CCA Cross Cutting Activities

An overview of the various work areas in the CCAs is shown in the figure below.



Cross-Cutting Activities are relevant to the different sub-systems of the five IPs taking into account the interactions between these sub-systems.

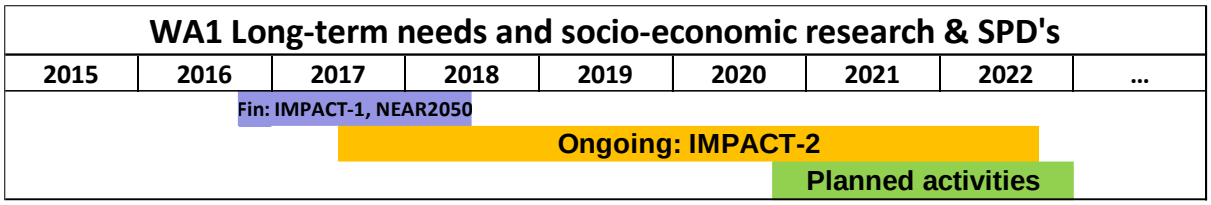
These cross-cutting activities ensure that the R&I activities within the different Innovation Programmes are closely aligned in terms of their objectives and their requirements, as well as the methodologies for evaluation and assessment of impacts. The cross-cutting activities facilitate a coordinated approach in order to avoid duplication and guarantee consistency.
CCA work is organised so as to achieve the objectives of the following areas:



Below a summary of the activities performed in the CCA Work Areas (WA). Activities under WA 3.4 (Smart Materials) has not started yet. The Work Areas on Smart Maintenance (WA3.3), Integrated Mobility Management (WA4.2) and Human Capital (WA6) were launched in September 2017, while WA 3.5 (Virtual Certification) was launched within the scope of Plasa 2 in December 2018.

WA1 Long-term needs and socio economic research

The objective of WA1 is to analyse the areas and the expected improvements that the works deployed under Shift2Rail bring to the European context in terms of social and economic benefits.



The topic is addressed in the CFM projects IMPACT 1, IMPACT2 and complemented by the OC project NEAR 2050.

Objectives for 2018 were the specification and definition of the long-term societal goals to which the rail system is expected to contribute and to develop indicators and methods to be used in assessing the achievement of the goals. The work includes analysis of short and long term trends expected to affect the railway sector and identification of key factors for the development of a successful railway system. The work also includes an operationalization of societal objectives e.g. greening of the society, smart inclusive growth et al.

Reports were delivered in 2018. The WA1 activities were focused on passenger and freight traffic.

Further objectives for 2018 were to develop specifications for the four S2R System Platform Demonstrators (SPDs) high-speed passenger rail, regional passenger rail, urban passenger rail (metro) and rail freight, a road map for the SPD implementation and an enhancement of the SPD use cases including a data collection planning. The SPDs serve as a common base for the KPI modelling, mode choice modelling and socio-economic analysis. Drafted use cases for each SPD segment were developed in close collaboration with the TDs leaders, and has been reviewed and validated by the Shift2Rail Members. The mode choice modelling is under development and is currently in a data collection phase, with data collection performed together with the KPI data collection team.

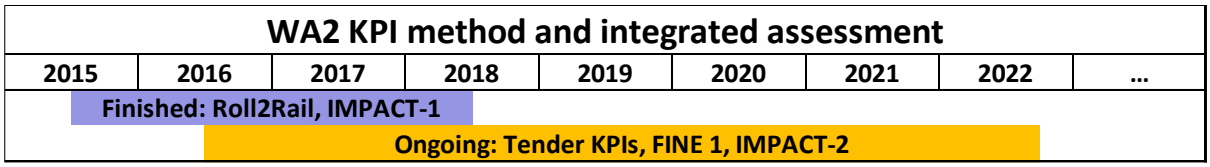
During 2018 in WA1, seven deliverables were planned in IMPACT-1 and one in IMPACT-2. They have all been submitted. The overall progress is in line with the plans. Since the beginning, WA1 has accomplished the planned work up to the end 2018.

WA 2 –KPI (Key Performance Indicators) method development and integrated assessment

The objectives of the Work Area 2 are to capture the impacts of the TDs and to assess how they contribute to the key S2R targets by defining and quantifying key performance indicators for their results.

WA progress

This WA builds upon the following projects: ROLL2RAIL (LP), FINE 1, IMPACT-1, IMPACT-2 and a tender focused on the support for KPIs development.



The main objectives for 2018 were to finalize the structural and qualitative modelling and to set up the first quantitative KPI model. Based on the SPDs defined in WA1.2 the S2R reference scenarios were refined and adopted to the quantitative KPI model. The CFM-project FINE 1 delivered the reference trains and reference scenarios in a very detailed definition, which has been used as basis for SPD refinement.

In 2018, the S2R JU launched a series of mitigation measures, including instructions from the S2R GB, in order to improve the cooperation with the TDs. Modelling activities accelerated in 2018 to improve the gathering of all necessary information from the S2R TDs.

The cooperation with the consortium working on the tender "Long-term needs & socio-economic research" which aims to implement an IT-tool to demonstrate the impacts by using the KPI model, was continued, although no tangible results have been achieved in 2018.

The resulting KPI model has been refined and populated with values from four different sources:

1) Quantification of the individual improvements reported by the TDs
2) Parameters for the reference trains and reference scenarios
3) Relative distributions of the cost elements
4) Parameters for the SPDs

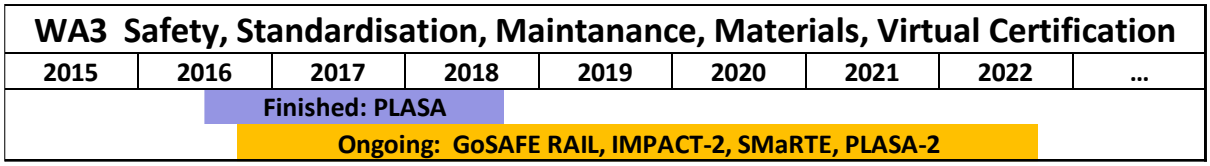
All those parameters were fed into the model and a first set of quantified values for the master plan targets "LCC", "Capacity" and "Punctuality" were computed.

Not all S2R activities were completed in 2018, notably with a gap for the IP2 and IP4 related TDs modelling. The integration of the three High level KPI models and the consideration of interdependencies within as well as in between the models is still to be done. The tool developed so far is only based on Excel as an early prototype to evaluate requirements on the later tool. The KPI activities has been extremely time consuming for all involved Members and JU staff, while Release 1 of the model is not yet at the expected level.

During 2018, 4 deliverables were planned and all of them had been released according to plan. Since the beginning, WA2 has reported having accomplished 70% (due to the missing building blocks) of the planned work up to the end 2018.

WA 3 Safety, Standardisation and Smart Maintenance

Work Area 3 builds on the activities of the projects Plasa/Plasa 2, GoSAFE RAIL, IMPACT2 and SMaRTE, the graph below refers to all the activities performed in the whole WA. All Work Areas except WA 3.4 (Smart Materials) have been running in 2018.



WA 3.1 – Safety

The objective of WA3.1 is to develop a global approach of the safety of the railway system. This approach is based on a global risk assessment model and aims at providing key results to manage the safety level of the existing railway system and to evaluate the safety improvements carried out in the S2R TDs.

The main objectives for 2018 were to develop a global safety framework and to propose a decision making process designed for the management of safety in operation.

The work area safety is addressed in the CFM project PLASA and the complementary Open Call project GoSafeRail, in a 3years' timeframe (Sept2016-Aug2019).

A decision making process to manage the safety in operation was proposed, based on the available risk assessments methods, and has been tested on several application cases. In that frame, an accurate quantification of the human reliability has proved to be crucial and was subject to a particular investigation.

In parallel, a global safety framework was developed to integrate risk assessments from a number of assets (e.g. bridges, slopes) and a network flow model outputs. The framework developed achieves improvements in railway safety management procedures by implementing the global safety key KPIs.

During 2018, all deliverables planned were submitted. The overall progress appears to be in line with the plan.

It can be concluded that overall, at the end of 2018, 100 % of the planned work can be considered as completed.

WA 3.2 – Standardization

The main objective of WA3.2 is to foster the transfer of Shift2Rail results and outcomes of innovation activities into standards or regulatory documents when needed and beneficial. It aims to provide a coordinated approach across the S2R research activities and to develop optimised pre-standardisation aligned processes with the relevant standardisation bodies, standard setting organisations, as well as ERA.

The Standardisation work area is covered in the IMPACT-2 CFM project, which started in September 2017.

In 2018, the standardisation potentials of the expected outcomes of the different S2R TDs have been assessed by a high-level standardisation roadmap, gathering the potential needs and opportunities for standardisation (Rolling Standardisation Development Plan).

The standardisation roadmap was completed for a first series of S2R projects in 2018 and the next enquiry to a second series of CFM and OC projects will be launched in 2019.

In 2018, S2R's roadmap was presented to main stakeholders at the Rail Standardisation Coordination Platform for Europe (RASCOP) – chaired by the EC on 16 October. The S2R JU is also systematically invited to dedicated JPC-R meetings to update on standardisation.

During 2018, the identification and connection with appropriate standardisation working groups (CEN, CENELEC, ETSI, and UIC) progressed. ISO/IEC standardisation bodies have also been contacted already.

In 2018 it became clear, that projects that do not aim for standardisation as a project result have difficulties to identify their standardisation opportunities at low TRL level. On the other hand, WA 3.2 identified synergies across all IPs for standardisation needs/opportunities for data format and communication interfaces.

WA 3.3 – Smart Maintenance

This Work Area is divided into cross-system and specific vehicle topics. The development of a common smart maintenance concept is based on a synthesis of all smart maintenance concepts within the S2R programme incorporating concepts for infrastructure as well as for rolling stock. The specific vehicle topics focus on condition based maintenance for passenger trains.

The Smart maintenance work area is covered in the IMPACT-2 CFM and the SMaRTE OC project.

The work of the first draft of a common smart maintenance concept further proceeded in 2018. This task requires the collaboration with all CBM related activities within S2R and therefore a questionnaire was sent out to all S2R IPs and involved TDs. IMPACT-2 collected all relevant information within the whole S2R activities context to provide a synthesis for all application areas such as:

- Ground-borne systems for infrastructure self-monitoring
- Wayside monitoring systems for the collection of rolling stock data
- On-Board monitoring systems for diagnosis of infrastructure
- On-Board systems for vehicle self-monitoring.

Based on the common maintenance concept a synopsis and definition of common standards for CBM for data collection and data transfer will be developed to suggest a European standard for CBM data. This work is at its very beginning but collaboration with the new S2R work stream on CDM has already started.

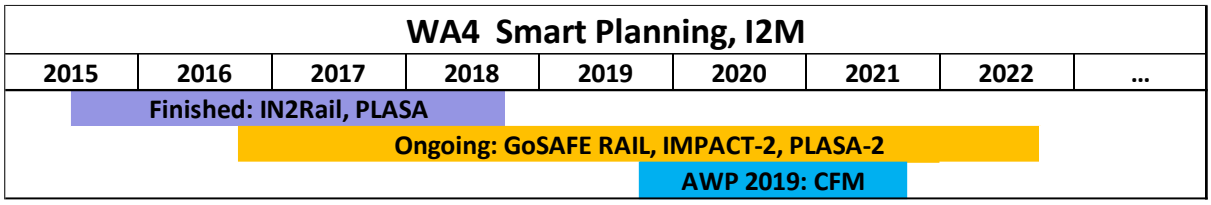
In the passenger vehicles topic demonstrators for CBM on selected passenger vehicles for regional (Alstom ET 440 Coradia), double-deck (Bombardier DosTo 2010), high speed (ICE 3/ ICE T) and suburban passenger transport have been defined. Data collection, - formatting and - transfer and analysis for selected components of these vehicles has started and is still ongoing. Pattern recognition methods will be applied after the transfer of data. The maintenance approach in the aviation sector was also analysed and provided the corresponding Deliverable as planned.

WA 3.5 – Virtual Certification

Virtual Certification is covered by work packages 4 and 5 of the CFM project Plasa-2 which started in November 2018. The objective of virtual certification within S2R's CCA is to provide recommendations for a mixed virtual/experimental certification process, which shall ultimately lead to a significant reduction of certification costs and duration.

The work on virtual certification has started as planned with the analysis of the state of the art and the evaluation of the benefits of the approach. The first steps to gather and review relevant documents from complementary projects and to develop a template to evaluate complementary projects and relevant studies have been fulfilled as foreseen in the project's schedule.

Work Area 4 SMART MOBILITY



Work Area 4.1 –Smart Planning

The aim of Smart Planning is to enable railway stakeholders to make the best decisions for the overall system, for example concerning schedules and the availability of rolling stock and staff, based on up-to-date operational data, taking into account all essential information in order to ensure that the quality promised is delivered to customers. The task also enables optimum allocation of funds by using knowledge of all relevant system parameters and their interaction to promote the best possible use of existing capacities.

This work area is addressed in the CFM project PLASA and the complementary Open Call project GoSafeRail. The plan for 2018 was to enhance the basic simulation model developed in 2017 to the impact of disruptions and to carry out case studies with actual operational data.

The model prototype developed in 2017 was extended to model the impact of disruptions. Operational data from DB from the timetable year 2017 was analysed to create a stochastical disruption model that allows simulating disruptions occurring to vehicles or infrastructure.

Two case studies, one on a national corridor (Hamburg-Frankfurt in Germany) and one on an international corridor (Stockholm-Copenhagen in Sweden/Denmark) were carried out.

During 2018, 2 deliverables were planned in PLASA which have both been finished. The project has been fully completed by 100% by end of august 2018.

Work Area 4.2 – Integrated Mobility Management

WA4.2 aims to integrate the data exchange between Traffic Management, Freight operations and Asset Management Services via the Integration Layer and to develop new business service application within IMPACT-2.

For 2018, the aim was to start the work on “TMS application supporting high-efficient Freight Operations” and “Advanced Rules and Business Logic supporting high efficient Freight Operations” by creating a set of use cases for both tasks defining the scope of the works to be carried out.

All Partners have delivered the use cases based on their proposed prototypes. These inputs are the basis to create the “Description of basic Use-cases for advanced Freight operation” and the “Description of Business Rules and Logic to support high-efficient Freight Operations”.
Status of the collaborative works:

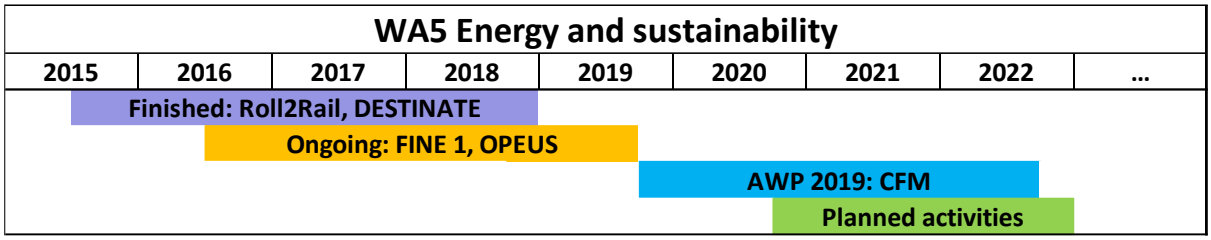
- Collection of use cases is close to finalization (95%), remaining activities are the reviews of the use cases, write up of the deliverable and TMT/SteCo review processes (overall completion rate: 75%)
- Description of Business Rules and Logic to support high-efficient Freight Operations.3 is in good progress (overall completion rate: 50%)

The status of both actions allows the start of the design of the prototypes in Q1/2 2019.

Some preliminary but limited works related to “Enhancement of the Integration Layer” allocated to describe the use-cases are executed.

Work Area 5 Energy and Sustainability

Work Area 5 builds on the results of the ROLL2RAIL (LP) and on the activities of the projects FINE 1 OPEUS and DESTINATE.



FINE 1 : all 24 deliverables scheduled to be completed by the end 2018 have been submitted.
DESTINATE was finalised during 2018 according to plan and OPEUS will be finalised in spring 2019.

WA 5.1 Energy

The overall objective of this work area is to develop a standardised methodology for estimation of energy consumption by simulation and measurement enabling the standardised specification of energy efficient railway systems.

The Energy work area is covered in the CFM project FINE 1 and in the OC project OPEUS.

During 2018, this WA defined a proposal for Energy Labelling in railways including alignment with the new standard FprEN 50591, “Specification and verification of energy consumption for railway rolling stock.” A sensitivity study of energy KPIs in railways was performed as well as an assessment of the EC strategy for energy and sustainability and how it relates to a specific strategy for the railways.
A study of energy related issues in the Future Railway System has been performed. The energy strategies of different stakeholders are described and two scenarios concerning the future technology are defined: the first considers only the S2R innovations, the second also includes further technology

developments outside of S2R. Based on these inputs subsequent research activities are suggested that contribute to further energy savings and reduction of CO2-impact.

In early 2018 the members of the CCA energy group successfully finalized the development process of an energy simulation tool. This allowed also to assess and quantify the energy improvements at SPD level. Consequently, the currently achieved sub-level energy KPIs have been gathered from the individual TDs, where energy improvements for the following technologies have been reported:

- Mass reduction on train level,
- Smart Power Supply,
- PM synchronous motor / Independently rotating motor-wheel-system and
- SiC-converters

The achieved improvements range between a minimum of 0.75% up to 8%.
The WA also implemented a rolling stock energy simulation tool used to evaluate, improve and optimise the energy consumption of rail systems with a particular focus on in-vehicle innovation.

WA 5.2 – Noise and Vibration

The overall objective of this work area is to reduce the annoyance and exposure to noise and vibration related to the railway sector in Europe and to provide the necessary system approach and leverage the results from all the IPs by applying effective noise control in the different technical demonstrators. The Noise and Vibration work area is covered in the CFM project FINE 1 and in the OC project DESTINATE.

An overall assessment and monitoring of noise effects in the S2R projects was performed, focused on a system level including rolling stock, infrastructure and the near environment and adding the perspective of traffic scenarios i.e. traffic mix of different vehicles on a certain infrastructure including day/night split etc.

These scenarios defined a system level and traffic scenarios will be used later as input parameters for N&V calculation and to assess the mitigation effects.

It was demonstrated that the model chosen provides expected results and is thus suitable to demonstrate the influence of the terrain, the different traffic scenarios and different noise mitigation measures. The model has a good balance between feasibility and realism.

However, the task to obtain a complete overview of all the different activities related to noise in the S2R project was much more demanding than expected and a comprehensive follow up and update will be necessary during 2019.

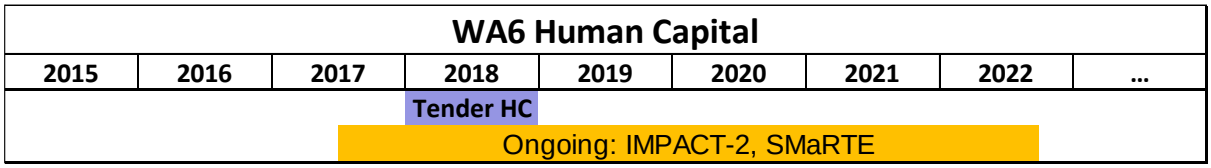
On interior noise a modelling project started with a review of state of the art of industrial interior noise prediction technology inside and outside the rail vehicle sector. In a second major step the modular prediction framework for railway industry interior noise predictions was defined. A third step and important starting point for the interior noise prediction in different acoustic environments (e.g. free field and tunnel) is the existing sound pressure distribution around the rail vehicle for source excitations from different geometrical positions. A comprehensive study including validation of methods for sound pressure distribution was undertaken.
Another study that was delivered, covers current methodologies for specification and characterization of airborne and structure borne noise sources applied by train manufacturers and proposed improvements. These methodologies and improvements are to be validated in 2019.

The Noise part of was recently included and described in an article "The quiet revolution in noise abatement" in the International Railway Journal[20].

The WA also developed tools and methodologies for railway noise simulation applying ATPA (Advanced Transmission Path Analysis.) A methodology to rank railway noise mitigation options and assess their cost-effectiveness based on life cycle costs was also developed. Auralisation and visualisation (A&V) was researched for exterior as well as interior railway sound. A&V is a useful tool to demonstrate and communicate the effects of different railway noise mitigation measures and design alternatives to non-experts. A prototype of a new system was demonstrated at InnoTrans.

Work Area 6 - Human Capital

The objective of WA 6 is to analyse the impact of future innovations resulting from the S2R IPs on the human factor in the rail system. The requirements and future needs of the humans in the system need to be taken into account in order to fully benefit from the advances in technology, for the workforce, but also for railway customers. The focus of the investigation lies on the impact on railway staff, but the impact on the customer is also considered.



The topic is addressed in the CFM-project IMPACT-2 WP 8 and complemented by the "Human Capital tender" and the ongoing OC project SMaRTE.

Objectives for 2018 were to assure that the requirements and future needs of the railway operator are taken into account and that the perspective of the operator is represented in future calls of the JU, e.g. through discussion with project members or the exchange of data.

During 2018, two deliverables were planned in IMPACT-2 and released. This indicates that 100 % of the deliverables for Impact-2 scheduled for 2018 were delivered and the overall progress is in line with the plan.

Human Capital Tender

The project studied the overall effects of the S2R innovations on the type of jobs and the future skill requirements for seven different job categories from the ISCO-classification. Further, it was investigated how to manage the necessary changes in the workforce. The final "Workshop on Technology and Skills in the Rail Sector" was held on November 30. The webinar initially planned to accompany the workshop had to be cancelled due to technical difficulties. Nevertheless the final report was submitted in time but the tender will only be closed in 2019 after the implementation of comments from the check by the S2R JU and subsequent validation.

SMaRTE

[20] https://www.railjournal.com/in_depth/the-quiet-revolution-in-noise-abatement

SMaRTE is investigating how to make the railway system more attractive to passengers by putting the user requirements in the focus of research. The objective in 2018was to review demographic and societal factors (technology, labour, personalization, access, economy, safety, security) affecting transport use at each step of a journey. Trends and factors were explained and grouped and fed into definitions of user profiles (personas) and the experience map in passenger surveys. The project faces slight delays in the submission of deliverables, but was able to complete 90 % of the tasks planned in 2018.

1.7.7. IPx activities

Current activities in S2R are developing the fundamental building blocks that will allow the generation of interoperable solutions that would provide a practice answers to the challenges highlighted in the S2R Master Plan and a contribution towards the objectives achievement.

The combination of those building blocks enabled the identification of new railway Capabilities for the next generation of railway system, that have been highlighted in the Multi-Annual Action Plan Executive View (PART A) – adopted by the S2R Governing Board in 2017. It appeared evident in 2018 that the activities originally planned in S2R in the Multi Annual Action Plan (Part B) address only partially the potential that newly identified disruptive technologies can provide towards the railways Capabilities. This is the reason why the S2R JU introduced in its Annual Work Plan 2018 new activities where disruptive technologies or thinking can accelerate the pace towards radical system innovation.

In 2018 the S2R JU funded 4 different projects that all just started in December 2018. They address the following ambitions:

- Concepts for the future autonomous railway vehicles “train-centric”;
- Promising disruptive technologies impacting automation systems and maintenance concepts;
- Digitalisation of railways services, operations and production;
- Transversal exploratory research activities and knowledge transfer;
- Block chains as a Distributed Ledger for Attribution of Remote Condition Monitoring Data in Rail;
- Flexible medium voltage DC electric railway systems.

1.8. Calls for tenders

With regard to the implementation of Procurement activities, the S2R JU has complied with the principles of the EU financial regulation and the guidance provided in the European Commission Procurement Vademecum. This resulted in being able to implement activities obtaining the best value for money compared to other similar programmes, for example in the case of the in the tool supporting the S2R Programme.

The values established for the different procurement procedures, which in any case are below any materiality level considering the total value of the R&I activities and the Programme, result from the collective knowledge of the staff involved in it and their experience in previous private and public organizations.[21]

The S2R JU published the following calls for tenders in 2018 (open tender procedures):

[21] Also in answer to point 15 of Discharge 2016 of EP, reference P8_TA-PROV(2018)0173.

S2R.17.OP.04 and S2R.18.OP.02. Support to the ERTMS Deployment action plan as baseline for Shift2Rail (IP2) innovative solutions

The objective of this tender is to ensure the establishment of the essential baseline for the deployment of the future S2R Innovative Solutions through the support to the coherent deployment of European Railway Traffic Management System, a horizontal priority aiming at ensuring in the interoperability of the EU railway system. The action is a part of a global project on deployment of ERTMS in the European Union, as defined in the TEN-T Guidelines and the MoU signed between the EC and the European Railway Associations in 2016.

- The contract notice was published in EU Official Journal on 16 October 2017. As this initial tender procedure (S2R.17.OP.04) was terminated without award of the contract (all the received tenders did not reach the minimum award quality levels) a new open procedure (S2R.18.OP.02) was published in the EU Official Journal on 31 May 2018
- The framework contract was awarded to ERTMS Users Group consortium and the contract award notice published in the EU Official Journal on 12 October 2018
- The total value of the framework contract is EUR 8 000 000, of which EUR 1.6 million committed in 2018.

S2R.18.OP.01. Study on use of fuel cell hydrogen in railway environment

This tender is the result of the work of the FCH JU and S2R JU joining their resources to assess the opportunities for the and market potential analysis for the use of fuel cell and hydrogen technologies as part of the energy hybrid solutions for the railway sector with a multi modal approach and view. It has the objective to provide case studies by segment (shunting locomotives, freight/last mile locomotives, regional trains) expressing potential opportunities and carry out a concept design for each case study compared with other alternative solutions, in a multimodal perspective. Case studies should be substantiated on data acquired in dialogue with relevant stakeholders; identify technical and not technical barriers for the implementation of fuel cell and hydrogen technologies in the rail sector and show R&D, regulation and standard's needs.

- The contract notice was published in EU Official Journal on 9 March 2018
- The contract was awarded to Roland Berger GmbH and the contract award notice published in the EU Official Journal on 12 June 2018
- The total value of the contract is EUR 569 500, of which EUR 269 500 funded by the S2R JU in 2018 while the difference was funded by the FCH JU.

S2R.2018.OP.05 Study on alternative communication bearers in the railway environment

The objective of the study (direct service contract) was to identify and assess alternative bearer technologies for enhancing train to ground communications in the context of challenging operational and passenger digital connectivity requirements.

- The contract notice was published in EU Official Journal on 5th October 2018 with an estimated total value of EUR 150.000,
- The procedure was terminated without award, as the received tender did not reach the minimum award quality levels. The non-award contract notice is expected to be published in EU Official Journal in January 2019.

As laid down in Article 66(9) of the 2012 Financial Regulation and Article 134(1) points (a) to (f) of the rules of application (RAP)[22], each authorising officer must draw up a list of negotiated procedures without prior publication of a contract notice carried out during the previous financial year. In 2017 the following procedure was launched using Article 134(1)(a) of the RAP as a legal basis :

S2R.2017.NP.03 - Cross-Cutting Activities – Human Capital

- The circumstances which justify the use of this negotiated procedure were: no suitable tenders were submitted in response to the open procedure S2R.2016.OP.02 and after the initial procedure was completed, i.e. publication of the cancellation notice in the EU Official journal (ref: 017/S 011-015630 of 17/01/2017)
- The S2R JU Authorising Officer decided to launch a negotiated procedure and invite all the tenderers that submitted a tender under the initial open procedure
- The contract was awarded to consortium Netherlands Organisation for Applied Scientific Research and University of Newcastle and the contract award notice published in the EU Official Journal on 01/02/2018.
- The total value of the contract is EUR 200 000, against 2017 budgetary commitment.

1.9. Dissemination and information about projects results

The S2R JU aims at the dissemination of its Innovation Programmes' results achieved through the current and future Projects. Dissemination activities have European scientific and academic community as it principal, but not exclusive, target. Dissemination plays an essential role within the S2R Programme, being at the core of its success.

Dissemination activities start with the concept of building the S2R JU as a platform for R&I in the railway sector, where all interested parties may contribute and exchange as necessary. The S2R JU website hosts specific CFM Projects activities and links to OC Projects' websites and dissemination activities, as well as the Lighthouse Projects and other related projects (See also section 2.1).

In addition, the S2R JU exhorted all its projects to make use of the new "*Common Dissemination Booster*" tool made available by the EC Common Support Centre (RTD, Unit J.5).

The S2R projects IMPACT-2, FR8RAIL, FR8HUB and IN2TRACK clustered in a project group and were selected to make use of this pilot dissemination service for:

- Service 2: Stakeholder/End-User mapping
- Service 3: Portfolio Dissemination Plan Development
- Service 4: Portfolio Dissemination Capacity Building
- Service 5: Dissemination Campaign in Practice.

Services 2, 3 and 4 have been delivered. By the end of 2018, projects were collaborating with the S2R JU to make the most out of this possibility.

Dissemination of projects was a very important part of Shift2Rail's participation at InnoTrans 2018, world's largest rail trade fair. More details on Shift2Rail's participation at this event are available on Section 2.1.1. events.

[22] Article 74(10) and points (a) to (f) of Point 11 Annex 1 FR 2018 Financial Regulation

Project events

24 January - Mid-term conference with S-CODE, In2Track and In2Smart, Paris
25 January – Safe4Rail mid-term conference, Prague
6 March - NEAR 2050 Final Conference, Wiesbaden, Germany
18 April - Shift Freight to Rail (including IP5 projects Smart-Rail, ARCC, FFL4E, FR8RAIL, DYNAFREIGHT, SMART and INNOWAG)
19 April – Shift2Rail Lighthouse projects final event
20 April – Mid-term event of Co-Active and ATTRACkTIVE, Vienna
27 June - DYNAFREIGHT Final Conference
26 September - Final Conference CONNECTA and Safe4Rail, Paris
12 December – PINTA Closing Event

1.10. Operational budget execution

The S2R GB adopted the AWP 2017 on 9 November 2016 and its amendment n° 2 to the budgetary figures on 27 October 2017.

The amended Budget corresponded to the specific needs of the JU, including transfers within the initially adopted budget, recognising the unused Payment and Commitment Appropriations on administrative and operational expenditure in relation to the previous budgetary years and the move of expert expenses on Call evaluations from the administrative to operational line.

The Budget amendment also cancelled the payment appropriations assigned for the S2R Lighthouse Projects. Since the initial planning of the budget, it had been decided that these projects would remain under the administration of the European Commission. The appropriations were not collected by the JU at any point in time.

In accordance with the S2R Financial Rules Art.6§5, the S2R JU has established in its Budget Title 4: Unused Appropriations not required in the year. This Title is of technical nature and recognises the appropriations available for applying n+3 rule on the following budgetary years.

In addition to the transfers made towards Title 4 as part of the budget amendment, the Executive Director has exercised its rights in Accordance with Article 10 of the S2R Financial Rules by transferring appropriations from Title 2 to Title 4. This action has been implemented as response to the multiannual budgetary planning of the JU. The JU has ability to reactivate credits from Title 4 in the following budgetary year. This reactivation will be implemented as part of budget amendment in 2018.

In terms of Commitment Appropriations, Title 3, the Operational budget, represents 89.0% of the overall S2R 2017 Budget. The execution rate of the Operational budget in both Commitment and Payment Appropriations was respectively 100% and 84.2%. The Payment appropriation were mostly used for the pre-financing of the Grants resulting from the 2017 Call for Proposals, for a total amount of EUR 28.0 million.

1.11. In-Kind Contributions

In accordance with article 4(3) of the S2R Regulation, "t*he members of the S2R Joint Undertaking other than the Union shall report by 31 January each year to the Governing Board of the S2R JU on the value of the contributions referred to in paragraph 2 made in each of the previous financial years*".

Article 4(2) of the S2R Regulation establishes that the total contribution to be provided by the Other Members[23] and totalling EUR 470 million shall consist of:

- ***IKOP***[24] ***(in-kind operational)***: at least EUR 350 million, including at least EUR 200 million from the founding members other than the Union and their affiliated entities, and at least EUR 150 million from Associated Members and their affiliated entities. In accordance with Article 16(3)b of the S2R Statutes, IKOP consists "*of the costs incurred by them [the Other Members] in implementing indirect actions less the contribution of the S2RJU and any other Union contribution to those costs*".

- ***IKAA (in-kind other activities)***: at least EUR 120 million, of which at least EUR 70 million from the Founding Members other than the Union and their affiliated entities, and at least EUR 50 million from Associated Members and their affiliated entities. These contributions shall consist of the costs incurred by them in implementing additional activities outside the work plan of the S2R Joint Undertaking, which are complementary to this work plan and contribute to the objectives of the S2R Master Plan. Other Union funding programmes may support those costs in compliance with the applicable rules and procedures. In such cases, Union financing shall not substitute for the in-kind contributions from the members other than the Union or their affiliated entities.

The aforementioned In-Kind Contributions are in addition to the financial contributions, in the form of cash, of the Other Members to the 50% of the administrative costs of the JU.

Other Members' reporting for 2018

The Other Members of S2R submitted their reporting on IKOP and IKAA to the JU by 31 January 2019. The JU requested that the Members perform an additional verification of the submitted figures, and some of them provided an updated reporting by 13 February 2019.

The Lighthouse Projects are excluded from this reporting as they are assimilated into open calls and within the administrative management of the European Commission.

This third report covers IKOP related to 28 months of R&I activities (4 months in 2016 and the activities of 2017 and 2018); while in terms of IKAA, the activities are considered eligible as from the date of acceptance by the Other Members of the S2R JU Statutes by means of their respective letters of endorsement.

In accordance with Article 4(4) of the S2R Regulation, the Other Members shall have the costs related to IKOP and IKAA certified by an independent external auditor appointed by the entity concerned.

IKOP and IKAA Certification

By 30 April 2018, the Other Members have provided the JU with audit certificates on the Total Project Costs (and consequently IKOP) and IKAA costs declared for the year 2017. After due examination of the relevant certification and, in particular, the audit standards applied to the issuance of the "audit certificates", the acceptable corresponding IKOP contributions have been "validated" by the Executive Director in 2018. They will therefore be accounted towards the obligation set in Article 4(2) of S2R

[23] The "Other Members" are defined as the Founding Members of the JU, with the exclusion of the Union, and the Associated Members.

[24] As laid down in Article 16(2) and Article 16(3)(b) of the Statutes.

Regulation to the Other Members as well as recorded as Net Assets of the Joint Undertaking in the Annual Accounts 2018.

By the deadline of 31 January 2019, none of the Other Members was in the position to have its costs related to 2018 IKOP and IKAA certified. Nonetheless, this is in line with the Commission position communicated officially in July 2016, which clarifies that the certification of costs (based on which IKOP is calculated) should be annual, and it should be transmitted to the relevant JU by its members by 30 April. This is also essential for the preparation of the Annual Accounts of the JU and the JU's reporting.

With regard to the Final Annual Accounts of S2R JU, all IKOP contributions reported but not validated in 2018 will be accounted for as "to be validated" considering that:

- 82.5% of the IKOP reported "to be validated" is supported by the certification

- the validation of IKOP by the JU will be performed in the course of 2019.

On 1 May 2019, based on the audit certificates received and the Projects' cost statements, the situation of IKOP and IKAA is as following:

	IKOP REPORTING											
	TOTAL PROJECT COST				CO-FUNDING			IKOP				
Other Members	AAR 2016 - AAR 2017	AAR 2018	TOTAL	of which CERTIFIED	AAR 2016 - AAR 2017	AAR 2018 estimates	TOTAL	AAR 2016 - AAR 2017	AAR 2018	TOTAL	*Validated as Net Assets*	*To be validated (1)*
Alstom(*)	7,559,443	11,098,216	18,657,659	***18,639,214***	3,197,987	4,652,602	**7,850,589**	4,361,456	6,445,614	**10,807,070**	-	*10,807,070*
Hitachi / Ansaldo STS	5,221,406	6,491,649	11,713,055	***11,713,055***	2,321,374	2,879,220	**5,200,594**	2,900,033	3,612,429	**6,512,462**	*2,901,013*	*3,611,449*
Bombardier Transportation	4,199,073	7,111,354	11,310,426	***11,285,232***	1,836,642	2,752,459	**4,589,102**	2,362,430	4,358,894	**6,721,325**	*2,180,999*	*4,540,326*
CAF(*)	5,779,389	6,800,813	12,580,202	***12,549,403***	2,703,380	2,772,265	**5,475,646**	3,076,008	4,028,548	**7,104,556**	*423,699*	*6,680,857*
Network Rail(*)	1,217,401	3,152,682	4,370,084	***3,620,660***	542,269	1,759,501	**2,301,770**	675,133	1,393,181	**2,068,314**	-	*2,068,314*
Siemens(*)	4,944,798	7,991,239	12,936,037	***12,936,037***	2,149,701	3,520,081	**5,669,782**	2,795,097	4,471,158	**7,266,255**	*2,299,546*	*4,966,709*
Thales(*)	2,904,992	6,342,069	9,247,061	***6,179,956***	1,239,238	2,909,635	**4,148,873**	1,665,753	3,432,435	**5,098,188**	*726,210*	*4,371,978*
Trafikverket	4,671,044	4,406,014	9,077,058	***3,592,653***	1,143,375	1,637,541	**2,780,916**	3,527,669	2,768,473	**6,296,142**	*2,736,609*	*3,559,534*
Founding Members	**36,497,546**	**53,394,037**	**89,891,583**	**80,516,211**	**15,133,967**	**22,883,305**	**38,017,272**	**21,363,579**	**30,510,732**	**51,874,311**	***11,268,074***	***40,606,237***
Aerfitec	192,774	1,283,799	1,476,573	***461,668***	85,669	570,520	**656,189**	107,105	713,278	**820,384**	-	*820,384*
Amadeus	11,656	6,499	18,155	***65,185***	5,756	11,722	**17,478**	5,899	- 5,223	**677**	-	*677*
AZD Praha	612,573	1,415,165	2,027,738	***2,027,738***	265,691	617,955	**883,646**	346,882	797,210	**1,144,092**	*346,882*	*797,210*
Competitive Freight Wagon	1,179,995	788,906	1,968,902	-	524,397	366,128	**890,526**	655,598	422,778	**1,078,376**	-	*1,078,376*
Deutsche Bahn AG	6,293,025	8,163,511	14,456,536	***14,456,536***	2,134,823	2,600,701	**4,735,525**	4,158,201	5,562,810	**9,721,011**	*4,160,729*	*5,560,282*
Diginext(*)	926,104	954,253	1,880,357	***1,880,357***	411,561	424,070	**835,631**	514,543	530,183	**1,044,726**	*514,543*	*530,183*
EUROC	215,525	904,036	1,119,561	-	72,539	420,673	**493,211**	142,987	483,363	**626,349**	-	*626,349*
Faiveley	1,652,716	2,338,715	3,991,431	***3,663,639***	708,639	1,004,640	**1,713,279**	944,077	1,334,075	**2,278,152**	*929,229*	*1,348,923*
Hacon(*)	1,611,237	2,651,186	4,262,423	***4,262,423***	714,031	1,175,175	**1,889,206**	897,206	1,476,011	**2,373,217**	*897,206*	*1,476,011*
Indra(*)	2,436,641	3,688,797	6,125,438	***6,135,010***	1,105,095	1,619,164	**2,724,260**	1,331,546	2,069,632	**3,401,178**	*1,365,498*	*2,035,680*
Kapsch	1,157,276	1,868,700	3,025,976	***3,025,976***	514,294	830,449	**1,344,743**	642,982	1,038,251	**1,681,233**	*642,982*	*1,038,251*
KnorrBremse	661,604	1,383,010	2,044,614	***2,044,614***	294,017	610,722	**904,739**	367,587	772,288	**1,139,875**	*367,587*	*772,288*
MerMec(*)	599,059	1,046,292	1,645,351	***1,645,351***	266,248	464,395	**730,643**	332,811	581,897	**914,708**	*332,811*	*581,897*
SmartDeMain	1,425,102	1,519,200	2,944,302	***1,466,733***	572,257	783,348	**1,355,605**	852,845	735,852	**1,588,697**	*117,658*	*1,471,039*
SmartRaCon	1,077,981	1,614,409	2,692,390	***340,726***	443,293	558,638	**1,001,931**	634,688	1,055,771	**1,690,459**	-	*1,690,459*
SNCF(*)	961,713	1,203,808	2,165,521	***849,976***	426,109	639,805	**1,065,913**	535,605	564,003	**1,099,608**	-	*1,099,608*
SWITRACKEN	206,633	439,679	646,312	***10,322***	95,444	181,156	**276,600**	111,189	258,522	**369,712**	*5,742*	*363,970*
Talgo(*)	226,234	538,837	765,071	***765,071***	100,538	236,059	**336,597**	125,696	302,778	**428,474**	*129,096*	*299,378*
Virtual Vehicle Austria Consortium VVAC	1,525,280	2,363,870	3,889,150	***3,628,261***	680,221	1,065,182	**1,745,403**	845,059	1,298,688	**2,143,747**	*594,697*	*1,549,050*
Associated Members	**22,973,128**	**34,172,671**	**57,145,800**	**46,729,585**	**9,420,621**	**14,180,503**	**23,601,124**	**13,552,508**	**19,992,169**	**33,544,676**	**10,404,662**	**23,140,014**
Total	**59,470,674**	**87,566,709**	**147,037,383**	**127,245,796**	**24,554,588**	**37,063,808**	**61,618,396**	**34,916,086**	**50,502,901**	**85,418,987**	**21,672,737**	**63,746,251**

(1) Of which KEUR 52 591 is supported by an audit certificate and will enter into IKOP validation process in 2019

	IKAA REPORTING			
Other Members	In-Kind Additional Activities as at 1 June 2018	In-Kind Additional Activities as at 31 April 2019	TOTAL	*of which Certified as at 1 May 2019**
Alstom(*)	11,912,418	-	**11,912,418**	*11,912,418*
Hitachi / Ansaldo STS	1,480,421	2,230,522	**3,710,942**	*3,710,942*
Bombardier Transportation	15,688,168	-	**15,688,168**	*15,688,168*
CAF(*)	8,946,296	-	**8,946,296**	*8,946,296*
Network Rail(*)	2,085,477	134,726	**2,220,203**	-
Siemens(*)	6,500,000	1,600,000	**8,100,000**	*8,100,000*
Thales(*)	4,420,995	3,444,111	**7,865,106**	*7,865,106*
Trafikverket	25,159,312	-	**25,159,312**	-
Founding Members	**76,193,086**	**7,409,358**	**83,602,444**	***56,222,930***
Aerfitec	503,836	920,799	**1,424,635**	-
Amadeus	2,750,000	-	**2,750,000**	-
AZD Praha	689,659	311,242	**1,000,901**	*689,659*
Competitive Freight Wagon	395,963	235,169	**631,132**	-
Deutsche Bahn AG	19,359,030	9,572,083	**28,931,113**	*28,931,113*
Diginext(*)	540,000	270,000	**810,000**	*530,000*
EUROC	2,126,240	-	**2,126,240**	-
Faiveley	3,881,311	493,956	**4,375,267**	*4,375,267*
Hacon(*)	3,649,563	3,908,105	**7,557,668**	*7,557,668*
Indra(*)	1,688,292	113,753	**1,802,045**	*1,708,045*
Kapsch	1,231,345	907,000	**2,138,345**	*2,138,345*
KnorrBremse	4,791,972	2,595,574	**7,387,546**	*4,791,972*
MerMec(*)	976,244	820,000	**1,796,244**	*1,796,244*
SmartDeMain	2,750,490	543,340	**3,293,830**	*1,706,180*
SmartRaCon	547,996	444,456	**992,452**	-
SNCF(*)	934,632	-	**934,632**	-
SWITRACKEN	195,592	16,300	**211,892**	*2,461*
Talgo(*)	1,810,762	996,222	**2,806,984**	*2,806,984*
Virtual Vehicle Austria Consortium VVAC	5,028,375	838,003	**5,866,379**	*5,383,267*
Associated Members	**53,851,303**	**22,986,004**	**76,837,306**	***62,417,205***
Total	**130,044,389**	**30,395,362**	**160,439,751**	***118,640,136***

IKOP

The progress and acceleration realized since the end of 2016 is confirmed and is well in line with the usual Programme Management S-Curve.

As indicated under the definition of IKOP, these costs represent the difference between the Total Project Value and the S2R JU funding (or estimated).

The 2018 IKOP is the result of the 2018 activities performed by the Other Members, resulting from the grants awarded and signed since the beginning of the autonomous JU activities in 2016:

EUR million

	R&I activities			
	awarded and signed	**realized**		%
	Sept 16 - Dec 18	**2018**	**Sept 16 - Dec 18**	
Total Value	**365.4**	**87.6**	**147.0**	*40.2%*
S2R funding	162.1	37.1	61.6	*38.0%*
IKOP	**203.3**	**50.5**	**85.4**	***42.0%***

In order to allow the S2R JU to be in the position to sign the relevant grant agreements, the Union provided the necessary Commitment Appropriations to match the S2R funding of EUR 162.1 million above (excluding OC), against the Other Members' commitment of EUR 365.4 million. In terms of Union Payment Appropriations, they were used to provide the pre-financing up to 45% of the estimated funding in accordance with the relevant provisions of the grant agreements.

It should be noted that the estimated requested funding included in the 2018 Other Members' declarations is foreseen to remain within the provision of the relevant Membership Agreements. In fact, Article 2(2) of each Other Member's Membership Agreement signed with the S2R JU establishes that "*the Member agrees to limit its reimbursement request in indirect actions funded under Article 3(1)(a) of the S2R JU Regulation to an amount not exceeding 44.44% of the Member's total eligible costs in implementing indirect actions. In case of research and innovation activities delivering the expected results through a series of intertwined actions throughout successive S2R JU Annual Work Plans, and without prejudice to the provisions concerning co-funding rates established in the S2R JU Annual Work Plans, this 44,44% threshold shall be applied cumulatively taking into account the final amount of reimbursement requested at the end of the last action implementing the specific intertwined research and innovation activities".*

The percentage resulting from the cumulative declarations in 2018 at Programme level for all S2R Members is 41.91%, within the maximum level of 44.44%.

However, it is to be noted that the intermediary reports of the following Members show an IKOP rate slightly below 55.56%: Network Rail, Thales, CFW, Indra, SNCF, SmartDemain and VVAC. This will be

followed up by the S2R JU in 2019 and in any case will result in a grant final payment which will correspond in a cumulative rate not exceeding [25]44.44% rate of the Total Project Cost.

IKAA

In terms of IKAA, the total expected contribution by the end of the S2R Programme is estimated to be above the minimum amount of EUR 120 million, established in accordance with the S2R Regulation. By the end of 2018, **the cumulative IKAA declared by the Other Members already amounts to EUR 160.4 million, corresponding already to 134% of the total estimated value. Out of this amount, EUR 118.6 million were already certified.**

[25] In this respect, the Governing Board adopted Decision 16/2018 amending the Other Members' model Membership Agreement; the specific Membership Agreements have been adopted in 2019.

1.12. Synergies with the Union Programmes/ Funds and national funded R&I

During the first months since its autonomy, the S2R JU started some activities and participated to Regional events organized by the Committee of the Regions and European Economic and Social Committee to consider how to make use of activities planned in other Union Programmes and Funds in relation with the Railway sector, in particular EFSI, Regional and Cohesion Fund. This work stream further developed during 2018.

In terms of national funded R&I activities in the Railway sector, the S2R JU invites the relevant MS to present their programmes and projects in the context of the meetings of the SRG. This allows discussion on way to interconnect the different activities and ensure that resources are leveraged for the best results. This is an ongoing process and it is becoming more and more relevant in view of standardization processes and market uptake.

In this respect, with the support of the Chair of the SRG, the S2R JU signed a cooperation agreement with the SEESARI initiative on 18 September 2018 for collaboration in R&I, future demonstrations and deployment. Similarly, the S2R JU reached an agreement on a MoU with the Czech Republic and with ETSI at the end of 2018. The JU continued contacts with the Rail Baltica Project covering the Baltic States and Poland: the objective is to ensure that rail R&I and, in particular, S2R innovative solutions are embedded in new rail projects. At the end of 2018, the Governing Board adopted a decision on the preparation, negotiations and signing of agreements between the S2R JU and European regions, other international organizations and bodies to ensure the adequate implementation of the S2R Regulation.

The S2R JU continued the discussion with the "Stairways to Excellence" a European Parliament Pilot Project executed by DG-JRC together with DG-REGIO. The project aims to support EU28 countries and regions in developing and exploiting the synergies between European Structural and Investment Funds (ESIF), Horizon 2020 and other EU funding programmes. This should create more opportunities for the regions/countries to obtain funding apart from only Horizon 2020, with the objective to increase innovation potential and implement efficiently innovative solutions.

1.13. Launch of 2019 Calls for Proposals and Tenders

On 4 December 2018, the S2R GB adopted the AWP 2019 and budget that resulted from the work performed by the JU with its Members, partners and Bodies during large part of 2018. The S2R JU published on its website the AWP 2019, containing the text of the 2019 call for proposals in its Annexes 1 and 2, in mid of December 2018. On 15 January 2019, the S2R JU opened for submission in the Horizon 2020 Funding & tender opportunities portal the 2019 Call for proposals to progress more focused activities in the execution of the S2R R&I Programme. This lengthy process includes the key contribution of the S2R Members, the review and advice at different points of the SC, SRG, ERA and UR-ID and the adoption of the S2R GB, after the overall work was finalized under the responsibility of the Executive Director.

Since its appointment, the Executive Director was requested by the Members to ensure the streamline of the S2R Programme, starting with its administration. The Executive Director, together with the Programme Office, looked at the simplification process introduced by the European Commission through the Lump Sum Grant approach; after extensive internal discussions and analysis decided to propose to the S2R GB, as part of the AWP 2018, the adoption of the Lump Sum Grant approach, which was subsequently implemented through the Lump Sum Pilot in the CFM part of the 2018 Call. This met

R&I stakeholders expectations that public international bodies in charge of mission-oriented Programmes, such as the S2R JU, are willing and capable to experiment with both bringing in new expertise (e.g. establishing novel forms of collaboration to pool and share expert knowledge) and changing routines and processes to build dynamic organisational capabilities (including performance management, procurement, grants, etc.). The S2R JU is at the forefront of such processes in a risk management approach.

The implementation of the pilot Lump Sum Grant is set up in a confined Programme control framework, i.e. for the Projects to which the S2R JU Members are eligible. In fact:

a. Although the Lump Sum Grant approach does not require the beneficiaries to report on detailed eligible costs and audit requirements during the implementation stage on the project level, the Total Project Cost of the S2R JU Members is subject to audit and certification in accordance with Article 4.4 of the S2R Regulation on the programme level. Hence, in this specific context, Lump Sum Grants halve the costs of financial audits without undermining reasonable assurance;
b. The S2R JU Members agreed to limit their request of funding to 44.44% compared to the H2020 rates of 100% (+25% flat rate for indirect costs) or 70% (+25%) depending on the nature of the Action, that is fully described (including FTEs). As a result, the funding to be received by the S2R JU Members does not exceed the 35.5% of the direct costs sustained by the latter to deliver the R&I activities of the S2R Programme (44.44 / 1.25 = 35.5). This means that the financial risk embedded in the Lump Sum Grant is extremely contained within the S2R JU: only one third of the costs needed to achieve the results might be exposed to eligibility/financial risks. This is not the case for any other programme under Horizon 2020;
c. There is an obligation for the S2R JU Members to limit their funding requests up to 44.44%, hence an obligation to deliver at least 55.56% of activities at their own costs. As a result, if the estimated Lump Sum Grant were to be overestimated compared to the Total Project Cost of one action, the concerned Members would be in the obligation to increase their activities up to the level of a balanced cumulative 44.44% funding and 55.56% IKOP (as a difference between Total Project Cost and funding received).

Consequently, the implementation of the Lump Sum Grant approach within the S2R JU Call for Members activities, although for key project values, remains in a confined environment where checks and balances are in place beyond the usual Horizon 2020 eligibility rules.

The R&I planned to be performed complements the activities already ongoing, with the objectives to reach higher TRLs (up to 7) or start work on specific domains (TRL 0 – 3). The following tables give a synopsis of the calls.

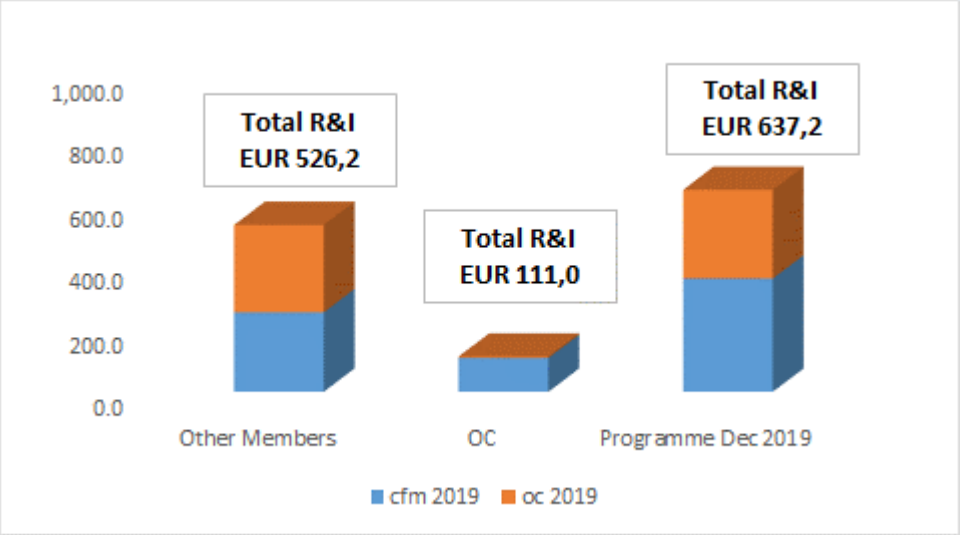
Activity	Type of call	Value of the actions (*)	Maximum S2R funding (*)	In-kind contribution (*)	publication date
Call for Proposals and/or Call for tenders	JU members eligible only	129.5	57.5	71.9	Q1 2019
Call for Proposals	Open, JU Members excluded	20.8	19.3	1.5	Q1 2019

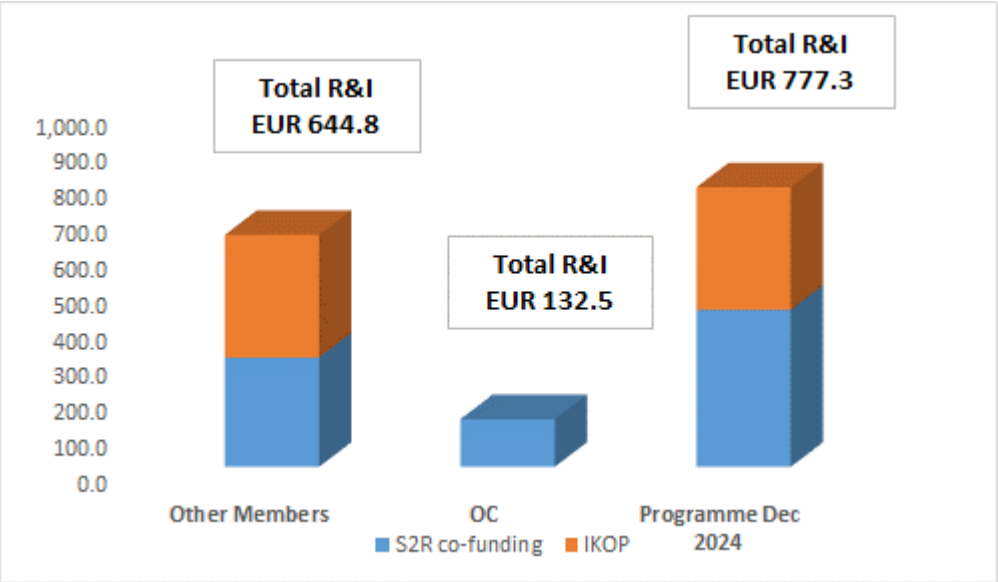
Call for Tenders	Open	1.4	1.4	0.0	Q1 & Q2 2019
Operational Experts	Open, including through REA and call for expression of interest (CEI)	0.5	0.5		
Total		**152.2**	**78.7**	**73.4**	

(EUR million)

With the Calls 2019 R&I activities up and running, the R&I activities performed in the Programme will reach EUR 637.2 million (including Lighthouse Projects as part of the S2R initiative), of which EUR 526.2 million performed by the Other Members with a funding made available by the S2R JU up to a maximum of EUR 251.0 million.

While in accordance with the respective Membership Agreements the Other Members agreed to limit their request for funding to 44.44% of the Total Project Costs, the OC topics are co-funded at the rates established in the H2020 Rules of participation





2. SUPPORT TO OPERATIONS

2.1. Communication activities

While communication in 2017 sought promoting the S2R programme as an integral part of the day-to-day railway world, 2018 activities focussed effort on presenting and disseminating the first prominent results from its R&I activities.

In September, InnoTrans 2018 offered a major stage for presenting the first S2R demonstrators to the world. Previously, in April, S2R had given a taste of what was to come, presenting an attractive stand at the Transport Research Arena (2018), before 3,000 members of the research community.

Having produced its first results, S2R gave great importance to disseminating these results to policymakers, in order to justify the investment and show reasons to pursue further public support for rail R&I activities in the future. In this line, S2R organised a dialogue on the future of R&I in June, with more than 150 stakeholders in the audience, and pursued collaboration with high-level policy makers, including Commissioner for Transport Violeta Bulc, MEPs and national ministers.

S2R has also boosted its outreach on social media and consolidated its newsletter, informing on its latest events, objectives, success stories and official announcements.

Furthermore, two communication agencies, Ecorys and 20 Seconds to Midnight, have supported S2R in its communication activities as part of a Framework Contract.

2.1.1. Events

The S2R JU participated in a number of institutional, external and internal meetings and conferences organised in Brussels and in some of the EU Member States.

Institutional events

Ten-T Days, a conference on the future of mobility held on 25-27 April 2018 in Ljubljana, was the main institutional event in which S2R JU participated in 2018.

The conference had a strong political tone as EU Commission Vice-President Šefčovič, Commissioner Bulc, Commissioner Creţu, Commissioner Oettinger, and several Ministers from different EU- countries participated. Overall, more than 2,000 stakeholders attended.

The S2R Executive Director moderated a panel on transport digitalisation and participated at a roundtable discussion on ERTMS. The S2R JU also had a small stand, presenting the goals and work done at the R&I Projects.

The S2R Executive Director also participated at the High-level Ministerial Meeting on Multimodality, which took place in Sofia, Bulgaria on 20 March 2018, as part of the 2018 Year of Multimodality.

S2R JU events

The S2R JU organised a major policy event: the S2 R&I Dialogue, which took place on 19 June 2018, in Brussels. It was an opportunity for more than 150 stakeholders to offer public support for S2R JU in a moment when the next MFF is at an important stage of discussion. It was also a platform for stakeholders to voice their suggestions for the future of European rail R&I.

Leading up to the creation of consortia to apply for S2R funding for non-Members, several entities have organised national information days across Europe, including:

12 January 2018 – Birmingham University organised a UK national brokerage event in Birmingham, about 100 participants.

8 February 2018 - Portuguese Railway Platform organised a national brokerage event in Lisbon, around 20 stakeholders attended.

4 June 2018 – The Austrian Ministry for Transport, Innovation and Technology organised a national brokerage event in Vienna.

29 November 2018 – The European Enterprise Network organised an international brokerage event in Strasbourg, attended by approximately 150 professionals from more than 10 European countries.

External events

S2R participated in 2018 in major events such across Europe, showing its first results to the general public:

Transport Research Arena (TRA 2018) – 16-19 April 2018 – Austria

S2R projects presented 27 scientific papers and the JU participated with a 66sqm stand at the exhibition area. S2R presented a very attractive stand, explaining its vision for the future of railways in Europe through an interactive 3D map and compelling visuals. S2R projects also had the opportunity to present their work at the stand.

TRA was an excellent occasion to get visibility in an event attended by more than 3.500 members of the transport research community. Especially relevant were visits to S2R stand by EU Commissioner for Transport Violeta Bulc and European Commission's Transport Director-General H. Hololei.

InnoTrans 2018 – 18-21 September 2018 – Berlin

S2R had a strong presence in its second appearance at InnoTrans, the largest rail fair in the world – presenting the first results of the initiative, barely two years since its inception. From 18 to 21 September 2018, S2R Projects presented more than 20 demonstrators.

Commissioner for Mobility and Transport Violeta Bulc and German Federal Minister for Transport Andreas Scheuer were the first guests to visit the S2R stand as part of the InnoTrans opening tour. At the visit, S2R project CONNECTA presented a wireless connected trams demonstrator. Broadcast live from Zaragoza, Spain, engineers showed how two trams could move in a coordinated manner without any physical link at a constant distance of about 6 metres, powered by 'virtual coupling' technology.

More than 150 people witnessed the live demo and the InnoTrans Daily newsletter highlighted S2R as a prominent exhibitor in the context of the Opening Tour.

The S2R stand hosted nine permanent demonstrators at its stand, including an obstacle-detection device, a multi-modal booking eco-system, a noise simulator, an energy-monitoring system in Virtual Reality, and more.

10 additional projects presented demonstrators at the presentation area of the stand, including and Intelligent Video Gate, Moving Block and Lean Tamping solutions.

Online channels were also an important part of the outreach activities during the fair as S2R created a dedicated InnoTrans page on its website. More than 20 news items and about 50 posts on Social Media platforms were published. Content on InnoTrans generated more than 3.000 unique page views on the S2R website and about 6.200 views on S2R corporate and demonstrator videos.

After the event, S2R developed 'shareable' videos based on the demonstrators presented at InnoTrans, aiming to disseminate further these results.

Overall, more than 160.000 trade representatives attended InnoTrans 2018, where S2R achieved to demonstrate its innovative power for the rail sector at a global level.

Politico Connected Transport Summit – 16 October 2018 – Brussels

For the second time, S2R sponsored the Politico Connected Transport Summit. As part of this agreement, S2R's image was featured on the conference programme and on social media.

Being one of the few representatives at the conference from outside the automotive sector, S2R highlighted the primary role of railways in a truly multimodal and connected future mobility system before 120 policymakers, and experts from transport and technology sectors.

Participation at other European and international events

S2R participated at a number of events besides the ones mentioned above:

- Multimodality event organized by the Commission, part of the Multimodality Year launched by Commissioner for Mobility and Transport V. Bulc;
- International Railway Summit, Prague (21-23 February);
- UIC Global Conference on Signalling, Milan (26-28 March);
- Rail Industry Meetings, Valenciennes (04-05 April);
- Infra Rail, London (1-3 May);
- Florence Rail Forum-Improving European Rail Freight, Florence (7 May);
- 2018 Summit of the International Transport Forum, Leipzig (23-26 May).

2.1.2. On-line communication

Website

In 2018, the website has been revamped with a new, more modern and responsive layout.

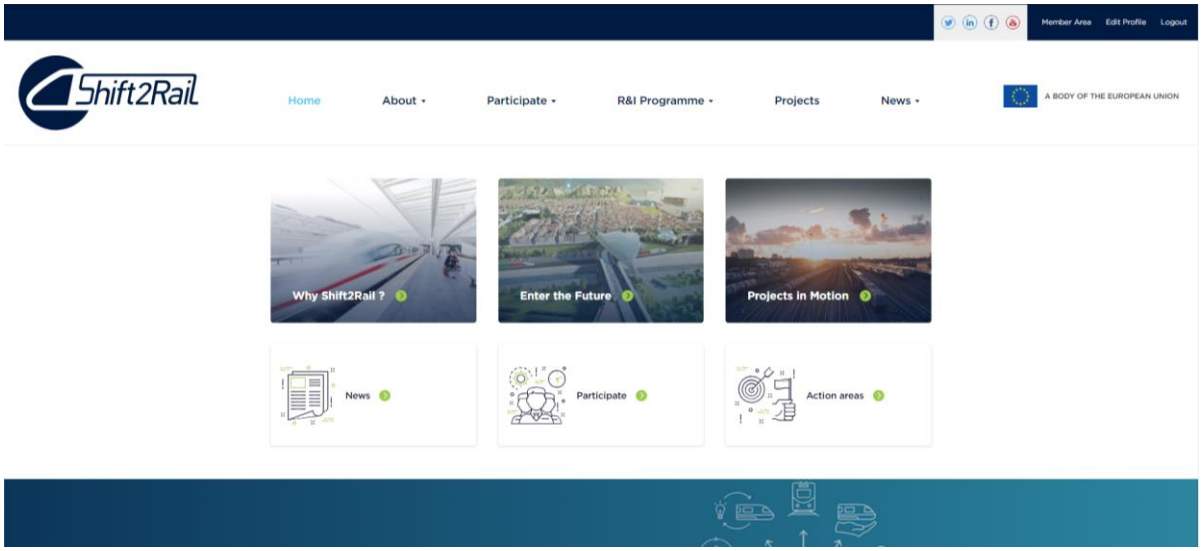


Figure 1: Shift2Rail revamped website in 2018

Important developments and enhancements were also undertaken in the CMS back-end, making the web site easier to maintain.

Changes have been implemented to the Cooperation Tool in order to manage the mini-sites of OC projects. Previously, it used to manage only CFM projects. The main S2R website was adapted in order to improve links to the project mini-sites. These interventions have helped to improve harmonisation across the website design.

Web statistics showed a steady growth since January with the number of pages viewed averaging 25.000 per month, with peaks in March and September (coinciding with InnoTrans).

In total, the S2R website received 12.35% more visitors than in 2017 and had a 3.6% growth on the number of pages viewed.

The S2R newsletter has been consolidated, with four issues published in 2018. The newsletters are sent to around 800-900 people. It is important to note that Shift2Rail subscribers base has suffer a

great decrease in 2018 after requiring additional explicit permission by the users to remain in the S2R database, in line with the new data protection regulation that entered into force this year. Efforts will be made in 2019 to grow our audience.

As per the previous year, the events calendar was updated constantly with all S2R JU events and meetings. Documents approved by the S2R GB have been made accessible and Press Releases or articles covering S2R activities and success stories were regularly posted.

New dedicated sections for press releases, newsletters and publications have been added. S2R also made available on its site the capabilities 3D map, produced in 2018 and presented at TRA, showing the vision for the future of S2R. A dedicated website on S2R's presence at InnoTrans was created to inform on the demonstrators presented at the fair.

A new map showing the location of all the S2R members at participating entities was created and uploaded the website, aiming to show the scope of the collaboration within the initiative.

Social media

The S2R JU has dedicated time and resources to feed its social media accounts – Twitter, LinkedIn and Facebook – with high-quality content and to engage with the rail community, aiming to enlarge the amount of public interested in Shift2Rail activities.

In 2018, S2R published for the first time 'shareable' videos on social media platforms on its most striking innovations, both produced in-house and by the S2R projects themselves.

S2R has dramatically increased its followers, especially on Twitter: from 796 in January to 2.300 by the end of the year.

Press

In 2018, the S2R JU was featured in articles in a range of magazines, industry press and online media. Some major media outlets have featured content on S2R goals, namely the Financial Times in February; and regional and national press, such as El Diario Vasco and Diario de Gipuzkoa.

A large coverage has been given to S2R in specialised media such as the Railway Gazette, the Global Railway Review and the International Rail Journal, as well as national specialised media, such as ZEV Rail, Der Eisenbahningenieur and Revista Vía Libre.

S2R Members magazines such as SNCF's Avancées and Plasser&Theurer's Today have extensively featured S2R activities and goals.

The official Results magazine of the European Commission on R&I-funded activities, featured three S2R projects and explained S2R's programmed in its editorial, in a rail-dedicated issue published in May.

Four S2R newsletters have been issued in 2018, covering topics such as the demonstrators presented at InnoTrans, reports from events such as TRA and the Shift2Rail R&I Dialogue as well as announcements related to the Call for Proposals. In 2018, S2R launched its section 'Capability in the spotlight'. 'More value from data', 'logistics on demand' and 'Mobility as a Service' have been

explained in subsequent newsletters, taking a practical angle, aimed to both specialised and non-specialised public.

Transversal communication products

S2R Capabilities 3D map

S2R created an interactive 3D map to illustrate how the next generation railway technologies will completely transform our travel experience in the future. The tool shows how the 12 innovation capabilities that S2R projects are working to deliver will meet Europe's evolving mobility needs.

The 3D map offers a vision of the transport systems of the future, featuring a fully digitalised railway system with trains running closer together and communicating via wireless connection as well as offering solutions for seamless transitions between different transport modes.

It was presented to Commissioner for Mobility and Transport, Violeta Bulc during the TRA conference; and it was used again at InnoTrans 2018 to show the vision of S2R on the rails of the future to the visitors.

Members map

The S2R JU developed a map, showing the location of all the entities participating in the initiative as of September 2018. The map has two versions: a print one, portrayed on a wall at S2R stands in TRA and InnoTrans; and an online version, available on the S2R website.

2.2. Legal and financial framework

The S2R JU legal framework refers predominantly to:

- Council Regulation (EU) N°642/2014 of 16 June 2014 establishing the Shift2Rail Joint Undertaking (OJ L 177, 17.6.2014, p. 9),
- The Delegation Agreement between S2R JU and the EC,
- The General Financial Regulation (EU, Euratom) No 966/2012) and its implementing rules[26], subject to any specific provisions of the Financial Rules of the S2R JU and the establishment act.
- The Financial Rules of the S2R JU, as adopted by the S2R JU GB on 30 July 2014 and the revised Financial Rules of the S2R JU, as adopted by the S2R JU GB on 11 December 2015.
- The S2R JU GB Decisions adopted since its establishment which framed the functioning of the S2R JU within the boundaries of the S2R Regulation and its Financial Rules, in particular the AWP to be approved by the GB (draft budget, Staff Establishment Plan, Scientific Priorities, calls, tenders, etc.)

[26] Regulation (EU, Euratom) No 966/2012 has been repealed by Regulation (EU, Euratom) 2018/1046 of 18 July 2018 on the financial rules applicable to the general budget of the Union, which entered into force and is applicable from 2 August 2018.

In addition:

- Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020 — the Framework Programme for R&I for the period 2014-2020 and repealing Decision No 1982/2006/EC (OJ L 347, 20.12.2013, p. 104), as well as 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 (OJ L 347, 20.12.2013, p. 81) is applicable to the grants awarded by S2R JU;
- The Staff Regulations of officials and the conditions of employment of other servants of the European Union are applicable to the staff of the S2R JU.

Additional reference documents may be found on the S2R JU's dedicated webpage: http://shift2rail.org/about-shift2rail/reference-documents/.

2.3. Budgetary and financial management

At year-end 2018, the JU had implemented 100% of its commitment appropriations made available in its adopted Budget. The payment appropriations were executed up to 82.3%. The implementation when compared to the full S2R Budget (including Title 4) was 100% in Commitment and 72.5% in Payment Appropriations.

With GB Decision 6/2017 of 27 October 2017, the S2R Governing Board adopted the initial Annual Work Plan and Budget for 2018. There were two amendments adopted to this document during the year 2018:

- GB Decision 1/2018 on 11 January amending the Annual Work Plan and Budget which did not have any budgetary impact and
- GB Decision, 12/2018 of 29 June 2018, amending the initially adopted budget later in the year.

GB Decision 12/2018 had the objective to adjust the initial adopted Budget to the evolving specific needs of the JU, including a number of transfers within the Administrative budget. These transfers had the objective to allocate better the resources needed for the running of the JU. In addition to the transfers between the Administrative budget lines, the overall Administrative budget was reduced by EUR 100 000 in both Commitment and Payment Appropriations. This amount was transferred to an operational line to cover the cost for experts supporting the project reviews.

In addition, considering the outcome of the Call 2018 in terms of expected pre-financing, the request for payments received by the date of the amendment and the estimated interim payments by year end, Payment Appropriations from the Operational budget were transferred to Title 4 of the Budget (Title 4: Un-used Appropriations not required in the year). This Title is of technical nature and, in accordance with the S2R Financial Rules, recognise the appropriations available for applying n+3 rule on the following budgetary years. It is used to increase transparency and accurate reporting of the JU. By allocating the appropriations in Title 4, they were identified as being used in the following years to meet the JU's legal obligations on payments and the JU could re-activate them as part of the initial Budget 2019.

	Commitment appropriations (including reactivations)					EUR '000
Title	Initial budget adopted	Amending budget	Transfers	Final adopted budget	Commitments made	%
	(1)	(2)	(3)	(4)=(1)+(2)+(3)	(5)	(6)=(5)/(4)
1	2 305	(100)	(12)	2 193	2 193	100 %
2	1 178	0	12	1 190	1 190	100 %
3	81 273	100	0	81 373	81 373	100 %
Total	**84 756**	**(0)**	**0**	**84 756**	**84 756**	**100 %**
4	0	0	0	0	0	0 %
GRAND TOTAL	**84 756**	**(0)**	**0**	**84 756**	**84 756**	**100 %**

	Payment appropriations (including reactivations)					EUR '000
Title	Initial budget adopted	Amending budget	Transfers	Final adopted budget	Payments made	%
	(1)	(2)	(3)	(4)=(1)+(2)+(3)	(5)	(6)=(5)/(4)
1	2 305	165	(12)	2 458	2 084	85 %
2	1 178	850	12	2 040	1 294	63 %
3	77 042	(9 650)	0	67 392	55 777	83 %
Total	**80 525**	**(8 635)**	**0**	**71 890**	**59 155**	**82 %**
4	749	9 001	0	9 750	0	0 %
GRAND TOTAL	**81 273**	**366**	**0**	**81 640**	**59 155**	**72 %**

Title 1 and Title 2 of the S2R Budget was executed up to 100% in commitment appropriations, demonstrating a reliable budgetary planning.

Title 1 - Staff Expenditure was mainly used for the salaries of the JU staff. During the year, the JU made also use of external support, to fill the gaps during the recruitment process on staff turnover and to cope with the important workload on JU activities.

The execution rate of the Payment Appropriations was 75.1%; showing an improvement in the budget implementation in relation to the previous budgetary year.

In addition to the budget amendment under GB Decision 12/2018, the Executive Director has executed its rights in Accordance with Article 10 of the S2R Financial Rules and transferred Appropriation within Administrative budget in the course of the year. These transfers are made to allow the JU to response the need of resources on specific items.

Title 3 Operational Expenditure

Title 3 of the S2R Budget constitutes the JU's Operational Budget. The vast majority of the JU's budget falls under this category representing 96.0% of the adopted overall budget (including Title 4). This Title covers the JUs Calls for proposals, Operational procurement and expert fees occurred as part of the evaluation.

The execution rate of the Operational budget in both Commitment and Payment Appropriations was respectively 100% and 82.8%. Majority of the Payment Appropriations were used for the pre-financing of the Grants resulting from the 2018 Calls for Proposals. Due to unforeseeable reasons, completely outside the control of the JU, two of the pre-financing payments resulting from this call became due in 2019 only and resulted the majority (EUR 8.3 million) of un-used Payment Appropriations for the year. These pre-financing payments are scheduled for the 1st quarter 2019.

Title 4 Unused appropriations not required in current Year

The amount included under Title 4 – Unused appropriations not required in Current year has been established to support a transparent implementation of S2R JU Financial Rules Art.6§5, the so called n+3 rule. In accordance with the Financial Rules and the general practise of the JU, these appropriations will be reactivated in the future year budget(s) of the following year and used first.

As a part of the Budget Amendment of 29 June 2018, GB Decision 12/2018, the JU has move some of its Payment Appropriation credits from operational line to Title 4. By this transfer, the JU has marked the appropriations available for re-activation on future budget years for the respective cost claims. The full EUR 9.8 million transferred to Title 4 has been re-activated as part of the initial budget 2019 and will be used against the payment obligations realised within that year.

2.4. Procurement and contracts

In order to reach its objectives and adequately support its operations and infrastructures, the S2R JU continued in 2018 to allocate funds to procure the necessary services and supplies. In the interest of sound financial management and to the possible extent, the S2R JU made use of Service Level Agreements (SLAs) with relevant Commission services (ICT, training, payroll, mission, experts reimbursements, interim staff, etc.) and participated in inter-institutional framework contracts (e.g.: travel agency services, IT services, interim staff services, audit services, office supplies). In addition, for services related to its premises, the S2R JU participated in inter-JUs framework contracts (IT and insurance services). In 2018 the S2R JU continue to use its own frame-work contract for communication and events services.

When for specific services or supplies a SLAs or a framework contract were not available, the S2R JU resorted to low-value contracts. In order to deal with exceptional circumstances the S2R JU launched in 2018 three negotiated procedures without prior publication of a contract notice. As lay down in the EU Financial Regulation, these procedures will be listed in the AAR 2019.

In order to establish the maximum values of procurement contracts, where necessary, the JU makes use of the collective experience of its staff involved in it, its Members and experts as necessary, driven by the principle of sound financial management. Although this was not formally documented in formal acts, audit trails are available also in the exchanges between the staff and the procurement sector to finalize the call for tenders before approval by the Executive Director.

During 2018 several guidance and templates for procurement procedures were drafted by the Legal Officer (i.e.: calendar, tender specifications, opening and evaluation of tenders, award procedures for low value contracts, etc.) in order to adapt them to S2R JU needs.

2.5. IT and logistics

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

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

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

S2R JU is participating to the joint strategic ICT plan of the JUs located in the White Atrium building. During 2017, the physical infrastructure was migrated to a private cloud computing infrastructure and it is expected that during 2018 the rationalization process will continue to maximize the limited resources available.

In 2017, analyses were conducted to further advance the adoption of the EC's ICT systems for HR (Sysper) and daily document management (ARES/HAN). The objective behind is to leverage the EC's proven working technology solutions already in place, but also to streamline and further harmonize the processes, procedures of record management, document archiving and electronic document cataloguing, secure storage and document access.

2.6. Human Resources

In 2018, In accordance with the establishment plan, the S2R JU recruited 2 SNEs and, with the agreement of the Budget Authorities, recruited a third one for a 1-year secondment in order to temporarily replace 1 Programme Manager who declined our offer of employment and couldn’t be replaced by a candidate from a reserve list. The S2R JU also replaced 2 colleagues who left the team: the Assistant to the Research and Innovation Unit and the Communication Officer. The recruitment of the Head of Research and Innovation was completed too, reinforcing the structure of the JU.

On top of the recruitment activities and routine daily HR management, particular attention was given to the swift and concrete implementation of HR-related decisions adopted by the S2R GB (Implementing rules).

Furthermore the second reclassification exercise of the JU was successfully carried out and in-house training was organized on Ethics and Integrity. The management team of the JU was provided with an individual feedback and guidance on their leadership skills which was delivered by an external contractor specialized in HR services and team building activities were also organized in order to reinforce the cohesion of the team.

For the second year, the S2R JU welcomed Bluebook Trainees in accordance with the SLA signed with DG EAC.

In 2018, the S2R JU team consisted of 23 staff members (including the SNEs) (see ANNEX B Establishment plan).

2.7. Data protection

The S2R JU continue to implement the EU data protection policies and legal framework. As regards the processing of personal data, the S2R JU continued to apply Regulation (EC) N° 45/2001, in particular by addressing prior checking operations to the European Data Protection Supervisor (EDPS) under Article 27 of Regulation (EC) No. 45/2001.

The role of the data protection officer continued to be exercised in 2018 by the S2R JU's Legal Officer.

A new EU Data Protection Regulation entered into force on 11 December 2018[27] in order to be brought in line with the GDPR. To ensure compliance with the new data protection principles – even before the entry into force of the new Regulation- , the S2R JU requested the services of an external company specialised in EU data protection law. In particular the S2R JU:

- Updated privacy policies in order to provide transparent information, communication and modalities for the exercise of the rights of the data subject (articles 14 to 16 of Regulation (EU) 2018/1725)
- Reviewed data processing operations and published the record of the current processing activities under its responsibility in a central register (article 31(5) of Regulation (EU) 2018/1725)
- included the new provisions in contract templates
- Provided guidance to S2R staff.

3. GOVERNANCE

3.1. Governing Board (GB)

In accordance with the S2R Regulation, the S2R GB continued its work steering the JU through the adoption of decisions to be implemented and executed by the ED. Three meetings of the Board were convened in 2018, dealing with both operational and administrative aspects. Important decisions were taken, such as the approval of the list of actions proposed by the ED selected for funding under the 2018 Call, the amendment of the MAAP Part B and the adoption of the 2019 AWP, including the adoption of the lump sum funding pilot scheme, which was already launched in the CFM Call 2018 for the first time and will significantly contribute to the administrative simplification of the R&I activities.

[27] Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC.

Following the adoption of "GB Decision 16/2018 regarding the amendment of the membership agreements between the Shift2Rail Joint Undertaking and the members other than the Union", the revision of the Membership Agreements with the Founding Members and with the Associated Members was launched to define the maximum limit of the reimbursement requests (44.44% of the project cost) in relation to the totality of the Member's costs in implementing intertwined indirect actions calculated cumulatively, rather than, for each indirect action, to the total costs in implementing that indirect action.

Furthermore, on 7 June 2017, the S2R GB mandated the Executive Director to establish the necessary process to allocate EUR 5.6 million of funding still available within the Union funding available for the Associated Members. An Invitation to S2R JU Associated Members to submit an answer in view of the realignment of their activities and additional commitment to the S2R Programme was published in June 2017, ensuring transparency and equal treatment. The Invitation was made public to provide the opportunities to third entities to join existing Associated Members to perform railway R&I. Consultations on the membership agreements were conducted with the eleven associated members who answered the invitation. The Membership Agreements with the Associated Members have been revised to take into consideration the "report regarding the outcome of the invitation to Shift2Rail JU Associated Members to submit an answer in view of the realignment of their activities and additional commitment to the Shift2Rail Programme" and the subsequent negotiation process. Subject to the approval of the revised versions of the Membership Agreements by each member, the Executive Director of the S2R JU will transmit the amended membership agreements to the Governing Board for approval by written procedure by beginning of 2019.

Moreover, HaCon, one of the associated members of the S2R JU and also a member of the S2R JU GB, became a wholly-owned subsidiary of Siemens AG, one of the nine S2R founding members and a member of the S2R GB. As the provisions on changes to membership (Article 4 of the Annex to the Regulation) do not cover the possibility of termination of membership in this particular situation, the S2R GB decided that HaCon should maintain their status as Associated Member and be entitled to a seat in the GB as per Article 6(1)(c) and (d) of the Statutes and the Decision of the GB n° 4/2016 appointing the representatives of associated members to the S2R JU GB.

The Governing Board was informed of the upcoming European Court of Auditors' audit on the implementation of the actions included in the Action Plan in response to the recommendations of the interim evaluation of the S2R JU.

Furthermore, a number of decisions were adopted concerning administrative issues and issues related to the personnel (adoption by analogy of rules of employment of staff of the EU).

3.2. Executive Director (ED)

According to Article 10 of the S2R Statutes, the ED is the chief executive responsible for the day-to-day management of the S2R JU in accordance with the decisions of the S2R GB. The ED is the legal representative of the S2R JU. The ED is accountable to the S2R GB. He is supported by the JU staff organized in a Programme Office.

The S2R JU ED was appointed on 16 February 2016. He took his duties on 16 May 2016.

The ED is supported by the Head of R&I and the Head of Finance and Administration. The Programme Office under his responsibility complied, in 2018, with the Governance and Process Handbook which

describes in details the processes and procedures to monitor the performance of the Projects that will be implementing the Programme through an integrated Programme Management approach.

Moreover, the ED was provided by the S2R GB with a mandate to establish relations with European regions and other European and international organizations,

3.3. States Representatives Group (SRG)

To date, 33 countries have nominated representatives to this group. During 2018, the SRG held its eighth and ninth meetings on 18th April and on 19th September respectively. One of the main tasks in both meetings was the consultation with the Member States and the Associated Countries on the JU's AWP 2019 as well as on the review of the MAAP.

In the eighth meeting, which took place in Vienna, the SRG discussed the importance for the JU to establish regional strategic partnerships and MoUs, preparation of the AWP 2019, the MAAP review and testing facilities infrastructure.

In the ninth meeting, held in Berlin in the margins of the InnoTrans event, the discussions focused, inter alia, on Horizon Europe, the contribution to the draft Strategic Research and Innovation Agenda, draft AWP 2019 and railway research beyond S2R (S2R2) preparation.

Furthermore, a written procedure was launched in 2018 for the election of the new Chairperson and Vice-Chairperson of the SRG, effective as of 1st January 2019 for a period of two years.

In both meetings, the participants were informed in detail about the ongoing and planned activities of the JU.

3.4. Scientific Committee (SC)

The SC is an advisory body to the S2R JU focusing on the long-term research and identifying scientific and technological achievements and development priorities.

The S2R JU SC held its ninth meeting on 16th April 2018 in Vienna. Following the resignation of the Chairperson and a member of the SC due to a risk of conflict of interest, as both were participating in projects co-funded by the S2R JU, the newly adopted GB Decision n°07/2018 on "Rules on the prevention and management of conflict of interests applicable to the S2R JU bodies" was presented by the S2R JU. In the context of the continuous process for the assessment of Conflict of Interest, the S2R JU took note of the declarations provided by the members of the SC in view of addressing possible risks.

The JU also presented the revision of the first draft of the AAR 2017, the revision of the MAAP Part B, the KPI model, the preparation of InnoTrans 2018, and an update on the draft AWP 2018. The members provided specific comments on the different topics in order to contribute to the document finalisation. A discussion on the long term strategy for railway research beyond S2R (S2R2) also took place.

Furthermore, a written procedure was launched following this meeting in order to elect a new Chairperson. The newly elected S2R JU SC Chairperson's mandate runs from 8 May 2018 to 16 September 2019. A new SC member, Mr Klaus Moessner, was also appointed.

The tenth meeting of the S2R JU Scientific Committee was held on 20 September 2018 in the margins of the InnoTrans event in Berlin.

A discussion on a more active role of the SC members and a proposal for a new set-up of the SC took place. The SC members unanimously agreed the ED would request a revision of the Rules of Procedure of the SC, in order to allow members of the SC to be contracted as individual experts by the S2R JU for the review of S2R projects, whilst ensuring their independence and impartiality and the absence of conflict of interest.

The SC provided the opinion on the final draft AWP 2019.

3.5. Innovation Programme's Steering Committees (SteCos)

In 2016 all IP's SteCos were formally established and each of them adopted its Rules of Procedures, in line with the indications of the S2R GB.

The SteCos convened regular meetings (four meetings in total in 2018) and their role was to ensure the necessary coordination of activities within each IP and to provide input in assisting the JU in the planning of its future activities (i.e. input for the AWP 2019, the global planning, the MAAP review, etc.). As from the signature of the first OC grants, the coordinators of the OC projects were invited to participate to the SteCo meetings in order to present their plans in a way to ensure coordination of actions and to maximise synergies among projects.

During 2017, the S2R JU together with the IP Coordinators work towards the evolution of the IP meetings more on technological and operational content than administration. This was further enhanced in 2018, focusing on TDs results and adding IPs' joint meetings on specific thematic areas (e.g. automation, digitalization, telecoms, cyber-security, integrated traffic management).

3.6. European Union Agency for Railways (ERA)

Article 12 of the S2R Statutes clarifies the areas of cooperation between the S2R JU and ERA. In order to ensure that strong cooperation is established with ERA, the rules of procedures of all relevant groups established by the S2R JU foresee the participation of representatives from the ERA (either as observers or direct members of these groups); this ensures that the Agency is duly prepared to take into account the results of the Programme in its activities.

As a result, staff members of ERA have been participating in meetings of the S2R GB (cf. 3.1) and the IP SteCos, but also in the groups which were tasked with the drafting of the MAAP and contributing to the S2R JU AWP.

The S2R Governance and Process Handbook[28] clarifies the way ERA can access the R&I activities performed within the S2R Programme in the areas of their competence, interoperability and safety. It worth to mention that the S2R JU provided to ERA in 2018 the GoA2 specification as a possible game changer integration in the next release of the CCS TSI.

[28] https://shift2rail.org/wp-content/uploads/2017/12/S2RJU-Governance-and-Process-Handbook_20171010_v11_Cleanv-nd.v2.pdf

In addition, regular coordination meetings have been organised between the two EDs, operational staff and communication staff. The overall objective is to ensure that the R&I innovative solutions that will be delivered by the S2R Programme will be considered in the pipeline of ERA activities in order to avoid any step back in the future market uptake.

The role of ERA in the context of 4th Railway Package, once duly implemented, will be another asset to facilitate the deployment of the S2R Innovative Solutions.

In addition, with the objective to avoid overlapping activities, the S2R JU assess the requests for R&I coming from ERA and ensure their implementation to maximize the use of public funding. Building upon parallel structures would constitute a waste of resources.

The S2R JU also supported the EC in its ERTMS Deployment Action Plan, participating to the ERTMS Policy Board meetings and advertising the ERTMS Deployment Action Plan Consultation on its website.

4. INTERNAL CONTROL FRAMEWORK

4.1. Financial Procedures

The S2R JU Financial Rules were adopted by the S2R GB on 30/07/2014 and amended on 11/12/2015. The Financial Rules do not depart from the model Financial Regulation for public-private partnership bodies referred to in Article 209 of the Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012. Since its budgetary autonomy, the S2R JU has been using ABAC (accounting system of the European Commission) for its financial management.

The S2R JU Manual of Financial Procedures has been prepared in line with Article 17(3) of the Financial Rules of the S2R JU and incorporated. The main purpose of the document is to identify actors, describe the financial circuits and detail procedures regarding the implementation of the S2R JU Budget. The financial circuits take into account the structure of S2R JU and the risks associated with the management environment.

The Financial Rules of the S2R stress the need to differentiate between the initiation of a financial transaction and the verification of the same transaction in order to guarantee the principle of segregation of duties.

The S2R JU budget in respect of this document has been divided mainly into two types of expenditure;

- Administrative Expenditure covering both; Titles 1 and 2 of S2R Budget, and
- Operational Expenditure covering Title 3 of the Budget.

The new Title 4 is dedicated to account for un-used appropriations.

Due to their nature and the difference in ICT tools implemented at the S2R JU to manage them, the financial circuits between these two expenditure types are different.

The Manual of Financial Procedures describes in detail financial circuits the S2R JU implements per type of transactions and the roles and responsibilities of each actor involved. To a less extent, it also describes the basic principles on main procedures (grants & procurements). In 2017, this document has been reviewed to streamline and improve the internal financial processes.

It should be noted that the specific S2R JU financial procedures are complemented by *vademecum* established for the overall Horizon 2020 research family as well as by S2R JU Programme Handbook.

The S2R GB formally appointed the Accounting Officer of the Commission as the Accounting Officer of the S2R JU on 18/03/2016.

4.2. Ex-ante Controls on operational Expenditure

The S2R JU adopts the standard financial circuits in ABAC Workflow for the commitments and payments. The circuit has a three-step authorisation performed by the following financial actors:

- Initiating Agent (OIA and FIA)
- Verifying Agent (OVA and FVA) and
- Authorising Officer (AO).

Staff members designated by the AO to verify financial operations are chosen on the grounds of their knowledge, skills and appropriate professional experience.

The S2R JU financial circuits comply with the requirements of the four eyes principle, segregation of duties and the independence of the verifier. In addition, in view of the limited staff, they also provide the flexibility necessary to ensure the continuity of operations.

For the operational expenditure of the JU, S2R JU recognises two different types of transactions: ones solely performed in the ABAC Workflow and ones with the initiation and verification functions outside the ABAC environment in a tool called SYGMA. This tool is also linked to ABAC which allows real time controls over the budget and its implementation.

The nature of the transaction defines the system where the initiation and verification is performed:

- ABAC for all procurement related transactions and
- SYGMA for any transactions related to grant management

In all transactions, whether initiated in SYGMA or ABAC, the AO will give his/her authorisation in ABAC only.

A key element of the ex-ante controls is the "*Guidance Horizon 2020 ex-ante controls on interim & final payments*" adopted by the CSC Steering Board on 15 Dec 2016 and applicable as such to the S2R JU. The main consequence of this simplified ex-ante control approach is that the limited details asked to beneficiaries to be provided in each periodic report do not allow the S2R JU to check most of the conditions for the eligibility of costs. Ex-ante controls in Horizon 2020 are therefore trust-based, focusing on whether:

- the work has been done (as described in the periodic reports)
- the reported effort and use of resources is reasonable and in accordance with the plan
- sufficient explanation and justification are provided for any substantial deviations (see Section 2.5).

In practice, the assessment involves comparing the Description of the Action (DoA) and the budget earmarked with the work actually carried out, as explained in the periodic report, and the costs being claimed in connection with it.

Certain elements (such as risk factors or deviations) are less in evidence when checking interim periodic reports than when assessing final reports. Moreover, since CFS are required only as part of the final reports, ex-ante controls in final periods will be more in-depth. Moreover, officers may take a more flexible approach to ex-ante controls in interim periods by asking beneficiaries for additional clarification in the ensuing reporting period. However, by the time the final payment is made, all outstanding issues should have been dealt with.

4.3. Ex-post Control of Operational Expenditure and Error Rates Identified

Ex-post controls are defined as the controls executed to verify the financial and operational aspects of finalised budgetary transactions in accordance with Article 19 of the S2R JU Financial Rules.

The controls are the last stage of the JU's control strategy in the project life cycle. This stage includes the ex-post audits as well as the recovery/correction of any amounts found to have been paid in excess of the sum due.

Ex-post Control of Operational Expenditure at S2R JU fall under the Horizon 2020 Audit Strategy. The implementation of the Horizon 2020 Audit Strategy will be the responsibility of the Common Audit Service (CAS).The role of the CAS is defined in the Commission Communication of 18 September 2013 establishing the Common Support Centre (CSC)[29]. The CAS has been designated as the single entity for implementing the H2020 audit campaign on behalf of the CSC stakeholders such as S2R JU.

The main objective of the Horizon 2020 Audit Strategy is to provide the ED with the necessary elements of assurance in a timely manner on the Horizon 2020 budget for which they are responsible by contributing to:

- assessing the legality and regularity of Horizon 2020 project payments;
- providing an indication of the effectiveness of the related ex-ante controls;
- providing the basis for corrective and recovery mechanisms, if necessary;
- attaining residual error rates at an acceptable level at the closure of Horizon 2020, once the financial impact of all audits, correction and recovery measures has been taken into account[30].

The actions identified to realise these objectives include:

- the gradual achievement, in a cost effective-way, of quantitative multi-annual targets in terms of audited participations;
- the closure and communication of audit findings and extension of audit findings to those responsible for their implementation providing the basis for corrective and recovery activities, if necessary.

Different indicators are calculated to provide a comprehensive view of legality and regularity:

Overall Detected Error Rate: this is the error rate derived from the results of all audits, whether audits on a representative sample of beneficiaries or audits implemented for other reasons (large

[29] Communication on the delegation of the management of the 2014-2020 programmes to Executive Agencies SEC(2013)493 of 18 September 2013, section 5.1.2

[30] Legislative Financial Statement as part of the 2011 Commission proposal for the Regulation on H2020 (COM/2011/809) of 30 November 2011, pages 98-102

beneficiaries, preventive audits, risk factors, etc.). Its value is cumulative and can be calculated for a specifically to S2R JU or for the whole Research and Innovation Family.

Representative Error Rate for the Framework Programme: this is the error rate derived solely from the results of the CRS on the whole Research and Innovation Family, extrapolated to the overall population and calculated for each FP as a whole. This error rate provides an estimate of the level of error in the given Framework Programme at the time of the audits, but does not factor in the follow-up and corrections/recoveries undertaken by Commission services after the audit, nor does it provide information on the net final financial impact of errors.
Residual Error Rate: the residual error rate, on a multi-annual basis, is the extrapolated level of error remaining after corrections/recoveries undertaken by S2R JU following the audits that have been made. The calculation of the residual error rate is made in accordance with the H2020 Audit Strategy and is based on the following assumptions:

- all errors detected will be corrected;
- all non-audited expenditure is clean from systematic material errors so that the residual error rate can be estimated to be equal to the non-systematic error rate (for expenditure subject to extension of audit findings this is only assumed when the respective extension procedures have been closed).

The residual error rate develops over time and depends on the assumptions set out above. This indicator is reliable and acceptable for the purposes for which it was intended, i.e. as a legality and regularity indicator on the progress made, through its ex-post audit strategy, in dealing with errors over a multi-annual basis. However, it remains an estimate as long as not all cost claims have been received and not all cases of extension of audit findings have been fully implemented yet.

Ex-post controls of the Horizon 2020 programme globally in 2018

The Common Representative Sample (CRS) provides an estimate, via a representative sample of cost claims across the Research and Innovation Family, of the **overall level of error** in the Research Framework Programmes, across all services involved in its management. All of these grants follow the same homogeneous overall control system set out in this report.

The CRS is complemented by 'risk-based' audits; audits selected according to one or more risk criteria. These audits are intended to detect and correct as many errors as possible, for instance by targeting the larger beneficiaries and through the identification of possibly fraudulent operators. These audits are also referred to as 'corrective' audits.

At this stage of the programme lifecycle, cost claims totalling 9 billion euro of requested funding had been received by the services by the end of 2018. The first Horizon 2020 audits were launched in the middle of 2016 and further audits were launched in 2017 and 2018. Two Common Representative Samples (CRS), Common Risk Samples and Additional Samples have been selected. In total, by December 2018, 2383 participations had been selected for audit, covering all the services signing grants in Horizon 2020.

In total, the audit of 1155 participations has been finalised by 31/12/2018 (763 in 2018). This includes 164 out of 303 participations selected in the first 2 CRS. The error rate at 31/12/2018 is:

Overall detected error rate based on 1155 participations: 1,62%

Representative Error Rate for the Framework Programme: based on 164 out of 303 participations selected in the first and second CRS is 2.43%. However, taking into account the draft audit reports, the

expected representative error rate for the full sample will be around 3.32%.

Residual Error Rate for the research family: 2,22%, expected to rise to around 2.45% when taking into account the draft audit reports.

As last year, the error rates set out above **must still be treated with care**. The two first CRS are not yet complete, and so the error rate is not yet fully representative of the expenditure that it covered. In addition, the first CRS was taken at an early stage of the programme in order to provide an early indication of the error rate and, also, to help assess whether the simplifications introduced in Horizon 2020 had been effective. The nature of expenditure in the first years of the programme may not be totally representative of the expenditure across the whole period of expenditure. And the programme is in any case multi-annual, so the error rates, and especially the residual error rate, must be considered over time. In particular, the cleaning effect of audits over time will tend to increase the difference between the representative/detected error rate and the residual error rate, with the latter finishing at a lower rate.

There is nevertheless evidence that the simplifications introduced in Horizon 2020, as well as the increased experience of major beneficiaries, are reducing the number and level of errors made by beneficiaries. However, beneficiaries still make a number of errors, sometimes because of a lack of understanding of the rules, sometimes because of a non-respect of the rules.

To improve clarity of the rules and compliance with them DG RTD has already taken the following actions:

- The Model Grant Agreement, and its accompanying annotations, have already been adjusted to introduce simplifications or clarifications on different points. The results of the first audits were considered in a working group bringing together auditors from the Commission and the Court of Auditors to see where additional simplifications and clarifications may be needed[31].
- Considerable efforts have been made to ensure clear communication of the rules and guidance to participants and their auditors. In 2018, the Common Support Center has been attending and coordinating 15 events organised by the National Contact Points of members States and associated members with a total of 1819 participants.
- Lump sum funding has already been used for the SME stage 1 calls grants as well as by the S2R JU for its CFM Call 2018. Trials of lump sum funding for collaborative projects began in 2018 to evaluate if this form of entitlement funding, which would avoid errors of legality and regularity, is appropriate to achieving all the objectives of research policy. These trials will continue in 2019, and include the extension of lump sum funding to the ERCEA Proof of Concept grants.

The Financial Statement accompanying the Commission's proposal to the legislative authority for the Horizon 2020 regulation states: "*The Commission considers therefore that, for research spending under Horizon 2020, a risk of error, on an annual basis, within* ***a range between 2-5 % is a realistic objective,*** *taking into account the costs of controls, the simplification measures proposed to reduce the complexity of rules and the related inherent risk associated to the reimbursement of costs of the research project. The ultimate aim for the* ***residual level of error*** *at the closure of the programmes after the financial impact of all audits, correction and recovery measures will have been taken into account, is to* ***achieve a level as close as possible to 2 %****.*"

The first audit results suggest that the detected (and in future representative) error rate will remain within the established range. Together with the experience in FP7, they also suggest that the objective for the residual error rate will be respected.

[31] This meeting took place on 14 March 2018.

In conclusion, DG RTD still considers that the error rate will fall within the range established in the Financial Statement, so it does not consider that a reserve is needed for Horizon 2020 expenditure.

Ex-post control 2018: S2R JU Specific sample

Given the relatively small share of the S2R JU's budget (less than 1%) compared to the overall H2020 budget, the number of projects selected for ex-post audit by the CAS via the common representative sample is limited. Therefore, S2R JU in line with Annex 1 to the H2020 audit strategy, planned for additional audit sampling (i.e. JUs' specific sample) in order to ensure sufficient ex-post audit coverage and allow a representative error rate on S2R JU expenditure to be calculated over time. This is necessary to provide reasonable assurance to the JU's Executive Director in view of his declaration of assurance and the separate discharge procedure for the JU. There were no S2R JU cost claims selected as part of the Common Representative Samples for the H2020 research family, selected by the CAS in years 2016 and 2017. One risk based audit on S2R JU cost claim has been launched as result of implementing the H2020 Audit Strategy which has been finalised in 2018 with zero adjustment.

In 2017, in addition to the risk based audit detailed above, the JU launched representative audits covering 15 additional cost claims. After launching the representative audits, the total coverage raised into KEUR 1 324 representing 40% of the all cost claims validated in that year.

By 31 December 2018, S2R JU had validated cost claims for a cumulative total of KEUR 32 280 covering 25 projects. In 2018, the JU launched additional 14 representative audits on its population and one risk-based audit based on its own risk assessment. This brought the direct coverage of the S2R JU launched audits into KEUR 4 662 (14%) and in-direct coverage into KEUR 16 757 (52%).

Batch	Audit launch year	Launched	On-going	Finalised	Of which	
					Representative	Risk-based
1	2017	16	13	4	3	1
2	2018	15	15	0	0	0
Total		**31**	**28**	**4**	**3**	**1**

Numbers referenced in terms of cost claims

Total Number of Cost Claims validated at 31/12/2018	515
Total Cost Accepted by S2R JU (cumulative) (A)	32,279,672
Total cost audits launched 2018 (B)	4,662,476
Total cost Audits finalised 31/12/2018 (C)	435,515
Direct coverage of total audits (B / A)	14%
Direct audit coverage of the finalised audits (C / A)	1%
In-direct coverage* of the total audits	52%
In-direct audit coverage* of the finalised audits	13%

* taking into account the audited entity's participation on other S2R projects contributing to the sum in (A)

Out of the 15 audits launched in Batch I, there were four final audit reports available at 31 December 2018 to the JU; one related to the risk based audit and three from the representative sample. These participations represent 1% of the direct and 13% of in-direct coverage in S2R JU accepted cost claims.

Overall detected error rate based on 4 participations: by applying simple average is 0.94% and by

applying weighted average is 1.19 %

Representative Error Rate based on 3 out of 29 participations selected in the first and second representative batch: by applying simple average is 1.25% and by applying weighted average is 1.24%

S2R JU Residual Error Rate: by applying simple average is 0.92% and by applying weighted average is 0.97%

A sufficient audit coverage in finalised audits will be ensured via the selection of the ex-post audits in 2018 and after to be completed and reported in future years. S2R JU recognises that the results available at 31 December may be considered limited in respect of their coverage from the total cost accepted by the JU. The results becoming available after 31.12.2018 will be reported accumulatively in the Annual Activity Report 2019 and after.

S2R JU has reported the respective error rates in terms of both, simple and weighted average. The nature and characteristics of the population determine which one of these two methods provide more representative characteristics of the results. At the cut off 31.12.2018, no material difference was detected between these two approaches. Although the results available may be considered limited in respect their coverage, the error reported is below the targeted threshold of 2%.

Implementation of audit results

As a result of errors identified during the S2R JU ex-post audits, JU funds paid unduly must be recovered. The audit results reported by 31 December 2018 relate to interim payments of S2R Grant Agreements. Therefore, all errors detected in favour of the JU are corrected in due course by offsetting against the future payments.

4.4. Audit of the European Court of Auditors

The European Court of Auditors (ECA) with its mission of February 2018 completed its work which resulted in S2R JU Annual Audit Report for the year 2017, in accordance with the ECA mandate as defined in the TFEU.

The European Court of Auditors released the following opinions:

Opinion on the reliability of the accounts

"In our opinion, the accounts of the Joint Undertaking for the year ended 31 December 2017 present fairly, in all material respects, the financial position of the Joint Undertaking at 31 December 2017, the results of its operations, its cash flows, and the changes in net assets for the year then ended, in accordance with its Financial Regulation and with accounting rules adopted by the Commission's accounting officer. These are based on internationally-accepted accounting standards for the public sector."

Opinion on the legality and regularity of revenue underlying the accounts

"In our opinion, revenue underlying the accounts for the year ended 31 December 2017 is legal and regular in all material respects "

Opinion on the legality and regularity of payments underlying the accounts

"In our opinion, payments underlying the accounts for the year ended 31 December 2017 are legal and regular in all material respects."

Furthermore the S2R JU gave detailed answers to ECA reported findings; the report was adopted by the ECA at its meeting of 2 October 2018.

During the course of 2018 and in anticipation to the adoption of the final report, the S2R JU took the necessary actions to remedy to the main comment of ECA ensuring the strict application and implementation of procurement procedures.

At the end of 2018, ECA started its work for the audit of the Annual Accounts 2018.

4.5. Internal Audit

The Internal Audit Service (IAS) of the EC performs the role of Internal Auditor of the S2R JU and, in this respect, it reports to the S2R GB and the ED indirectly.

The first audit mission consisted in establishing a risk profile of the S2R JU with the objective to establish a triennial audit plan. The IAS Strategic Internal Audit Plan 2017-2019 has been presented to the S2R GB in June 2017.

In accordance with this audit plan, the IAS performed in 2018 a Limited Review of the implementation of Internal Control Standards in the S2R JU.

In its Final Audit Report of 24 September 2018, the ongoing efforts made by the JU to develop a robust internal control system is recognised.

From the 5 important recommendations to management to address the shortcomings identified for the ICAS that were not yet fully implemented, only 1 still required implementing actions in 2019: the finalisation of the KPI model.

In 2019, IAS will conduct a review of the Horizon 2020 grant process and in 2020 of the JU performance management. The strategic internal audit plan will be subject to an annual review.

4.6. Risk management and conflict of interest

The S2R JU implements a risk policy to manage risks and opportunities related to the execution of the S2R Programme. The S2R JU follows the principles of the recognised international standards and aligns to the requirements of the EC as indicated in the Communication SEC (2005) "*Towards an effective and coherent risk management in the Commission services*".

Risk is defined as "*any event that could occur and adversely impact the achievement of the S2R Joint Undertaking strategic and operational objectives. Lost opportunities are also considered as a risk*".

The Risk Management system aims at enabling informed decision making with the objective of optimising the ratio between the level of acceptable risk by the S2R JU and the use of the relevant resources by anticipating and proactively identify, analyse, treat, control and monitor risks and opportunities.

With regard to programme specific risk management, the S2R Cooperation Tool as well as the relevant grant agreements related to the different Projects provide for the framework for management of risks and opportunities, with the possibility to scale them up at the proper level till the ED and S2R GB.

For the purpose of implementing the requirements of Article 23 of its constituent act pertaining to the prevention of conflicts of interest, the S2R JU has adopted rules governing conflicts of interest in respect of its members, bodies, staff and seconded staff, as well as its S2R GB members. The responsibility on conflict of interest is within the competencies of the ED.

4.7. Anti-Fraud Implementation and Indicators

The S2R JU continued to implement in 2018 the Shift2Rail Anti-Fraud Strategy 2017-2020[32], a tailor-made anti-fraud strategy complementing the Horizon 2020 strategy, including an assessment of its risks and opportunities.

In accordance with the S2R Anti-Fraud Strategy, 5 indicators are used to report on the results of fraud prevention and detection activities. At the end of 2018, the following can be reported:

	Indicator	Result
1	Number and value of contracts subject to close monitoring or additional controls due to an assessment of a high risk of fraud.	0
2	Number (and trend in number) of files sent to OLAF for investigation.	0
3	Time elapsed between receipt by staff or management of first information on alleged internal fraud and transmission to OLAF.	NA
4	Time elapsed between OLAF requests for information and date when information is provided to OLAF.	NA
5	Time elapsed between receipt of an OLAF report and the decision on recovery or disciplinary sanctions by the S2R JU	NA

The Anti-Fraud Strategy also includes an Action plan designed to implement this strategy and covering the stages of the anti-fraud cycle: prevention, detection, investigation and corrective measures. A first review of the Action Plan took place on the first quarter of 2018 a second review in the 3th quarter of 2018. In particular, during 2018 some corrective measures were taken:

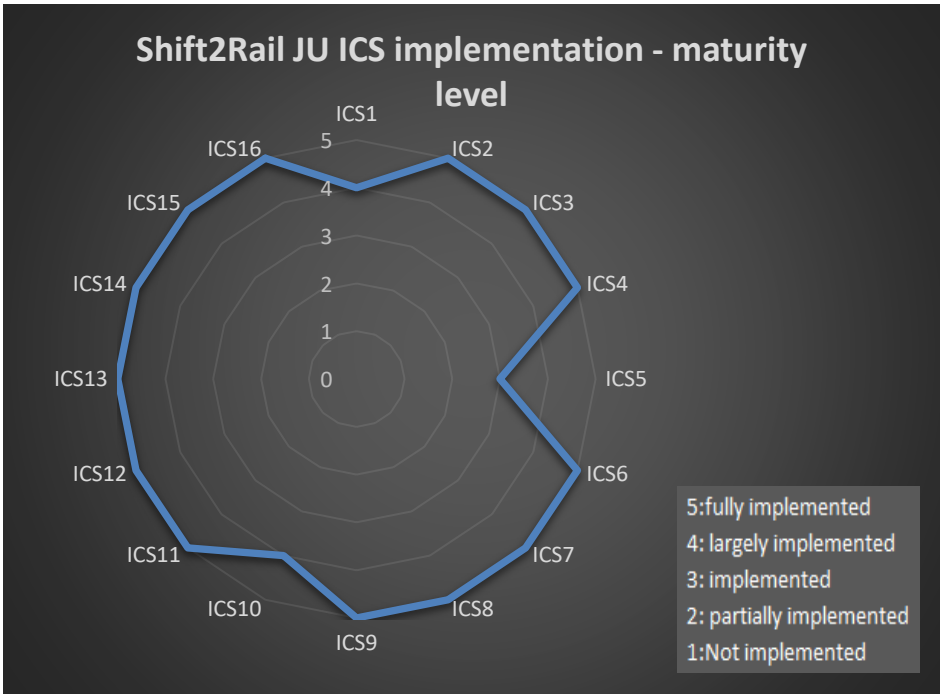
[32] https://shift2rail.org/about-shift2rail/reference-documents/

- Organisation of a new training on ethics and integrity for S2R JU staff
- Nomination of a new "person of confidence "with OLAF (S2R JU Legal Officer)
- Adoption by the S2R JU Governing Board of a new Whistleblowing and Anti-harassment procedures.

4.8. Compliance and effectiveness of Internal Control

The Internal Control Standards (ICS) is based on the Commission's ICS and adapted to the S2R JU's context and specificities; compliance with the standards are continuously monitored. An action plan was established at the end of 2016 and had been progressively implemented to ensure the sound financial management of the S2R Programme.

The following internal assessment of the S2R JU's ICS has been performed in order to evaluate the compliance and effectiveness of the Internal Control. It is to be noted that this internal assessment has been supported by the conclusions and recommendations of the IAS Final Audit Report, of 24 September 2018, on the Limited Review of the implementation of Internal Control Standards in the Shift2Rail Joint Undertaking.



Shift2Rail JU Internal Control assessment 2019 - AAR 2018			
Scale	*1:Not implemented - 2: partially implemented - 3: implemented - 4: largely implemented - 5:fully implemented*		
Internal Control Standard	Definition	Assessment 2019 - AAR 2018	Status
ICS1	Mission	Recommendation N° 1 of the IAS Final Audit Report 2018 "Harmonisation of the presentation of the S2R mission statement". An assessment of the S2R JU mission statement will be performed in the course of 2019 in the relevant documentation.	4
ICS2	Ethical and organisational values	Decisions on Conflict of Interests are adopted by the Governing Board. In 2018 the JU formalised the rules laying down guidelines on whistleblowing in addition to the organisation of awarness session on anti-fraud and ethic.	5
ICS3	Staff allocation and flexibity	Flexibility and right balance between professional and personal life has been an important concern for the organisation. The staff turnover remains an important concern generating long term risk for the S2R JU activity (Establishment plan)	5
ICS4	Staff evaluation and development	Staff performance is evaluated against individual annual objectives, which fit with Shift2Rail goals and objectives. The Learning and Development Policy has been adopted by the Governing Board. Implementing procedure will be developed by HR in 2019.	5
ICS5	Objective and performance indicators	Recommendation N° 2 of the IAS Final Audit Report 2018 " Finalisation of the KPI model" Key performance indicators are in the process of establishment to help management evaluate and report on progress made in relation to their objectives. KPIs model presented to the GB in 2018. The final model is expected in 2019. The expectations are to progress step by step, with new KPIs validated on an annual basis plan.	3
ICS6	Risk management process	The Shift2Rail Risk Management Policy is part of the S2R JU Governance and Process Handbook adopted by Executive Director Decision in 2017. The results of the annual risk assessment 2018 have been communicated into the Annual Work Plan (AWP) 2019 and in the Annual Activity Report 2018. The Risk assessment 2018 has been organised with the support of external consultants. In their conclusions, they confirmed the approach that S2R JU has been following in the last two years.	5
ICS7	Operational structure	Financial circuits: This part is considered as largely implemented. Effective ex-ante and ex-post controls are in place and in respect of the Financial rules, guidance and procedure. Sensitive function: The S2R JU policy on sensitive function was adopted in 2018. IT Governance: The current ICT set up which resulted in a private cloud service in place for the overall JUs provides contractually the framework for business continuity addressing one of the major shortcoming of previously having ICT infrastructure in the building.	5
ICS8	Processes and procedures	IAS Recommendation N° 3 of the IAS Final Audit Report 2018 "Strenghten application of the financial manual and checklists". Since the IAS limited review took place, the JU has strenghtened the application of the financial manual by performing quarterly ex-post controls on administrative expenditure. Significant improvement was observed. In 2019, a focus will be given to 1. risk assessment on the use of paperless system for administrative expenditure and 2. reinforcing the internal procedures for the operational expenditure (operational tender and grant agreements).	5
ICS9	Management supervision	The supervisory approach of the activities is reflected in current financial approach and financial rules as well as with the operation of the Programme Handbook since mid-2017.	5
ICS10	Business continuity	IAS Recommendation N°4 of the IAS Final Audit Report 2018: "Awareness raising and testing of the BCP" A revised JU's Business Continuity Plan and Disaster Recovery Plan document is approved at technical level on 10 April 2018. Since the IAS limited review took place, an awareness raising session of the BCP has been organised to JUs staff (in January 2019). Tests have been performed and will be finalised, with reports and conclusions at Q2 2019.	4

Shift2Rail JU Internal Control assessment 2019 - AAR 2018			
Scale	*1:Not implemented - 2: partially implemented - 3: implemented - 4: largely implemented - 5:fully implemented*		
Internal Control Standard	Definition	Assessment 2019 - AAR 2018	Status
ICS11	Document management	IAS Recommendation N°5 (last one) of the IAS Final Audit Report 2018: "Update the document management policy". Since the IAS limited review took place, the S2R JU Document Management Policy has been updated in accordance with the new processes in place with the implementation of ARES IT Tool, and information session has been organised for the S2R JU staff.	5
ICS12	Information and communication	Internal communication enables management and staff to fulfil their responsibilities effectively and efficiently, including in the domain of internal control. Shift2Rail has an external communication strategy to ensure that its external communication is effective, coherent and in line with the JU's key political messages (Communication Strategy adopted by Executive Director in 2017). Since 2018, a new private cloud contractor is providing the services. As a consequence, the additional business security requirement for the JU has been assessed with the chosen solution.	5
ICS13	Accounting and financial reporting	Adequate procedures and controls are in place to ensure that accounting data and related information used for preparing the organisation's annual accounts and financial reports are accurate, complete and timely. In 2016, the JU revised the financial information submitted to the Commission central accounting and reporting systems.	5
ICS14	Evaluation activities	Evaluations of expenditure programmes and other non-spending activities are performed to assess the results, impacts and needs that these activities aim to achieve and satisfy.	5
ICS15	Assessment of internal control systems	In its Final Audit Report on Limited Review of the S2R JU Internal Control System, the IAS considered it was fully implemented. The JU prepares an annual assessment of the implementation and effectiveness of the internal control system based on the requirements laid down in the decision on the 16 ICS. The JU reported the implementation status of each internal control standard in its AAR 2017, and now in its AAR 2018. In 2019, an action plan will be prepared for the implementation of the new Internal Control Framework applicable at European Commission since 2018.	5
ICS16	Internal audit function	The Internal Audit Service of the European Commission will perform the function of internal auditor of the S2R JU, in compliance with the relevant international standards. The IAS provides independent, objective assurance and consulting services designed to add value and improve the operations of the S2R JU.	5

The status of the implementation of the S2R Internal Control Framework demonstrates the relevance for the S2R JU to embed risk based management and control systems within its activities to deliver its Programme.

In this respect, the S2R JU looks forward to prepare an implementation action plan of the new Internal Control Framework proposed by the EC in the course of 2019.

5. MANAGEMENT ASSURANCE

5.1. Assessment of the Annual Activity Report by the Governing Board

The ED submits the draft AAR to the S2R GB for assessment and approval. Once approved by the S2R GB, the AAR is made publicly available. No later than 1 July of each year the AAR together with its assessment shall be sent by the ED to the ECA, to the Commission, to the European Parliament and the Council.

The S2R GB takes note of the results achieved and recommends the JU to continue improving its effectiveness and efficiency with the Members' stronger support.

5.2. Elements supporting assurance

In addition to the specific supervisory activities of the ED, the main elements supporting the assurance are:

- the Certificate of the Accounting officer,
- the information received from the Head of R&I, the Head of Administration and Finance and the Data Protection Officer,
- the results of the audit of the ECA,
- Internal Audit Service risk assessment,
- the overall risk management performed in 2018 as supervised by the ED,
- the key performance indicators in place,
- the dedicated ex-ante controls of the JU's operational and administrative expenditure,
- the Other Members' reporting of in-kind contributions,
- the follow-up and monitoring of Call process with signature of most CFM and OC projects on time (TTG 90%) despite the 2018 exceptional situation with the late award of call 2018,
- the exceptions reported in the "*exception and non-compliance register*" and the remedial measures put in place.

5.3. Reservations

The ED is not aware of any element that would bring him to introduce a reservation in the AAR 2017.

5.4. Overall conclusion

Not applicable.

6. DECLARATION OF ASSURANCE

I, the undersigned, Carlo M Borghini, Executive Director of Shift2Rail Joint Undertaking

In my capacity as authorising officer by delegation

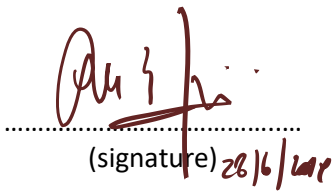
Declare that the information contained in this report gives a true and fair view[33].

State that I have reasonable assurance that the resources assigned to the activities described in this report have been used for their intended purpose and in accordance with the principles of sound financial management, and that the control procedures put in place give the necessary guarantees concerning the legality and regularity of the underlying transactions.

This reasonable assurance is based on my own judgement and on the information at my disposal, such as the results of the self-assessment, ex-post controls, the work of the internal control coordinator, the observations of the Internal Audit Service and the lessons learnt from the reports of the Court of Auditors for years prior to the year of this declaration.

Confirm that I am not aware of anything not reported here which could harm the interests of the Joint Undertaking.

Brussels, 28 June 2019



.....

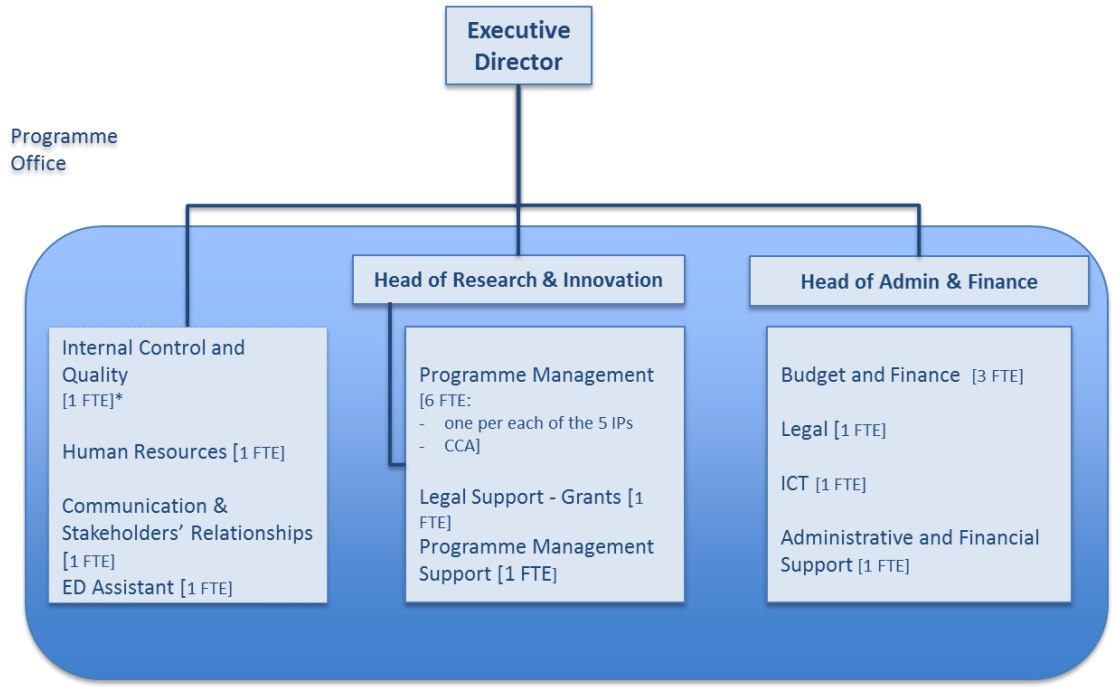
(signature) 28/6/2019

carlo m borghini,
Executive Director

[33] True and fair in this context means a reliable, complete and correct view on the state of affairs in the Joint Undertaking.

7. ANNEXES[34]

ANNEX A Organisational chart of the S2R JU



** Still to be recruited*

[34] It should be noted that the Annexes related to publications from Projects, patents from Projects, materiality criteria are not included considering that the Projects' activities started only 1 September 2016.

ANNEX B Establishment plan

Function group and grade	Temporary agents					
	2016		2017		2018	
	Authorised under the EU Budget	Filled as of 31/12/2016	Authorised under the EU Budget	Filled as of 31/12/2017	Authorised under the EU Budget	Filled as of 31/12/2018
	Temporary posts	Temporary posts	Temporary posts	Temporary posts	Temporary posts	Temporary posts
AD 16						
AD 15						
AD 14	1	1	1	1	1	1
AD 13						
AD 12						
AD 11						
AD 10						
AD 9	2	1	2	2	2	2
AD 8	1				1	1
AD 7		1	1	1	1	1
AD 6			1	1		
AD 5		1				
AD TOTAL	4	4	5	5	5	5
AST 1-11						
AST TOTAL						
AST/SC 1-6						
AST/SC TOTAL						
TOTAL	4	4	5	5	5	5
GRAND TOTAL	4	4	**5**	**5**	**5**	**5**

Contract agents	Authorised 2016	Filled as of 31/12/2016	Authorised 2017	Filled as of 31/12/2017	Authorised 2018	Filled as of 31/12/2018
Function Group IV	7	8	11	9	11	10
Function Group III	3	3	3	5	3	3
Function Group II	3	2	2	1	2	2
Function Group I						
TOTAL	**13**	**13**	**16**	**15**	**16**	**15**

Seconded National Experts	Authorised 2016	Filled as of 31/12/2016	Authorised 2017	Filled as of 31/12/2017	Authorised 2018	Filled as of 31/12/2018
TOTAL	**0**	**0**	**2**	**0**	**2**	**3**[35]

[35] Of which 1 SNE replacing two maternity leaves during 2018 and 2019.

ANNEX C Indicators and Scoreboard of KPIs

TABLE I - Horizon 2020 Key Performance Indicators[36] common to all 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	Result 2018
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	33.13%
	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	N.A.
SOCIETAL CHALENGES	14*	Publications in peer-reviewed high impact journals in the area of the JU	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	78

[36] (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	Result 2018
	15*	Patent applications and patents awarded in the area of the JU	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	4
	16*	Number of prototypes testing activities and clinical trials	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	65
	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	11
	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	24
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	H2020		Yes	176

	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	Result 2018
	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	H2020		Yes	176
	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	H2020			none
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)	H2020		Yes	228
	NA	Time for signing grant agreements from the date of informing successful applicants (average values)		Average under H2020 (days)	Joint Undertaking	H2020		Yes	52
AUDITS	NA	Error rate		% of common representative error; % residual error	CAS	H2020		Yes	1.24% and 0.93% for S2R JU; 2.43% and 2.22% for the Horizon 2020 research family

	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	Result 2018
	NA	Implementation of ex-post audit results		Number of cases implemented; in total €million; ´of cases implemented/total cases	CAS	H2020		Yes	N.A.
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	H2020	-pre-financing (30 days) - interim payment (90 days) -final payment ((90days)	Yes	<u>Operational:</u> Pre-financing: 100% Average number of days: 11 Interim/final: 83.3% Average number of days: 89 <u>Administrative:</u> Pre-financing: N/A Interim/final: 97.1% Average number of days: 15 <u>Number of experts appointed</u>: 29

	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	Result 2018
HR	NA	Vacancy rate (%)		% of post filled in, composition of the JU staff [37]	Joint Undertaking	H2020			96%
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	H2020	100% in CA and 90% in PA	Yes	100% in CA 82.3% in PA
	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		H2020	Yes	22 late payments 2.9%

NOTES:

12,14,15,16,17,18*: The upcoming Control Gates (April) and project Reviews could generate improved data for this KPI which is cumulative on the S2R running projects in 2017.
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.

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

TABLE II - Indicators for monitoring H2020 Cross-Cutting Issues38 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	Result 2018
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	**At the submission:** 325 Applicants from 21 Member States **In the signed grant agreements:** 157 Beneficiaries from 21 Member States
		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	76.3 M € from 21 Member states
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	**At the submission:** 6 applicants from 3 countries **In the signed grant agreements:** 4 Beneficiaries from 3 countries
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	2 Associated countries beneficiaries 0.3M€

[38] (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	Result 2018
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	29 Beneficiaries are SMEs and they benefit of 9.51% of the total contribution
6	Gender	6.1 Percentage of women participants in H2020 projects	Gender of participants in H2020 projects	H2020 Beneficiaries through project reporting		YES	Yes	17.8% of applicants 12.9% among beneficiaries
		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	21.05%
		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		• **S2R JU Governing Board** : 15% of representatives are female in the GB members only and 21% including alternates • **S2R JU States Representatives Group** 34% of representatives are female • **S2R JU Scientific Committee** : 40% of members are female

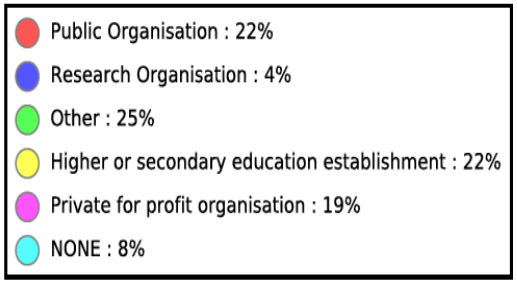
Correspondence in the general Annex 2	Cross-cutting issue	Definition/Responding to question	Type of data required	Data to be provided by	Data to be provided in/to	Direct contribution to ERA	Automated	Result 2018
7	International cooperation	7.1 Share of third-country participants in Horizon 2020	Nationality of H2020 beneficiaries	H2020 beneficiaries at the grant agreement signature stage	JU AAR RTD Monitoring Report	NO	Yes	0%
		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	NO	Yes	0%
9	Bridging from discovery to market [39]	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	26.3% (share of projects) 59.8% (share of financial contribution)
		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	100% follow up as per Grant Agreement

[39] 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	Result 2018
NA		Scale of impact of projects (High Technology Readiness Level)	Number of projects addressing TRL[40] between…(4-6, 5-7)?	Joint Undertaking	JU AAR RTD Monitoring Report			TRL 4-6 (incl. projects up to TRL 4):8 TRL 5-7: 4 Total: 12
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	115 beneficiaries 60.3% of the total beneficiaries
		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	72.64%
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	85.1 M€
		12.2 PPPs leverage: total amount of funds leveraged through Art. 187 initiatives,	Total funding made by private actors involved in PPPs	Joint Undertaking Services	JU AAR RTD Monito			157% **225%** considering only the S2R Members

[40] 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	Result 2018
		including additional activities, divided by the EU contribution	- 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)		ring Report			certification process ongoing
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	315 Dissemination and outreach activities other than peer-reviewed publications 34.868 persons reached
14	Participation	14.2 Proposal evaluators by country	Nationality of proposal evaluators	Responsible Directorate /Service/Joint Undertaking in charge with the management of proposal evaluation				29 experts (28 from 12 EC Member States + 1 from Associated Countries)

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	Result 2018
		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				Extract from S2R Experts Pool statistics 
sNA	Participation of RTOs and Universities	Participation of RTO[41]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	33 participations of RTOs 9.97% of total 27 participations of Universities 8.16% of total BUDGET – 15.63%

[41] RTO: Research and Technology Organisation

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	Result 2018
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)[42]	Responsible Directorate /Service/Joint Undertaking	JU AAR RTD Monitoring Report			0%

Notes:

*H2020 applicants - all those who submitted H2020 proposals

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

13*: The upcoming Control Gates (April) and project Reviews could generate improved data for this KPI which is cumulative on the S2R running projects in 2017.

[42] 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	Result 2018
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	See table IV
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	See table IV
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	See table IV
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	First results available (PINTA, FINE-1)
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	One open point of the TSI Infra (tender and IN2TRACK-2)

#	Key Performance Indicator	Objective	Data to be provided by	Baseline at the start of H2020	Target at the end of H2020	Automated	Result 2018
6	Number of Integrated Technology Demonstrators (ITDs) and System Platform Demonstrations (SPD)	Improve market uptake of innovative railway solutions through large-scale demonstration activities	JU	Multi-Annual Action Plan	4 SPD	Yes	First results available (IMPACT 1)
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	100% of the operational funding
8	Percentage of topics resulting in signature of GA	Ensure a sufficiently high call topics success rate	JU	n.a.	> 90%	Yes	100%
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	*

TABLE IV – Initial Estimation – Release 1.0 - of the Key Performance Indicators of the Shift2Rail Programme

		LCC	Capacity	Punctuality
	Target	-50%	+100%	+50%
SPD	High speed	-18%	+74%	+19%
	Regional	-24%	+49%	+15%
	Urban	-18%	+28%	+11%
	Freight	-40%	+91%	+71%

KPIs

One of the objectives of the Shift2Rail Joint Undertaking defined in its regulation is to seek developing, integrating, demonstrating and validating innovative technologies and solutions that uphold the strictest safety standards and the value of which can be measured against, inter alia, 3 quantitative Key Performance Indicators (KPIs). The targets defined are the following: reduction of LCC by 50%, improving the reliability & punctuality by 50% and doubling the capacity.

As the railway system is a very interlinked and complex system, it is required to have specific tools and methods to evaluate the effect of technological developments. This question is highly relevant for Shift2Rail as the technologies, which are developed, are to be evaluated with respect to four scenarios called System Platform Demonstrators (SPDs). Hence an approach of estimating the above mentioned KPIs applied on the four generic SPDs based on the market segments high-speed rail, regional rail, metro and freight rail[43] has been applied which were defined in the S2R Master Plan[44].

As some of the Shift2Rail technologies (e.g. Innovation Programme on IT Solutions for Attractive Railway Services) are targeting to increase modal share of rail within the transport sectors by satisfying the customer's travel experience, those innovations cannot be taken directly into account in the three quantitative KPIs, only via an increased load factor. Therefore a dedicated model on the improvement of the attractiveness of the rail system is developed independent from the model discussed here (see also explanations to "demand effect").

[43] IMPACT-1 – D4.1 "*Reference Scenario*" – 2018, Issue 1

[44] Shift2Rail - *Shift2Rail Master Plan (MP)* – 2015

The first quantitative KPI estimation was carried out early 2018. It is based on the result of the initial model, Release 1 developed in a Call for Members project, IMPACT-2[45]. This current calculation gives a first indication on the impacts of the Shift2Rail innovations on the three quantitative KPIs.

The Release 1 KPI model covers areas, which have major impacts on the improvements. Other aspects such as positive effects related to noise reduction or the interrelations between innovations at different parts of the railway system, e.g. between vehicle and track will be considered in the next iteration.

The first results displayed in the table highly rely on the improvements that the Shift2Rail innovations declare to reach. The improvement data is provided by the Shift2Rail projects based on their status. The data collection has been carried out quite early during the Shift2Rail life-time, therefore for some Shift2Rail innovations there were no estimations yet or they have claimed to bring relatively conservative improvements.

Key Performance Indicators - KPI
The KPI Life-Cycle-Cost (LCC) is defined as the cost for the railway undertaking over the lifespan of the systems. Hence they are the investment cost, operative cost like maintenance, labour or energy cost and, where applicable, the dismantling cost.

The KPI Capacity is defined as the maximum possible capacity, which is the maximum number of transportable passengers in one peak hour for the passenger transport scenarios and the maximum of tonne-kilometres in 24 hours for freight.

The KPI Reliability and Punctuality is measured as a 50% decrease of late arrivals mainly caused by unreliability of technologies.

System Platform Demonstrators - SPDs
The results of Release 1 are based on the reference scenarios (state of the art technologies in 2013) described in the deliverable D4.1 “Reference Scenarios” of IMPACT-1 [3]. The data for this scenarios were collected from various sources whereas usually there could only one source for each certain parameter be found. The coherence check is scheduled for the next iteration of the model.

Further there are aspects for the four different market segments of the SPDs, which need to be kept in mind, when reviewing the result table. Those aspects are due to the inherent structure and specificities of the different market segments:

For the High Speed passenger transport (SPD1), relatively new or constantly upgraded vehicles and lines are taken into account, which are more or less best of class in Europe. Therefore, it is on the one hand a much elaborated basis to start from and on the other hand it can be assumed that effects at less developed railways will show much higher results.

The main relevant KPIs for typically Regional Rail (SPD2) lines are LCC and punctuality. Hence the challenge is here to provide a punctual service at lower cost.

[45] IMPACT-2 – D4.1 “Initial quantitative KPI model” – 2018, Issue 1

Concerning Metro Rail (SPD3), there are few activities dedicated directly on Metro in direct relation to the specific S2R JU objectives in the short term. Therefore, the results for Metro are mainly based on positive effects of the innovations developed for High Speed or Regional trains as e.g. reduction of energy consumption or improved maintenance. They are not optimised for this special form of rail transport, but can help to reduce LCC and improve capacity.

Because SPD4, Freight rail, is not focussing on passenger transport, but freight transport, it differs in some definitions and focus points from the other three SPDs. Further the modelling has not only to consider technological improvements, but also operational optimisation for rail freight transport. Moreover, as generally the introduction of innovations in freight rail operation takes more time than in passenger transport, the technology level in execution is quite moderate. Taking both into account, the more legacy basis to start from and the technological and operational effects, the achievable benefits are much higher than for the other three SPDs.

Further some innovations cannot show their full potential, because there is only one scenario per market segment. Those scenarios are optimised to show the majority of positive effects, but cannot be set to show every effect of every Shift2Rail innovation.

IP specific results

Besides the results for the whole railway system, Release 1 is also able to show results individually for the Innovation Programmes of Shift2Rail. It was decided to show the improvements for every programme on the bases on which it really can have an influence at. This means that for example the reduction of costs for Signalling is compared to the overall costs of the Signalling system. In this way, not only the improvements for the whole railway system, but also the improvements of individual parts of it can be shown.

Demand effect

As already explained in the background, large parts of positive effects especially for the passenger transport (SPD1-3) are not adequately measurable through LCC, capacity and punctuality, e.g. new IT solutions (IP4), effects of other innovations such as noise mitigation, customer oriented services and better quality, increased comfort for the customers, better governance etc. Those will be included in the attractiveness model. Therefore, the increase of demand is not considered in the results for the passenger SPDs, yet, meaning that for the first results there is no change in the load factor and therefore in the demand included. For the freight SPD, a demand increase could already be considered and therefore also it positive effect of the contribution margin.

ANNEX D Annual accounts

In line with the reporting requirement detail in FR 2018 Article 130.4, the Financial Framework Partnerships >4 years are reported under section 1.6 of this document.

BALANCE SHEET

EUR '000

	Note	31.12.2018	31.12.2017
NON-CURRENT ASSETS			
Property, plant and equipment	*2.1*	*235*	*264*
Pre-financing	*2.2*	*41 652*	*30 064*
		41 887	**30 328**
CURRENT ASSETS			
Pre-financing	*2.2*	*19 240*	*36 502*
Exchange receivables and non-exchange recoverables	*2.3*	*29 757*	*9 647*
		48 998	**46 149**
TOTAL ASSETS		**90 885**	**76 477**
CURRENT LIABILITIES			
Payables and other liabilities	*2.4*	*(69 211)*	*(36 770)*
Accrued charges	*2.5*	*(24 685)*	*(28 770)*
		(93 896)	**(65 541)**
TOTAL LIABILITIES		**(93 896)**	**(65 541)**
NET ASSETS		**(3 011)**	**10 936**
Contribution from Members	*2.6*	*187 070*	*89 241*
Accumulated deficit		*(78 305)*	*(11 925)*
Economic result of the year		*(111 776)*	*(66 381)*
NET ASSETS		**(3 011)**	**10 936**

STATEMENT OF FINANCIAL PERFORMANCE

EUR '000

	Note	2018	2017
EXPENSES			
Operating costs	*3.1*	*(108 268)*	*(63 366)*
Staff costs	*3.2*	*(1 547)*	*(1 364)*
Other expenses	*3.3*	*(1 960)*	*(1 651)*
Total expenses		**(111 776)**	**(66 381)**
ECONOMIC RESULT OF THE YEAR		**(111 776)**	**(66 381)**

CASHFLOW STATEMENT[46]

EUR '000

	2018	2017
Economic result of the year	*(111 776)*	*(66 381)*
Operating activities		
Amortization and depreciation	*52*	*48*
Cash contribution from Members	*79 165*	*34 476*
(Increase)/decrease in pre-financing	*5 673*	*(25 767)*
(Increase)/decrease in exchange receivables and non-exchange recoverables	*(20 110)*	*147*
Increase/(decrease) in payables	*32 441*	*32 034*
Increase/(decrease) in accrued charges	*(4 085)*	*22 460*
Increase/(decrease) in in-kind contribuions	*18 663*	*3 010*
Investing activities		
(Increase)/decrease in intangible assets and property, plant and equipment	*(23)*	*(28)*
NET CASHFLOW	**–**	**–**
Net increase/(decrease) in cash and cash equivalents	*–*	*–*
Cash and cash equivalents at the beginning of the year	*–*	*–*
Cash and cash equivalents at year-end	*–*	*–*

STATEMENT OF CHANGES IN NET ASSETS

EUR '000

	Contribution from Members	Accumulated Surplus/ (Deficit)	Economic result of the year	Net Assets
BALANCE AS AT 31.12.2016	**51 755**	**–**	**(11 925)**	**39 831**
Allocation 2016 economic result	*–*	*(11 925)*	*11 925*	*–*
Cash contribution	*34 476*	*–*	*–*	*34 476*
Contribution in-kind	*3 010*	*–*	*–*	*3 010*
Economic result of the year	*–*	*–*	*(66 381)*	*(66 381)*
BALANCE AS AT 31.12.2017	**89 241**	**(11 925)**	**(66 381)**	**10 936**
Allocation 2017 economic result	*–*	*(66 381)*	*66 381*	*–*
Cash contribution	*79 165*	*–*	*–*	*79 165*
Contribution in-kind	*18 663*	*–*	*–*	*18 663*
Economic result of the year	*–*	*–*	*(111 776)*	*(111 776)*
BALANCE AS AT 31.12.2018	**187 070**	**(78 305)**	**(111 776)**	**(3 011)**

[46] Following the appointment of the Accounting Officer of the Commission as the Accounting Officer of S2R JU, the treasury of S2R JU was integrated into the Commission's treasury system. Therefore, S2R JU does not have any bank accounts of its own. All payments and receipts are processed via the Commission's treasury system and registered on intercompany accounts which are presented under the heading exchange receivables.

ANNEXE E LIST OF ACRONYMS

Abbreviation	
ABAC	Accrual Based Accounting
ADI	Austempered Ductile Iron
AO	Authorising Officer
ATO	Automated Train Operation
AWP	Annual Work Plan
AAR	Annual Activity Report
BA	Business Analytics
CA	Commitment Appropriation
CAS	Common Audit Service
CAPEX	Capital Expenditure
CBM	Condition-Based Maintenance
CBTC	Communication Based Train Control
CCA	Cross Cutting Activities
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CFM	Call for Members
CRS	Common Representative Sample
CREL	Core Release
CSA	Coordination and support action
CW	Cloud Wallet
DOI	Digital Object Identifier
DRIMS	Dynamic Railway Information Management System
EC	European Commission
ECA	European Court of Auditors
ED	Executive Director
EDPS	European Data Protection Supervisor
EDV	Electronic Distributor Valve
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	European Norm
ERA	European Union Agency for Railways
ERRAC	European Rail Research Advisory Council
ERTMS	European Rail Traffic Management System
ETCS	European Train Controlling System
EU	European Union
EUG	**ERTMS Users Group**
FACTs	Flexible AC Transmission Systems
FFFIS	Form Fit Functional Interface Specifications
FIS	Functional Interface Specifications

FREL	Final Release
GA	Grant Agreement
GDPR	General Data Protection Regulation
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GoA	Grade of Automation
H2020	Horizon 2020, EU framework programme for Research and Innovation
HST	High-Speed Train
IA	Innovation Action
IAS	Internal Audit Service
LP	Lighthouse Project
ICT	Information and Communications Technology
IEC	International Electrotechnical Commission
IKAA	in-kind contributions to additional activities
IP	Innovation Programme
IPR	Intellectual Property Rights
ISO	International Standardisation Organisation
IT	Information Technology
ITD	Integrated Technology Demonstrator
JTI	Joint Technology Initiative
JU	Joint Undertaking
KPI	Key Performance Indicator
LCC	Life Cycle Cost
LIDAR	Light Detection and Ranging
LTE	Long-Term Evolution (standard for wireless communication)
MAAP	Multi-annual Action Plan
MaaS	Mobility as a Service
MB(S)	Moving block (System)
MC	Mission Critical
MNO	Mobile Network Operator
NaaA	Network as an Asset
NaaS	Network as a Service
NLOS	non-line-of-sight
NTP	Network Time Protocol
OC	Open Call
ODM	Operational Data Management
OMTS	On-board Multimedia and Telematics Services
OPEX	Operating Expenditure
PA	Payment Appropriation
RCA	Railway Command Control and Signalling Architecture
R&I	Research and Innovation
PPP	Public Private Partnership
PRM	Persons with Reduced Mobility

PTC	Positive Train Control
PTI	Platform Train Interface
QoA	Quality of Service
RAL	Unpaid amount
RAMS	Reliability and Maintainability System
RBC	Radio Block Centre
RFID	Radio Frequency Identification
RIA	Research and innovation action
RoI	Return of Investment
S2R	Shift2Rail
SC	Scientific Committee
SDG	Sustainable Development Goals
SETA	Single European Transport Area
SiC	Silicon Carbide
SLA	Service Level Agreement
SME	Small and Medium Enterprise
SNE	Seconded National Expert
SPD	System Platform Demonstration
SRG	States Representatives Group
SWL	Single Wagon Load
TAF	Telematic Application for Freight
TAP	Telematic Application for Passengers
TCMS	Train Control and Monitoring System
TC	Tender Call
TCO	Total Cost of Ownership
TD	Technology Demonstrator
TL	Train Load
TMS	Traffic Management System
TRL	Technology Readiness Level
TSI	Technical Specifications for Interoperability
TSP	Travel Service Provider
UAV	Unmanned Aerial Vehicle
UG	User Group
UN	United Nations
WA	Work Area
WP	Work Package
WSP	Wheel Slide Protection