

A future policy based public private partnership for rail

1. Mission and focus

The European rail sector requires decisive action to simplify its systems and operations while enhancing its fundamental capabilities, with European innovation to make rail systems more agile, resilient and competitive.

The core emphasis is to

- deliver the policy objectives of a Single European Rail Area and strengthen the Single Market,
- manage a harmonised and coordinated innovation transition,
- deliver competitive services across three vital domains for Europe's socio-economy:
 - passenger and tourist mobility,
 - green freight operations, and
 - EU industrial and military strategic capabilities.

This mission focuses on targeted research and pre-deployment activities, leveraging railway fundamental capabilities.

2. Specific context, challenges and objectives

Context

Rail is vital for Europe.

A well-functioning rail system is strategically important for the economy and security of the EU and its Member States. Rail is also central to achieving sustainability in transport, being the greenest mass transport mode.

The EU railway value chain is a global leader in the design, manufacturing and maintenance of railway systems and products, providing clean transport solutions and employment to 2.3 million Europeans and making a significant contribution of EUR 143 billion to the EU total GDP, of which 659,000 jobs and EUR 102 billion correspond to the rail supply industry¹.

In the EU, manufacturers have maintained a positive trade balance in the past decade in the context of a strongly consolidated global market.

This global industrial leadership and competitiveness has been achieved through the development of products and solutions within the internal European market, with both public and private investments. But this position is not guaranteed and cannot be taken for granted. New competitors, particularly from China, are looking to establish themselves both in Europe and globally.

It is therefore imperative to support at European level the increased competitiveness of rail as a core part of the transport and mobility infrastructure for its citizens and in view of its security, and to support

¹ Source: The transition pathway for the EU Mobility Industrial Ecosystem, European Commission, 2024: <https://op.europa.eu/en/publication-detail/-/publication/fcbf7748-c0af-11ee-b164-01aa75ed71a1/language-en>

a healthy European rail industry, developing solutions for European benefit, and exporting these solutions to consolidate the position of the sector at global level.

Research and Innovation is needed in the rail sector to preserve and reinforce the competitiveness of the rail industry while decreasing the costs of the rail assets and operations in terms of Opex and Capex in an existing complex system. A specific attention should be paid to reduce the foreign dependencies of raw materials and electrical components². Implementation of innovation and the associated evolution should be more coherent, faster and affordable in a context of scarcity of public funding, taking in account the significant investments needed for regenerating, modernising and digitalising a diverse and partly aged railway assets.

In the Political Guidelines for the next European Commission 2024-2029 President von der Leyen announced a Clean Industrial Deal that will enable more investments in clean and strategic technologies, so that the future of the clean and cutting-edge tech industry is made in Europe. A successful rail sector is an integral part of the Clean Industrial Deal.

The EU and private and public partners are already supporting research and innovation efforts through the Europe's Rail Joint Undertaking (EU-RAIL) and before it the Shift2Rail Joint Undertaking (S2R). Those partnerships have fundamentally changed the landscape of European rail research and innovation for the better, enabling European approaches and solutions, as demonstrated for example by the development of Automatic Train Operations, improved traction systems improving overall energy management, Digital Automatic Coupler (DAC) as a key enabler for a competitive rail freight.

Within S2R, 695 prototype testing activities were carried out across the programme up to 2023³, with an average technological readiness level (TRL) reached of 5/6, i.e. technology validated or demonstrated in relevant environment. Many technologies reached higher TRLs and these are described in the EU-Rail catalogue of solutions for market uptake. Moreover, it is reported that -with further private development- 72 new EU harmonised products, processes and methods have been launched into the market⁴.

The Partnership Evaluation study⁵ indicated that a lesson drawn from S2R is that the implementation of new approaches and solutions within the rail system is not only about technology, but also about the introduction in diverse operational environments and rail systems to realise a Single European Rail Area, which is something EU-Rail started to address with the new EU-Rail System Pillar and Deployment Group.

² as highlighted as well in the recent EC study on “*Addressing European research and innovation challenges for system transitions in energy and mobility*”: <https://op.europa.eu/nl/publication-detail/-/publication/46e16a85-9d7f-11ef-85f0-01aa75ed71a1/language-en>

³ See EU-Rail Annual Activity report 2023, scoreboard of Horizon 2020 KPIs: https://rail-research.europa.eu/wp-content/uploads/2024/06/Annex_GB-Decision_10_24_CAAR_2023-signed.pdf

⁴ See EU-Rail Annual Activity report 2023, scoreboard of Horizon 2020 KPIs

⁵ <https://op.europa.eu/en/publication-detail/-/publication/e6cc1f91-6421-11ef-a8ba-01aa75ed71a1/language-en>

Challenges

The rail sector faces multifaceted challenges that demand coordinated Union action. The primary challenge lies in the heterogeneity of the European rail system and operations, fragmentation among national systems, with historically independent development of standards and technologies creating expensive bespoke solutions and makes the necessary migration towards digital and more harmonised technical solutions, a real challenge given the insufficiency of funds for investments. The sector still struggles with structural fragmentation between operators and infrastructure providers (on top of its large European supply base of several system integrators, train builders, signalling systems providers, infrastructure constructors, safety system suppliers, etc.), compounding geographical divisions. The complexity of introducing agile approaches in brownfield situations and fragmented business models, coupled with reduced public funds availability, presents significant hurdles. Additionally, the sector faces the challenge of maintaining competitiveness against other transport modes while managing the digital transition. The need to simplify the system supporting the Single European Rail Area while ensuring cybersecurity and environmental resilience adds another layer of complexity.

Additionally, rail faces a range of threats to rail resilience, including natural hazards, terrorist attacks, insider threats, or sabotage, as well as public health emergencies, which have increased in the last years, also in terms of risk associated levels.

Moreover, the society in the EU and in the (Western) world is facing profound change, driven for example, by demographic evolution, climate change, migrations, urban development, labour market and social conflicts. The offer of both freight and passenger rail services should evolve accordingly. Therefore, consideration of broader socio-economic matters is important to inspire and guide strategic choices in this field.

Objectives

European support for rail is vital to achieving sustainability goals and maintaining European technological sovereignty. The known challenges underscore that a lack of a European approach towards a system simplification would significantly undermine the EU's industrial leadership and competitiveness, and the European ability to respond to passengers' and businesses' needs.

The challenge and opportunity for the future resides in capitalising on past achievements and focussing on simplifying the rail system to make it a more attractive and creating the conditions for an effective and affordable deployment of innovations.

The primary objectives are therefore on making the rail system more agile, resilient, and competitive.

This requires both increased and new collaborative R&I focused efforts, as well as new pre-deployment European actions.

Agility objectives include developing systems capable of reacting dynamically to disruptions and implementing shorter innovation cycles, notably through enhanced modularity and simplified certification processes.

Resilience objectives encompass ensuring cybersecurity, maintaining sovereignty over rail system operations, and building environmental change resistance. Such work will support the protection of railway transport and its critical infrastructure and contribute to the resilience of critical entities

operating that infrastructure in the railway sector and to enhance preparedness and response against current threats, both by reinforcing certain elements of the Critical Entities Resilience Directive⁶ and by making use of resources in a coordinated manner open to aspects of international cooperation.

Competitiveness objectives target significant cost reductions in both upfront and lifecycle expenses, improved asset utilisation and system performance, and strengthened EU industrial leadership. These objectives align with the need to extend the scope beyond SERA to include complete rail market coverage, including urban rail systems and multimodal transport integration, since urban nodes are included in the revised TEN-T guidelines aligned with the EC Communication on EU Urban Mobility Framework.

3. Rationale why an EU approach is needed

A coordinated EU-level approach is essential due to the cross-border nature of rail operations and the need for standardised solutions. The “Much More than a Market” report by Enrico Letta underpins that a European rail network is vital for European cohesion, making European coordination imperative.

Historical evidence shows that uncoordinated research activities have led to poor market uptake of innovative rail solutions and limited direct leverage of EU funding. The complexity of the rail system, with its interconnected nature, demands harmonised implementation of innovations and technologies across national boundaries, and well beyond any market initiative from a single or group of limited players. A sustained EU approach is essential to ensure interoperability of the future rail solutions and operational system harmonisation, which cannot be achieved through isolated national/regional or purely private initiatives. By enabling the supply industry to deliver standardised products across the network, economies of scale can be increased, significantly reducing both production and implementation costs through shared knowledge and best practices. This approach not only benefits large rail systems, such as rolling stock, but also enhances the development and affordability of smaller rail specific components, fostering greater efficiency and competitiveness – including of SMEs – across the European rail sector. A fully coordinated approach also prevents parallel developments by individual stakeholders, with the EU acting both as a federator and as a catalyst for efficient research delivery and future affordable deployments into a system and network approach.

Why a rail PPP for rail innovation structure is necessary

This coordinated European approach is not easy and requires political and sectorial will with European structures to achieve success. Achieving the SERA will require an adequate level of investment and a stability on the long-term planning for rail – something that can only be achieved if the European rail system (network and rolling stock, assets and operations) is looked at its entirety, with a dedicated EU approach towards addressing the challenges.

The current set up of Europe’s Rail Joint Undertaking supports these essential changes; with the research and innovation focussed through the Innovation Pillar, the activities to support harmonised operations and harmonised specification and standard development for a system architecture

⁶ Directive (EU) 2022/2557 of the European Parliament and of the Council of 14 December 2022 on the resilience of critical entities and repealing Council Directive 2008/114/EC (Text with EEA relevance) <https://eur-lex.europa.eu/eli/dir/2022/2557/oj>

convergence through the System Pillar, and the broader deployment activities handled through the Deployment Group. This serves as a benchmark for any future initiative at European level.

The public-private partnership of EU-RAIL, and S2R before it, provides a vital and unique structure in which challenges can be addressed jointly by the EU rail sector and the Union and its bodies, and European solutions delivered. A joint undertaking, in particular, is a unique opportunity to capitalise on a structured and dedicated environment that fosters the exchange of expertise, cross-fertilization between stakeholders, and ultimately, the deployment of advanced technologies. This collaboration is essential as the railway sector requires a deep and complex domain knowledge that must align with the emerging technological landscape. For instance, AI cannot be effectively trained without this specialized domain knowledge and data is scattered among different European stakeholders. The outputs of the EU-Rail innovation pillar, system pillar and deployment group – for instance – will play a pivotal role in this context, ensuring that the railway sector stays at the forefront of technological advancements and remains competitive on a global scale.

Such an approach is fundamental to address market failures that are still present in both the delivery and implementation of rail research and innovation. On one side the rail sector's nature complex interactions between subsystems and actors limit the potential development of breakthrough solutions, without a deep coordination and alignment that only PPP structure offers. On the other side, the PPP structure enables shared risk management and a visibility on future possible investments stemming from research outputs, including with the setup of normative and legislative instruments needed in rail (for example to counterbalance the fact that who need to bear the costs of implementation of an innovation it is not the same actor that gather the benefit, leading to a market failure⁷).

The Joint Undertaking structure also provides a stable platform for engagement, supported by a dedicated administrative structure that stimulates research ideas and allows industry to undertake together research activities and increased private leverage contribution (financial and in-kind resources). It allows also engagement with academia, leveraging cutting-edge research to drive future advancements with industrial commitments. It allows also a unique interface between the public and private sector, as well as a single-entry point to enable synergies with other sectors and initiatives that have now the possibility to create a positive impact in the rail sector.

Further the Joint Undertaking structure is an ideal launchpad for consideration of pre-deployment and deployment activities, as demonstrated by the European DAC Delivery Programme, and the recent activities on the future radio system. A network-wide innovation in the European railway system can only work if accompanied by appropriate pre-deployment measures within (or strictly aligned with) that Joint Undertaking/PPP model, to encourage potential future investors, reassured by a long-term EU strategy, including by a common approach on standards and regulations. This would encompass the assessment of cost/benefits (benefits not only captured by Private companies but also Public / Society), the appropriate changes to operational procedures; and a well-conceived migration plan with coordinated investments & fundings.

⁷ The EC final Report on ERTMS Retrofitting strategy Funding and Financing, shows that it is more difficult for RUs to prove a positive business case, creating a bottleneck to the overall deployment.

Without a future public-private partnership structure, the possibility to achieve a SERA will be significantly reduced, reducing the competitiveness of rail in the future transport mix, and undermining the ability of the supply industry to use Europe as the test bed on which to compete globally.

Planned Implementation and outputs/impacts (resources needed & R&I)

The work of a new partnership, building on the achievements of S2R and EU-RAIL, contributes to making rail a more attractive transport option for both passengers and freight operators, supporting the EU's broader climate and mobility objectives while ensuring the sector's long-term competitiveness. For this it would focus on delivering the following targets:

- Service Quality Enhancement: focussed on reliability and punctuality improvements, building on the development and implementation of improved Control Command and Signalling and Traffic and Capacity Management Systems. The COVID-19 experience demonstrated that rail freight can achieve 80-90% punctuality rates when provided with adequate capacity, compared to the previous 60% average. This demonstrates that a more efficient management of the capacity in the network is needed to cope with the high-density traffic during regular situation.
- Cost-Effective Solutions: contributes to making rail a more attractive transport option for both passengers and customers, supporting the EU's broader climate and mobility objectives while ensuring the sector's long-term competitiveness. Asset development, given their substantial costs and long lifespans, will undergo specific strategic and financial analysis to ensure the best impact on society and an optimal return on investment.
- System Optimisation: the holistic development of the network infrastructure and future proof rolling stock, with integrated digital connectivity, will create the foundation for enhanced services for passengers and businesses. contributes to making rail a more attractive transport option for both passengers and freight operators, supporting the EU's broader climate and mobility objectives while ensuring the sector's long-term competitiveness.
- Resilience and improved security: the necessary accompanying steps to improving the performance of the rail system through digitalisation also necessitates the appropriate resilience and cybersecurity developments. Rail vehicle and infrastructure resilience to climate change and military challenges requires a development of solutions to ensure better resilience against more frequent extreme weather events (for example flooding), and better adaptability to functional use change, for example in the case of a need to move large numbers of troops and equipment on the European rail network.

Implementation focuses on systematic development and deployment of standardised and modular EU innovations for the new simplified rail system.

Such an approach is necessary to support more efficient and reliable operations, improving services for passengers and freight customers while decreasing costs across the entire EU network. This approach also applies to infrastructure and rolling stock, where the 'designed-to-build' and 'designed-to-maintain' mantra should be adopted. A set of solutions for European-wide application would allow economies of scale and significantly reducing the cost of assets development and maintenance. Additionally, further robotisation for both construction and maintenance and in general automation

applied at network and system level address the growing issue of workforce shortages, ensuring efficiency and sustainability across the European rail sector.

It is an implementation users and demand driven, where the emphasis on technology is related to the offering of better and more attractive services, through for example digital systems integration, automated operations, assets modernisation, and cybersecurity enhancement.

The activities cover basic research, development, and demonstration, with appropriate resource allocation across different Technology Readiness Levels (TRLs). Considering the current geopolitical context, it is essential to secure and focus the funds on rail research that will bring impacts on rail's attractiveness for decision makers and customers. This means that the next programme has to be based on sound and solid impact assessments. Additionally, approaching the rail system with harmonised European solutions will enhance security and coordination in both a cybersecurity and military mobility context.

To minimise the 'innovation valley of death' an optimised choice among innovative railway projects is necessary. This means, the economic viability for each selected project must cover not only the technological risks but also the financial risks resulting from the complexity of the railway system.

A simplified rail transport system would also allow an easier integration of the various modes to achieve the optimal end-to-end transport solution, exploiting common European approaches and solutions for digital booking and ticketing (physically, on data, on ticketing and schedules, on organisation – stakeholders' cooperation, on administrative matters and regulations).

A new European Competitiveness Fund will provide investment capacity to invest in strategic initiatives to ensure that strategic technologies are developed and manufactured in Europe. It is essential that there is space within the European Competitiveness Fund to support a rail partnership supporting European objectives.

This encompasses the successful transition from research to market implementation requires strategic support for pre-deployment activities. The pioneer Digital Automatic Coupler (DAC) trains case demonstrates how large-scale testing across Europe serves as a crucial stepping stone (risk-reduction) between research and full deployment. This phase proves essential for validating functionality and system interoperability, reliability, and performance in real-life operations across different environments and conditions, as well as preparing their alignment of harmonised operations for the implementation of a single European solution.

Additionally, pre-deployment support represents a strategic better investment in Europe's rail future. The ERTMS variants implementation experience shows that significant funding is necessary for successful system-wide deployment in a very complex and bespoke rail national environment, with an estimated €29 billion needed for the TEN-T Network alone⁸. This initial investment in a new PPP focused on the rail system simplification has the capability to deliver long-term economic benefits through decrease complexity/costs and allow for a coordinated European implementation.

The new rail partnership would implement a "policy-based budget", with a performance-based approach relying on the ability to track progress towards achieving the above-mentioned targets for

⁸ https://transport.ec.europa.eu/transport-modes/rail/ertms/eu-funding-ertms_en

the EU policy objectives. The investment effort required to simplify the rail system and deliver improved services for the entire EU network is :

- approximately **€3 billion for R&I activities**, with half (€1.5 billion) coming from EU funding and half from industry contributions. This expanded R&I scope, compared to previous initiatives, addresses the need for costly yet essential one-time developments of innovative solutions aiming to transition the diverse existing legacy systems into a new, simplified European rail system, building upon past Joint Undertaking achievements and incorporating new R&I advancements.
- Approximately **€15 billion for pre-deployment activities**. The scale of investment needed is substantially larger as it required the diverse participation of stakeholders across different countries to upgrade their systems and make investments in their network. It would require significant European procurement activities to enable a first implementation at system level, that can then be replicated based on the pre-deployment results at scale. The estimation considers similar efforts being made by the European Union for the modernisation of the European Air traffic Management where 1.3 billion euros of EU grants have been provided against 1.4 billion euros of industry investments. The simplification and modernisation of the rail future does not only rely on an equivalent European future Traffic Management implementation, but of several other European standardised solutions to be deployed as a system in the network. Considering the past ERTMS support efforts from the Union through the Connecting Europe Facility, the estimate of the investment needed for DAC, FRMCS, Satellite applications, other technology game changers and possibly future Traffic Management solutions harmonised at European level. Additionally, pre-deployment instruments could be used to facilitate the integration and promotion of a new generation of High-Speed solutions, directly supporting the creation of a European High-Speed network linking capitals and major cities, requiring further private investments and also possible dual use solutions of rail assets. The estimated amount for all those pre-deployment activities across the network seems the appropriate order of magnitude for a strategic investment in Europe's future, supporting both technological sovereignty and economic sustainability through a rail system simplification.

4. Inclusiveness and transparency

Success depends on maintaining an inclusive and transparent approach throughout all stages of research, development and implementation. The existing partnership structure (EU-Rail JU) has already created a solid base of committed rail economic operators to R&I and system change, with a wide EU geographical coverage. Not capitalising on this achievement would mean a reduction of both inclusiveness and transparency at European union level on future possible rail investments. EU-Rail is a unique Joint Undertaking setup where not only the manufacturing and technological driven industry is an invested member, but also operating companies, infrastructure managers and research centres. It is a setup that should be maintained as the only one capable to translate effectively and timely R&I output into real impacts with a system implementation across EU Countries.

It should be strengthened, enlarged and capitalised on a rail stakeholders' networks, linking more universities/research centres, more small medium enterprises and attracting start-ups with industry actors across that are ready to invest in a PPP, leveraging EU funds.

Partners composition and target groups + cooperative approach

The partnership shall be composed by all those players ready to:

- Perform Research & Innovation activities, exploring new concepts, allowing further step change in technological application to different rail sub-systems while committing to demonstration activities, validating the new technological solutions.
- Implement solutions into systems in operation, paving the way for deployment of the solutions onto the market.

The partnership is expected to involve infrastructure managers, railway operators, technology providers, research institutions, public authorities, in a cooperative framework, allowing exchange of expertise and views, towards shared strategic and technical objectives. A particular focus is to be brought on a strong participation of Research Institutions (including universities) and SMEs and Start-ups to ensure the integration of their specific capacities into the programme. This diverse composition enables cooperation across EU Member States, resulting in dynamic exchange and collaboration. Additionally, in supporting of the global competitiveness of the European rail supply industry, R&I cooperation should, in that perspective, be seek and open to third countries that do not hinder the accessibility of their domestic procurement markets to European companies.

The target groups span passengers, freight operators, tourists, military logistics, industrial users, and local communities in order to ensure that the results of R&I positively impact as much economic operators as possible in Europe.

In addition, partnering with other sectors and Union bodies is also essential to ensure a cross fertilisation and that the rail sector is taking-up relevant innovative solutions (e.g. batteries, chipsets, etc...) and apply them in the rail system in a harmonised way, creating economies of scale with the successive implementation. Successful cooperation in the past has taken place with Clean Hydrogen JU for exploring the use of hydrogen as a power source for rolling stock. Ongoing collaboration with SESAR JU (air/train traffic management) or SNS JU (development of FRMCS and use of 5G/6G in railway applications) is also demonstrating the ability of a PPP, representing rail R&I, in creating those synergies which otherwise single actors would not have created or not having the possibility of achieving any system and significant impact for the EU.

5. Meeting EU priorities / added value

Through coordinated efforts in policy oriented research, innovation, and pre-deployment activities, the initiative is capable to respond to the European Union priorities for a Prosperous and Competitive Europe through cut-edge rail solutions developed by its industries for retaining their global leadership role, for a Strong and Secure Europe strengthening the rail resilience of its system and ensure harmonised and secure operations in critical infrastructures, and providing an accessible, affordable and attractive transport mode across borders to all its citizens, for a Free and Democratic Europe.

The mission directly supports EU strategic objectives with a simplified and modernised rail system easier to implement for a greener, more connected and resilient European transportation network.

The initiative supports environmental sustainability through rail's inherent advantages in emissions reduction and energy efficiency, as well as in its low footprint in space utilisation for mass transport.

It drives economic growth through improved connectivity and freight transport efficiency, including for a European freight net zero logistics.

It brings people, regions and Countries closer together with an efficient higher speed rail system and shorten the travel time distances in a harmonised manner across Europe.

The development of a simplified rail system will position the EU as a global leader in rail affordable solutions and operations, supporting strategic autonomy in military mobility and clean industrial technologies. It fosters an industrial ecosystem that develop European manufacturing, technology, and expertise. By strengthening European suppliers, the EU can enhance strategic autonomy, secure its supply chains, and maintain control over critical rail infrastructure innovations.

The partnership enables efficient pursuit of synergies and cooperation with other relevant European, national, and regional programmes. It supports social cohesion by enhancing connectivity between regions and, given its wide geographical reach, creating opportunities for technological advancement across the entire EU.

This proposed comprehensive PPP approach, from R&I to pre-deployment, ensures successful translation of innovations from concept to implementation, leveraging from the Single Market and creating lasting value for the European rail sector and for the EU. It is to be seen as an investment for the future, including for creating a more economically sustainable rail system.

This strategic PPP investment approach to rail system development represents a significant opportunity to address current challenges while preparing for future needs. By having a system view and focusing on impactful innovations and by fostering deployments in Europe, the rail sector will achieve greater agility in responding to market demands and enhanced competitiveness in the broader transport and mobility landscape.