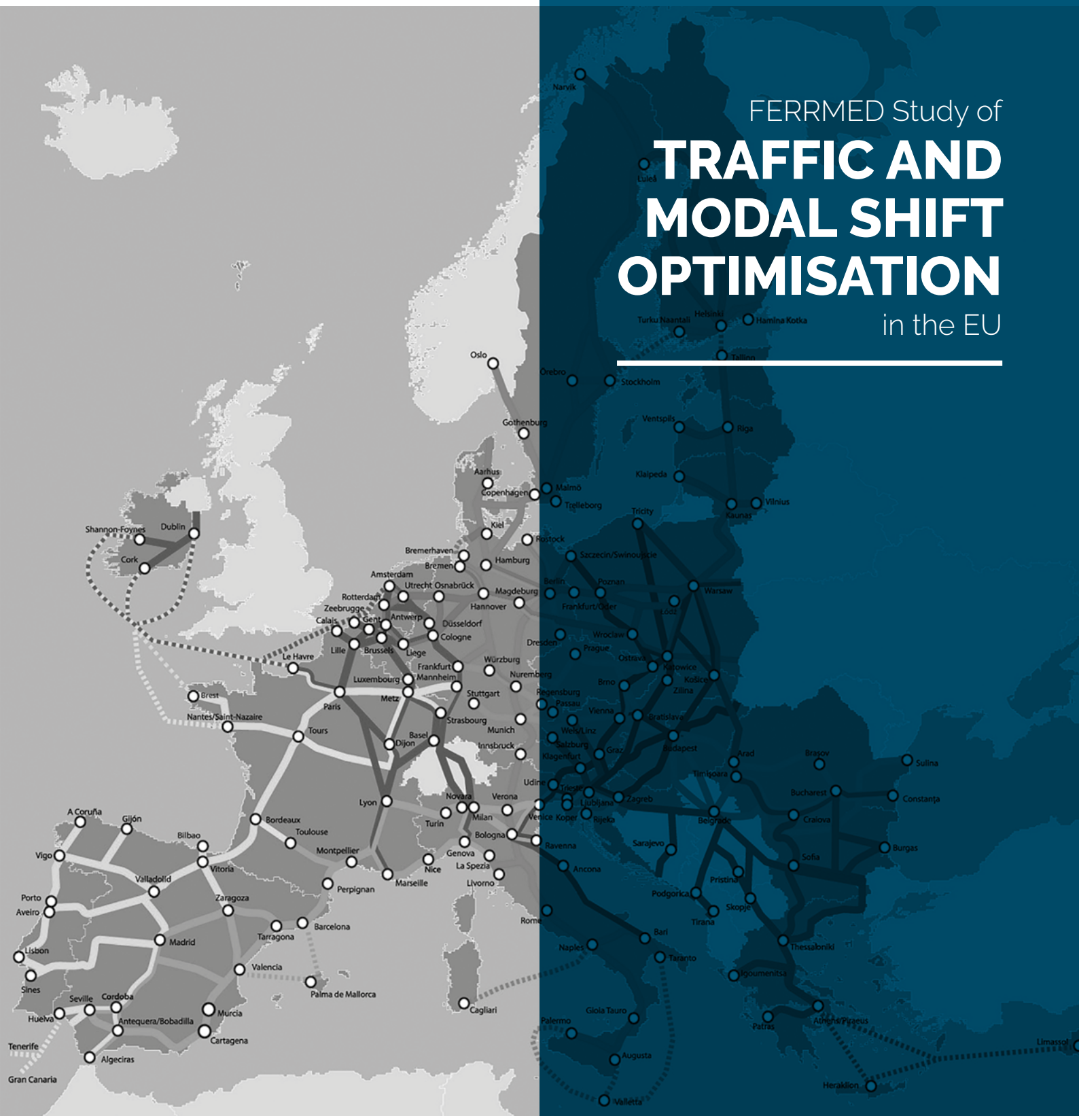
FERRMED Study of

# TRAFFIC AND MODAL SHIFT OPTIMISATION

in the EU




FERRMED

Promotion du Grand Axe Ferroviaire de marchandises
Scandinavie-Rhin-Rhône-Méditerranée Occidentale A.S.B.L.

*Per fer les coses bé cal:*
*primer, l'amor a elles; segon, la tècnica.*

*To do things right,*
*first you need love, then technique.*

**Antoni Gaudí**

Published by:
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ISBN: 978-2-9603405

Printed in Spain, November 2023

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# Table of contents

# What is FERRMED?

FERRMED is a multisectoral non-profit Association that was founded by the private sector in Brussels on the 5th of August 2004 in order to improve rail freight transport efficiency and industrial competitiveness in Europe and neighbouring countries.

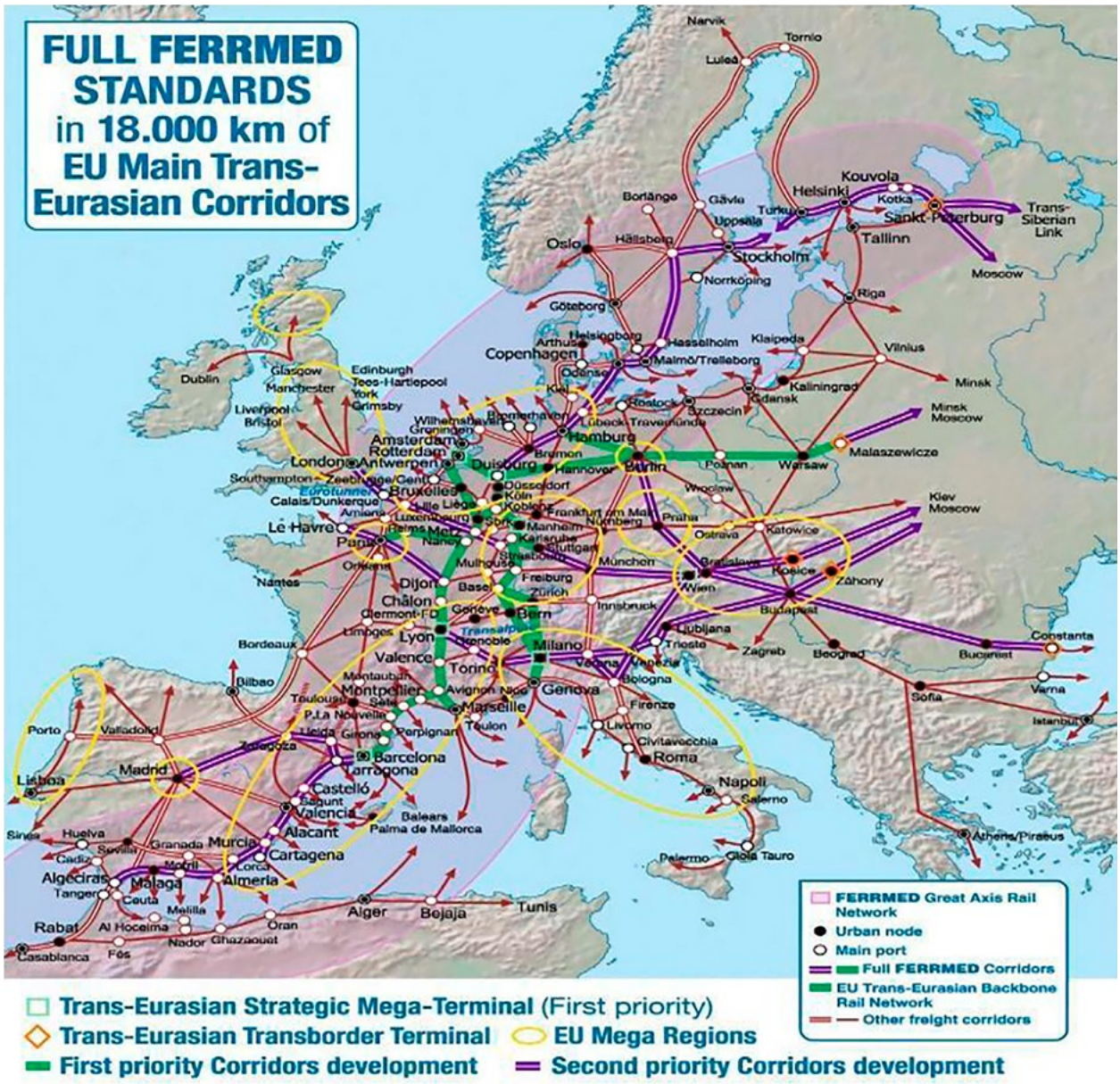
FERRMED promotes the implementation of common technical railway standards, the so-called *"FERRMED Standards of Reference/Recommendations"*, the improvement of the connections of Ports and Airports with their respective hinterlands, the full implementation of "FERRMED Corridors" (for freight, considering only the most important part of the EU Railway Core Network) and the conception of a Great Rail Freight Axis: Scandinavia-Rhine-Rhone-Western Mediterranean.

Another key FERRMED objective is the optimisation of the full logistics chain considering combined transport, appropriate intermodality, reducing costs, increasing quality, assuring traceability and reliability, accomplishing lead times and timetables and improving management procedures in the transport systems, within the framework of 5G and the Circular Economy.

FERRMED was officially constituted in August 2004, but recruitment of members actually began with its launch in October 2003.

The main target of FERRMED at that time was to look for a reticular and poly-centric priority rail network at EU level (with common and ambitious standards defined by our Association), instead of developing only "priority projects" (mainly trans-border sections).

Figure 1
**Full FERRMED Standard Implementation in the EU transport Network**

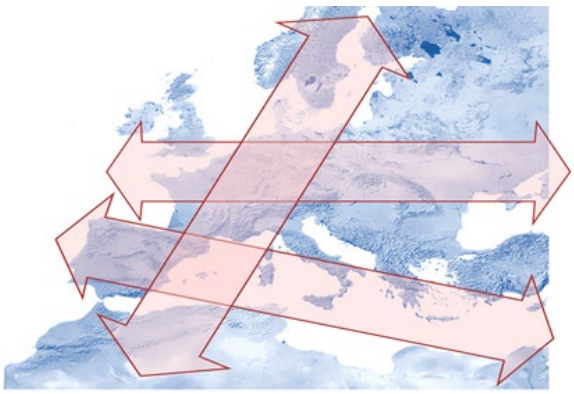



One key element in this proposed priority network was a North-South network linking the most important economic locomotive regions in the EU from Scandinavia to Western Mediterranean via the Rhine and Rhone Valleys (crossing the Alps in the North of Italy and the Pyrenees on the Eastern side).

Figure 2
**Main freight routes North-South in the EU**


We considered that in the EU there are three socioe-conomic growth vectors and in 2007-2009 we selected the North-South vector to carry out a study (named the **FERRMED Global Study**) demonstrating that the implementation of FERRMED Standards of Reference is the first stage to reverse the stagnant state of the Railway in the land transport system.

Figure 3
**The three socio-economic growth vectors in the EU**



As a result of the Global Study, the European Commission accepted most of the FERRMED recommendations. After discussions with the EU Parliament and the Council of Ministers, it was agreed that the target freight train length of

1,500 m would be reduced to 740 m and that the UIC-C loading gauge would only be compulsory on new lines. Through the Ministries of Transport of various Member States and through the Coordinators of the Trans-European Corridors, we continue to this day, step by step, to push for longer trains, broader loading gauge and ERTMS implementation.

Another key issue FERRMED has pushed for, is the implementation of the standard gauge on the railway tracks of the Mediterranean Corridor in Spain, which is now slowly moving forward.

Following the presentation of the Global Study results, several involved Member States have adopted part of the FERRMED proposed development plan.

FERRMED has carried out or commissioned several more studies like the **"FERRMED freight wagon concept"**, **"FERRMED freight locomotive concept"** and the **"FERRMED Study of the Southern section of the Mediterranean Corridor"**.

We have also released many statements regarding intermodal freight transport, particularly related to railway, including an implementation proposal for the FERRMED standards and recommendations for a selective (the most frequently used) part of the EU TEN-T Core Network.

FERRMED drove the creation of the "EC Core Net Cities Platform" and the "EU Core Net Cities Tribunes" with important meetings in some major EU cities.

FERRMED has signed Memoranda of Understanding with UIC, CCTT, Zhengzhou Municipal Government, Middle Corridor and Liuzhou Railway Vocational College. **We have very close relationships with these key institutions seeking a more competitive rail network at EU and Eurasian level. To further this goal, FERRMED also joined the group WP3 - Migration of the EDDP (European DAC Delivery Programme) enabled by Europe's Rail (formerly Shift2Rail).**

Figure 4
**Trans-eurasian main routes**

Through the "Belt and Road" initiative, jointly with Zhengzhou Peoples' Municipal Government, we have launched the "Eurasian Connectivity and Industrial Cooperation Forum". Editions of the Forum have already been held in China and in the EU and will continue in the future.

FERRMED organises several conferences every year in different European locations. The Steering Committee meeting and the General Assembly are held in a clearly decentralised way across the EU.

**In June 2019, with full knowledge of the European Commission, FERRMED launched the "FERRMED Study of Traffic and Modal Shift Optimisation in the EU" that was completed in October 2023.** The conclusions of the Study could facilitate the establishment of coherent transport network improvement plans at EU level, to attain the EU targets for railway transport by 2030 and the Green Deal environmental achievements with regard to the EU land transport system.

After 19 years, FERRMED has many contacts, members and partners everywhere, and we look forward to consolidating our presence across the EU and even Eurasia.

# FERRMED members and partners

(October 2023)

- AEMT-AIE (Agrupació d'Interès Econòmic Empreses Municipals de Tarragona)
- Aeroports de Catalunya
- Ajuntament de GIRONA
- AMEC (Associació Multisectorial d'Empreses)
- ANESCO (Asociación Nacional de Empresas Estibadoras y Consignatarias de Buques)
- ARDANUY Ingeniería, S.A.
- ASCAME
- ASCER (Asociación Española de Fabricantes Azulejos y Pavimentos Cerámicos)
- Asociación Murciana de Logística AML
- Association Internationale pour le Tunnel de Salau
- Autoridad Portuaria de Alicante
- Autoridad Portuaria de Almería
- Autoridad Portuaria de Baleares
- Autoridad Portuaria de Cartagena
- Autoridad Portuaria de Castellón
- Autoridad Portuaria de Valencia
- Autoritat Portuària de Barcelona
- Autoritat Portuària de Tarragona
- AUTOTERMINAL, S.A.
- Ayuntamiento de BAZA
- BARCELONA REGIONAL
- BCL (Barcelona-Catalunya Centre Logístic)
- BEST (Barcelona Europe South Terminal)
- Transports Calsina Carré, S.L.
- Cámara de Comercio, Industria y Navegación de ALMERÍA
- Cámara Oficial de Comercio, Industria y Navegación de CASTELLÓN
- Cámara Oficial de Comercio, Industria, Servicios y Navegación de MURCIA
- Cambra de Comerç de GIRONA
- Cambra de Oficial de Comerç, Indústria i Serveis de LLEIDA
- Cambra de Comerç, Indústria, Serveis i Navegació de REUS
- Cambra Oficial de Comerç, Indústria, Serveis i Navegació de BARCELONA
- CCTT (International Coordinating Council on Trans- siberian Transportation)
- CELSA (Compañía Española de Laminación)
- Centre Européen de Fruits et Légumes
- Cercle d'Infraestructures
- CFL MULTIMODAL S.A.
- Chambre de Commerce du Grand- Duché de LUXEMBOURG
- Chambre de Commerce et d'Industrie de Région Auvergne-Rhône-Alpes
- CIMALSA (Centres Logístics de Catalunya)

- CLECAT (European Association for forwarding, transport, logistic and customs services)
- COEC (Confederación Comarcal de Organizaciones Empresariales de Cartagena)
- COEIC (Col·legi Oficial d'Enginyers Industrials de Catalunya)
- COIICV (Colegio oficial de Ingenieros Industriales de la Comunitat Valenciana)
- Col·legi d'Enginyers de Camins, Canals i Ports de CATALUNYA
- Colegio de Ingenieros Industriales de Andalucia Oriental
- Colegio de Ingenieros Industriales de la Región de Murcia
- Consorci de la Zona Franca de BARCELONA
- CROEM (Confederación Regional de Organizaciones Empresariales de Murcia)
- Development TGV Languetoc-Roussillon
- East-West Intermodal Logistics Plc. (Hungary)
- EIA (European Intermodal Association)
- Energie TGV
- ERFA (European Rail Freight Customer Platform)
- EUROMEDITERRANEAN BUSINESS ASSOCIATION (Business Eumed)
- Europakorridoren AB
- FemVallès
- FemCat (Fundació Privada d'Empresaris)
- FGC (Ferrocarrils de la Generalitat de Catalunya)
- FOC (Fundació Occitano Catalana)
- Foment del Treball Nacional
- FORD
- FUNDACIÓN ICIL (Institut Català de Logística)
- Fundación PROAVE
- GLOBALLEIDA
- Grand Port Maritime de MARSEILLE-FOS
- HUPAC – Intermodal Transport
- IBS (Interessengemeinschaft der Bahnspediteure) e. V.
- ICAB (Il·lustre Col·legi de l'Advocacia de Barcelona)
- ICL Iberia Limited SCS
- INCASOL (Institut Català del Sòl)
- Institut d'Economia i Empresa IGNASI VILLALONGA
- ISL (Isntitute of Shipping Economics and Logistics)
- La Transalpine (Comité pour la liaison européenne transalpine Lyon -Turin)
- LFP Perthus (Línea Figueras Perpignan)
- Logitren Ferroviaria, S.A.
- LOHR Industrie
- Meeting y Salones
- MERCABARNA (Mercados de Abastecimientos de Barcelona)
- METLINK PORTS
- Middle Corridor (Trans-Caspian International Transport Route)
- MP2 (Syndicat Mixte Plateforme Pyrénées Méditerranée)
- MSSA (Metaux Speciaux)
- Paeria de LLEIDA
- PIMEC (Petita i Mitjana Empresa de Catalunya)
- Ponentia Logistics SA
- Port de BRUXELLES
- Port Rail Almanzora Levante, S.L.
- Ports de la Generalitat

- PROEXPORT
- PROJECT44
- PROMÁLAGA (Empresa Municipal de Iniciativas y Actividades Empresariales de Málaga)
- R+D+4i Euro-Action Group
- RACC (Reial Automòbil Club de Catalunya)
- RAIL FREIGHT GROUP
- RAILGRUP
- RELATS S.A.
- SABA Infrastructures
- Schneider Electric
- SEAT
- Soluciones Logísticas Integrales, S.A.
- Stadler Rail Valencia, S.A.U.
- TENALACH CONSULTING SA / TOMAS EXPEDICIONES, S.A.
- The Bothnian Corridor
- TMZ (Terminal Marítima de Zaragoza)
- TRADISA
- TRIMODAL Europe B.V.
- UNIFE (Union des Industries Ferroviaires Européennes)
- YANGZHOU TONGLEE REEFER CONTAINER Co., Ltd

# Acknowledgements

**Undertaking the FERRMED Study of Traffic and Modal Shift Optimisation in the EU, has been possible thanks to the great and, in many cases, altruistic dedication of the FERRMED STUDY INTERNATIONAL DEVELOPMENT TEAM (FESDIT) composed of the following members:**

- Ramón Adé, Manager in Logistics and International Trade, General Manager, Terminal Marítima de Zaragoza
- Seyed Mohsemi Abolfazl, Graduate in the field of Civil Engineering for Risk Migration and Master in Science, Antwerp University
- Valentí Ambròs, Industrial Engineer, Adviser to the FERRMED President
- Joan Amorós, Doctor in Industrial Engineering, FERRMED President
- Sven Andersen, Graduate Engineer (Diplom Ingenieur)
- Lluís Bassas, Industrial Engineer, Adviser to the FERRMED President
- Simó Batlle, Civil Engineer and Master in Urban Projects, Head of Planning and Intermodality, CIMALSA
- Pierre Borgoltz, Diploma HEC, Diploma 2e Cycle IEDES and MPA, Former Co-operation Coordination, SENECA. FERRMED Adviser
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- Arnau Ferrer, Geographer, FERRMED Senior Analyst
- Pablo García, Master in International Trade, Managing Director, Synergy
- Manuel J. García, Graduate in Economics and Master in Port Management and International Sea Transport, Head of Business Development Intelligence, Port of Valencia
- Àngel Gil, FERRMED Secretariat
- José Antonio Gómez, Industrial Engineer, Deputy Secretary General, FERRMED
- Eduard Gràcia, Economist, FERRMED Adviser
- Arthur Kendall, Writer, teacher, coach
- Efrain Larrea, Transport Planning Engineer, MCrit
- Henry Maillard, Consultance Mobilité. FERRMED Adviser
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- Olaf Meyer-Rühle, Master in Science in Economics and International Development, OMR Conseil, FERRMED Adviser
- José María Ojea, Industrial Engineer, Adviser to the FERRMED President
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- Josep Maria Rovira, Industrial Engineer, Secretary General, FERRMED
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- Naya Vallés, Degree in Applied Management, FERRMED
- Joan-Josep Vallvé, Industrial Engineer, Adviser to the FERRMED President
- Thierry Vanelslander, Professor in Applied Economics, Antwerp University
- Edwin Van Hassel, Civil Engineer and Doctor in Applied Economics, Antwerp University
- Hiwot Workie, Civil Engineer, FERRMED

Besides the technical team, we would like to give our recognition to Antwerp University (Department of Transport and Regional Economics) and Barcelona University (Faculty of Geography) for their involvement facilitating the collaboration of different professors, alumni and students. We also appreciate the dedication of MCrit consultancy, which has provided much needed assistance in several matters, particularly in all that concerns modelling of origin-destination matrices, land transport networks, investment needs as well as environmental impact.

Moreover, we wish to acknowledge the dedicated work on data collection by several students (Pau Amorós, Alejandra Chalen, Judit Cort, Jokin De Carlos, Emma González, Sergi López, Víctor Mencía, Gerard Oliver, Jordi Pont, Elisabet Puig and Laura Puig), under the guidance of FESDIT members.

In addition, we must mention the close collaboration in the exchange of ideas and concepts of:

- Manuel Alarcon-Espinosa, Europe's Rail
- Giulia Ambrogio, Ambrogio Transporti SpA
- Marc Billiet, Senior Advisor – EU Goods Transport, IRU
- Alba Carré, CEO, CALSINA-CARRÉ
- Carlos Castells, Equimodal
- Denis Choumert, AUTF president
- Josef Doppelbauer, ERA Executive Director
- Gert Fregien, Doctor of Engineering.
- Joerg Greshake, Greenbrier Europe
- Stefan Hagenlocher, HWH Transport and TIS
- Reinhard Hillmann, VTG
- Marc Hunziker, VTG
- Raluca Marian, Director – EU Advocacy, IRU General Delegate to the EU
- Joao Meireles, SIEMENS Mobility
- George Raymond, Railweb
- Mar Rivas, STADLER Valencia
- Isabelle Ryckbost, Secretary General, ESPO
- Anna Samsonova, LOHR Industrie
- Ralf Charley Schultze, UIRR President
- Josep Maria Serena, Industrial Engineer
- Patrick Sluga, SWS PS Power Solutions GmbH
- Godfried Smit, ESC Secretary General
- Ádám Talosi, CEO, EAST-WEST GATE Intermodal Terminal

- Ricard Vendrell, Head of Office representation in Spain, HUPAC
- Marcin Wójcik, Advisor to Matthias Reute

The Study could not have been completed without the sponsorship of CIMAL-SA, Diputació de Barcelona, Diputació de Girona, Diputació de Lleida, Diputació de Tarragona and Ferrocarrils de la Generalitat de Catalunya (FGC). We are extremely grateful for their support.

Last but not least, we must express our ongoing appreciation to all FERRMED members for their continuous loyalty to and support for our Association, which makes possible the achievement of milestones like the delivery of this FERRMED Study of Traffic and Modal Shift Optimisation in the EU.

**Mr. Joan Amorós**
*FERRMED President*
*General Coordinator of the Study development*

# Foreword

**Ms. Adina VĂLEAN**
*European Commissioner for Transport*

In the history of European integration, transport has given us territorial cohesion across the Union and smooth supply chains that support economic growth. It has given rise to industries and trade. But we can do better, and by completing the trans-European transport network (TEN-T), we will do better.

Our TEN-T policy targets a reliable, seamless, and high-quality trans-European transport network across the European Union that supports a fair transition towards climate-neutrality. The objective is to eliminate physical gaps, bottlenecks and missing links by 2030 for the core network, and by 2050 for the comprehensive network.

Completing the single market in railways is an integral part of this vision. It will open the door to improved cross-border rail services, ultimately providing consumers and industries with better choices and improved connectivity across the EU.

As outlined in this study, data suggests that container trains have real potential to increase rail freight traffic. But growing cross-border rail freight traffic requires a fully functional single European railway area. The revised TEN-T Regulation strengthens the requirement for interoperable railway infrastructure, introducing new factors such as loading gauge and track gauge.

At European level, we are also developing the right tools to manage infrastructure capacity and optimise its use, through the proposal for a regulation on managing rail infrastructure capacity and rail traffic. This will complement work on infrastructure development and upgrades.

TEN-T is a symbol of our unwavering dedication to forging a more sustainable, interconnected, and prosperous Europe. It is more than just infrastructure; it provides the foundations for a fair transition to climate-neutrality, offering a multitude of transport options and the right incentives to drive change.

We embark upon the transformative journey of updating the TEN-T together, confident that it will reshape transport in Europe, further increasing its force as a catalyst for economic growth.

**Ms. Karima DELLI**
*President of the Committee on Transport and Tourism European Parliament*

The European Union is at a real crossroads when it comes to defining its transport system for the coming decades. A policy choice that has to be made having in mind the challenges put by the climate emergency, and the Green Deal objectives and concrete targets established in relation to it.

The efforts stemming from the Fit for 55 package to move towards zero emissions are, in this regard, necessary and welcome. Beyond this, modal shift is key, if the transport sector as a whole is to its part in the decarbonisation of our economy. Rail is the mode which allows for greater economies of scale with less externalities, notably emissions and energy consumption. The prominent role that rail must therefore play, as the backbone of our logistics and supply chains, was identified by the Commission in its 2020 Sustainable and Smart Mobility Strategy. Ambitious but undoubtedly achievable targets were set therein, both for 2030 and 2050, which established clear direction for the policies and investments that should be given priority. It is therefore now a matter of political will..

The ongoing revision of TEN-T regulations aims at establishing an invigorated framework for the necessary development and upgrade of infrastructures to make this shift happen. Nevertheless, such general guidelines are not enough to ensure that its implementation will be successful and optimal. It is in this context that the FERRMED Study on "Traffic and Modal Shift Optimisation in the EU" becomes an extremely valuable and timely input. It provides a unique compass in orienting the upcoming years' investments - both Union and national, public and private - towards the most added-value European projects.

With funds in the Connecting Europe Facility regrettably limited, it is crucial that optimal use of these funds is made, in order to achieve the greatest cumulative impact across the Union. Therefore, such a detailed compilation of information, which allows for clear prioritisation based on a cost-benefit analysis using a common methodology, paves the way for sound decision-making. And while continued vigilance is needed to avoid side-lining peripheral and less densely populated regions and to rather ensure their convergence and overall cohesion, the "Priority investment Plan for EU integrated land freight transport" provides for a secure and quick return on the investment of EU taxpayers' money, both in terms of socioeconomic benefit and climate.

Ensuring the connection of ports and intermodal freight terminals to rail should be a priority. This will enable the bulk of the transport of goods across the Union - and notably across borders - to be done by train, leaving road transport for last-mile distribution. This is the real structural answer to the current truck driver shortage that we are experiencing and will also tackle another major externality of road transport: aside from its large share of overall transport emissions, the mode suffers from low labour and social standards. In this regard, rail offers multiple competitive advantages over other modes based on the same volume and distance of transport, in terms of reduced labour intensity, climate impact and energy costs, offering, as it does, a five-fold reduction in emissions and a ten-fold reduction in energy consumption - key in the context of the current energy crisis. Where infrastructure is properly designed and maintained, rail has also demonstrated strong modal resilience, even becoming a dependable base for communication, mobility and supply under extreme, adverse conditions, as we have witnessed in the last two years in Ukraine.

Rail, however, must close the competitive disadvantage gap with road when it comes to flexibility. This is why the "FIRRST" concept presented by the study could represent a breakthrough, combining the best features of the two worlds. The choice of locations for intermodal terminals, as presented, is critical to optimising such a system and allow the railway network to absorb the increased volumes. The Study has already done the bulk of this analysis, extremely well. What is needed, besides materialising such physical infrastructure, with sufficient transhipment capacity, and making use of features such as digital automatic coupling, is to ensure that existing and future capacity is permanently managed in an optimised way, making use of the coordinated planning possibilities, including real-time contingencies, that digital technologies allow.

To sum up, it is obvious that there is a lot of work to be done in order to reduce the current specific and structural bottlenecks for rail to become the backbone of a truly sustainable European transport system. However, thanks to FERRMED, we now have in our hands a thorough study that sets the path ahead with greater certainty. It is therefore just a matter of living up to it with decided policy and funding choices, coherent with the visions and objectives already established. And the moment to do so is definitely now.

**Mr. Alberto MAZZOLA**
*President*
*Community of European Railway and Infrastructure Companies (CER)*

2023 is an important year for progressing in the achievement of the EU Green Deal and the objectives of the EU Sustainable and Smart Mobility Strategy by adopting higher ambition in EU's transport infrastructure under the TEN-T Regulation reform. This FERRMED Study is certainly a very timely contribution to the modification of the TEN-T Regulation. The Action Plan proposed by the study is based on comprehensive data collection on freight flows and supported by a socio-economic and environmental impact assessment.

The choice of locating logistics hubs, intermodal terminals and further investments to railway corridors are valid parameters for a faster and more flexible integrated rail-road transport system. The study is providing answers to these points to trigger a much needed modal shift to rail.

CER agrees with the findings of the study in setting priorities to invest in railway infrastructure improvements. It is necessary to start with the Extended Core Network, where most of the land freight transport activity is taking place and continue with the sections of peripheral Member States.

CER advocates better connectivity of sustainable transport modes such as railways to ports and freight terminals and enhanced and additional urban nodes. It will be vital to realise such multimodal TEN-T connections in the core network and the comprehensive network by 2030 and 2050, respectively.

The economic case is clear for realising the EU land freight priority investment plan. CER pleads to have sufficient funding for realising the infrastructure projects. It is crucial that Member States utilise all available public or private funding in the near future. To this end, the next EU financial framework should cover TEN-T infrastructures beyond the current 2021-2027 budget, including the Connecting Europe Facility. The Cohesion Fund will be also important for infrastructure investments. Acknowledging that railway transport and infrastructure are defined as green economic activity by the EU Taxonomy, private funding would also be considered to complement the public funding.

**Mr. Josef DOPPELBAUER**
*Executive Director*
*European Railway Agency (ERA)*

We are currently facing multiple crises, with the COVID pandemic still ongoing and reports of tragic events caused by Russian aggression against Ukraine in the news daily. These acts of war are causing endless human suffering on European soil and affect the economy, leading to gas and material shortages, and increasing inflation. Record heat and persistent drought are making climate change more tangible than ever.

Mobility and transport of people and goods is essential for economy and society – but transport also contributes 25 % to the greenhouse gas emissions of the European Union, making the transport sector the second largest emitter after energy production. The environmental impact of freight transport represents 30 % of the total emissions of the transport sector. Besides being the safest mode of transport (which is also reflected in relatively low external cost), rail is the most sustainable mode, with its two key advantages of being low friction, and of providing economies of scale through bundling of transport volume, resulting in at least five times less CO2, and ten times less energy consumption per transport unit (for freight: ton km).

The European Commission has set its objectives for the "Green deal" - making Europe carbon neutral by 2050. To achieve this objective, the transport system needs to be transformed in order to make it climate neutral: to create an efficient, decarbonised European transport system. Modal shift to rail therefore is a key aspect of meeting the ambitious decarbonization targets for transport as per the European Green Deal.

Free movement of people, goods, and finance are the intangible values of the European Union – the European railway system, however, is still struggling with cross-border movement. Going the long distances by rail freight makes sense economically and ecologically – but it means that borders will have to be crossed, and national regulations cause delays and add costs. Cross-border operation is the Achilles heel of European rail – inadequate cross-border services bring down the market share of rail, making the vision of rail being the backbone of multimodal passenger and freight services in Europe an ever-unattainable goal.

The modal share of rail in the European Union is low, but the modal share of rail across borders is still significantly lower. During the last decades, rail modal share has been lost because of the decline of transport of mass goods (e.g.

iron ore), and rail withdrawing from "unprofitable market segments" such as single-wagon load transport. We are running out of time to turn things around. As the carbon crisis/climate change is imminent, the timing of measures is important – the earlier the effect, the better it is for the environment.

The comprehensive study by FERRMED provides timely knowledge of the scope for traffic and modal shift optimisation on the main corridors of the EU Core Network with particular focus on freight transportation. It found that 55 % of total road freight transport performance was over distances of more than 300 km of which roughly one third were over more than 1,000 km. A modal shift could result in a doubling of rail modal share and 40 million tons of CO2 saved per year, if 90 % of road freight over distances of more than 700 km (this is at distances where Combined Transport is truly competitive) was shifted to rail. Apart from the necessary political will to make such a shift happen, investment will be needed into more intermodal terminals and connections to ports, as well as more pocket wagons to accommodate semi-trailers that today constitute 75 % of the freight transport on roads.

To cope with the future demand for mobility, necessary capacities need to be built up in the European rail network. Here, too, the FERRMED Study provides valuable insights, in particular, where in the EU Extended Core Network the priority investments for infrastructure improvement should be directed to. The study provides an analysis of all existing intermodal terminals, considering origin-destination matrices to define the required capacity and determine necessary additional terminals.

In addition to capacity building, measures will be necessary to remove barriers to cross-border rail, which are more cost effective than large-scale construction projects and critical in making investments effective – such as, for example, the Brenner Base Tunnel which needs efficient operation across borders.

Innovation, in particular projects related to digitalization of the railway network, can help to provide greater operational efficiency (lower cost for better quality of service), improved diagnostic options and predictive maintenance, and increased line speed at shorter headways. An appropriately designed and maintained railway infrastructure will be primordial for sustainable modal shift.

Overall, the FERRMED Study identifies the need for around €77 billion in investment in Europe to achieve these modal shift targets, which pales in comparison to the estimated €240 billion required by 2030 for charging infrastructure and reinforcement of the electrical power grid to make road transport electric, without mentioning other challenges such as the supply of materials for batteries, etc.  Also taking into account the socio-economic and environmental impact, the FERRMED Study has made a most valuable contribution to the debate, attributing recommendations and action points to the European Commission, the Council, and the Parliament, the Member States, and the European railway sector. As such, it will support the European Union Agency for Railways in its mission to move Europe towards a sustainable and safe rail system without borders.

**Mr. Godfried SMITH**
*Secretary General*
*European Shippers Council (ESC)*

Looking at the challenges we face in logistics, combined transport is a solution to most of them.

What are the current challenges?

It is difficult to find people who want to do logistics functions (such as that of truck drivers). In addition, due to the acts of war in Ukraine, energy is very expensive. Finally, we are facing a lot of road congestion.

In the short and medium term, many of these problems will, in my view, persist. The number of unfilled vacancies for truck drivers is expected to increase to 1 million across Europe. Energy remains expensive due to low supply and the EU is making road transport more expensive through a variety of measures such as the Emission Trading Scheme and road tolls.

Rail transport is considerably more energy efficient due to the low friction energy of steel on steel (instead of pneumatics on asphalt in road transport). Also, rail transport is less labour intensive.

However, this study shows that much is still needed to capture all these benefits. Rail infrastructure is heavily used by passenger and cargo trains and many terminals are obsolete. What makes this study so valuable is that it reveals where investments can pay off most and which innovations can contribute to increasing efficient rail freight transport. Where the European Union is committed to increasing the share of rail freight, current barriers must be removed. The new Combined Transport Directive that is being prepared plays at this very moment an important role here.

To make combined transport even more attractive to shippers in the coming years, capacity must be increased. This can be done by removing bottlenecks identified in this study but also by increasing quality and predictability. ESC is working with industry partners to ensure a good exchange of data to make essential information such as Estimated Time of Arrival (ETA) available. It is important to speed up these developments because it is precisely now that rail transport has a strong competitive edge. With the advent of carbon neutral and autonomous vehicles, this lead will not disappear, but it will diminish.

**Ms. Raluca MARIAN**
*Director EU Advocacy and General Delegate of IRU's Permanent Delegation to the European Union*
*International Road Transport Union (IRU)*

As responsible transport modes, we must respond in a sustainable way to the expected increases in EU freight transport demand by 2050, which, depending on the source, may double or triple. To match the demand, all transport modes are needed individually and in combination.

The Green Deal objectives can only be met through the creation of a resource efficient, sustainable freight transport network in the EU where all individual freight transport modes meet each other and cooperate to serve the needs of the EU economy.

While transport modes have to better cooperate, EU policy-makers should also play their part, by adopting a more horizontal approach in freight transport and logistics policy and law-making to further facilitate combined and multimodal solutions. This obviously does not mean that modes can no longer function individually or continue to improve their efficiency and reduce their environmental footprint; but multimodal transport should thrive much more than today.

The FERRMED Study is timely as major revisions of EU transport infrastructure, combined transport, weights and dimensions and digitalisation rules are either already on the table or to be expected. The study sets very ambitious objectives which are necessary for palpable change; its title could have focussed more on improving modal cooperation. But in essence, the study does not avoid a new innovative approach to challenges that have been lingering in combined road-rail transport for too long. Such a new approach stimulates debate, activates resilience and can open the door to potential new innovative solutions to turn existing and upcoming challenges into opportunities. An increase in combined and multimodal transport based on a healthy economic foundation is necessary for serving the economy.

FERRMED opened the door to IRU during the preparation of this final study report to start discussions on a new approach to improve the efficiency of combined and multimodal transport. IRU will provide its full support to this new opportunity to cooperate and is open to opportunities with other players in the multimodal transport chain.

This FERRMED Study merits thorough examination and consideration. Hopefully it will contribute to improved and increasingly diversified multimodal freight transport services in the EU.

**Mr. Ralf-Charley SCHULTZE**
*President of the UIRR, the international union for road-rail combined Imagetransport in Brussels*

Intermodal freight transportation and Combined Transport, its impact-maximising version, offer the most effective means to insert energy-efficient and low-externality non-road modes of transport – electric rail and waterborne means – into long-distance transport chains.

FERRMED conducted this substantial Study to quantify the infrastructure aspects of having more road-rail Combined Transport. How much investment is needed into the railway infrastructure to enable the doubling of rail freight's market share by 2050? Two-thirds of the €500 billion investment need of rail freight, identified by FERRMED, have already been pledged by EU Member States under the TEN-T programme. The remainder is an affordable €5-6 billion per year on the level of the entire European Union.

The gradually deteriorating overall impact of Europe's long-distance inland freight transportation, 75 % of which is based on trucks, can be most effectively and most affordably reversed with the lowest risk through using more Combined Transport. This is the way Combined Transport delivers.

I congratulate FERRMED for its hard work in demonstrating this in the Study.

**Mr. Josep Maria ROVIRA**
*Secretary General*
*FERRMED*

Throughout the almost 20 years of FERRMED's existence, our concern has been the promotion and improvement of the rail freight service throughout the European Union. Among the founding objectives was the improvement of the connection of the Iberian Peninsula with Europe via France, recognising the importance of the Mediterranean Corridor within the Union.

After more than 3 years of pressure, backed by freight mobility data and rail network studies, and with the involvement of all the administrative bodies involved, the Commission finally recognised the importance of the Mediterranean Corridor and included it in the European Core Network.

Once the Commission had established a plan to optimise the European Network in order to improve environmental conditions, it became clear to us at FERRMED that the envisaged measures alone would not be enough to achieve the target of 30 % railway market share of freight transport, mainly measures taken by member states, many of which contributed very little to the objectives set.

After some reflection on the best way of pursuing the 30/2030 objective, it was decided, in 2019, to create international working groups within FERRMED, which would be open to all interested parties.

These working groups concluded that a prospective study needed to be done to explore the advantages of concentrating actions on the most crowded sections of the Transeuropean Network. This would allow the 30 % of railway share target to be achieved through more focussed investment. After an in-depth analysis, the conclusion was reached that it could be accomplished by focusing on the most used parts of the network, which represent 65 % of the total, the result of analysing the load density of the busiest sections.

In order to carry out a study of the necessary development over time of the the railway network, interim goals were set, for rail share of the land freight transport system, of 23 % by 2025-2027 and 30 % by 2030-2033.

From these premises, work started on finding suitably qualified people to carry out this task. The first initiative was to find an engineering group specialising in railway technology, and MCRIT was chosen to provide technological expertise and support.

All this took place during the last quarter of 2019 and the beginning of 2020, in the midst of the COVID pandemic, with all the difficulties this entailed.

From the beginning, work on the study involved trainees to collaborate on field-work tasks.

We also had the collaboration of the Universities of Barcelona and Antwerp (Department of Mobility, for the study of issues related to the trans-Eurasian rail network).

In 2020 a working group was also set up to manage the day-to-day activity of the study, which was joined by prominent university specialists and technologists from all over Europe, under the acronym of FESDIT (FERRMED Study Development International Team).

Work on the study proceeded with an analysis of the transport volumes in the transeuropean network (Extended Core Network), which identified the sections with volumes that are consistently the highest. This information was used to map out a priority network, representing those parts which carry 65 % of the total transport volume.

The purpose of this analysis was to ascertain the viability of transferring goods from other means of transport to the railway, in order to reduce costs, journey times, road accidents, the effects of greenhouse gases and the burning of fossil fuels, creating instead a combined transport system of road-rail.

Analysis was carried out of the viability of expanding railway infrastructure in every chosen section, with the associated investments, and expanding the network of logistics terminals, both in terms of volume and number of terminals, as well as their connections with both the rail and road networks. In 2021, it became clear from this analysis that rail logistics needed modifying, linking it more closely to the road via a new system which we called +FIRRST (FERRMED Fast, Flexible, Integrated Rail-Road System of Transport). The system is based on the concept of Mobility as a Service (MaaS) and consists of a new management system, a new type of multi-modal terminal and total integration of land freight transport.

In parallel, work was carried out to determine the type of rolling stock required (locomotive and freight wagons) to properly implement the +FIRRST system.

Finally, a complete socio-economic and environmental analysis has been carried out, with highly satisfactory results.

Overall, work on the study has involved more than 45,000 hours of work. It has been carried out by a team of 24 experts, engineers, economists, geographers and senior experts, the Universities of Antwerp and Barcelona and the consulting firm MCrit.

**Mr. Joan AMORÓS**
*President*
*FERRMED*

The land freight transport in the EU is facing strong challenges in the first third of 21st century: In spite of the impact of COVID-19 pandemic, the demand for freight transport is expected to grow by more than 50 % until 2050, according to the European commission (Reference Scenario 2020, Energy, Transport and GHG Emissions – Trends 2020).

The main question is how the EU transport network can absorb this important increase of volume and how to achieve the basic objectives of the European Green Deal in all that concerns inland transport.

Decarbonisation is passing in a significant amount, through transport. In the case of freight transport and logistics, decarbonisation can only be achieved by further reducing the environmental footprint of individual modes and by having a better balance of share among modes.

In fact, over the last 20 years, there has been no substantial change in the market share of the various modes of freight transport. In the case of rail and combined transport, this is due to the lack of adequate infrastructure and operation management for freight trains, insufficient number and capability of intermodal terminals, bottlenecks solving and lack of coherent integrated land freight transport plan at EU level, to meet the targets originally set out in EC (2011) White Paper on Transport Policy and in the European Green Deal.

For all these reasons, FERRMED launched in June 2019 the "FERRMED Study of Traffic and Modal Shift Optimisation in the EU".

The basic objectives of the Study are:

- To investigate the distribution of current freight transport volumes in the multimodal TEN-T Network
- To identify the EU Strategic logistics hubs
- The definition of appropriate scenarios of traffic share and traffic increase in the inland transportation modes
- To define a new concept of intermodal terminal
- To develop a Fast, Flexible, Integrated, Rail-Road System of Transport (+FIRRST), as a novel way of organising multimodal rail-road transport in the form of "Mobility as a Service" (MaaS)
- To investigate what should be the adequate rolling stock

- To analyse the capacity of the transport system (bottleneck solving and additional intermodal terminals according to the expected traffic of the different scenarios)
- To propose the establishment of a "Priority investment Plan for EU integrated land freight transport", with first priority for sections with the highest freight volumes

After more than four years of hard work (more than 45.000 hours) of an international team composed by 24 experts (engineers, economists and geographers), 12 students with two Universities involved, Antwerp and Barcelona as well as a consultant company, MCRIT, the Study has been concluded in October 2023. As far as we know, there has never been a study or any research undertaken, with inventories of road and rail infrastructures as well as intermodal terminals, with the level of detail achieved in the FERRMED Study.

The main conclusions are:

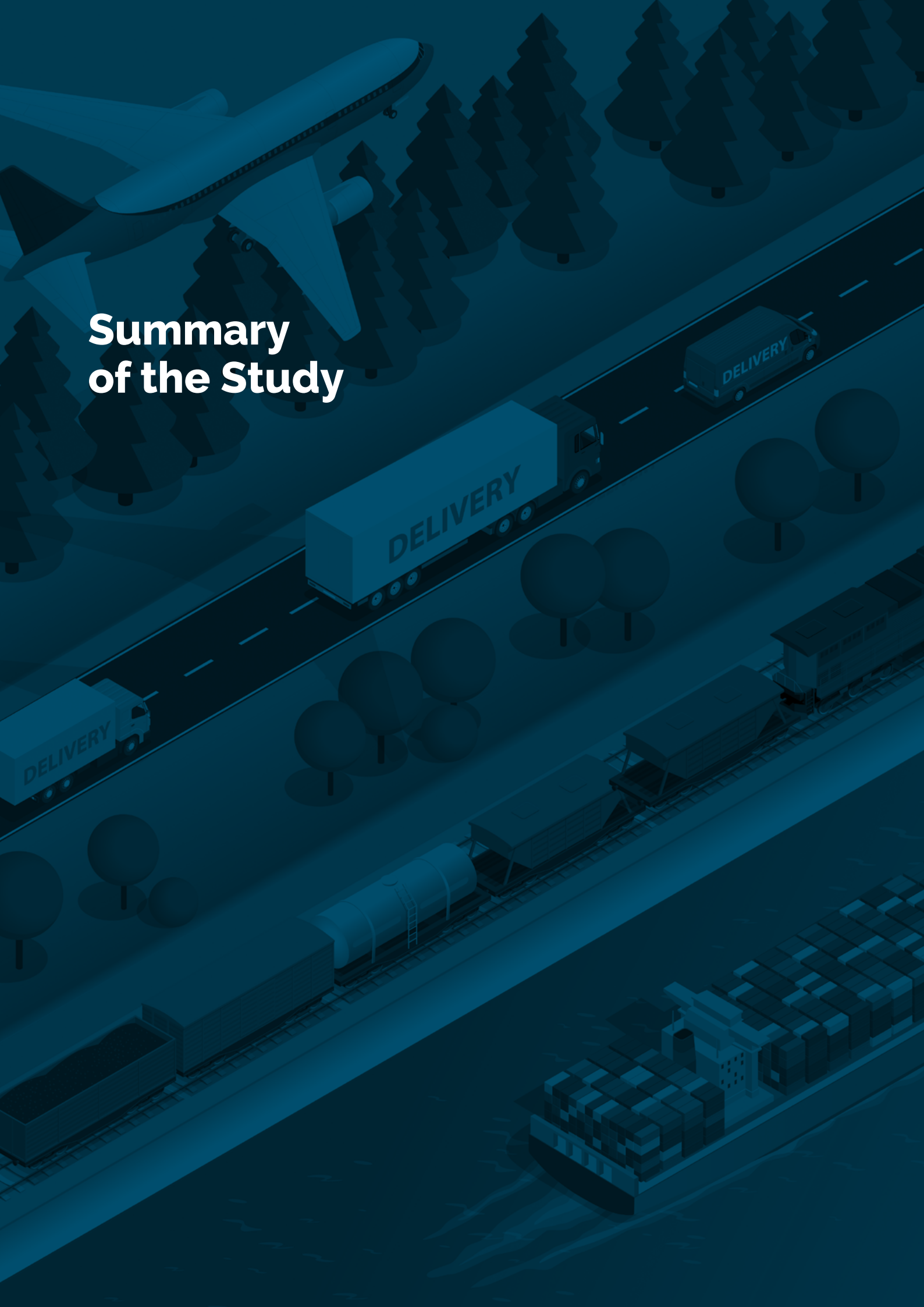
- **Investing in 23 % of the EU Extended Core Network generates 101 % of total net present value (NPV).** Slightly positive NPVs in further 37 % of the network are almost offset by negative NPVs in the remaining 39 %.

- **Implementing the Fast Flexible Integrated Rail-Road System of Transport (+FIRRST)** to move all kind of ILUs (semi-trailers, containers and swap bodies) to different destinations in the form of "Mobility as a service" (Maas), is the best way to boost the stagnant share of the railway in land freight transport.

- **Properly interlinking the identified EU Strategic logistic hubs and key interconnection nodes with the +FIRRST system**, including the new intermodal terminal concept, is key for the achievement of Green Deal targets on transport **(51.5 % operational cost reduction and 77 % externality reduction)**.

We expect that the analysis, conclusions and recommendations of the Study will provide insights and relevant evidence to materialise the Greening Freight Package and to establish the adequate guidelines for a true integration of the freight transport in Europe.

# Summary of the Study



# 1. BACKGROUND

## 1.1. Performance and environmental impact of the European land freight transport system

In the year 2021, total freight transport performance in the EU-27 was almost **2.4 trillion tonne-kilometres,** of which roughly **77 % were transported by road, 17 % by rail and 6 % by inland waterway**[1].

In spite of the environment-friendly efforts made by the sector, the impact of heavy-duty road vehicles on the environment is still severe: some **210 million tonnes of CO2** per annum, representing **26 % of total greenhouse gas (GHG) emissions of the road transport sector** as a whole[2].

On the other hand, the **lack of flexibility** in freight train management and the **shortage of adequate intermodal infrastructure**, do not facilitate the growth of combined transport.

## 1.2. Present conditions of the European land freight transport system

In the EU, according to the "World Economic Forum"[3]:
- 24 % of freight vehicles run empty;
- The loading of the rest is, on average, of 57 % in terms of weight capacity;
- Overall efficiency is hence only 43 %.

1 EU Transport in Figures 2023 (Table 2.2.1)
2 EEA (European Environment Agency) Transport and environment report 2021. Decarbonising road transport -the role of vehicles, fuels and transport demand (EEA Report No. 02/2022)
3 FERRMED Conference (2019) Opening speech of Mr. Antonio Tajani MEP, Chairman of the Committee for Constitutional Affairs, Former President of the European Parliament. https://www.weforum.org/agenda/transportation/

# 2. COMPREHENSIVE PLAN OF MODAL SHIFT OPTIMISATION

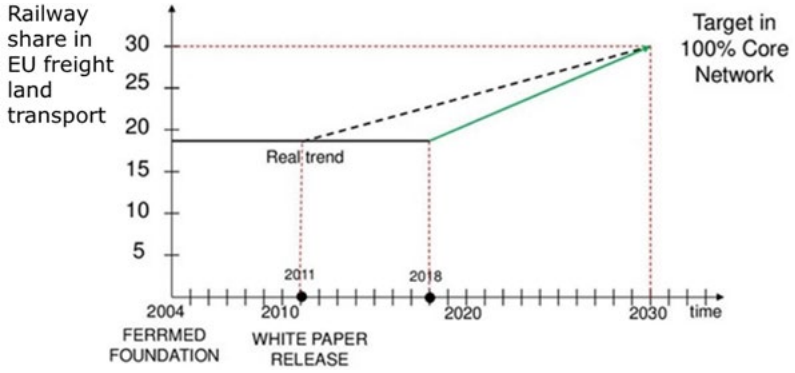
## 2.1. Starting points

Considering:

- The performance of the EU land freight transport system and its environmental impact
- The economic growth and the resulting growth in freight transport demand expected between 2021 and 2030
- The present inefficiencies of the rail freight transport system
- The waste of economic resources in unprofitable investments
- The lower specific energy consumption and external costs of combined transport versus the road

**Under the scope of the "European Green Deal", a comprehensive plan at EU level of modal shift optimisation, aiming for an integrated land freight transport system, is urgently needed.**

Figure 1
**Railway share real versus planned**




## 2.2. Key messages

- Under the framework of the European Green Deal, to concentrate efforts on achieving the "EC (2011) White Paper on Transport Policy" targets in the most heavily used sections of the corridors of the Core Network already defined by the EC (EU Backbone Network).
- To advance the implementation of innovative actions in the railway system (infrastructure – operation – rolling stock), seeking more flexibility and drastic operating cost reduction.
- To compel automation, "intelligent freight trains" and "intelligent intermodal terminals".
- To develop a new concept of intermodal terminals, avoiding shunting movements.

- To integrate the rail-road transport system in the form of "Mobility as a Service"(MaaS).
- A mandatory Action Plan at EU Extended Core Network level, led by the European Commission (EC), previously agreed by the European Parliament (EP) is urgently required.

### 2.3. Eurasian transport system challenges

The continuous increase in trade between Eurasian countries[4] (EU and North Africa included) require strengthening of the performance of the global transport interconnection system, particularly railway, where it is necessary to identify strategic hubs and implement shorter transit times and long, compact, and intelligent trains, as well as smart and efficient intermodal terminals and ports. This is key to reducing logistics costs and environmental impact.

## 3. OBJECTIVES OF THE STUDY

### 3.1. Preliminary

Considering that there has been no increase in EU rail freight share in the last 15 years (17.9 % in 2005 and 17.3 % in 2017) and that the EU Transport Extended Core Network is too vast (c.80,000 km), **the shift from road to rail requires the concentration of investments in a selective part of the main corridors of the Extended Core Network. To identify** the most heavily used sections in the EU land transport network and **the best procedures to transfer freight from road to rail**, FERRMED has initiated a major study highlighted below.

### 3.2. Basic objectives

The objectives of the study are:

- **To identify current total freight transport by mode** in the main corridors of the EU Core Network (EU Backbone Network);
- **To identify the main logistic hubs in the EU;**
- **To define a new integrated Rail-Road system of transport for freight;**
- **To propose an Action Plan to achieve the EC (2011) White Paper on Transport Policy targets by 2030** (30 % of inland freight transport over 300 km carried by rail or barge) **and "Green Deal" targets,** in the most heavily used sections of the corridors, covering 65 % of the traffic (tonne-kilometres) related to the EU Extended Core Network.

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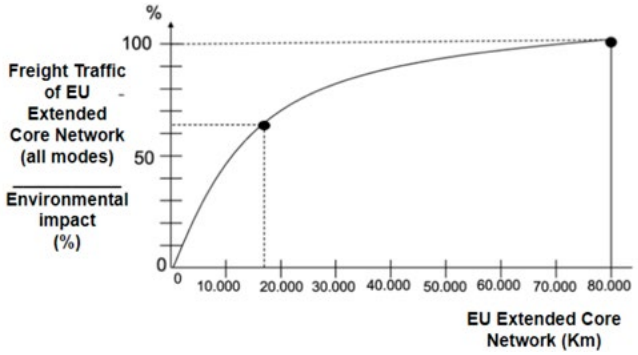
4 According to China National Railway Co., the Trans-Eurasian railway network performed unexpectedly well under the severe constraints imposed by the measures against the COVID-19 outbreak. In the first half of 2020 the Eurasian land bridge responded remarkably to the surging demand for rail freight in both ends of the Eurasian Continent, producing overall growth of 50 % in China – Europe container traffic over the same period the previous year.

Figure 2
**FERRMED approach to achieve the 30 % of railway share over total long-distance inland freight in the EU**




## 3.3. Main topics considered in the shift to rail

- We do not conceive having road competing against rail; we consider the railway as the main complement to road traffic. In most cases, road is best for short distances and for the first and last mile. **Railways should be at the service of the road as the most flexible mode,** suitable for carrying heavy goods vehicles (HGVs) and trailers/semi-trailers, swap-bodies and containers for long distances on request (and/or point-to-point traffic).
- To achieve the appropriate shift from road to rail, considering a new, fast and flexible way to manage freight trains, "**combined transport" (CT) is key, mainly unaccompanied CT**.


Example of a train carrying semi-trailers and containers with Sdggmrss T3000e wagons.

# 4. BASIC STRUCTURE AND CONTENTS OF THE STUDY

- Identification of EU Extended Core Network sections with most cargo movements (all transport modes) → "Backbone Network" (65 % of the Extended Core Network transport) (c.80,000 km of corridors analysed, equivalent to c.200,000 km of individual modes: rail, road and IWW);

- Determination of main strategic logistics hubs;
- Analysis of the key intermodal terminals and main interconnection links, back-up links and feeder links in the "Backbone Network". Bottleneck analysis;
- Definition of the "FERRMED Fast, Flexible, Integrated Rail-Road System of Transport (+FIRRST)";
- Best routes inside the "EU Backbone Network" for interconnection with the Eurasian Transport System;
- Socio-economic and environmental impact assessment;
- Action Plan.

## 5. TASK FORCE

It has been a major study work. The task force involved consisted of:

- **24 experts:** academics, engineers, economists, geographers and senior analysts from all over the EU
- **12 students:** from Economics, Engineering and Geography Faculties
- **2 Universities involved:** Antwerp University and Barcelona University
- **1 Consultancy:** MCrit
- **45,000 work hours spent:** between June 2019 and October 2023

## 6. TABLES AND MAPS OF LAND TRANSPORT

Detailed data collection has been carried out, considering 2,608 elementary sections of the EU Extended Core Network Corridors (as average sections of 30 km length).

The sources of data are:

- **Data gathering** from several sources for the **year 2015** (or 2018), mainly **UN-ECE, EUROSTAT, CEDR, OPEN RAILWAY MAP, OPEN STREET MAP** for road and rail.
- **Complementary** data obtained from **national sources** wherever necessary (e.g. Italian toll motorways association, Croatian national transport model, etc.).
- **Inland waterway** transport calculated using an **assignment** model based on **origin-destination matrices** obtained from **national sources**
- **Validation of data** by national experts + filling of gaps

## 7. DETERMINATION OF EU BACKBONE NETWORK

The EU Backbone Network has been determined by examining the combined transport volume of each elementary section (rail, road and IWW) of the EU Ex-

tended Core Network (ECN). A threshold of 122,000 tonnes/day are required in each elementary section to form part of the Central Backbone Network. All sections with transport volumes above this threshold make up 65 % of the TEN-T ECN (in blue on the map below).

For peripheral countries, we consider as second priority those sections with transport performance over 65 % of the ECN related to the corresponding Member State (in red on the map).

Figure 3
**Transport performance**


EU Core Network (aggregated): **77,240 km**
EU Central Backbone Network: **18,040 km (23,3 %)**
EU Extended Backbone Network: **8,500 km (11 %)**
Backbone Network 65 % threshold: **122,000 tonnes/day**

The corresponding ECN threshold of 65 % of transport performance in each Member State is detailed in the following table.

Table 1
**Country thresholds in 1,000 tonnes/day**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 116 | Germany | 172 | Finland | 31 | Lithuania | 63 | Portugal | 28 |
| Belgium | 180 | denmark | 119 | France | 128 | Luxembourg | 204 | Romania | 73 |
| Bulgaria | 35 | Estonia | 62 | Croatia | 21 | Latvia | 43 | Sweden | 50 |
| Switzerland | 155 | Greece | 39 | Hungary | 174 | Netherlands | 213 | Slovenia | 92 |
| Czech Republic | 155 | Spain | 100 | Italy | 161 | Poland | 83 | Slovakia | 72 |

## 8. DETERMINATION OF STRATEGIC SOCIO-ECONOMIC HUBS

To identify and determine the EU hubs, 4 factors were used as selection criteria: Input-Output flow, Manufacturing Gross Value Added (GVA), Population and a Combined Index.

- **Inflow-Outflow:** total freight volumes (to destinations at a distance of 300 km and more from the centroids of the hub's NUTS 3 components) handled per day resulting from the OD matrix.
- **Gross Value Added (GVA) manufacture:** value added of manufactured goods produced in an area or an economic sector.
- **Population:** First filter to select the main EU urban agglomerations as candidates to become a Hub. Interrelated hubs are still not defined, the population of their corresponding urban agglomeration had to exceed 1 % of the EU population (4.5 m inhabitants). For the EU Interrelated Hubs, their population had to be between 0.5 and 1 % of the EU population (over 2.2 m inhabitants).
- **Combined Index:** value resulting from combining the Population, GVA and Input-Output flow values. Using the combined index, the main 30 logistics hubs are identified and duly listed in the following chart.

Figure 4
**Combined index**

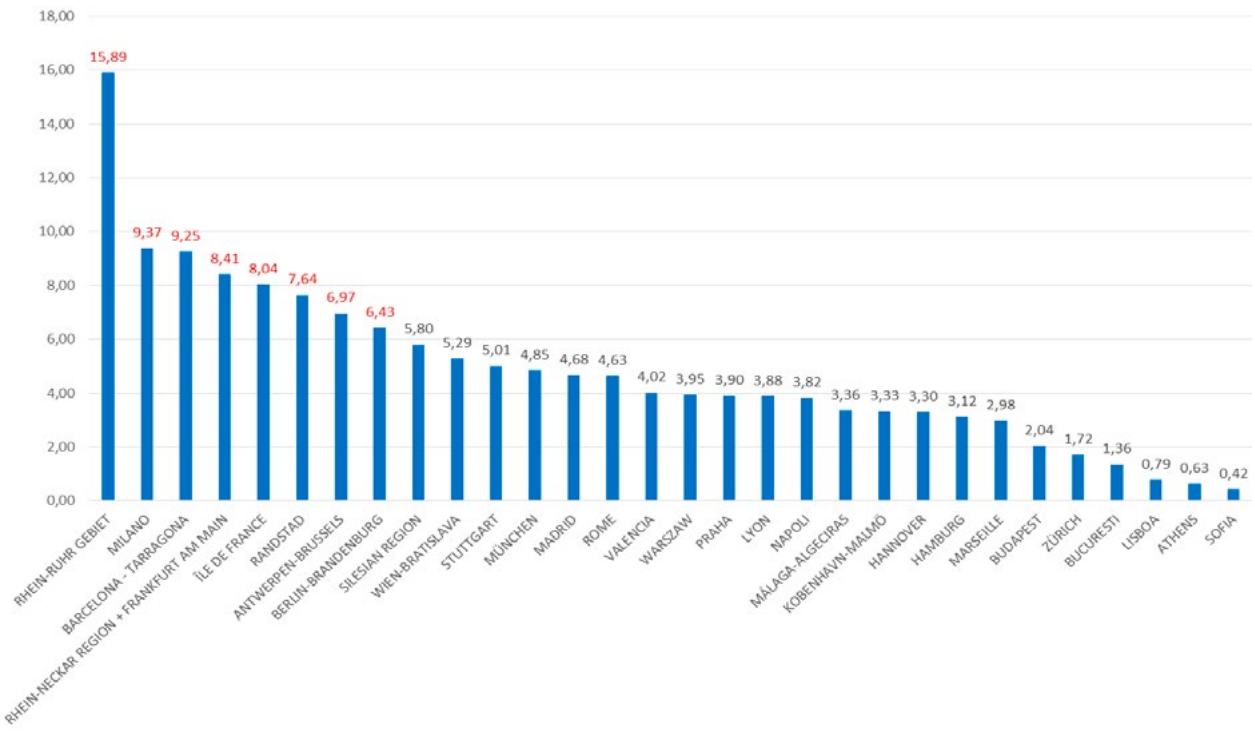
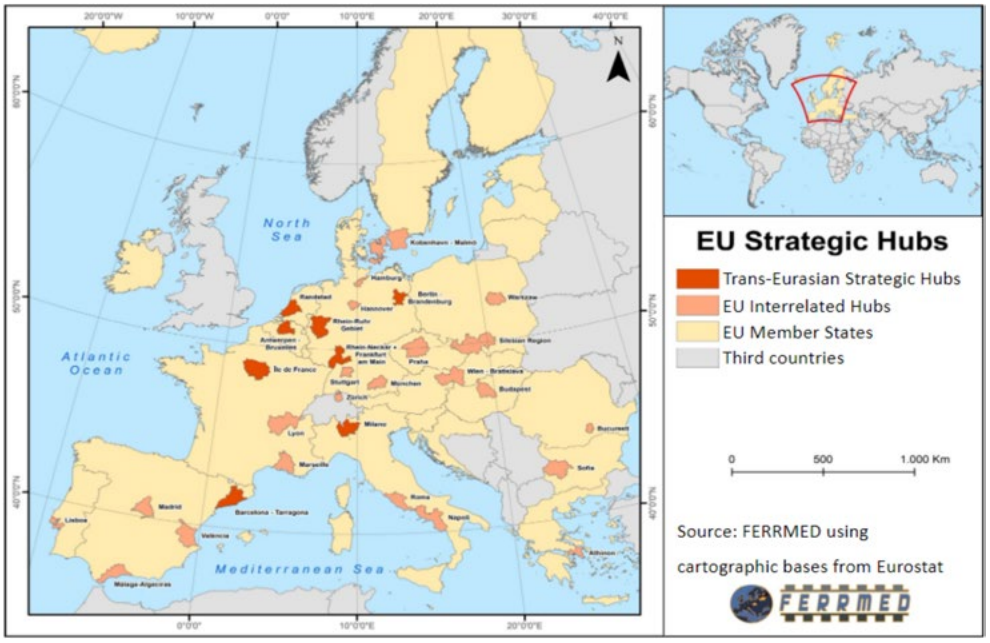


Figure 5
**EU Strategic Hubs**




*Source: FERRMED*

## 9. DATA COLLECTION FOR INTERMODAL TERMINALS IN THE EU ECN

Exhaustive analysis of all existing intermodal terminals (those handling ILUs, ie semi-trailers, containers and swap bodies) in the EU Extended Core Network (ECN) has been carried out using the following basic properties:

1. Contact information
2. Modes served
3. Opening hours for loading/unloading
4. Total terminal area ($m^2$)
5. Configuration: Dead-End / Pass-Through
6. Number and usable length of tracks (m), for loading/unloading (L/U)
7. Number and usable length of tracks (m), for marshalling/shunting
8. Number of gantry cranes
9. Number of reach stackers
10. Available services

According to the data collected, a preliminary classification of the existing intermodal terminals was performed:

Table 2
**Classification of the existing intermodal terminals in the EU**

| Classification of L/U | | European Union | Share (%) |
|---|---|---|---|
| < 250 m | A | 127 | 19.7 |
| 251 m - 500 m | B | 280 | 43.5 |
| 501 m - 700 m | C | 163 | 25.3 |
| 701 m -750 m | D | 47 | 7.3 |
| > 750 m | E | 27 | 4.2 |
| | **Total** | **644** | **100** |
| | **Pass through** | 79 | **12.3** |
| | **Dead end** | 565 | **87.7** |

Note: Existing Intermodal terminals in continental EU + Switzerland

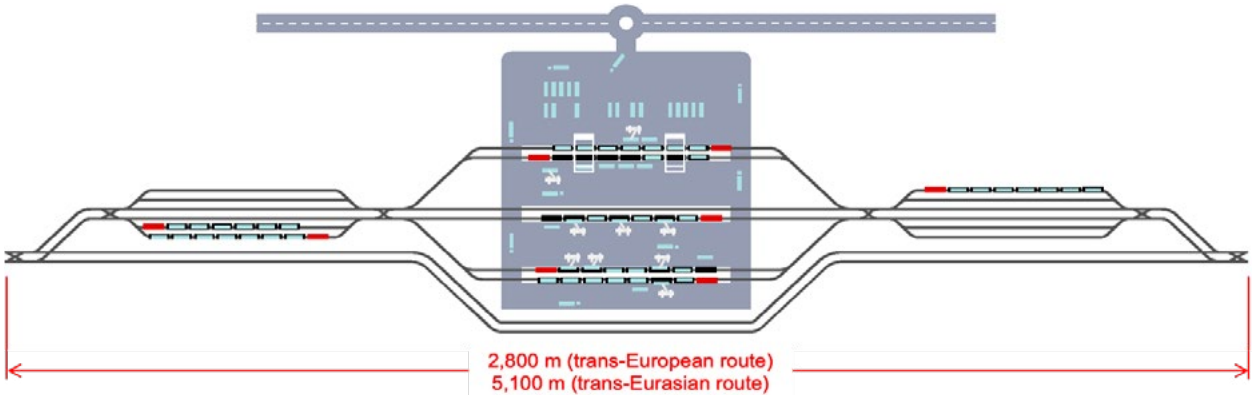
As the table shows, only 12 % of the terminals are pass-through and almost 90 % of the terminals are not suitable for trains of 740 m length. This is a significant handicap, because excessive shunting movements are required.

Figure 6
**Map of existing intermodal terminals in the EU**

*Source: FERRMED*

FERRMED proposes a new intermodal terminal concept as set out in the following figure.

Figure 7
**+ FIRRST terminals layout concept**




*Source: FERRMED*

The central part of the terminal is the area for loading/unloading tracks. The two buffers are only to park trains if the L/U track area is completely occupied. The length of each buffer is approximately 900 m. This distance, plus the L/U tracks section, allows trains to decelerate from 100 km/h to a complete stop and to accelerate from zero to 100 km/h (in order to create minimum disturbances on the main line).

## 10. SELECTION AND ANALYSIS OF MAIN INTERCONNECTION, BACK-UP AND FEEDER LINKS

The best existing routes to interconnect the intermodal terminals of the EU logistics hubs have been duly analysed including back-up and feeder routes.

The main data collected are:

- Train length
- Loading gauge
- ERTMS implementation
- International track gauge
- Number of tracks
- Electrification
- Train speed acceptance
- Track gradient
- Operation issues
- Rolling stock issues
- Link section traffic saturation (bottlenecks)

Adequate solutions to solve bottlenecks and any other constraints are duly identified.

# 11. FORECAST TRAFFIC SCENARIOS AND MODELLING OF ORIGIN-DESTINATION MATRICES

We have built a modelling tool based on Origin-Destination matrices by mode (road, rail, IWW) coming from the ETISplus project (officially used by and for DG MOVE).

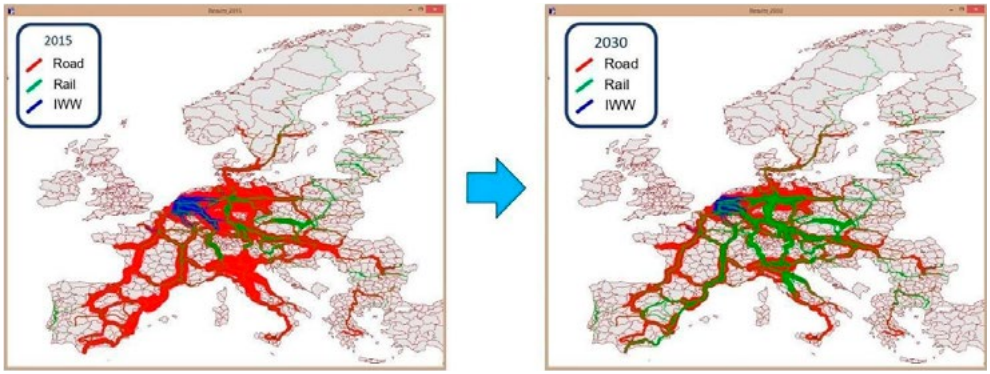
The ETISplus model has been recalibrated using the real transport volume data collected (2015/2018) by the FESDIT team.

To determine the improvements required to absorb traffic onto the railway, according to the EC (2011) White Paper on Transport Policy targets, four different scenarios are considered:

- **Mid term stagnant (2025)**
  - The target is **23 %** of tonne-km by rail on **average in Europe** and in each **individual country** (as much as possible).
- **Long term stagnant (2030)**
  - The target is **30 %** of tonne-km by rail on **average in Europe** and in each **individual country** (as much as possible).
- **Long term (2030) 20 % increase**
  - We start from the 2030 stagnant scenario
  - On top of it we add globally 20 % transport performance in all sections and modes
- **Long term (2030) +20 % with port traffic rebalancing**
  - We start from the 2030 +20 % scenario
  - The assumption that the increase of transport in the Mediterranean – Eurasian route in the future will be: 20 % on the Northern ports and 80 % on the Southern ports, until reaching approximately a 60 %/40 % share north/south.

The evolution of freight transport density by mode from 2015 to the 2030 stagnant scenario is clearly represented in the figure below.

Figure 8
**Evolution of freight transport density by mode in the EU**




*Source FERRMED traffic model*

Inflow+outflow volumes for all the main nodes in the EU, in every Member State, have been identified.

The following figures show the inflow+outflow volumes for NUTS 2 (France) and for NUTS 3 (Spain).

The inflow-outflow handled daily in thousands of tonnes, is as follows:

Figure 9
**Inflow+outflow volumes handled daily in French regions**
FRANCE (NUTS 2) - OVER 300 KM

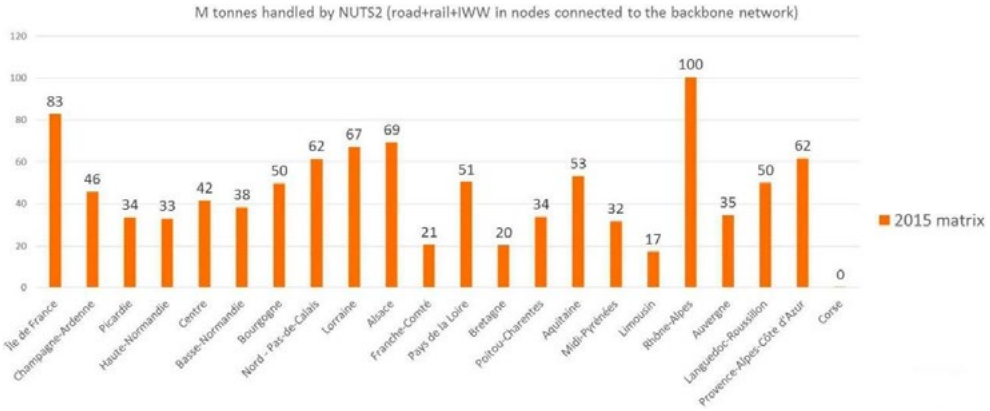
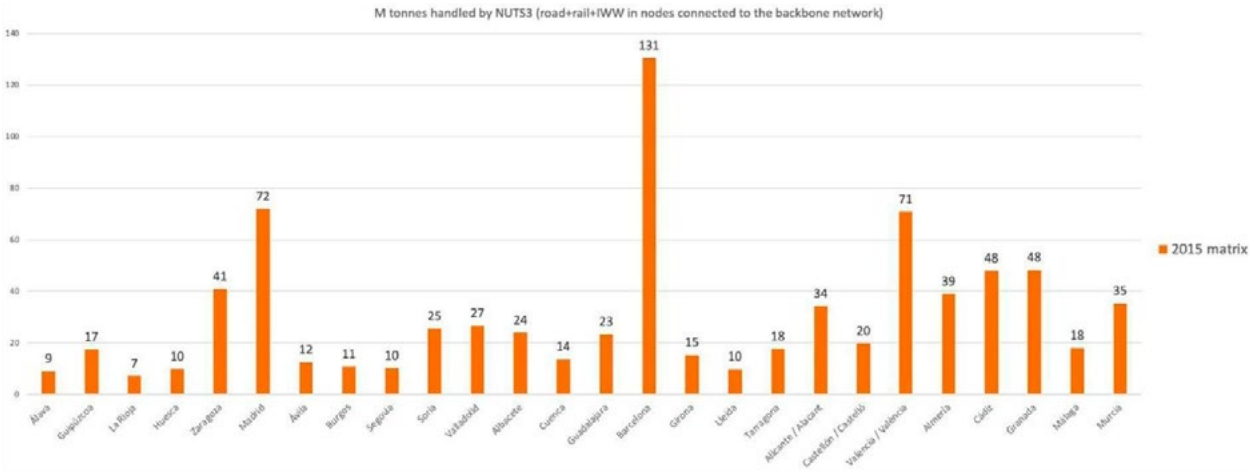



Figure 10
**Inflow-outflow handled daily in Spanish provinces**
SPAIN (NUTS 3) - OVER 300 KM



# 12. ANALYSIS OF THE IMPACT OF TRAFFIC SCENARIOS ON INTERMODAL TERMINALS AND INTERCONNECTION LINKS

## 12.1. Intermodal terminals

The global capacity of the existing terminals in all the EU nodes, by NUTS 2 or NUTS 3 (depending on the country and the inflow-outflow volumes), has been analysed considering the corresponding amount of freight volume, case by case, that must be transported by rail (30 % of the global transport performance rail + road) compared to current rail transport.

First of all, the present capacity of the existing terminals and sidings of manufacturing companies has been calculated (considering 3 shifts on 7 days/week).

We have assumed that point-to-point (ptp) traffic by railway (as it is mainly related to fully-loaded O/D trains) could be only increased by 10 % in central countries and by 30 % in peripheral countries.

The remaining unserved transport volume must be absorbed by the +FIRRST system (on-demand trains and a new intermodal terminal concept). For more details, see section 10 above.

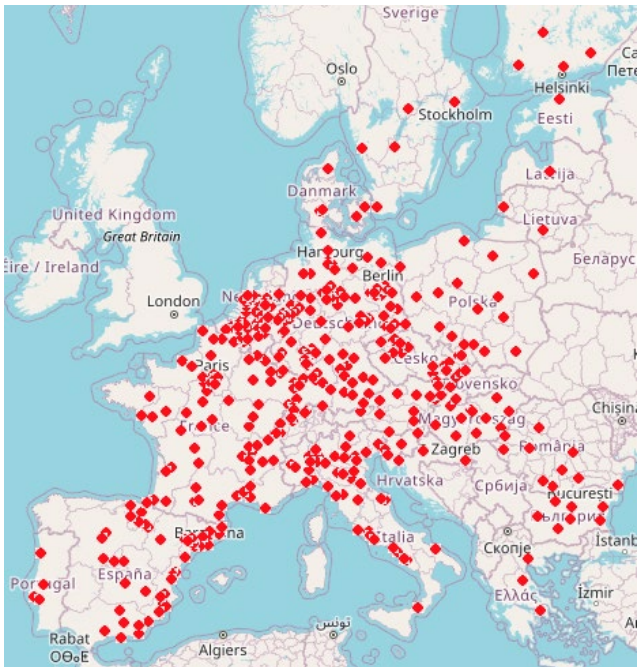
Table 3 shows the example of the Stuttgart node, in which 3 additional +FIRRST terminals are requested in order to absorb the forecast transport volumes for 2030 (values expressed in tonnes per day).

Table 3
**Capacity table of terminals for the Stuttgart region (figures in tonnes/day)**

| Terminal | Global traffic Rail + Road 2015 (30 %) | PTP Rail traffic 2015 | PTP | | FIRRST | | PTP Port Share scenario 60/40 | |
|---|---|---|---|---|---|---|---|---|
| | | | 2030 Rail traffic stagnant | 2030 Rail traffic + Δ20 % | 2030 stagnant | 2030 Δ20 % | PTP 2030 Δ20 % 60/40 | FIRRST 2030 Δ20 % 60/40 |
| STUTTGART | 58,800 | 26,000 | 28,600 | 34,320 | 30,200 | 36240 | 34,320 | 36,240 |
| Car terminal in Illingen | | | 1,000 | 1,000 | | | 1,000 | |
| DUSS container terminal in Kormwestheim (Stuttgart) | | | 25,760 | 25,760 | | | 25,760 | |
| DP World in Neckarhafen (Stuttgart) | | | 4,200 | 4,200 | | | 4,200 | |
| DUSS container terminal in Neckarhafen (Stuttgart) | | | 5,320 | 5,320 | | | 5,320 | |
| Neckarhafen in Stuttgart | | | 400 | 400 | | | 400 | |
| New +FIRRST mini terminal in Stuttgart | | | | | 800 | 800 | | 800 |
| New +FIRRST strategic hub semi-compact terminal in Heilbronn (A6) | | | | | 18,400 | 18,400 | | 18,400 |
| New +FIRRST strategic hub terminal between Mühlacker - Illingen | | | | | 18,400 | 18,400 | | 18,400 |
| DUSS trimodales container terminal in Heilbronn | | | 2,380 | 2,380 | | | 2,380 | |
| Südzucker in Heilbronn | | | 500 | 500 | | | 500 | |
| Audi car factory in Nekarsulm | | | 450 | 450 | | | 450 | |
| Container-Terminal Hafen Heilbronn | | | 2,380 | 2,380 | | | 2,380 | |
| Neckarhafen in Heilbronn | | | 650 | 650 | | | 650 | |
| **Total** | | | **43,040** | **43,040** | **37,600** | **37,600** | **43,040** | **37,600** |
| **Difference** | | | **14,440** | **8,720** | **7,400** | **1,360** | **8,720** | **1,360** |

The capacity analysis of the existing intermodal terminals in the EU shows that 425 additional new +FIRRST terminals are required across the EU (plus Switzerland) to accomplish a railway share of 30 % over distances of 300 km as stated in the EC (2011) White Paper on Transport Policy. See Figure 11 for locations of the proposed new terminals.

Figure 11
**Location of +FIRRST new terminals**




## 12.2. Interconnection links

Railway traffic growth has been calculated as follows:

- **Freight Trains**
  The number of trains is calculated according to the transport volume of the different scenarios, considering that in 2030 the average net tonnage carried by a train will be 700 tonnes (except in the countries that today have an average of 700 net tonnes or more: in these cases, we keep the present figures, as they are now, for 2030).

- **Passenger Trains**
  Traffic growth to 2030 is calculated according to the EC Staff working document (SWD)[5] estimation of a 24 % increase for conventional lines and 55 % in HSL.

5 Add this as a footnote:
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0005&from=EN

When the total railway traffic on a conventional line of two tracks is greater than 200-220 trains/day, we consider that there is a bottleneck. The corresponding actions to solve existing or forecast bottlenecks have been properly identified and evaluated.

Other key issues analysed are the loading gauge (P400/P410), ERTMS implementation and the availability of 740 m long trains. Suitable actions to implement these infrastructure characteristics have been also duly stated.

See below Table 4 for an example of the table used for the identification of bottlenecks.

Table 4
**Existing and forecast railway traffics**

| From | To | Km | N° of tracks | ACTUAL TRAFFIC 2015 | | | FORECAST TRAFFIC 2025 | | | FORECAST TRAFFIC 2030 | | | FORECAST TRAFFIC 2030 (Δ 20 %) | | | FORECAST TRAFFIC 2030 (Δ 20 %) + PORT REEQUILIBRIUM (60/40) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Pass-enger Trains / Day | Freight Trains / Day | Total trains / Day | Pass-enger Trains / Day | Freight Trains / Day | Total trains / Day | Pass-enger Trains / Day | Freight Trains / Day | Total trains / Day | Pass-enger Trains / Day | Freight Trains / Day | Total trains / Day | Pass-enger Trains / Day | Freight Trains / Day | Total trains / Day |
| Marseille | Miramas | 62.1 | 2 | 61 | 25 | **86** | 67 | 34 | **101** | 76 | 38 | **114** | 76 | 46 | **122** | 76 | 66 | **142** |
| Miramas | Tarascon | 38.5 | 2 | 61 | 28 | **89** | 67 | 29 | **97** | 76 | 30 | **106** | 76 | 36 | **112** | 76 | 63 | **138** |
| Tarascon | Avignon | 23.2 | 4 | 61 | 41 | **102** | 67 | 60 | **127** | 76 | 75 | **151** | 76 | 90 | **166** | 76 | 124 | **199** |
| Avignon | Valence | 127.0 | 4 | 35 | 41 | **76** | 39 | 75 | **113** | 43 | 100 | **144** | 43 | 121 | **164** | 43 | 153 | **197** |
| Valence | Lyon | 104.4 | 4 | 129 | 60 | **189** | 142 | 93 | **235** | 160 | 119 | **278** | 160 | 142 | **302** | 160 | 174 | **334** |
| Lyon | Macon | 71.0 | 4 | 72 | 72 | **144** | 79 | 96 | **175** | 89 | 117 | **206** | 89 | 140 | **229** | 89 | 168 | **258** |
| Lyon | Bourg en Bresse | 70.2 | 2 | 30 | 31 | **61** | 33 | 31 | **64** | 37 | 31 | **68** | 37 | 37 | **74** | 37 | 37 | **74** |
| Macon | Dijon | 125.0 | 4 | 96 | 78 | **174** | 106 | 105 | **210** | 119 | 129 | **248** | 119 | 155 | **274** | 119 | 182 | **301** |
| Bourg en Bresse | Dijon | 135.1 | 2 | 28 | 37 | **65** | 31 | 37 | **68** | 35 | 37 | **72** | 35 | 44 | **79** | 35 | 44 | **79** |
| Dijon | Damblain | 110.0 | 2 | 4 | 41 | **45** | 4 | 59 | **64** | 5 | 77 | **82** | 5 | 93 | **98** | 5 | 116 | **121** |
| Damblain | Nancy | 106.1 | 2 | 6 | 41 | **47** | 7 | 56 | **63** | 7 | 72 | **79** | 7 | 86 | **94** | 7 | 108 | **116** |
| Nancy | Metz | 55.2 | 4 | 89 | 55 | **144** | 98 | 70 | **168** | 110 | 88 | **198** | 110 | 105 | **215** | 110 | 121 | **232** |
| Metz | Thionville | 30.9 | 4 | 88 | 95 | **183** | 97 | 105 | **202** | 109 | 120 | **229** | 109 | 144 | **253** | 109 | 155 | **264** |
| Metz (CL + HSL) | Strasbourg (CL + HSL) | 155.2 | 4 | 12 | 29 | **41** | 13 | 31 | **44** | 15 | 34 | **48** | 15 | 40 | **55** | 15 | 45 | **60** |
| Strasbourg | **Basel (Swiss border)** | 137.0 | 2 | 93 | 29 | **122** | 102 | 31 | **133** | 115 | 32 | **147** | 115 | 38 | **154** | 115 | 44 | **159** |
| Metz | Longuyon | 64.5 | 4 | 4 | 20 | **24** | 4 | 20 | **25** | 5 | 21 | **26** | 5 | 26 | **31** | 5 | 27 | **31** |
| Perpignan | Narbonne | 66.2 | 2 | 56 | 25 | **81** | 62 | 60 | **122** | 69 | 78 | **147** | 69 | 93 | **163** | 69 | 128 | **197** |
| Narbonne | Montpeller | 96.5 | 2 | 85 | 38 | **123** | 94 | 70 | **164** | 105 | 91 | **196** | 105 | 109 | **215** | 105 | 150 | **255** |
| Montpellier | Nimes | 57.0 | 4 | 89 | 38 | **127** | 98 | 67 | **165** | 110 | 88 | **198** | 110 | 106 | **216** | 110 | 146 | **256** |
| Nimes HSL | Lyon HSL | 148.3 | 2 | 21 | 0 | **21** | 23 | 0 | **23** | 26 | 0 | **26** | 26 | 0 | **26** | 26 | 0 | **26** |
| Nimes | Tarascon | 28.1 | 4 | 49 | 42 | **91** | 54 | 77 | **131** | 61 | 102 | **163** | 61 | 123 | **184** | 61 | 163 | **224** |
| Valence | Grenoble | 97.0 | 2 | 45 | 4 | **49** | 50 | 4 | **54** | 56 | 4 | **60** | 56 | 5 | **61** | 56 | 5 | **61** |
| Grenoble | Montmélian | 48.3 | 2 | 45 | 4 | **49** | 50 | 4 | **54** | 56 | 4 | **60** | 56 | 5 | **61** | 56 | 5 | **61** |
| Lyon | Ambérieu | 54.0 | 2 | 67 | 35 | **102** | 74 | 41 | **115** | 83 | 48 | **131** | 83 | 57 | **141** | 83 | 65 | **148** |
| Ambérieu | Montmélian | 98.2 | 2 | 79 | 35 | **114** | 87 | 41 | **128** | 98 | 45 | **143** | 98 | 55 | **153** | 98 | 61 | **159** |
| **Portbou / Cerbère (Spanish border)** | Perpignan | 48.0 | 2 | 6 | 5 | **11** | 7 | 45 | **52** | 7 | 70 | **77** | 7 | 84 | **91** | 7 | 130 | **137** |
| Thionville | **Bettembourg (Luxembourg border)** | 27.2 | 2 | 144 | 76 | **220** | 158 | 76 | **234** | 179 | 76 | **255** | 179 | 91 | **270** | 179 | 91 | **270** |
| Dijon | Dole | 45.2 | 2 | 42 | 11 | 53 | 46 | 11 | 57 | 52 | 11 | 63 | 52 | 13 | 65 | 52 | 13 | 65 |

# 13. OPERATION AND ROLLING STOCK

## 13.1. FERRMED Fast, Flexible, Integrated Rail-Road System of Transport (+FIRRST)

### + FIRRST System - Introduction

The only way to achieve the EC targets of road freight transfer to rail is to incorporate a system that can move isolated semi-trailers, containers and swap-bodies (ILUs) from/to different destinations in a fast, flexible integrated rail-road system of transport. It is a novel way of organising intermodal rail-road transport in the form of "Mobility as a Service (MaaS). +FIRRST is a combined transport system aligned with the road (as the most flexible mode).

### Kind of trains provided

Point-to-Point (Ptp), Stop at Intermediate terminals (Sai) and Stop on Request (Sor).

### Network considered (first priority)

EU Backbone Network (Central plus Extended) and additional feeder links. Approx.: **27,000 km**.

### +FIRRST System requirements

- **A set of specific intelligent freight trains** (minimum length 740 m), with multipurpose wagons that can carry truck trailers, swap bodies and containers, connecting the EU strategic hubs' intermodal terminals and intermediate terminals in the interconnection links between hubs, throughout the EU Backbone Network.
- **A set of dual locomotives** (electric + electric batteries/diesel) able to carry freight trains of 1,800 – 2,000 t gross weight.
  Note: By letting the train coast while stopping in the terminal tracks, we can use normal locomotives (not dual) as well.
- **A set of "pass-through"** flexible intermodal terminals capable of fast loading/unloading truck trailers and/or containers onto and from freight trains throughout the EU Backbone Network.
- **An integrated rail-road freight flow control system** (in the ERTMS or similar framework) supported by a real time rolling planning concept.

### +FIRRST integrated freight control system

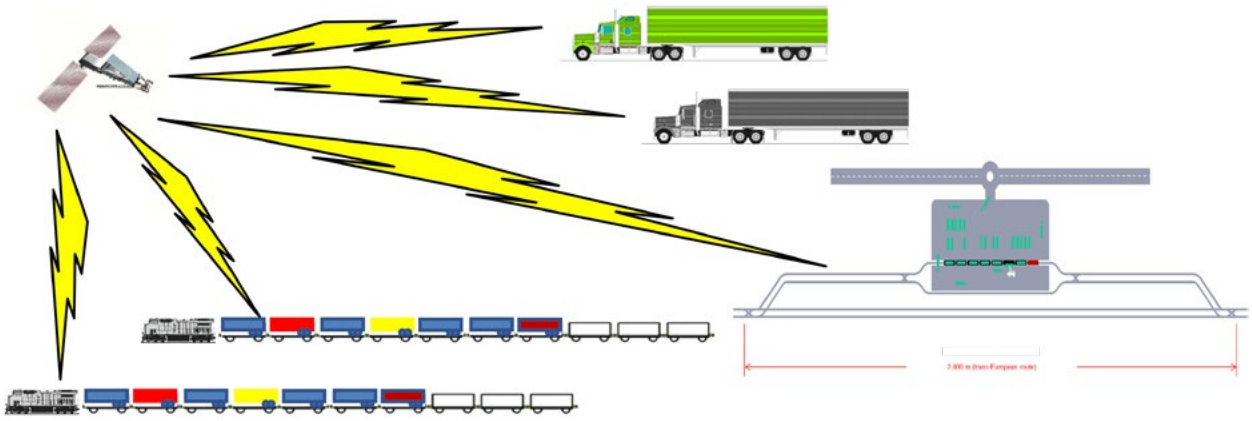
For an optimal functioning of the +FIRRST system, full control of the +FIRRST trains and HGVs in a single database is required. This will allow stops to be set case by case – in the intermediate terminals that are the origin/destination of trailers/containers transported or to be transported – in advance.

Several +FIRRST trains (Ptp, Sai and Sor) will be operative, in a framework of a real time rolling planning concept, interlinking the EU Socio-Economic Strategic Hubs (and related intermediate hubs) defined in the FERRMED Study.

The +FIRRST system will be applied in the Central and Extended EU Backbone Network (approx. 27,000 km).

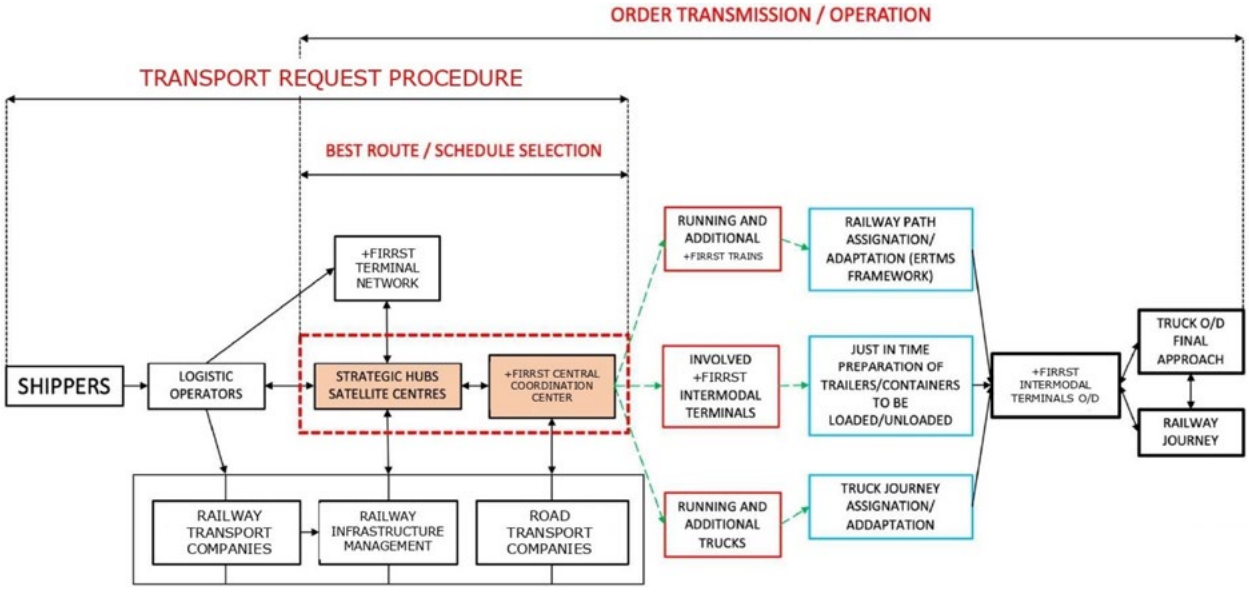
In summary, +FIRRST is a combined transport system at the service of the road (as the most flexible mode), with stops on request (from Ptp to Sal/Sor freight trains).

Figure 12
**Real time +FIRRST combined transport management**



The +FIRRST system operational procedure, step by step, is formally represented in the following workflow diagram.

Figure 13
**+FIRRST System operational procedure**

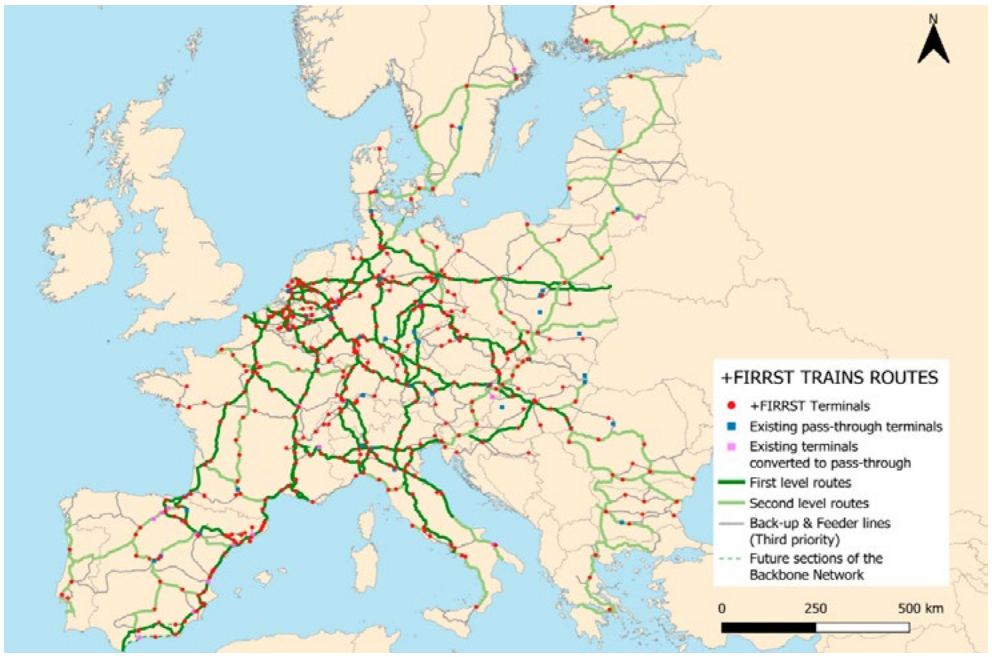


### +FIRRST train route definition

+FIRRST train routes will be developed in the corridors of the Central and Extended EU backbone network, linking the +FIRRST terminals and the existing conventional pass-through terminals.

The Origin/Destination of the trains will be the intermodal terminals of the main EU logistics hubs, with possible stops in intermediate terminals according to real time demand information.

Figure 14
**+FIRRST train routes in the EU (approach)**




## 13.2. Test of the +FIRRST system

The Study report suggests that tests of the +FIRRST system will be carried out in order to validate the recommendations below.

- **Key point**
  To select the appropriate TEN-T corridors, linking the suitable terminals of selected strategic socio-economic hubs.

- **Test conditions**
  – High freight transport volume in the sections of the selected corridor
  – Adequate number of existing pass-through intermodal terminals
  – +FIRRST terminals implemented (or simulated)
  – ERTMS (or similar) fully implemented
  – Loading gauge suitable for unaccompanied combined transport

– Intelligent trains including the availability of adequate locomotives and wagons
– Reinforcement of the role of the European Railway Agency (single European railway space); (at least in the corridors where the tests are to be performed)
– +FIRRST Central Coordination Centre operated by the European Agency for Railways (ERA), linked with Member State "satellite" centres

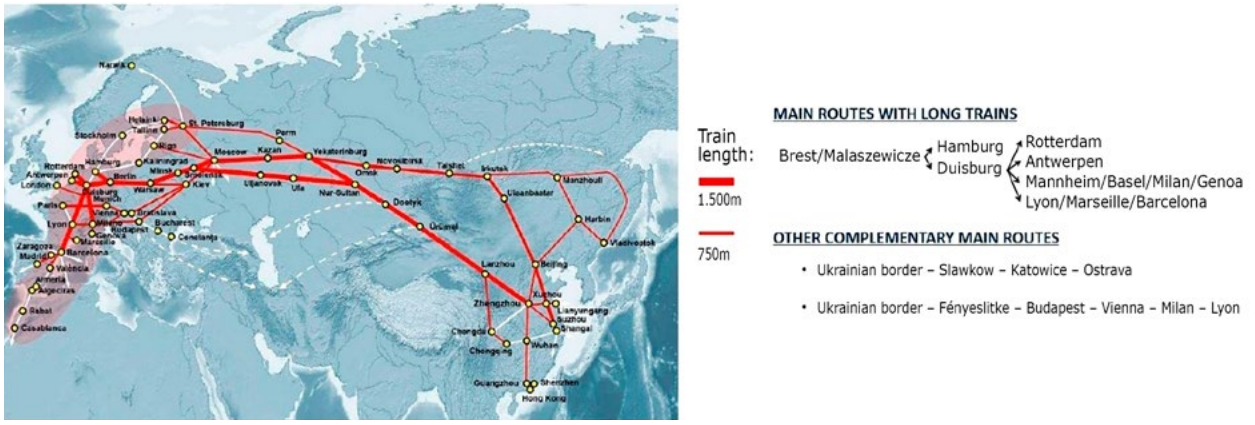
## 14. TRANS-EURASIAN MAIN RAILWAY NETWORK ENHANCEMENT

FERRMED proposes properly interlinking the EU and Chinese logistics strategic hubs.

In the case of the EU the main logistics hubs are: Duisburg, Hamburg, Rotterdam, Antwerpen, Frankfurt/Mannheim, Milan and Barcelona.

The basic interconnecting routes with 1,500 m long freight trains are duly marked on the map.

Figure 15
**Trans-Eurasian Main Routes**




The gradual evolution from 600 m to 1,500 m train length must be planned on the aforementioned routes.

See the image below of a test of 1,524 m long trains in France.

Long train test in France.
Freight trains with two engines and 72 wagons, 1,524 metres long and weighing 4,020 tonnes. Trial conducted in France between the towns of Sibelin and Nîmes in the first quarter of 2014. Project Marathon.

Figure 16
**Long train test in France**

Freight trains with two engines and 72 wagons, 1,524 metres long and weighing 4,020 tonnes. Trial conducted in France between the towns of Sibelin and Nîmes in the first quarter of 2014. Project Marathon.

# 15. SUMMARY OF PROPOSED ACTIONS IN THE EU

## 15.1. Summary of actions

The list of Member State actions identified and additional actions proposed by FERRMED is as follows:

### Summary of Member State actions identified

- 12,285 km of new lines
- 44,105 km of upgraded existing lines (ERTMS, P410 loading gauge implementation, 25kV AC, and adaptation of the lines for trains up to 740 m long)
- 46 upgraded existing and new terminals
- **Total: €481.9 B**

### Summary of FERRMED proposed additional actions

- 1,939 km of new lines
- 11,170 km of upgraded existing lines (international track gauge, ERTMS, P410 loading gauge implementation, 25 kV AC and adaptation of the lines for trains up to 740 m long)
- 425 new +FIRRST terminals
- New lines: €31.18 B
- Existing line upgrading: €26.89 B
- New terminals: €11.06 B
- Upgraded terminals: €570 M
- +FIRRST system required rolling stock:
  – Electric locomotives (dual types): 950 units, €3.99 B
  – Multipurpose freight wagons: 19,950 units, €3.59 B
- **Total: €77.27 B**

## 15.2. Examples of proposed actions

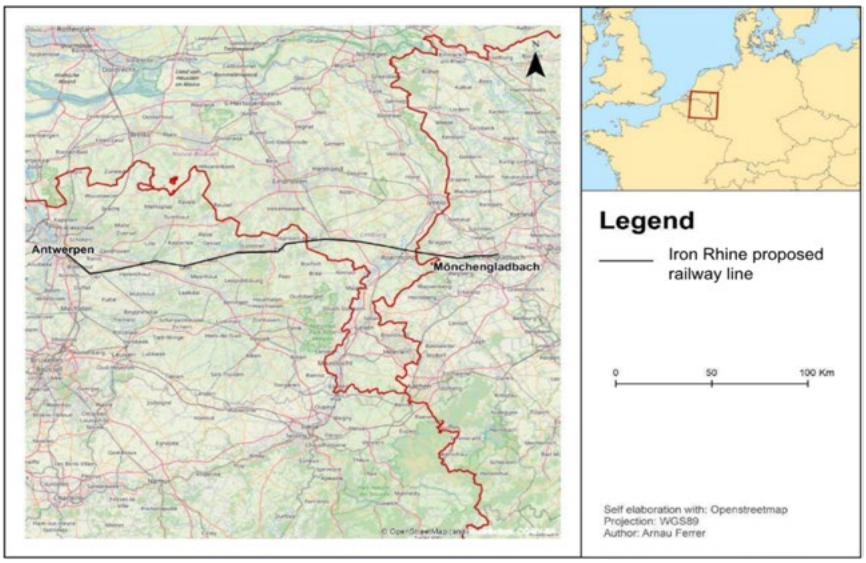
### 15.2.0.0.1. INTERMODAL TERMINALS

Figure 17
**+FIRRST Terminal in Dijon**
(Located in an former marshalling yard)


*Source: FERRMED, based on OSM and Eurostat cartographic layers*

### 15.2.0.0.2. INTERCONNECTION LINKS

Figure 18
**New Iron Rhine proposed railway line**




*Source: FERRMED, based on OSM and Eurostat cartographic layers*

## 16. SOCIO-ECONOMIC AND ENVIRONMENTAL ANALYSIS

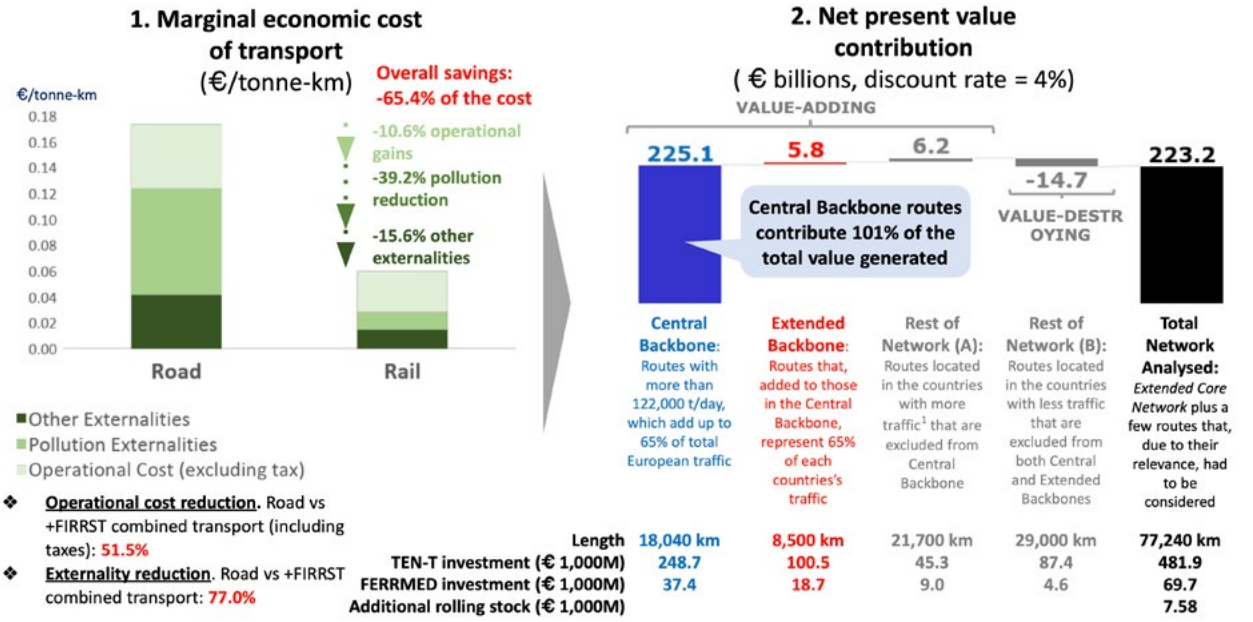
The purpose of this analysis is to assess the socio-economic and environmental impact of FERRMED's recommendations.

Its scope therefore encompasses analyses of:

- Operational efficiency improvements due to the recommended shift from road to combined transport
- Related externality cost reductions (e.g. pollution, CO2, etc.)
- Investment costs required to generate these benefits
- Economic Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR)
- Potential for private investment in +FIRRST terminals

The preliminary socio-economic impact assessment is as follows:

Figure 19
**Conclusions of the socio-economic evaluation in terms of NPV**




1. The countries within (A) are Austria, Belgium, Czech Republic, France, Germany, Luxembourg, Hungary, Italy, Netherlands, (Slovakia) and Switzerland.

# 17. MAIN CONCLUSIONS AND RECOMMENDATIONS

## 17.1. Main conclusions

Investing in 23 % of the EU Extended Core Network generates 101 % of net present value (NPV) contribution, socio-economically and environmentally.
Slightly positive NPVs in further 37 % of the network are offset by negative NPVs in the remaining 39 %.

- **Infrastructure**
  - **First priority** investments in the part of the Extended Core Network that supports 65 % of land freight transport performance (18,040 km, 23 %).
  - **Second priority** to be devoted to sections of peripheral Member States in which is concentrated 65 % of the land freight traffic of the country (8,500 km, 11 %).
  - **Third priority** in the rest of the Network (50,700 km, 66 %).
  - Investments gradually assigned according to transport volume of different sections.
  - **In summary:** To achieve the EC (2011) White Paper on Transport Policy targets, in addition to the actions already identified by EU Member States, some 1,939 km of new lines and 425 new intermodal terminals are required.

- **Operation**
  Gradual implementation of +FIRRST system for freight combined transport in the Central and Extended Backbone Network (c. 27,000 km).

- **Key achievements**
  - 52 % operational cost reduction
  - 77 % externality reduction

## 17.2. Recommendations

- **To the EC (DG MOVE)**
  To establish a "Priority Investment Plan for EU Integrated Land Freight Transport System" with highest priority where there is the most freight transport.
- **To the European Council and EP**
  To consent to the proposed "Priority Investment Plan for EU Integrated Land Freight Transport System".
- **To the Member States**
  To establish the corresponding national investment plans in accordance with the "Priority Investment Plan for EU Integrated Land Freight Transport System".
- **To the transport sector (logistics operators, transport operators, freight forwarders, …)**
  To engage in specifying/finalising and implementing +FIRRST.
- **To the EU key associations/federations**
  To agree on common guidelines, aiming for an integrated land freight transport system, with key associations (such as BUSINESS EUROPE, CER, CLECAT, ERFA, ESC, FERRMED, IRU, SME UNITED, UIRR…) to support the "Priority Investment Plan for EU Integrated Land Freight Transport System", including +FIRRST testing in preselected corridors.