Deliverable 7.2
Executive Summary

European rail freight corridors' role

1. Executive Summary

The Task 7.2 objective is the elaboration of the freight transport vision. Corridors are the tools for developing the core network up to 2030. In 2050 corridors are the network lanes in an EU comprehensive network where denser traffic and freight priorities are managed according to the "European rail network for competitive freight" law enforced in 2011.

Before elaborating the vision it is necessary to assess:

- The target volumes share of the Accessible Market
- The reasons for achieving the above target and any obstacles.

It is concluded that the Rail Market share targets are 200% growth by 2030 and 400% growth by 2050. The challenge is important but achievable:

- The demand exists when service quality, performances and reliability are aligned to road modality.
- The offer exists since the better utilization of existing infrastructures is envisaged in an industrialized approach.

Investments have to continue according to current EU strategy & plans towards 2030 and afterwards for achieving better performances and increased capacity. Investments have been assumed continuing with the past trend. Additional research efforts can play a significant role in continuing the innovation and supporting exploitation of available knowledge.

1.1 The vision on rail freight corridors

1.1.1 The vision statement

The European rail system economy is regaining its technological and industrial leadership position world-wide. The freight mobility vision in a European society overwhelmingly served by electrified rail encompasses few existing components which, once used in a systemic industrial scale and managed in a synchronized sequence, are capable of delivering performances far superior to their individual capabilities. The costs/service performances, enhanced as a result, are able to match all different traffic segments and are capable of attracting new traffic to rail freight. The technological innovations generate a big part of the needed capacity on the rail tracks.

The European rail network for competitive freight is fully operational, constituted by high productivity corridors integrated between themselves into strategic nodal points where traffic bundling is achieved for economies of scale generation. The nodal points on the rail corridors are the traffic multipliers. They collect freight in the traffic attraction zones allowing the production of longer, heavier and commercially faster trains to be managed. The cargo trains, be them intermodal, conventional, industrial or mixed, have priority in capacity allocation on this network where the most advanced ERTMS, signalling, technologies are deployed delivering intense track performances on management, control, frequency, safety and security. The new rail freight industrial scale reduces the operative service costs, increasing its competitive profile. All cargo trains running between nodes in the traffic attraction zones are regular and scheduled by a published timetable. Departure and arrival times are fixed according to the cargo availability on

departure and cargo needs at destination. Any disruption is managed by exception minimizing inconveniences.

The network accessibility is secured by the Nodal points. Some of them are the Union's sea ports securing the entry/exit of the maritime world trade lanes while others are located on the Union's overland borders for traffic interchanges on the two Trans-Siberian and Trans-Asia rail corridors. These strategic Nodal points are themselves linked to the inland network of, freight villages, hubs, dry ports, logistics centres, industry terminals, according to a hierarchy role. Smaller scale rail heads and terminals organized as spokes of larger hubs represent the accessible fingers for traffic collection and delivery into less busier zones. The rail network infrastructure bottlenecks identified in the past decades have all been completed delivering the needed capacity. The full core network is fully electrified with homogenous voltage and the different safety/signalling systems have been solved by ERTMS. The interoperability inside the core network affecting the technical standards the safety rules as well as the rolling stock used for the rail service performances is fully operable and implemented. The corridors management ownership and control, allow smart maintenance solutions reducing costs and idle time. The upgrading of lines and nodes in the European core network represented by the freight corridors has been accomplished. New operating schemes for 1500m long trains loading gauge P 400 and new trains composing technologies such as coupling trains/wagons based on automatic coupling, have been introduced as from 2020 considering new generations of freight trains and rolling stock.

The European wagon fleet is composed of new generation equipment having opened a completely new age in wagons technological construction. New shapes, lighter materials and components reduce the bogeys weight allowing higher carrying payloads, mitigated noise and reduced maintenance requirements. This made possible the extensive introduction of automatic coupling and electric wiring all along the trains. These technologies introduce a completely new dimension in wagons/trains performances both in braking, safety, security, capacity, weight and length opening up rail freight to colossal new markets such as perishable, reefer, fruits & vegetables, temperature controlled. The greater part is represented by flat units for intermodal transport while the remaining part is constituted by general purpose standardized and specialized wagons. The wagons fleet is based on a modular concept. The specialization is achieved through components or superstructures added to the standard wagons when needed. Advanced technologies are operating for securing both cargo protection, customs, sanitary controls, as well as track and trace. Electronic seals are applied at origin and checked at the entry points into the Union by relevant gates systems without human intervention. Technology boxes applied to wagons carrying not unitized special cargos are capable of giving information via GSMR of their position, travelling conditions temperature. These technology boxes can through axels sensors inform about cargo weight, wagons technical conditions avoiding shunting manoeuvres and preventing idle time. The equipment productivity, track and trace, safety monitoring and the maintenance conditions are greatly enhanced as a result. The seamless and economical viable implementation of this new generation wagons fleet is secured by a sustainable migration strategy based on European wide commitments to the new standards generating private investments.

The local authorities, in coordination with the central policy makers, have in the last decades implemented an effective urban and regional spatial territorial planning being aware, as they are, that the urban hubs constituted by city agglomerates are also logistics hubs. This territorial planning supports the European Mobility policies tending to a better utilization of the available space/resources. Higher productivity from new infrastructure investments delivers a more environmentally friendly freight mobility. Logistics services in rail equipped facilities contribute to traffic concentration and support new ways of serving distribution channels and reverse logistics. The logistics is represented by the consumers goods needed in the proximity shops/high street markets as well as by local productions together with classified waste management. The spatial planning is in charge of the strategic Nodes geographic location in the traffic attraction zones. Traffic industrialisation of both intermodal, conventional, industrial, or mixed longer faster and heavier trains is realised in these nodes. The nodes located in the centres/proximities of the traffic attraction zones become hubs for city logistics and last mile distribution effected with battery or hybrid low emission vehicles. The road congestion around urban areas and on the motorways is then reduced due to substantial freight shift to rail. The "zero mile" tendencies for local productions and for the rail system ability to be competitive also on shorter distances, support this evolution. The overall freight mobility system is more environment friendly, sustainable, accessible, congestion free and liquid.

The freight operators are managing traffic volumes in economies of scale. They compete for costs and services in the market place, but they cooperate if and when necessary for optimizing the available carrying capacity, avoiding empty running or unused trains space. Likewise in other transport modes, they achieve service integration by extensive collaborative models either through vertical or horizontal integration processes such as space sharing, slot sharing on regular scheduled trains deriving proportionate benefits and costs savings. When multiple services operating in competition are not possible, they are operated under proper authorities' control in a shared service concept. The resources management, competitiveness, service segmentation tailored to customers' needs, low costs guidance, ICT managed flows, real time, are the game drivers. The logistics service providers, outsourcers, orchestrators, transport organizers, 3rd and 4th party logistics are key actors in the traffic shift to rail optimisation having total neutrality. They search for the best available solution for their customers.

Innovative equipment, materials and minerals have reduced substantially the battery volumes for energy storage and conservation to a level unimaginable only few years back. These new capabilities have opened up a new horizon for energy recovery using it for shorter distances and last mile distribution, saving fossil fuels. The overall operating costs have been reduced as a result.

The European Rail System economy through accessibility, is capable of delivering to the users a door to door service experience with full value proposition to the customers.

The Rail freight personnel is qualified to cope with the new market challenges. The human resources are well taught on new technologies, marketing expertise, customer orientation, ICT and rail system capabilities having undergone years of specialized training during the years identified as the "rail freight rejuvenation decades". Complete new generations of young employees have entered the business giving it new life,

enthusiasm and credibility. They are the key actors of the rail freight success. There is a strategy in place in the rail freight industry for being capable of competing with other businesses in attracting well-educated staff. It is thanks to these new generations that rail freight has become the major resource: of a European Society overwhelmingly served by electrified rail.

1.1.2 The vision elements

The rail freight based mobility vision is composed by the following elements determining modal shift:

- The innovation components
- The resource: category drivers (corridors, network, management)
- The traffic segments drivers (intermodal, group of wagons, blocked trains)

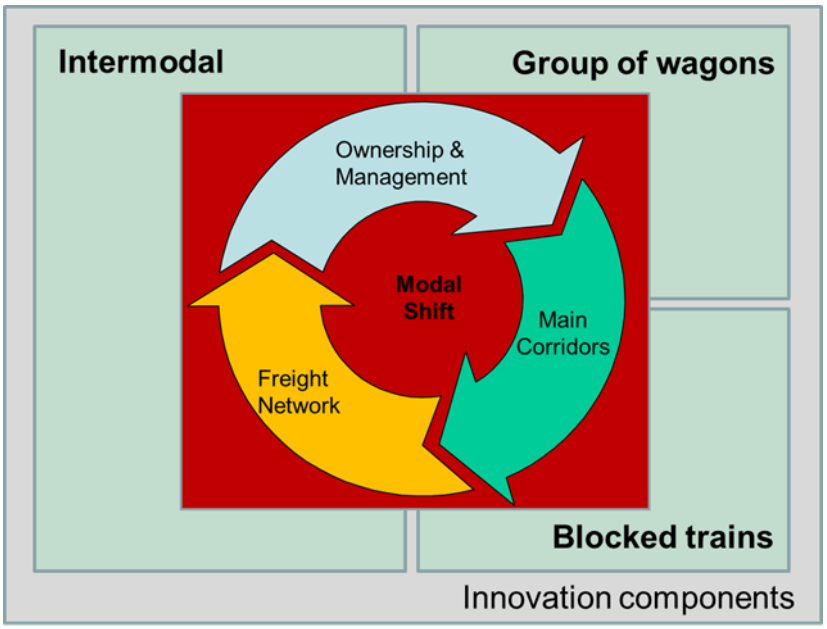

Figure 1: The mobility vision with its components

1.1.3 The innovation components and their contribution to the vision

The visioning of the future in a picture justifying decision making to be implemented at the 2050 target horizon, includes the systemic perspective of

- breakthrough innovations,
- continuity of evolutions.

While new breakthrough innovations are hard to forecast, it is more difficult to predict their level of implementation. In order to build the vision and elaborate on its components, it is necessary to rely on ideas and consolidated available experiences. One

has also to realize that ideas and proposals available today will be finally developed and ready for implementation may be in 5 to 10 years as past experiences of the railway area have shown. One has to mention that a regulation for a migration and implementation strategy is required. So even assuming fast-tracked development, the ideas of tomorrow will have limited chance to be realized on a big scale by 2050 due to European wide authorization and implementation. The adaptions of the existent railway infrastructures assume therefore greater relevance. The Rail ecosystem has such a long lead time to market that the improvements to be considered are already known or experimented.

The innovation categories are grouped as follows:

Infrastructure – EU plans and guidelines for developing the core network, of which corridors are key elements, have been already defined. The corridors called the "Connect Europe" infrastructure are in the implementation phase with completion time at different points in the next decade up to 2030. The related actions and investments measures are in place although the allocated funds might not be covering the entire plan. For each corridor a coordinator has been nominated making sure that all the efforts around the corridor implementation are fulfilled according to the planned target. Additional guidelines have been set regarding the extended network and its completion time line target is falling within the following two decades beyond 2030 arriving at 2050. Significant rail infrastructures like lines and nodes not yet in the planning phase cannot be operational by 2030. Likewise infrastructures not planned by 2030 cannot be operational by 2050 in the best case and by 2060 in the worst case. The logistic infrastructure associated to the European rail freight corridors includes as well terminals, rail ports and dry ports.

Rolling Stock – The complete renewal lead time in order to incorporate the available technology may take several decades. In fact the current fleet average age is more than 30 years which means that a substantial part of the fleet is more than 40 years of age. Even when considering that

- additional rolling stock is required for additional traffic,
- part of the rolling stock may be renewed/upgraded with extraordinary maintenance intervention or retrofitting,
- the new/renewed rolling stock is preferentially used in corridors/rail tracks with higher traffic.

It is hard to imagine a lead time shorter than 20-30 years for new wagons technology now available to be fully in place. The locomotives life-cycle is considered to be about 3 decades and sometimes more. The full replacement cannot be a fast operation either, but their employment in the network is differentiated and answering different criteria.

ICT technologies – The ICT implementation may have much shorter lead time, for local/departmental new solutions. Comprehensive applications, limited to a single company as an ERP, have a cycle time evaluated in 10-20 years. If the ICT scope covers industry comprehensive solutions such as standardization, the lead time required for full interoperability may be the same as for the infrastructure and the rolling stock fleet. Some ICT evolutions in terms of data properties and technical protocol standardization, are not limited to the transport industry but linked to more general use in economy and society. This may vary the process according to external drivers relating to the reference technology and the industry sector.

Business Model & Services – May include a number of innovations such as service/geography scope alliances, collaborative supply chain process, corridor companies, vertical integration, collaborative fleet management, capacity management optimization, leveraging new technology and market opportunities. New regulatory and

monitoring models should facilitate operators collaborating in certain activities and services while competing in other ones. Some new business models are already developing encouraging first step changes while a lot needs to be accomplished in order to renew the industry models in a way capable of maximizing the market evolution exploiting the industrialization potential.

People – The human element brings the knowledge and the energy for developing any innovation. In the next ten years many old timers will be retired. A complete rejuvenation will take place. The rail freight personnel need to become better qualified to cope with new technologies, marketing expertise, customer orientation, ICT and Rail system capabilities. Complete new generations of young employees have to enter the business overcoming the scepticism of old timers encrusted in bad practices, failures and pessimistic attitudes of the "it cannot be done" syndrome. Even if average age of people is high, time has to be measured in decades considering that a worker generation lasts 40 years. Training and other solutions can influence the evolution, but they are impacting differently the new generations of workers.

Regulation & Territory planning – Regulation and Planning have to move to an European wide coordinated approach, with an effective European mobility vision. A huge effort is required to systematically enrich implement harmonize existing and future guidelines. Within this cluster the role of European Authorities, Agencies and similar kind of players is bound to evolve. The shift of power from National Governments to European authorities and the process for finding adequate balancing in the mutual roles proved to be a very slow process. The speeding up of this evolution is difficult to predict.

1.1.4 The resources category drivers

The resources category drivers group together three elements:

- Corridors
- Freight Network
- Ownership & Management

Corridors are up to 2030 the way the EU Commission wants to concentrate investments and governance innovation in order to build up the expected core network. They represent the traffic lines also in 2050. They represent the lines where capacity is allocated with priority to freight according to the European Rail Network for Competitive Freight. The Investments develop capacity both in terms of new lines, bottlenecks, by passes and interoperable/automation technologies. The network key points are the entry points into the EU and the sea ports. The goods have to be captured there into the rail system in economy of scale shifting from road when inland waterways are not available. This concept creates a strong priority for developing rail connections and services to/from sea and dry ports. In this way the available capacity and services attractiveness is secured to the Rail system for industrialized performances at the entry points.

The sub topics segmented in corridors, entry points and inland nodes have been summarized in the following table with reference to impacts and feasibility (additional information is available in the full Task 7.2 Deliverable).

Description and other information					Feasibility		
Short description	Impact on rail share/target	Consequences /implications	Alternative solutions	Coordination & Interdependencies	Financial	Political	Technical/Technological
Corridors policy implementation including core network and extended network through Nodes	Consistent with EU rail policy for increasing capacity and performances . Generation of capacity is paramount for modal shift.	Productivity increase both on corridors and on rest of network. Recover the mission of an Asset based business model.	Dedicated freight infrastructure. Class road system. Maximize productivity of existing infrastructure.	Territory planning in terms of mobility. Modular approach in systems and interoperability.	Large investments already allocated with need to be continued. High impact. Public funding (see below for nodes).	Continuity to be assured in planning and execution. No burocratical barriers. EU governance.	Already decided: consistency with objectives and interoperable.
Entry point industrialization : Sea port and overland entry points	Maximize freight capturing in points where economy of scale exist already.	Modal shift fulfillment. Transport chain integration between different modalities (sea, rail). Service frequency.	Standardize rail track gauge.	Territory planning. Consistency with corridor development.	Local/targeted investments suited to specific objectives. Local dues possibilities. High impact.	From national to local scope and objective. Local communities involvement for congestion and sustainability.	Transfer technologies available. Evolution mechatronics technologies.
Inland Nodes industrialization including new hubs and terminals. Their location selection both on corridors or accessible to them. Comodality implementation . Technologies and mechatronics.	Freight bundling and freight multipliers implementing modal shift and comodality. Last mile distribution/collection and city logistics.	Point to point freight industrialization . Longer faster and heavier trains. Capacity generation, economy of scale generation, congestion and pollution abatement. 24 hours working cyde.	No alternative.	Territory planning. Consistency with corridor development.	Smaller scale single investments from private or PPP. Market driven logic on true costs and true profit. High impact, high return. Visibility and transparency of freight mobility policy.	Local planning for environment sustainability. Local benefit balance.	Transfer technologies available. Evolution mechatronics technologies.

Figure 2: Description & feasibility - Source: SPIDER PLUS project

Freight Network has to leverage the fully interoperable corridors capabilities developing a geographical infrastructures and services coverage consistent with the different territorial requirements. Inland terminals are able to play as traffic multipliers in a three level network concept. The first level is represented by the EU entry points and the interconnections between corridors playing as major gateways. The second level is represented by the major traffic attraction zones with their hubs, freight villages and other infrastructures serving geographical areas with high traffic generation. The third level is represented by relatively minor traffic areas with city hubs, smart hubs and industrial sidings.

All these three levels are easy accessible to their targeted traffic, properly interconnected and served with competitive Rail accesses realizing appropriate integration with other transport modes. The new generation of rolling stock allows industrialized performances.

The sub topics segmented in network development, interoperability and rolling stock have been summarized in the following table with reference to impacts and feasibility (additional information is available in the full Task 7.2 Deliverable).

Description and other information					Feasibility		
Short description	Impact on rail share/target	Consequences /implications	Alternative solutions	Coordination & Interdependencies	Financial	Political	Technical/Technological
Network concept development through Nodal classes. Classes defined according to types of Activity.	Door to door fulfillment. Every node class is instrumental to modal shift while coherent with transportation chain integration.	City logistics and last mile distribution. Corridor integration. Cost reduction through easier accessibility, industrialization. 24 hours working cycle.	No alternative.	Territory planning. Consistency with corridor development.	As described in nodes.	As described in nodes.	As described in nodes.
Effective Interoperability and Accesibility	OSS. Modular approach. Seamless flow in terms of total chain performance both physical, virtual and administrative.	Accelerating competition, accessibility, cross border, barriers/burocracy abatement, free circulation into EU rail freight space.	No alternative.	Interoperability is interfacing both physical and virtual network including rolling stock and ICT systems. Accesibility for comodal solutions.	No funding impact.	Standardization and harmonization processes. Uniformity in safety std. Cross border acceptability and EU accepted governance.	No technological barriers apart from Rail track gauge. Voltages are other constraints are self imposed delaying the transition.
Rolling stock adequacy.	Vital tool for capacity and service development induding industrialization.	Capacity and service development. Cost reduction through longer heavier and faster trains.	No alternative.	Convergence on modular approach and standardization.	Market driven logic on true costs and true profit. Driven by market need and rail freight modernization. Private investments of magnitude. High impact.	No major constraints	No technology gaps. Modernization and modular approach to be adopted. Innovative materials, electric lines through the train, couplings, brakes, designs are available.

Figure 3: Description & feasibility - Source: SPIDER PLUS project

Ownership & Management is the true ingredient for maximizing the investments. This is the key for delivering industrialised performances in a seamless transportation chain while leveraging available technological opportunities. The New "Single Rail Transport Area" management concept is developed and applied with appropriate progression and integration of pre-existing components. The management models have consolidated approaches to balance Passengers and Freight competition on infrastructure capacity and the Freight priority where appropriate.

In parallel to supranational governance model, the offer becomes international. The collaborative business model allows the different offer components to contribute in synergy for developing the market and satisfying the Demand. The Market is fully liberalized and monitored. The Infrastructure costs are fairly and transparently allocated to rail as well as to other modes in a way to recover investments.

The sub topics segmented in governance, industrialization, subsidy & charges, sustainability, management tools have been summarized in the following table with reference to impacts and feasibility (additional information is available in the full Task 7.2 Deliverable).

Description and other information					Feasibility		
Short description	Impact on rail share/target	Consequences /implications	Alternative solutions	Coordination & Interdependencies	Financial	Political	Technical/Technological
Single European uniform transport area	Coordinate traffic approach according to macro traffic attraction zones. Network governance coherent with traffic management requirements.	Capacity and service development. Cost/service competitiveness compared with other modes.Freight priorities on EU Rail Network for Competitive Freight.	Limitation to corridors	Interdependency with national infrastructure management and national rules and regulation.	No major constraints	EU central governance and regulation.	No technological constraints. Single ICT system to be integrated.
Rail freight industrialization	Vital tool for capacity optimization leveraging on scale factors achieving competitive performance on asset based business	Longer, faster and heavier trains.Significant operating cost reduction to be fulfilled through full utilization of train capacity.	No alternative.	Data management platform. Transport participant into the same loop. Cooperative business model.	Capacity generation reducing investments on new lines. Limited to additional rail overtaking sidings. Low impact.	No major constraints	No technological constraints. ERTMS implementation. Adaptation and integration of existing components.
True cost & true profit	Subsidies in favor of other modes distort competition. Harmonized charging on level playing field favor rail freight share.	Clear and transparent guidance on competitive game.	No alternative.	None specific.	Limed impact. Longer lead time.	Consistency with mobility policy objectives.	No constraints.
Transport sustainability	Sustainability requirements favor modal shift.	Energy saving GHG emissions, carbon footprint, less dependence on fossil fuels.	No alternative.	Innovations in other sectors.	Benefits from other sectors innovations. Low impact. Private and public.	No constraints.	Application of innovations from other sectors.
Management tools: ICT, competences & training, collaboration & new business models	New technologies & enabling ICT management tools/systems, support accessibility, collaboration between market actors making rail more attractive.	Seamless information flow adherent to physical flow. Real time traffic management. Planning and Just In Sequence. Low cost society principle.	No alternative.	Data management platform. Cooperative approach.	Investments in ICT have a pay back shorter than other rail investments. Medium impact. Public, private and PPP. Training activities favor generation change.	Commercial information barrier.	Technologies progress extremely fast. The way to manage them is by modular approach.

Figure 4: Description & feasibility - Source: SPIDER PLUS project

1.1.5 The traffic segments' drivers

The traffic category drivers are elaborated in three segments:

- Intermodal
- Single/group of wagons
- Blocked trains

Intermodal transport is the dominant market segment. It is more consistent with the market demand flexibility and the offer capability to industrializing performances.

The following chart with market share per traffic segment is the result of a number of inputs processed by the project team on qualitative basis.

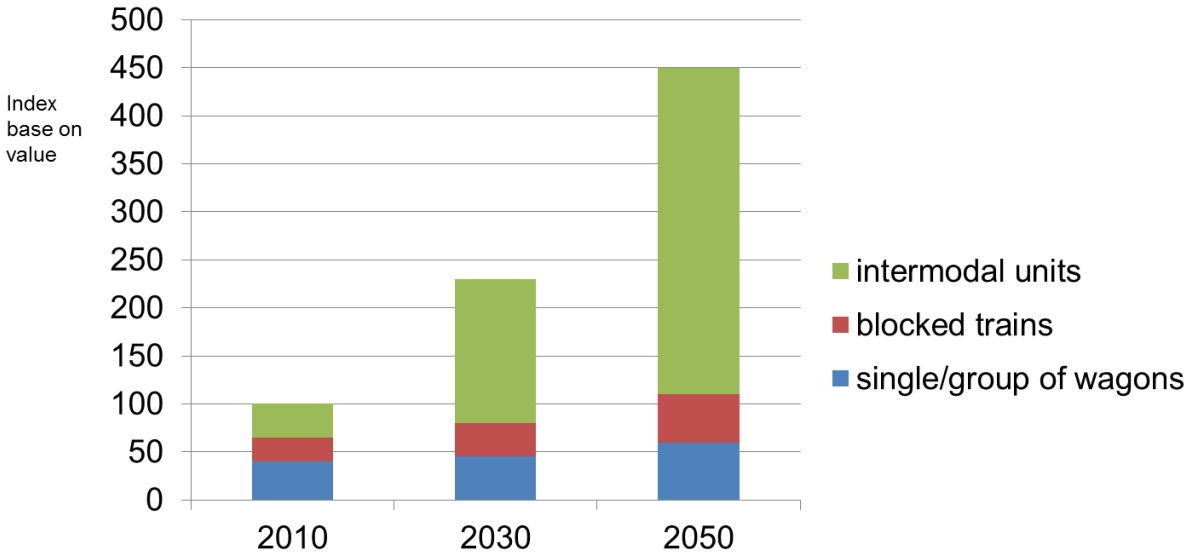

Figure 5: Share by production scheme – Source: Eurostat

Intermodal

Intermodal units are entering into the network in

- the entry ports and loaded on trains with the support of a dry port when needed immediately after ship unloading,
- in the inland terminal closest to origin with automatic check at entry gate in case of entry in a secondary terminal.

All administrative documentation is pre-prepared and electronically shared between all participant actors to the traffic flow at booking or before arrival of unit load at the entry points. Simplified rail transit customs procedures and security when appropriate are managed in a way requiring physical stop only by exceptions. Unit loads are automatically recognized in nodes due to electronic tagging and managed accordingly for internal handling and for monitoring inside the node and along the traffic flow. While booking, the full tracing is outlined and confirmed according to available capacity and operating models. Tracking is available to shippers and all participant actors, by flow segment and responsibility, ever since the entry up to the exit of the unit to/from the network. Quality performances are defined in the market and are certified by independent agencies. Forecasting and planning capability of shippers are monitored in the transport chain. Service levels are segmented according to shippers' requirements and mutual commitments between operators. Pricing is related to volume commitments contributing to overall efficiency.

Intermodal units are moved in the network in dedicated or mixed trains according to traffic design and schedule, with seamless electronic transfer of responsibility between collaborating players at given physical or virtual gates. Wagons join trains by traffic segments linked in multi hubs model, including direct lines between mayor nodes whenever possible. Wagons are designed for automatic coupling and decoupling and simultaneous automatic braking control. New traffic development and its balancing facilitates better use of time slots and in general of capacity. Wagon design allows to accommodate intermodal units in a modular concept avoiding waste of capacity. Preventive maintenance concepts are regularly applied to wagons. In particular preventive monitoring of axle bearing condition aims at handling the problem with axle

box detection, evidencing Source: of wheel flats, track damages and services disruption. Within individual traffic segments, wagons travel as part of blocked trains. Specialized lines and nodes are operated in transparent and consistent models with full interoperability. Mechatronics supports efficient, quick and timely handling of unit load and shunting. Unit load handling can contribute to operating trains composition and reconfiguration in intermediate nodes in alternative to wagons handling/shunting. Manoeuvring in terminals is operated timely and efficiently.

The "intermodal unit" definition includes new wagon concepts addressing the last mile distribution. They are able to capture market share in the smaller sidings where door-to-door services can substitute road transport.

Each operator can provide different services. Specialization in single service segments/locations and vertical/horizontal integration are both applied successfully with conflicts managed according to the operator's consolidated experience. Competition and collaboration are managed in the interest of the overall offer competitiveness and scale exploitation. One Stop Shop (OSS) and Single Point of Contact (SPC) are combined with Concurrent Planning. The multi-channel distribution approach is achieved through cooperation with all the key actors in the Rail transport chain such as forwarding agents, MTOs, logistics operators, integrators, consolidators, etc. Such cooperation is based on economic interests through the sharing of the benefits deriving from economy of scale generation and the traffic industrialisation. Revenues are shared between operators collaborating to the traffic flow according to principles of cost transparency and value brought into it. Shippers, in their role of customers can decide/influence value allocation and selection of actors contributing to the flow of their goods. The European agencies and monitoring systems support new business model preventing distortion occurrences.

Assets such as rolling stock, intermodal unit, both specific and for general purpose, are fully interoperable being designed according to transparent technical specification for interoperability (TSIs) and telematics applications for freight subsystems (TAF TSIs). Assets are provided by specialized companies on a pay to use basis or are owned by the operators themselves only if fully internally utilized. Authorisation and certification for the interoperable European railway system is fast, transparent, efficient and is undertaken in an economic manner within an optimised process within the EU. Virtual certification systems are common practice for new rolling stock. Asset design is able to facilitate filling in/out the different type of units and matching up/downstream handling equipment. Assets are designed according to sustainability principles in the perspective of minimizing the Total Cost of Ownership for their whole lifecycle. Shippers, logistics operators, transport operators and asset owners, collaborate for best asset utilization and its reduced incidence in the cost chain. Empty assets are tracked and maintained according to principles of maximum availability and minimum empty movements.

From all the above considerations, an effort has been made to synthesize in a chart a number of identified elements which are relevant for achieving the Corridors efficiency and effectiveness for fulfilling the vision. These elements have been grouped for simplification in coherent families. For each family a number of actions are in progress up to 2030. The actions are set to produce operational results capable of fulfilling the vision. These results have different impacts on Capacity and Performances. The intensity level of such impacts are ricocheting immediately on the future rail system ability of absorbing and moving the traffic volumes set out by the European Commission in the White Paper, quantified in the SPIDER PLUS Work Packages.

elements	actions up to 2030 in progress	results	impacts on capacity	impacts on performan.
new infrastructures (tunnel, by passes, connections) bottlenecks elimination electrification, class upgrading of old lines sea port rail connectivity gauge C (4 mt high) modular technical standardization	Gothard, Monte Ceneri, Monte Olimpino, Loetschberg II phase, III valico Genova, Betuwe to Oberhausen, Rastatt by pass, Mulheim to Basel 70% completed, Knappenrode Horka Wegliniec, Berlin Poznan near completion, Oderbruche Bridge in service, Iron Rhine from Antwerp to Ruhr planned, Med Corridor to Spain completed 2016, Brenner Valle Susa, Parma La Spezia, Genova XX Miglia, ...	total corridors operational compatibility + std gauge C (4 mt high), energy savings	↑↑↑	↑↑↑
East interchanges with Tran Siberian and Trans Asian in industrial scale	entry points into EU such as Brest to Poland & Cop to Hungary to be industrialized + tunnel to	connectivity & accessibility to/from East in industrial scale	↑↑	↑↑
accessibility and nodes integration co-modal accessibility new sidings to lines and industrial park	geographical positioning of hubs & nodes in the traffic attraction zones for accessibility & relay to last mile distribution	connectivity & accessibility to/from traffic attraction zones	↑↑	↑↑
EU rail network for competitive freight interoperability ERTMS level 3	network governance & operative standardization in core network & in progress to comprehensive network, new ERTMS implementation in all core network	cross border acceptability, safety & security standardization, rolling stock acceptability	↑↑	↑↑
sea port multimodal competitive organization longer, commercially faster & heavier trains hubs, freight villages, ind parks, dry ports capacity of hubs compatible with corridor capacity door to door transport industrialization city hubs & last mile	aligning sea/dry ports, hubs & terminals to industrial scale coherent with maritime & overland traffic volumes with terminals connected to city logistics platforms	steady/reliable capacity management on the network in a door to door experience	↑↑	↑↑
Galileo ICT management systems ICT operational trains capacity management real time information for emergency response common information highway platform e-freight, e-customs, e-seals, RFID technology box on wagon network governance OSS	combination of physical & virtual network & ability to manage & govern the entire logistic universe both information, people, units & traffic flows	capacity of managing the entire supply chain in DTD in real time, in safe, seameless and synchro mobility. The services are in total quality	↑↑	↑↑
balancing production requirements with commercial needs multichannel distribution approach offer driven business model integrated/cooperative supply chain planning operators cooperative approach competition/liberalization traffic flows knowledge and accessible market potential short distance offerings	door to door offerings with intermodal centric logistics, recognition of customer needs, marketing driven society, identification of target markets, selling via multichannel, price transparency	e-economy, e-tools, B2B, e-accessibility, co-loading trains agreements, regained competiveness on short distances	↑	↑↑
rolling stock tech, design and materials braking system automatic coupling wagons electric wire predictive maintenance robotics, mechatronics, in transfer tech hybrid locomotives momentum traction in terminal	new rolling stock generation suited to customers' needs, new wagons operational performances, modular and harmonized characteristics suitable to robotics and mechatronics, maximizing handling and loadability	new market openings, new enabling facilities, new customers' needs satisfied, new competitive profile towards market & competing modes, noise abatement	↑↑	↑↑
operators international EU wide focus space planning logistic engineering working cycle H24 T7	New logistics planning & organization, EU wide Rail freight space, Working cycle compatible to Sea Ports & cargo handling on 24h 365days/Y, combination of time with space	productivity increase, elimination of transport interruptions, logistic system alignment, reduced space consumption, vertical culture	↑↑	↑↑
environment and sustainability energy saving safety and security quiet rail	utilize environmental friendly transport means & technologies based on human protection & energy conservation	reduced congestion & pollution, fossil fuel consumption, reduced accidents and noise	↑	↑
personnel qualification personnel training	trained railfreigh personnel to highly qualified skills according to specific areas of influence	higher accuracy, safety & security	↑	↑

Figure 6: Elements, actions and results; one arrow= medium; two arrows = high (>40% capacity, >5% performances); three arrows = very high (>60% capacity, >10% performances) – Source: SPIDER PLUS project

Single wagons/group of wagons

The wagons, either traffic specific or multipurpose, are entering the network in industrial areas connected with rail. Loads are dealt with inland terminal closest to origin/destination where goods are stored and/or value added activities are performed. Wagons exit the network with the same principles they enter. The single wagons or group of wagons loads are only capable of competing with the single truck load in selected market segments. Wagon rental, for most standard design, is accessible without the need of long term commitment to obtain competitive availability and renting prices. Operators, freight forwarders and end customers can track and trace the wagon throughout the supply chain. Wagon technology is complemented by marshalling technology for directing automatically wagons groups to suitable nodes and hubs.

The handling of single wagons in gigantic marshalling yards is limited to sites where existent European SWL-hubs are still in operation. The future role of this type of production has to be secured by development of new operational schemes in conjunction with the intermodal rail freight services. Private sidings are more and more complemented by Rail industrial parks where a variety of value added logistics operations are performed. Over all SWL had in the past a more or less decreasing share in the European railway area. There are still actions needed to revitalize this sector. However a limited contribution of SWL to the targeted volumes for shift to rail is expected.

The innovation driven by intermodal traffic brings benefit also to SWL.

Blocked trains, either traffic specific or multipurpose, include two different profiles:

- dedicated full trains within industrial facilities and/or connecting sea ports and other nodes
- full trains composed with intermodal units and/or single wagons, travelling in segment of the network as full trains since no action is required for modifying the original composition.

Dedicated blocked trains may provide specific services for transportation of massive flows between private sidings of the relating industries under specific conditions with reduced interoperability. Looking at the expected economic development transport of raw materials and basic commodities is not going to grow substantially in Europe in the next decades. Thus the contribution of this rail freight segment to the targeted shift to rail is also limited.

The following picture reproduces the individual elements relevant for the corridors vision components contained in the preceding figure. Here the guiding logic is to identify how the elements influence the three traffic segments, which are set to produce the volumes objectives contained in the White Paper for 2030 and 2050.

elements	intermodal	single/group of wagons	blocked trains
new infrastructures (tunnel, by passes, connections)	x	x	x
bottlenecks elimination	x	x	x
electrification, class upgrading of old lines	x	x	x
sea port rail connectivity	x	x	x
gauge C (4 mt high)	x	x	x
modular technical standardization	x	x	x
East interchanges with Tran Siberian and Trans Asian in industrial scale	x	x	x
accessibility and nodes integration	x	x	x
co-modal accessibility	x		
new sidings to lines and industrial park	x	x	x
EU rail network for competitive freight	x	x	x
interoperability	x	x	x
ERTMS level 3	x	x	x
sea port multimodal competitive organization	x	x	x
longer, commercially faster & heavier trains	x	x	x
hubs, freight villages, ind parks, dry ports	x	x	x
capacity of hubs compatible with corridor capacity	x	x	x
door to door transport industrialization	x		
city hubs & last mile	x		
Galileo	x	x	x
ICT management systems	x	x	x
ICT operational trains capacity management	x	x	x
real time information for emergency response	x	x	x
common information highway platform	x	x	x
technology box on wagon	x	x	x
e-freight, e-customs, e-seals, RFID	x	x	x
network governance	x	x	x
OSS	x	x	x
balancing production requirements with commercial needs	x	x	x
multichannel distribution approach	x	x	x
offer driven business model	x	x	x
integrated/cooperative supply chain planning	x	x	x
operators cooperative approach	x	x	x
competition/liberalization	x	x	x
traffic flows knowledge and accessible market potential	x	x	x
short distance offerings	x		x
rolling stock technologies, design and materials	x	x	x
braking system	x	x	x
automatic coupling	x	x	x
wagons electric wire	x	x	x
predictive maintenance	x	x	x
robotics, mechatronics, in transfer technologies	x		
hybrid locomotives	x	x	x
momentum traction in terminal	x	x	x
operators international EU wide focus	x	x	x
space planning	x		
logistic engineering	x	x	x
working cycle H24 T7	x	x	x
environment and sustainability	x	x	x
energy saving	x	x	x
safety and security	x	x	x
quiet rail	x	x	x
personnel qualification	x	x	x
personnel training	x	x	x

Figure 7: Elements assigned to production scheme - Source: SPIDER PLUS project

1.2 Destination mobility 2050

The vision has been developed along the path already outlined in WP5 where preliminary action areas have been identified in order to fill the gaps.

In WP5 the action areas have been segmented in:

- Access,
- Shift,
- Improve,

and this initial segmentation has been continued in summarizing the vision 2050.

The vision has been elaborated leveraging momentum created by the drivers of change about which comprehensive identification and analysis has been developed in WP6. The changes are slow and complex for a system as articulated as the Rail ecosystem is. So the likelihood that the vision can be realized is much larger if the considered elements are not only consistent with needs identified by industry experts, but are in line with more general drivers of change for the entire society.

Action area	Gaps (WP5)	Drivers of change (WP6)	Vision 2050 (WP7)
Access	Bottlenecks & Interconnections	Vertical cities, Decongestion, Multi-channel/internet retail, Urban logistics center, New sourcing strategies and local manufacturing, International trade, Larger container ships, 'Nodes centric' logistics	Multilevel network, Nodes as traffic catalyst and multipliers, Distribution approach as Close to port-close to market, Accessibility and connectivity from where to where, Traffic attraction zones, Space with time
	Interoperability	Modular design, Standardization, Simplification, Safety STD	Cross border, Industry standards, Compatibility & acceptability, Modular Concept
	Regulatory frame &	Accompanying measures, Migration strategies, Environmental awareness	Corridors/network planning & governance, Sustainability, Investments prioritization
Shift	Offering structure & Loading factor	Horizontal collaboration, Maximization of resources, Efficient and reliable wagon-group bundling systems	Capacity management, Collaborative business model, Management tools, Logistic engineering, Availability of differentiating offerings
	Sustainable solutions/ Renewable sources	Fossil fuels dependency reduction, Renewable energies	Reduced congestion, Minimized carbon foot print, Pay as you go, Energy storage, Nano technologies, Syncro mobility, Just in sequence
Improve	Effectiveness & Service Quality	ICT & Satellite communications: Real time and seamless information, Emergency response, Automated guided devices, Wagons design & technologies, Preventive maintenance, Service industrialization, Geographical nodal strategy	New rolling stock generation, ICT embedded in Rail solutions, Industrialized models, Value chain, Fully efficient service segments: intermodality, industrial trains, group of wagons, Syncro mobility & DTD seamless mobility, Multilevel network

Figure 8: Interaction between work packages – Source: SPIDER PLUS project

The vision proposed here is not only regarding what to do, already described in the EU White Paper, such as the share of rail in future freight mobility, but it is addressing how to fulfil it. The vision incorporates a number of elements which are already in the industry knowledge or have been successfully experimented. As a matter of fact there is no knowledge gap identified in WP5. On the contrary a strong need to exploit logistics solutions is needed. Due to long lead time for implementing innovations because of

industry complexity, this effort requires more than ten years and up to 2030. Additional innovations technologies and infrastructures have been in the meantime identified. Their implementation requires most of the following two decades. Their impact is likely to materialize by 2050

Since they play in a systemic concept the same elements may contribute to fill more than a single gap. The vision elements, linked to the gaps they contribute to fill, can be summarized as follow:

Bottlenecks & interconnections – The multilevel network allows services and interconnections with hierarchical level in order to support industrialized services. Nodes play as traffic catalyst and multipliers serving traffic attraction zones. Intercontinental trade develops distribution organizations as "close to the port and close to the market". The reverse for outgoing traffic. Accessibility and connectivity is provided "from where to where" in a seamless DTD approach. Space is conjugated with time dimension. The considered drivers of change facilitating this evolution are the traffic decongestion and the infrastructure centrality in vertical cities.

Interoperability – The cross-border seamless interoperable traffic flows overcome former national barriers. True European industry standards assure interoperable mobility solutions and their potential scalability. Compatibility with existing investments & Europe wide acceptability are considered while adopting standards and defining time windows for their upgrading. The modular concept is the way for exploiting interoperability.

The considered drivers of change facilitating this evolution are standardization and simplification for safety and efficiency with modular design for HW and SW solutions.

Regulatory frame & governance – The corridors/network planning & governance are managed in coordination between territory and transportation. Sustainability orients regulations and the way to apply them. Investments prioritization is decided according to priorities. The considered drivers of change facilitating this evolution are the regulatory frame in a true European direction and the sustainability driver supported by mitigation strategies.

Offering structure & loading factor – The capacity management of all resources is a major driver of industrial efficiency especially in the perspective of longer trains where the available capacity filling is mandatory. Collaborative business models are applied with appropriate sharing of business results. New Management tools consistent with the new operational industrialized and collaborative models support the operations beyond company boundaries. Logistics engineering allows exploiting value chain potential and capturing new markets. Differentiated offerings are available in a competitive market.

The considered drivers of change facilitating this evolution are the new business models leveraging collaboration while maximizing the resources utilization.

Sustainable solutions/Renewable sources – Congestion is reduced especially in metropolitan areas. Carbon foot print is minimized because of technologies able to reduce consumption. Pay as you go models allow to better manage fixed cost. Energy storage technologies support energy recovery and its use for reducing consumption peaks and facilitating operations. Nano technologies are supporting new rail applications. Synchro mobility and Just in Sequence models contribute to distress the supply chain and build new trade-off between inventory and transportation. The considered drivers of change facilitating this evolution are the environmental lifestyles largely applied also in business.

Effectiveness & Service Quality – New rolling stock generation supports an industrialized model. ICT is embedded in Rail solutions for a number of different applications. Industrialized models are continuously monitored versus performances including new operational approaches such as Synchro mobility & DTD seamless mobility.

Value chain mirrors cost chain in a wide business perspective. All rail service segments are managed in full efficiency. Intermodality, industrial trains, group of wagons and a multilevel network support differentiated competitive performances in an overall traffic flow perspective.

The considered drivers of change facilitating this evolution are the real time information and the spread of ICT applications. Service industrialisation is favoured by general Transport evolution towards asset-based business models as well as low cost society.

Although the road map is in charge of a different work package, an implementation principle may be anticipated. While capacity and performance are both important for the modal shift, priority has to be dedicated to service performances since the demand cannot be attracted without substantial upgrading of services offered to the customers.

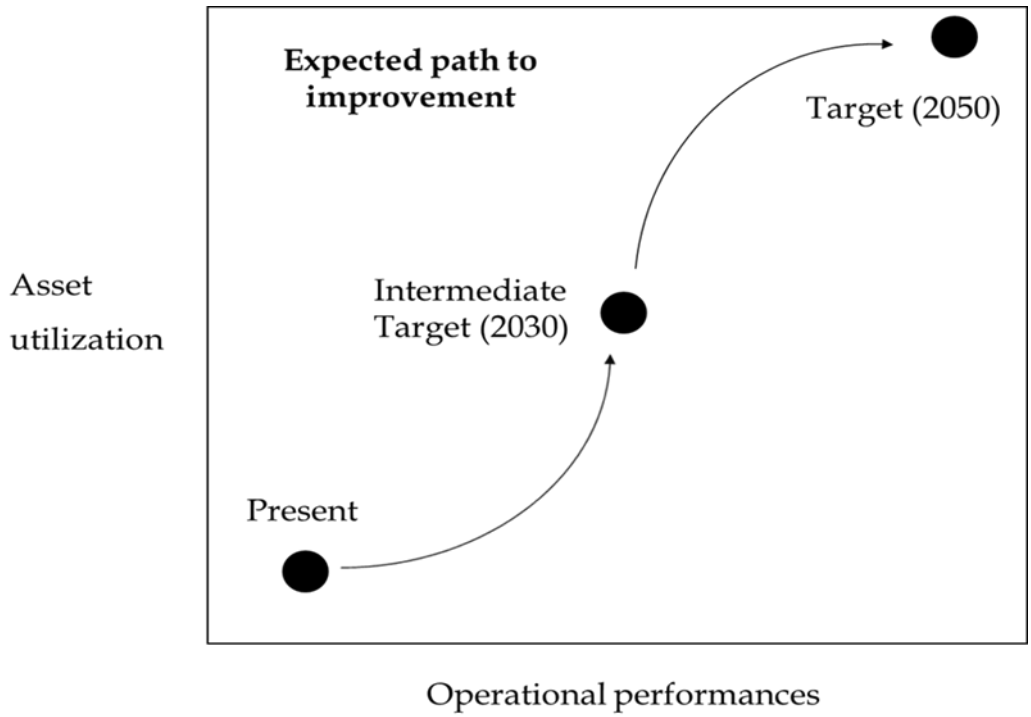

Figure 9: Future asset utilisation vs. operational performance – Source: SPIDER PLUS