CHALLENGE 2050
↗ THE RAIL SECTOR VISION

CONTENTS

FOREWORD

Rail is vital to the well-being of Europe's society and the strength of its economy. To maintain and develop this role in the future, the sector needs to meet enormous challenges. There is a need to protect the social, economic and environmental fabric. The railway community has developed *Challenge 2050*, a vision that identifies these challenges and makes a commitment to addressing them.

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***Challenge 2050* is the European rail sector's shared perception of where the rail system could be by 2050. The document first gives a brief overview of the rail sector and then sets out the sector's shared vision. It also identifies the many goals that are complementary to the vision and support a rail system that is responsive to the needs of Europe's citizens.**

The vision set out in *Challenge 2050* is endorsed by the following senior executives within the rail sector on behalf of their associations:

▷ Community of European Railway and Infrastructure Companies (CER) – *M. Moretti, Chairman*
▷ European Freight and Logistics Leaders Forum (F&L) – *F. Arendt, Chairman*
▷ European Infrastructure Managers (EIM) – *G. Malm, Chairman*
▷ European Passengers' Federation (EPF) – *T. Garrod, Chair*
▷ European Passenger Train and Traction Operating Lessors' Association (EPTTOLA) – *T. Gilbert, President*
▷ European Rail Freight Association (ERFA) – *F. Coart, Chairman*
▷ European Rail Research Advisory Council (ERRAC) – *J. Doppelbauer, Chairman*
▷ European Shippers' Council (ESC) – *D. Choumert, Chairman*
▷ International Union of Private Wagon Owners (UIP) – *Dr. E. Lehmann, Chairman*
▷ International Union of Public Transport (UITP) – *A. Depledge, President UITP European Union Committee*
▷ International Union of Railways (UIC) – *G. Pepy, President, European Region*
▷ The Association of the European Rail Industry (UNIFE) – *P. Citroën, Director General*

1. INTRODUCTION

Challenge 2050 brings together all aspects of the business of running the railway system to deliver outputs that support the sector's vision through the short, medium and longer terms right up to 2050. Many outputs are already in development or identified as priorities for the near future.

Challenge 2050 aims to encourage sector stakeholders to come together and align their positions and activities to meet the challenges of the future and develop rail transport.
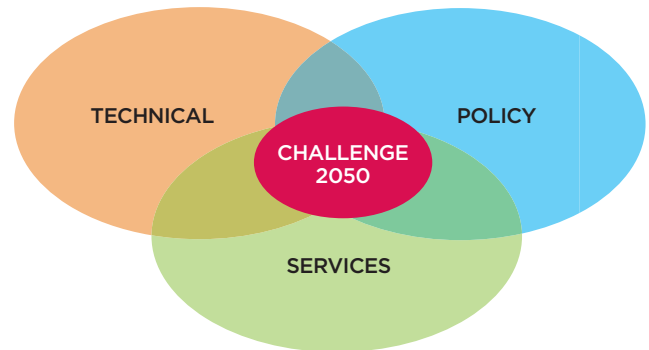
As a view of where the European rail sector perceives the rail system could be in 2050, the purpose of *Challenge 2050* is to orient and guide the railway sector, as well as policy makers and other stakeholders, to enable the innovation and investment on which sustainable mobility in Europe depends. The paper takes account of the European Commission's 2011 White Paper on Transport, which sets out a vision for the future European transport system and a policy agenda through to the Year 2050[1].

The goals for rail from the Commission's 2011 Transport White Paper:
By 2050 rail should substantially expand its modal share over medium and long distances for both passenger and freight, based on a dense network connected to all core airports and sea ports, a major expansion of the high speed network, and the deployment of ERTMS and of a European multimodal information, management and payment system.

We have written this document as if the reader is already in 2050, looking back at how the rail sector has been transformed over the intervening decades. Although *Challenge 2050* is not a commentary of the rail sector's position at the time the paper was written, our perspective has been considerably influenced by the rail system as it is today and it builds on this foundation.

By 2050 the railway has developed from the best of what there is today - an absolute commitment to safety, green credentials, expertise in passenger and freight transportation, global leadership in railway research, innovation and manufacturing and, above all, its prime position as the provider of Europe's transportation needs. But the railway of 2050 is also a very different railway; one that has moved significantly forwards and one that provides the backbone of the European transport structure.

To meet the challenges of climate change, the supply of energy and transport network congestion, rail has attracted a multi-fold increase in its share of passenger and freight markets, particularly for longer-distance trips.

Rail now has a pivotal role delivering a competitive and environmentally-friendly transport system, growing the economy, enhancing personal mobility and supporting social cohesion. The rail system has adapted and will continue to adapt, enabling further modal shift and maintaining its position as the mode of choice, consistently.

Rail responds to users' needs, delivering reliable, affordable and attractive services as the core of a seamless and safe mobility network. The sector has applied its innovation skills to an assault on avoidable costs and to attracting new users, achieving significant modal shift. Rail has attracted new customers by providing high-quality services that have stimulated popular support for rail and laid the foundation for public investment.

Mobility is co-modal and the playing field between modes has been levelled so that decision-makers can determine developmental strategies based on truly comparative costs between different transport modes. An integrated transport system, with rail as its backbone, continues to enable a more competitive European economy with each mode playing to its strengths.

Europe's rail sector leads the world and is at the cutting edge globally, continually growing its share of international markets as a result of investment in research and innovation and appropriate regulatory support. A strong European railway area is the key to sustainable mobility in a low-carbon society; it is also essential for economic growth, social cohesion and people's expectations of mobility.

1. *White Paper on Transport: Roadmap to a single European transport area- towards a competitive and resource-efficient transport system, European Union 2011*

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2. THE SECTOR

Rail is vital to delivering the growth agenda on which a dynamic society depends. It is the 'greenest' transport mode. It is the most capable form of transport for addressing congestion and the most pragmatic in terms of efficient land-use.
It is at its most effective and economic when managing large flows of people and freight.

The rail sector is a major contributor to the economic and social health of Europe as it provides employment for a significant number of highly trained personnel [1]. Throughout the Union they work in companies of different sizes either directly providing transportation services or as part of the supply and logistics chain. Their activities provide the foundation not only for operating the railway system but also for Europe's successful rail supply industry, which makes considerable contributions to the needs of the global rail equipment market [2].

Rail makes an important contribution to the growing demand for mobility; it accommodates demographic change, supports the important social focus on personal well-being and adapts to changing trends in consumer behaviour. The sector draws on a range of knowledge-based skills in which Europe leads the world, aided by standards that are de facto world standards – whether in safety, vehicle technology, telematic applications, systems design, civil engineering or operations.

Rail has seized a considerable opportunity and continues to embrace the renaissance that has made it into a consistently dependable rail network that provides the backbone of a European transport system in which modes cooperate and play to their strengths.

The sector's framework allows it to innovate and compete effectively, delivering a smart, integrated, green and high-quality service that is focussed on the needs of European citizens and rail's customers (passengers, freight shippers).

1. In 2008, rail transportation services in the EU-27 alone employed 790,000 people, compared with 411,000 people in air transportation services. The total figure for the rail sector is very much greater when account is taken of rail-related employment in manufacturing, construction and administrative and support services. See EU Transport in Figures, Statistical Pocketbook 2011, European Commission and also http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Transportation_and_storage_statistics_-_NACE_Rev._2
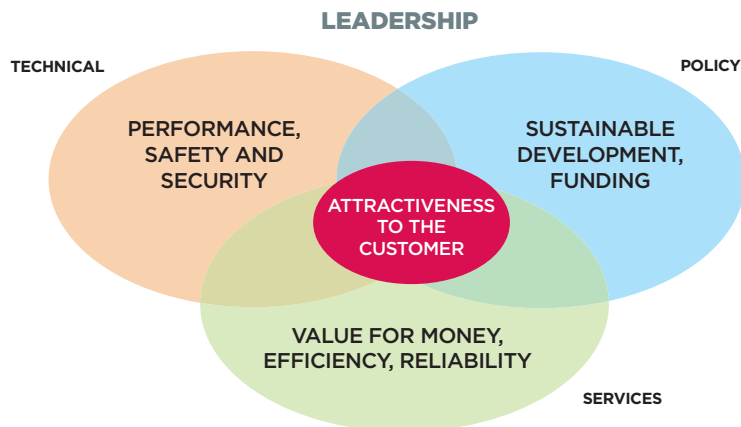
2. UNIFE World Rail Market Study Boston Consulting Group, 2010

3. VISION AND GOALS

RAIL IS...

... at the heart of an integrated, attractive transport system in which each mode plays to its strengths, enabling a more competitive European economy

... central to delivery of a strategy that has resulted in a massive cut in Green-House Gas (GHG) emissions, reduced oil dependency and mitigated the challenge of congestion

... the enabling factor for sustainable mobility that underpins economic growth and a dynamic society

LEADERSHIP

TECHNICAL

POLICY

PERFORMANCE, SAFETY AND SECURITY

SUSTAINABLE DEVELOPMENT, FUNDING

ATTRACTIVENESS TO THE CUSTOMER

VALUE FOR MONEY, EFFICIENCY, RELIABILITY

SERVICES

The vision and goals in *Challenge 2050* are all underpinned by the steps taken in the core rail system fields of **policy** (what needs to be done), **technology** (developing the tools to enable it to be done) and providing **services** (what the user sees and receives when a customer of rail). These apply across the whole vision, overlap and come together to enhance the overall attractiveness of rail to the customer.

◐ VALUE FOR MONEY

RAIL IS A COMPETITIVE AND VIABLE FIRST CHOICE OF TRANSPORT MODE IN TERMS OF COST AND QUALITY OF SERVICE FOR BOTH PASSENGER AND FREIGHT USERS THUS SUPPORTING THE ECONOMY OF EUROPEAN MEMBER STATES

POLICY

Rail is a "value for money" choice in 2050 as a result of developing a number of policies:

▷ Support for research and development to develop resource-efficient technologies.

▷ Agreements to share the benefits of innovation and to incentivise reduced whole life costs.

▷ Authorisation and certification for the inter-operable European railway system is fast, transparent, efficient and is undertaken in an economic manner within an optimised process between the EU and at a national level.

> **" Transporting my goods by rail offers the best value for my customers and the supply chain "**

▷ Economies of scale have been introduced by the development and application of common standards for interoperability, particularly safety certification and equipment authorisations.

▷ Frequently incompatible national standards have been completely reshaped with considerable help from the sector.

▷ The sustainability of the rail network in more sparsely populated areas is assured, wherever financially relevant. Cost drivers are transparent and technology and standards adapt to local conditions without compromising the safety of the rail network.

TECHNOLOGY

▷ Investment in new, more resource-efficient technologies have and continue to reduce the sector's costs and help drive greater value for money internally and externally.

▷ Management tools assess whole life (Life Cycle Assessment or LCA) environmental and economic impact and allow easy comparison of maintenance and/or replacement costs.

▷ The use of modular sub-systems and components enables upgrades during a vehicle's service life in response to changing customer perceptions and requirements.

SERVICES

▷ The sector's success is based on customer support brought about by consistently high-quality services and attractive pricing.

▷ Very high levels of customer satisfaction reflect user contentment with high-quality, reliable and good value services. The sector has experienced and continues to attract a multi-fold modal shift to rail.

▷ Longer distance passenger travel is mainly by rail and rail shifts more freight than any other transport mode. End-to-end journey times are highly competitive with other modes - rail services adapt to customer needs and are easy to use.

▷ A network of high speed passenger services linking key hubs and conurbations is complemented by dense multi-modal local networks providing seamless integration for the first and last stages of most peoples' journeys.

▷ Targeted investment in infrastructure, trains, system automation and well-motivated staff provides a reliable, high-capacity railway system.

▷ Shared information platforms and robust IT tools make possible real-time data exchange between rail service providers and also integrate with the data platforms of other transport modes.

▷ Customers enjoy continuous access to their personalised journey information systems and all freight is traced and tracked in real-time through all stages of transit, whatever the mode.

▷ With access to continuous high-speed data, passengers treat their journey as a seamless extension of their working or leisure environment.

⊙ PERFORMANCE

> TRAINS ARE ON TIME AND PROMISED
> FACILITIES FOR FREIGHT AND
> PASSENGERS ARE AVAILABLE

POLICY
▷ The creation of a level-playing field between transport modes, with comparable and transparent intermodal pricing arrangements and internalisation of external costs, facilitates an open, competitive market. This shows what each mode does most effectively and provides a constant incentive to improve and further tailor services to users' needs.

TECHNOLOGY
▷ The system is highly automated both operationally and for monitoring vehicle and infrastructure condition and maintenance. This enhances system reliability and cost efficiency, improved customer service and a satisfied and proud workforce.

▷ The network is engineered for resilience. Performance is optimised by real-time traffic management, maximising capacity, conserving energy and minimising inconvenience to the passenger and the freight user. On the rare occasions when disruption occurs, services are automatically and dynamically reconfigured and customers advised.

SERVICES
▷ Success is measured by consistently satisfying the customer (both internally and externally). High customer satisfaction levels underpin the political support which, in turn, ensures the investment that is vital to providing and sustaining quality services. This is the foundation for achieving the essential modal shift on which the EU's sustainable transport strategy turns.

⊙ SAFETY AND SECURITY

> RAIL IS THE SAFEST MODE OF
> TRANSPORT

POLICY
▷ In 2050 rail is still the safest mode of land transport and it is actively moving towards being the safest mode of all sectors.

▷ The operational risk caused by third parties at critical interfaces, such as between road and rail at level crossings, has been significantly improved.

▷ A harmonised process covers most aspects of verification and authorisation. Virtual certification systems are common practice for new rolling stock.

TECHNOLOGY
▷ Significant improvements in reliability, availability, maintainability and safety of the railway system all add to the overall attractiveness of the system to the customer.

▷ In the event of an incident, systems restart quickly. System performance in degraded mode is close to that in normal operational mode.

▷ New operational and track engineering techniques are commonplace. Intelligent infrastructure, rolling stock and other system components are autonomously monitored in real-time.

▷ Maintenance performed on infrastructure is undertaken safely as a result of greater reliance on automated intervention methods.

SERVICES
▷ Competition and business-led management are important factors for developing rail transportation. However, achieving this level of performance relies on collaboration between all parties in the railway sector to ensure effective management of critical interfaces.

▷ Close monitoring of the system attracts customers who know their personal security is ensured whilst using rail services.

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◉ CONSISTENCY

> PASSENGERS AND FREIGHT USERS RECEIVE A CONSISTENTLY HIGH-QUALITY SERVICE

POLICY
▷ Trains are highly reliable and punctual. Rare failures are accompanied by a performance regime that compensates affected customers appropriately.

▷ The European railway sector operates a system that is planned with resilience in mind, whether to cope with external disruption (such as adverse weather conditions), internal disruption (caused by train service delivery problems) or with events such as planned closures for maintenance work.

▷ Passengers enjoy seamless journeys in a comfortable, safe and secure environment, reassured by the availability of real-time traffic and whole-journey information that keeps them abreast of their varying journey options should problems arise with inter-connection with another mode.

▷ Building on expertise from within the rail sector and from other modes, network infrastructure availability is at a high level. This is measured by appropriate performance regimes for passenger and freight traffic.

▷ Bringing together innovative technologies and concepts, the design, construction, operation and maintenance of network infrastructure is adaptable, automated and weather resilient[1].

TECHNOLOGY
▷ Railway premises and the trains themselves are always clean and well presented. The Rail Operating Community works closly with local planners to find practical ways of enhancing the ambiance around railway premises.

▷ Traceability and reliability makes rail the highest quality link in the co-modal transport chain.

▷ Customers benefit from new approaches to system management in the event of disruption.

❝ Whether I am in Madrid or Manchester the station is always a clean and safe place to be ❞

▷ Interoperable communications networks and intelligent systems deliver real time traffic and journey information. This ensures that disruption is minimised and provides users with a safe and secure environment for seamless journeys.

SERVICES
▷ The sector listens to its customers. Responding to customer needs and aspirations builds a significant level of trust in rail as a brand.

▷ Users have clear and reliable information, whether it is about fares and tariffs or alternative arrangements during service disruption.

▷ There is widespread political support for rail with its reputation for transparency and value for money.

◉ CAPACITY

> RAIL CAPACITY IS MAXIMISED ON A NETWORK DESIGNED TO MEET CUSTOMER NEEDS AND MITIGATE CONGESTION IN OTHER TRANSPORT MODES

POLICY
▷ The European railway system facilitates co-modal surface transport with user-friendly multi-modal hubs that improve urban connectivity for passengers and purpose-designed strategic trans-shipment facilities for freight.

▷ Improved system utilisation and organisational arrangements maximises capacity on busy corridors.

▷ Forward planning and investment provides new capacity on busy corridors where the route allows and where improvements in operational arrangements are insufficient.

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1. See for example, the For Ever Open Road project, launched by the Federation of European Highway Research Laboratories and the sister programmes of research, known as the FOR x 4 Initiative, extending applications to other modes, http://www.foreveropenroad.eu

▷Service frequencies, train capacity and yield management techniques are combined intelligently to ensure passengers usually get the type of seating and shippers the type of service they want at the times that they want.

TECHNOLOGY
▷Innovation and effective deployment of traffic management technology maximises existing capacity.

▷Adapting to new technologies for advanced distribution and logistics requirements, eliminating bottlenecks, providing services to fill strategic 'missing links' and running higher capacity trains at faster consistent speeds allows the sector to offer a very attractive product to customers.

▷Train interiors are adaptable to the needs of different groups of users, such as families, business travellers, people with reduced mobility, and groups of travellers.

SERVICES
▷Stations contribute to a positive journey experience: they are accessible, welcoming, secure, always comfortable, fit for purpose and fully adapted to the needs of users with reduced mobility.

▷The sector continually develops and exploits new traffic opportunities. Major ports, airports and significant new traffic sources are either already linked or are preparing to link to the European railway system.

▷End-to-end services are faster and simpler for users, with improved inter-modal transfers.

▶ CONNECTIVITY

> **RAIL IS THE BACKBONE IN AN INTERCONNECTED AND SEAMLESS CO-MODAL TRANSPORT SYSTEM**

POLICY
▷Rail services are the backbone link in an interconnected and seamless co-modal chain. For both freight and passengers, each mode is deployed because it provides the most appropriate transport for a particular journey leg and for each part of the chain

"My train is on time and I have information about my connecting services when I need it"

▷Co-modal transport with user friendly multimodal hubs improve urban connectivity for passengers. Purpose-designed strategic transshipment facilities for freight are the norm. The European railway system helps provide the optimal whole journey experience.

▷For example, public transport, cycle facilities, car sharing, car rental or taxi services are closely integrated with rail services.

▷The sector works with public authorities to create seamless end-to-end journey connectivity between modes and to provide high-quality local and regional services that complement the attractiveness of longer distance rail services.

▷Freight customers benefit from reliable track, trace and alert systems. Telematics systems enable passengers to plan the most cost-effective, time-efficient and convenient co-modal journeys. This enables standard systems architecture and the integration of information systems throughout Europe.

TECHNOLOGY
▷The rail system supports vital pan-European rail corridors and co-modal links with other continents – a practical demonstration of the technological and operational innovations that have made it a global leader.

▷Interoperability ensures trains cross state borders without delay or operational constraint, offering a smart alternative to medium-distance flights and sea and road-borne freight flows.

▷Vehicles powered by alternative fuel sources includuing electricity, play an increasingly important part in local travel. Stations offer facilities for bike parking and vehicle fueling or battery-charging points.

SERVICES
▷International freight corridors connecting major freight concentration hubs linked to freight villages, ports and other bulk freight sources, underpin a step-change in service quality. Reliable, fast freight services have opened new markets.

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⊙ SUSTAINABLE DEVELOPMENT

> THE EUROPEAN RAILWAY SECTOR PROVIDES AN ATTRACTIVE AND RESOURCE-EFFICIENT SOLUTION FOR SUSTAINABLE MOBILITY AND TRANSPORT AND A SIGNIFICANT CONTRIBUTION TO REDUCTIONS IN GREENHOUSE GAS (GHG) EMISSIONS AND DEPENDENCY ON OIL

POLICY

▷ The sector makes a vital contribution to the environmental, economic and social well-being of the European Union. Careful attention to the challenges of noise and vibration together with thoughtful spatial planning policies and the development of strategically-located freight concentration centres have overcome resistance in highly-populated areas to the further development of traffic flows.

▷ Rail engages with those responsible for spatial planning and urban developers to ensure the rail system is seen as an asset for better land use, combatting congestion and facilitating environmental and social enhancement.

▷ The European railway sector maintains and continues to expand its leading position while continuously improving its contribution to sustainability through responsible business leadership.

▷ Rail has a very high environmental performance that is in line with the "Moving Towards Sustainable Mobility" strategy[1].

TECHNOLOGY

▷ Rail operates cost-beneficial passenger and freight operations on a "forever open" railway system that controls noise and vibration to socially and economically acceptable levels.

▷ Management tools assess whole life environmental and economic impact. These allow comparison of maintenance and/or replacement strategies for track and infrastructure based on traffic and whole life evaluation.

▷ Optimised vehicle design allows easy upgrades during a vehicle's service life in response to changing customer perceptions and requirements and business needs and usage.

SERVICES

▷ The European railway sector supplies its customers and society with attractive, cleaner and resource-efficient solutions for sustainable mobility and transport.

❝ I am proud to tell people I work in the rail sector ❞

⊙ PEOPLE

> THE RAIL SECTOR ATTRACTS PERSONNEL WHO ARE MOTIVATED AND COMMITTED TO PROVIDING A MODERN, FLEXIBLE AND CRUCIAL SERVICE

POLICY

▷ Developing the commercial and customer service skills of railway personnel is essential for attracting customers to use rail services

▷ Enterprises acknowledge the importance of investing in the personal development of every member of staff throughout their career. Working for the railway is a source of pride for staff.

▷ The railway sector champions and develops technical railway schools. It actively supports the importance of better gender balance in technical professions.

▷ Continuing improvement, innovation and flexibility, combined with a long-term commitment to building on the skills of all those working in the sector, has helped ensure a high-quality railway community, motivated by professional excellence.

1. "Moving towards Sustainable Mobility: European Rail Sector Strategy 2030 and beyond"
(http://www.uic.org/IMG/pdf/pres-strategy.pdf) – published in 2010 and provides and approach to environmental and sustainability topics in the European rail sector. It outlines how the rail sector should be performing in environmental terms in 2030 and 2050, and provides a framework that allows companies in the rail sector to make suitable long-term plans.

▶ ELEMENTS UNDERPINNING ALL THE GOALS

SECURING INVESTMENT

▷ The sector's competitiveness and wider value is important to a sustainable future and to a developing regional economy. Measures that ensure transparent cost comparisons between modes, including the internalisation of external costs such as safety, congestion and environmental damage highlight the true cost of operating a rail system. This has developed over a number of years and it is now a strong tool for providing attractive, value-for-money rail services.

▷ Innovative financing tools tap new sources of funding, securing additional investment, in particular to increase capacity and improve reliability by alleviating bottlenecks, filling missing links and enabling intelligent systems throughout the European railway network. This unlocks further economic growth, reinforced social cohesion and contributes to the freer movement of Europe's citizens.
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▷ Investment decisions taken within the sector are made after careful appraisal, using a holistic approach that takes account of whole-life, whole-system considerations. This maximises overall value to the rail sector, the customer, society and the European economy.

▷ Sustainable and ambitious public funding for rail infrastructure guarantees the quality of the network, facilitating the success of rail transport services for the benefit of the customer. This allows operators to accurately forecast future market needs, enabling them to invest in quality services such as new rolling stock, new services, and higher frequency services.

▷ Proper compensation of PSO contracts is guaranteed and this provides stability and predictabilty.

**LEADERSHIP WITHIN
THE RAIL SECTOR**

▷ The sector's leaders act determinedly and collaboratively across functional and territorial boundaries to run a safe and efficient rail system while respecting the rules of competition. There is clear focus on the strategic direction and the needs and aspirations of the sector's customers.

▷ Global leadership of the European railway sector is rooted in a culture that places a premium on consumer understanding, continuous innovation and a readiness to adapt to technological and commercial opportunities, many of which span national and regional boundaries.

▷ The rail sector is determined to develop the future vision and to ensure that forward strategy retains and evolves rail as the backbone of a sustainable European transport system.

▷ Rail maintains its leading position as the backbone of the European transport network by consistently delighting all customers. All parts of the sector collaborate closely to ensure the entire service delivery chain is robust.

▷ With a strong foundation provided by the technical specifications for interoperability and common safety methods, the rail sector takes responsibility for delivering a suite of standards that supports the provision of a cost-effective and fully interoperable European railway system.

THE POSITION OF EUROPE AS A GLOBAL SECTOR PLATFORM

▷ The innovative, sustainable and highly competitive European rail sector is leading the world.

▷ The sector's supply industry is recognised globally for its leadership in the design and construction of a large range of high performing, very cost-effective and energy efficient products.

▷ The Rail Operating Community is seen as global experts in the design, construction, operation and maintenance of a world-class rail system.

▷ This position is underpinned and strengthened by a seamless European research and innovation programme that assures continuity through radical research, applied research, development, demonstration and innovation in products and services.

DELIVERING CHANGE

▷ All administrative and technical barriers to interoperability have been removed and economic and social conditions converged.

▷ The railway system has achieved better performance and lower costs whilst respecting subsidiarity and without prejudicing the competitive efficiency of the European railway system.

▷ Solutions are developed from a whole-sector approach to deliver consistently high-quality services, for example, ensuring timely and relevant customer information at times of disruption. Solutions draw on stakeholder

collaboration and technical innovation, ensuring that rail is highly competitive when compared to road and aviation. The Shift Rail initiative and also ERRAC, the Technology Platform for rail research and innovation, have been core components in achieving this vision.

▷ The European rail sector is founded on an efficient and effective policy of collaborative development which is supported by a pragmatic regulatory framework that addresses funding and financing issues as a pre-requisite.

▷ Overcoming the challenges facing the sector and achieving our vision required a supreme, coordinated effort and considerable focus. The sector worked and continues to work closely with all the key players at the most appropriate levels to secure appropriate levels of public funding in partnership with private funding.

▷ The European rail sector has achieved global leadership and continues to meet the objectives and needs of society. To achieve its vision, the sector required combined public and private funding of around one trillion Euros, largely to plug the funding gap for retention and development of infrastructure that is fit for a mid-century railway system.

▷ To make every aspect of this vision a reality, the sector had to identify and address a considerable range of issues that were the key drivers for change. Accompanying the *Challenge 2050* vision for the future of rail is a paper that describes how me might take the first steps towards achieving this vision. Please read this supporting paper in conjunction with *Challenge 2050.*