Transport Research Knowledge Centre

Directorate-General for Mobility and Transport

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• TOWARDS AN INTEGRATED TRANSPORT SYSTEM – FREIGHT FOCUS

Research contributing to integration and interoperability across Europe

Contents

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Additional information on transport research programmes and related projects is available on the Transport Research Knowledge Centre website at **www.transport-research.info**

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Executive summary

One of today's main policy challenges for the European Union is improving the functioning of a transport system that is still patchy. Currently, rather than a truly **European transport system**, several barriers exist to the seamless movement of passengers and goods across borders.

There are **operational barriers** stemming from diversity in regulations, **technical barriers** from incompatible technologies, **infrastructure barriers** due to the incomplete network of major cross-border links across the continent, and **legal barriers** because of the lack of pertinent European legislation.

This Policy Brochure addresses these issues with a focus on freight transport. Major issues which are of interest to both freight and passenger transport are examined, such as the development of the **Trans-European Transport Networks (TEN-T)**, with the attendant **European traffic management and information systems** on the networks of the various modes.

In addition, issues specific to freight transport are addressed. These include:

- **barrier-free international road and rail transport** and the opening of these markets to competition;
- the interoperability of **electronic fee collection** across European road networks, which is of particular interest to Heavy Goods Vehicles (HGVs);
- **logistics solutions** based on harmonised communication framework conditions and **Information and Communication Technologies (ICT)** platforms, which are key to intermodality and comodality.

After having introduced the subject and illustrated the policy framework, this Policy Brochure provides a review of past and ongoing research that contributes to turning the current patchwork into an integrated, harmonised, defragmented and interoperable European transport system. The research reported on here is primarily EU-funded research. Relevant research carried out in individual Member States and outside the continent is also included.

1

Integrating the freight transport system: The scope of the topic

For the common European market to function smoothly there is a need for an **integrated transport system** that allows the free movement of goods within EU territory. This is vital for economic growth and for territorial cohesion. An integrated transport system clearly calls for harmonisation of rules and interoperability of networks.

The challenge which EU transport policy has historically faced has been the diversity of transport infrastructure, equipment and regulation across Member States. This fragmentation has been recognised as a barrier to the seamless transport of goods across Europe since the beginning of the development of a common transport policy in the 1950s.

Therefore, issues of **defragmentation, harmonisation and interoperability** have ranked high in the EU transport policy agenda. This is reflected in the policy developments related to the individual transport modes, as well as in the launch of the idea of Trans-European Transport Networks (TEN-T).

As the focus of this publication is on freight transport, the modal perspective needs to be accompanied by an examination of the developments in logistics solutions which facilitate **intermodality** – the use of loading units on different modes – and **comodality** – the use of different modes in combination to obtain a sustainable utilisation of resources.

Road transport

International transport by trucks was subject originally to a number of **constraints**, such as quota restrictions, national restrictions against operators from other EU countries and prohibition of cabotage. EU policy has aimed at **opening this market to competition**, freeing it gradually from its various constraints.

As the process of market opening progressed, issues of potential distortions and unfairness of competition were tackled. This resulted in social regulations, particularly to reinforce safety standards. To eliminate distortion in competition due to differences of costs across countries a **harmonised approach to road transport taxes and charges** has been developed.

The increasing adoption of **electronic toll collection systems** for Heavy Goods Vehicles (HGVs), which is seen today in various Member States, calls for interoperability of the technology used as well as for cross-border organisation of the payment procedures. This also has been tackled in recent EU policy developments.

Foreign registered vehicles are a large share of freight traffic in certain countries. **Enforcement of the violations** committed by these vehicles is difficult because of the lack of a mechanism for sharing vehicle data across national borders and the lack of a legal framework for cross-border enforcement of penalties. This constitutes a problem because impunity may result in drivers' poor or unsafe behaviour.

Rail transport

Similar to road, international **goods traffic by rail** has undergone a process of market opening. Today this market is liberalised, but Member States are in different stages of implementing new legislation and railway packages. The harmonisation of safety systems is a key goal of EU policy and is an integral part of the real opening up of the market.

Several barriers still prevent full interoperability of the rail networks of various countries. These include diversity of control-command systems, track gauge, traction power supply voltages and maximum axle loads. Steps towards interoperability have been made with the adoption of Directives which, among other things, impose the use of **ERTMS**, the European Rail Traffic Management System, for priority TEN-T projects.

Waterborne transport

Transport of goods by sea in the EU has the second largest share in terms of tonne-kilometre after road transport (CEC, 2009a). The creation of a **European maritime transport space** without barriers, where the transport of goods between Community ports is simplified, is a goal of EU policy. Work is ongoing on harmonisation, rationalisation and simplification of administrative procedures as well as on the assessment of communication and positioning technologies.

The establishment of a European maritime transport space is a precondition for the deployment of the **'Motorways of the Sea'**, a key element of the TEN-T. Inland navigation is often a cross-border transport mode. The EU is developing a common policy to expand its use whilst better integrating it in the transport logistics chain.

Air transport

Air transport is a niche market restricted to high value density and perishable goods; nonetheless it is of **strategic importance for freight**. Air traffic management in Europe suffers from heavy fragmentation. Airspace management is organised around national boundaries so that the current European route network is still a patchwork of national routes. For this reason

the shortest available routes are not always followed by international flights. Also, there is technical fragmentation due to the diversity of equipment, especially in ground systems.

Against this background, EU policy has aimed at harmonising the management and regulation of airspace and the underlying enabling technologies, and achieving a **Single European Sky** where the air traffic management system is able to provide higher safety, capacity and efficiency.

TEN-T

The idea of trans-European networks, covering the areas of transport, telecommunications and energy, emerged in the late 1980s in conjunction with former EU Commission President Jacques Delors' proposals for completion of the single market.

TEN-T covers all transport modes, from road and rail connections to inland waterways and the 'Motorways of the Sea', from ports to airports. TEN-T policy has aimed at completing infrastructure projects of European interest, interconnecting national networks and overcoming technological barriers across national borders.

Intermodality

The greater use of intermodality, whereby **different transport modes are used along the transport chain**, using each mode to best effect, is a key element of the EU freight transport policy. In particular, it is promoted in medium and long-distance corridors – for Alpine crossings due to the environmental sensitiveness of these areas – and for port-hinterland and terminal-to-terminal connections.

Various **barriers** inhibit, however, the wider use of intermodal transport. These include the lack of a coherent network of modes and interconnections, capacity problems at terminals, the lack of technical interoperability both between and within modes, and a variety of regulations and standards. Levels of performance and service quality between modes are uneven and there are different levels of liability and a lack of information about intermodal services. As a result, intermodal door-to-door transport still offers **untapped capacity** and partnership opportunities.

More secured data transparency and exchange of information along the logistics chain, increased use of Information and Communication Technologies (ICT) and technical standardisation, or at least harmonisation, on loading units contribute to increase the market for intermodal transport and make it more cost-effective.

2

Policy background: The developments of the common transport policy

Road transport

The 1957 Treaty of Rome established the need for a common transport policy, but it was not until the mid-1980s that the EU started to enact legislation to allow a **free international market for road freight transport**. Before, for-hire road haulage between Member States was subject to authorisations working under two mechanisms: bilateral agreements imposing quotas on the number of movements, and Community permits allocated to Member States according to quotas. In addition to these market entry regulations, bilateral agreements typically specified price brackets.

These constraints were increasingly relaxed during the 1980s and 1990s. All limitations on the number of permits were eventually eliminated in 1993 with the introduction of Community licenses. **Cabotage**, prohibited before 1990, has been increasingly authorised since then. The lengthy controls at borders to which vehicles were subject were eliminated in 1990 (Degli Abbati, 1987; Ross 1998; Stevens 2004).

As market entry constraints were loosened, **social rules on road haulage** have been adopted to prevent unfair competition and reinforce safety standards. The concern that operators that have to bear the greater costs of working in a more tightly regulated environment are undercut has led recently to the adoption of legislation relating to driving times, rest periods and checks.

The EU aims to ensure that operators **receive fair and equitable access to the market and competition is not distorted**. In this respect, the variation existing among Member States in rates for use of road infrastructure, vehicle taxes and fuel duties is a challenge. Therefore, the EU has committed itself to develop a comprehensive approach to road transport taxes and charges (CEC, 2001; CEC 2008a; CEC 2009b).

Common rules have been adopted which set minimum rates for taxes paid by HGVs and for fuel excise duties. This is a step towards reducing the differences across countries.

Infrastructure charging, based on the **'user pays'** and **'polluter pays'** principles, is a milestone in the EU policy agenda since the 1990s: it is a particularly effective means of managing congestion and reducing other environmental impacts.

The **'Eurovignette' Directive** (1999/62) on the charging of HGVs for the use of certain infrastructures recognised the 'user pays' principle by allowing Member States to levy distance-based charges to recover the cost of construction, maintenance and operation of infrastructure. This Directive provided the legal framework for the implementation of a common charge, the so-called 'Eurovignette', by the Netherlands, Sweden, Belgium, Luxemburg and Germany, which, at that time, had no tolling system on their roads and therefore had no possibility to charge HGVs from other countries for using their infrastructure. However, Member States have the freedom to implement it according to their own pace and political priorities.

The Directive subsequently approved in 2006 (Directive 2006/38) represents the first step towards taking account of external costs: it will allow a **greater variation in tolls** to reflect the congestion and the pollution caused by vehicles.

In 2008 the European Commission put forward a proposal for amending the existing Directives

(CEC, 2008b). According to the existing Directives toll rates may be varied according to vehicle emission standards or congestion levels but under a constraint of revenue neutrality. This has resulted in only few countries exerting the option. Sufficient **incentives** are still not in place for operators to modernise their vehicle fleet with cleaner vehicles and to adapt their route planning towards more sustainable practices. The proposal eliminates the revenue neutrality constraint and extends the scope of the existing Directives beyond the TEN-T to avoid inconsistent pricing schemes between major corridors and other inter-urban roads.

Increasingly EU Member States are implementing **electronic tolling systems**. Initially these systems were implemented in a few countries prevalently on concession motorways; more recently a few countries have adopted network-wide electronic tolling schemes for trucks (Germany, Austria, Czech Republic, Slovakia). Others like France are planning such systems. To make travel across different countries easier the EU has laid down rules for the interoperability of tolling systems.

Directive 2004/52 had set the framework for a **European Electronic Toll Service (EETS)**, by which road users only subscribe to a single contract with an EETS provider in order to pay the charges related to any charging scheme requiring on-board equipment. The detailed definition of the EETS, including technical, procedural and legal issues and a schedule for implementation, was set in a European Commission decision in 2009.

Two other application areas where EU-wide interoperability is relevant relate again to ITS (Intelligent Transport Systems) technologies. These are the areas of real-time traffic and travel information services and the area of e-freight services. The latter consists of the provision of en-route information on the location and condition of transported goods, especially dangerous goods (CEC, 2007a). Together with electronic toll, these applications are part of the EU Action Plan for the Deployment of ITS (CEC, 2008c).

The EU needs a system which **ensures enforcement** of all drivers regardless of nationality. The 2005 Council Framework Decision called 'COPEN 24' applies the principle of mutual recognition only to fines for criminal offences. A few Member States have reached bilateral agreements covering mutual enforcement of traffic violations. In 2008 the Commission put forward a proposal for a Directive establishing a procedure for enforcement of the sanctions regarding safety-related traffic offences (CEC, 2008d).

Rail transport

The Commission's 1996 White Paper on revitalisation of Community railways (CEC, 1996) and the launch of the freight freeways (CEC, 1997a) was followed in 1998 by a proposed infrastructure package on charging, capacity allocation, separation of infrastructure management and operation and licensing (CEC, 1998). This led to the approval of three Directives in 2001, which have opened up the main rail axes to international freight traffic and have defined the role of the rail infrastructure manager in providing access to the infrastructure for rail service operators.

The **2001 Transport White Paper** proposed the liberalisation of cabotage in national markets as well as the promotion of further harmonisation in the field of safety and interoperability, and the creation of a network of railway lines dedicated to freight services (CEC, 2001).

Since then a number of policy initiatives have been introduced, namely:

- **Establishing a freight market on a European scale.** Directive 2004/51/EC has liberalised both national and international freight services on the entire European rail network from January 2007.
- Developments towards **Europe-wide technical interoperability and safety systems** with Regulation No 62/2006.
- **Identification of a rail network in the context of TEN-T.** The Commission has launched and encouraged the development of ERTMS, a common command, control and signalling system designed to replace existing national systems. The EU also provides considerable financial support for the rail sector through its cohesion policy (CEC, 2007a).

These initiatives have not yet come to full fruition. Progress towards interoperability has been slow and difficulties at some borders remain. Consequently, various significant problems relating to the quality of rail freight services also persist. The various EU initiatives have not yet succeeded in ending the fragmentation of the European rail system (CEC, 2007a).

The 2001 White Paper initiative to create a network of railway lines dedicated to freight services has now been superseded by the concept of a network with priority to freight, thus revitalising the **freight freeways concept** (CEC, 2008e). The ultimate aim is to promote competitive international rail freight services to counter the long-term loss of market share, mainly to road transport.

Waterborne Transport

Following the **1997 Green Paper** (CEC, 1997b), the Commission has supported the liberalisation of port services. The need to integrate ports more fully into the Trans-European Transport Network, taking into account their key role in global trade and their vital transhipment function, was emphasised in the **1999 Communication on Short Sea Shipping** (CEC, 1999). A better understanding is needed of the role of governments in infrastructure planning, and of the respective roles of the public and private sectors in financing infrastructure both at seaports and at the inland terminals to which they are linked.

The **Marco Polo Programme** will help to shift more freight from roads to short sea shipping, rail and inland waterways with the launch of freight services and facilities of strategic European cross-border interest.

Short sea shipping was recognised in the 2001 White Paper as having a role to play in improving the competitiveness and sustainability of transport in Europe. However, this sector has to cope with a negative image problem. The Commission has set out a programme for **promoting short sea shipping** (CEC 2003), including harmonising standards for intermodal loading units. The European Commission's working paper **'Towards a European maritime transport space without barriers'** (CEC 2007b) initiated a consultation process on

allowing short sea shipping to fully benefit from the internal market through facilitation and simplification of administrative and documentary procedures, and putting maritime freight transport on an equal footing with other transport modes. A European Action Programme for the Promotion of Inland Waterways has been launched with the **NAIADES communication** (CEC, 2006a). This includes the development of European River Information Services (RIS) in coordination with TEN-T.

Air transport

In 2004 a package of legislation was adopted on air traffic management to establish the **Single European Sky**. This legislation was intended to have a major impact on fragmentation. It is expected to be achieved by fostering airspace rationalisation and restructuring, consolidation of facilities, and harmonisation of systems and procedures. In particular, it introduced a single European upper flight information region and cross-border functional airspace blocks. However, fragmentation problems still persist. Therefore, in 2008 the European Commission put forward a proposal for a **new regulatory framework of the Single European Sky**. The focus is on the provision of a framework which should drive the performance of the air traffic management system (CEC, 2008f).

TEN-T

The 1992 Maastricht Treaty establishing the European Union provides the legal basis for the TEN-T. According to the Treaty, it is the remit of the Community to establish guidelines covering priorities and identifying projects of common interest, to implement measures for interoperability and standardisation, and to provide support to projects with different financial tools, primarily the **Cohesion Fund**. Rules for the granting of Community financial aid were set in a series of subsequent regulations adopted in 1995, 1999, 2004 and 2007. The limitations on the cost of the investment that the Community can cover have been loosened in favour of certain categories of projects, in particular cross-border projects and projects involving sustainable modes.

The first TEN-T guidelines were adopted in 1996. The first set of 14 projects, called the **Essen projects**, was enlarged in 2004 when new guidelines were adopted. These included a set of 30 priority projects, covering high-speed and conventional railways, road motorways, the 'Motorways of the Sea', multimodal corridors, airports, inland waterways and **Galileo**. Also, the new guidelines introduced the **European coordinators**.

Some of the projects have been finalised: the Øresund fixed link connecting Sweden and Denmark, the Malpensa airport in Italy and the Betuwe railway line linking Rotterdam to the German border. Other are close to completion: the PBKAL project, consisting of the high-speed railway linking Paris-Brussels-Cologne-Amsterdam-London, the West Coast Main Line, the rail line crossing Great Britain from south to north, and the Nordic Triangle, which will upgrade rail, road and maritime infrastructures serving connections among Norway, Sweden, Finland and Russia (CEC, 2009c).

The Commission has begun a **review of the TEN-T policy** with the publication of a **Green Paper in 2009** (CEC 2009d). Questions discussed include how to shape the future multimodal network and how to ensure timely completion. Network planning is a key issue. Some argue that the current priority projects approach fails to capture additional network benefits. Therefore it could evolve towards a priority network approach which would allow more systematic incorporation of the nodes, ports and

airports as the network's entry points and the main intermodal connection points that underpin strong network integration. Other recent developments in the TEN-T area have focused on plans for linking TEN-T to neighbouring countries outside the EU.

Intermodality

Intermodality, whereby freight can be transferred relatively seamlessly between modes due to the simplification of processes, procedures and use of standard loading units such as containers and swap bodies, is a major priority for European freight transport policy. The 1997 Communication set out the general strategies and actions (CEC, 1997c). The objective is to develop a framework for the optimal integration of different modes so as to enable an efficient and cost-effective use of the transport system through seamless, customer-oriented, door-to-door services whilst promoting competition between transport operators.

Implementing a European intermodal transport system requires the coordinated development of transport policies at European, national and regional level. Four key strategies to provide the necessary impetus to the development of intermodal transport have been identified as:

- **implementing a European strategy on infrastructure;**
- **establishing the single transport market: harmonisation of regulation and competition rules;**
- **identification and elimination of obstacles to intermodality and the associated friction costs; and**
- **greater implementation of ICT in the freight transport sector.**

Whilst the **2001 White Paper** recognised that intermodality is of fundamental importance for developing competitive alternatives to road transport, there have been few tangible achievements. Action is therefore needed to ensure fuller integration of modes so that individual services and links can be joined to create efficiently managed transport chains.

The **Mid-term Review of the 2001 White Paper** states that **'comodality'**, which has been defined as the efficient use of different modes either on their own or in combination, will result in more optimal and sustainable utilisation of resources. Alternatives to congested road corridors entail comodal logistic chains which optimise the use of transport infrastructure within and across the different modes. This includes transalpine tunnels, rail corridors and intermodal nodes for rail, sea or air transport (CEC, 2006b).

Intermodality is set to increase, particularly if initiatives such as **Green Corridors** and **'Motorways of the Sea'** achieve their potential. Its success will also depend on investment to solve bottlenecks at key loading and transfer terminals. The EU has acknowledged that there is a need to establish and agree future standards in terms of unit sizes and compatibilities (CEC, 2009b). These standards need to be agreed quickly to allow the relevant investment decisions to be made.

Intermodality could be further encouraged by the use of **Single Window Platforms** (SMART-CM), which are expected to play an increasingly important role in the future efficiency and sustainability of freight. This is a key area of the **EU Freight Logistics Action Plan** (CEC, 2007c). More effective provision of information will match loads to capacity more efficiently and will reduce the transporting of empty and partially-full loads. Its role could, however, be expanded and enhanced significantly. At present, 'electronic freight exchanges', whereby capacities are matched to loads, tend to operate on a single-mode basis. Better integrated ICT linkages between organisations along an entire supply chain would allow much improved forecasting of volumes to be moved, avoiding a great deal of unnecessary travel. The world of ICT is fast moving, and one can be reasonably confident that new applications will emerge to address these and other opportunities.

3

Research context: Improving technology, information systems, pricing and management

European research into integrated freight transport is being conducted against a policy background that is based on:

- **competition both within and between modes;**
- **cooperation between modes when beneficial;**
- **liberalisation of transport markets;**
- **harmonisation of conditions under which transport must operate;**
- **technical standardisation in order to promote the development of fully-interoperable transport networks.**

The research reported in this Policy Brochure strongly reflects this context while emphasising ICT aspects.

The need to harness improved technology

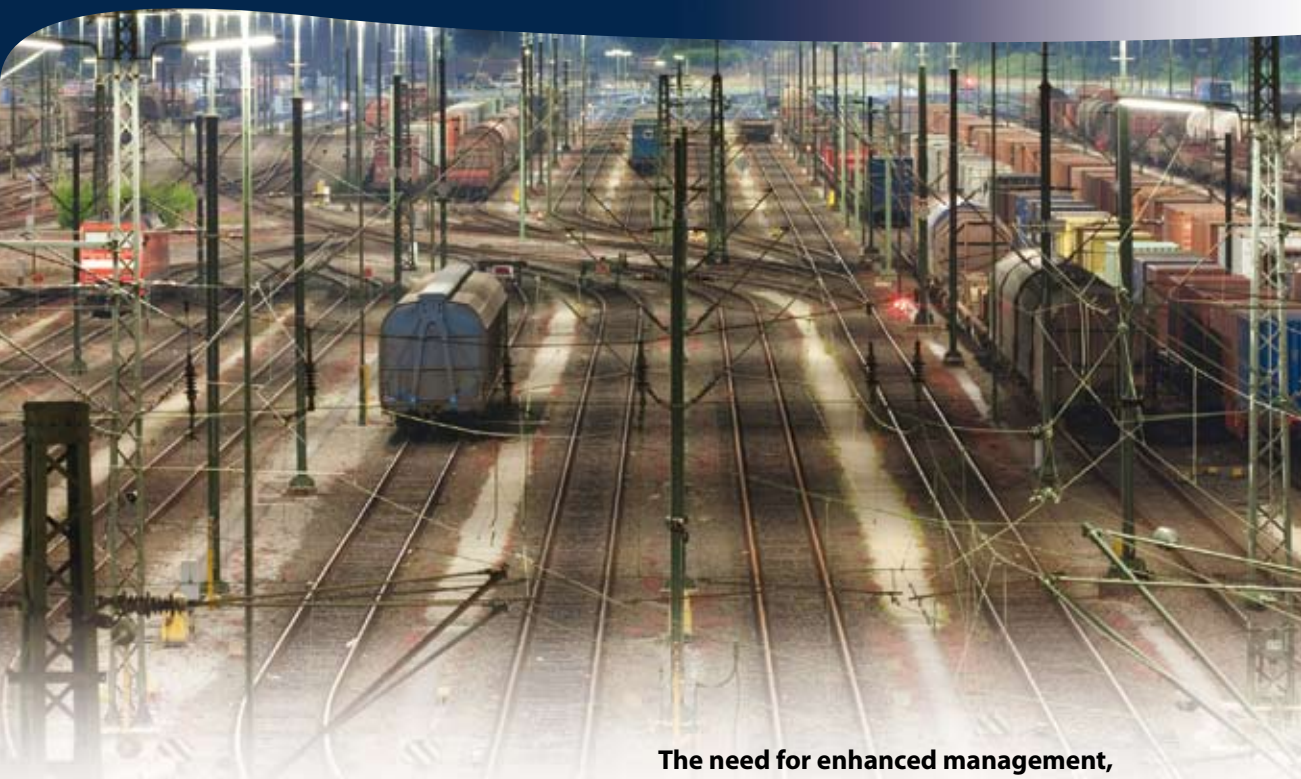
Technological change affects all modes of transport, spurred by the desire to achieve lower cost of operations and provide better service. **Technological development** is needed to facilitate interoperability of networks. Harmonisation is an enabler of liberalisation. Streamlining pan-European industrial business processes and procedures in a holistic logistics approach is a basic condition for the development of technologies to facilitate transport.

There is a need for a **common interoperable electronic fee collection system** to be implemented on European roads, as the different existing national systems are a barrier to smooth freight transport across borders. In the rail sector all operators need to have access to the European network through the use of compatible technology. In the air sector there is a need to overcome the current fragmentation of the European air traffic management (ATM) system, which limits capacity, affects safety and adds to costs.

The need to embrace ITS and ICT in the freight sector

Intelligent Transport Systems (ITS), such as information systems that allow truck drivers and freight operators to make informed decisions when planning their international trips, can contribute to the improved efficiency of freight transport at European level. For this there is a need to **develop interoperable traffic information services** at the European level which build on harmonised and standardised data structures and exchange services.

ITS and ICT offer rapidly **expanding opportunities to plan, manage and control freight movements** and the transport assets that are used for these. Yet the freight sector is considered a laggard in the use of such technologies. Road transport,



as the main freight transport user of such technologies at present and with the added advantage of providing door-to-door movement, will reinforce its modal advantage unless other modes make great efforts to catch up.

Hence the considerable research interest in recent years into the design and development of ICT-based tools for asset management and for tracking and tracing on modes such as rail and water and for intermodal movements, leading to the creation of various web-based platforms for freight transport management. At the same time, ICT enables harmonised border crossing procedures and paperless freight transport processes.

The need to get prices right

Different infrastructure charges, registration fees and taxes across EU countries inevitably result in different **transport prices which often do not reflect the real – internal and external – costs** of transport and lead to distortions in competition. In response to this need for harmonisation, research has been concerned with investigating road charging schemes and marginal-cost pricing, including environmental issues.

The need for enhanced management, maintenance and safety systems

As rail networks become busier and interoperability allows locomotives and rolling stock to venture further across Europe, it becomes important to have **enhanced and standardised management, maintenance and safety systems** so that networks and assets can be used in an efficient and safe way.

Maritime environmental management and safety similarly requires considerable attention if these modes are to play a larger role in the future of European freight transport. A contribution to improved safety on roads, which is a priority policy goal, comes from cross-border enforcement of penalties: how to ensure it, having taken into account the current legal and organisational barriers, is an objective for research.

The need to support infrastructure projects of European interest

The huge resources needed for the implementation of large infrastructure projects require suitable tools to enable decision-making that ensures cost-effectiveness. For the same reason, there is a need to develop new approaches to the funding of such investments.

4

Research programmes: The funding frameworks

EU-funded research is carried out principally within the European Commission's framework programmes for research and technological development.

The **Fourth Framework Programme** (FP4) was the first large programme dedicated specifically to research supporting the common transport policy with more than 280 projects funded. Transport projects were also funded under the Telematics Application Programme.

The **Fifth Framework Programme** (FP5) was divided into four thematic programmes with transport covered by Competitive and Sustainable Growth (GROWTH), User-Friendly Information Society (IST), and Energy, Environment and Sustainable Development (EESD). Research for policy-making was covered in particular in the GROWTH key action on sustainable mobility and intermodality.

The **Sixth Framework Programme** (FP6) included seven Priority Thematic Areas (PTA) with transport covered by Sustainable Development, Global Change and Ecosystems (PTA 6), Aeronautics and Space (PTA 4), and Information Society Technologies (PTA 2). Research having a specific policy character was covered by an eighth priority area which also included transport projects, specifically relevant to TEN-T.

This Policy Brochure reports on research results relating predominantly to projects funded under FP6, some of which are still running at the time of publication.

The **Seventh Framework Programme** (FP7) is currently underway, and it is too early to include results in this Policy Brochure. However, project details are included on the TRKC portal. FP7 is divided into 10 thematic priorities. One is transport, including aeronautics, with EU funding of more than EUR 4 billion.

A significant contribution to the definition of the FP7 work programme and of current research needs is a result of the recently-established **European Technology Platforms**. These cover individual modes as well as intermodal transport and continuously update strategic research agendas.

Part of the research reported in this Policy Brochure was carried out within studies funded on a one-off basis by the European Commission's former Directorate-General for Energy and Transport (DG TREN), now the Directorate-General for Mobility and Transport (DG MOVE). Other reported projects belong to the European Commission's **Civil Justice Framework Programme**, and to the EU INTERREG III Programme, which promotes international cooperation and balanced regional development.

In addition, a few national research projects from EU countries are included in the sections that follow. This Policy Brochure also reports on research on deregulation of markets in the EU funded by the **Sloan Foundation** in the United States.

5

Research results and benefits: Findings on individual transport modes and intermodality

Road transport

Impacts of international market opening

A key driver of deregulation of international road freight transport was the desire to eliminate government discrimination based on the nationality of freight transport provider. Resistance to adopting deregulation came from concerns of individual Member States that their domestic carriers would lose business in a more competitive environment. A recent study carried out by the Trucking Industry Programme of the Sloan Foundation has shown that these concerns were unjustified, as the **deregulation of the international trucking sector** did not alter the distribution of this activity across EU countries (Lafontaine and Valeri, 2009). The study also found statistical evidence that the dismantling of the system of authorisations and the elimination of border controls had positive effects in terms of efficiency: likely cost savings were achieved for reasons such as more direct routing and reduced amount of empty backhauls. The cost savings were passed onto shippers who then chose to rely on trucking to a greater extent for their international transport needs.

Cost pricing: Getting the price right

A review of research on road charging and marginal social cost pricing has shown that the soundest principle in transport infrastructure is short-run marginal-cost pricing (**IMPRINT-NET**, 2008). Research has confirmed that charging HGVs on the basis of kilometres driven is a good solution because it encourages efficient road haulage through better load factors and fair competition between countries. Inter-urban kilometre-based charges for HGVs have been introduced so far in Switzerland, Austria, Germany, Czech Republic and in 2010 in Slovakia. HGV charging schemes are being planned in France, Belgium, Hungary, the Netherlands, Poland and Sweden.

Simulation exercises were carried out using the **Brenner TEN-T corridor model** in order to better understand the impacts of **differentiated road tolls** on motorways and inter-urban roads for freight transport (**DIFFERENT**, 2008). The simulations considered a single differentiation criterion or a mix of differentiation criteria (in terms of EURO category, vehicle size and road type) and a number of target variables (travel times, costs, emissions, revenues of operator). The results of cost-benefit analyses have shown that when a single differentiation scheme is implemented, all scenarios produce a loss in social welfare and the costs are always higher than in the BAU (Business As Usual) scenario. The reduction of travel times and emissions are not sufficient to compensate for the significantly higher travel costs. Also, in the case of mixed differentiation schemes the costs of toll schemes exceed the benefits, even though better results are obtained in terms of less traffic congestion and pollutant emissions. In the case of time-saving oriented toll differentiation, gains in social welfare have been achieved.

Interoperable tolling systems

Building on the specifications made in the Directive on the **Interoperable Electronic Road Toll Systems in Europe**, research has designed and demonstrated a high-level architecture for road charging interoperability (RCI, 2008). This RCI architecture is based on dedicated short-range communications (DSRC) and global navigation satellite system (GNSS) technologies and allows any user with the correct on-board equipment (OBE) to access a European Electronic Toll Service anywhere in Europe. This is done through a single contract with the EETS provider, which in its turn stipulates a contract with the toll charger. The user thus receives a minimum number of invoices, and ideally one invoice only. The RCI architecture has been successfully demonstrated with an operational testing involving two trucks travelling through Germany, Switzerland, France, Spain, Italy and Austria, and equipped with one interoperable OBE able to automatically adapt its functional behaviour when crossing borders to comply with the rules of the specific country tolling scheme.

A national research project has developed and demonstrated a functional concept for a kilometre-based charging system for HGVs based on the marginal cost principle (**ARENA**, 2008). In contrast to currently operating systems this concept can manage many toll service providers and is interoperable with the future EETS service. Furthermore, this system can levy tax throughout the entire road network, taking into account road characteristics and static and dynamic vehicle properties.

Research on **interoperability of road charging systems** carried out in the **CESARE IV** (2009a) project has provided useful information for the drawing up of the Commission's Decision on the definition of the EETS, as in the case of the 'EETS basic guidelines', which consists of technical, operational, legal and fiscal conditions for ensuring the interoperability and the successful development of EETS. These conditions, validated on the basis of the results of other projects and initiatives, have been put in the form of rights and duties for the main roles identified by the organisational model (toll charger, EETS provider, service user and interoperability manager). A focus has been put on the development of the legal, administrative, economic and operational framework of the interoperability management and the plan for its implementation (CESARE IV, 2009b).

European-wide information systems

Research in the **DATEX II** (2009) project has developed **standardised specifications for harmonised communication and exchange of traffic information** between traffic centres, traffic operators and other stakeholders across boundaries. This DATEX II protocol permits a more effective use of ITS for cross-border traffic management in implementing the road TEN-Ts. It can also be extended according to users' specific needs, currently covers a wide range of information content in the road transport domain, such as travel times, road infrastructure status, weather and public events which affect traffic conditions. The DATEX II protocol has been deployed both at national and regional level in several European countries.

The effectiveness of cross-border traffic management also depends on the quality and quantity of information provided by the cooperating traffic operators. In this respect, research has investigated the relationship between the quality and costs/benefits of ITS services in order to develop guidelines at European level for the assessment of the **quality of traffic data and information services** and for the definition of optimal quality levels (**QUANTIS**, 2009). The lack of a common definition of quality and standards has been a stumbling block for the improvement of data quality of ITS services. A first step has been taken by publishing an **International Organization for Standardization (ISO)** technical report (ISO, 2008), but the lack of a standard way of defining the aspects of service quality has represented a barrier to the definition of optimum service levels.

A concept for an ICT infrastructure capable of integrating existing information services (such as parking information, traffic information, weather information, etc.) for the provision of a pan-European standard-based **on-trip traffic information service** has been developed (**EMOTION**, 2009). The analysis of legal, organisational, economic and technical issues related to this integrating process has resulted in a set of specifications and

recommendations for the development of this concept, which has been successfully validated with the implementation of two prototypes and a web-based application at city and national level. One of the services provided by this concept is dynamic traffic information specific to HGV drivers.

HEAVYROUTE (2008) has developed a **route planning application for HGVs**. This application permits users to calculate the most cost-effective routes for road freight transport across Europe and improve driving safety. It calculates different solutions which take into account various infrastructure constraints for HGV (bridges, tunnels, environmental zones, etc.) and indicates the most convenient route on the basis of criteria like fuel consumption, environment and infrastructure costs.

Cross-border enforcement

Research has explored opportunities to harmonise legal and operational issues in cross-border enforcement. The **eNFORCE** concept was developed initially within the **VERA2** project. eNFORCE is a network of agencies and organisations responsible for managing the operation of cross-border enforcement. The concept also comprises a data exchange service relating to vehicle owner information. The **VERA3** project developed and tested a pre-operational version of eNFORCE involving Spain, France, the Netherlands and Austria. The concept foresees, in accordance with the **2005 Framework Decision COPEN 24**, that criminal financial penalties for violations committed while the driver is abroad are enforced in his or her home country.

EUROSPARKS was a project co-funded by the EU within the **UK SPARKS Network** which aims at finding solutions for cross-border enforcement of civil traffic laws. This will help local authorities across Europe to carry out enforcement and recover fines. EUROSPARKS carried out an analysis of existing legislation on the mutual recognition of penalties, cooperation between court services and debt recovery. It was found that there is no effective legal basis for the cross-border enforcement of civil offences at European level. Three potential solutions were identified: creation of a new directive, extension of COPEN 24 to cover all financial penalties, and bi- or multilateral agreements between Member States.

Building on best practice from regional approaches that have established bi- or multilateral agreements, a common approach at EU level to cross-border enforcement has been developed by the **CAPTIVE** (2006) project. This approach defines which enforcement processes need to be undertaken in a common way and in accordance with common operational standards. The implementation of a common approach is a complex task as it involves different actors at different levels, from EU to local. Therefore, a plan for implementation has been developed. The provision of a legal basis, which would ultimately enable enforcement of all penalties, is a key element of the plan. For this a series of interim steps envisaging more limited **cross-border cooperation** is proposed, before a full legislative package is implemented. Other elements are technical standards and tools for the automation of data management, which need to build on the experience of the **VERA** projects, the proposed driving licence data exchange system, **RESPER**, and the already operational vehicle registration and driving licence data exchange system, **EUCARIS**.

Rail transport

Implications of liberalisation, harmonisation and interoperability

Much recent research has been directed towards assisting the European policy goals of liberalisation, harmonisation and interoperability on the European rail network.

Liberalisation and harmonisation call for standardised systems for non-discriminatory charging for network access and allocation of train slots that can be implemented effectively on pan-European rail freight priority corridors. The different rates of progress between countries in rail market deregulation and in the emergence of intra-modal and intermodal competition have been shown to be significant impediments to implementing such corridors (**REORIENT**). A demonstration project has investigated such a system for more **transparent bidding for train paths** and charging across EU railways, and for the development of a 'one-stop-shop' for requesting short-term paths (**PARTNER**). Such liberalised access requires improved systems of route management, not least to manage the expected greater demand for route capacity (**NEW OPERA**). An independent European body may be required to ensure that there is no discrimination between different types of trains and that the same priority rules apply across all corridors (NEW OPERA, PARTNER).

Increasing rail traffic as a result of modal shift and on-rail competition will require attention to the **various bottlenecks and capacity restrictions** at key locations on the rail network. As many such bottlenecks are exacerbated by the different speeds of different types of trains, more homogenous speeds would be advantageous. New dedicated high speed train routes can help free up valuable capacity for freight trains and local passenger trains on existing routes, suggesting that an overview approach to traffic allocation is needed. By improving rolling stock rotation times and increasing the productive use of drivers, easing of bottlenecks could lead to significant cost reductions, perhaps between 30% and 50% of operating costs when considered alongside the use of longer freight trains (NEW OPERA).

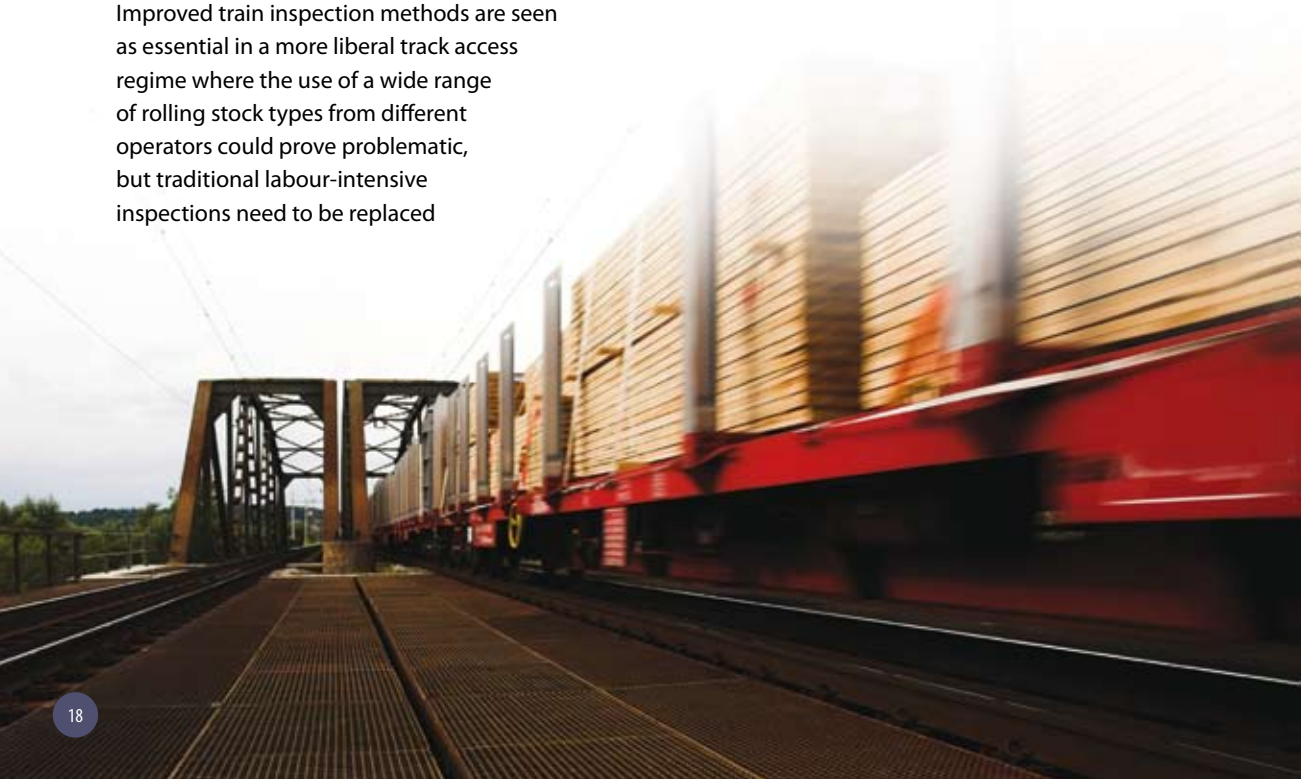
Given the difficulties in expansion of rail infrastructure in the short term, **longer trains** offer perhaps the best option of using existing capacity more effectively (**FERRMED**, 2008). When new infrastructure is being designed,

consideration should be given to providing a loading gauge that allows double-stack container operations (NEW OPERA).

Better use of rail route capacity also calls for faster freight trains that can **integrate more successfully with passenger timetables**. This requires higher-powered locomotives for freight trains, which is a particular problem on non-electrified routes. As a result the balance between electric and diesel traction is moving in favour of electric (NEW OPERA). Where electrification is not viable, other alternatives to diesel for high-performance freight operation have been considered, both in terms of cost and environmental performance. Simulated operations on a major French rail corridor indicate that a gas turbine locomotive would be advantageous in terms of emissions, reliability and overall cost over a 30-year life cycle, a diesel locomotive with the same level of performance would consume less energy (**ELODIT**).

Improved train inspection methods are seen as essential in a more liberal track access regime where the use of a wide range of rolling stock types from different operators could prove problematic, but traditional labour-intensive inspections need to be replaced by technical solutions in order to provide improved safety and service quality together with reduced operating costs. Automated checkpoints to detect overheating axle boxes have been developed and installed on a railway line between Vienna and the Austrian-Hungarian border (**CHECKPOINT**).

Interoperability is key to competitive international rail freight operations to enable trains to pass seamlessly between national networks. Across Europe there is considerable variation in interoperability status between countries, with much lower impediments to achieving interoperability in some countries (e.g. in Scandinavia) than in others, such as new Member States and Greece. A study of barriers to interoperability along a major international rail freight corridor in the east of Europe has identified that **technical issues are the biggest single barrier**. The high cost of making the required technical changes is also a major barrier to implementing the EU's interoperability directives (REORIENT).



Border crossing delays are a major factor impeding the timeliness and cost-effectiveness of international rail freight movement, because they entail interchange of traffic between **Infrastructure Managers (IMs)** and often also involve a transfer of haulage from one **Train Operating Company (TOC)** to another. Demonstration projects have examined various border transfer stations, some involving a change of track gauge, and have shown that significant reductions in border waiting times can be achieved, largely by the introduction of better and more integrated data management and transfer systems rather than through changes to physical operating systems (**INTERFACE**).

The busy Brenner route is a particularly challenging rail corridor which would benefit from improved interoperability, especially for rail combined transport services. This has been the subject of both research and demonstration projects, covering such aspects as:

- **the provision of interoperable rail traction involving multi-voltage locomotives;**
- **the development and testing of specialised wagons suitable for the carriage of conventional road semitrailers for unaccompanied intermodal transport;**
- **improved information systems providing for online train monitoring including estimated time of arrival (ETA) information accessible for all parties involved in rail transport (including infrastructure operators train operators, combined transport companies and terminal operators) and the specification of a coherent and transparent corridor management scheme (BRAVO).**

Management of freight traffic, maintenance and safety

Research has continued into the development and implementation of the **European Rail Traffic Management System** and the associated **European Train Control System (ETCS)**, including research into their impacts on improving interoperability along major rail freight corridors. It has shown that whilst implementation of the early technological stages of the system would yield only modest benefits in terms of increased capacity, the so-called ETCS level 3, which involves replacing traditional fixed block signalling sections with a 'moving block' system, could lead to capacity increases of up to 50% (NEW OPERA).

Whilst European railways have made substantial progress in the development of information systems for particular important aspects of their operations, different elements of information management systems within organisations are often poorly interfaced and there are many difficulties in exchanging information in a timely manner. Research is now underway in an attempt to create a holistic, coherent rail information management system which will integrate major railway sub-systems (**TAF-TSI**). The basic information system requirements for train control and monitoring, maintenance, management and communications will be redefined, paving the way for widespread introduction of innovation in the management of infrastructure, traffic management (including ERTMS), train operations and rolling stock (**INTEGRAIL**).

Safety management is also important for a liberalised rail freight market, as safety approval is a

significant barrier to entry in many cases. Research has been conducted towards developing a common safety management system for European railways, to establish a consistent and common set of criteria for safety performance, to provide guidance for setting safety and performance targets, and for assessing risks and for specifying duties, rules and regulations. A key aim of such research is to develop a comprehensive and consistent safety management programme for European railways which would assist in the development of interoperability (**SAMRAIL**).

Maintenance management has also received attention, with particular emphasis being placed on methods for collecting real-time data on the maintenance status of equipment and rolling stock. A **European Diagnostic Data Network** (EDDN) is under development with the aim of providing immediate diagnostic information so that operators know the status of all equipment, and maintenance can be scheduled effectively. A **European Technical Documentation Network** (ETDN) aims to use computer and web technologies to improve the benefits and usability of technical manuals and documents (**EUROMAIN**). Standard communication infrastructures have been defined to support a wide range of applications that will allow improved train fleet management based on remote diagnostics and maintenance (**TRAINCOM**). The creation of maintenance databases based on the concept of Reliability **Centred Maintenance** (RCM) allows more accurate information on repair costs and the costs of preventive maintenance, and facilitates the development of a Life Cycle Costing (LCC) approach to items of rail infrastructure (**RAIL**).

The need for increased use of ICT and ITS

There is a need for **significantly increased use of ICT and ITS technologies** in the rail freight industry if it is to become more competitive against road transport in particular. Research has identified a range of benefits – to users but more particularly to rail operators – from the use of such technologies for wagon fleet management, including tracking and tracing of such assets (**F-MAN, FIRE**). Efficient data exchange through the effective use of advanced ICT is seen as important in promoting interoperability and in reducing delays at border crossings. Through the development of **effective system interfaces**, rail operators can continue to use their existing data formats and protocols whilst still benefiting from a more integrated management of the end-to-end freight transport corridor. Data exchange and information integration can be facilitated by using a state of the art message broker (**CroBIT**).

Other research has examined how to provide customer-driven rail freight services on the long corridor between the Benelux countries and Turkey, on which complex interoperability and border crossing issues need to be resolved. Measures include integrated telematics solutions for train control, tracking and tracing of shipments, effective ways of handling temperature-controlled cargoes and new technology for the transport of unaccompanied semi-trailers as well as the provision of information to customers. Integration of the new *Betuwelijn* railway line in the Netherlands with the wider European rail network has also been investigated (**CREAM**).

Waterborne transport

The use of ICT to increase interoperability, harmonisation and standardisation

Vessel Traffic Management and Information Services (VTMIS) is a concept for the provision of maritime information services in response to public and private demand. It aims to minimise risks for safety and the environment while maximising the efficiency of waterborne transport. Research has been conducted to identify and demonstrate how safety and efficiency in waterborne transport may be enhanced whilst recognising the value that certain derived information may present to other transport modes, thereby improving interconnectivity and interoperability between modes (**EMBARC**).

It has been recognised that a more pro-active approach to the management of vessel traffic in European waters, and the enhancement of services provided to shipping in general, will promote a safer, more efficient and environmentally-friendly platform for maritime transport. The **MARNIS** project has recommended improved exchange of information and interaction between the various authorities related to maritime transport and traffic, including not only maritime safety related authorities but also enforcement authorities such as customs and immigration.

Technology has been employed in developing the functional architecture of a secured cargo black box application which allows tracking and tracing of vessels at all times. The **S-CBB** project has shown that the use of modern telematics applications can provide proof of discharge of goods. This will be achieved by minimising administrative procedures and guaranteeing the integrity of operations within the EU.

The **ALSO DANUBE** project focused on offering SMEs inexpensive ICT solutions for the planning, management, monitoring and administration of intermodal logistics chains utilising inland navigation as an environmentally-friendly mode of transport. The implementation of such solutions to the European waterway network will improve the competitiveness of inland navigation as a whole.

ALSO DANUBE introduced new systems and technologies in the area of data exchange and communication. The increasing opportunities to move freight along the river Danube and the number of countries involved require a more extensive exchange of geographical data and closer cooperation between them. An open virtual network, based on a broad European approach, linked actors in logistics chains by interconnecting existing information and communication systems via a **Common Source Logistic Database** (CSL. DB). This was also interactively linked to traffic management systems (e.g. the River Information System, **DoRIS**, in Austria). Web-based client applications, advanced Electronic Data Exchange (EDI) solutions and innovative telematics technologies were integrated, demonstrated and evaluated within different supply chains.

Air transport

The Single European Sky challenge

Today, the European **air traffic management** (ATM) system is fragmented both in terms of service provision and equipment. Decisions by stakeholders involved in planning, managing and executing flights are taken in isolation from each other, even when they have impacts on others. This leads to inefficient flight profiles. The diversity of standards and manufacturers for technical equipment is also the cause of extra costs, imposed by inefficient procurement and unnecessary customisation. The current level of interoperability between air traffic management systems in Europe is low, especially in ground systems.

An answer to these challenges is provided by the EU **Single European Sky ATM Research (SESAR) Programme** which constitutes the technological pillar of the Single European Sky policy. SESAR aims at developing the new generation air traffic management.

SESAR has developed a new approach to air traffic management known as the **SESAR concept of operation** (SESAR, 2007). Key features of the concept are the move from airspace to trajectory based operations, which allows aircrafts to achieve preferred routes and arrival times, and collaborative planning, which allows parties involved in flight management to collaborate and establish network operations plans. This contributes to enhanced flight efficiency. In addition, the concept foresees that new technologies will be embedded into a harmonised and interoperable technical architecture.

Research in the **C-ATM** project had contributed to the development of the SESAR operational concept, in particular for the aspects relating to the collaborative processes and the communication of data between the different stakeholders involved in the strategic, tactical and real-time phases of the definition of the network operations plans. More recently, the **SUPER HIGHWAY** project has addressed the design of a network of routes in the European airspace in compliance with the airspace organisation described by the SESAR operational concept.

TEN-T

Supporting the implementation of large infrastructure projects

EVA-TREN (2008) research has developed guidelines for improving the **methodologies** for **the assessment** of large infrastructure projects. These guidelines take into account that the evaluation of a project is a continuous process from the initial concept to the operational phase, and focus on the interactions between *ex-ante* appraisals, monitoring and ex-post evaluation. The ex-post evaluation of a number of projects considered strategic for the development of TEN-T provided useful inputs for improving the methodologies for ex-ante appraisal.

One project has developed a scientific approach to the **funding of large transport infrastructure investments** at the European level (**FUNDING**, 2007). Possible structures for an EU transport infrastructure fund have been considered, as well as issues related to decision criteria, acceptability, efficiency and spatial equity effects. The project used a **spatial computable general equilibrium model** to explore the regional economic impacts of TEN-T priority projects. The model was also used to assess the Europe-wide spatial equity and efficiency impacts of a hypothetical European infrastructure fund that would provide an EU subsidy proportional to the benefit spillovers outside the investing countries. The main conclusions have been that the rate of return of many projects is low and not all projects have significant benefit spillovers; however, when benefit spillovers have been assessed, the rate of return increased significantly.

The creation of a network for the dissemination of knowledge on the **management and organisation of large infrastructure projects** in the EU has gathered useful information on best practices and lessons learnt, and helped develop an evaluation and monitoring tool (the Infrastructure

Project Assessment Tool), which permits a more efficient implementation and monitoring of large infrastructure projects (**NETLIPSE**, 2010). This research has identified a management approach which offers, in combination with other specific factors, the best chances of success in managing the complexity of large infrastructure projects. This includes high level of cooperation between stakeholders, capable project supervisors, involvement of competent people, capability of finding new management solutions and the capability of using windows of opportunity.

Better exploitation of the existing infrastructure

Research in the **ARCHES** (2009) project has developed tools and procedures for a more efficient assessment of the conditions of highway structures linking the Central and Eastern European Countries (CEEC) and EU Member States and their faster, cost-effective, long-lasting rehabilitation in order to make them adhere to the Member States' quality standard. These tools cover:

- structural assessment and monitoring of highway structures to optimise their use and avoid unnecessary interventions;
- strategies to monitor and prevent their deterioration and improve their strength and durability by using innovative reinforcement materials and techniques;
- complementary techniques to achieve their optimum rehabilitation.

Intermodality

Striving for larger market share

The **greater use of intermodality** is a key element of EU freight transport policy. There continues to be considerable research effort in the intermodal field. Various ways of reducing the costs of door-to-door intermodal transport – in terms of technical, organisational and commercial aspects – have been identified, as have ways to improve service quality. The possible impacts of such initiatives have been tested on three important EU corridors: Patras – Gothenburg, Genova – Manchester, and Barcelona – Warsaw. The likely impacts of the internalisation of external costs of the various modes of freight transport have also been studied (**RECORDIT, REALISE**).

Developing the technology

Research has continued at European level into the design, development, evaluation and application of improved technologies for intermodal freight transport. Rail 'piggyback' movement of road trailers suffers from complex and time-consuming terminal operations due to the need to load the trailers in sequence along the train. An **innovative rail wagon** has been designed, featuring a swivel well-wagon design whereby all wagons of a train can be loaded simultaneously (**MODALOHR**). This would reduce terminal costs and dwell times, allowing rail to compete over much shorter distances than traditionally – some 300 km rather than 500-600 km as at present (**CARGOSPEED**). Similar wagons were envisaged in research into improving the intermodal rail share of freight traffic on the Brenner corridor (BRAVO).

Various existing and potential technologies for the **horizontal transfer of unit loads** between modes (i.e. transfer without the need for vertical lifting) have been evaluated in order to determine their role in supporting interoperability in terms of handling methods and their ability to be incorporated into existing intermodal transport operations. **INHOTRA** has successfully demonstrated the most promising types of such transfer technology.

Fast freight train services and networks could compete against air freight in Europe, but also coordinate with air on a global scale to provide the European legs of longer routes. Research has been conducted into how such **express rail freight systems** can be developed to serve the air freight and time-critical cargo sectors. One pilot study examined a link between Amsterdam Schiphol and Frankfurt Airport (**CO-ACT**) and another undertook research into links to Paris Roissy – Charles de Gaulle airport (**CAREX**). The European Intermodal Association (EIA) will investigate pan-European challenges such as terminal and interoperability issues.

The use of ICT and ITS

It is widely accepted that ICT and ITS hold great promise for the reduction of the potential problems of intermodality resulting from the fact that there are modal transfers to manage and that often a multitude of different actors are involved during the door-to-door journey. A European thematic network has reviewed a wide range of EU projects relating to intermodal freight transport as to the likely future use of ICT/ITS, the proposals for further exploitation of ICT/ITS in the field, and the likely ways in which such technologies will be deployed in the future (**E-FREIGHT, THEMIS**).

A European coordination action for intermodal freight transport has taken a case study approach to identifying best practice in ICT applications in intermodal transport, covering amongst other applications tracking and tracing, asset management, IT-based administrative procedures and the integrated management of the door-to-door intermodal system (**PROMIT**).

Various EU research projects have developed **web-based applications** for the management of intermodal freight transport (**SMART-CM**), involving the development of pilot scheme multimodal information systems and online access to intermodal service timetables, service offerings and prices, tracking and tracing of consignments, and information on exceptions (**CESAR II, D2D**). An open access web portal and e-marketplace providing a comprehensive range of services necessary to provide door-to-door intermodal freight transport has been designed, developed and tested (**GIFTS**). An expanded information system relating to combined transport services, including amongst other elements timetables available on the Internet, was developed as part of the development of the Brenner corridor and is now in use with intermodal operators (BRAVO).

In recognition of the potential cost advantages to large operators of installing expensive ICT/ITS solutions in intermodal freight transport, there has also been research into **lower cost ICT solutions** that would allow small and medium-sized enterprises (SMEs) to compete effectively in such transport chains, highlighting major advantages to such companies like the development of vastly simplified online freight booking and reservation systems (**FREIGHTWISE**).

A real-time end-to-end **tracking and tracing system**, involving active radio tags, and able to operate across all operators, modes and borders, has been developed, demonstrated and evaluated for the specific needs of the parcels sector (**PARCELCALL**).

ICT is also seen as having a role to play in reducing **border crossing delays**. Three demonstrator projects on the scope for innovative solutions to reduce the times required for border crossings have focused on providing a better flow of real-time information between actors and (where appropriate) faster transhipments between trains where issues such as changes in track gauge remain. Combinations of such measures have been shown to offer very significant time savings at borders (**INTERFACE**).

Further research has applied state of the art technologies in the fields of sensing, tracking and tracing, telecommunications and data processing to intermodal transport, to enhance **security and safety especially for hazardous cargoes**. The resulting system allows such cargoes to be tracked and monitored in real-time using a web portal (**SIMTAG**).

6

Policy implications of research: What to do now?

Road transport

Fair pricing policies, which charge users according to real costs, require a correct estimation of internal and external transport costs. The use of case studies and transport accounts data can produce reliable marginal-cost estimates for the formulation of efficient pricing policy. Research on pricing differentiation has shown that it is better to build gradually on existing differentiation, giving priority to differentiation elements which are easy to understand by users and providing adequate information on the price structure of the charging schemes. Dedicated EU directives should provide the legislative framework and define principles and scope of pricing schemes.

The RCI high-level architecture for **road charging interoperability** has provided a European technical reference for the development of DSRC/GNSS-enabled road charging solutions, and has been endorsed in the EETS Decision of 2009.

The **DATEX II** data exchange specifications between traffic operators at European level have become a standard under the Technical Committee 278, 'Road Transport and Traffic Telematics', of the European Committee for Standardization (CEN). However, in order to pursue its policy objectives of enhanced safety and efficiency in the European road network, the EU should also encourage the harmonisation across Europe of Variable Message Signs (VMS), which should provide standardised presentations of information to road users.

The existing proposals put forward at EU level relating to **cross-border penalty enforcement** are restricted to a class of criminal offences in the area of safety. The scope of these proposals needs to be substantially increased. This is important in light of the widespread implementation of toll collection systems for HGVs across Europe. The EU should aim to create a common data-sharing system and a legal framework for enforcement of all penalties. This way, all road users will be assured of fair treatment according to the Treaty principle of non-discrimination, and a contribution will be made to the achievement of road safety targets.

Rail transport

Recent research has significant implications for railway infrastructure operators and train operating companies, both in terms of identifying investment priorities for many aspects of railway operation including infrastructure, rolling stock and information systems.

Perhaps more important are the lessons for national governments regarding how they can achieve the required **liberalisation of rail markets** and the much needed **interoperability between different railway networks**, particularly in the international freight sector. Increased

interoperability and exchange of traffic between European networks leads to a greater need to ensure compatibility between technical systems used in each country, but given that technical barriers at borders, such as track gauge changes, are not likely to be resolved except in the longer term, interoperability rests more on management and information systems than on new technology.

Hence there are important lessons to be learned about how ICT can be harnessed in order to achieve **maximum compatibility and ease of information transfer** across company and national boundaries. New systems need to be complementary to existing information systems used by national organisations, calling for considerable attention as to how different information sub-systems are interfaced.

In the longer term systems will need to be replaced with much greater scope and functionality. This will raise continuing questions about the design of such systems as well as their costs. More generally, there is a need to focus on how new technologies, and most particularly ICT technologies, can be harnessed and effectively implemented to reduce industry costs.

Waterborne transport

The highly international nature of the maritime shipping industry poses great challenges for the implementation of **standardised systems of management and control**, and for maintenance of high standards of safety on a pan-European scale. Water transport, both maritime and on inland waterways, plays a major role in bulk freight movements in Europe. The challenge is to capture traffic and market share in more general, merchandise freight markets.

'**Motorways of the Sea**' is not yet a proven concept and major challenges remain in turning it into sustainable commercial operation, largely due to the high costs to shippers of such services. Policy-makers need to address how the costs of such door-to-door operations can be made more competitive to ensure the future viability of such shipping operations.

Air transport

The operational concept defined within the SESAR Programme for European air traffic management of the future will contribute to cost-effectiveness targets by reducing the cost per flight. There is a need to align the SESAR technological research programme with the '**functional airspace blocks**' initiatives currently underway in order to achieve additional benefits like defragmentation and creation of economies of scale.

TEN-T

The EU should encourage the development of appropriate models to more effectively assess the **economic convenience of large transport infrastructure projects** applying for Community funding. The infrastructure project assessment tool developed by research has made a significant contribution to the improvement of the management of complex projects for both the EU and Member States.

Intermodality

Intermodal freight transport offers one of the best opportunities for increased use of rail and water modes because of its ability to integrate such modes effectively within longer door-to-door transport movements. However, achieving this integration requires considerable policy intervention.

Policy-makers need to plan for, and possibly influence, the range of **future intermodal technologies**. There is a need for cooperation at international level to agree on and streamline pan-European industrial business processes and procedures in a holistic sustainable approach (EIA policy goals). Investments are needed in order to reach holistic logistics goals of being seamless, reliable, available, accessible, secure, sustainable, accountable, affordable and transparent (EIRAC research criteria).

Increased use of ICT is especially important for intermodal transport due to the need to create seamless door-to-door transport movement involving two or more modes and to allow information flow between the various actors, operators and intermediaries involved.

Key European freight transport corridors need to be provided with strong intermodal capability, which will entail further **development of rail and water modes and the elimination of capacity bottlenecks**. **SuperGreen** aims to assist the Commission with defining the '**Green Corridor**' concept and promotes the development of European freight logistics in an environmentally-friendly manner. Adequate provision of intermodal terminals must be ensured at key traffic generating points and good intermodal connections between ports and their hinterlands must be ensured.

7

Future research developments: What next?

Road transport

Research has successfully demonstrated the RCI architecture, but further research is needed for preparing the industrial development of the EETS. There is a particular need for a deeper analysis of issues relating to intellectual property rights and the definition of a clear European roadmap to the **deployment of the EETS.**

With respect to **cross-border enforcement**, research should focus on identification of practical solutions relating to data sharing, classification of offences and enforcement processes, as well as on sharing of best practice.

A number of research needs are currently being addressed by ongoing research projects. In line with the European Commission's ITS Action Plan (CEC, 2008c), **EASYWAY** is supporting a service-oriented deployment of ITS by promoting the harmonisation of services and the coordination of traffic information and management systems with a view to providing European road users with Europe-wide integrated services.

E-FREIGHT is investigating issues related to the simplification and harmonisation of regulatory requirements across modes and EU Member States. It is in particular investigating solutions for a single transport document in order to make the flow of goods in the EU smoother. **FREIGHTVISION** is developing a long-term vision and action plan for sustainable long-distance freight transport able to attract – as much as possible – all stakeholders' commitments.

Rail transport

The major strides now being taken to liberalise the rail freight market, and to

boost competition both within the rail industry and between modes, call for further research, including work in the field of efficient pricing.

Further major developments in ICT can be expected in the coming years and this will call for further work into how such technologies can be implemented to the benefit of the European rail industry.

Strategic Rail Research Agenda 2020

The European Rail Research Advisory Council has identified areas of research to improve the integration of freight rail transport (ERRAC, 2007):

- **intelligent mobility:** to work towards a European-wide intelligent infrastructure with compatible technology between Member States and across transport modes, and to support improved customer information systems;
- **faster implementation of new technologies:** to improve the spread of European homologation, calling for streamlined testing and acceptance procedures without compromising safety regimes;
- **new accounting and planning models:** to provide a better understanding of the costs of operating and maintaining rail infrastructure;
- **infrastructure developments:** to deliver interoperability, increased capacity, increased axle weights and track stability while having low maintenance costs.

Finally, EU enlargement brings opportunities and a need for further research into rail infrastructure investment requirements to enhance integration and development. A clearer view of the strategic network requirements is needed. The technical and managerial issues impeding the development of intermodality and interoperability also require further attention.

Waterborne transport

Additional research is required to address the following issues in waterborne transport:

- how to make **better use** of the existing infrastructure;
- how to **increase the share** of inland **waterway** transport and shift more freight from road to water;
- how to achieve better communication of the new concepts among all stakeholders;
- how to develop short sea shipping further (to alleviate environmental pressures) and to achieve **seamless integration from port to hinterland**.

More research is needed on the issue of better connecting emerging markets and peripheral regions with the European core regions using the advantage offered by sea transport, specifically through the development of an innovative European network of 'Motorways of the Sea'. In particular, issues relating to the efficient link of sea transport with other surface transport modes will be addressed by identifying barriers which currently prevent short sea shipping services from becoming an integrated part of door-to-door supply chains.

Air transport

Research relevant to the development of the Single European Sky will be carried out within the umbrella framework of the SESAR Programme. The definition phase of the **European air traffic management system of the future** has concluded and it has now entered the development phase, which will produce the required new generation of technological systems.

Intermodality

Priority areas for research

The following priority areas for research have been identified for improving intermodal freight transport (EIRAC, 2005; EUTP II):

- **standardisation of loading units** to improve interoperability;
- setting up of a **network of transfer nodes** around Europe;
- eliminating differences in **national regulations** which currently are barriers to achieving seamless and flexible interoperability across Europe;
- defining the most suitable ICT system which can serve the needs of all participants;
- harmonising paperwork, simplifying and reducing the number of **transport documents**;
- reviewing existing regulations at European and international level to develop an integrated approach to the implementation of **security** measures for freight transport, and for risk assessment along the whole chain;
- improving the **cooperation** between the actors within the supply chain, which may result in higher competitiveness through lower costs, shorter lead times and better quality of service.

8

References

Note that for projects where no website is given, project information can be obtained from the TRKC website at www.transport-research.info
Websites given in the references below were last accessed in the period 1-12 April 2010.

- ALSO DANUBE, Advanced Logistic Solutions for Danube Waterway, FP5. www.alsodanube.at
- ARCHES (2009), Assessment and Rehabilitation of Central European Highway Structures, Deliverable D15: Final Activity Report, FP6. www.arches.fehrl.org
- ARENA (2008), Kilometre tax for heavy goods vehicles in Sweden. A proposal for a functional concept, ARENA Report 2008.1. National project from Sweden. www.arena-ruc.com
- BRAVO, Brenner rail freight action strategy aimed at achieving a sustainable increase of intermodal transport volume by enhancing quality, efficiency and system technologies, FP6. www.bravo-project.com/home/index.shtml
- CAPTIVE (2006), Common application of traffic violations enforcement, final report. www.ec.europa.eu/transport/roadsafety_library/publications/captive_final_report.pdf
- CARGOSPEED, Cargo Rail Road Interchange at Speed, FP5. www.cargospeed.net
- C-ATM, Co-operative Air Traffic Management, FP6
- CEC (1996), "A Strategy for Revitalising the Community's Railways", White Paper. COM(96)421, Brussels
- CEC (1997a), "Trans-European Rail Freight Freeways". COM(97)242, Brussels
- CEC (1997b), "Sea Ports and Maritime Infrastructure", Green Paper. COM(97)678, Brussels
- CEC (1997c), "Intermodality and intermodal freight transport in the European Union. A system approach to freight transport. Strategies and actions to enhance efficiency, services and sustainability". COM(97)243, Brussels
- CEC (1998), "Proposal for a Council Directive relating to the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure, proposal for a Council Directive amending Directive 95/18 on the licensing of railway undertakings, proposal for a Council directive amending Council directive 91/440 on the development of the Community Railways". COM(98)480, Brussels
- CEC (1999), "The development of short sea shipping in Europe: a dynamic alternative in a sustainable transport chain – 2nd progress report". COM(99)317, Brussels
- CEC (2001), "European Transport Policy for 2010: Time to Decide", White Paper. COM(2001)370, Brussels
- CEC (2003), Programme for the Promotion of Short Sea Shipping and a draft Directive on Intermodal Loading Units. COM(03)155, Brussels
- CEC(2006a), "Communication from the Commission on the promotion of inland waterway transport NAIADES – An integrated European action programme fro inland waterway transport". COM(2006)6, Brussels
- CEC (2006b), "Keep Europe moving – Sustainable mobility for our continent", Mid-term review of the European Commission's 2001 Transport White Paper. COM(2006)314, Brussels
- CEC (2007a), "The EU's freight transport agenda: Boosting the efficiency, integration and sustainability of freight transport in Europe". COM(2007)606 final, Brussels

- CEC (2007b), "Towards a European maritime transport space without barriers", working paper. (SEC 2007), Brussels
- CEC (2007c), "Freight Transport Logistics Action Plan". COM(2007)607, Brussels
- CEC (2008a), "Strategy for the internalisation of external costs". COM(2008)435, Brussels
- CEC (2008b), "Proposal for a Directive of the European Parliament and of the Council amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures". COM(2008)436/3, Brussels
- CEC (2008c), "Action Plan for the Deployment of Intelligent Transport Systems in Europe". COM(2008)886, Brussels
- CEC(2008d), "Proposal for a Directive of the European Parliament and of the Council facilitating cross-border enforcement in the field of road safety". COM(2008)151, Brussels
- CEC(2008e), "Proposal for a Regulation of the European Parliament and of the Council concerning a European rail network for competitive freight". COM(2008)852, Brussels
- CEC (2008f), "Proposal for a Regulation of the European Parliament and of the Council of 25 June 2008 amending Regulations (EC) No 549/2004, (EC) No 550/2004, (EC) No 551/2004 and (EC) No 552/2004 in order to improve the performance and sustainability of the European aviation system". COM(2008)388, Brussels
- CEC(2009a), "EU Energy and Transport in Figures. Statistical Pocketbook 2009". Directorate-General for Energy and Transport, Brussels
- CEC (2009b), "A sustainable future for transport: towards an integrated, technology-led and user-friendly system". COM(2009)279/4, Brussels
- CEC (2009c), "TEN-T Trans-European Transport Networks. Implementation of the priority projects. Progress Report 2009". Directorate-General for Energy and Transport, Brussels
- CEC (2009d), "TEN-T: A policy review – Towards a better integrated trans-european transport network at the service of the common transport policy", Green Paper. COM(2009)44, Brussels
- CESAR II, Co-operative European System for Advanced information Redistribution II, FP5. www.cesar-online.com
- CESARE IV (2009a), Common Electronic Fee Collection System for a Road Tolling European Service, Newsletter Issue 5. CESARE IV project, CEC, DG Energy and Transport. www.asecap.com/english/projets-cesare4-en.html
- CESARE IV (2009b), Common Electronic Fee Collection System for a Road Tolling European Service, report D2.1 (version 3.2): Interoperability Management Framework, CEC, DG Energy and Transport. www.asecap.com/english/projets-cesare4-en.html
- CHECKPOINT, The integration of checkpoint systems into solid state interlockings for automatics train supervision. Austrian Innovative System Railway (ISB) research project
- CO-ACT, Creating Viable Concepts for Combined Air/Rail Cargo Transport, FP5
- CREAM, Customer-driven Rail-freight services on a European mega-corridor based on Advanced business and operating Models, FP6
- CROBIT, Cross-Border Information Technology, FP5. www.crobit.org

- DATEX II (2009), DATEX II – the key to successful information exchange. DATEX II project, CEC, DG Energy and Transport. www.datex2.eu
- Degli Abbati C. (1987), "Transport and European Integration". CEC, Brussels
- DIFFERENT (2008), User Reaction and Efficient Differentiation of Charges and Tolls, D8.3 – D9.2: Report on Impacts of Charge Differentiation for HGV and Motorway Toll Differentiation to Combat Time Space Congestion, FP6. www.different-project.eu
- D2D, Demonstration of an integrated management and communication system for door-to-door intermodal freight transport operations, FP5. www.d2d.no/d2d
- EASYWAY, Linking Europe in a harmonised way, TEN-T 2007-2013 Multi Annual Programme. www.easyway-its.eu
- E-FREIGHT, European e-Freight capabilities for Co-modal transport, FP7. www.efreightproject.eu
- EIA, European Intermodal Association. www.eia-ngo.com/category/projects
- EIRAC (2005), Strategic Intermodal Research Agenda 2020, European Intermodal Research Advisory Council. www.eirac.eu
- ELODIT, High-powered locomotive for non-electrified lines. French Technologies for goods transportation (Operational Group 6) research project
- EMBARC, European study for baseline and advanced regional and coastal traffic management, FP5
- EMOTION (2009), Europe-wide Multi-modal On-trip Traffic Information, executive summary, FP6. www.emotion-project.eu
- ERRAC (2007), "European Rail Research Agenda 2020", European Rail Research Advisory Council. www.errac.org
- EUROMAIN, European railway open maintenance system, FP5. www.euromain.org
- EUROSPARKS. Cross-border civil traffic enforcement – Legal research. Project funded by London's Enforcement Task and the European Commission's Civil Justice Framework Programme. www.eurosparks.org
- EUTP II, Thematic Network on Freight Transfer Points and Terminals, FP5. www.eutp.org
- EVA TREN (2008), Improved Decision-Aid Methods and Tools to Support Evaluation of Investment for Transport and Energy Network in Europe, final report, FP6. www.eva-tren.eu
- FERRMED (2008), Explanatory Dossier: Linking harbours and promoting a sustainable railway freight network. www.ferrmed.com/eng/
- FIRE, Freight Information in the Railway Environment, FP4
- F-MAN, Rail Car Asset Management, FP5. www.fman.org
- FREIGHTVISION, Vision and action plans for European freight transport until 2050, FP7. www.freightvision.eu
- FREIGHTWISE, Management Framework for Intelligent Intermodal Transport, FP6. www.freightwise.info/cms
- FUNDING (2007), Funding Infrastructure: Guidelines for Europe, final report, FP6. www.econ.kuleuven.be/funding

- GIFTS, Global Intermodal Freight Transport System, FP5. www.gifts.newapplication.it/gifts/
- HEAVYROUTE (2008), Intelligent Route Guidance for Heavy Vehicles, D 3.1: First version of design and specification of route guidance, driving support and critical infrastructure management, FP6. heavyroute.fehrl.org
- IMPRINT-NET (2008), Implementing pricing reforms in Transport – Networking, deliverable 2: Pricing reforms in the inter-urban road sector, FP6. www.imprint-net.org
- INHOTRA, Integration of Interoperable Intermodal Horizontal Transhipment Techniques in Intermodal Transport Operators, FP5. www.inhotra.org
- INTEGRAIL, Intelligent integration of railway systems, FP6. www.integrail.info
- INTERFACE, Improvement of intermodal terminal freight operations at border crossing terminal, FP5. www.newopera.org
- ISO (2008), "Intelligent Transport Systems - Integrated transport information, management and control – Data quality in ITS systems", ISO/TR 21707:2008
- Lafontaine F. and Malaguzzi Valeri L. (2009), "The deregulation of international trucking in the European Union: form and effect", Journal of Regulatory Economics 35, p.19-44
- MARNIS, Maritime Navigation and Information Services, FP6. www.marnis.org
- MODALOHR, The low-floor and articulated MODALOHR wagon. www.modalohr.com/gb.htm
- NETLIPSE (2010), Network for the Dissemination of Knowledge on the Management and Organisation of Large Infrastructure Projects in Europe, Playing with Complexity – Management and Organisation of Large Infrastructure Project, FP6. www.netlipse.eu
- NEW OPERA, New European wish: operation project for European rail network, FP6. www.newopera.org
- PARCELCALL, An Open Architecture for Intelligent Tracing Solutions in Transport and Logistics, FP5
- PARTNER, Path allocation re-engineering of timetable network for European railways, FP5
- QUANTIS (2009), Quality Assessment and Assurance Methodology for Traffic Data and Information Services, deliverable 1: Definition of Key European ITS Services and Data Types. CEC, Directorate-General for Energy and Transport. www.quantis-project.eu
- PROMIT, Promote innovative intermodal freight transport, FP6. www.promit-project.net
- RAIL, Reliability centred maintenance (RCM) Approach for Infrastructure and Logistics of Railway Operations, FP5. www.datsi.fi.upm.es/~rail/index.html
- RCI (2008), Road Charging Interoperability Pilot Project, final brochure, FP6. www.ertico.com/en/projects/completed_projects/rci.htm
- REALISE, Regional Action for Logistical Integration of Shipping across Europe, FP5. www.realise-sss.org/
- RECORDIT, Real Cost Reduction of Door-to-door Intermodal Transport, FP5. www.recordit.org

- REORIENT, Implementing change in the European railway system, FP6.
- Ross J.F.L. (1998), "Linking Europe. Transport Policies and Politics in the European Union", Praeger
- SAMRAIL, Safety management in railways, FP5. www.samnet.inrets.fr
- S-CBB, Secured Cargo Black Box, FP5. www.cargoblackbox.com
- SESAR, Single European Sky ATM Research. www.eurocontrol.int/sesar/public/subsite_homepage/homepage.html
- SESAR (2007), The ATM Target Concept. SESAR Definition Phase, deliverable 3, Single European Sky ATM research programme (2007)
- SIMTAG, Safe Intermodal Transport Across the Globe, FP5
- SMART-CM, SMART Container Chain Management, FP7. www.smart-cm.eu/
- Stevens H. (2004), "Transport Policy in the European Union", Palgrave Macmillan (2004).
- SuperGreen, Supporting EU's Freight Transport Logistics Action Plan on Green Corridors Issues, FP7. www.supergreenproject.eu/
- SUPER HIGHWAY, FP6. www.sh.isdefe.es/public/main.html
- TAF-TSI, Telematic Applications for Freight – Technical Specification for Interoperability. www.railneteurope.com/index.php/taftap-tsi.html
- THEMIS, Thematic Network in the Optimal Management of Intermodal Transportation Services, FP5
- TRAINCOM, Integrated Communication System for Intelligent Train Applications, FP5. www.traincom.org
- VERA3, Cross-border enforcement of road traffic violations. Project funded by the CEC, Directorate-General for Energy and Transport

Glossary

ATM	Air Traffic Management
BAU	Business As Usual
CEC	Commission of the European Communities
CEEC	Central Eastern European Countries
CEN	Comité Européen de Normalisation / European Committee for Standardization
DSRC	Dedicated Short-Range Communications
EDDN	European Diagnostic Data Network
EDI	Electronic Data Interchange
EETS	European Electronic Toll Service
EIA	European Intermodal Association
EIRAC	European Intermodal Research Advisory Council
ERRAC	European Rail Research Advisory Council
ERTMS	European Rail Traffic Management System
ETA	Estimated Time of Arrival
ETCS	European Train Control System
ETDN	European Technical Documentation Network
EU	European Union
FP4/5/6/7	Fourth / Fifth / Sixth / Seventh Framework Programmes on Research and Technological Development, funded by the European Commission
GNSS	Global Navigation Satellite System
HGV	Heavy Goods Vehicle
ICT	Information and Communication Technologies
ISO	International Organisation for Standardization
IM	Infrastructure Manager
IT	Information Technology
ITS	Intelligent Transport Systems
LCC	Life Cycle Costing
OBE	On-Board Equipment
PTA	Priority Thematic Area
RCI	Road Charging Interoperability
RCM	Reliability Centred Maintenance
RIS	River Information Services
SME	Small and Medium-sized Enterprises
SESAR	Single European Sky ATM Research
TEN-T	Trans-European Transport Network
TOC	Train Operating Company
TRKC	Transport Research Knowledge Centre
VMS	Variable Message Signs
VTMIS	Vessel Traffic Management and Information System

This Policy Brochure addresses the solutions which are being developed across Europe to achieve integration of the transport system. The focus is on freight transport. Operational, technical, infrastructure and legal barriers still hamper the seamless movement of goods across borders. A review is provided of the developments of EU policy relating to harmonisation of the regulatory framework; interoperable networks, based on standardised technologies; and logistics solutions, based on information and communication technologies, facilitating intermodality and comodality. Associated research, mostly from European Framework Programmes, together with some key results and implications are presented.

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