## THEMATIC SYNTHESIS OF TRANSPORT RESEARCH RESULTS

# PAPER 9 OF 10

# INTEROPERABILITY

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**European Commission**
**Transport RTD Programme**
**Fourth Framework Programme**

# Contents

# EXECUTIVE SUMMARY

This paper provides a structured guide to the findings and policy implications of research relating to interoperability carried out in the Transport RTD Programme[1]. (See Section 1 for advice on how to use the paper.)

Improved interoperability, in particular for the freight sector, is seen as one of the most promising fields in order to boost efficiency and quality of Europe-wide transport systems. The future performance of railway networks, integrated transport chains or urban transport infrastructures will heavily depend on achieving a high degree of interoperability within single modes and across inter-connected modes. Paving the way towards the desired single European airspace will in the same manner require a high level of technical interoperability of air traffic management equipment. Hence, RTD in various areas from strategic to mode specific has contributed to producing harmonised standards, prototype specifications and supporting tools, and has formulated policy measures to back technological development.

In this paper, results are reviewed for "clusters" of research projects in ten inter-related areas:

*Scenarios*
Future decisions on the Common Transport Policy (CTP) and the Trans European Networks were addressed by providing a set of policy scenarios for the European transport system through to the year 2020 that could meet CTP objectives for economic efficiency, regional development and environmental protection. Identified early policy actions that would be appropriate across all scenarios have been tax reforms, experiments with low emission zones, tele-commuting and road pricing.

*Tools and methodologies*
Several software assessment and modelling tools were developed that support decision making in strategic transport planning, in particular for the Trans-European Transport Network. Considered indicators and variables include technical and traffic parameters, as well as scenario based assumptions on transport demand and environmental impacts. Specifically for the waterborne sector a decision support system for intermodal transport was produced, which takes into account technical, organisational and environmental regulations.

*Organisation*
A number of studies have produced analytical frameworks and assessments in order to identify prevailing hurdles to interoperability and greater efficiency of transport systems. Derived recommendations comprise e.g. the harmonisation of organisational structures and regulatory frameworks, the stimulation of telematics usage, and the reduction of various entry barriers.
Heading towards the proposed Citizens' Network, research studies confirmed that some sort of limited competition should be encouraged instead of full market deregulation.
A new handbook provides guidance and evaluation methods for establishing new freight platforms, or transhipment areas, and was successfully validated.
In the rail sector the state of the level of implementation of the EC Directives that have

[1] Part of the Fourth Framework Programme for Community activities in the field of research, technological development and demonstration for the period 1994 to 1998.

introduced flexibility in the rail sector in various member states has been assessed, identifying the difficult financing of interoperability as the primary obstacle.

*Pricing*
The costs of urban mobility and schemes to finance it can now be evaluated using a newly developed handbook, which addresses seven major cost categories. The handbook provides practical support for both long-term mobility planning and short-term operational decisions. By promoting the harmonisation of the knowledge base for policy decisions across Europe, it anticipates to increase efficiency and fair competition between operators and modes.
Through case studies on five transport corridors evidence was provided that marginal cost pricing can be implemented in practice because such prices are found measurable. This is understood to be the basis for efficient future pricing policies.
Automating the handling of standardised freight pallets will allow for significant improvements in shipment efficiency, the reduction of transfer times and costs.

*Quality of networks*
Explicit recommendations for trimodal (waterway, railroad and road) transport chains included suggestions for the appropriate location of a desired trimodal freight terminal in Basle/Switzerland in order to reduce external costs. A simulation tool and generic guidance was provided that allows freight operators, such as shipping companies, port authorities and railway companies, to evaluate and improve train connections from seaports to the hinterland. The viability of successful intermodal freight transport between the Nordic countries and the European mainland was demonstrated in a study that revealed several important contributing factors. Co-operation in urban transport can be enhanced by using a multi-criteria decision support tool that helps organisations responsible for different aspects of urban transport systems to identify areas where greater co-operation is possible. The potential of urban traffic management systems was tested and evaluated through simulation studies and field trials. Simulations were found to be a cost-effective means of screening alternative solutions prior to pilot or full scale implementation. Two principal concepts for city logistics were developed, namely load zone management and electronic logistic management. From the analysis of previous practice and 33 city case studies a market research method was promoted that allows for flexible application, highlighting some specific characteristics. To reverse the trend of railway systems loosing market share, substantial changes to rail infrastructures, organisation and operation were proposed, addressing a forecast demand for freight transport in the year 2020.

*Quality of terminals/transfer points*
General guidelines and principles for the implementation of a freight village information system were developed, which led to a demonstration model of the information system. Moreover three management tools were devised for the assessment of freight village (FV) concepts. Comprising a user-friendly electronic handbook, addressing transport and storage operations in FV areas, a Decision Support System, and a Training Software Tool on technical guidelines for operators, and recommendations on communication, organisational matters, professional skills and related training of staff, work revealed that integrated freight villages – which allow for modal change and in addition offer a broad range of logistics and transport services at one single spot – do significantly foster intermodality and efficiency.
A set of solutions was identified to tackle the accessibility of freight terminals and to overcome the lack of co-operation, in particular with respect to poor exchange of electronic data and a lack of return loads.
A demonstration system was devised for the GPS based automatic location of Intermodal

Transport Units and vehicles inside intermodal terminal areas, in particular for maritime container terminals. Acoustic positioning systems were found to be feasible in the real environment even if the accuracy and availability requirements are not completely achieved. The integration of advanced terminals and innovative freight networks was found to be more efficient when bundling of small flows helped to establish hub-and-spoke concepts for medium to long distances. Equally, new generation terminals were found to be economically viable at high freight volumes.
A multi-criteria evaluation tool was developed to identify the priorities for improvements in the transport services to and from high speed rail terminals.

*Traffic management and control*
The European Rail Traffic Management System (ERTMS) requires a large set of interface specifications, test tools and validation processes to be elaborated. A dedicated System Requirement Specification (SRS), which describes all technical details and integrates the Reliability, Availability, Maintainability and Safety (RAMS) documentation, has been produced. Furthermore, a rail operations management philosophy was defined building on six technical measures supporting the progressive implementation of ERTMS.
A set of verification tools for testing of Eurocab components, limited to moderate levels of overall system functionality, was developed that will be the future reference for interoperability testing and validation of the complete ERTMS.
The European Train Control System (ETCS) requires similar test exercises, that have commenced on the Vienna – Budapest cross-border rail link.
In the air sector, research into ATM improvements has looked in particular at interface effects between the European region and neighbouring Air Traffic Control (ATC) regions.
Traffic management in cities has been addressed by evaluating a range of physical measures for traffic management through their practical implementation in a number of cities.

*Technology development*
Tackling infrastructure costs of railway power supply systems, specifications for the prototype of a high voltage booster unit compensating for voltage drops of main power transformers were formulated. Two innovative technological solutions based on state-of-the-art power electronics, i.e. pure power electronics and mixed components, were identified as likely systems for future standardised booster units.

*Freight*
A pilot system for communication between Combined Transport operators and their clients was developed, that is organised as a stand-alone interface allowing clients to book or query for status information while being connected to the Internet.
An in-depth analysis of existing waterway infrastructures on the Danube river and adjacent canals has focused on navigable conditions, transport capacity and existing ports, their facilities, typical goods and capacities. It highlighted the unique possibility to create a powerful inland waterway backbone along the Danube river, as long as road and rail networks in South-Eastern Europe have not reached western standards.
The prototype of a centralised, web-based communication node, that allows to handle inhomogeneous information from various sources in a complex shipment process, was established. Complementary, a common and open distributed information and communication platform for adaptive tracing of transport chains and tracking of general cargo through all sections of the logistic chain was brought up. Moreover, an integrated system for freight intermodal transport that supports the functionality of documentation, booking, in/out gate, traffic optimisation, warehouse management, transport management and route scheduling was

provided.
The introduction of telematics technologies to realise really integrated computer-controlled freight platforms will require several special features. It has been demonstrated that the adoption of faster transhipment devices without the support of computer-aided management does not produce significant changes in the performances of freight terminals, however the implementation of computer-aided management systems is cost-effective for every actor in the chain.
Combining state-of-the-art technologies for pallet systems, tagging and tracking systems and automatic loading units, an integrated system, to demonstrate that a fully automated and electronically managed palletised distribution is feasible, was developed. The three pillars of the concept are standard or customised pallets, radio tagging and read/write devices, and three Automatic Loading Units for transferring vehicle loads of palletised goods.
Recommendations to standardise a future European loading unit with the main dimensions of current standard swap bodies were elaborated, and a standardised future European loading unit that will be suited for all current European transport modes was specified. The latter will include providing two sizes for road transport, a rail transport unit, and a unit for inland waterway transport.
According to the findings of research multi-modal transport will need to implement an integrated information system that manages transport demand, the supply side, the optimal use of infrastructure and all of the networked assets used. This may be achieved by introducing a hierarchical trunk sector networking structure made up of dedicated components for interconnected nodes and terminals.
A database of 96 European freight platforms was created, identifying key characteristics such as transhipment volumes, infrastructure, on-site company interactions and financial arrangements. Based on this analysis, a handbook was developed that provides guidance and evaluation methods for establishing new freight platforms.

*Architecture*
The work has identified the potential of interchanges within the public transport system and terminals connecting public transport to individual car use. Updates with new procedures to the TEN-T guidelines were proposed to support decisions on interchange location, taking account of different stakeholder interests.
In order to establish a framework for functional architectures of CNS/ATM (Communication, Navigation and Surveillance/Air Traffic Management) components, a system model was produced that is based on operational scenarios for the time frame 2005-2010.

# 1. INTRODUCTION – HOW TO USE THIS PAPER

This paper provides a structured guide to the results of Research and Technical Development (RTD) projects relating to *interoperability*, carried out in the European Community's Transport RTD Programme. It is one of a series of papers:

| **Paper no.** | Theme |
|---|---|
| 1 | Sustainable mobility – integrated perspective |
| 2 | Sustainable mobility – economic perspective |
| 3 | Sustainable mobility – social perspective |
| 4 | Sustainable mobility – environmental perspective |
| 5 | Urban transport |
| 6 | Efficiency and quality |
| 7 | Safety and security |
| 8 | Human factors |
| 9 | Interoperability |
| 10 | Freight intermodality |

Of the 275 projects financed by the Programme, 56 dealt (partly or fully) with the issues of interoperability. Most of these projects were finalised in the year 2000.

How to use this paper:
You are recommended to use this paper to locate RTD results on topics where you have a particular interest, rather than reading the paper from start to finish:

- Start in Section 5 to get an overview of the topics addressed by "clusters" of RTD projects.
- Read the part of Section 6 that summarises the findings for each topic of interest to you.
- Use Annex 1 to identify the individual projects relating to that topic.
- Use Annex 2 to review the key results from each of these projects.

Further details on individual projects can be obtained from their web sites (noted in Annex 2, where available) and from the following Commission web sites:

- http://europa.eu.int/comm/transport/extra/home.html, which includes summaries and the full final reports of individual projects, as well as a variety of analyses and publications prepared by the EXTRA project;
- http://cordis.lu/transport/src/project.htm, which provides the project objectives and summary results as compiled by the RTD project teams.

The other Sections of this paper can help you to gain an overall picture of the interoperability theme, associated policy issues and the objectives for RTD.

The analysis in this paper is the responsibility of the EXTRA project team, and does not represent the official viewpoint of the European Commission.

# 2. SCOPE OF THEME

## 2.1 Definition of interoperability

Interoperability is generally defined within the transport sector as a process where at least two different operating parties/systems work together effectively. This includes freight transport as well as passenger transport. If the transport process goes across different modes, the process is also intermodal.

At a European level, interoperability is the ability of national and geographically defined transport networks to provide efficient operations and services across national borders and across technical, physical, geographical, legislative, organisational and socio-economic barriers. For example, interoperability occurs when the rolling stock of a national railway company is able to operate on the whole of the trans-European railway network, or when two previously separated networks are interconnected and able to support common fleet operations.

In telematics, interoperability is the ability of systems to provide services to and accept services from other systems, and to use the services so exchanged to enable them to operate effectively together.

Interoperability is a multi-faceted concept, which can be distinguished by different dimensions, levels and scales. The main focus of this thematic paper and the corresponding RTD projects is on the dimensions of **technical and corporate interoperability**. For completeness and to show the full context of interoperability, a wider definition of dimensions, levels and scales is given in the following text:

The four major **dimensions** are:
- *Technical interoperability*, which occurs when there are links between different transport systems through similar and compatible technologies.
- *Corporate interoperability*, which occurs when different organisations are willing and able to co-operate to provide transport services for users.
- *Juridical interoperability*, which occurs when impediments to interoperability, such as national anti-trust laws and differing implementation of EU Directives by Member States, are removed or harmonised.
- *Cultural interoperability*, which occurs when the impact of differing social factors such as regional or national linguistic or cultural barriers are reduced.

Three **levels** of interoperability can be used to categorise interoperability in terms of the different transport markets and modes:
- *The horizontal level of interoperability* is defined as the interoperability within individual transport markets (operations, telematics, and infrastructure).
- *The vertical level of interoperability* is defined as the interoperability between different markets (e.g. between infrastructure and operations).
- *The multi-modal level of interoperability* is defined as interoperability among the different modes of a transport system.

Three main **scales** of interoperability are:
- The *European scale*, which encompasses not only the interoperability between companies

using the same mode in different countries, but also between companies from different modes within Europe.
- The *sector scale*, which only includes the interoperability between companies using the same mode in the same or different countries.
- The *company scale*, which simply examines the interoperability which individual companies experience.

## 2.2 Topics included in the theme

Interoperability is a high priority affair within the transport sector in Europe and has a close relation to intermodality (which is addressed in another thematic paper within EXTRA). Cultural interoperability is addressed in the thematic paper *sustainable mobility - social aspects*.

The main topics within the theme of interoperability are concerned with:

*Policy features* – policy plays an important role to improve the conditions for interoperability and reduce non-technical barriers. Policy-related topics are:
- to develop unified evaluation schemes/ assessment methods
- to agree on frameworks for action
- to promote consensus formation among decision makers, for cross-border transport as well as for local/regional transport according to the aim of the Citizens' Network
- to provide legal boundary conditions for the introduction of new technologies and procedures for interoperability
- to promote technical harmonisation and create unified standards and certification schemes for technologies and procedures for interoperability

- to improve the preconditions for interoperability infrastructure, including new infrastructure construction
- to promote spatial co-ordination
- to install interaction processes between decision-makers and decision-takers.

*Infrastructure* features – the physical boundary conditions for interoperability can be divided between track and terminals, and the main topics are:
- to improve the (internal) operation of the infrastructure
- to harmonise and standardise physical interfaces
- to develop unified and harmonised safety standards for the operation and construction of infrastructure, including working conditions.

*Operational* features – the process of interoperability covers the following topics:
- compatibility of means and components of operation, including the means of transport
- seamless transition within the transport chain from one operator to another
- economic and efficient operating procedures.

*Organisational* features – planning and organisation of interoperability addresses the following topics:
- coherent organisational concepts
- compatibility of the organisation / planning tools and administration

- common organisational strategies.

*Information technologies* – information technologies, especially telematics, have a key function to provide safe and efficient interoperability, and include the following topics:

- compatible information concepts and systems
- traffic management systems
- traffic command and control systems
- tracing and tracking systems
- standards for data flow, data content and interfaces
- harmonised safety standards and certification procedures
- compatibility of hardware and software.

## 2.3 Significance of the theme

Each day, the transport systems in the European Union carry about 150 million commuters, deal with about 100 million business trips, transport about 50 million tonnes of freight, and provide 15 million courier, express goods and parcel deliveries. More than 6.5 million people deal with this task, and the transport industry contributes 5% to the European gross national product. Integrated, reliable freight and passenger transport is fundamental to Europe's economic success and mandatory for the European Single Market.

Transport is characterised by growing demand. Passenger transport volume has grown by more than 110% since 1970, and is forecast to increase by 40% between 1995 and 2010 within the EU. Freight transport volume in the Member States has grown by more than 50% since 1970 and is forecast to increase by 37% between 1995 and 2010. Growth in freight volume has been accompanied by growing reliance on road transport. While lorries offer a flexible, door-to-door service, reliance on road freight has created problems of its own. Key freight corridors are congested as well as many passenger corridors.

In order to meet increasing transport demand within limited means for infrastructure development, the efficiency and capacity of transport systems have to be enhanced, while maintaining or improving safety standards. One major contribution lies in resolving the lack of interoperability e.g. railway interoperability concerning electrification and signalling.

The costs of the lack of interoperability within the transportation system are enormous, estimated to be around 30 % of the overall transportation costs. In particular, different procedures due to different legal matters reduce transportation speed and increase costs and tied-up capital. Increased costs are due to non-standardised packing, non-standardised dimensions (ISO /Euro), non-standardised control management and info systems, non-standardised transhipment equipment, non-standardised gauge and non-standardised energy supply.

# 3. POLICY CONTEXT

## 3.1 Policy objectives related to the theme

The Common Transport Policy Action Programme 1995-2000 consists of policies and actions in three fundamental areas, and all have relevance to interoperability:

- **improving quality** by developing integrated and competitive transport systems based on advanced technologies which also contribute to environmental and safety objectives *(technical interoperability);*
- improving the functioning of the **single market** in order to promote efficiency, choice and a user-friendly provision of transport services while safeguarding social standards *(juridical, corporate and cultural interoperability);*
- broadening the **external dimension** by improving transport links with third countries and fostering the access of EU operators to other transport markets *(juridical, corporate and cultural interoperability).*

The particular key areas for interoperability are:

- Improving integration of transport modes, including better use of those modes offering unused or potential capacity
- Supporting and developing new technologies for improving interoperability
- New legislative initiatives with a focus on liberalisation of the railway sector
- Promoting technical harmonisation and standardisation
- Internalisation of external costs to reduce unacceptable divergence between different modes and transport processes
- Supporting the development towards a wider Europe with a focus on Eastern and Central Europe.

In the Green Paper "The Citizens' Network", interoperability was considered in relation to the TEN-T. "*The Trans-European Networks, which cover transport, telecommunication and energy, were established by the treaty of the European Union ...promoting the interconnection and interoperability of national networks while taking account of the need to link island, landlocked and peripheral regions with the central regions of the Community".*

The White Paper " A strategy for revitalising the Communities' railways" addresses interoperability in chapter 72 " *to reduce the regulatory, technical and operational differences that could prevent trains circulating freely without stopping at frontiers".*

The Commission paper on "Intermodality and intermodal freight transport in the European Union" highlights interoperable and interconnected operations to promote:

- Intermodal freight operators in fair competition
- Open access to infrastructure
- Common infrastructure and transport pricing principles
- Co-ordination of intermodal timetables.

## 3.2 Policy issues related to the theme

Safeguarding European mobility of persons and goods is a prime concern of the European Union and its policy. Therefore, interoperability is high on the European transport policy agenda, especially in the context of the development of the TEN-T.
The implementation of an efficient modal and intermodal transport system with a high degree of interoperability requires a co-ordinated development of transport policy and research on all levels, European, national and regional. The knowledge base on the barriers and solutions to enable efficient interoperability has grown significantly over recent years.

A more general focus is now being placed on the development of a framework for integrating the different modes into a transport chain. A *more efficient and cost-effective use of the transport system* is enhanced through this integration by:

- Strengthening of door-to-door services
- Increasing competition between transport operators
- Advancing technology.

Interoperability and intermodality concern both freight transport and passenger transport. The well functioning of public passenger transport in Europe and its attractiveness are a major policy issue which is being addressed by RTD activities, improved planning and better use of operational capabilities. Task Forces (e.g. on intermodality) have supported the co-ordination of the efforts of different actors.

Full interoperability - when there is a maximum degree of interoperability among the operators and operations for each of the different levels, dimensions and scales defined in Section 2.1 - may look like the perfect solution. However, it is apparent that not all improvements to interoperability bring positive benefits to society. If a gain in interoperability is accompanied by a reduction in economic efficiency, then it is necessary to determine on a cost-benefit basis the optimal degree of interoperability that should be introduced.

This ”optimal interoperability” is defined as the highest degree of interoperability that can be attained without incurring more marginal costs than benefits.

# 4. RTD OBJECTIVES

The overall aims of the Transport Programme concerning interoperability are:

- to develop a more efficient, safer and more environmentally friendly transport system for passengers and goods;
- to facilitate the interconnection and interoperability of the separate transport networks;
- to increase the efficiency of each individual mode and improve co-ordination between them;
- to provide industry, transport operators, users and authorities with the appropriate decision-making instruments based on better knowledge and understanding of mobility, traffic flows, their interactions and interdependencies.

The general objective of the research is to arrive at pre-normative or pre-legislative conclusions, making it possible to incorporate into the transport sphere new policy options and facilitate the implementation of new generic technologies. In addition, the research will further support the development of the European Union by establishing the preconditions for an efficient trans-European transport system.

Interoperability features are closely related to the intermodality research topics.

An important feature of interoperability is the organisational aspect. The organisation of transport systems and regulation/deregulation of the transport sector are important areas for implementation of the CTP. This area for investigation includes the development of measures of performance, economic and other policy instruments, and institutional/organisational frameworks designed to promote interoperability, efficiency and spatial co-ordination on management and regulation issues. Operation of different national systems requires harmonisation or co-ordination to ensure that the European network provides the best possible service to transport users.

Research has to identify the key problems of interoperability, and the conditions needed for such interoperability. The research activities therefore address the organisation and management of the European transport system and the spatial and temporal co-ordination of transport and socio-economic activities. Particular attention is given to TEN-T improvements and extensions, including the interfaces with urban and regional transport networks. One example is RTD towards the introduction of the ERTMS (European Rail Traffic Management System), which will enable seamless cross-border railway transport. Similarly in the air sector, research concerning ATM (Air Traffic Management) systems is helping to meet the requirements of interoperability.

A second item in the rail sector is the research on improving railway organisation and administration, focusing on non technical aspects of a European ”Rail Transport System” in order to support the new ”multi-operator” railway structure.

Improvements in the TEN-T are also targeted in research into integrated transport chains, where specific attention is given to improving the quality of networks and terminals/transfer points. Similar aims hold for waterborne transport, where the transfer points are the ports.

Organisational and operational features are addressed in the urban sector RTD, which aims to develop strategies for changing modal split and promoting multi-modal transport.

According to the overall RTD objectives, research concerning interoperability can be categorised in four main areas:

**Policy support –** this area addresses decision-makers at different levels. This includes regional, national and European politicians. Projects are developing tools and methodologies, and will provide decision support and options for policy makers.

**Concepts** – this area concerns the development, improvement and evaluation of concepts for interoperability.

**Technical components** – this area concerns the development, testing and introduction of technical components and sub-systems to enable interoperability. In this area, the Transport Programme objectives are in some cases based on the findings of the BRITE-EURAM programme. A specific emphasis is given to cross-border transport issues.

**Information technology** – within this area, telematics concepts are being developed, tested and evaluated. It should be mentioned that in the Telematics Programme of DG XIII, related research affecting interoperability is also carried out.

# 5. SUMMARY OF RESEARCH CLUSTERS

## 5.1 Overview

The RTD projects contributing to the interoperability theme can be considered within ten clusters, each relating to one of the four main RTD target areas identified in Section 4.

The research on interoperability is focused in four main areas:

- *Policy support*
- *Concepts*
- *Technical components*
- *Information technology*

It is rather difficult to separate interoperability and intermodality. Many of the projects dealing with interoperability have intermodality features and vice versa.

In this paper, the RTD projects in FP4 contributing to the development of interoperability are considered within ten topic areas or "clusters". These clusters are:

**Clusters**

*Scenarios*
*Tools and methodologies*
*Organisation*
*Pricing*
*Quality of networks*
*Quality of terminals/transfer points*
*Traffic management and control*
*Technology development*
*Freight*
*Architecture*

## 5.2 RTD clusters

This Section defines the scope of research in each cluster. More specific objectives are given in Section 6. The titles and objectives of relevant RTD projects are listed in Annex 1, together with a Table identifying the cluster(s) to which each project contributes most strongly.

### *Scenarios*

In the area of *scenarios*, the research will develop different scenarios of future transport demand to help assess different policies.

### *Tools and methodologies*

In this area, *tools and methodologies* will be produced to support decision-makers in assessing

different measures and developments for future interoperable European transport systems.

### *Organisation*

*Organisation* is an important domain of the interoperability theme and describes the policy-related conditions for improvements in collaboration and procedures between the operators.

### *Pricing*

In the area of *pricing*, the research will evaluate current pricing approaches and propose new pricing schemes.

### *Quality of networks*

In the area of improving the *quality of the networks*, research aims to develop concepts and requirements to improve the efficiency and economy of transport chains and to increase the share of interoperability in transport for small networks like urban areas, or enhanced networks such as the TEN-T. Improvement of networks also includes the development of concepts and methods to promote changes in modal split towards more environment-friendly and safer modes.

### *Quality of terminals/transfer points*

In the area of improvements to the *quality of the terminals/transfer points*, the research aims to develop concepts and requirements to improve the efficiency, economy and accessibility of terminals/transfer points. Emphasis lies on organisational concepts and procedures, administration within the facilities and interconnectivity of terminals.

### *Traffic management and control*

In the area of *traffic management and control*, research activities focus on components and strategies for traffic management systems for interoperability, particularly for cross-border transport. Key items are harmonisation and compatibility issues at a European level. This area is mainly focused on the rail and air sectors.

### *Technology development*

In the area of *technology development*, research activities are concentrated on the development of specific (new) technologies with impacts on interoperability.

### *Freight*

In the area of *freight*, research aims to improve freight flows and information/data exchange by the introduction of advanced telematics systems, concerning road freight transport as well as rail freight transport. The projects have links to the FP4 Telematics Programme.

### *Architecture*

In the area of *architecture*, research deals with the development of functional architectures of information technologies for the interconnection of transport management systems.

# 6. SYNTHESIS OF FINDINGS FROM COMPLETED PROJECTS

This Section provides a synthesis of the research objectives and main findings from completed projects for each of the RTD clusters defined in Section 5. The key results, policy implications and achievements of individual projects are summarised in Annex 2.

Results from the following projects have been included in the current version of this thematic paper:

| Clusters | Sector | Relevant RTD projects |
|---|---|---|
| *Scenarios* | *Strategic research* | POSSUM |
| *Tools and methodologies* | *Strategic research* | ASTRA, CODE-TEN, COMMUTE, EUROSIL |
| | *Integrated transport chains* | LOGIQ |
| *Organisation* | *Strategic research* | MINIMISE, SORT-IT |
| | *Urban transport* | ISOTOPE, REFORM |
| | *Rail* | LIBERAIL |
| *Pricing* | *Urban transport* | FISCUS |
| | *Strategic research* | PETS |
| | *Integrated transport chains* | TACTICS |
| *Quality of networks* | *Integrated transport chains* | APRICOT, OSIRIS, SCANDINET |
| | *Urban transport* | INCOME, INTRAMUROS, LEAN, MOTIF |
| | *Rail* | EUFRANET |
| | *Waterborne* | EUDET |
| *Quality of terminals/transfer points* | *Integrated transport chains* | FREIA, FV-2000, IMPREND, PRECISE IT, TERMINET |
| | *Urban transport* | HSR-COMET |
| *Traffic management and control* | *Rail* | ACRUDA, EMSET, ERTMS Tests, ETCS-VB, EUROSIG, OPTIRAILS |
| | *Air* | ABEAM |
| | *Urban transport* | OPIUM |
| *Technology development* | *Rail* | HVB |
| | *Integrated transport chains* | |
| *Freight* | *Integrated transport chains* | CESAR, EUDET, ITESIC, OCTOPUS, PISCES, PLATFORM, TACTICS, UTI-NORM, X-MODALL (X-MOD/1) |
| | *Rail* | |
| | *Urban transport* | REFORM |
| | *Waterborne* | EUDET |
| *Architecture* | *Urban transport* | CARISMA |
| | *Air* | FARADEX |

## 6.1 Scenarios

***Research objectives***

Objectives in this area are:

- to develop a set of different policy scenarios on the CTP and TEN-T, establish a range of possible actions, assess their feasibility and determine when actions should be taken, all under consideration of sustainable mobility criteria;
- to produce transport demand scenarios for the EU beyond 2020, to develop detailed forecasts of factors which will affect future transport demand, and to extend and enhance a strategic transport model of the EU based on the scenarios.

***Main findings***

Future decisions on the Common Transport Policy (CTP) and the Trans European Networks were addressed by providing a set of policy scenarios for the European transport system through to the year 2020 that could meet CTP objectives for economic efficiency, regional development and environmental protection. The scenarios explored alternative social and political developments outside the transport sector, and show what transport policies would then deliver the targeted outcomes. In particular, the role of technology and the potential to decouple transport growth from economic growth were described. Identified early policy actions that would be appropriate across all scenarios have been tax reforms, experiments with low emission zones, tele-commuting and road pricing.

## 6.2 Tools and methodologies

***Research objectives***

Objectives in this area are:

- to develop tools and models for strategic policy assessment related to the CTP targets and TEN-T, to improve the ability of tools used for assessing the long-term secondary impacts of European policy making, and to design a common methodology and tools for strategic policy impact assessment;
- to provide a set of guidelines, criteria and modelling and evaluation tools for an overall spatial evaluation of the TEN-T;
- to provide a comprehensive strategic assessment methodology for corridors and to identify major policy-related issues, their associated scenarios and assumptions;
- to develop decision support tools, aiming at the development of economic regions towards economic-logistic transfer regions and the development of corporate business strategies for industrial logistics;
- to provide information on criteria and constraints employed by decision-makers and construct a decision process model, regarding the infrastructure network, quality factors and the legal and institutional environment of transport;
- to define a methodology and computer software for assessing the environmental impacts of multi-modal transport policy options.

***Main findings***

A system dynamics modelling platform was developed integrating four sub-models that cover macro-economic activity, regional economics and land-use, transport demand and environmental impacts. The software tool contains interfaces between the sub-models allowing for feedback loops to be established, thereby capturing the inter-relations between variables. Output indicators include traffic volumes, vehicle numbers, environmental impacts,

and economic, social and employment indicators. Forecasts can be produced for a 30 year time frame from the base year 1996; alternatively the programme offers a backcasting mode to identify measures that will help to achieve a desired end-state. In demonstration runs, the effects of fully integrated sets of policy measures – addressing policy decisions in the fields of taxation, construction of the Trans-European Transport Network, mitigation of air pollution and safety improvements – were found to produce the best results.

A strategic policy assessment methodology and tool for evaluating the impacts of the development of pan-European corridors was produced, that supports nine detailed corridor studies. The applied four scenario approach combines information on socio-economic development, policy development and infrastructure planning. As a practical tool a comprehensive information system was brought up covering 30 European countries. It provides information on politics, regional socio-economic data, regional road information, foreign trade, transport costs, resource costs, networks and maps. The ultimately developed guidelines allow to assess transport investments to support the policy of expanding the European Union to Baltic and Central European countries. From scenario based exercises with a time frame until the year 2015 combinations of road and rail projects were generally found to offer the greatest benefits.

Another research effort delivered a methodology for strategic environmental assessment (SEA) of transport policies, plans and programmes, supported by a software tool for the assessment of air pollutant emissions, energy consumption, noise and safety impacts. Assessment methods covered all principle transport modes, and impacts from other categories such as land use and ecological damage. The software focuses on impacts at European, national, regional and corridor level, aggregated from the impacts associated with individual transport links and nodes. Output data are presented in a Geographical Information System, and are differentiated according to the height of emission into the atmosphere, while external input data include traffic flows and vehicle fleet composition. A pilot assessment of TEN-T was performed using the new software, which provided an initial quantification of the impacts of policies and infrastructure, and also demonstrated the feasibility of the SEA method. TEN-T is projected to increase overall passenger and freight travel demand, but with a substantial shift to rail and a reduction in road network congestion.

An evaluation framework and a software tool to support a structured approach to the assessment of regional development effects was developed, which covers the selection of criteria for evaluation, the estimation of impacts, and the definition of weighting factors for combining different impacts. Furthermore, guidance is provided on the choice of traffic modelling methods. A simplified set of guidelines was brought up to serve those cases where the decision-maker requires a quick low-cost evaluation of alternatives rather than a sophisticated one. The described evaluation framework is now available for use in real-life decisions on the TEN-T and other major long-distance transport projects.

Factors defining the intermodal environment and influencing the associated decision-making process have been categorised for the waterborne sector. This led to a software tool labelled Decision Support System (DSS) for intermodal transport, intending to provide the user with all relevant information related to planning, investment, organisation and service provision in intermodal transport. The software tool itself is based on a mathematical Decision Process Model (DPM) building on findings from field surveys, and has been validated by a sectoral case study on intermodal shipments of chemical products taking into account technical, organisational and environmental regulations.

## 6.3 Organisation

***Research objectives***

Objectives in this area are:

- to identify strategic approaches, policy measures and evaluation techniques for improved organisation of the passenger and freight transport sectors in the European transport market as a whole;
- to assess the impacts of deregulation in EU and EFTA, determine the optimal balance between market competition and transport regulation, and develop appropriate management and organisational structures and performance criteria. This includes identifying policy options to improve relationships (between regulators and operators and between operators) and to ensure consistency of organisation and interconnection between EEA and CIS networks;
- to evaluate possible modifications to organisational structures and legal status in urban public transport operations, according to the effectiveness of existing structures and contracts;
- to investigate the potential of rail transport under the influence of liberalisation of the use of infrastructure, assess the medium and long-term effects of liberalisation, and propose appropriate corrective measures and new initiatives;
- to determine the fundamentals for formulating an overall European RTD strategy to develop further the logistics processes supporting external trade by Member States.

***Main findings***

A common analytical framework was set up to identify existing impediments to interoperability, in particular addressing the principal barriers to the development of a more economically efficient transport system. In the course of case studies, the proposed policy measures were evaluated and assessed along a set of criteria like net benefits or cost-benefit ratios assuring positive impacts on systems' interoperability.
Several principle areas of activity for the Commission were outlined in order to improve interoperability and economic efficiency: stimulation of telematics usage, increased use of modern transport equipment, promotion of improved interconnectivity and interoperability of transport networks, harmonisation of organisational structures and regulatory frameworks.

A comprehensive analysis of existing barriers to interoperability and interconnection, and their underlying reasons has led to a couple of recommendations for (political) organisation. Firstly, competition should be promoted particularly through extending cabotage and deregulation in inland waterways, rail and express coach operations, and also in input markets, including vehicle leasing, labour and ancillary markets such as baggage handling. In urban and regional transport, tendering and franchising should be promoted rather than head-on competition, while the rail sector requires horizontal and vertical separation of organisation and structures, along with network re-configuration. Finally, entry barriers need to be reduced with respect to congested air, sea and rail infrastructures, possibly through the use of auctioning systems. Entry requirements, such as vehicle age limits, may need to be tightened in the road freight and waterborne freight industries. Overall, policy priority should focus on finishing the liberalisation of the European transport market along the introduced measures, before attempting to increase interoperability, interconnection and intermodality.

The initiative for creating and specifying the urban public transport (UPT) network was assessed, and concluded that a fully deregulated system does not adequately address collective goals and system integration. Overall, studies found support for the Citizens' Network (EC

Green Paper) preference for some form of limited competition. Various forms of contract appropriate to this regime were identified, with special consideration to the case of rail-based systems. Reductions in unit operating costs of around 15% were found feasible over fully regulated operations, even with no redundancies or wage reductions.

A database of 96 European freight platforms – transhipment areas where many transport companies, such as forwarders and logistic service providers – was created, identifying key characteristics such as transhipment volumes, infrastructure, on-site company interactions and financial arrangements. Based on this analysis, a handbook was developed for local authorities and transport sector companies. The handbook provides guidance and evaluation methods for establishing new freight platforms and has been validated on four test sites using computer simulations.

In the rail sector the state of the level of implementation of the EC Directives that have introduced flexibility in the rail sector in various member states has been assessed. In particular, the financing of interoperability has been identified as a "brake" in the liberalisation process.
According to their approach to implementation, EU countries have been grouped into four scenarios:

- "the wise state and lean railway" (Sweden, The Netherlands and Portugal);
- "rail unbundling and privatisation" (United Kingdom);
- "the vertically integrated commercially oriented railways holding" (Austria, Belgium, Finland, France, Greece, Ireland, Italy and Spain); and
- "commercialisation of public utility and third party access" (Germany).

Common to all scenarios is the replacement of general subsidisation by contractualisation and the transfer of public service obligation to regional and local authorities.

## 6.4 Pricing

### *Research objectives*

Objectives in this area are:

- to inform the Commission about the current situation concerning pricing of transport in the Member States;
- to estimate the impacts of alternative pricing policies on transport demand and modal split;
- to analyse existing cost allocation methodologies and financial schemes and conceive new ones in response to identified gaps and weaknesses in urban transport.

### *Main findings*

A newly developed handbook gives practical guidelines for evaluating the costs of urban mobility and selecting ways to finance it. A total of seven types of costs are addressed, comprising those associated with infrastructure, vehicle related operations, congestion, accidents, emissions, noise and other external effects. From the review of current pricing strategies it became clear that existing mechanisms and levels are failing to provide appropriate signals to influence behaviour. To indicate a way forward the relative merits of new mechanisms such as private finance, value capture (e.g. from transport infrastructure investment) and cross funding (e.g. from private to public transport) are explained. The handbook provides practical support for both long-term mobility planning and short-term operational decisions. By promoting the harmonisation of the knowledge base for policy decisions across Europe, it anticipates to increase efficiency and fair competition between

operators and modes.

Through case studies on five transport corridors, a practical methodology to calculate marginal social costs for all modes, understood to be the basis for efficient pricing policies, was confirmed. For instance, the current price of inter-urban car travel is estimated to be too high relative to the marginal social cost in 2010, partly as a result of tighter vehicle emissions regulations. On the other hand, the case for urban road pricing in congested cities was confirmed, while there is a general justification for lower prices in public transport, but again only in urban areas. In contrast long-distance road freight is commonly under-charged, because taxes do not increase sufficiently with the impacts of vehicle weight and travelling distances. Now evidence is provided that marginal cost pricing can be implemented in practice because such prices are measurable, however refinements are needed to the practice of estimating prices on a nation wide basis.

The introduction of Automatic Loading Units for transferring vehicle loads of palletised goods, combined with the use of standardised pallets, and radio tagging and read/write devices will yield substantial improvements to road and rail freight utilisation, reductions in intermodal transfer times and costs, improved logistics management and advances in automating and managing freight terminals and warehousing. Virtual management of freight distribution will allow instant access to goods location, goods identity, stock taking and financial audit.

## 6.5 Quality of networks

***Research objectives***

Objectives in this area are:

- to evaluate strategic options for the development of a Trans-European railway network mainly dedicated to freight transportation, and to establish an overall strategy for the implementation of a freight network;
- to analyse quality aspects influencing intermodal transport, identify means of improving interoperability and interconnectivity, and demonstrate new organisational concepts with the integration of new or improved technologies;
- to integrate the inland waterway system in door-to-door logistic chains extending beyond the river Rhine area, by linking inland navigation to rail transport to destination areas in South and Southeast Europe and using road transport for the final distribution in local areas;
- to improve the access to infrastructure and information on intermodal transport services - in particular for SME’s and small value flows and connections with peripheral or isolated regions in the Community;
- to produce guidelines and a decision support system for authorities, transport operators and the transport supply industry on the design of better market-oriented urban transport systems;
- to develop and integrate strategies for optimisation of urban traffic control, driver information systems and public transport systems within urban transport management systems;
- to develop a methodology which allows the different urban actors to assess the level of integration of information flows in their urban centre, and to provide a set of guidelines for the harmonisation of the information given to passengers and car drivers by different information providers;

- to develop and demonstrate new concepts to distribute and collect goods in urban areas;
- to optimise systems for integrated rail-seaport connections, by creating a model for the development of a hub-and-spoke system linking seaports and regions in their hinterland by rail, and producing requirements for an information and communication system to support the business process as well as terminal operation.

### *Main findings*

Trimodal (waterway, railroad and road) transport chains have been assessed in order to reduce environmental impacts, in particular for alpine regions along the main traffic corridors to southern and south-eastern Europe. Explicit recommendations included suggestions for the appropriate location of a desired trimodal freight terminal in Basle/Switzerland in order to reduce external costs compared to Combined Transport, to further undertake complex environmental impact assessments aiming at establishing additional multimodal terminals in the middle section of the river Rhine, e.g. at Mainz or Mannheim/Germany, to trigger considerable shifts away from road transport and on how to improve interoperability as a mandatory precondition of trimodal transport chains and terminals, such as integrated terminal designs, advanced design of inland barges, the introduction of common Intermodal Transport Units (ITU), various organisational aspects, and the implementation of efficient information systems. The differing priorities of various user groups in passenger transport have been highlighted in a market research, that avoided to look only at the typical frequent, well-informed traveller. Major findings included the perceived necessity to locally confirm user needs, and to directly measure user satisfaction in order to indicate actual product quality in transport services.

A simulation tool and generic guidance was provided that allows freight operators, such as shipping companies, port authorities and railway companies, to evaluate and improve train connections from seaports to the hinterland. New and efficient solutions are based on three principal rail services, namely seaport container shuttles, bundling container transport flows from different quay sites of one seaport in order to dispatch them towards a dry port, long-distance trains between the dry port and a hub in the hinterland, and short-distance shuttles, providing rail feeder services to and from hinterland destinations. Interestingly, rail freight operations over distances between 100 and 500 km were found to be economically viable, if only transport volumes and frequencies are high enough. The application of information and communication systems along the whole transport chain, together with free access for all operators to infrastructure will foster competition in intermodal transport.

The viability of successful intermodal freight transport between the Nordic countries and the European mainland was demonstrated in a study that revealed several important contributing factors. In order to assure a commercial basis, reasonable intermodal track rates, a fair railway slot practice, the consolidation of flows into fewer terminals and corridors like continental freight freeways, correct and relevant information in different phases of the transport chain, and closer co-operation between intermodal operators are mandatory.
New fixed links from Scandinavia to the European mainland are foreseen to improve intermodal transport services, however port terminals must be capable of handling ferries and rail units alike. Legislative action may help to level the imbalance between transport modes by re-imposing certain restrictions on road freight and through the accelerated liberalisation of the rail sector.

For urban transport the need to enhance co-operation has been addressed by producing and site-testing a multi-criteria decision support tool that helps organisations responsible for

different aspects of urban transport systems to identify areas where greater co-operation is possible. The current situation in a city has been assessed against best and worst case scenarios according to selected criteria and objectives. A set of indicators relating to cost, operational performance, environmental impact, socio-economic effects and safety consequences has been developed. Those criteria can be weighted according to the value judgements of individual actors in each city, although default weights provide a useful means of cross-city comparison. This assessment helps users to prioritise potential changes to the urban transport system, and at the same time, it is a tool to enhance co-operation between the local actors.

The potential of urban traffic management systems was tested and evaluated through simulation studies and field trials in London, Piraeus, Turin and Gothenburg. Simulations were found to be a cost-effective means of screening alternative solutions prior to pilot or full scale implementation. The resulting guideline for transport managers and local authorities now provides information on infrastructure requirements, factors affecting the benefits, and other implementation issues. Among the encouraging measures of urban traffic control were giving priority to public transport, leading to journey time savings of up to 15%, automatic vehicle location for buses, and bus priority at traffic signals and through dedicated lanes. With the use of variable message signs, coupled to automatic incident detection functions, the possibility for traffic re-routing can save around 25% of travel times for individual transport. Finally, a fully integrated traffic management systems applied to the city of Turin, sharing data and control signals between sub-systems, has reduced travel times for both general traffic and public transport by 20%, with an accompanying modal shift of 3% to public transport. Additionally, local pollutant emissions were estimated to fall by 21%.

Two principal concepts for city logistics were developed, building on the comprehension that integrated strategies combining infrastructure investments, information technology and the provision of door-to-door freight services are the most effective in meeting customer objectives. On the one hand load zone management is a scheme for automatic reservation of space in a city centre for loading and unloading lorries, supported by stricter enforcement of regulations to prevent illegal parking by private cars in that zone. A system was designed relying on common Internet access, making it available to a wide range of users. Here, messages are transferred from the central reservations system to a display panel at the loading zone via the mobile phone network. On the other hand electronic logistic management provides a basic structure for data processing from source to destination along a logistic chain, to facilitate integrated planning, monitoring and control of the movement of goods. A prototype system was developed, tailored to the needs of a logistic service provider; showing that it can reliably manage the required tasks with full functionality.

When targeting improvements in public transport services, market research tools are utilised to draw conclusions on customer demand. From the analysis of previous practice and 33 city case studies a market research method was promoted that allows for flexible application, highlighting some specific characteristics. If a detailed segmentation of consumer preferences is required, a market survey should be carried out on a local basis. Market studies should ensure that adequate differentiation is obtained between user groups and their respective service attributes. For example, primary and secondary requirements can be distinguished, so that secondary needs such as passenger information are not under-estimated. The level of fares is important, but transport users are prepared to pay for good quality on important features. Therefore surveys should be geared towards quantifying the willingness of the customer to pay for certain improvements.

To reverse the trend of railway systems loosing market share, substantial changes to rail infrastructures, organisation and operation were proposed, addressing a forecast demand for freight transport in the year 2020. A new assignment of railway routes to different services was devised, based on three sub-networks. A core network, strongly dedicated to freight shipment, would cover the industrial regions of central Europe. An intermediate network would mainly be focused on freight but could also carry local passenger trains, while a mixed network would normally grant priority to passenger trains. Based on this scenario the modelling results indicated that traffic on the dedicated network could increase significantly, while journey times on this network could be cut by 20 to 30%. The decline in modal share of rail could be reversed, taking the share back up to 16%. Gains in national markets would be of the same order of magnitude as gains in international transport, though varying between Member States.

## 6.6 Quality of terminals/transfer points

### *Research objectives*

Objectives in this area are:

- to identify promising innovations for bundling networks, new generation terminals and terminal nodes, with regard to automation and robotisation of processes;
- to produce an SME operator guide to intermodal transport, in order to facilitate the establishment of commercially-viable relations with freight villages, their services, procedures and information systems;
- to analyse and evaluate freight village structure and lay-out, in order to determine whether the proximity of different transport and logistics activities is a key factor for the use of intermodal transport, and to develop guidelines and management tools to improve working conditions and security for freight village operators;
- to provide recommendations on improving the pre- and end-haulage at terminals, for transport companies, terminal operators, policy makers and other organisations in the field of intermodal/interoperable transport;
- to define priorities for connection and interfacing of metropolitan areas with the high-speed rail network.

### *Main findings*

General guidelines and principles for the implementation of a freight village information system were developed, which led to a demonstration model of the information system. In order to foster transparency in the intermodal transport market, a classification system of freight villages according to the services and facilities provided was recommended. Furthermore, policy actions by the European Commission aimed at integrating SME’s into the intermodal transport system were supported. Specific actions may include education, training and information on market developments, as well as the application of new technologies, providing easy access to information systems and services.

From the assessment of two principal concepts for freight villages (FV's) – i.e. integrated and non-integrated freight villages – three management tools emerged. They comprise a Good Practice Code, in the form of a user-friendly electronic handbook, addressing transport and storage operations in FV areas, a Decision Support System (DSS), that has been field-tested by three FV's, and a Training Software Tool on technical guidelines for operators, and recommendations on communication, organisational matters, professional skills and related

training of staff, ultimately promoting the implementation of environmental management systems. In summary, integrated freight villages – which allow for modal change and in addition offer a broad range of logistics and transport services at one single spot – were found to more significantly foster intermodality and efficiency.

A set of solutions was identified to tackle the accessibility of freight terminals and to overcome the lack of co-operation, in particular with respect to poor exchange of electronic data and a lack of return loads. Organisational solutions were found to be most important, based on improved communications, co-operation, and the understanding that shippers are the most important actors in the intermodal transport chain. Specific areas for improved co-operation were seen in the better co-ordination of opening times at terminals, shippers, forwarders and container depots, which should cut costs for hauliers, the regular communication between terminal operators and other actors in the transport chain to identify bottlenecks and efficiency savings at terminals, and better co-operation between hauliers and intermodal operators to improve planning, data exchange and the organisation of return loads.

A demonstration system was devised for the automatic location of Intermodal Transport Units (ITU's) and vehicles inside intermodal terminal areas, in particular for maritime container terminals. The Global Positioning System (GPS) integrated with a dead reckoning system gives excellent results all over the stacking area and guarantees the accuracy and availability requirement for the position measurement. Acoustic positioning systems are feasible in the real environment even if the accuracy and availability requirements are not completely achieved. On the other hand, the combination of GPS and acoustic systems, even if technically quite easy to implement, does not significantly increase the accuracy and availability of the automatic location system to justify the costs. The potential customers of the location systems were mainly found in maritime terminal operators with a significant traffic volume and high automation level. Overall, while automatic location systems are likely not to be cost effective for inland terminals, they will be necessary to increase competitiveness and efficiency of maritime terminals.

The integration of advanced terminals and innovative freight networks was found to be more efficient when bundling of small flows helped to establish hub-and-spoke concepts for medium to long distances. Equally, new generation terminals were found to be economically viable at high freight volumes (>200,000 units). Five case studies at existing intermodal terminals allowed to evaluate required investments and operational costs, and performed transport chain cost comparisons with conventional unimodal (road) transport. More in-depth research was recommended to perform cost/benefit analyses for the whole network with integrated terminals, the development of efficient feeder services and regional networks, and the evaluation of risks and benefits related to highly robotised and automated terminal operations.

More attractively connecting urban centres to high speed rail (HSR) networks was found to strongly depend on the respective characteristics of (local) transport demand, especially because average trip frequencies by high speed rail are higher than by standard rail services, showing their importance in attracting passengers from other modes. Hence, a multi-criteria evaluation tool was developed to identify the priorities for improvements in the transport services to and from terminals. Increasing the frequency of metro services during HSR peak hours emerged as a promising solution, the preferential access for taxis also scored reasonably well, as did the integration of taxi tariffs with train fares (e.g. by joint ticketing). In order to speed up the transit through rail terminals and to advise the passenger on available services,

the integration of pricing systems between local transport services and HSR, and the introduction of improved reservation systems for booking train and taxi needs to be promoted.

## 6.7 Traffic management and control

### *Research objectives*

The specific objectives of research in the rail sector are:

- to prepare for full-scale trial tests of the European Rail Traffic Management System (ERTMS) in a number of pilot sites located in France, Germany and Italy;
- to create a set of common interoperability and technical specifications for a Europe-wide common railway safe signalling system, to be used as an input for standardisation activities;
- to set in place a pilot installation of ERTMS on the Vienna – Budapest line;
- to prepare for a full-scale functional validation of the on-board ERTMS sub-system and to provide interoperability tests with some existing signalling systems in Europe on the Madrid -Sevilla line;
- to define an assessment framework and criteria for safety architectures used in the guided public transport industry and to develop a certification scheme, which will be adopted in the validation phase for ERTMS;
- to develop harmonisation rules and regulations for the ERTMS control-command system, open for all European railways, and to facilitate the transition period between existing control-command systems and ERTMS;
- to identify functional and technical facilities for pan-European rail traffic management within the ERTMS framework.

The specific objectives of research in the air sector are:

- to assess effects at the external interfaces to the European Air Traffic Management System implementation area and to identify possible technical and operational solutions;
- to identify the feasibility of an Air Traffic Management concept that can be implemented from the year 2005 on, and to assess the operational, technological and economic aspects through modelling and simulation to gain confidence in the viability of its implementation;
- to design and implement a range of physical traffic management measures in cities, including parking management and guidance, traffic calming and bus prioritisation, to evaluate their impacts (concerning transport efficiency, safety and modal split in urban areas), and to make recommendations for future urban transport policy.

### *Main findings*

In the rail sector, the European Rail Traffic Management System (ERTMS) requires a large set of interface specifications, test tools and validation processes to be elaborated. The primary target here is to ensure true functional interoperability for operators throughout European rail networks, and to set the groundwork for (future) national bodies responsible for interoperability certification. One of the prominent issues in developing ERTMS is the provision of comprehensive software tools that have to be validated and assessed at the ERTMS test sites.

A dedicated System Requirement Specification (SRS), which describes all technical details and integrates the Reliability, Availability, Maintainability and Safety (RAMS) documentation, has been produced. Additional specifications for testing the system, including scenarios for demonstration sites in different countries, have finally led to the agreement on contracts for three pilot and demonstration sites at major European railway links.

Further, a rail operations management philosophy building on six technical measures supporting the progressive implementation of ERTMS, starting with enhancements in information management and co-operative processing, while later on the fully comprehensive management system would be endorsed, has been defined. Suggestions on how to add value to

the Europe-wide management of railway operations by adopting national traffic management procedures, and a conceptual baseline for rail traffic management, identifying key elements such as real-time data collection of current operations on a traffic corridor, data processing and dissemination of crucial information, provision of tools to evaluate necessary actions if operational problems occur, and integration of external links to achieve intermodality, have been produced. This work was complemented by an overview of perceived barriers for the technical implementation of a pan-European rail traffic management system, notably the critical knowledge of local conditions which will allow for viable corridor-wide solutions, and the interdependency of accurate forecast information and the related management of potential conflicts in operation.

A set of verification tools for testing of Eurocab components, limited to moderate levels of overall system functionality, was developed that will be the future reference for interoperability testing and validation of the complete ERTMS. A total of 40 Eurocab tools for dedicated laboratory and on-site tests was brought up, with the Eurocab simulator undergoing acceptance tests, backed by verification tests on the Spanish high speed link Madrid – Seville.

The European Train Control System (ETCS) requires similar test exercises, that have commenced on the Vienna – Budapest cross-border rail link. The test application included the installation of an ETCS track-side system with direct connection to existing on-site signals, complemented by the fitting of two locomotives with the on-board ETCS components. The test setup has allowed for a partial demonstration of the interoperability of on-board systems from several major manufacturers. Overall, the first pilot application of a complete ERTMS/ ETCS system proved the operational, interoperability and safety benefits of the concept, and encouraged larger scale demonstrations over a longer time period.

In the air sector, research into ATM improvements has looked in particular at interface effects between the European region and neighbouring Air Traffic Control (ATC) regions. Recommendations have been made for the involvement of non-ECAC states. This would involve holding meetings for knowledge exchange and staff training, co-operation in the planning of common route structures, common selection of navigation aids, promoting civil/military agreements on the co-ordinated use of air space, and general attempts to improve information management.

Traffic management in cities has been addressed by evaluating a range of physical measures for traffic management through their practical implementation in a number of cities (Gent, Heidelberg, Liverpool, Nantes, Patra and Utrecht), and making recommendations for the future development of urban transport policies. Schemes to restrict road space and parking space for private cars proved very successful in terms of their impact on travel behaviour and consequent environmental benefits. The main difficulty lay in opposition from shopkeepers, although residents and visitors were generally supportive. The effects of traffic calming, found to reduce overall traffic speeds and noise at a local level, parking management and guidance, which appeared successful in reducing circulating traffic at a local level, and public transport priority, that did not have a strong influence on modal split, have been investigated. Finally, measures to favour cyclists and pedestrians had only limited effect on modal shift when used in isolation, but were perceived by users to improve safety.

## 6.8 Technology development

***Research objectives***

Objectives in this area are:

- to develop an electronic booster which compensates the voltage drop of the main power transformer of railway sub-stations, in order to keep sufficient voltage on the overhead line and to avoid the construction of costly new sub-stations;
- to develop a wagon that allows a fast and easy loading and unloading of palletised goods, with a high degree of automation.

***Main findings***

Specifications for the prototype of a high voltage booster unit compensating for voltage drops of main power transformers were formulated, that are expected to help reduce infrastructure costs of railway power supply systems. With four major prevailing current systems across Europe, the standardisation of booster units applicable for alternating current and direct current systems alike is foreseen to significantly contribute to the establishment of the European Rail Traffic Management System (ERTMS). From detailed analysis two innovative technological solutions based on state-of-the-art power electronics can be distinguished:

- pure power electronics systems – booster auto-transformer with load tap changer using semi-conductor devices (STCSB) and the thyristor controlled booster (TCSB);
- mixed systems – static var compensators (SVC), thyristor switched capacitors (TSC), static var generators (SVG), static series synchronous capacitors (SSSC), and unified power flow controllers (UPFC).

## 6.9 Freight

***Research objectives***

Objectives in this area are:

- to optimise consignment flows within the rail and road sectors, by integrating state-of-the-art tracking and tracing systems within a seamless consignment management structure;
- to establish the basis for a common standard interface for information and data exchange and distribution between combined transport operators and their clients, mainly road hauliers and freight forwarders;
- to define information approaches to enable a transport chain to be scheduled and managed as a single process, over a range of modes and with different providers, without the need for all the participants to adopt the same information system or even the same information standards;
- to create a common and open distributed method for adaptive and pro-active tracing of communication chains and tracking of general cargo through all sections of the logistic chain, from factory to consumer, with regard to integration of small inland terminals;
- to enhance terminal management and the integration of existing telematics systems by improving communication protocols and connections between terminals , evaluating their application in terms of scheduling, planning systems ,etc. and designing a simulation model for dynamic scheduling of combined rail-road transport;
- to build up a prototype of an information service for rail-based international freight transportation.

### *Main findings*

A pilot system for communication between Combined Transport operators and their clients, mainly road hauliers and freight forwarders, was developed. The system is organised as a stand-alone interface allowing clients to book or query for status information while being connected to the Internet, and comprises a common standard interface for information, data exchange and distribution.

An in-depth analysis of existing waterway infrastructures on the Danube river and adjacent canals has focused on navigable conditions, transport capacity and existing ports, their facilities, typical goods and capacities. Moreover, the study has analysed inland ship fleets, the prevailing transport market conditions, trade and transport flows, and forecast future trade flows based on developed scenarios in the Danube corridor. In conclusion, there currently is a unique possibility to create a powerful inland waterway backbone along the Danube river, as long as road and rail networks in South-Eastern Europe have not reached western standards. This would require a single regulatory framework for EU countries, acknowledged accession countries and countries such as Ukraine, alike. A logical next step then would be the promotion of transnational infrastructure and fleet investments to cope with the forecast growth in transport on the Danube.

The prototype of a centralised, web-based communication node, that allows to handle inhomogeneous information from various sources in a complex shipment process, was established. It includes connecting and integrating several transport modes, logistic providers, forwarders, agents and depots into a main 'umbrella' module, thereby successfully improving information flow, trackability and reliability of short to medium distance shipments. The Internet based concept was customised and demonstrated with two existing medium haul corridors (Valencia – Madrid and Marseilles – Lyon. The demonstration phase confirmed the idea of a centralised information and communication node for regional intermodal transport corridors.

A common and open distributed information and communication platform for adaptive tracing of transport chains and tracking of general cargo through all sections of the logistic chain was brought up. The systems contains a tracing and e-mail-based communication system to process and communicate information to partners, and a tracking and identification system for gathering information related to physical cargo operations. The distributed non-hierarchic cargo tracing and tracking platform was found to be a good solution for managing complex transport corridors, since it allows transport actors to communicate efficiently.

In a complementary project an integrated system for freight intermodal transport that supports the functionality of documentation, booking, in/out gate, traffic optimisation, warehouse management, transport management and route scheduling was provided. The concept includes an Internet-based tracking and tracing logistics system communicating to external systems using Electronic Data Interchange (EDI) and E-mail. While the focus was primarily on intermodal chains between ports and other modes, the related benefits were mainly confined to shipping lines, road hauliers and trading parties. The anticipated benefits are reduced costs, less unproductive movements, less environmental impact, and enhanced services to buyers of transport services.

The adoption of telematics technologies to realise really integrated computer-controlled freight platforms will require the following highlighted features: computer-based booking and dispatch systems for the reservation of transport capacity and for the allocations of loading

time and position, fast loading/unloading devices, intelligent gate procedures and automated guidance of trucks to reserved loading places, electronic devices to automatically locate and register intermodal transport units in the yard, and computer-aided yard allocation policies. It has been demonstrated that the adoption of faster transhipment devices without the support of computer-aided management does not produce significant changes in the performances of the terminal, however the implementation of computer-aided management systems is cost-effective for every actor in the chain.

Combining state-of-the-art technologies for pallet systems, tagging and tracking systems and automatic loading units, an integrated system, to demonstrate that a fully automated and electronically managed palletised distribution is feasible, was developed. The three pillars of the concept are standard or customised pallets, radio tagging and read/write devices, and three Automatic Loading Units (ALU's) for transferring vehicle loads of palletised goods. A prototype ALU has been designed to be compatible with ISO-conforming Europallets, indeed other pallet systems for the automotive industry and for the consumer retail trade were identified as well.

Recommendations to standardise a future European loading unit with the main dimensions of current standard swap bodies were elaborated, and a standardised future European loading unit that will be suited for all current European transport modes was specified. The latter will include providing two sizes for road transport, a rail transport unit, and a unit for inland waterway transport. For optimised intermodal operations a maximum gross weight in road transport of 44 t must be allowed, together with the introduction of standardised stackable European loading units of 13.6 m in length. Standardisation of loading units should thereby consider the requirements of inland waterway barges and rail wagons as well.

According to the findings of research multi-modal transport will need to implement an integrated information system that manages transport demand (i.e. shipper requirements), the supply side, the optimal use of infrastructure and all of the networked assets used. This may be achieved by introducing a hierarchical trunk sector networking structure made up of dedicated components for interconnected nodes and terminals. A timeline for gradual implementation of market driven changes was proposed for the short-term (next 18 months), mid-term (12 to 42 months) and long term (36 to 66 months). It would include software developments, organisational measures, and the gradual introduction of improved hardware into the road and rail sectors. The conclusion from this study is that transport policy and the particular regulations derived from it will need to be adapted and revised, in order to allow for improved conformity of multi-modal transport procedures, and significantly better performance.

A database of 96 European freight platforms – transhipment areas where many transport companies, such as forwarders and logistic service providers – was created, identifying key characteristics such as transhipment volumes, infrastructure, on-site company interactions and financial arrangements. Based on this analysis, a handbook was developed for local authorities and transport sector companies. The handbook provides guidance and evaluation methods for establishing new freight platforms, and has been validated on four test sites using computer simulations.

## 6.10 Architecture

### *Research objectives*

Objectives in this area are:

- to establish co-ordinated architectures for the interconnection of long-distance transport using telematics applications, and to facilitate consensus formation among policy makers at European, national and regional/local levels;
- to define the functional architecture of overall air traffic management systems and data exchange.

### *Main findings*

Interchanges within the public transport system and terminals connecting public transport to private car use were found to be in need of dedicated policy towards the location of major interchanges. Because such infrastructure has tremendous influence on land-use and land values in the vicinity of the site, and may generate much traffic locally, strong co-operation is needed between transport and regional planners. It was proposed to update the TEN-T guidelines with new procedures to support decisions on interchange location, taking account of different stakeholder interests. Specific findings include that short transfer and waiting times are crucial for passenger satisfaction with an interchange. This requires harmonised schedules for all modes available at the interchange, through ticketing for multi-modal journeys, and co-operation between modes in handling system interruptions.

To co-ordinate efforts in the development and design of a European Air Traffic Management System (EATMS), a number of RTD activities are devoted to establishing a framework for functional architectures of CNS/ATM (Communication, Navigation and Surveillance/Air Traffic Management) components. On the basis of operational scenarios for the time frame 2005-2010, a system model has been produced – addressing interoperability – with a description of internal and external interface aspects.
All subsequent developments of EUROCONTROL ATM scenarios should build on experience from FP4 projects to avoid divergence in methodology and design.

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# ANNEX 1 RTD PROJECTS CONTRIBUTING TO THE THEME

This Annex lists the titles and objectives of RTD projects relevant to the theme of interoperability. The following Table identifies the RTD cluster(s) to which each project contributes significantly.

| Clusters | Sector | Relevant RTD projects |
|---|---|---|
| *Scenarios* | *Strategic research* | POSSUM, SCENES 10-11-12 |
| *Tools and methodologies* | *Strategic research* | ASTRA, CODE-TEN, COMMUTE, EUROSIL |
| | *Integrated transport chains* | LOGIQ |
| *Organisation* | *Strategic research* | LOGICAT, MINIMISE, SORT-IT |
| | *Urban transport* | ISOTOPE, REFORM |
| | *Rail* | LIBERAIL |
| *Pricing* | *Urban transport* | FISCUS |
| | *Strategic research* | PETS |
| | *Integrated transport chains* | TACTICS |
| *Quality of networks* | *Integrated transport chains* | APRICOT, EU-SPIRIT, IQ, OSIRIS, SCANDINET |
| | *Urban transport* | INCOME, INTRAMUROS, LEAN, MOTIF |
| | *Rail* | EUFRANET |
| | *Waterborne* | EUDET |
| *Quality of terminals/transfer points* | *Integrated transport chains* | AFTEI, FREIA, FV-2000, IMPREND, PRECISE IT, TERMINET |
| | *Urban transport* | HSR-COMET |
| *Traffic management and control* | *Rail* | ACRUDA, EMSET, ERTMS Tests, ETCS-VB, EUROSIG, OPTIRAILS |
| | *Air* | ABEAM, HEROE, TORCH |
| | *Urban transport* | OPIUM |
| *Technology development* | *Rail* | HVB |
| | *Integrated transport chains* | ROLLING SHELF |
| *Freight* | *Integrated transport chains* | AFTEI, CESAR, EUDET, ITESIC, OCTOPUS, PISCES, PLATFORM, TACTICS, UTI-NORM, X-MODALL (X-MOD/1) |
| | *Rail* | FIRE |
| | *Urban transport* | REFORM |
| | *Waterborne* | EUDET |
| *Architecture* | *Urban transport* | CARISMA |
| | *Air* | FARADEX |

| Project acronym | Title | Objective(s) |
|---|---|---|
| ABEAM | Across the borders EATMS effect | The main objective is to assess the interface effects outside the EATMS implementation area and to identify possible technical and operational solutions to any problem discovered. Compatibility is essential for interoperability, interconnection and accessibility of different ATM systems to improve the safety, capacity, reliability and quality of air transport. |
| ACRUDA | Assessment and certification rules for digital architecture | The main objectives of ACRUDA are the definition of the assessment framework and criteria for safety architectures used in the guided public transport industry and the development of a certification scheme for safety architectures. The results are intended for the ERTMS validation. |
| AFTEI | Air freight transport and European intermodality | The project aims to define the conditions for intermodality between the air transport chain and other modes of transport, from the economical, logistic and information system point of view, to highlight the economic chain supporting door-to-door freight transport. The project will identify actions that can contribute to an improvement of the ability for freight users to make use of the optimal transport mode at each point of the transport chain. The project will clarify the legal, technical and economical issues that permit pilot actions to be promoted, and will address contributions to standardisation bodies and European Union Programmes. |
| APRICOT | Advanced pilot tri-modal transport chains for the corridors West – South/South-East Europe of combined transport | APRICOT aims to increase the competitiveness of intermodal transport by integrating inland waterway transport with optimal logistic door-to-door chains outside the Rhine corridor, by linking waterway transport with rail transport to destination areas in southern and south-eastern Europe, and road traffic to local destinations. The project will therefore develop structures for advanced tri-modal transport chains, prove their cost-effectiveness and efficiency, evaluate their economical and environmental impact, and formulate recommendations that will be tested in three case studies. |
| ASTRA | Assessment of transport strategies | The aim is to develop tools needed for strategic policy assessment related to CTP targets and the TEN-T. |
| CARISMA | Co-ordinated architectures for the interconnection of networks for suitable mobility with telematics applications | The project aims at supporting consensus formation on transport issues related to the interface and interconnection between long distance transport networks and local/ regional transport networks of all modes. Current practice will be assessed, best practice established, and actions to be taken at European, national and local levels proposed. |
| CESAR | Co-operative European system for advanced information redistribution | The aim of the project is to promote improved performance and quality in intermodal transport through information systems. CESAR will establish the basis of a common standard interface for information and data exchange and distribution between combined transport |

| Project acronym | Title | Objective(s) |
|---|---|---|
| | | operators and their clients. A demonstration project with major operators of the two main north-south trans-Alpine routes is included. Outputs include reports on communication interfaces and the pilot operation, and the production of a handbook with recommendations for smaller European combined transport operators. |
| CODE-TEN | Strategic assessment of corridor developments, TEN | The general aim of the CODE-TEN project is to assist with decision-making in the complex environment of contemporary transport geography characterised by the new concept of 'corridor'. It will provide a comprehensive strategic assessment methodology that can apply to corridors and will seek to identify and present major policy-related issues and the associated scenarios and assumptions in a consistent way. |
| COMMUTE | Common methodology for multi-modal transport environmental impact assessment | The aim of the project is to define a methodology for strategic assessment of the environmental impacts of transport policy options, to support transport policy decision making at the European level. |
| EMSET | Functional EUROCAB component validation on the Madrid – Sevilla line | The main objective of EMSET is to perform the preparatory activities conducive to a full-scale functional validation of the onboard ERTMS subsystem. Such validation includes interoperability tests via several external specific transmission modules with some main existing signalling systems used in Europe. |
| ERTMS Tests | ERTMS test preparation | The project addresses the full range of preparation activities leading to full scale trial tests of the European Rail Traffic Management System in a number of pilot sites to be located in France, Germany and Italy. This includes the functional, system and subsystem specification as well as an overall safety concept. Aspects on ergonomics and automation will be addressed. |
| ETCS-VB | Test strategy for ETCS based on the pilot installation Vienna – Budapest | The main objective of ETCS-VB is to set in place a pilot installation of the ERTMS, level 1, on the Vienna – Budapest line. This first complete installation as an overlay on an existing line will demonstrate the performance of the new European train control system and the interope-rability with existing ATP systems. Further ETCS-VB shall lead to approval or revision of the ERTMS specification for subsequent wide application on the railway network in Europe. |
| EUDET | Evaluation of the Danube waterway as a key European transport resource | The research will provide a comprehensive evaluation of the Danube waterway's efficiency as a key infrastructure of the S. E. axis supporting traffic flows between Western and Eastern Europe. |
| EUFRANET | European freight railway network | The main objective of the EUFRANET project is to identify and evaluate strategic options for the development of a Trans European railway network mainly dedicated to freight transport. Besides the aim to decrease the freight transport cost and to improve transport quality and services, it is also envisaged to improve the rail freight transport organisation and |

| Project acronym | Title | Objective(s) |
|---|---|---|
| | | interoperability. New railway technologies will be identified and evaluated for freight transport. |
| EUROSIG | Development of the complete ERTMS concept | The main objective of EUROSIG is the development of a European wide common concept for a railway safe signalling system. EUROSIG should demonstrate the technical feasibility of the ERTMS system concept as well as establish a common approach to assess the system safety. |
| EUROSIL | European strategic intermodal links | The aim of the project is to provide a spatial European set of guidelines, criteria and modelling and evaluation tools based on an overall spatial evaluation framework, elaborated on a common methodology for the TEN and PEN. |
| EU-SPIRIT | European system for passenger services with intermodal reservation, information and ticketing | The project aims at establishing conditions for a significant shift in long distance travel from individual motorised transport to intermodal transport. EU-SPIRIT will identify technical (e.g. interoperability of telematics databases) and non-technical (e.g. organisation, culture, legal and commercial barriers) obstacles that prevent efficient information on the possibilities of intermodal transport, and afterwards establish solutions – validated in a number of pilots – to reduce those barriers. |
| FARADEX | Functional architecture reference for ATM systems & data exchange | The main objective of the FARADEX project is to define the functional architecture of overall Air Traffic Management Systems (ATMS) and serve the EATCHIP/ EATMS programme. In particular FARADEX will consolidate the state of the art and form a reference for the future ATMS, and address the problem of interfaces with airlines, airports, military and meteorological systems and neighbouring systems outside the ECAC area. The problem of interoperability at a functional level will be a major issue. |
| FIRE | Freight information in the railway environment | The project aims at building a prototype of an information service for rail based international freight transportation. The service is designed to respond to the needs of the users of the European rail based freight transportation system by defining a general architecture and setting up a field test of a prototype information service. |
| FISCUS | Cost evaluation and financing schemes for urban transport systems | The project aims at analysing existing cost allocation methodologies and financial schemes and conceiving new ones in response to identified gaps and weaknesses. Methodological frameworks to assess urban transport financing schemes and evaluate real urban transport costs will be defined, real urban transport costs evaluated and new financing schemes designed. |
| FREIA | Towards the networking of European freight villages | The aim of the project is to facilitate the access of SMEs (small & medium-sized enterprises) to intermodal transport by establishing relations with freight villages, their services, procedures and information systems. Outputs include comparisons of regional differences in the commercial practices of SMEs and freight villages, |

| Project acronym | Title | Objective(s) |
|---|---|---|
| | | the development of a freight village information system concept and a reference book/CD-ROM user guide for SMEs and freight villages. |
| FV-2000 | Quality of freight villages structure and operations | The aim is to analyse and evaluate freight village structure and layout in order to determine the extent to which the proximity of various transport and logistics activities influences the use of intermodal transport. The study will also establish the merits and limits of freight village development to benefit intermodal transport. |
| HEROE | Harmonisation of European rail rules for operating ERTMS | The main objective of HEROE is to harmonise rules and regulations for the new ERTMS control-command system in nominal and degraded situations. A common level of safety will be fixed and the transition period will be addressed. |
| HSR COMET | Interconnection of the high speed rail network with other transport modes: Connection in metropolitan areas of HSR terminals | The project aims to provide guidelines for improvement of interconnections with High-Speed Rail (HSR) terminals. A comprehensive analysis of demand identifying HSR users and users' demand for urban intermodal connections will be carried out. Urban transport modes/op-tions that best meet users' requirements for interconnection with HSR terminals will be determined. Priorities for the development of these interconnection options on the basis of an impact assessment analysis will be identified. General policy guidelines for developing and supporting the interconnection options addressing economic, land use, financing, tariff, interconnection services and legal/institutional issues will be defined. |
| HVB | High voltage booster | The project HVB aims to design and develop a high voltage electronic booster which compensates the voltage drop of the main power transformer of railway substations due to increasing power consumption in rail transport. New structures with semiconductors will be studied as well as more classical converters. Such new boosters should avoid the construction of cost intensive new power stations. The interoperability of the new booster is an important issue, therefore major European railway companies as well as the manufacturing industry are involved. |
| IMPREND | Improvement of pre- and end-haulage | IMPREND aims at improving pre- and end-haulage at terminals, thus enhancing the efficiency of terminals as an integral part of the intermodal transport chain. The project involves an overview of the intermodal structures and methods of pre- and end-haulage working. This will be followed by an overview of formulae for improving pre- and end haulage. Six case studies will be demonstrated. The final report will include recommendations for transport and terminal operators and other intermodal transport players, including policy makers. |
| INCOME | Integration of traffic control with other measures | The aim of the project is to develop and integrate strategies for the optimisation of Urban Traffic Control, |

| Project acronym | Title | Objective(s) |
|---|---|---|
| | | Dri-ver Information Systems and Public Transport Systems within Urban Traffic Management Systems (UTMS). EU, national and local policy/user requirements for integrated UTMS will be established, integrated UTMS in EU and strategies/software for their optimisation will be reviewed, field trials will be evaluated and guidelines provided on the effectiveness of integrated strategies. |
| INTRAMUROS | Integrated urban transport concepts and market orientated urban transport systems/on demand urban transport systems. | The project aims to provide new knowledge on the integration of the different actors involved in urban transport management systems (local authorities, public transport operators, regional authorities), including market oriented urban transport systems, and to develop a conceptual methodology for assessing the integration of these actors. The current status of integrated urban transport management systems will be reviewed. Strategies and concepts for co-ordinating the various actors and operators will be developed, with special attention to urban traffic control, interurban traffic control and public transport. A methodology which allows the different urban actors (including users and suppliers) to assess the level of integration in their urban centre will be developed. Guidelines will be provided for the harmonisation of the information provided to car drivers and passengers and the allocation of tasks corresponding to the different information providers. |
| IQ | Intermodal quality | The objective is to improve the competitiveness of intermodal transport through technological improvements. The study analyses the quality aspects influencing intermodal transport (both the terminals and the network), working on improving interoperability among terminals, their interconnectivity and intermodal transport accessibility. It involves the production of an interactive simulation tool to analyse the effect of changes in the system on intermodal transport performance, demonstrators of the project findings in 4 cities, and preparation of recommendations on the implementation. |
| ISOTOPE | Improved structure and organisation for transport operations of passengers in Europe | The project aims to investigate the institutional framework for public transport operations. Existing legal status and organisational structures for public transport operations in the European countries will be described and compared. The pros and cons of various organisational forms in terms of effectiveness and efficiency will be analysed. A strategic approach to the development of public transport operations will be provided to political decision-makers, transport planning authorities, public transport authorities and operators. The way in which organisational structures may be improved in order to increase the role of public transport in European urban areas will be identified. |
| ITESIC | Integration of technologies for European short intermodal corridors | The project aims to develop and demonstrate a one stop shop for intermodal freight transport in short and medium distance corridors by developing a working environment capable of covering the requirements of the logistic planners and operators. ITESIC will fill the gap |

| Project acronym | Title | Objective(s) |
|---|---|---|
| | | between existing information systems that today do not communicate to each other. It will re-engineer the process of sending cargo through corridors, eliminating for instance the need to send the same information to the maritime leg, the railway leg and the customs. It will replace this by a single procedure capable of delivering the information to all interested parties regardless of the mode of transport that they operate. |
| LEAN | Integration of lean logistics in urban multi-modal transport management to reduce space demand and optimise use of transport mode | The project aims to develop and demonstrate new concepts to distribute and collect goods in urban areas. Current European city-logistic schemes will be reviewed, the feasibility of new concepts analysed, and new systems tested, at the following levels: Logistics to improve productivity in transport organisation; City-Terminal operation to improve forwarding processes along the whole logistics chain, even with additional goods transfer points and handling costs; telematics to improve control of goods distribution process; tools for administrations to influence transport without radical disruption of economic activities; alternative transport modes to support significant modal shift to rail. |
| LIBERAIL | Liberalised and interoperable railways | The main objective of LIBERAIL is to investigate the new potential of rail transport under the influence of liberalisation of the use of infrastructure. In particular the impact on interoperability will be analysed as well as the cost of using infrastructure and the level of service. |
| LOGICAT | Concerted action on logistic, supply and demand chain management in Europe | The main objective is to determine fundamentals for for-mulating an overall European RTD strategy to further develop logistics of competitive and external trade of the states, while reducing congestion and all other negative impacts on the environment and humans. A particular objective will be to identify and demonstrate the potential of new and innovative intermodal transport concepts. |
| LOGIQ | Intermodal decision. The decision making process in intermodal transport | The aim of the project is to identify actors in the decision making process and to provide information on their criteria and constraints for using intermodal transport. These include the three key variables of infrastructure networks, quality factors and the institutional/environ-ment/legal issues. The results of the analysis of the decision making process, and the variables which determine it, will be used to construct a decision process model for possible computer applications. Two case studies are included, one sectoral (chemical) and one geographical (Rhine). |
| MINIMISE | Managing interoperability by improvements in transport system organisation in Europe | The aim of the project is to analyse the European transport market as a whole and to design specific measures in order to promote interoperability and economic efficiency of the trans-European transport system. |
| MOTIF | Market orientated transport in focus | The project aims at deriving the means to design better Market Oriented Urban Transport Systems (MOUTS) as |

| Project acronym | Title | Objective(s) |
|---|---|---|
| | | part of a set of pull measures aimed at balancing modal split more in favour of collective transport systems. Mobility demand requirements and urban transport systems characteristics will be identified. Market success factors will be selected and the most promising Product-Market Combinations (PMC) will be derived. Most appropriate MOUTS will be defined for a set of case studies where such PMCs exist. Guidelines will be produced for authorities, transport operators and transport supply industry to improve the market orientation of the overall urban transport system, individual transport systems and transport components, respectively. |
| OCTOPUS | Towards distributed heterarchic workflow methods for pro-active tracing of cargo | OCTOPUS aims to create a common and openly distributed method for the tracing of communication chains and tracking of general cargo through all sections of the logistic chain. The project focuses on the integration of small but flexible inland terminals. The project involves identification of the workflow, followed by the design and development of the heterarchic communication layer and adaptive identification tools. These will be tested in case studies covering the Scandinavia – France and Greece – Germany corridors. |
| OPIUM | Operational project for integrated urban management | The project aims at developing physical traffic management measures in the areas of parking management and guidance, traffic calming and bus priority measures. A range of measures will be designed and implemented in six cities. The impact of the measures on transport efficiency, safety and modal split in urban areas, with parti-cular reference to the impact on vulnerable road users will be evaluated. Recommendations will be provided for the future development of urban transport policies, taking account of different urban environments including legal and institutional barriers, the need to improve the quality of life and the needs of different users of the urban transport system (including elderly and disabled persons). |
| OPTIRAILS | Optimisation of traffic through the European Rail Traffic Management Systems | The main objective of the project is to identify functional and technical facilities for the Pan-European rail traffic management within the ERTMS framework. It is intended to improve real time train dispatching and route planning, rail node fluidity, and customer and operating staff information. |
| OSIRIS | Optimised system for an innovative rail integrated seaport connection | This project is aimed at developing integrated rail connections to seaports and planning a hub and spoke system between different seaports and the economic regions in their hinterland. It focuses on user requirements, transport demand, intermodal terminal concepts, rail transport, business structure and the requirements for an information and communications system. Case studies feature hub and spoke systems based on ports in the Rhine delta. |
| PETS | Pricing European transport systems | The aim of the project is to inform about the current pricing of transport modes and to forecast the |

| Project acronym | Title | Objective(s) |
|---|---|---|
| | | consequences of moving to a more appropriate price structure and level. |
| PISCES | Pipeline intermodal system to support control, expedition and scheduling | This project is focused on the difficulties of providing information through the transport chain to enable the efficient implementation of logistic systems. PISCES will enable a transport chain to be scheduled and managed as a single process over a range of modes and with different providers, without the need for all the participants to adopt the same information system or standards. The project is primarily concerned with intermodal chains between ports and other modes, with demonstrations in the Ireland – UK – Netherlands corridor. |
| PLATFORM | Computer controlled freight platforms for a time-tabled rail transport system | PLATFORM aims to enhance the competitiveness of rail freight by implementing a more cost-effective way of managing traffic flows through the enhancement of terminal management and the integration of existing telematic systems. It will consider the improvement of terminals as "value-adding" centres for intermodal operations, communication improvements between terminals and will evaluate applications in 8 rail/road terminals in Italy, France and Spain. A simulation model for dynamic order scheduling will also be developed. |
| POSSUM | Policy scenarios for sustainable mobility | The aim of the project is to develop a set of alternative policy scenarios to assist in decision making on the CTP and the TEN. |
| PRECISE-IT | Precise automatic location system for the management of ITUs and vehicles inside intermodal terminals | Precise-IT intends to contribute to the optimisation of intermodal terminal operations, addressing operational problems related to the position of ITUs and/or vehicles in the terminal. The aim is to set up and test a demonstration system for the automatic location of ITUs and vehicles in the terminal area. The project, which includes a demonstration case study, will investigate several technologies and identify a range of modular solutions. |
| REFORM | Research on freight platforms and freight organisation | The project aims at analysing and evaluating the effects of freight platforms regarding the urban traffic and providing guidelines and criteria for designing, locating and organising freight platforms in urban areas. An empirical investigation as a basic requirement for modelling and simulating the effects of freight platforms will be carried out. A methodology to estimate the different effects of freight platforms will be developed. Practical application and evaluation in test sites will be carried out with a focus on co-ordination of big inter-ports with city terminals, organisational and operational requirements, multi-modality, and operational improvements to be expected from co-operation schemes. |
| ROLLING SHELF | Rolling shelf | This project has the objective of improving short distance intermodal transport operations for palletised goods and parcels. Rolling Shelf is characterised by a high degree of automated goods transfer, thus reducing |

| Project acronym | Title | Objective(s) |
|---|---|---|
| | | transfer costs and increasing the attractiveness of rail transport over shorter distances. The project therefore aims to create a greater market share for rail for high value and sensitive palletised goods over distances of about 100 km. The project includes an economic evaluation of the system and will propose a network of terminals, suitable goods wagons that allow easy loading/unloading and a telematic solution for handling and tracing orders. |
| SCANDINET | Promoting integrated transport in peripheral areas of the Union case Scandinavia | The project objectives are to identify the potential demand for intermodal transport in peripheral and isolated areas of the EU; to identify the possibilities for combined international, national and transit flows in selected corridors and terminals; to explore the possibilities for reducing the distance for which intermodal transport is viable; and to design a concept for closing identified gaps in information flows. The concepts will be validated in 3 to 4 corridor case studies and a guide for intermodal transport users and service providers will be produced. |
| SCENES 10-11-12 | Modelling and methodology for analysing the interrelationship between external developments and European transport | The project has three objectives: to produce transport demand scenarios for the EU for 2020 and beyond; to develop detailed forecasts of factors which will affect transport demand into the future; and to extend (to Eastern Europe) and enhance (with new data) a strategic transport model of the EU and carry out model runs based on the scenarios. |
| SORT-IT | Strategic organisation and regulation in transport | The aim of the project is to develop measures addressing the organisation of the European transport system, and to consider policy options concerning relationships between regulators and operators. |
| TACTICS | The automated conveying and transfer of intermodal cargo shipments | TACTICS aims to demonstrate that loading bay and intermodal transfer of palletised goods can be fully automated, electronically managed and networked into computer based logistics within existing transport systems, and that these goods can be transferred in an uninterrupted recyclable intermodal distribution chain. This will be verified by the construction of a functional system, which will also demonstrate mechanical engineering, electronic control and logistics software solutions. The project includes a cross-European case study involving electronically-tagged products using the same recyclable palleting. The benefits of such a system would include streamlined loading and unloading, more efficient use of vehicles and warehouses, and reduced consumption of fuels and packaging. |
| TERMINET | Towards a new generation of networks and terminals for multi-modal freight transport | The objective of the project is to identify promising innovative bundling networks and new generation terminals and nodes for combined uni-modal and intermodal transport in Europe. The main aspect is the automation of processes to produce enhanced value for money. The project aims to provide a framework for recommending certain terminal and terminal node concepts for different types of nodes and bundling |

| Project acronym | Title | Objective(s) |
|---|---|---|
| | | concepts and vice versa. This will be tested in 5 case studies and decision-supporting software tools will be produced. |
| TORCH | Technical, economical and operational assessment of an ATM concept for the year 2005 | The main objective of TORCH is to define and assess the feasibility of a viable, consolidated air traffic management concept that can be implemented from the year 2005 based on the OCD target concept, but applicable in the short term. The assessment will cover the operational as well as the technical and economic aspects. |
| UTI-NORM | Current state of standardisation and future standardisation needs for intermodal loading units | The project aims to report about future standardisation trends and decisions that will influence vehicle design and transfer equipment lay-out. It will also study the parameters of European infrastructure design, European vehicle legislation and the efficiency of the European transport system, the current state of this debate and its historical, technical and economical sources. |
| X-MODALL (X-MOD/1) | The optimised exchange between all modes of all conforming consignments | The primary function of X-MODALL (X-MOD/1) is to optimise overland European united consignment flows by road and rail. The aims are therefore to provide infrastructure strategies and frameworks for intermodal networking, facilitate an open-systems operating environment and to specify the technology and interfacing protocols necessary to implement it, to develop the strategy's software components and to assist in further developing EC regional policy and infrastructure. It also looks at innovative vehicle and intermodal load unit design. |

# ANNEX 2 MAIN FINDINGS FROM COMPLETED RTD PROJECTS

This Annex summarises the findings from completed projects for which the Final Report has been approved or made available (in alphabetic order of project acronyms). Project web page references are provided where known. Summaries of all projects are available from the two web sites given in Section 1 of this paper.

## Index of available RTD project results:

| Project acronym and title | Key results and policy implications |
|---|---|
| **ABEAM:**<br>**Across the borders effects of air traffic management** | ***KEY RESULTS***<br>ABEAM has produced:<br>• a set of region-specific recommendations on how to mitigate discovered interface effects; regions covered have been NAT (North Atlantic), AFI (African and Indian ocean), MID (Middle East) and for Europe the non-ECAC countries;<br>• general recommendations on how to involve non-ECAC States in further development and implementation processes, e.g. by holding meetings for knowledge exchange and staff training, by co-operation in the planning of common route structures, by common selection of navigation aids, by promoting civil/military agreements on the co-ordinated use of air space and by general attempts to improve information management;<br>• proposals on how to improve collaboration in decision making and IFPS (Initial Flight Plan Processing System) issues.<br><br>***POLICY IMPLICATIONS***<br>The study's achievements are an important constituent in the overall ECARDA (European Coherent Approach for RTD in Air Traffic Management) framework of developments towards the future EATMS. |
| **ACRUDA:**<br>**Assessment and certification rules for digital architectures** | ***KEY RESULTS***<br>ACRUDA has produced:<br>• recommendations on the content of a Quality Handbook that describes a quality system for assessment of safety-critical digital structures in the field of railway signalling<br>• a common set of assessment criteria to evaluate the processes and products of the digital architecture with regard to product life cycles - the ACRUDA assessment procedures and criteria for vital computers<br>• software assessment criteria that address requirements, planning, design, testing, integration and validation of software products<br>• hardware assessment criteria that cover requirements, design and testing with respect to defined standards like CEN03 or IEC01.<br>The following steps have been carried out to validate the assessment framework for practical use:<br>• three application cases helped gain experience on the use of the assessment methodology, for different types of safety digital structures<br>  • DIGISAFE, single channel architecture, based on the coded mono-processor<br>  • ELEKTRA, dual channel architecture, adopting safety bag techniques<br>  • SARA, modular computer-based architecture including distributed processing and a hierarchical layered control system, adopting hardware redundancy for vital sections<br>• close interaction with the ERTMS (European Rail Traffic Management System) project strengthened technical links for the application of assessment methods on ERTMS test sites<br>• integration of two demonstration sites in Paris (Matra) and Naples (Ansaldo)<br>• organisation of two User Group Meetings with the aim of reaching relevant actors in the European rail industry, especially those involved in ERTMS.<br><br>***POLICY IMPLICATIONS***<br>The project's results will be adopted for ongoing validation of ERTMS demonstration sites. The contribution to policy issues is expected to evolve in the overall frame of the development of rail traffic management concepts. |

| Project acronym and title | Key results and policy implications |
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| **AFTEI:**<br>**Air freight transport and European intermodality** | *The final results of this project were not available when this Thematic Paper was prepared.* |
| **APRICOT:**<br>**Advanced pilot trimodal transport chains for the corridors West – South/ South-East Europe of combined traffic** | ***KEY RESULTS***<br>APRICOT has produced:<br>• an appraisal of trimodal (waterway, railroad and road) transport chains in order to reduce environmental impacts, in particular for alpine regions along the main traffic corridors to southern and south-eastern Europe;<br>• recommendations for the appropriate location of a desired trimodal freight terminal in Basle/Switzerland in order to reduce external costs compared to Combined Transport, representing the current baseline;<br>• recommendations to further undertake complex environmental impact assessments aiming at establishing additional multimodal terminals in the middle section of the river Rhine, e.g. at Mainz or Mannheim/Germany, to trigger considerable shifts away from road transport; and<br>• recommendations on how to improve interoperability as a mandatory precondition of trimodal transport chains and terminals, such as integrated terminal designs, advanced design of inland barges, the introduction of common Intermodal Transport Units (ITU), various organisational aspects, and the implementation of efficient information systems.<br><br>***POLICY IMPLICATIONS***<br>The study's positive assessment of the opportunities of trimodal transport chains for several regions in Europe should be supported by policy incentives during the implementation stage. The anticipated merger of inland barge, road and rail transport will allow for environmental friendly transport services with considerable impacts on modal shift, thus promoting sustainability in intermodal and interoperable shipments. Policy backing is considered crucial to assure acceptance in the transport market, which earlier attempts to implement trimodal transport chains failed to deliver. |
| **ASTRA:**<br>**Assessment of transport strategies** | ***KEY RESULTS***<br>ASTRA developed a system dynamics modelling platform integrating four sub-models (covering macro-economic activity, regional economics and land-use, transport demand and environmental impacts). The interfaces between the sub-models allow feedback loops to be established, thereby capturing the inter-relations between variables. Output indicators include traffic volumes, vehicle numbers, environmental impacts, and economic, social and employment indicators. Forecasts are produced from a base year of 1996 to a time horizon of 2026. The ASTRA model was demonstrated by simulating the effects of five policy packages (each consisting of sets of policy measures) and also a more comprehensive set of measures. The scenarios addressed policy decisions in the fields of taxation, construction of the Trans-European Transport Network, mitigation of air pollution and safety improvement. As an example of the system dynamics approach, the simulations considered different ways of spending the revenue from increased taxation – either for a reduction in labour costs or for construction of new transport infrastructure. Overall, the fully integrated set of measures produced the best results across the range of economic, environmental and employment indicators. Other significant points from the policy analysis were as follows:<br>• None of the tested packages was able to meet the Kyoto requirements for abatement of greenhouse gas emissions.<br>• No further significant improvement could be identified for road accidents. |

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- Air transport growth would be significant in all scenarios, and in some cases would counterbalance most of the environmental benefits of policies giving a reduction in road transport.

***POLICY IMPLICATIONS***

ASTRA has shown that the system dynamics methodology allows for a long-term assessment of the wider socio-economic and environmental impacts of transport policy packages, and provides inherently consistent indicators to enable a direct assessment by the policy-maker. Moreover, the methodology is available in an operational software model for policy assessment on a European scale. This can be used to forecast the "what-if" consequences of planned policies, or be run in a "backcasting" mode to identify measures that will achieve a desired end-state.

**CARISMA:**

**Concerted Action for the interconnection of networks**

***KEY RESULTS***

CARISMA brought together experiences from across Europe to provide a state-of-the-art review of approaches to network inter-connection. The main focus was on interchanges within the public transport system and terminals connecting public transport to private road journeys.
Policy towards the location of major interchanges was identified as one key issue. Such infrastructure has tremendous influence on land-use and land values close to the site, and consequently can generate much traffic locally. Strong co-operation is therefore needed between transport and regional planners. CARISMA proposed that the TEN-T guidelines should be updated with new procedures to support decisions on interchange location, taking account of different stakeholder interests. Financing of interchanges is another problem area. A key issue is the extent to which the largely profitable long-distance operators or the often-subsidised local operators should pay. Also, to what extent should the revenues from rising land prices and economic development around the interchange be captured to fund the basic infrastructure?
CARISMA concluded that there is no standard solution, but that legislation is needed to ensure that decisions are in line with public policy objectives. Even in those countries where formalised procedures exist for network planning, there is often a lack of criteria and clear responsibilities for decisions on the location of interchanges.
CARISMA found that short transfer and waiting times are crucial for passenger satisfaction with an interchange. This requires harmonised schedules for all modes available at the interchange, through ticketing for multi-modal journeys, and co-operation between modes in handling system interruptions. These requirements may be at odds with the priorities of the interchange operator, more interested in generating revenue through retail and other services. Thus there is a need for unified management of the facility, supported by good co-operation from the connected transport systems, which may in turn require public intervention.

***POLICY IMPLICATIONS***

CARISMA concluded that there appear to be gaps between the responsibilities of planning agencies at various levels that can act as impediments to the effective planning and running of interchanges. Therefore there is a need to define the authorities responsible for the inter-connection of long distance, regional and local transport networks. In parallel with this, the financial responsibility for interchanges needs to be defined. The project noted that deregulation of public transport does not facilitate smooth and seamless travel, whatever the other benefits. Therefore privatisation needs to be accompanied by effective legislative and planning frameworks to encourage co-ordination of services. CARISMA advocated further research to identify the effects of different franchising schemes on the quality of multi-modal journeys.

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| **CESAR:** | ***KEY RESULTS*** |
| **Co-operative European system for advanced information redistribution** | The main outcome of CESAR is a pilot system for communication between CT operators and their clients, mainly road hauliers and freight forwarders. A mix of centralised and decentralised system types was selected by CESAR partners: status information is stored in a central database which is continuously updated by CT operators, while a booking interface allows clients to directly contact CT operators. The system is organised as a stand-alone interface allowing clients to book or to query for status information from a PC connected to the Internet, without any CESAR specific programs installed on it. Strict access rules to common information are defined, since CT operators participating to CESAR may be competitors as well.<br><br>***POLICY IMPLICATIONS***<br><br>A co-operative approach has enabled CESAR partners to provide a common standard interface for information and data exchange and distribution, while keeping their decentralised structure (which responds to a number of national or specific user requirements). Other interested operators are expected to join in the near future, thus leading to a step-by-step development of European standards for client-operators and operator-operators interfaces.<br>The main benefits of the CESAR system are obviously addressed to CT operators and their clients, but the improvement of intermodal transport can benefit the society as a whole, helping to reach the goal of sustainable mobility. CT operators have the possibility to enlarge their market and increase the quality of service offered to their clients, while clients can make bookings and get status information more quickly and effectively via the Internet, without the need of major changes to their in-house systems. |
| **CODE-TEN:** | ***KEY RESULTS*** |
| **Strategic assessment of corridor developments, TEN improve-ments and extensions to the CEEC/CIS** | CODE-TEN developed a strategic policy assessment methodology and tool for evaluating the impacts of the development of pan-European corridors. The tool applies a scenario approach to elaborate consistent images of the future that combine information on three aspects: socio-economic development, policy development and infrastructure planning. Using these images, the alternatives for corridor development are subjected to impact assessment to help in decision-making. The images build on 4 scenarios of socio-economic and political developments through to the year 2015, named:<br>• Renaissance – high economic growth and fast integration of neighbouring countries into the EU;<br>• Dilution – high growth and slow integration;<br>• Solidarity – low growth and fast integration;<br>• Fragmentation – low growth and slow or no integration.<br>A comprehensive information system was produced on a CD-ROM covering 30 European countries. This provides information on politics, regional socio-economic data, regional road information, foreign trade, transport costs, resource costs, networks and maps. It has supported in-depth corridor studies on: Via Baltica, Berlin-Warsaw-Moscow, Dresden - Budapest - Istanbul, Venice – Kiev, The Danube Waterway, Copenhagen - Stockholm - Helsinki - Moscow, Salzburg - Belgrade - Thessaloniki, the Mediterranean short sea shipping and the Lisbon-Madrid-Paris Trans-European link. Descriptions of infrastructure strategies and traffic flow estimations (based on the development of the various scenarios and corridors until the year 2015) have led to the impact assessment of the various alternatives for corridor development, focusing on accessibility, environment and socio-economic factors. Combinations of road and rail projects were generally found to offer the greatest benefits. |

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| | ***POLICY IMPLICATIONS*** |
| | CODE-TEN gives guidelines for assessing transport investments to support the policy of expanding the European Union to Baltic and Central European countries. The method could also be applied more generally to other infrastructure programmes. CODE-TEN recommended that, in addition to project-specific assessment, the whole set of related projects should be subject to strategic assessment. The DECODE method elaborated in CODE-TEN is one method for carrying out this analysis. |
| **COMMUTE:** | ***KEY RESULTS*** |
| **Common methodology for multi-modal transport environmental impact assessment** | COMMUTE delivered two main end products:<br>• a methodology for Strategic Environmental Assessment (SEA) of transport policies, plans and programmes;<br>• a software tool for assessment of air pollutant emissions, energy consumption, noise and safety impacts.<br>The SEA methodology comprises:<br>• a framework covering the basic methodological requirements for SEA of multi-modal transport developments, together with guidelines on the integration of various analytical approaches (such as cost-benefit and multi-criteria analysis);<br>• detailed methods for assessing major types of impact (emissions, energy, noise, safety) for road, rail, air and waterborne transport. Methods for other impact categories such as land use and ecological damage are also outlined.<br>The software tool embodies the detailed methods. It focuses on impacts at European, national, regional and corridor levels, aggregated from the impacts associated with individual transport links and nodes (such as urban areas, harbours and airports). The calculation includes the life-cycle emissions for power stations and refineries. Output data are presented in a Geographical Information System, and also are differentiated according to the height of emission into the atmosphere. External input data include traffic flows and vehicle fleet composition.<br>A pilot SEA of the TEN-T was conducted in collaboration with three other projects. Each link and node in the TEN-T was assessed. The interfacing of the COMMUTE software with a transport model was also demonstrated, and comparisons made between COMMUTE results and those from other models. |
| | ***POLICY IMPLICATIONS*** |
| | The pilot SEA work provided an initial quantification of the impacts of TEN-T policies and infrastructure, and also demonstrated the feasibility of the SEA methods. TEN-T is projected to increase overall passenger and freight travel demand, but with a substantial shift to rail and a reduction in road network congestion. Road vehicle emissions (other than $CO_2$) will fall, while the air sector will see substantial increases in total emissions. TEN-T is estimated to reduce $CO_2$ emissions relative to a do-nothing scenario, and to improve traffic safety. |
| **EMSET:** | ***KEY RESULTS*** |
| **Eurocab Madrid – Seville European Tests** | EMSET has:<br>• completed the specifications of the Eurocab tests, and associated tools for site tests;<br>• developed 40 Eurocab tools for dedicated laboratory and on-site tests, with the Eurocab simulator undergoing acceptance tests;<br>• performed FFFIS (Form Fit Functional Interface Specifications) verification tests on the Spanish high speed link Madrid – Seville<br>  • for the Eurobalise signalling sub-system, using functional on-board prototypes from companies Adtranz, Ansaldo, Alstom and Siemens; in particular the reliable interoperability of track side components, transmission antennas and |

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cockpit equipment was verified, and
- for the Euroradio communications sub-system using equipment from companies Alstom, Adtranz, Ansaldo (with CSEE Transport), Alcatel and Dimetronic; more specifically the proper interaction between company specific data receivers and the uniform message generator was successfully validated.

***POLICY IMPLICATIONS***

The EMSET project has developed a set of verification tools for testing of Eurocab that have been limited to moderate levels of overall system functionality. The future reference (i.e. Class1 functionality) for interoperability testing and validation of the complete ERTMS will be derived from the set of tools that have been specified and applied during the EMSET project duration. For the Euroradio component of the whole system some inconsistencies with the definition of transmission protocols at user level and GSM specifications have been determined, which hint at the need for additional compliance testing in this area.

**ERTMS Tests:**

**ERTMS Proof of Feasibility and Preparation of Tests**

***KEY RESULTS***

ERTMS Tests has produced:
- a System Requirement Specification (SRS), which describes all technical details and integrates the Reliability, Availability, Maintainability and Safety (RAMS) documentation;
- a review of interface specifications between the elements of the system in order to ensure interoperability of the European Train Control System (ETCS);
- a set of specifications for testing the system, including scenarios for demonstration sites in different countries;
- Specific Transmission Module (STM) prototypes for future testing;
- three contracts for pilot and demonstration sites, taking account of the need to upgrade existing commercial lines; the selected trial sites comprised an approx. 40 km long TGV link between Paris CDG airport and Tournan (SNCF), an approx. 40 km long section of the Berlin – Halle/Leipzig main line (DB), and a 70 km long high speed line between Arezzo and Firenze (FS); and
- regular CD-ROMs to disseminate all project results to relevant stakeholders and actors.

***POLICY IMPLICATIONS***

The project's results contribute to the implementation of the whole ERTMS/ETCS concept by proofing the feasibility of new common approaches towards rail traffic management systems. From elaborating all relevant technical specifications the project helped bridge the gap to pilot and demonstration applications of existing railway environments.

**ETCS-VB:**

**Test Strategy for ETCS, based on the Pilot Installation Vienna – Budapest**

***KEY RESULTS***

The following main tasks were performed during the ETCS-VB project:
- the installation of an ETCS track-side system (TSS) between Parndorf and the Austrian-Hungarian border on the ÖBB railway line (15 km), based on a decentralised architecture with direct connection to on-site signals;
- the installation of an ETCS track-side system (TSS) between the border and Hegyesholm on the MÁV railway line (30 km), based on the existing centralised EVM track circuit system;
- the fitting of two locomotives – one from ÖBB and one from MÁV – with the on-board ETCS components required for the tests;
- the performance of preparatory tests to validate the installations and to evaluate a

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set of operational scenarios that were to serve as the core set of operational test for the pilot test trials;
- the successful performance of tests with the complete ERTMS/ETCS level 1 installation in both Austria and Hungary; and
- the partial demonstration of the interoperability of on-board systems from several major manufacturers by means of cross border tests using the ÖBB locomotive.

***POLICY IMPLICATIONS***

The first pilot application of a complete ERTMS/ETCS system has proven the operational, interoperability and safety benefits of the concept. Larger scale demonstrations over a longer time period were definitely encouraged by results of the ETCS-VB project. This supported the continuation of the development programme of ERTMS/ ETCS as well as its consolidation as the mandatory European signalling standard for high-speed traffic applications.

**EUDET:**

**Evaluation of the Danube waterway as a key European transport resource**

***KEY RESULTS***

EUDET has:
- performed an in-depth analysis of existing waterway infrastructures on the Danube river and adjacent canals, with respect to
  - navigable conditions per river/canal section,
  - transport capacity per section, depending on waterway width and depth, the capacity of locks, and headroom below bridges,
  - existing ports, their facilities, typical goods and capacities;
- analysed inland ship fleets – i.e. fleet structures and their capacity – per country, design aspects in ship and transhipment technology, existing shipyards, and infrastructure bottlenecks related to the interaction of ports and current fleets;
- has analysed the prevailing transport market conditions in the Danube corridor, e.g.
  - recent economic developments in bordering states,
  - the current structure of transport markets per country,
  - the inland navigation market compared to the rail sector,
  - Danube river to sea connections, especially to North Sea and Mediterranean sea ports, with a focus on multi-modal services;
- performed an analysis of trade and transport flows in the Danube region;
- forecast future trade flows based on developed scenarios for the Danube corridor;
- analysed and modelled potential transport volume and summarised the waterway's potential on a per country basis; and
- elaborated recommendations for initiatives aiming to improve the Danube's competitiveness, by identifying needs for investment and schemes for market restructuring.

***POLICY IMPLICATIONS***

Currently there is a unique possibility to create a powerful inland waterway backbone along the Danube river, as long as road and rail networks in South-Eastern Europe have not reached western standards. This would require a single regulatory framework for EU countries, acknowledged accession countries and countries such as Ukraine, alike. A logical next step then would be the promotion of transnational infrastructure and fleet investments to cope with the forecast growth in transport on the Danube. Finally, new organisational structures and logistics concepts are mandatory to close perceived entrepreneurial gaps.

**EUFRANET:**

**European freight**

***KEY RESULTS***

An initial market survey showed that the majority of shippers interviewed are

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**railway network**

satisfied with domestic rail transport, but regard the quality of international rail transport as inadequate. Main criticisms included poor flexibility and reliability, a lack of co-ordination between operators, inadequate information, high costs, unreliable pricing policies, and a failure to co-operate in exploiting logistical systems. EUFRANET modelled the development of demand for freight transport in 2020. Under a "current trends" scenario, rail would continue to lose market share to the road sector, falling from 14 to 9%. By combining the demand model with a model of the railway network, the project then evaluated the potential effects of changes in rail infrastructure and operations. A new assignment of routes to different services was devised, based on three sub-networks:

- a core network strongly dedicated to freight, covering the industrial regions of central Europe;
- an intermediate network mainly dedicated to freight but also carrying local passenger trains; and
- a mixed network on which passenger trains would normally have priority.

The modelling results indicated that traffic on the dedicated network could increase significantly, accounting for 85% of total freight traffic on just 20% of the rail network. Journey times on this network could be cut by 20 to 30%. The decline in modal share of rail could be reversed, taking the share back up to 16%. Gains in national markets would be of the same order of magnitude as gains in international transport, though varying between Member States.

***POLICY IMPLICATIONS***

The implementation of a dedicated freight network and operating system would require a number of actions:

- infrastructure investment to remove bottlenecks (for instance crossing the Pyrenees and the Alps);
- the agreement and implementation of standards and systems to overcome a lack of interoperability across the network;
- the introduction of a slot scheduling and assignment method for international services; and
- some degree of harmonisation of the subsystems used by the train operators (pricing, information, reservation, tracking and tracing etc.)

**EUROSIG:**

**Development of the complete ERTMS concept**

***KEY RESULTS***

(ERTMS) EUROSIG has produced:

- a complete set of interface, test and test tool specifications which will be adopted for other ERTMS projects, ensuring true functional interoperability for operators throughout European rail networks;
- tools for the EUROBALISE project, allowing actual components to be checked against defined interface specifications;
- tools for the EURORADIO project regarding the definition of test configurations for laboratory or in-situ system tests; this work was carried out in close co-operation with the EMSET project.

***POLICY IMPLICATIONS***

The specific contribution of the ERTMS EUROSIG project to the overall ERTMS concept will be further pursued by projects such as EMSET that focuses on test specifications and test tool development.
Subsequently the achievements of ERTMS EUROSIG are intended to be the base for (future) national bodies responsible for interoperability certification.

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| **EUROSIL:**<br>**European strategic intermodal links** | ***KEY RESULTS***<br>Through a series of 12 case studies, EUROSIL identified examples of good practice in appraising the benefits of multi-modal transport investments. However, it was clear that few of the current modelling approaches deal explicitly with regional development effects, and there are further deficiencies in the evaluation of those impacts.<br>Therefore EUROSIL developed an evaluation framework and software tool to support a structured approach to the assessment of regional development effects. This covers the selection of criteria for the evaluation, the estimation of impacts, and the definition of weighting factors for combining different impacts according to the selected criteria. Guidance is provided on the choice of traffic modelling methods. For those cases where the decision-maker requires a quick low-cost evaluation of alternatives rather than a sophisticated evaluation, EUROSIL has constructed a simplified set of guidelines.<br><br>***POLICY IMPLICATIONS***<br>The case studies highlighted a number of barriers to intermodality:<br>• inadequate information flows between the variety of actors;<br>• problems with slow procedures at border crossings;<br>• differences in technical standards and regulations between Member States, e.g. for vehicle size and weight;<br>• a lack of co-ordination at interchanges (such as different companies working different hours); and<br>• a lack of interoperability between modes, for instance concerning ticketing and information systems.<br>The EUROSIL evaluation framework is now available for use in real-life decisions on the TEN-T and other major long-distance transport projects. Its incorporation into new developments of user-friendly investment appraisal tools is recommended. |
| **EU-SPIRIT:**<br>**European system for passenger services with intermodal reservation, information and ticketing** | *The final results of this project were not available when this Thematic Paper was prepared. The project website can be found at* http://eu-spirit.jrc.es/ |
| **FARADEX:**<br>**Functional architecture reference for ATM system and data exchange** | ***KEY RESULTS***<br>FARADEX has produced:<br>• operational scenarios for the time frame 2005-2010, building on the Operational Concept Document (OCD) as the basis for a functional architecture; however, the differing scope from the OCD target year of 2015 was taken into account;<br>• a high-level model of the global CNS/ATM (Communication, Navigation and Surveillance/Air Traffic Management) functional architecture;<br>• a system model – addressing interoperability – with a description of internal and external interface aspects; and<br>• a static data model of EATMS that incorporates real-world data flows; the model is designed as a standard Microsoft Access database with an interface that allows the simulation of specific scenarios.<br><br>***POLICY IMPLICATIONS***<br>The scenarios developed in FARADEX are meant to be used by Europe-wide ATM |

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| | projects until they are replaced by EUROCONTROL ATM 2000+ scenarios. All of the subsequent development of the expected EUROCONTROL scenarios will build on the FARADEX scenarios to avoid divergence in methodology and design.<br>The results have been approved by the European Commission and by EUROCONTROL representatives, to foster progress on a future comprehensive ATM system. |
| **FIRE:**<br>**Freight information in the railway environment** | *The final results of this project were not available when this Thematic Paper was prepared.* |
| **FISCUS:**<br>**Cost evaluation and financing schemes for urban transport systems** | ***KEY RESULTS***<br>FISCUS has produced a handbook giving practical guidelines on evaluating the costs of urban mobility and selecting ways to finance it. This is intended particularly for policy-makers, planners and the managers of operating companies. The handbook covers two main issues: who pays for what, and who puts up the money (e.g. for new investments).<br>Seven types of cost are addressed, i.e. those associated with infrastructure, vehicle-related operations, congestion, accidents, emissions, noise and other external effects. The reader is given a step-by-step method of estimating these costs for their own city, with worked examples. Given that the availability of data may vary from city to city, the handbook offers two levels of assessment with different data input requirements (light and full). The results show the extent to which users bear the costs they cause – whether full costs, external costs (such as environmental damage) or variable costs.<br>FISCUS reported evidence that existing pricing mechanisms and levels are failing to provide appropriate signals to influence behaviour. For example, prices need to show greater differentiation according to the time of day and current traffic levels. Also, existing financing mechanisms (which typically rely on user charges and public budgets) are often not providing sufficient funding for the infrastructure and services that would support an optimal mix of traffic. Therefore the relative merits of new mechanisms such as private finance, value capture (such as taxing land values that benefit from transport infrastructure investment) and cross funding (e.g. from private to public transport) are explained.<br>FISCUS identified three financing packages for consideration, each combining various pricing mechanisms and sources of finance. The circumstances in which each package might work well are described.<br>• one is based on electronic road pricing, parking/cordon charges and public transport tariffs all being differentiated by time of day, with public budgets providing subsidies and capital as necessary;<br>• another is again based on differentiated charges, but with private finance and value capture;<br>• the third is based on making each mode commercially viable, with no subsidies or cross financing.<br>The first two packages are given preference, with the choice depending primarily on the adequacy of funds for investing in the transport system.<br><br>***POLICY IMPLICATIONS***<br><br>The FISCUS handbook aims to provide practical support for both long-term mobility planning and short-term operational decisions. By promoting the harmonisation of the knowledge base for policy decisions across Europe, it should increase efficiency and fair competition between operators and modes.<br>Electronic road pricing is often seen as the most powerful way of implementing efficient pricing. However, this will not necessarily be the most cost-effective or |

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| | practical solution in many situations. Therefore FISCUS gives advice on simpler pricing solutions, depending on city characteristics such as size, severity of environmental problems and the financial position of public transport. |
| **FREIA:** | ***KEY RESULTS*** |
| **Towards the networking of European freight villages** | The FREIA project sought to improve the accessibility of European freight villages and their related networks for transport SME's. One of the main achievements has been the development of general guidelines and principles for the implementation of a freight village information system. The result of this work is a demonstration model of the information system that can be seen at www.freight-villages.dk.<br>FREIA found that intermodal transport is being increasingly considered by SME's as an acceptable and relevant alternative. However, transport costs are a crucial factor, and a barrier to intermodal transport. Many SME's require commercial services (booking, information, reservation etc.), which can be located in European freight centres. Within such centres, the main requirement among SME's is improved physical facilities such as office and storage facilities and access to electronic information. FREIA recommended a classification system of freight villages according to the services and facilities provided, in order to make the market for intermodal transport more transparent.<br><br>***POLICY IMPLICATIONS***<br><br>The FREIA project supports policy actions by the European Commission aimed at integrating SME's into the intermodal transport system. SME's play an important role in the transport sector and account for almost 70 % of total EU company turnover. In order to retain their competitiveness, FREIA recommended that specific actions should be considered to prepare SME's for the substantial changes they have to face due to intermodality. These actions may include education, training and information on market developments, as well as the application of new technologies, providing easy access to information systems and services. |
| **FV-2000:** | ***KEY RESULTS*** |
| **Quality of Freight Villages Structure and Operations** | FV-2000 has:<br>• performed case studies in seven European countries covering a total of 14 freight villages (FV) representing two principal models, i.e. integrated FV's and non-integrated FV's, whereby the latter type does not allow for a change of transport mode at the terminal;<br>• carried out some 130 interviews with FV managers, logistics and transport providers, and public authorities involved with planning and developing freight terminals;<br>• found major benefits for regional economic development where integrated freight villages have emerged, owed to improved intermodality, the availability of attractive services, and the proximity of different transport and logistics activities at one site;<br>• assessed the environmental impacts of FV operation with particular respect to dangerous goods; from this assessment three management tools emerged<br>  • a Good Practice Code, in the form of a user-friendly handbook (available via the internet or on CD-ROM), addressing transport and storage operations in FV areas,<br>  • a Decision Support System (DSS), that has been field-tested by three FV's, meant to help assess the risks connected to handling of dangerous and flammable goods; this DSS builds on a database of some 160 substances and materials, and<br>  • a Training Software Tool (again available via the internet or on CD-ROM) comprising technical guidelines for operators, and providing recommendations on communication, organisational matters, professional skills and related training of staff, ultimately promoting the implementation of an environmental |

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| | management system in FV's.<br><br>***POLICY IMPLICATIONS***<br><br>From the results of FV-2000 it is obvious that both types of FV's, but integrated freight villages – which allow for modal change and in addition offer a broad range of logistics and transport services at one single spot – more significantly, do foster intermodality and efficiency, as addressed by major themes of current European RTD programmes. |
| **HEROE:**<br><br>**Harmonisation of European rail rules for operating ERTMS** | *The final results of this project were not available when this Thematic Paper was prepared.* |
| **HSR-COMET:**<br><br>**Intermodal connection of high-speed railway terminals in metropolitan areas** | ***KEY RESULTS***<br><br>From on-site surveys in France, Germany and Italy, HSR-COMET identified the principal characteristics of transport demand. There is significant variation between Member States. For example, in Italy and Germany professionals and managers account for around 50% of passengers, whereas in France two-thirds of users are not in this category. In Italy, more than half the trips are for business purposes, whereas private trips form the majority in France and Germany. In Germany, the average trip length ranges from 95 km to 265 km according to trip purpose, whereas in Italy and France the average trip is considerably longer – 465 km in France, while more than 70% of trips in Italy exceed 300 km. Average trip frequencies by HSR are higher than by standard rail services, showing their importance in attracting passengers from other modes. In Italy, over half the passengers make more than 5 trips per year. This figure drops to around 20% in France. Typically one-third of connection trips to and from the terminal are by private car (including "kiss-and -ride"), one-third by public transport, and roughly 15% each by taxi and walking.<br>The project developed a multi-criteria evaluation tool to identify the priorities for improvements in the transport services to and from terminals. An increase in the frequency of metro services during HSR peak periods (where available) emerged as a strong candidate. Preferential access for taxis also scored reasonably well, as did the integration of taxi tariffs with train fares (for example by joint ticketing). In addition, there seems to be a potential market for a special taxi or minibus service specifically dedicated to meeting the needs of HSR users.<br><br>***POLICY IMPLICATIONS***<br><br>HSR-COMET concluded that the promotion of high-speed rail needs improvements in the transport connections to and from the terminal and in the customer services available in the terminal. Since cars are the most significant means of access, policies should aim to address the environmental and congestion effects without discouraging travellers. This could mean greater provision of short-term parking spaces for drop-off and pick-up, or a good park-and-ride system. Taxis should also be promoted, with preferential fast close access to trains.<br>Terminals should provide high-quality basic services, since most passengers spend relatively little time there. (Indeed, the quality and variety of services on board the train are arguably more important, given the length of HSR trips.) Improvements are needed to speed up transit through the terminal and advise the passenger on what to do. These include:<br>• integration of pricing systems between local transport services and HSR;<br>• reservation systems (e.g. to book train + taxi);<br>• timetables that facilitate making connections; |

| Project acronym and title | Key results and policy implications |
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| | • complete travel information on the trip to the final destination<br>• simple improvements such as clear and visible signs. |
| **HVB:** | ***KEY RESULTS*** |
| **High voltage booster** | HVB has produced:<br>• a common European knowledge base on the power supply used in railway networks' by establishing a multi-national working group;<br>• an analysis of "classical" structures for voltage regulation, that are based on electromagnetic devices and/or mechanical switches; possible solutions were identified as primary side on-load tap changers, active voltage boosters, additional feeder, capacitive compensation using mechanical switches, series capacitive compensation with protection against default currents (with a saturable inductance), and moveable core coils for parallel compensation;<br>• an analysis of innovative solutions for voltage regulation based on state-of-the-art power electronics; possible solutions can be sub-divided into mixed or purely power electronics based solutions; the booster auto-transformer with load tap changer using semi-conductor devices (STCSB) and the thyristor controlled booster (TCSB) being examples of the first group; static var compensators (SVC), thyristor switched capacitors (TSC), static var generators (SVG), static series synchronous capacitors (SSSC), and unified power flow controllers (UPFC) being examples for the latter;<br>• recommendations on the use of high voltage booster units for 25 kV/50 Hz electrification systems as employed e.g. in France and the UK; one short term (SVC) and two feasible long term solutions (SVG and STCSB) have been proposed;<br>• prototype specifications for a high voltage booster unit compensating for voltage drops of main power transformers used in railway electrical sub-stations.<br>The project website can be found at http://www-leg.ensieg.inpg.fr/eurotrain/intro.html |
| | ***POLICY IMPLICATIONS***<br>The study involved major players from the railway supply industry, research institutions and universities, as well as railway operators, in order to establish a broad working platform to develop an operational high voltage booster. The further exploitation of results from the HVB project is foreseen to take place under the umbrella of the EC, integrating end users (railway companies), industrial consortia and research organisations in a scheme that will contribute to efforts in establishing the future European Rail Traffic Management System (ERTMS). |
| **IMPREND:** | ***KEY RESULTS*** |
| **Improvement of pre- and end-haulage** | Interviews in IMPREND showed that the most significant problems were time delays (associated with restricted opening times of terminals, consequent road traffic congestion and the poor punctuality of trains) and a lack of co-operation (e.g. poor exchange of electronic data and a lack of return loads).<br>Twenty-five solutions were identified to help overcome problems. Organisational solutions are dominant, based on improved communications and co-operation. However, successful implementation requires win-win benefits to be identified by the actors – in many cases, pre- and end-hauliers are not the direct customers of a terminal, and therefore receive lower priority than the shippers and railway operators. Demonstration projects showed that co-operation between pre- and end-hauliers typically fails, due to mutual competition. However, the introduction of round-table meetings of actors along the transport chain generated some co-operation.<br>Information and communication technologies appeared to have major potential, but the presence of many small independent road hauliers makes it difficult to get them to participate in a large overall information system unless there is very strong evidence that benefits will outweigh the costs. |

| Project acronym and title | Key results and policy implications |
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| | ***POLICY IMPLICATIONS*** |
| | IMPREND concluded that the shipper is the most important actor in the intermodal transport chain. However, it is difficult to influence the decisions of shippers, which form a large and diverse set of companies. IMPREND would recommend fostering better communication and co-operation between them, and this is an area where policy initiatives need to be tested.<br>Other areas where co-operation should be promoted are:<br>• co-ordination of opening times at terminals, shippers, forwarders and container depots, which should cut costs for hauliers;<br>• regular communication between terminal operators and other actors in the transport chain to identify bottlenecks and efficiency savings at terminals;<br>• co-operation between hauliers and intermodal operators to improve planning, data exchange and the organisation of return loads.<br>This requires the co-ordinated development of transport policy on European, national and regional levels. Possibilities for further consideration are:<br>• pilot funding for shippers to experiment with intermodal transport;<br>• the initiation of regular roundtable meetings between companies in the sector;<br>• further demonstration projects to identify and promote good practice in pre- and end-haulage;<br>• providing information infrastructure for data sharing.<br>In addition, further liberalisation of the rail sector is expected to improve the organisation and efficiency of intermodal transport. |
| **INCOME:** | ***KEY RESULTS*** |
| **Integration of traffic control and other measures** | In INCOME various combinations of UTMS components were tested and evaluated through simulation studies and field trials in London, Piraeus, Turin and Gothenburg. A guidebook has been compiled for transport managers and local authorities, summarising the results, infrastructure requirements, factors affecting the benefits, and other implementation issues. Highlights among the wealth of quantitative results were:<br>• Public transport priority in UTC. Public transport achieved journey-time savings of around 5-15% across three cities and similar improvements in journey-time reliability. In all cases the payback period was less than two years.<br>• Integration of UTC priority and automatic vehicle location for buses. This allows selective priority to be given to buses that are running late, thereby improving reliability. Predicted improvements in bus regularity and in passenger waiting times are around 10%.<br>• Bus gating at traffic signals. This involves holding back queues of private vehicles at traffic signals on strategic routes, allowing buses to overtake along segregated bus lanes. The bus lanes doubled the savings in bus delay compared to bus priority alone at traffic signals.<br>• Integration of UTC with variable message signs (VMS). These applications transferred data from UTC to VMS. The clearest benefits came from the earlier re-routing of traffic in response to incidents, activated by the automatic incident detection function of a UTC, increasing drivers' journey-time savings due to the VMS from 23% to 28%.<br>• Intelligent speed adaptation. This is a new in-vehicle technology aimed at reducing or preventing speeding, which can be integrated with UTC systems. Simulation results indicated a 50% reduction in accidents at speeds above 45 km/h, and speed reductions of up to 20%.<br>• Integration of PTS and DIS. Variable message signs can be used to suggest alternative routes to encourage drivers not to use important bus routes in congested areas. Simulations showed that reductions in bus delays could exceed 20%, although this is dependent on the local situation (e.g. if the alternative routes are also bus routes, the net benefits can be negative). |

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- Fully integrated traffic management systems (UTC, PTS and DIS). Sharing of data and control signals between sub-systems in Turin has reduced travel times for both general traffic and public transport by 20%, with an accompanying modal shift of 3% to public transport. Local pollutant emissions were estimated to fall by 21%. Modelling work for Gothenburg indicated a 9% modal shift, but smaller improvements in other indicators.

***POLICY IMPLICATIONS***

Urban traffic management systems are one of the key tools under the control of city authorities that can be used to support local policy objectives for mobility and the environment. Moreover, they can be implemented in the short term. INCOME has provided evidence of the additional benefits that can be achieved by using advanced systems in an integrated way.
Nevertheless, one of the lessons from INCOME is that the benefits must be estimated for the local situation. For example, public transport journey-time savings are dependent on congestion levels and the number of traffic junctions where systems can be used, and heavy congestion reduces the scope for some forms of bus priority. Simulation can provide a cost-effective means of screening alternative solutions prior to pilot-scale or full-scale implementation.

**INTRAMUROS:**

**Integrated urban transport concepts and market orientated urban transport systems / on-demand urban transport systems**

***KEY RESULTS***

INTRAMUROS has produced and site-tested a multi-criteria decision support tool that helps organisations responsible for different aspects of urban transport systems to identify areas where greater co-operation is possible. The current situation in a city is assessed against best and worst case scenarios according to selected criteria and objectives. A set of indicators relating to cost, operational performance, environmental impact, socio-economic effects and safety consequences has been developed. The criteria can be weighted according to the value judgements of individual actors in each city, although default weights provide a useful means of cross-city comparison. The assessment helps users to prioritise potential changes to the urban transport system. At the same time, it is a tool to enhance co-operation between the local actors.
A survey together with investigations at six test sites showed that:

- most organisations perceive the need for co-operation, and some are installing institutional arrangements and common procedures as a result;
- competition between operators often acts as a brake on technical and financial integration; and
- the efficiency benefits of public-private partnerships have been demonstrated.

***POLICY IMPLICATIONS***

The INTRAMUROS decision support tool provides city and regional traffic planners with a means of comparing quantitatively the relative benefits of different local strategies for improving the co-ordination and integration of the urban transport system. It has been designed as a flexible tool that can be applied to any city situation, or even for cross-city comparison (in support of national and European policy making).
The project concluded that there is no single organisational, financial and legal structure that will best encourage transport integration for all the different types and sizes of urban areas in Europe. Activity-based organisation, where actors have powers extending over different transport modes and across wide geographic areas, may be regarded as the most likely to induce better transport integration. However, such a structure cannot be imposed abruptly, and major transition may not be as sensible as lesser modifications to existing structures.

| **Project acronym and title** | **Key results and policy implications** |
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| **IQ:**<br>**Intermodal quality** | *The final results of this project were not available when this Thematic Paper was prepared. The project website can be found at* http://www.tfk-hamburg.com/iq/index.html |
| **ISOTOPE:**<br>**Improved structure and organisation for urban transport operations of passengers in Europe** | ***KEY RESULTS***<br>ISOTOPE concluded that:<br>• the initiative for creating and specifying the urban public transport (UPT) network should rest with local authorities – a fully deregulated system was found not to address collective goals and system integration in an adequate way;<br>• network design should be under the control of the administrative authority, although the design work may be contracted out;<br>• a UPT authority must include representation from the communities directly affected by the UPT system;<br>• traffic management and parking should be controlled by the same authority as UPT, in order to integrate the management of urban mobility;<br>• a regime of "limited competition" (where authorities define the transport product to be delivered and invite tenders for its execution by candidate operators) is to be preferred over full regulation (monopoly supply) or full deregulation; and<br>• in order to tackle urban mobility problems, partnerships between operators and authorities should be established that include clear definitions of standards of service and responsibilities.<br>Overall, the project found support for the Citizens' Network (EC Green Paper) preference for some form of limited competition. Various forms of contract appropriate to this regime were identified, with special consideration to the case of rail-based systems. It was concluded that reductions in unit operating costs of around 15% are feasible over fully regulated operations, even with no redundancies or wage reductions.<br><br>***POLICY IMPLICATIONS***<br>The project presents limited competition as a preferred regime. However, it is acknowledged that transition costs are significant. Policy goals like fare integration, concessionary fares and employment of minorities can be accommodated within the tender conditions of limited competition. Improved access to development areas, congestion and pollution issues can be handled by retaining public control of network design. Any move to comprehensive competitive tendering would require improved data collection, to enable value for money to be assessed in the use of taxpayers' money. |
| **ITESIC:**<br>**Integration of technologies for European short intermodal corridors** | ***KEY RESULTS***<br>ITESIC has produced:<br>• established the prototype of a centralised, web-based communication node, that allows to handle inhomogeneous information from various sources in a complex shipment process;<br>• connected and integrated several transport modes (i.e. rail, railway and waterborne), logistic providers, forwarders, agents and depots into a main 'umbrella' module, successfully improving information flow, trackability and reliability of short to medium distance shipments;<br>• successfully demonstrated and customised the Internet based concept with the players and users in the existing medium haul corridors<br>  • Valencia – Madrid, comprising a maritime leg with incoming and outgoing cargo to the port of Valencia, a connection to the railway services to and from Madrid, and road transport to and from the Madrid terminal to final destinations, and |

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- Marseilles – Lyon, comprising a maritime leg to and from the port of Marseilles, a connection with inland waterways services and road transport to and from the Lyon station to final destinations; and
- additionally validated the benefits of the concept using a 'Virtual Intermodal Chain Simulator', which yielded an overall positive resonance to the chosen approach.

***POLICY IMPLICATIONS***

The demonstration phase of ITESIC has confirmed the idea of a centralised information and communication node for regional intermodal transport corridors. Because a web-based communication interface eliminates the need for direct connection of numerous disparate systems, the concept shall be applicable and adaptable to other intermodal transport corridors across Europe. The exploitation of the ITESIC experience in further case studies should therefore be promoted.

**LEAN:**

**Introduction of lean logistics into urban multi-modal transport management**

***KEY RESULTS***

LEAN has studied in abstract concepts for city logistics, and with reference to approaches being considered in eight cities (Seville and Cordoba, Spain; Norwich, UK; Vienna, Wiener Neustadt and Linz, Austria; Regensburg and Halle, Germany). Estimates of utility value showed that integrated strategies combining infrastructure, information technologies and the provision of door-to-door freight services are the most effective in meeting stakeholder objectives. In Vienna, the introduction of a city freight terminal was estimated to offer a cost saving of 10% to freight service providers.

Two concepts were developed in greater detail – load zone management and electronic logistic management. Load zone management is a system for automatic reservation of space in a city centre zone for loading and unloading lorries, supported by stricter enforcement of regulations to prevent illegal parking by private cars in that zone. It aims to reduce traffic jams due to parked cars and lorries blocking the street. A system was designed based on Internet access, making it available to a wide range of users without them needing special software. Messages would be transferred from the central reservations system to a display panel at the loading zone via the mobile phone network.

A logistic management system provides a basic structure for electronic data processing from source to destination along a logistic chain, to facilitate integrated planning, monitoring and control of the movement of goods. This can support the consolidation of goods into fewer vehicles. A prototype system was developed, tailored to the needs of a logistic service provider. The system was shown to manage the required tasks with full functionality.

***POLICY IMPLICATIONS***

LEAN concluded that public administrations need to give active support in promoting the co-operation between market actors that is essential in establishing city logistic solutions and providing multi-modal hubs for freight transfer. The setting-up of regular stakeholder meetings is one aspect of this. In addition, promotional and restrictive measures may be needed to control freight traffic, such as the enforcement of loading zone regulations. A change in modal split between road and rail and the use of low-emission vehicles are also likely to need some policy-based encouragement.

However, the case studies suggested that city authorities have only limited understanding of freight transport issues, and focus their planning effort instead onto passenger transport. Therefore LEAN recommended a Europe-wide information campaign targeted on city planners to address this problem.

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| **LIBERAIL:** | ***KEY RESULTS*** |
| **Liberalised and Interoperable Railways** | Liberalisation of the transport market, which is a key objective of the EU, is hindered by the historical management of national networks and by high costs of infrastructure investments. The implementation of the EC Directives that have introduced flexibility in the rail sector (EC 91/440, 95/18 and 95/19) is far from complete. The state of the level of implementation of the EC Directives in the various Member States has been assessed. In particular, the financing of interoperability has been identified as a "brake" in the liberalisation process. According to their approach to implementation, EU countries have been grouped into four scenarios:<br>• "the wise state and lean railway" (Sweden, The Netherlands and Portugal);<br>• "rail unbundling and privatisation" (United Kingdom);<br>• "the vertically integrated commercially oriented railways holding" (Austria, Belgium, Finland, France, Greece, Ireland, Italy and Spain); and<br>• "commercialisation of public utility and third party access" (Germany).<br>Common to all scenarios is the replacement of general subsidisation by contractualisation and the transfer of public service obligation to regional and local authorities.<br>LIBERAIL has suggested three tools for calculating rail capacity:<br>• schedule building on line sections or divisions;<br>• simulation to assess the network effects;<br>• identification of long-distance paths that meet predefined quality and priority rules.<br>The project has also recommended the harmonisation of the calculation methods of full and marginal costs together with the explicit statement of the perimeter and contents of the infrastructure manager real estate and core activities. Proposals have been:<br>• each cost component should have an identified status, some components being reflected in the final price entirely and others partially;<br>• a geographical solution consisting in a full recovery for some sections and a variable one for others according to the strategic value of each section.<br><br>***POLICY IMPLICATIONS***<br><br>One of the keys to further progress in implementing the EC Directives is to ensure that competition works on a similar basis for all, to avoid "cherry picking" and to mitigate the feared social impacts of liberalisation. Until now, only very few countries have adapted their regulations and corresponding bodies in this direction. In addition, authorities should prevent misuses such as prohibitive pricing or dumping. New Directives should include guidelines for railway reforms and common operational, managerial, and performance indicators, so as to enable benchmarking.<br>Under the present circumstances in many countries the overall costs of the infrastructure cannot be fully raised within the railway system itself. At least during a transition period, the infrastructure manager has to be compensated as long as the capabilities of operators to pay is below the real costs of the infrastructure. As investments for railway infrastructure has to compete with all other state expenditure effective long-term planning has to be ensured by statutory policies. The price instrument can be used by public authorities to influence transport policies as well as external consequences on the environment and on regional development.<br>The following items should be addressed in more detail by new Directive and clarification and direction provided:<br>• tasks, obligations and responsibilities to guarantee safety applying to the different parties;<br>• different treatment of passenger and freight transport;<br>• length of the periods of exclusive rights assignment;<br>• cost basis for charging, as short-term marginal costs hampers privately-owned infrastructure managers to ensure the long-term existence of their network and requires subsidies; |

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| | • basis for short-term and long-term marginal cost definition;<br>• path allocation procedure in relation to parental rights and in relation to route categorisation in turn linked to the value of the service offered; and<br>• ensuring network integration and environmental and social policy objectives. |
| **LOGICAT:**<br>**Concerted Action on logistic, supply and demand chain management in Europe** | *The final results of this project were not available when this Thematic Paper was prepared. The project website can be found at* http://www.innovation.eutelis.fr/logicat/ |
| **LOGIQ:**<br>**Intermodal Decision (The Decision Making Process in Intermodal Transport)** | ***KEY RESULTS***<br>LOGIQ has produced:<br>• a categorisation of prominent factors defining the intermodal environment and influencing the associated decision-making process;<br>• a comprehensive field survey – comprising 92 interviews among stakeholders in intermodal transport, i.e. forwarders, shippers and shipping lines, – identifying the most important factors in the decision-making process;<br>• a mathematical Decision Process Model (DPM) of the decision-making process based on findings from the field survey; this software tool, labelled Decision Support System (DSS) for intermodal transport, intends to provide the user with all relevant information related to planning, investment, organisation and service provision in intermodal transport;<br>• a sectoral case study on intermodal shipments of chemical products taking into account technical, organisational and environmental regulations, in order to validate the project's choice of influencing factors in the decision-making process;<br>• a geographical case study on the river Rhine corridor – viewed as a strategic part of a Trans-European Network (TEN) – focusing on (already) established rail/ barge transport chains, identifying costs, transit time and reliability as the driving factors.<br><br>***POLICY IMPLICATIONS***<br>The LOGIQ project has brought up a new analytical tool which will help the three major groups of decision-makers to effectively assess and utilise the opportunities of intermodal transport. However, policy initiatives should promote intermodal transport by focusing on easing cost (pricing) issues, and by addressing quality aspects such as technical, operational and organisational factors. In general, those supporting measures must help to enhance the competitiveness of intermodal transport. |
| **MINIMISE:**<br>**Managing interope-rability by improvements in transport system organisation in Europe** | ***KEY RESULTS***<br>MINIMISE has produced:<br>• a common analytical framework to identify existing impediments to interoperability, i.e. principal barriers to the development of a more economically efficient transport system;<br>• an overview of identified policy measures – contributing to improvements in interoperability and efficiency in specific sectors – to overcome the above impediments;<br>• the evaluation of proposed policy measures in case studies, assessing them along a |

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set of criteria like net benefits or cost-benefit ratios assuring positive impacts on system's interoperability and economic efficiency;

- five scenarios intended to provide decision-makers with information about expected benefits as well as (public) investment costs for groups of events:
  - scenario 1 ("positive cost-benefit ratio") including 26 events at a total cost-benefit ratio of 3.0,
  - scenario 2 ("low public investments") including 19 events at a total cost-benefit ratio of 3.1,
  - scenario 3 ("high cost-benefit ratio for public authorities") including 22 events at a total cost-benefit ratio of 3.4,
  - scenario 4 ("reduction of external costs") including 18 events at a total cost-benefit ratio of 2.5,
  - scenario 5 ("benefits for service providers and consumers") including 14 events at a total cost-benefit ratio of 2.5.

***POLICY IMPLICATIONS***

In a last summarising step the MINIMISE project has outlined the following areas of activities for the European Commission in order to improve interoperability and economic efficiency: stimulation of telematics usage, the increased use of modern transport equipment, promotion of improved interconnectivity and interoperability of transport networks, harmonisation of organisational structures and regulatory frameworks.

**MOTIF:**

**Market orientated transport in focus**

***KEY RESULTS***

Through the analysis of previous practice and 33 city case studies, MOTIF identified market research methods and segmentations that will allow effective discrimination and valid conclusions to be drawn when targeting improvements in public transport services. Important findings included:

- Passenger priorities differ substantially between countries, with only punctuality/ reliability commonly achieving a high ranking. The postulated importance of travel speed in modal choice may be over-rated. Therefore user needs must always be confirmed locally.
- Previous market research has often focused on frequent travellers, and thereby failed to spot the different needs of other user groups. For example, only low importance is attributed on average to pre-trip information, but this aspect is significant for infrequent and potential users.
- The dependence of passenger requirements on socio-economic and journey characteristics is rather small, with only a 3-6% variation in the perceived importance of service attributes.
- A useful definition of good practice operation (i.e. indicators and benchmarks) on a European level is hard to find. This reflects the weakness of the correlation between delivered and perceived quality. Direct measurement of satisfaction will remain the more reliable indicator of product quality as seen by the customer.

***POLICY IMPLICATIONS***

MOTIF concluded that:

- If a detailed segmentation of consumer preferences is required, the survey should be carried out on a local basis. There are no standard European solutions.
- Market studies should ensure that adequate discrimination is obtained between different user groups and service attributes. Otherwise, crucial information disappears in the mean values. For feasibility reasons, the extent of segmentation must be limited. Pilot tests with the methodology can help to avoid wasting effort on low quality results. For example, primary and secondary requirements can be distinguished, so that secondary needs such as passenger information are not

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| | under-estimated.<br>• The level of fares is important, but users are prepared to pay for good quality on important features. Therefore surveys should be geared towards quantifying the willingness of the customer to pay for certain improvements.<br>Further work is needed to improve the ability of public transport operators to use market research effectively. For example, a standardised set of dimensions/segments would aid comparability of results and cross-operator learning, even though the finer detail of each survey must be determined locally. Also, a better understanding is needed of the relations between results from different market research methods, between delivered and perceived quality, and between perceived quality and modal choice. |
| **OCTOPUS:** | ***KEY RESULTS*** |
| **Towards distributed heterarchic workflow methods for proactive tracing of cargo** | To solve current communication problems during cargo tracing, OCTOPUS's objective was to design, test and validate a common and open distributed information and communication platform for adaptive tracing of communication chains and tracking of general cargo through all sections of the logistic chain. Such a platform allows all relevant partners in the transport chain to log on to the system and still use their own existing software and hardware.<br>The platform contains two technical layers:<br>• a tracing and communication e-mail-based system to process and communicate information to partners; and<br>• a tracking and identification system for gathering information related to physical cargo operations.<br>Both layers were tested and validated at different test sites for two cargo products: forest products and general cargo.<br>OCTOPUS focused on the integration of small, flexible in-land terminals that can benefit from the adaptive cargo tracing servers. The OCTOPUS's servers are installed on a scalable (i.e. modular and adaptive) and heterarchic (i.e. non-hierarchic) network, and each server supports local translation processes of the communicated messages. |
| | ***POLICY IMPLICATIONS*** |
| | The OCTOPUS's platform allows each entity transported within the chain to be located, goods flows to be optimised, eventual performance bottlenecks to be identified, and delays to be reported, with significant time gains during loading/unloading operations due to adoption of Electronic Transport Labels, read/write devices and e-mail-based communication systems. The distributed non-hierarchic cargo tracing and tracking platform is an efficient answer for managing complex transport corridors, since it allows transport actors to communicate efficiently. |
| **OPIUM:** | ***KEY RESULTS*** |
| **Operational project for integrated urban management** | OPIUM has evaluated a range of physical measures for traffic management through their practical implementation in a number of cities (Gent, Heidelberg, Liverpool, Nantes, Patra and Utrecht), and make recommendations for the future development of urban transport policies.<br>Schemes to restrict road space and parking space for private cars proved very successful in terms of their impact on travel behaviour and consequent environmental benefits. The main difficulty lay in opposition from shopkeepers, although residents and visitors were generally supportive.<br>Traffic calming reduced overall traffic speeds and noise at a local level. This was perceived to benefit vulnerable users and could reinforce measures to promote modal shift. However, there may be negative effects on vehicle emissions unless overall car use is restricted.<br>Parking management and guidance appeared successful in reducing circulating traffic |

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at a local level, and could influence modal split if implemented widely across a city. Parking measures were generally self-financing.
Public transport priority did not have a strong influence on modal split, but improved the speed and reliability of bus services. Greater modal shift might have been achieved if priority measures were implemented more extensively or integrated with traffic restrictions and improvements to bus services.
Measures to favour cyclists and pedestrians had only limited effect on modal shift when used in isolation, but were perceived by users to improve safety.
The greatest environmental benefits were achieved where road space was closed to private cars or where traffic volumes were reduced. Park-and-ride and parking schemes were successful in this respect. However, measures that led to slower speeds and increased journey times, such as traffic calming and bus priority, resulted in an increase in pollutant emissions.
All the schemes within OPIUM had a positive cost-benefit ratio, with payback periods of ten years or less.

***POLICY IMPLICATIONS***

OPIUM concluded that public consultation needs to play an increasingly important role in the development of traffic management measures. It is needed to gauge public opinion during scheme design and implementation, to educate the public about the likely benefits, and to take account of the needs and concerns of specific stakeholder groups such as shopkeepers. Stakeholder opposition proved to be the main hurdle to the schemes tested by OPIUM. Individual measures can yield benefits in their own right, even if used only locally, but their deployment as part of an integrated strategy has the potential to yield significantly greater benefits. In particular, public transport priority and bicycle measures are increasingly effective at larger scale.
OPIUM recommended a number of areas for further research, particularly in relation to public consultation and the evaluation of user needs.

**OPTIRAILS:**

**Optimisation of Traffic through the European Rail Traffic Management System (ERTMS/ETML)**

***KEY RESULTS***

OPTIRAILS has produced:

- a rail traffic management philosophy building on a six-tier operational approach. This ranges from a lower level exchange of information exchange between national traffic management centres up to the integrated management of a complete rail corridor. Such a philosophy allows for a progressive implementation of the ERTMS/ETML concept, minimising disruption to, whilst maximising the synergies of, the existing national operational systems and procedures;
- a conceptual baseline for rail traffic management. This identifies both the key functional elements such as real-time data collection of current operations on a traffic corridor, data processing and dissemination of crucial information, as well as the range of tools necessary for the solution of operational problems and for enabling the integration of the external links needed to support intermodality;
- a business model incorporating the six-tier management philosophy cited above;
- an overview of the perceived barriers for the technical implementation of a pan-European rail traffic management system in a corridor-wide scenario;
- a high-level process model of railway operations, highlighting the role of the train operator, path and track management;
- a definition of the generic interface requirements between the OPTIRAILS concept and national or regional traffic management systems;
- a preliminary cost/benefit analysis of implementation of the system in a representative trans-national scenario.

***POLICY IMPLICATIONS***

The project's achievements are an important contribution towards the implementation of ERTMS as a whole, supporting the interoperability of the European high-speed

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| | and conventional rail networks both from a legislative and operational point of view. Moreover, the creation of trans-European traffic management facilities constitutes a crucial element towards the achievement of a real integrated rail network within the Community. This is a major stepping stone for the competitiveness of international rail services, enabling railways to fully profit from the favourable market conditions created by the implementation of the Single Market, the gradual integration of Eastern and Central European countries, and the growing congestion affecting road and air traffic. An opportunity that is at the core of the Commission's strategy for revitalising the Community's railways. |
| **OSIRIS:** | ***KEY RESULTS*** |
| **Optimised system for an innovative rail integrated seaport connection** | OSIRIS has provided a simulation tool and generic guidance which freight operators can use to improve the quality of seaport-hinterland connections by trains. This is seen as the precursor to demonstration projects.<br>Key findings from market research conducted by OSIRIS were:<br>• In contrast to a widely held opinion regarding critical distances, intermodal freight transport by rail can be operated cost-effectively over distances shorter than 500 km if the volumes and frequency are high enough. Private regional railway companies could be successful over distances up to 100 km near major ports.<br>• The operation of a rail shuttle does not depend only on the distance but also on the volume, i.e. the frequency of the shuttles and the costs involved.<br>• The application of information and communication systems will play an important role in the development and implementation of intermodal transport.<br>• Additional terminals could be built or existing terminals modified in order to bundle seaport-hinterland transport where there is a low volume and a wider area of sources and destinations.<br>• The new and efficient solution for the seaport-hinterland connections by train is based on a configuration which includes three rail services:<br>  • seaport container shuttles, bundling container transport flows from different quay sites of one seaport in order to dispatch them towards a dry port,<br>  • long-distance trains between the dry port and a hub in the hinterland,<br>  • short-distance shuttles, providing rail feeder services to/from hinterland destinations. |
| | ***POLICY IMPLICATIONS***<br>The exploitation of the OSIRIS project depends on the will of decision-makers to reduce the dominance of road transport and to develop intermodal transport. The proposed new rail solution between seaports and their hinterland is a means to solve the bottleneck problems of the European road network close to major ports.<br>OSIRIS has shown that co-operation between all partners in the field of seaport-hinterland transport is necessary to implement freight intermodality efficiently. Decision-makers should therefore improve the exchange of information (EDI, tracking and tracing etc.) along the whole transport chain and increase the free access to infrastructure of all operators in order to encourage competition. The necessary synergy between freight operators (shipping companies, port authorities and railway companies) has to be catalysed by policy makers. |
| **PETS:** | ***KEY RESULTS*** |
| **Pricing European transport systems** | Through case studies on five transport corridors, PETS has shown that a practical methodology to calculate marginal social cost (the basis for efficient pricing policies) for all modes does exist, although many of the valuations remain subject to considerable uncertainty.<br>PETS also demonstrated that a purely commercial approach to transport pricing is not appropriate and may push prices in the wrong direction. However, the effects of |

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moving to a more efficient pricing system are likely to be diverse, depending on the national context and the current level of prices and subsidies. Thus it is not universally true that the more environmentally friendly modes would uniformly benefit at the expense of other modes.
For instance, the current price of inter-urban car travel is estimated to be too high relative to the marginal social cost in 2010, partly as a result of tighter vehicle emissions regulations. On the other hand, PETS confirmed the case for urban road pricing in congested cities. Similarly whilst there is generally a case for lower prices for public transport (bus, rail and air), in some places existing subsidies are already excessive. A substantial switching of trips onto public transport is justified only in the urban case, with a reduction of car traffic of up to 40% and a similar percentage increase in public transport.
In the case of road freight, long-distance freight is generally under-charged (with the exception of the Transalpine corridors through Switzerland), because taxes do not increase sufficiently with vehicle weight and distance travelled.
The modelling results also indicated that further extension of deregulation might not necessarily benefit rail transport in terms of the relative pricing compared with other modes, reflecting the different starting points in terms of pricing policies and subsidies between the modes.

***POLICY IMPLICATIONS***

The evidence from PETS demolishes the argument that marginal cost pricing cannot be implemented in practice because such prices cannot be measured. However, this does not mean that all the relevant agencies currently possess the information and ability to estimate marginal social cost, so further efforts will be needed on disseminating the methodology. In addition, further research is needed, for instance to refine the estimates of external costs and the estimation of prices on a countrywide basis.
PETS concluded that there is a clear case for reform of road freight vehicle taxation, to introduce a charge based both on vehicle characteristics and distance travelled.

**PISCES:**

**Pipeline intermodal system to support control, expedition and scheduling**

***KEY RESULTS***

PISCES focused on the difficulties of providing information through the transport chain to enable the efficient implementation of logistic systems. The principal outcome of the project is an integrated system for freight intermodal transport that supports the functionality of documentation, booking, in/out gate, traffic optimisation, warehouse management, transport management and route scheduling. The PISCES system enables the complete transport chain to be scheduled and managed as a single process, without the need for all participants to adopt the same information system or even the same information standards. All separate site users of PISCES are able to pool and store relevant information.
The PISCES system is an Internet-based track and trace logistics system communicating to external systems using EDI (Electronic Data Interchange) and E-mail technology. The only client-side requirement is a Java-enabled Web browser to access an URL. The system gives access to an Oracle database, where data about goods being moved are stored. Due to the high degree of confidentiality of the information, the database is provided with two levels of security. The external security level prevents access to the system from unauthorised users by means of a user code and a password, while the internal security level provides different privileges to different users by means of user profile identification.

***POLICY IMPLICATIONS***

The project is primarily concerned with intermodal chains between ports and other modes. Consequently, the prime benefits of the project are mainly confined to shipping lines, road hauliers and trading parties. The potential benefits from using the

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PISCES system include:

- reduced costs, achieved by better utilisation of resources, more optimised loads and close matching of shipments to priorities;
- less unproductive movements, less empty running for the positioning of containers;
- less environmental impact through fewer vehicle running miles, less movements of empty units for positioning and reduced vehicle waiting and queuing times;
- enhanced services to buyers of transport services via better planning information, enhanced track and trace and more reliable times.

**POSSUM:**

**Policy scenarios for sustainable mobility**

***KEY RESULTS***

POSSUM aimed to identify key issues for future decisions on the Common Transport Policy (CTP) and the Trans European Networks. The project has provided a set of policy scenarios for the European transport system through to the year 2020 that could meet CTP objectives for economic efficiency, regional development and environmental protection. The scenarios explore alternative social and political developments outside the transport sector, and show what transport policies would then deliver the targeted outcomes. In particular, the role of technology and the potential to decouple transport growth from economic growth are described.
The project identified a number of early policy actions that would be appropriate across all scenarios:

- Tax reform – a shift of the tax base from labour to the use of natural resources in order to strengthen incentives for dematerialization and energy conservation.
- Experiments with low emission zones – providing an incentive for the market to select clean vehicle technologies.
- Tele-commuting – experimenting with tele-working options in conjunction with land-use planning.
- Road pricing – taxation on the use of congested urban roads, coupled with measures that provide alternatives (such as quality public transport).
- Actions to provide integrated information systems.

Stakeholder consultations indicated that scenario building does generate innovative thinking on longer-term transport issues.

***POLICY IMPLICATIONS***

POSSUM characterised the CTP as facing large uncertainty with high potential impact. In this situation, the appropriate strategy is to proceed in small steps with frequent re-evaluations. It is also preferable to try several solutions in order to learn – the role of public policy is then to set targets that promote innovation and selection through market forces.
The main policy conclusions were:

- Both new technologies and the decoupling of transport growth from economic growth are needed to achieve sustainability targets.
- For technological innovation, action is needed at the European level to build consensus and provide incentives for rapid movement along clear technology trajectories. Support for innovation may need to precede open market developments.
- The CTP must be complemented by measures outside the transport sector (such as tax reform, regulation of information technology, and land-use planning).
- Those measures that have a long lead time (e.g. aimed at changes in behaviour) must start early.
- Measures should be adapted to local conditions where uniform national or European policies would be inefficient.
- The Trans European Networks must form part of an integrated transport strategy, such that they do not simply encourage more travel overall.
- The growth in air travel and the increased demand for leisure activities (e.g. from

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| | an ageing population) will act as other major constraints on the achievement of sustainable mobility targets. |
| **PRECISE IT:** | ***KEY RESULTS*** |
| **Precise automatic location system for the management of ITUs and vehicles inside intermodal terminals** | The PRECISE IT objectives were to set up and test a demonstration system for the automatic location of ITUs and vehicles inside intermodal terminal areas, in particular for maritime container terminals.<br>GPS (Global Positioning System) and acoustic have been selected in the preliminary stage of assessment of system requirements as the most interesting technologies for the set up of ITUs location systems. GPS was already used for precise location systems while it was not clear at the beginning of the project what kind of results could be reached for acoustic technologies. In particular the demonstration system in the La Spezia Container terminal put most efforts in finding a solution for reach stackers which are the most flexible vehicles inside the terminals and often are working in critical conditions from the position measurement point of view.<br>GPS integrated with a dead reckoning system gives excellent results all over the stacking area and guarantees the accuracy and availability requirement for the position measurement. The acoustic positioning system is feasible in the real environment even if the accuracy and availability requirements are not completely achieved. On the other hand, the combined use of GPS and acoustic systems, even if from the technical point of view is quite easy to implement, does not increase in significant manner the accuracy and the availability of the automatic location system to justify the costs.<br>The use of a Position Information Server which takes care of all the operations dealing with the management of position data, allows for a functional separation between the determination of the position information and the management of this information for the purpose of terminal operations (taken care by the operator's information system).<br><br>***POLICY IMPLICATIONS***<br><br>The potential customers of the location systems studied in the project are mainly maritime terminal operators with a significant traffic volume and high automation level. In any case both systems (GPS and acoustic) have to be improved before they can be put on the market. This is true especially for the acoustic system which still presents a series of problems related to the noise, the installation, the accuracy and the availability. The improvement of the systems means additional costs that will be supported only in presence of a real interest by the customers. On the other hand the costs for an acoustic location system are likely to be significantly less than the costs for a GPS system. While automatic location systems are likely not to be cost/effective for the inland terminal, they will be necessary to increase competitiveness and efficiency of the maritime terminals. Benefits include elimination of misplaced containers, better vehicle utilisation, improved information flow, fewer human errors and consequent improved safety. More efficient and reliable operations result in turn in lower costs and better quality of service to the customers. Moreover, there is a potential of the positioning information for added automation and additional uses. |
| **PLATFORM:** | ***KEY RESULTS*** |
| **Computer-controlled freight platforms for a time tabled rail transport system** | PLATFORM has produced:<br>A preliminary analysis of users requirements highlighting the following as main features of computer-controlled freight terminals:<br>• computer-based booking and dispatch systems for the reservation of transport capacity and for the allocations of loading time and position;<br>• fast loading/unloading devices;<br>• intelligent gate procedures and automated guidance of trucks to reserved loading |

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places;
- electronic devices to automatically locate and register the ITU (intermodal transport unit) position in the yard; and
- computer-aided yard allocation policies.

The adoption of computer-aided management and of new transhipment technologies are the two scenarios that have been simulated in the test site of CEMAT terminal of Verona, "Quadrante Europa". While at present forwarders and terminal operators are not co-ordinated and the ITU trips are generally planned only manually, computer-aided management would lead, thanks to automation, to lower service times in the various procedures, from the planning of ITU trips to the positioning of ITUs on the yard, and to the road and rail gate management. New transhipment technologies for cranes and lifters would allow to reach the maximum terminal capacity.
It has been demonstrated that the adoption of faster transhipment devices without the support of computer-aided management does not produce significant changes in the performances of the terminal. On the other side the adoption of computer-aided management systems is cost-effective for every actor in the chain. The only foreseen limitation to the effectiveness of such a policy, albeit not negligible, is the necessity of a coral adoption of the necessary devices and systems.

***POLICY IMPLICATIONS***

PLATFORM has demonstrated clearly that the path to follow for the improvement of the intermodal transport passes trough the adoption of new telematics technologies to realise really integrated computer-controlled freight platforms. The project represents a first step in this direction since the tools developed can be used as off-line instruments by the low- and medium-level management to analyse and evaluate different policies. The entire PLATFORM environment can help the high-level management and the decision makers of the intermodal chain to evaluate high-level policies aimed at improving intermodal transport.
In the near future it is possible to develop terminal oriented on-line tools able to choose in every situation the optimal management policy, to drive the operations and to communicate with the trucks arriving to pick-up or deliver ITUs.

**REFORM:**

**Research on freight platforms and freight organisation**

***KEY RESULTS***

REFORM has created a database of 96 European freight platforms, identifying key characteristics such as transhipment volumes, infrastructure, on-site company interactions and financial arrangements. Based on this analysis, a handbook was developed for local authorities and transport sector companies. The handbook provides guidance and evaluation methods for establishing new freight platforms. Topics included:
- financial and organisational issues, and their impact on the efficiency of platform operations;
- the impact of technology, equipment and design on platform efficiency;
- evaluation of potential impacts on urban traffic and the environment.

The guidelines were successfully tested by computer simulation at sites in Berlin, Brussels, Rome and Madrid. Depending on the local situation, the introduction of freight platforms was estimated to have different levels of benefit:
- In Rome, a network of platforms could reduce the total truck-kilometres driven within the city by 15%;
- In Brussels, transhipment from heavy trucks to vans would actually increase vehicle-kilometres and pollutant emissions, although action against illegal parking would significantly reduce congestion and fuel use;
- In Madrid, the number of delivery trips would be reduced by higher load factors and a cut in the number of empty truck movements, although traffic levels would rise in the vicinity of the platform (reducing speeds by 3%);
- In Berlin, the location of freight forwarders within the city would reduce their

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truck mileage by more than 40%, yield cost savings for the forwarders and increase the competitiveness of intermodal transport.

***POLICY IMPLICATIONS***

City-based freight platforms can reduce urban delivery traffic and emissions, as well as facilitating a switch from road to rail. However, experience to date has shown a need for better design work to improve efficiency and financial viability. Many local authorities and operators had requested an evaluation scheme – the REFORM project has met this need. The handbook does not replace a detailed analysis of the regional characteristics, which is essential for the optimal design of freight platforms. Rather, it provides a structured framework of how to plan platforms according to the specific regional issues. Similarly, the handbook supports, but does not replace, the critical interaction processes between public and private partners to reach agreement on their individual and mutual interests.
Freight platforms support economic as well as traffic policy objectives. Logistic centres may help to attract industry. Transport operators can achieve cost savings through co-operation agreements with other on-site companies. The provision of on-site services also increases operational efficiency. The role of local authorities, guided by the handbook, would include the provision of:

- suitable sites;
- appropriate regulations;
- transport infrastructure; and
- subsidies for other infrastructure, such as the establishment of bi-modal transhipment terminals.

**ROLLING SHELF:**

**Rolling shelf**

*The final results of this project were not available when this Thematic Paper was prepared. The project website can be found at* http://rollingshelf.com/index.html

**SCANDINET:**

**Promoting integrated transport in peripheral areas of the Union**

***KEY RESULTS***

SCANDINET demonstrated the viability of creating intermodal transport services in peripheral areas and over short distances on a commercial basis. A study of freight flows revealed a number of factors that are important to the success of intermodal freight transport between the Nordic countries and the Continent:

- reasonable intermodal track rates;
- a fair railway slot practice;
- consolidation of flows into fewer terminals and corridors like continental freight freeways;
- correct and relevant information in different phases of the transport chain; and
- closer co-operation between intermodal operators.

By identifying and quantifying important service characteristics for both single-mode and intermodal freight transport, SCANDINET showed that a gap exists between the quality of service desired and the quality of services supplied. Ultimately, successful operators will be those who combine assurance in meeting service vector requirements with the lowest price.

***POLICY IMPLICATIONS***

SCANDINET has demonstrated that there is a need for policy-oriented actions in peripheral areas and over short and medium distances for the development of intermodal freight transport, in spite of small flows, large areas and sparse population in the Scandinavian countries. New fixed links will improve connections from Scandinavia to the European mainland. As all transport from the Nordic countries to continental Europe involves at least one sea leg, port terminals should be considered in all policy measures promoting intermodal transport, because problems arise from

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| | incompatibility between ferry and rail terminals. Currently, no port in the Baltic Sea operates a full-size intermodal terminal that is able to handle complete block trains. Such policy actions will be integrated into the decision by the European Commission to develop short-sea shipping inside the EU (Green Paper, December 1997) and, particularly, with the Nordic countries. From a legislative point of view, the imbalance between transport modes will have to be redressed, either by the re-imposition of certain restrictions on road-freight or via the accelerated liberalisation of the rail sector – probably the best solution will involve a combination of both policies.<br>SCANDINET recommended that the European Commission should speed up initiatives for improving the collection of statistics on international flows of Intermodal Transport Units, in order to support better targeting of policy action. |
| **SCENES 10-11-12:**<br>**Modelling and methodology for analysing the interrelationship between external developments and European transport** | *The final results of this project were not available when this Thematic Paper was prepared.* |
| **SORT-IT:**<br>**Strategic organisation and regulation in transport** | ***KEY RESULTS***<br>SORT-IT has:<br>• carried out 152 interviews with national government departments and major transport companies covering characteristics such as legislation, type of regulation and organisation, type of ownership, market structure, reasons for perceived barriers to interoperability and interconnection;<br>• performed an accompanying literature review about the aforementioned characteristics;<br>• used several models to assess specific aspects of intermodal transport, e.g. costs and productivity, competition (simulation), interoperability and demand;<br>• highlighted the following findings and derived recommendations, respectively:<br>  • policies of commercialisation and privatisation continue to be pursued, particularly in air, rail and express coach operations,<br>  • competition should be promoted particularly through extending cabotage and deregulation in inland waterways, rail and express coach operations, and also in input markets, including vehicle leasing, labour and ancillary markets such as baggage handling,<br>  • with respect to urban and regional transport, tendering/franchising should be promoted rather than head-on competition,<br>  • with respect to rail, horizontal and vertical separation should be considered, along with network re-configuration,<br>  • entry barriers need to be reduced with respect to congested air, sea and rail infrastructure possibly through the use of auctioning systems. Entry requirements (vehicle age limits for example) may need to be tightened in the road freight and waterborne freight industries.<br><br>***POLICY IMPLICATIONS***<br>SORT-IT concluded that policy priority should be on finishing the liberalisation of the European transport market along the introduced measures, with emphasis on inland waterways, short sea shipping and passenger road transport. Once the strategic reorganisation of the transport market is consolidated, focus should switch to increasing interoperability, interconnection and intermodality, which has already been |

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| | widely established for the air and road freight sectors. |
| **TACTICS:** | ***KEY RESULTS*** |
| **The automated conveying and transfer of intermodal cargo shipments** | Despite years of development in the transport and distribution industry, only two modular loading solutions, the container and the pallet, have been adopted on a truly international basis. The pallet has become the most popular Small Loading Unit, but the lack of international standardisation has limited exploitation of integrated pallet distribution systems. The European pallet population has many different pallet types, and most loading interfaces (especially vehicles) are not compatible with standard pallet formats. This is a substantial obstacle to a true and effective interoperability on a Europe-wide scale.<br>By combining state-of-the-art technologies for pallet systems, tagging and tracking systems and automatic loading units, the TACTICS group has developed an integrated system to demonstrate that a fully automated and electronically managed palletised distribution is feasible. The TACTICS system is based on three key products:<br>• standard (ISO-conformed Europallets) or customised pallets;<br>• radio tagging and read/write devices; and<br>• three Automatic Loading Units (named SHOTGUN, MAGNUM and EXCALIBUR) for transferring vehicle loads of palletised goods. The MAGNUM ALU has been identified as the most versatile solution.<br>The TACTICS prototype ALU has been designed to be compatible with Europallet ISO formats. However, the TACTICS group identified new pallet systems for the automotive industry and for the consumer retail trade. |
| | ***POLICY IMPLICATIONS***<br>The availability of fully automated distribution solutions identified by the TACTICS group makes it viable to fully exploit the benefits of total electronic management of freight distribution. The long-term benefits lead to 'live' or 'real-time' audit of freight movements. Virtual management of freight distribution will allow instant access to goods location, goods identity, stock taking and financial audit.<br>The benefits for all participant types (distributor, warehouse, freight terminal, logistics groups and transport companies) are substantial. The potential efficiencies of the TACTICS systems will bring significant improvements to road and rail freight utilisation, reductions in intermodal transfer times and costs, improved logistics management and advances in automating and managing freight terminals and warehousing. |
| **TERMINET:** | ***KEY RESULTS*** |
| **Towards a new Generation of Networks and Terminals for Multimodal Freight Transport** | TERMINET has:<br>• identified and investigated into innovative networks, which were found to be more efficient when bundling of small flows helps to establish hub-and-spoke concepts for medium to long distances;<br>• identified and investigated into new generation terminals, which were found to be economically viable at high freight volumes (>200,000 units), however requiring to compare them to conventional terminals or shunting yards in terms of real (non subsidised) costs;<br>• outlined cost and performance criteria for clients of advanced terminals;<br>• highlighted harmonisation measures at the EU level meant to promote the operational implementation of new generation terminals;<br>• set up five case studies at existing intermodal terminals (Metz/F, Busto Arsizio/I, Venlo and Valburg/both NL, and Duisburg/D);<br>• evaluated these case studies in terms of investment and operational costs, and performed transport chain cost comparisons with conventional unimodal (road) |

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transport; and
- identified perceived barriers for implementation of new generation multimodal terminals and associated innovative networks.

***POLICY IMPLICATIONS***

The TERMINET project has tackled the majority of topics concerning the integration of advanced terminals and complex freight networks. However, several aspects need more in-depth research in order to pave the way for the implementation of this concept, such as cost/benefit analyses for the whole network with integrated terminals, the development of efficient feeder services and regional networks, and the evaluation of risks and benefits related to highly robotised and automated terminal operations.
In the context of a refined implementation strategy for new generation intermodal terminals specific transport related barriers should be further investigated and assessed. Finally, the scalability and flexibility of new terminal concepts – primarily for smaller applications – needs to be evaluated.

**TORCH:**

**Technical, economical and operational assessment of an ATM concept for the year 2005**

*The final results of this project were not available when this Thematic Paper was prepared.*

**UTI-NORM:**

**Current State of Standardisation and Future Standardisation Needs for Intermodal Loading Units**

***KEY RESULTS***

UTI-NORM has:
- surveyed current container standards related to intermodal transport, as well as the role of non-standardised loading units, used in European container shipments;
- has elaborated recommendations to standardise a future European loading unit with the main dimensions of current standard swap bodies, and to include stackability, top corner fittings and certain additional strength requirements to the design;
- specified a standardised future European loading unit that will be suited for all current European transport modes, by
  - providing two sizes for road transport (rigid truck and semi-trailer) with optimised height to make best use of the maximum allowed overall vehicle height of 4,000 mm, light weight to avoid tare penalties and rather cheap to produce,
  - providing a rail transport unit utilising the maximum clearance of corridors, and loading patterns available with the majority of the current European rail wagon fleet,
  - providing a unit for inland waterway transport, designed to be stacked at least four elements high, and
  - considering the problems of cellular ships to carry different size loading units, because they are mainly designed to accommodate ISO containers.

***POLICY IMPLICATIONS***

There are some considerations for transport policy measures that will address standardisation needs of intermodal loading units in Europe, such as keeping the legal framework on dimensions of road vehicles stable, and promoting the evolution of rolling stock towards a combination of pallet wide stackable freight containers and platform chassis configurations. For optimised intermodal operations a maximum gross weight in road transport of 44 t must be allowed, together with the introduction of standardised stackable European loading units of 13.6 m in length. Standardisation

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| | of loading units should thereby consider the requirements of inland waterway barges and rail wagons as well.<br>The inclusion of small European short sea carriers into harmonised EDI and Internet systems for communication between ocean carrier, terminal operator and forwarder shall be promoted by pilot projects. |
| **X-MODALL** (X-MOD/1)**:**<br>**The Optimisation of Modular Intermodal Freight Systems for Europe 2000+** | ***KEY RESULTS***<br>X-MODALL (X-MOD/1) has:<br>• proposed an integrated information system (X-CRS) that manages transport demand (shipper requirements), the supply side, the optimal use of infrastructure and all of the networked assets used;<br>• outlined a hierarchical trunk sector networking structure made up of dedicated components for interconnected nodes and terminals (X-NodeNet), new modular load units (Xpak), a flexible HomeBase/AnywayBase model for road freight (X-Road), and new modular configurations for freight trains encompassing modular wagon groups (X-Rail);<br>• identified possible savings in the range of 10-15% of current costs for intra-European surface freight transport, once the full set of procedures is introduced; further significant savings are possible with respect to the benefits accruing to fully integrated logistics and manufacturing activities (which can not be reliably quantified at this time);<br>• considered and evaluated the potential of transparently integrating the demand side (the supply chain – B2B, B2C, etc.) with the supply side, together with the technical and organisational changes necessary to benefit all of the parties involved, i.e. industry, consumers, manufacturers, suppliers, environmental interests, planners and government; and<br>• proposed a timeline for gradual implementation of market driven changes for the short-term (next 18 months), mid-term (12 to 42 months) and long term (36 to 66 months), that would include software developments, organisational measures, and the gradual introduction of improved hardware into the road and rail sectors. These time scales are possible only if all parties constructively assist and endorse the changes necessary, so that Europe can have the quality of freight services it urgently requires within the next decade and beyond. At the same time, manufacturing and logistics will need progressively to assimilate these enhancements to freight transportation and react accordingly, so that the transportation linking distributed manufacturing activities becomes truly and transparently integrated within the supply chain itself.<br><br>***POLICY IMPLICATIONS***<br>From the results of the X-MOD/1 research study it is obvious that transport policy and the particular regulations derived from it will need to be adapted and revised, in order to allow for improved conformity of multi-modal transport procedures, and significantly better performance across the length and breadth of Europe. Furthermore, the flexibility of adopting the X-MODALL approach will help support EC policy development in terms of cohesion and improved integration of the accession countries, whilst taking account of desired regional developments (subsidiarity). |