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**Thematic Research
Summary:**

Transport Management

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Foreword

This paper has been produced as part of the TRKC (Transport Research Knowledge Centre) project of the Sixth Framework Programme, priority thematic area “Sustainable Development, Global Change and Ecosystems”.

The role of TRKC, as its predecessor project EXTR@Web, is to collect, structure, analyse and disseminate transport research results. It covers EU-supported research as well as key research activities at the national level in the European Research Area (ERA) and selected global programmes. The main dissemination tool used by TRKC is the web portal at www.transport-research.info

The approach to dissemination of results of research projects adopted by the TRKC team includes the following three levels of analysis:

- Project Analysis, which provides, project by project, information on research background, objectives, results, technical and policy implications;
- **Thematic Analysis**, which pools findings of research projects according to a classification scheme based on thirty themes, fixed for the project life time; the product of this analysis activity is the set of **Thematic Research Summaries (TRS)**; the present document belongs to this set;
- Policy Analysis, which pools findings of research projects according to combinations of themes, based on ad-hoc policy priorities which are agreed with DGMOVE of the European Commission and a representative group of research users.

This Thematic Research Summary deals with Transport Management (for all modes). The aim is to provide the reader with a synthesis of completed EU-funded projects which have dealt with the theme. The paper is intended for policy makers at the European, national and local levels, as well as any interested reader from other stakeholders and from the academic and research communities.

Disclaimer and acknowledgement

The TRKC team is fully responsible for the content of this paper. The content of this paper does not represent the official viewpoint of the European Commission and has not been approved by the coordinators of the research projects reviewed.

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Executive Summary

This paper has been produced as part of the TRKC (Transport Research Knowledge Centre) project of the Sixth Framework Programme. The role of TRKC is to collect, structure, analyse and disseminate transport research results. TRKC provides comprehensive coverage of transport research in EU programmes as well as key research activities at national level within the European Research Area and selected global programmes.

The paper is one of the thematic research summaries (TRS). The TRSs aim at providing a synthesis of research results and policy implications from completed projects. Each TRS deals with a theme according to the classification which the TRKC project has adopted. The theme of this TRS is “transport management”.

The first part of the paper includes a brief analysis of the scope of the theme, and a policy review where the main policy developments at EU level are summarised.

The transport management theme is very wide ranging, covering all transport modes and overlapping with numerous other themes. It includes traffic management (for all modes) as well as mobility management aspects for passengers and logistics for freight. Although the use of pricing as a tool to regulate demand is a form of transport management, projects dealing with pricing and tolling aspects are not included in this paper, as that is the subject of a separate TRS published by the TRKC project.

This paper summarises results of 35 projects (25 of them EU projects and 10 national activities from Greece, Romania, Slovakia, Spain, Sweden and Switzerland), spread across six sub-themes. The first two sub-themes deal with cross-modal or mode-independent transport management aspects and the remaining four sub-themes relate to transport management projects which focus specifically on each of the four main transport modes (road, rail, waterborne and air transport).

The first of the six sub-themes deals with **urban traffic, public transport and mobility management**, in which results of six projects are described in two clusters:

- A cluster on *mobility management and Demand-Responsive Transport (DRT)*. This included a project on mobility management strategies which developed a monitoring and evaluation toolkit and a best practice methodology for developing a mobility management plan; a project on addressing organisational and technical issues in DRT which implemented innovative public transport services and organisational platforms; a Swiss study on sustainable transport management at holiday resorts which revealed

that different traffic management policies have different effects on staying guests, day visitors and local residents; and a project on evaluating measures for controlling car use in metropolitan areas where user preferences and real behaviour were surveyed.

- A cluster on *urban traffic management*, including an open model for network-wide intersection-based transport management which demonstrated the feasibility of integrated ITS (Intelligent Transport Systems) deployment in four pilot cities; and a project on the synergy effects of means to deal with congestion in the city of Stockholm, concluding that a lower urban toll with effective mobility management measures could have the same effect as a higher toll.

The second sub-theme, also mode-independent, covers **freight traffic management, terminals and logistic chains**. The six projects in this section are divided into two clusters:

- *Technical aspects of logistics operations*: this cluster includes a project which developed and validated an innovative e-logistics platform for urban areas; a project which developed an integrated info-box system for improved food safety and logistics; and a Romanian project which developed a web-based electronic system for intermodal container management.
- *Strategic freight management and logistics*, a cluster containing three new project results: a follow-on EU project on best urban freight solutions which produced various best practice handbooks; a study on intelligent intermodal transport which produced a management framework and a reference architecture; and a demonstration project to improve intermodal terminal operations at border crossings which achieved a 25% average reduction in border waiting times.

The third sub-theme focuses on **road network and traffic management**. Five projects are included here in two clusters, as follows:

- A cluster on *traffic and safety applications*. This included a project on intelligent roads that furthered the state-of-the-art on collecting travel time information, combining data sources and providing drivers with dynamic information on road surface risk; a project on speed adaptation (ISA) policies which evaluated user reactions and analysed benefits and barriers to implementation; and a national project in Spain which provided a tool for road managers to set appropriate speed limits tailored to road sections.
- A cluster on *traffic and network management strategies*, including a project on management measures on long distance road corridors on the Trans-European Road Network which produced a best practice guide and proposals for “quick win” measures; and a project which produced a handbook and decision support system for managers of secondary road networks.

The fourth sub-theme is on **rail network and traffic management**. The five projects in this sub-theme, clustered into two groups, are:

- Projects related to *maintenance aspects*, which included the design of an architecture and standard platform for a European railway open maintenance system; and a project that developed, implemented and evaluated a Reliability Centred Maintenance (RCM) approach on various types of railway track and trackside equipment.
- Projects related to *operational aspects* of railways, including a demonstration on path allocation re-engineering for Infrastructure Managers and Railway Undertakings; a project which recommended improvements to models used for rail punctuality incentives to operators in Sweden; and a freight action strategy for the Brenner rail corridor which included an open corridor management scheme and information systems for combined transport.

The fifth sub-theme deals with the waterborne mode: **maritime and inland waterway traffic and port management**. Three projects are described in this section:

- Two *maritime* projects: one of which dealt with tele-maintenance and support through intelligent resource management for ship operation and produced outputs including a Safety Management System and a Remote Maintenance Platform; and second project which provided a framework for port quality management based on a study in a Greek port.
- One project, in Slovakia, dealt with the subject of *inland waterways*, building up a River Information Services (RIS) test centre.

The final sub-theme covers **air traffic and airport management**. Six projects (all EU projects) are described, as follows:

- An *Air Traffic Management (ATM)* cluster, in which one project integrated the most promising elements of co-operative ATM research in Europe into one overall, fully inter-operable and integrated air/ground concept of operation; another enhanced a 3D virtual reality system for Air Traffic Control (ATC); a third project developed an integrated ATC wake vortex system to allow closer spacing between aircraft taking off and landing; and two further projects developed an Advanced Surface Movement Guidance and Control (A-SMGC) system at airports.
- A single project relating to *airport management*, which developed a decision-support system for airport stakeholders and policy-makers to support airport development, planning and operations.

A final section summarises implications and recommendations for further research, based on some key outputs of the projects reviewed.

This is not a comprehensive compendium of all transport management related research results: the projects chosen are selective and cover those for which results have made available to the TRKC project and with a bias towards projects with some policy implications rather than purely technical projects.

The annex at the end of this paper lists the projects with information on the TRKC website (www.transport-research.info) which are relevant to the transport management theme, arranged by the six sub-themes above. This listing includes projects described in this paper, older projects already described in the preceding version of this paper (EXTR@Web, 2006f) and projects that are either ongoing or have recently finished where results have not yet been made available, and which will be included in a subsequent version of this paper. This annex lists projects by name/acronym, including information on the programme to which it belongs, the project website (if any) and in which Thematic Research Summary (TRS) it is (or will be) described.



Acronyms

A-SMGCS	Advanced Surface Movement Guidance and Control System
AR	Augmented Reality
ATC	Air Traffic Control
ATM	Air Traffic Management
B2B	Business to Business
B2C	Business to Client
CEC	Commission of the European Communities
CLS	City Logistics Solutions
CO ₂	Carbon monoxide
DRT	Demand-responsive transport
ERA	European Research Area
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
EU	European Union
EXTR@Web	Exploitation of Transport Research via the Web (predecessor project to TRKC)
DGMOVE	Directorate General for Mobility and Transport (European Commission DG from 2010)
DGTREN	Directorate General Transport and Energy (European Commission DG up to end of 2009)
ERDF	European Regional Development Fund
FP5 / 6 / 7	Fifth / Sixth / Seventh Framework Programme (EU R&D programmes)
GDP	Gross Domestic Product
GSM	Global System for Mobile telecommunications
GPS	Global Positioning System
HGV	Heavy Goods Vehicle



HMI	Human-Machine Interface
ICT	Information and Communication Technologies
IM	Infrastructure Manager (rail)
ISA	Intelligent Speed Adaptation
ISO	International Standards Organisation
ITS	Intelligent Transport Systems
KA	Key Action (sub-groupings in FP5)
NoE	Network of Excellence
PTA	Priority Thematic Area (sub-groupings in FP6)
R&D	Research and Development
RCM	Reliability Centred Maintenance
RFID	Radio Frequency Identification
RIS	River Information Systems
RU	Railway Undertaking
SESAR	Implementation programme for the Single European Sky (SES)
SES II	Single European Sky II
TEN	Trans-European transport Network
TRKC	Transport Research Knowledge Centre
TRS	Thematic Research Summary
UCC	Urban Consolidation Centre (= city logistics scheme)
UIC	Union Internationale des Chemins de fer (International Union of Railways)
UML	Unified Markup Language
UNECE	United Nations Economic Council for Europe
UTC	Urban Traffic Control
v2i	Vehicle to Infrastructure
v2v	Vehicle to Vehicle
VMS	Variable Message Sign



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1. Introduction

This paper provides a structured review of the research relating to transport management carried out in EU-funded research projects. “Transport management” is one of thirty themes in the classification scheme adopted by the TRKC project, shown in the table below.

Table 1. The classification scheme adopted in TRKC

<i>Dimension 1: sectors</i>
<ul style="list-style-type: none"> • passenger transport • freight transport
<i>Dimension 2: geographic</i>
<ul style="list-style-type: none"> • urban transport • rural transport • regional transport • long-distance transport • EU accession issues
<i>Dimension 3: modes</i>
<ul style="list-style-type: none"> • air transport • rail transport • road transport (including walking and cycling) • waterborne transport • innovative modes • intermodal freight transport
<i>Dimension 4: sustainability policy objectives</i>
<ul style="list-style-type: none"> • economic aspects • efficiency • equity and accessibility • environmental aspects • user aspects • safety and security
<i>Dimension 5: tools</i>
<ul style="list-style-type: none"> • decision support tools • financing tools • information and awareness • infrastructure provision including Trans-European Networks (TENs) • integration and policy development • Intelligent Transport Systems (ITS) • regulation/deregulation • land-use planning • transport management • pricing and taxation • vehicle technology

The scheme has been adopted to enable search facilities in the TRKC portal, and to ensure comprehensive coverage of research results and appropriate policy analysis in the Thematic Research Summaries (TRS). Definitions for each theme are found on the TRKC portal at http://www.transport-research.info/web/projects/transport_themes.cfm.

The TRKC project has planned to produce final versions of the TRSs for 28 of the 30 themes by 2010 (EU accession issues and Innovative modes not being covered due to lack of projects), with some of the TRSs treating two themes together where there were low numbers of contributing projects and where similarities existed between the themes. This is the final version of the TRS on Transport Management and replaces the first version issued in 2009.

A large number of research projects have dealt with the transport management theme and the nature of the TRKC's classification scheme is that all overlap with at least one other theme, and in many cases several themes. The "Transport Management" TRS produced in the predecessor project (EXTR@Web, 2006f), reviewed research from 20 European projects belonging to the Fourth and Fifth Framework Programmes for R&D (FP4 and FP5) and four selected national projects – 25 projects overall. The present paper adds 35 new projects, mainly European projects from FP5 and the Sixth Framework Programme (FP6) but including ten national projects.

The research reviewed in this paper does not represent the entire range of research dealing with transport management carried out in Europe. The paper focuses on research from those projects which have made documentation on results available to the TRKC team after the issue of the EXTR@Web paper in 2006. A summary of the research on transport management topics reported on in the previous EXTR@Web paper is also included to make the reader aware of the full range of research which has dealt with the theme. For completeness, projects from FP6 which are on-going or which, although completed, have not yet made results publicly available, are also listed.

The paper is organised as follows. Sections 2 and 3 set the scene. Section 2 includes a brief analysis of the scope of the theme. Section 3 provides an overview of the policy priorities at EU level which underpin the research objectives. The sources for this section are principally European Commission documents which have set the policy agenda such as white papers, green papers, and communications.

Section 4 reports on the results from research. The section is structured into six sub-themes to make the broad area of research in the transport management field more manageable. For each sub-theme, overall research objectives are presented and linked to

policy goals, then research findings are synthesised. A special focus is given to the policy implications of research results. Sources for Section 4 are documents available from the projects and reporting on their achievements, essentially the project final reports.

The sub-themes covered in section 4 are:

- Urban traffic, public transport and mobility;
- Freight traffic management, terminals and logistic chains;
- Road network and traffic management;
- Rail network and traffic management;
- Maritime and inland waterway traffic and port management; and
- Air traffic and airport management.

The Annex includes the list of the EU-funded research projects for each of the six sub-themes. Addresses of the websites of the projects are included with hyperlinks. In several cases these websites make the project documentation available to the public. This may include final reports and project deliverables.

2. Scope of the Transport Management theme

The “transport management” theme covers the management of traffic and transport services for all modes, covering both passenger and freight transport. This includes changing the way in which existing transport systems are used (particularly with respect to infrastructure) and the strategic and tactical management and control of traffic.

Tactical traffic management and network management, which is part of transport management, involves monitoring the actual traffic situation in real-time (including volumes, speeds, incidents, etc) and then controlling or influencing the flow using that information in order to increase network efficiency, safety, or other objectives. Objectives are to optimise transport networks and efficiently organise public transport by achieving better traffic flows, improved traffic flows and increased quality in public transport. This way, congestion, emissions and traffic volume can be reduced.

Transport management measures are mainly divided into traffic information and control and improving public traffic flow. They also involve a wide range of approaches, including increases and reductions in network capacity, reallocations of that capacity, and changes in the operation of public transport, rail, air or waterborne transport. With an efficient traffic management system the network operator can meet goals set by the politicians regarding traffic levels within the city centre, emission levels etc.

Measures and tools to influence road use and traffic flows are:

- Conventional traffic management;
- Urban traffic control systems;
- Intelligent Transport Systems, which use new technology to improve the performance of the road network;
- Traffic calming measures;
- Parking management;
- Mobility management;
- Traffic information systems covering all transport networks and all modes;
- Freight management; and
- Supply chain and Logistics management.

The last four measures above also apply to other modes.

Measures to influence public transport use and increase its efficiency include:

- New and modified bus services;
- Intermodality in urban trips;
- Integration of modes;
- Fleet management systems;
- Bus priority and high occupancy vehicle lanes; and
- Changes in bus and rail frequencies.

Traffic and transport management policies and measures may also be extended to provisions for slow modes (cycling, walking, etc).

For other modes, Air Traffic Management (ATM) and airport management are relevant to this theme, as is railway network management (signalling, allocation of train slots, etc). The transport management theme also covers River Information Services and management of ports and terminals.

Transport management is a very wide theme and overlaps with several other themes covered by the Transport Research Knowledge Centre. In order to avoid unnecessary duplication, this Thematic Research Summary (TRS) does not include traffic management projects which are primarily devoted to safety (these are covered in the Safety and Security TRS), or the use of infrastructure charging as a tool to manage and influence traffic (this is the subject of a future TRS on Financing, Pricing and Regulation/Deregulation). Traffic and transport management research that is primarily technological is covered in a separate TRS on Intelligent Transport Systems (ITS). For more comprehensive information by mode, readers are also advised to refer to the Thematic Research Summaries on Road Transport, Rail Transport, Waterborne Transport and Air Transport.

3. Policy context

The 2001 EU White Paper on Transport (CEC, 2001) identified as major difficulties the following issues: the imbalance in the development of the different modes, congestion on the main overland routes and in cities, as well as in airspace, and the major impact transport is having on the environment and on citizen's health. Transport and traffic management is a key tool to address these problems, alongside infrastructure investments, pricing, regulatory and fiscal measures and Intelligent Transport Systems.

Key transport management related measures from the 2001 White Paper that have already been adopted include:

- The promotion of intermodal transport, modal rebalance and logistics with the MARCO POLO programme;
- The development of large-scale industrial programmes such as Galileo, ERTMS (European Rail Traffic Management System) and SESAR (new generation of Air Traffic Management system);
- The approval of the European Single Sky legislation;
- Supporting harmonised co-ordinated deployment of traffic management measures and strategies using ITS on the Trans-European Road Network (DGTREN [now DGMOVE] multi-annual programmes).

Developing and improving economic and resource efficiency is the key objective for the renewed Lisbon strategy in 2005. Increased economic efficiency will enable a reduction in transport costs and in resource use. Detailed objectives of the Lisbon strategy with relevance to transport management include improved utilisation of existing networks, tackling congestion and increasing accessibility, developing urban transport schemes, developing charging policies, increasing synergies between modes and improving logistics in all transport systems.

The economic well-being of citizens and businesses and social cohesion in Europe are to a considerable extent based on an efficient, accessible and competitive transport system which reconciles the need for mobility meeting users' needs using advanced traffic management systems, helping travellers, freight distributors and transport operators make a more efficient use of the networks.

Within the EU's 7th Framework Programme for Research and Development (FP7 - 2007-2013), technological innovation in transport contributes directly to the European competitiveness, environmental and social agendas. Based on the Strategic Research Agendas developed by the European Technology Platforms in transport, activities include the "greening" of surface and air transport, the modernisation of air traffic management, decongesting European transport corridors, urban mobility, intermodality and interoperability, safety and security in transport and a competitive industrial base.

According to the 2006 mid-term review of the 2001 Transport White Paper (CEC, 2006a), there is no reason in the longer run why aircraft should have sophisticated communication, navigation and automation, but not ships, trains or cars. New technologies coming to market in the near future will gradually provide new services to citizens and allow improved real-time management of traffic movements and capacity use, as well as the tracing and tracking of flows for environmental and security purposes. As well as providing benefits to transport operators and users, new systems will be able to provide public administrations with rapid and detailed information on infrastructure and maintenance needs. Transport management applications can increase the efficiency of networks, reduce the need to build new infrastructure, enhance driving comfort and also help to increase safety and security, as well as tackling wasteful transport patterns in the interest of environmental sustainability.

Given that the policy context for transport management is rather specific to each transport mode, a summary of main EU measures and policies by mode is given below.

3.1 Road transport policy context

Road accounts for the great majority of inland passenger and freight transport in the EU (approximately 83% and 72% respectively). The very rapid growth in car ownership in the New Member States has made transport management a pressing issue in these countries, despite the historically lower level of traffic management systems and services. The enlargement of the EU and the Single European Market have led to greater volumes of international and transit traffic – both freight and passenger.

The parts of the road network which require traffic management the most are urban areas, where most congestion occurs, and on the Trans-European Road Network (TERN, or road TEN-T), which serves as the core motorway and high-quality road network linking the different regions and Member States of the EU, and which carries the great majority of regional and long-distance traffic.



Intelligent Transport Systems (ITS) are a key tool for traffic management in both cases, but especially for interurban networks such as the TERN, where congestion is less recurrent (as in urban areas) and can be caused by seasonal traffic peaks, incidents, closures, roadworks, weather, etc, and where in many cases diversionary routes, traffic demand and capacity management solutions exist.

Interurban traffic management includes traffic control centres, tactical management (such as lane control, variable speed limits, hard shoulder running and automatic incident detection), as well as strategic management (longer distance diversions or re-routing, data exchange and common approaches such as traffic management plans involving neighbouring road authorities, etc).

Such measures, largely using ITS, have been supported and fostered by the European Commission over the past decades with recent activities including the FP7 work programme and the publication of the ITS Action Plan (CEC, 2008a). ITS systems have considerable benefits in improving traffic flows, increasing safety and improving services to road users, for relatively little costs compared to the cost of building new infrastructure. Research into ITS for road traffic has been supported in EU programmes since the 1980s, and from the mid 1990s the TEN-T budget line of the Commission has supported a number of “Euro-Regional projects” to study and deploy systems on the TERN to improve traffic management and user services (EasyWay, 2009). EU support has focused on systems and services with European added-value, i.e. on trans-European and in particular cross-border corridors, where due to this support there have been significant advances in cross-border traffic management and co-operation between neighbouring countries and road operators (e.g. cross-border Traffic Management Plans, which now exist in several parts of Europe).

Regarding road traffic management in urban areas, the policy context is rather different. Although many traffic management and control techniques used on interurban networks are valid, with some traffic management plans near key conurbations integrating the interface to urban networks, urban traffic management principally involves traffic signal management and co-ordination, priority and improvements to public transport and a more comprehensive mobility management approach, given in particular that a much greater proportion of trips in urban areas are regular journeys (e.g. commuting). In addition, the principle of subsidiarity means that Member States and their respective regional and local administrations determine local transport policies. Nevertheless, the EU can and does promote the study and exchange of best practice. Projects under the CIVITAS initiative, for example, bring together cities in different countries to research, implement and share urban transport and traffic solutions, and aspects such as co-modality and urban-interurban interface are being incorporated into traffic management projects on the TERN.

More recently, the EU has stepped up actions in this field, with the 2007 Green Paper on Urban Mobility (CEC, 2007d), followed by the Urban Mobility Action Plan (CEC, 2009b). The latter includes measures to promote reliable travel information and protection of passengers' rights, to support the sharing of experience and knowledge, and to encourage integration, interoperability and connections between networks.

3.2 Rail transport policy context

Building a modern, competitive railway network is indeed a top priority in Europe both for the smooth operation of the EU internal market and for the development of a sustainable transport system. EU efforts in this regard focus on opening up rail markets to greater competition, promoting technical standardisation between rail systems and modernising Europe's rail infrastructure – including through the use of new technology – while working to ensure safety and promoting passenger rights.

One of the key EU policies affecting rail traffic management has been opening of the rail market, involving the separation of rail infrastructure and train operations at national level and allowing new operators to provide passenger and freight services. This opening of networks has largely been achieved for rail freight services, whereas open access passenger services only exist in certain Member States so far, although public service contract awards to private train operators for passenger network operation are more common.

This market opening has increased demands on rail network management, with the need to allocate and manage train slots to different operators, while at the same time ensuring maximum safety and reliability of passenger and freight services.

The competitiveness of railways for international passenger and freight traffic is still hampered to a large extent by lack of interoperability, i.e. different signalling and electrification systems in different countries, and for some countries, different track gauges. This often requires a change of locomotive at borders, or the provision (at a higher cost) of trains which can run under different systems, for example the Thalys high speed trains linking France, Belgium, the Netherlands and Germany are equipped with seven different signalling and speed control systems.

Thus, a second major plank of EU policy is to increase the interoperability of networks and control systems to improve efficiency. This involves directives and research into

harmonising infrastructure, signalling, telecommunications and data transmission, as well as operational procedures. Key directives relating to this issue are Directive 96/48/EC on interoperability of the European high speed railway system and Directive 2001/16/EC on interoperability of the conventional railway system (both directives last modified in 2004).

The development and deployment of ERTMS (European Rail Traffic Management System), which encompasses ETCS (European Train Control System) and GSM-R (Global System for Mobile communications - Railway) to unify signalling and speed control in Europe, forms a major part of the EU's railway policy. These are major industrial projects aimed at enabling interoperability throughout the European Rail Network, to make rail more efficient, competitive and safer.

In addition, the EU created the European Railway Agency in 2006, with the objective of building an integrated European railway areas by reinforcing rail safety and promoting interoperability.

3.3 Waterborne transport policy context

One of the EU's major policies in maritime transport is to promote Short Sea Shipping between Member States, both in terms of increasing the efficiency of multimodal journeys with a sea element and in terms of promoting coastal shipping as a way of transferring freight away from busy land corridors (for example direct sea links between Spain and Italy to reduce road transit traffic through southern France). The Motorways of the Sea concept is a key initiative in this regard, aimed at further facilitating the start-up of innovative integrated inter-modal transport solutions, simplifying administrative requirements and supporting initiatives in the field of the "greening" of transport.

Other EU maritime policies touch less on traffic management, but rather safety rules preventing sub-standard shipping, reducing the risk of serious maritime accidents and minimising the environmental impact maritime transport. In the absence of tight controls on ships' routings, which means that administrative and customs procedures must remain in ports, the focus on transport management for this mode is on increasing efficiency at ports. In this respect, the EU's e-Maritime initiative aims to development integrated information management systems for identification, monitoring, tracking and reporting of vessels at sea and on inland waterways, as well as enhancing the throughput of both passengers and freight. The Commission is also working towards an integrated cross-border and cross-sectoral EU surveillance system in order to increase interoperability of national maritime surveillance systems and improve the effectiveness of shipping.

Traffic on inland waterways has achieved overall positive growth in recent years, with a considerable re-dynamism of the industry. Nevertheless, there are still capacity reserves on most main waterways, with congestion, capacity and reliability problems being considerably less severe than for other transport modes. EU policies focus on strengthening the competitive position of inland navigation for freight transport, with several significant projects funded within the MARCO POLO programme. Another key part of this is research and implementation of River Information Systems (RIS) on main waterways in order to manage vessel traffic more efficiently.

3.4 Air transport policy context

The air transport sector is the mode where transport management is most advanced, with Air Traffic Control (ATC), airport management and on-board systems being essential to efficient and safe operation. The most important EU policy, as proposed in the 2001 White Paper and adopted in 2004 under Regulation 550/2004, is the Single European Sky legislation (CEC 2007a). This ambitious initiative to reform the architecture of European ATC was necessary to end the fragmented national approach and thereby allow ATC to meet future capacity and safety needs. This Regulation established common requirements for operation and interoperability, in particular in terms of creating cross-border blocks of airspace so that airspace structures are determined by the operational reality of traffic rather than political borders.

In 2007, the EU established a joint undertaking to develop SESAR, the new generation of European ATM. This is the technological element to the Single European Sky. The SESAR joint undertaking (modelled on the successful Galileo joint undertaking) aims to bring together R&D efforts in the EU, organising and co-ordinating development of the SESAR project, implementing the ATM Master Plan, organising and funding technical R&D, etc.

In 2007, an Action Plan for Airport Capacity, Efficiency and Safety in Europe was adopted (CEC 2007b), with proposed actions to make better use of existing airport capacity, create a consistent approach to air safety operations at aerodromes, promote co-modality and improve efficiency and environmental aspects at airports.

Finally, a roadmap towards the implementation of the Single European Sky II (SES II) was adopted in a high level conference in Madrid in February 2010 (CEC, 2010). This endorses and reinforces Functional Airspace Blocks as drivers of performance and change of the ATM landscape. SES II provides for a Functional Airspace Block co-ordinator (appointed in

August 2010) as well as an independent performance review body. A roadmap is also proposed for the transition from research and technical innovation in the SESAR field to synchronised deployment through appropriate regulatory implements and financial incentives.

3.5 Freight policy context

In addition to the traffic management of freight flows by the different transport modes above, transport management for freight also involves administrative, organisational and regulatory aspects related to logistics. In 2007, the EU's first Freight and Logistics Action Plan (CEC 2007c) was adopted. This provides for the establishment of a roadmap for an ICT (Information and Communication Technologies) application to follow the movements of goods across modes and borders, a concept called e-Freight. The EU's vision is of a paper-free, electronic flow of information associating the physical flow of goods, allowing full tracking and tracing.

Within the ITS Action Plan (CEC 2008a), the EU aims to establish a framework for developing Intelligent Transport applications for freight transport logistics, including monitoring dangerous goods and transport of live animals, as well as digital mapping. Interoperability of electronic fee collection for lorries is also a key EU policy, including the development of an on-board unit with a single interface for data exchange. Identifying and finding practical solutions to freight bottlenecks in Europe is also part of the European Commission's work towards increasing the efficiency and quality of freight transport.

Furthermore, the EU proposes, in co-operation with industry, a set of benchmarks for intermodal terminals (including ports and airports), which is a crucial step for increasing freight and logistics efficiency. Best practice promotion in multimodal freight transport is also promoted and funded in part by the MARCO POLO programme, in order to address the current under-utilisation of this solution which can stem from lack of knowledge, lack of integration or the costs and delays caused by transshipment. As part of this, the EU intends to extend the role of Short-sea Promotion Centres into inland logistics.



4. Research findings

4.1 Introduction

The research which is reviewed in this Thematic Research Summary (TRS) deals with six sub-themes.

The first sub-theme deals with **urban traffic, public transport and mobility management**. Readers interested in this sub-theme are also referred to the Thematic Research Summaries on Passenger Transport (EXTR@Web, 2005a) and on Urban Transport (EXTR@Web, 2005b), and the Policy Brochure “User-friendly and Secure Passenger Transport” (TRKC, 2010b).

The second sub-theme is centred on **freight traffic management, terminals and logistic chains**. Readers interested in this sub-theme are also referred to the Thematic Research Summaries on Freight Transport (TRKC, 2009a) and on Intermodal Transport (EXTR@Web, 2005f) and the Policy Brochures “Intermodal Freight Terminals - In search of efficiency to support intermodality growth” (EXTR@Web, 2006c), “Urban freight transport and logistics - An overview of the European research and policy” (EXTR@Web, 2006d) and “Towards an Integrated Transport System – Freight Focus” (TRKC, 2010a).

The third sub-theme concerns **road network and traffic management** (outside urban areas). Further information on road traffic and transport projects is also provided in the Road Transport TRS (TRKC, 2009b), whereas readers interested in research into ITS for traffic management and other road transport applications are referred to the TRS on Intelligent Transport Systems (TRKC, 2009c).

The fourth sub-theme concerns **rail network and traffic management**, which is also further dealt with in the Rail Transport TRS (TRKC, 2009d). Interested readers are also referred to the Policy Brochure “Rail transport - EU policy and its impact on the rail system” (EXTR@Web 2006b).

The recently published Policy Brochure “Traffic Management for Land Transport – Research to increase the capacity, efficiency, sustainability and safety of road, rail and urban transport networks” (TRKC, 2009e) is also of interest regarding the above sub-

Table 2. EU-funded projects relevant to the theme

Sub-theme	Contributing projects
Urban Traffic, Public Transport and Mobility Management	<p><u>EU projects covered in this TRS paper:</u> FAMS, MOST, OMNI</p> <p><u>Other projects covered in this TRS paper:</u> D6 (NRP41) (Switzerland), EMMA - Evaluation of Measures for Controlling Private Car Use in Metropolitan Areas) (Sweden) , Integrated Transport Scheme in a Rural Area (UK), Synergy effects of management means to decrease congestion and environmental influence (Sweden), The Attractive City - Traffic integration or segregation for the sustainable city (Sweden).</p> <p><u>EU projects covered in the previous Transport Management TRS (EXTR@Web, 2006f):</u> MOBISERVICE, PRISCILLA, SMART NETS, TOSCA, Urban Transport Benchmarking Initiative</p> <p><u>Other projects covered in the previous Transport Management TRS (EXTR@Web, 2006f):</u> A9 (NRP41) (Switzerland), Breaking the Habitual Choice of the Private Car (Denmark), Managing and financing of urban and regional transport in Europe from the viewpoint of Hungarian solutions (Hungary)</p> <p><u>Other EU projects for which the TRKC project has not yet received results, and which will be included in a future update of this TRS paper:</u> CITYMOBIL, ISCOM, SUCCESS</p>
Freight Traffic Management, Terminals and Logistic Chains	<p><u>EU projects covered in this TRS paper:</u> BESTUFS II, eDRUL, IBOS, Heavy Route, INTERFACE, FREIGHTWISE</p> <p><u>Other projects covered in this TRS paper:</u> GECOTRAM (Romania)</p> <p><u>EU projects covered in the previous Transport Management TRS (EXTR@Web, 2006f):</u> BESTUFS¹, E-THEMATIC, F-MAN, MOSCA, NECL, PROTRANS, SULOGRTRA</p> <p><u>Other projects covered in the previous Transport Management TRS (EXTR@Web, 2006f):</u> TAKSU (Finland)</p>
Road Network and Traffic Management	<p><u>EU projects covered in this TRS paper:</u> INTRO, LDC, PROSPER, SENSOR</p> <p><u>Other projects covered in this TRS paper:</u> REVEL (Spain)</p> <p><u>EU projects covered in the previous Transport Management</u></p>

¹ Covered in EXTR@Web TRS on Freight, but also relevant to Transport Management

Sub-theme	Contributing projects
	<u>TRS (EXTR@Web, 2006f):</u> CENTRICO, STREETWISE
Rail Network and Traffic Management	<u>EU projects covered in this TRS paper:</u> BRAVO, EUROMAIN, PARTNER, RAIL <u>Other projects covered in this TRS paper:</u> Incentives for increased rail punctuality (Sweden) <u>EU projects covered in the previous Transport Management TRS (EXTR@Web, 2006f):</u> IMPROVERAIL, PROMAIN, SAMRAIL
Maritime and Inland Waterway Traffic and Port Management	<u>EU projects covered in this TRS paper:</u> TELEMAS, ARCOP <u>Other projects covered in this TRS paper:</u> OPSPEMAPT (Greece), RISVD (Slovakia) <u>EU projects covered in the previous Transport Management TRS (EXTR@Web, 2006f):</u> INTRASEA, WATERMAN-TS
Air Traffic and Airport Management	<u>EU projects covered in this TRS paper:</u> AD4, ATC-Wake, C-ATM Phase 1, EMMA, EMMA2, SPADE <u>Other EU projects for which the TRKC project has not yet received results, and which will be included in a future update of this TRS paper:</u> CAATS II, SINBAD, SUPER-HIGHWAY

4.2 Sub-theme 1: Urban Traffic, Public Transport and Mobility Management

4.2.1 Background

The sub-theme deals with traffic and transport management in urban areas, including mobility management and “soft” measures to influence transport use, as well as street and highway management and public transport management.

Research reported in the previous edition of this paper (EXTR@Web, 2006f) covered results of five mobility management related projects, as follows:

- Measures to promote pedestrian and cycle traffic (A9 [NRP 41]);
- Technological and operational tools to support car sharing (TOSCA);
- Benchmarking for urban transport, involving data and qualitative information for a range of indicators relating to the themes of behavioural and social Issues in public transport; cycling; demand management; and public transport organisation and policy (Urban Transport Benchmarking).

- Possibilities for using newer research in the development of policy interventions with the aim of breaking transport habits and promoting public transport (Breaking the habitual choice of the private car).
- Managing and financing of urban and regional transport in Europe (from the viewpoint of Hungarian solutions).

The EXTR@Web paper also covered results of three urban traffic management projects:

- Tools to provide an open systems framework supporting a wide range of urban traffic management strategies, using mobility management techniques (MOBISERVICE);
- Bus priority strategies and impact scenarios in large urban areas, including evaluation of actions in three cities and best practice guide (PRISCILLA);
- Real-time traffic signal management for urban areas (SMART NETS);

Research in this area focuses on many diverse issues. A major theme relates to mobility management and demand responsive public transport services.

4.2.2 Research objectives

A first set of research objectives in this sub-theme concerns policies on mobility management. A project on Mobility Management strategies (MOST) aimed to analyse existing strategies and their impacts, develop new innovative strategies and formulate policy and implementation strategies and scenarios based on analysis of framework conditions. The FAMS (Flexible Agency for collective demand responsive Mobility Services) trial project on Demand-Responsive Transport (DRT) aimed to improve DRT by addressing organisational and technical issues at the heart of this kind of transport model by improving communication, integration and co-operation amongst all the actors. It focused on scaling up technology, services and business models currently adopted in DRT and to support the evolution from single DRT applications towards the concept of a flexible agency for collective demand-responsive mobility services.

A Swiss project (D6/NRP41, Universität Bern, 2001) into sustainable transport management at holiday resorts looked at strategies in nine Alpine resorts (six in Switzerland and one each in Austria, Germany and Italy). The aim was to evaluate the process, stakeholder involvement and end-results in terms of traffic and environmental factors. Another national project, in Sweden (EMMA), evaluated measures for controlling private car use in metropolitan areas, another, 'The Attractive City' project' (TØI - Institute of Transport Economics, 2008) has examined the role of different drivers in urban planning and traffic management, while in the UK, the 'Integrated Transport Scheme in a Rural Area' project (Transport Planning International, 2005) examined the coordination required between different transport providers in a rural area in order to support local health services.

A second set of research objectives covered urban traffic management issues. Objectives included developing a network-wide, intersection driven model that will act as an intermediate layer which isolates the actual network infrastructure (OMNI project), and the analysis of combining management means (including tolling, parking and public transport measures) to decrease car traffic demand and the potential to decrease the congestion, environmental influence and the use of energy in the transport sector (“Synergy effects of management means to decrease congestion and environmental influence” project).

4.2.3 Research results

4.2.3.1 Mobility management and Demand-Responsive Transport

The MOST project developed a Monitoring and Evaluation Toolkit, providing different assessment methods, objectives and levels. Field test demonstrations were conducted, grouped into six thematic fields: educational institutions; tourism (rural areas or cities); health institutions (hospitals, centres for outpatients or disabled persons); site development (new or restructured sites like leisure or business parks); temporary sites / events (cultural and sports events, construction sites); and mobility centres / mobility consulting (for companies, cities or regions). The project proposed a best practice methodology for developing a mobility management plan, including phasing (start-up, stakeholder involvement, analysis, surveys, design of services and instruments, impact measurement, and assessment).

The FAMS project on Demand-Responsive Transport (DRT) successfully developed and implemented innovative public transport services and organisational platforms. In particular, the project developed a specific architecture based on a common service centre (sharing a number of services for planning, managing and monitoring the different type of flexible services), e-business services between the different actors involved (including operators and users), and a communications network based on GSM and GPRS technology.

The project on sustainable transport management at holiday resorts (D6/NRP41, Universität Bern, 2001) found that in the nine Alpine resorts studied, car traffic will grow by around 17% on average from year 2000 to 2015, with a detrimental effect on the environment, whereas local public transport is unable to absorb the increase without major expansion. The implementation processes, acceptance and impacts of traffic management schemes vary according to resort type. For example, health resorts are more aware of the negative effects of traffic than other holiday resorts, although guests in these resorts often have to rely more heavily on private vehicles because many of them are elderly or

physically frail. Consequently, in such resorts, the main focus is on comprehensive traffic restraint. “Upmarket” resorts attracting a larger percentage of guests with a high purchasing power see the implementation of well-designed traffic measures as an attraction, making the resort more pleasant. The percentage of excursion tourism also plays an important part: whereas traffic-restraint measures and pedestrianisation tends to benefit holiday guests and locals, they are often seen as obstacles to day visitors by car or coach. Traffic management measures need to avoid imposing undue restraints on local residents to be accepted by the community. Traffic restraint measures tend to be more favourably looked upon by staying guests in resorts with, for example, such measures in Gstaad in Switzerland being favourably received by 70–80% of guests.

The EMMA project in Sweden (Göteborgs Universitet, 2007) studied how car users evaluate and respond to three travel demand management measures: individualised marketing, road pricing and prohibition. Focus group interviews and web surveys were used, as well as actual data on travel pattern changes following introduction of road charging in the Norwegian city of Trondheim. It was shown that acceptance and adaptations were less for the coercive measures and that the adaptations followed a psychological cost-minimisation principle. However, whether more efficient car use, using public transport, or changing activity patterns were more attractive depended on age of the car users, type of trip (work, shopping, leisure), and type of demand management measure.

Also in Sweden, the competition between traditional traffic integration and its segregation according to road hierarchy has been examined within ‘The Attractive City - Traffic integration or segregation for the sustainable city’ (TØI - Institute of Transport Economics, 2008). This project sought to examine the interplay between the differing priorities and needs of various users and interest groups and examined their relationship with measurable factors such as traffic volumes and speeds. It also assessed how these can be reconciled in order to produce an ‘attractive city’. Key tasks in achieving these objectives were found to be the implementation of a number of operational and design measures:

- The definition of appropriate goals
- The creation of a land use and transport policy package to achieve required traffic volumes and environmental quality;
- Appropriate use of ITS to control traffic volume, speed and character;
- Creation of a public transport network to support sustainability;
- The creation of a two-tier car network: Highways and traffic calmed (low speed) urban roads and streets;
- The creation of an urban street network that improves the favours environmentally-friendly modes;
- Creation of more and bigger car-free zones;
- Significantly roles for park & ride and bike & ride.

Lastly, the 'Integrated Transport Scheme in a Rural Area' project (Transport Planning International, 2005), undertook a desktop study to examine the scope for synergies and savings between a number of Patient Transport services offered by different agencies and authorities, finding that a 30% saving could be achieved through greater coordination including greater flexibility, a better identification of patient needs and improvements in IT booking systems, leading to time saving both in transit and waiting, as well as increased capacity.

4.2.3.2 Urban traffic management

The project "Open model for network-wide heterogeneous intersection-based transport management" (OMNI, 2003) demonstrated the feasibility of integrated deployment of advanced Intelligent Transportation Systems (ITS) and applications in four pilot cities, overcoming the legacy constraints imposed by existing infrastructure, and developed a network-wide intersection-driven model which is generic, open and flexible. The technological approach to implementing the OMNI model facilitated the adoption of standard communication protocols, independence from operating systems; high level of scalability; and a distributed architecture.

The OMNI model is therefore able to carry out the following functions:

- managing information exchange among all the components of the model,
- monitoring of the physical status of the different devices (local controllers, sensors, subsystems) constituting the road infrastructure,
- defining a complete model of the network,
- creating a traffic control model,
- real-time updating the dynamic status of the entities present in the urban network,
- reporting in real-time the events produced and detected by the applications.

The OMNI model provides a good starting point for harmonisation of traffic management processes within European urban areas. Of particular note is the use of UML within the architecture design that is increasingly used within developing traffic management applications.

A Swedish project on synergy effects of management means to decrease congestion and environmental influence (Vägverket, 2003) analysed two scenarios for the city of Stockholm, combining tolls (urban road charging), workplace parking taxes, incentives for car sharing, and measures to increase the attractiveness of public transport and cycling.. The study compared a higher rate of toll (peak period price of 4 SEK – approximately €

0.38 – per kilometre) with limited additional measures with a scenario with a lower toll (peak period price of 2 SEK/km) combined with more comfortable and newer trains, more attractive public transport fares, more cycle lanes, etc. The study showed that the combination of different traffic and mobility management means should be included in analysis models and traffic prognosis used for infrastructure planning, so the effect could be compared with the effects from traditional infrastructure investments. The result also showed that a combination of the lower road toll combined with other management means to reduce congestion and encourage modal shift have almost the same effect on congestion than the twice as high toll does alone.

4.2.4 Policy implications

4.2.4.1 Mobility management and Demand-Responsive Transport

The MOST project showed that mobility management can successfully be triggered and implemented by various clients (most common are city or regional administrations or public transport providers), as long as they seek co-operation and good co-ordination. It can be applied in various thematic fields on a city or site level and can vary from local and very concentrated actions up to wider scale approaches covering whole regions. The project also made mobility management more accessible by giving more insight into its process, while providing evidence of positive impacts of mobility management, which include increasing the use of sustainable transport modes, increasing accessibility and modal choice, and addressing traffic and air quality problems. Further research was recommended on costs and benefits of mobility management, on links with non-transport policies (e.g. energy, health, the environment, housing, planning and the economy), and improvements using Information and Communication Technologies (ICT).

The results and implications of MOST can be compared with the MOBISERVICE CENTRE (“Mobility management service centres”) project, described in the EXTR@Web paper (EXTR@Web, 2006f). This project included guidelines and recommendations for the transferability of systems and services from one mobility management service centre, city or region to another.

Key implications from the FAMS project are that it is feasible to make DRT management interoperable within an e-business environment, allowing co-operation between transport providers. Different operators were able to benefit from a shared IT infrastructure and users benefit from a centralised service centre able to serve their travel needs in an integrated way. However the project also found significant structural barriers in both regulatory and institutional terms for widespread development of flexible agency related services for Demand-Responsive Transport. In order to understand the future viability of these mobility services, regular assessment and monitoring of patronage and revenue trends in the ongoing trials was recommended.

Regarding transport management in holiday resorts in the Alps, it is recommended that appropriate strategies, such as traffic or parking restraint, pedestrianisation or public transport improvements, be carried out in close consultation with residents and businesses. Transport management can also be effectively used as a product strategy, from containing the level of traffic nuisance to avoid losing existing clients, to shaping a new and well-marketed image for the resort. Further investigation is needed into the practical viability of the following four sets of measures:

- Bypasses and pedestrian areas;
- Comprehensive traffic restraint;
- Making local public transport more attractive;
- Operation and layout of public car parks.

Implications from the Swedish EMMA project on travel demand management indicate that coercive demand management measures (prohibition and road pricing) need to be combined with non-coercive (or “soft”) measures (information) to achieve public acceptance, effectiveness, and political feasibility. Furthermore, how car users adapt needs to be forecasted so that more effective adaptations (e.g., public transport use) are also made less psychologically costly.

The ‘Integrated Transport Scheme in a Rural Area’ project clearly demonstrated the need for greater co-ordination and better uptake of IT in managing transport services with better links to other door-to-door and conventional public transport services as well as centralised transport demand management at a higher level. This would enable greater savings of scale.

4.2.4.2 Urban traffic management

The OMNI project was technical in nature and did not produce policy implications. The project on tolling and other measures in the city of Stockholm showed that investments in public transport could be a way to use the receipts from urban road pricing. The receipts from the lower road toll proposed could finance a significant package of public transport improvements which, combined with the modest toll, could almost entirely eliminate traffic congestion in the city centre.

4.3 Sub-theme 2: Freight Traffic Management, Terminals and Logistic Chains

4.3.1 Background

The sub-theme brings together the sub-themes in the previous EXTR@Web TRS on Transport Management (EXTR@Web, 2006f) “Freight traffic management” and “Control and management of logistics chains”. Research reported in these sub-themes of the EXTR@Web paper covered a range of topics, including e-logistics and e-fulfilment (E-THEMATIC), asset management for railway freight wagons (F-MAN) and a decision support system for integrated door-to-door delivery (MOSCA). Further projects in the EXTR@Web paper dealt with a new, safe and rapid intermodal freight transport system across the Mid-Nordic countries with connection from East and West (NECL), research into the role of third party logistic service providers and their impact on transport (PROTRANS), and supply chain management, logistics and transport (SULOGTRA).

Other related actions have been carried out under the MARCO POLO programme for 2007 and 2008, particularly under the themes “Catalyst Actions” and “Common Learning Actions”. These projects tend to deal with freight logistics and aim to support European harmonisation measures. They are not covered in this paper however as they do not constitute applied research directly relevant to the transport management theme.

4.3.2 Research objectives

Research objectives are classified into two clusters. The first, at an operational level, deals with technical issues relating to logistics. In this cluster, research aimed to investigate, develop and validate an innovative ICT platform and schemes for improved management of freight distribution and logistic processes in an urban area (eDRUL). Another European project (IBOS) aimed increase the transparency of information in the logistic chain of perishable goods such as meat products. A Romanian project (GeCoTraM) aimed to develop an electronic system for container management, focusing on data exchange.

A second cluster deals with freight and logistics management at a more strategic level. This included research to further develop City Logistics Solutions (CLS) with a particular focus on medium-sized urban areas and cities in New Member States (BESTUFS II), to support intermodal freight transport by improving the management and exchange of

information between large and small stakeholders across business sectors, transport modes and administrations (FREIGHTWISE), to examine the potential for alternative freight routing strategies through the use of ITS (HeavyRoute), and research into improving the efficiency of freight flows across international borders (INTERFACE).

4.3.3 Research results

4.3.3.1 Technical aspects of logistics operations

The project “e-Commerce enabled Demand Responsive Urban Logistic” (eDRUL) investigated, developed and validated an innovative e-logistics platform and supported service models for improved management of freight distribution processes in urban areas. Strongly based on integration with e-Commerce/e-Business architectures and concepts, the solutions developed enable the management of available resources of the logistics system (fleets and available capacity, logistics platforms, goods collection and unload areas, routes, etc) in a way to realise flexible, demand-driven freight distribution schemes integrated within urban ITS. The ITS applications and enabling technologies used included web-enabled information and booking services for clients (B2C segment), information exchange, resource sharing for e-logistics operators (B2B segment), delivery notification and information through mobile phones and SMS, goods dispatching software for trip planning and optimisation of resources (i.e. vehicle capacity), in-vehicle display units and hand-held devices to support vehicle drivers and goods delivery operators tasks, vehicle location systems and long-range wireless communications. The concept was successfully tested in four European cities: Aalborg, Eindhoven, Lisbon, and Siena.

A project to develop a European integrated Info-Box system for improved food safety and logistics (IBOS) close the information gap that exists in the logistic chain for meat products between slaughterhouse and supermarket, in order to improve food safety. The project developed a plastic transport crate with an in-moulded transponder and optional temperature logger, numerous RFID applications (transponder technology, interface and communication software, etc) and a supply chain management system with local and central applications (software/hardware), as well as testing the integrated Info-Box system in three countries. These trials found that the IBoS system functions and processes fulfilled the requirements of paperless documentation of data for proof and origin, that use of the IBoS system leads to significant reductions in work steps (hand written entries, data input into data processing systems, etc) and that its use leads to a reduction of work of 8-10 hours a week at the butcher in the supermarket and saves 1 out of 5 workers at the refrigerated areas in the meat company. After this final pilot the info-Box System is ready for exploitation.

The project “Electronic system for container circulation management in multimodal transport for the European integration on the transport corridors across Romania” (GeCoTraM) developed web services in order to assure the message changes between the agents involved in multimodal freight transport at the container terminal level. These were based on XML / EDI (Extended Mark-up Language, Electronic Data Interchange) standards. The messages included special instructions regarding container handling, container pick-up notice instructions, pick-up instructions, container release order, container movement reporting, loading instructions, and so on. The system comprises components for system administration and components oriented on user services.

4.3.3.2 Strategic freight management and logistics

The project “Best Urban Freight Solutions II” (BESTUFS II, 2008) further expanded and strengthened a network of urban freight stakeholders that was developed in the previous BESTUFS project. BESTUFS II provided Best Practice Handbooks on waste transport logistics in urban areas, environmentally-friendly vehicles (experiments and incentives), control and enforcement in urban freight transport, and city access restriction schemes.

The study on a Management Framework for Intelligent Intermodal Transport (FREIGHTWISE) showed that the complex nature of booking freight services can be reduced to just four roles and six messages. The roles and messages form a framework which has been named the “Freightwise Framework”. This framework identified the four roles in intermodal transport as the Transport Service Provider, the Transport User, the Transportation Network Manager, and the Transport Regulator. The framework utilises six messages: Transport Service Description, Transport Execution Plan, Transport Execution Status, Transport Item Status, Transport Operation Status, and Network and Traffic Status. All the information that is necessary to publish, advertise, plan, book, execute and invoice an intermodal transport service is within these messages.

Nine regional business cases across Europe were tested, with each one identifying areas where FREIGHTWISE could improve their efficiency. For example, the Elbe business case, centred on a terminal in Hamburg, focused on integrating the status messages defined in the project into the LogIT D2D transport chain management tool. This enabled the project manager to follow up on the status of all transports, particularly with respect to the weight and dimensions of each load item, thus allowing efficient stowage.

FREIGHTWISE also developed a reference architecture for freight transport management systems. This architecture covers a set of common definitions and solutions which provide simplified exchange of messages between partners in the intermodal chain, mechanisms

for automating decisions, enabling technology for efficient exchange of scheduled information, integration of intermodal planning systems with the commercial environment, and interfaces to traffic management systems (e.g. for planning and incident management). This project is ongoing and by its end in April 2010, it will have provided a tool that allows Transport Users to search among the transport services published in a standard format by Transport Service Providers, and to combine them into transport chains.

INTERFACE (Improvement of intermodal terminal freight operations at border crossing terminal) was a demonstration project on innovative solutions to improve rail border crossing terminal operations, to reduce customs waiting time, increase safety, harmonise regulations and to develop additional functions to accommodate certain border crossing terminals. The project's demonstrators were at rail crossings between Austria and the Czech Republic, Spain and France, and Italy and Switzerland.

Border waiting times were reduced from an average of 82.5 minutes at the three sites to 61.5 minutes in March 2005. The expected reduction of 30 minutes per train was not fully reached, but the impact of the improvements initiated by the Austrian-Czech demonstrator was significant for Combined Transport (CT) trains in both directions. The percentage of CT trains that leave Breclav station in the Czech Republic with a delay of less than 60 minutes significantly to 75%. Together with general improvements in slot allocation, locomotive provision and fewer technical imperfections the demonstrator measures led to a situation where almost 65% of all departing CT trains have a delay of less than 30 minutes. Improvements were mainly influenced by the availability of improved information on intermodal transport train, leading to less manual data entry being needed, and faster processing of train documents. In the Czech case however, the impact of its accession to the EU during the course of the demonstration project must be taken into account, as that also contributed to a reduction of stop-over times at the border.

Freight operations are strongly dependent on routing strategies which need to be both economically advantageous as well as acceptable to local and national governments. This subject, and how it may be addressed by ITS has been examined by the "Intelligent Route Guidance of Heavy Vehicles" Project (HeavyRoute, 2006), which produced an advanced route guidance and advice system for trucks. Working with all the major stakeholders, the project has used electronic mapping systems to link road infrastructure and operational characteristic to the truck operators and drivers through the three applications based on vehicle/ infrastructure interaction. These have included:

- Pre-trip route planning – producing allowable routes based on 'HGV specific data', together with physical and legal restrictions on the Infrastructure, fuel

consumption, emissions, safety, driver comfort and infrastructure maintenance costs.

- Driving support – Real time driver warning and information to avoid critical situations (for example recommended speed to avoid roll-over).
- Monitoring and management of HGV's at bridges - for example advice on speed, minimum vehicle spacing and/or lane change to ensure appropriate loading.

4.3.4 Policy implications

4.3.4.1 Technical aspects of logistics operations

The eDRUL and IBOS projects were mainly technical, with few policy implications. However the solutions from eDRUL are able to benefit different city distribution scenarios and service models, including city distribution services in limited traffic areas (access restriction measures), consumer-driven goods delivery services using of dedicated infrastructure (e.g. pick-up or collection points), optimisation of deliveries through co-operation of networked transport service providers, and door-to-door delivery services to special user categories such elderly and disabled consumers. IBOS solutions form a good example in developing electronic tagging applications to track perishable goods in Europe with the option to harmonise electronic tagging applications at the procedural and technical levels.

The GeCoTraM project in Romania helped to create conditions for better integration of container multimodal transport information by assuring the transmission in real time of messages to all the business partners and information transparency at business partner level. This increases the efficiency and speed of multimodal transport, reduces costs and reduces the probability of misdirection of containers.

4.3.4.2 Strategic freight management and logistics

The BESTUFS II project made numerous policy and research recommendations, including the following which are the most relevant to the transport management theme:

- Achieving free-flowing towns and cities: Recommendation that any measures to control access or tackle congestion should be analysed regarding their implications for urban freight transport; and that further efforts are made pilot, promote and adopt measures to help improve the efficiency of urban freight transport.
- Air pollution, CO₂ and noise: Recommendation for urban authorities to review existing access restrictions to ensure there is a good technical rationale behind them; and that guidance on harmonised goods vehicle access rules be published by the EU.

- Smart urban freight operations: Recommendation on standardisation of formats and interfaces at the European level and better integration of local rules (delivery restrictions, etc) into digital mapping systems used for on-board navigation.
- Urban Consolidation Centres (UCCs – or city logistics schemes): Recommendation that policy makers ensure that UCC trials have sufficient support and funding to run for a period that allows proper measurement and analysis of results. UCC research and trials would not normally be able proceed without funding except in the case of new property or commercial developments: public funding support is therefore needed in these cases.
- Last mile solutions require further research support to develop innovative approaches (particularly telematic applications) and monitoring of solutions.
- Freight in small and medium-sized urban areas: Recommendation of research into comparing the nature and scale of freight transport solutions in different small and medium-sized urban areas.
- Port cities and innovative urban freight solutions: Recommendation to collect detailed information on transport flows related to ports and terminals and to estimate future port development in order to have a good basis for transport planning; and that guidance and preference systems for HGVs be implemented in port approaches, incentives be given for higher load factors, and that environmental zones, rail and urban distribution centres, etc be considered.

The simplification in booking proposed by FREIGHTWISE has implications for the management of intermodal freight in that, if the Freightwise Framework becomes a standard tool for managing intermodal transport (as is recommended by the project), the overall efficiency of intermodal transport; including transshipment and integrating facilities, will greatly improve. A standardisation process of the FREIGHTWISE systems under ISO Technical Committee 204 (Working Group 7: General fleet management and commercial freight) is foreseen.

The INTERFACE project concluded that from the railway operator's point of view, it is often more efficient to invest in data interoperability projects than in "hardware". Interfaces to and from involved actors have to be customised but the core system used for railway data exchange on a European level (HERMES) should not be changed. It is very important to integrate of the whole IT scenery at the railway companies, in order to be able to provide reliable information on intermodal transport.

The possibilities of transferring the solution were shown by the two railway companies in the Austrian/Czech demonstration (ÖBB and ČD), both of which use the developed tools already with most of their neighbouring railways. This emphasises the market potential of the solution: it has a high acceptability among all involved actors and it could be easily transferred to other locations or organisations. Better and more reliable information flows

contribute towards railway interoperability and improve the competitiveness of railways in the international freight transport sector. It should be noted that several similar projects are also deployed at cross-border level and funded under the MARCO POLO programme.

4.4 Sub-theme 3: Road Network and Traffic Management

4.4.1 Background

Research reported in the previous paper (EXTR@Web, 2006f) in this field of covered results of two “Euro-Regional” TEN-T projects studying and implementing traffic management, user information and other measures on the Trans-European Road Network. The two projects showcased in the EXTR@Web paper were CENTRICO and STREETWISE, which between them covered the Benelux countries, Northern France, Western Germany, the UK and Ireland. Other closely related projects in other parts of Europe (now part of the larger ongoing EasyWay project) are ARTS, CORVETTE, SERTI, VIKING, CONNECT and ITHACA.

4.4.2 Research objectives

A first set of research covered traffic and safety applications. This included the development of traffic and safety monitoring techniques, including use of data fusion, to assist network operation (INTRO project), and research on speed limits (REVEL) and adaptation policies (PROSPER).

A second set covered traffic and road network strategies, including traffic management strategies for long distance corridors (LDC) and for secondary road networks (SENSOR).

4.4.3 Research results

4.4.3.1 Traffic and safety applications

Among other research activities, the Intelligent Roads (INTRO) project looked at traffic and safety monitoring issues for road network management. Pro-active traffic management relies on up-to-date information about the state of the road network. More accurate estimation and prediction of road traffic conditions utilising all data sources is becoming essential to reduce congestion and increase traffic safety.



Travel time estimation was one area of work, which quantifies traffic condition in a way that is easy to understand and prompts users to utilise the alternatives in case of congestion, thus contributing to greater network efficiency. INTRO advanced the state-of-the-art for travel time information (based mainly on fixed sensors) by using data from probe vehicles (floating car data – FCD), data from urban road networks and data from toll stations on French motorways.

At present, incident detections take place after the occurrence of an incident. It would be more useful to detect the traffic risks on the network prior to an accident. INTRO therefore investigated the possibilities of indicators to measure traffic risk and then to inform the drivers about the risk and to manage the traffic risk. The data input for this detection comes from both fixed and mobile sensors. Two types of safety indicator were developed, the individual braking time risk and the platoon braking time risk.

The Spanish project REVEL aimed to achieve a method for setting adequate speed limits tailored to each road section. It conducted theoretical studies and data analysis including real accidents and speeds, many of them coming from pilot sections selected for this purpose. Based on actual speed measures obtained from different selected road sections, a new methodology for modelling a speed profile was derived, representing both space and time speed distribution. In addition, a new method for modelling a safety profile from speed measures was developed. This is related to the specific design features of road sections (with its inherent own risk factors) which results in its own accident record. Both the safety profile and the speed profile were compared and a set of specific safety criteria has been obtained for each road type. Road managers therefore have at their disposal a tool for setting speed limits in a rational way, and for relating them to the design speed

PROSPER (Project for Research on Speed Adaptation Policies on European Roads) project used laboratory experiments (driving simulator) and field studies (in Hungary and Spain) in combination with interviews and surveys to collect information and develop new knowledge concerning Intelligent Speed Adaptation (ISA). It concluded that physical speed management measures are suitable for spot-based speed reduction, but are inefficient in generating network effects. They should therefore be seen as complementary to ISA, not an alternative. ISA can contribute to better road safety without increasing travel time, by reducing speed variance, and accident reduction is in the order of 20-40% depending on the deployment characteristics. Other benefits are reduced noise and exhaust emissions, in particular in urban areas. Furthermore, trials in the project showed that mandatory (intervening) systems bring a more substantial effect than only informative (Speed Alert) systems. The design of the driver interface is the key to the long term safety effect.

traffic flow and lessen the chances of accidents due to “surprise” effects (such as sudden changes in road geometry, road surface, weather conditions or traffic conditions). Reliable and timely data is the key to effective road traffic management and this project which developed some innovative concepts based on existing technology should be followed up with larger scale tests. A key area not looked at is that of business case aspects: who pays for improved information, the road operator or the driver? If it is the latter, then there is a risk that increased safety may only be available for those willing to pay more by having in car monitoring and display equipment – on the other hand widespread application of systems and services will ensure that the price falls.

The REVEL project allowed a geometric restitution of the trace made by the vehicles in each direction to be made, as well as obtaining the road geometry and observed speed profiles to be improved. The policy implications are related to the assessment by authorities for the application of speed limits depending on the characteristics of the road, thus providing a tool for network managers to implement more appropriate speed policies.

ISA (PROSPER project) can contribute greatly to road traffic management by reducing accidents and increasing the efficiency of traffic flow, through reducing the speed variance of vehicles. A current limitation is that many countries and regions do not have information on speed limits available in a format suitable for ISA and there is presently no functioning method for collection and distribution of speed limit information for cross-border applications. In addition, evaluation studies have found that the more intruding and controlling an ISA system is, the less it will be accepted by the drivers. At the same time, however, the more intruding and controlling, the greater the effects on speed and on traffic safety in general. These are the key barriers to ISA deployment, thus making gradual market deployment of such systems a good approach.

4.4.4.2 Traffic and network management strategies

The experiences in the LDC pilot and demonstration projects have shown the potential benefits of co-operation in managing traffic on cross-border road corridors and provide guidelines to network managers on how to start co-operation and co-ordinated actions from a situation where co-ordination is currently low or non-existent. These include institutional issues such as who to involve, the roles of each partner, and different problems, approaches and legal situations in neighbouring countries.

Increasing European integration has led to greater cross-border traffic and in many cases (e.g. within the Schengen zone), the virtual disappearance of borders. It is therefore essential that “border effects” caused by different approaches by neighbouring road network operators are also eliminated. This does not require an identical approach to traffic management, ceding an operator’s responsibilities or changing national legislation

and procedures, but rather the adoption of pragmatic approaches such as Memoranda of Understanding on co-operation and co-ordination procedures such as sharing and dissemination of data and traveller information and a procedure to deal with incidents, closures, bad weather, diversions, etc, including the decision chain on each side of the border and on other upstream and downstream networks. LDC measures allow the traffic flow to be positively influenced by interregional diversions, thereby helping to achieve a better distribution of the traffic on the network, as well as preventing or reducing traffic congestion, which benefits the economy, road safety and the environment.

The focus is therefore on “quick win” solutions. This will contribute to EU objectives regarding the TERN (Trans-European Road Network) that a continuous level of service shall be provided, including seamless cross-border services.

The traffic management strategies for secondary road networks developed by the SENSOR project were above all a guide to operators, so do not generate policy implications as such (implications and recommendations are organisational and technical). There is however increased interest by local road authorities in traffic management tools which match their needs and budgets, and the exploitation of the results of this project is a process that can be carried out over the next decade, as the nature of the results enables the incorporation of new technologies – enhanced simulation capabilities in the road management framework – without substantial additional effort.

This coupled with current cross-border traffic management strategies and the use of support tools between road operators on the TERN could form a good basis for integrating TERN management with urban areas.

4.5 Sub-theme 4: Rail Network and Traffic Management

4.5.1 Background

The sub-theme into rail traffic management provides additional projects to those covered in the previous EXTR@Web paper, which covered improved tools for railway capacity and access management (IMPROVERAIL), maintenance and management of railway Infrastructure (PROMAIN), and safety management in railways (SAMRAIL).

More recent projects cover rail maintenance, path allocation, rail freight on an intermodal corridor and punctuality.

4.5.2 Research objectives

A first cluster of projects deals with maintenance aspects contributing to transport management for railways. These include an open maintenance system for railways (EUROMAIN project) and a reliability-centred maintenance approach (RAIL project).

A second cluster covers operational aspects, including path allocation re-engineering (PARTNER), incentives for increased rail punctuality (a Swedish national project) and a freight action strategy for the Brenner rail corridor (BRAVO).

4.5.3 Research results

4.5.3.1 Maintenance aspects

The EUROMAIN project (European Railway Open Maintenance System) intended to fully define and specify a complete maintenance support system for railways. It contributed to technical specifications for interoperability and European standards by designing an architecture and standard platform of the European Diagnostic Data Network, including data formats and diagnostic database. It also provided a standard specification of the European Technical Documentation Network for maintenance. Project participants successfully demonstrated their hardware and software prototypes on trains from three different manufacturers in three countries. In France the platform was demonstrated on an SNCF train produced by Alstom, in Austria the operator was ÖBB with a train from Siemens, and in Italy the Trenitalia train was manufactured by Bombardier.

The RAIL project (Reliability centred maintenance Approach for Infrastructure and Logistics of Railway Operations) developed, implemented and evaluated RCM (Reliability Centred Maintenance) analysis on various types of track circuitry, axle counters, point machines, signals and interlocking devices. The project produced a state-of-the-art report covering RCM, safety, regulations and machines used in railway infrastructure in four European countries. It went on to propose a list of maintenance tasks through the RCM Task Selection, in order to simplify decision-making on the part of maintenance operators.

The criticality of railways' sections and components was assessed in order to improve understanding of the part played by each component and potential weaknesses. Criticality of a railway section (in five classes, from non-critical section to highly critical section) was based on six criteria:

- Technological complexity of maintaining the section;
- Economic revenue;
- Traffic density;
- Availability (including whether single/double track);
- Exploitation (operational factors including train type mix);
- Maintainability and costs (technical and process complexity).

A RAIL Toolbox was developed, which described maintenance tasks in order to improve the effectiveness of the task of maintenance operators. This is a first applicable internet-based tool for performing RCM analysis in the field of railway infrastructure, and can be applied to all infrastructure components.

4.5.3.2 Operational aspects

The PARTNER project provided an assessment of the state-of-the-art in European rail timetable planning. Following an overview of user requirements and the development of technical specifications, including capacity and charging aspects, the project produced a demonstrator targeted both at Infrastructure Managers (IM) and Railway Undertakings (RU). It aimed to meet their differing requirements, e.g. the IM needs a system to speed up the slot allocation process and to co-ordinate international routes, which is linked to legacy systems of timetable design; whereas the RU requires flexible and transparent means to place their requests to the IM for train paths and to receive an immediate response. The system developed and demonstrated is an interface and shared working area based on commercial software utilities as well as new data exchange standards based on XML formats. It is therefore complimentary to current timetable design systems in Europe, and does not replace them.

The demonstration showed that it is possible to achieve better support in IM-to-IM co-operative planning, data standardisation, utilisation of more advanced methods for capacity allocation, standardised European methods for formulating track access fees, improved support for “border/delivery” time negotiations, closer integration between Timetable Domestic Systems, and increased performance of the overall timetable process on international rail corridors.

A national project by the Swedish National Rail Administration, called “Incentives for increased rail punctuality – State-of-the-art and means of development” (Banverket/TFK, 2005), carried out theoretical studies of punctuality, bonuses and penalties in Sweden. Interviews with ten stakeholder organisations in that country (rail and public transport authorities and train operating companies in Sweden) revealed great interest in incentive models as a tool to achieve improved train punctuality. Not all of the operators were satisfied with the results from the models tested, the main problem being the difficulty in

finding out and agreeing on the major cause of a delay, hence the difficulty in determining who is responsible.

A sufficiently strong relation between the incentive model in use and increased punctuality has not yet been proved. While most of those interviewed believed the attempts so far in working with incentive models have brought the problem into focus and have had a positive impact on rail punctuality on the whole, there was a view that penalty for delays is too high and ought to be based on business economic calculations.

A project for a Brenner Rail Freight Action Strategy (BRAVO, 2007) developed and demonstrated several components for conventional rail freight and intermodal services on the Brenner Corridor (railway line between Munich and Verona via Austria). This involved an open corridor management scheme, with interoperable rail traction (multi-current electric locomotives), a quality management system and an advanced customer information system.

4.5.4 Policy implications

4.5.4.1 Maintenance aspects

EUROMAIN was a technical project without direct policy implications, but it has provided the baseline for a new FP6 project called INTEGRAIL. This new project has a broader scope than EUROMAIN, and aims to create a holistic, coherent information system that can integrate the major railway sub-systems and deliver a higher level of co-ordination and co-operation between key railway processes.

From the RAIL project, successful application of RCM requires a good understanding of the equipment and structure, and the associated systems, subsystems and items of equipment, together with the possible failures and their consequences. The Toolbox developed in the project should allow greater efficiency, cost savings and safety gains in the maintenance of railway infrastructure equipment.

4.5.4.2 Operational aspects

The demonstrator in the PARTNER project will be further developed under the name ROMAN Cross Border, and a pilot test installation between RFI (the Italian rail infrastructure company) and ÖBB (Austrian Railways) is aimed at. The project has produced a system that, if widely used, will bring numerous benefits to the rail industry in terms of competitiveness and market share, brought about by more flexible, responsive and accurate slot allocation, transparent charging, moving towards meeting UIC (International Union of Railways) initiatives in timetable planning, assisting short term

requests for paths and introducing bid standardisation across EU railways. This should have follow-on benefits for train operators and customers, e.g. improved network capacity, easier access to infrastructure and reduced transport costs.

Despite some shortcomings in the rail punctuality incentive models, the Swedish research project by Banverket determined that it was possible to deal with the gaps identified and that there was good reason to continue the development since the models can function as a tool for the operators to reach better punctuality. Next steps identified were improvements to the incentive models, especially through a greater precision in handling the cause of disruption, involving actors in the field who are affected by the disturbances on a secondary basis, and developing incentives for specific critical punctuality moments.

The approach developed by the BRAVO project is in line with the European policy goals of liberalisation and interoperability, and integrates infrastructure, technical, legal and operational aspects due to a more flexible timetable management. The project lays the foundations for achieving a significant increase in the volume of intermodal freight on the Brenner corridor and can be seen as a blueprint applicable to other European corridors. The project included the development of an information system for combined transport which includes Europe-wide services of intermodal operators and other co-operation partners. Following the end of the project, this tool is now in commercial operation². The project showed that improving quality and efficiency can bring about a considerable growth in combined transport.

4.6 Sub-theme 5: Maritime and Inland Waterway Traffic and Port Management

4.6.1 Background

As most maritime and inland waterway research projects focus on port operations, handling, intermodality, vessels and safety, the number of projects directly related to management of vessel movements is limited. Research into waterborne transport management reported in the EXTR@Web paper was a regional initiative under the INTERREG III programme focusing on inland transport on sea routes, i.e. links to and from ports (INTRASEA project). In addition, the WATERMAN-TS project provided a technical secretariat for a range of waterborne traffic and transport projects.

² See: www.kombiverkehr.de/web/Englisch

4.6.2 Research objectives

Three projects looked at maritime operations. Firstly, an EU FP5 project on Tele-maintenance and support through intelligent resource management for ship operation (TELEMAS) aimed to raise the quality, safety and efficiency of vessel operation by exploiting available IT technologies and tools to implement an intelligent ship operation concept. Secondly, a Greek project (OPSPEMAPT) looked at the organisation of port services production and efficiency management. This project aimed to identify the qualitative and quantitative specifications of the efficient organisational, functional and administrative characteristics, which should be acquired by passenger terminals at ports.

The ARCOP (2006) project aimed to design a new route for shipping Russian oil and gas. This alternative route was to be set after a careful examination of the transport chain's technology-based cost-efficiency, as well as taking into account environmental and other risk factors.

A further project dealt with inland navigation. This was a national project in Slovakia which aimed to provide a base for preparing the application of a River Information Services (RIS) system for the country's inland waterway system, focusing on building up a RIS test centre (RISVD project).

4.6.3 Research results

4.6.3.1 Maritime transport

The TELEMAS project produced, among other outputs, an integration middleware platform, a Safety Management System, a Remote Maintenance Platform and e-learning modules and concepts. These make up a virtual database providing the vessel command and ship owner with accurate and timely vessel and operation information, consisting of coupled data from various sources.

The OPSPEMAPT project studied Piraeus port in Greece and identified distortions in port economics because public and private actors involved in port operations (either as service providers, or port users) do not assume responsibility for a proportion of the costs of port operation at a proportion that equals their benefit from the operations. The scientific research on quality management in ports provided a framework that may reveal opportunities to the practitioners and the decision makers within the port industry in resolving current quality issues.

The ARCOP project proved that Russian oil and gas transportation by a Northern Sea Route is technologically possible and economically feasible. In so doing, ARCOP set up and applied the following strategic objectives to the Arctic Sea area, which were necessary for maritime route design:

- Clarify the regulatory basis of the considered region's shipping practice,
- Define a common understanding of the legal status of the Arctic sea routes
Define the economics of the considered region's shipping practice: duty fees, border formalities, identification of economic actors.
- Identify the correct technical requirements concerning the vessels operating along the considered route.

4.6.3.2 Inland waterways

The RISVD study analysed the situation regarding River Information Services in the Slovak Republic, proposed the structure of a national RIS test centre and costed it. The study took into account not only the conditions contained in the forthcoming EU RIS Directive and the policies of other multi-national bodies, but also the geographical and administrative prerequisites in the Slovak Republic.

4.6.4 Policy implications

The waterborne transport management projects covered in this paper were technical in nature and did not produce policy implications. The Slovak study did however provide the base for the implementation of the RIS Directive on the country's inland waterway system, and the Greek study should lead to a fair distribution of costs for port services production and provision between the public and private sector, thus helping to eliminate existing market distortions in the port industry. Lastly, the ARCOP project formed a basis for the work carried out by the Arctic Council in the setting of the Arctic Marine Shipping Assessment (2005-2008), emphasising future developments regarding safety and environmental issues.

4.7 Sub-theme 6: Air Traffic and Airport Management

4.7.1 Background

Air traffic management and airport management is a new sub-theme that was not included in the previous EXTR@Web TRS on traffic management, and has been included here in order to ensure that the paper reflects traffic management research across all transport modes.

Note that many airport and Air Traffic Control / Management (ATC / ATM) projects, while relevant to the transport management theme, are highly technical and involve research into specific systems and sub-systems, therefore only a small selection of less technical projects are included in this paper. Other related projects can be found in the TRS on Air Transport (EXTR@Web, 2005c).

4.7.2 Research objectives

One area of research was Co-operative Air Traffic Management where a project aimed at refining and assembling the most promising areas of recent research so far developed through EATMP, EC and/or National programmes (C-ATM project, Phase 1). The objective was to integrate these elements into one overall, fully inter-operable and integrated air/ground concept of operation, ensuring both operational and technical coherency. Another project (AD4) worked to enhance a 3D virtual reality system, called D3 (D-cube), for the real time visual representation and manipulation of data in the field of Air Traffic Management and Control, both in open space (particularly in the approach phase) as well as at the airport level. A further EU project developed an Integrated Air Traffic Control wake vortex safety and capacity platform (ATC-Wake). Two other related projects looked at Advanced Surface Movement Guidance and Control at airports (EMMA and EMMA2).

Airport management is another focus of research, where the SPADE project aimed to develop a decision-support system for airport stakeholders and policy-makers, to support airport development, planning and operations.

4.7.3 Research results

4.7.3.1 Air Traffic Management

The C-ATM Phase 1 project defined medium-term operational concepts for Air Traffic Management and also defined high level specifications from interoperability specification and high-level architecture. Thirdly, it defined a validation plan, certification documentation, and implementation/transition themes. A cost-benefit analysis was also undertaken.

C-ATM Phase 1 furthered the state of the art in the areas of integrated operational concepts, refining network operational plans, and 4-D trajectory exchange principles and collaborative flight management, compatibility between 4-D and ASAS, and also succeeded in organising a wider community of air service providers. A specific mention should be made of the C-ATM User Group which was set up by a group of air navigation service providers and airlines alongside the project team. This greatly helped the project to obtain the buy-in and endorsement of airspace users and key ATM actors in Europe that was necessary for success.

The AD4 project (AD4, 2007) developed a 3D air situation display (3D radar picture) based on the representation of visual elements within a purely synthetic 3D Virtual Environment. Such virtual environment provides a 3-dimensional perspective display of the ATC controlled sector. This environment, called “D3” (D-cube), is a 3D Virtual Reality system for real time visual representation and manipulation of geo-referenced data such as terrain, meteorological data, telemetry data, GNSS (satellite), surveillance data (radar tracks) and flight plan data. An Augmented Reality (AR) “D4” technology and demonstrator was developed (combining 3D space with time), to prove applicability of the AR visualisation technology in the development of an HMI for tower controllers. New elements included in this include aircraft labels and time-related visual elements, e.g. future position of aircraft, acceleration, etc, that can provide additional information to the user about the real scene being observed.

The ATC-Wake project (ATC-Wake, 2005) developed an integrated platform for ATC (Air Traffic Control) that will allow variable aircraft separation distances, as opposed to the fixed distances presently applied at airports. This requires dealing with the issue of Wake turbulence (i.e. the vortex created behind an aircraft when landing or taking off), which why, for safety reasons, large fixed separations between aircraft are required.

A variety of existing subsystems were integrated within the ATC-Wake Integrated Platform, which was used to evaluate the interoperability of the ATC-Wake system with existing ATC systems in use at various European airports, to assess the safety and capacity improvements that can be obtained by local installation of this integrated system, to evaluate operational usability and acceptability of the ATC-Wake system and to plan and to assess cost elements for further development, implementation and exploitation. The system comprises four components: ATC-Wake Separation Mode Planner, ATC-Wake Predictor, ATC-Wake Monitoring and Alerting, and ATC-Wake Detector. It was shown that the functional integration of the components is successful and it will be technically feasible to integrate Wake vortex prediction/detection information into existing ATC systems.

This platform is a key step that will lead to installation of an integrated ATC decision support system at airports, enabling air traffic controllers to apply new optimised (weather based) aircraft separation.

The EMMA project (European airport Movement Management by A-SMGCS) and its follow-on projects EMMA2, led to comprehensive results that supported the regulation and standardisation bodies, as well as industry, in the early and efficient implementation of A-SMGCS (Advanced Surface Movement Guidance and Control System). The project set de facto standards for A-SMGCS systems and their operational usage and streamlining of existing products, and validated them at test beds in three airports (Milan, Toulouse and Prague). The concept incorporated surveillance, control, routing and guidance services as well as new onboard-related A-SMGCS services.

4.7.3.2 Airports

The SPADE project (Supporting platform for airport decision-making and efficiency analysis) developed a supporting platform for airport decision-making. This was a system design comprising elicitation of use cases (decision-support requirements of stakeholders), system specification, specification evaluation, design, and design validation.

Demand and supply-side analyses were conducted regarding tools for assisting airport-domain experts. These resulted in a prioritised list of potential use cases for the SPADE system. The supply-side analysis prepared a list of state-of-the-art decision-support tools and a structured template for a systematic description of these tools. Each of the identified tools was described, addressing its capabilities, integration constraints and requirements, as well as its potential contribution to the SPADE system. The demand-side survey and the supply-side analysis were then matched and analysed to determine existing tool

combinations that can be used and integrated in order to perform the elicited use cases. This resulted in a list of 18 use cases for possible implementation in the SPADE system. These comprised "Strategic" use cases (providing decision-support for a medium or long-term time horizon through the use of macroscopic, low level-of-detail tools); and "Operational" use cases (providing decision-support for a short- to medium-term time horizon through the use of microscopic, high level-of-detail tools).

Examples of the tools developed for strategic use are a flight schedule generator, an airport capacity and delay analysis tool and a landside capacity and delay tool. Examples of tools for the operational use cases are a runway occupancy planner, a fast-time airside simulation tool (for aircraft flows), a fast-time landside simulation tool (passenger flows), a noise model and a cost-benefit model.

4.7.4 Policy implications

4.7.4.1 Air Traffic Management

C-ATM has explored ground that will pave the way for SESAR (Single European Sky implementation) and other future R&D initiatives in Air Traffic Management. The project explored the limits in concept areas that will be utilised in future ATM development within the SESAR project context. Implications are technical rather than policy-oriented, with the project having pushed state-of-the-art one step further in several areas of ATM including integrated operations concepts, refinement of Network Operations Plans, refinement of 4-D trajectory exchange principles and collaborative flight management, etc, as well as bringing together a wider community of airlines and air navigation service providers.

The AD4 project results contributed to SESAR (Single European Sky) air traffic management objectives, including increasing safety and security and reducing operating costs. An effective use of 3D technologies for the ATC has to take into consideration the integration of 3D displays with the (existing) 2D air situation display by the provision of 2D-3D combined Air Traffic Control displays. The need of such combined display arises from the fact that while 3D representations improve local situation awareness, pure 3D visualisation tends to be disruptive for controllers global situation awareness. The solution to this problem consists of conserving a global 2D display while properly integrating in it appropriate 3D displays.

The ATC-Wake project made significant steps towards assessing the safety implications of wake vortices (turbulence) generated by aircraft when landing or taking off, in terms of allowing variable spacing between aircraft according to meteorological conditions. This would contribute to Air Traffic Management by increasing the capacity of airport runways.

However, although the project showed that integrating wake vortex prediction/detection into existing ATC systems is feasible, it also concluded that wake vortex phenomena during departures is still not fully understood, and further research is needed before the outcome of the departure safety assessment will be ready for approval by regulatory authorities. Further validation, including safety, HMI and technology cases and shadow mode field trials, are therefore recommended.

The EMMA and EMMA2 projects are important milestones towards a Europe-wide introduction of A-SMGCS in order to increase the safety, the throughput and the efficiency of airports in compliance with EUROCONTROL, and in view of a worldwide ICAO standardisation. Both projects support the SESAR Single European Sky initiative. Air navigation service providers, airports and airlines now need to investigate local implementation needs for higher level A-SMGCS services.

4.7.4.2 Airports

The SPADE project contributed to improved decision-making process quality and homogenising decision-making at a European level through standard use cases related to airports. Stakeholders were positive towards the system and it was perceived as user-friendly, but a need was identified to clarify how it would fit within an organisation and on business models. The main contributions of the system to transport management objectives are to support airport managers in their strategic and operational roles, to support modelling decisions, increase the efficiency of operations, to assist in the management of environmental aspects by specifying noise exposure and potentially to contribute to safety and security through risk assessment analysis tools. Its wide adoption can also contribute to standardising and harmonising airport-related technology, operations and procedures at a European level, thus improving interoperability – an essential goal in air traffic and airport management given its major international dimension.

4.8 Implications for further research

This section summarises implications and recommendations for further research, based on some key outputs of the projects reviewed.

Congestion, conventional pollution, health damage and accidents are largely concentrated in urban areas and need to be addressed in an integrated way. EU-sponsored research is continuing into the formulation and exchange of best practice in areas such as transport infrastructure, norm-setting, congestion and traffic management, public transport services, infrastructure charging, urban planning and safety issues.

Projects and implementations require the close co-operation of many industry partners and this is particularly the case with air and rail transport, where close working between different infrastructure providers, traffic managers and operators is essential in managing traffic efficiently and safety, while providing seamless services to the end user.

Finally, the roles of the various European Technology Platforms should be mentioned in the context of future research plans and strategies. ERTRAC, ERRAC, WATERBORNE^{TP}, ACARE and EIRAC, the European advisory councils for road, rail, waterborne, air and intermodal transport respectively, have produced Strategic Research Agendas into their respective modes, which include proposed actions related to traffic management as well as other aspects (ERTRAC, 2004; ERRAC, 2007; WATERBORNE^{TP}, 2006, ACARE, 2004 and EIRAC, 2005). Websites for these five technology platforms are given in the Annex under the relevant sub-theme (mode).

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Annex: List of projects by sub-theme

Sub-theme 1: Urban Traffic, Public Transport and Mobility Management				
Project acronym	Project title	Programme	Project website	Coverage
A9 (NRP 41)	Pedestrian and Cycle Traffic	National (Switzerland): National Research Programme 41	none	Covered in EXTR@Web paper
CITYMOBIL	Towards Advanced Road Transport for the Urban Environment	FP6 – SUSTDEV-3 – Global Change and Ecosystems	www.citymobil-project.eu	In future TRS if reports become available
D6 (NRP 41)	Sustainable Transport Management at Holiday Resorts	National (Switzerland): National Research Programme 41	none	This paper
EMMA	Evaluation of Measures for Controlling Private Car Use in Metropolitan Areas	National (Sweden): Formas programme	none	This paper
FAMS	Flexible Agency for collective demand responsive Mobility Services	FP5 – IST – KA1: Systems and Services for the Citizens	www.famsweb.com	This paper
ISCOM	Information Systems for Combined Mobility Management in Urban and Regional Areas	FP5 – IST – KA1: Systems and Services for the Citizens	www.ssp-consult.de/iscom	In future TRS if reports become available
	Integrated Transport Scheme in a Rural Area	National (UK): DfT - Accessibility & Equalities Unit	none	This paper
MOBISERVICE	Mobility Management Service Centres	FP5 – IST – KA1: Systems and Services for the Citizens	none	Covered in EXTR@Web paper

Sub-theme 1: Urban Traffic, Public Transport and Mobility Management				
Project acronym	Project title	Programme	Project website	Coverage
MOST	Mobility Management Strategies for the Next Decades	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	website no longer active	This paper
OMNI	Open Model for Network-wide heterogeneous Intersection-based transport management	FP5 – IST – KA1 “Systems and Services for the Citizen”	website no longer active	This paper
PRISCILLA	Bus Priority Strategies and Impact Scenarios Developed on a Large Urban Area	FP5 – IST – KA1 “Systems and Services for the Citizen”	www.trg.soton.ac.uk/priscilla	Covered in EXTR@Web paper
SMART NETS	Signal Management in Real Time for urban traffic Networks	FP5 – IST – KA1 “Systems and Services for the Citizen”	www.smart-nets.napier.ac.uk	Covered in EXTR@Web paper
SUCCESS	Smaller Urban Communities in Civitas for Environmentally Sustainable Solutions	FP6 – SUSTDEV-2 – Sustainable Surface Transport	www.civitas-success.org	In future TRS if reports become available
TOSCA	Technological and Operational Support for Car sharing	FP5 – IST – KA1 “Systems and Services for the Citizen”	www.atc.bo.it/tosca/deliverable7_1.pdf	Covered in EXTR@Web paper
-	Breaking the Habitual Choice of the Private Car	National (Denmark): TRIP	none	Covered in EXTR@Web paper
-	Managing and financing of urban and regional transport in Europe from the viewpoint of Hungarian solutions	National (Hungary): KOZ – KMUFA	none	Covered in EXTR@Web paper

-	Synergy effects of management means to decrease congestion and environmental influence	National (Sweden): SRA-Vägverket	none	This paper
	The Attractive City - Traffic integration or segregation for the sustainable city	National (Sweden): SRA/Vägverket 2000-2009 - SRA Research and development programme 2000-2009	none	This paper
-	Urban Transport Benchmarking Initiative	DGTREN – Miscellaneous projects	www.transportbenchmarks.eu	Covered in EXTR@Web paper

Sub-theme 2: Freight Traffic Management, Terminals and Logistic Chains				
Project acronym	Project title	Programme	Project website	Coverage
BESTUFS	Harmonisation of strategies and highlighting best practice to determine optimum Urban Freight Solutions (Thematic Network)	FP5 – Growth – KA 2 “Sustainable Mobility and Intermodality”	www.bestufs.net	Covered in EXTR@Web paper
BESTUFS II	Best Urban Freight Solutions II	FP6 – PTA 2 “Information society technologies”	www.bestufs.net	This paper
eDRUL	e-Commerce enabled Demand Responsive Urban Logistic	FP5 – IST – KA1 – Systems and services for the citizens	www.edrul.org	This paper
EIRAC	European Intermodal Research Advisory Council	FP7 – Sustainable Surface Transport	www.eirac.net	Not covered as it is not a research project

Sub-theme 2: Freight Traffic Management, Terminals and Logistic Chains				
Project acronym	Project title	Programme	Project website	Coverage
E-THEMATIC	Thematic Network on e-Fulfilment	FP5 – IST – KA1 – Systems and services for the citizens	none	Covered in EXTR@Web paper
F-MAN	Rail Car Asset Management	FP5 – IST – KA1 – Systems and services for the citizens	none	Covered in EXTR@Web paper
FREIGHTWISE	Management framework for Intelligent Intermodal Transport	FP6 – PTA 6 “Sustainable Development, global change and ecosystems”	www.freightwise.info	This paper
GECOTRAM	Electronic system for container circulation management in multimodal transport for European integration on the transport corridors across Romania	National (Romania): RELANSIN	none	This paper
HeavyRoute	Intelligent Route Guidance for Heavy Vehicles	FP5 – Growth, Key Action 3 “Land Transport and Marine Technologies”	http://heavyroute.fehrl.org/	This paper
IBOS	European Integrated Info-Box System for improved food safety and logistics	FP5 – IST – KA1 – Systems and services for the citizens	none	This paper
INTERFACE	Improvement of intermodal terminal freight operations at border crossing terminal	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	none	This paper
MOSCA	Decision Support System for Integrated Door-to-Door Delivery: Planning and Control in Logistic Chains	FP5 – IST – KA1 – Systems and services for the citizens	www.idsia.ch/mosca	Covered in EXTR@Web paper

NECL	North East Cargo Link	INTERREG III	www.necl.se	Covered in EXTR@Web paper
PROTRANS	The Role of Third Party Logistics Service Providers and their Impact on Transport	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	none	Covered in EXTR@Web paper
SULOGTRA	Supply Chain Management, Logistics and Transport	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	none	Covered in EXTR@Web paper
TASKU	Tracking and Tracing of Freight Transport	National (Finland): VALO	none	Covered in EXTR@Web paper

Sub-theme 3: Road Network and Traffic Management				
Project acronym	Project title	Programme	Project website	Coverage
CENTRICO	Central European Region Transport Telematics Implementation project	DGTREN / DGMOVE MIP – Multi-annual Indicative Programme, TEN-T budget line	www.easyway-its.eu/1/index.php?option=com_content&task=view&id=38&Itemid=71	Covered in EXTR@Web paper
ERTRAC	ERTRAC European road transport 2020: a vision and strategic research agenda	FP6 – PTA 6 “Sustainable Development, global change and ecosystems”	www.ertrac.org	Not covered as it is not a research project. However a summary is given in the TRS on Road Transport (TRKC, 2009b)
EURAMP	European ramp metering project	FP6 – PTA 2 “Information Society Technologies”	www.euramp.org	See Thematic Research Summary on Road Transport (TRKC, 2009b)
INTRO	Intelligent Roads	FP6 – PTA 6 “Sustainable Development, global change and ecosystems”	http://intro.fehrl.org	This paper
LDC	Long Distance Corridors (sub-project of CENTRICO, STREETWISE and CORVETTE)	DGTREN / DGMOVE MIP – Multi-annual Indicative Programme, TEN-T budget line	none	This paper
PROSPER	Project for Research on Speed Adaptation Policies on European Roads	FP5 – Growth – Key Action 2 – Sustainable Mobility and Intermodality	none	This paper

Sub-theme 3: Road Network and Traffic Management				
Project acronym	Project title	Programme	Project website	Coverage
REVEL	A methodology to update speed limits	National (Spain): CEDEX	none	This paper
SENSOR	Secondary Road Network Traffic Management Strategies – Handbook for Data Collection, Communication and Organisation	FP5 – Growth, Key Action 2 “Sustainable Mobility and Intermodality”	none	This paper
STREETWISE	Seamless Travel Environment for Efficient Transport in the Western Isles of Europe	DGTREN / DGMOVE MIP – Multi-annual Indicative Programme, TEN-T budget line	www.easyway-its.eu/1/index.php?option=com_content&task=view&id=43&Itemid=76	Covered in EXTR@Web paper

Sub-theme 4: Rail Network and Traffic Management				
Project acronym	Project title	Programme	Project website	Coverage
BRAVO	Brenner Rail Freight Action Strategy aimed at achieving a Sustainable Increase in Intermodal Transport Volume by Enhancing Quality, Efficiency and System Technologies	FP6-SUSTDEV-2 – Sustainable Surface Transport	www.bravo-project.com	This paper
ERRAC	European Rail Research Advisory Council – Strategic Research Agenda	FP6 – PTA 6 “Sustainable Development, global change and ecosystems”	www.errac.org	Not covered as it is not a research project
EUROMAIN	European Railway Open Maintenance System	FP5 – IST – KA1 – Systems and services for the citizens	www.euomain.org	This paper

Sub-theme 4: Rail Network and Traffic Management				
Project acronym	Project title	Programme	Project website	Coverage
IMPROVERAIL	Improved tools for Railway capacity and access management	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	www.cts.cv.ic.ac.uk/html/ResearchActivities/projectDetails.asp?ProjectID=13	Covered in EXTR@Web paper
PARTNER	Path Allocation Re-engineering of Timetable Network for European Railways	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	none	This paper
PROMAIN	Progress in Maintenance and Management of Railway Infrastructure	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	www.promain.org	Covered in EXTR@Web paper
RAIL	Reliability Centred Maintenance (RCM) Approach for the Infrastructure and Logistics of Railway Operation	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	www.datsi.fi.upm.es/~rail/index.html	This paper
SAMRAIL	Safety Management in Railways	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	www.samnet.inrets.fr	Covered in EXTR@Web paper
-	Incentives for increased rail punctuality – State-of-the-art and means of development	National (Sweden): Banverket (Swedish Rail Administration)	none	This paper

Sub-theme 5: Maritime and Inland Waterway Traffic and Port Management				
Project acronym	Project title	Programme	Project website	Coverage
ARCOP	Arctic Operational Platform	FP5 (Other)	www.arcop.fi	This paper
INTRASEA	Inland Transports on Sea Routes	INTERREG III	www.intrasea.org	Covered in EXTR@Web paper
OPSPEMAPT	Organisation of Port Services production and efficiency management – Administration of passenger terminals	National (Greece): Operational Programme Competitiveness	none	This paper
RISVD	River Information Systems as part of the pan-European RIS: Test centre in the Ministry of Transport	National (Slovakia)	none	This paper
TELEMAS	Tele-Maintenance and Support through Intelligent Resource Management for Ship Operation	FP5 – IST – KA1 – Systems and services for the citizens	www.telemas.de	This paper
WATERBORNE ^{TP}	WATERBORNE Technology Platform	FP6-SUSTDEV-2 – Sustainable Surface Transport	www.waterborne-tp.org	Not covered as it is not a research project
WATERMAN-TS	Waterborne Traffic and Transport Management Technical Secretariat	FP5 – Growth – KA2 – Sustainable Mobility and Intermodality	none	Covered in EXTR@Web paper

Sub-theme 6: Air Traffic and Airport Management				
Project acronym	Project title	Programme	Project website	Coverage
ACARE	Advisory Council for Aeronautics Research in Europe	FP6 PTA 4 "Aeronautics and space"	www.acare4europe.org	Not covered as it is not a research project
AD4	4D Virtual airspace management system	FP6 PTA 4 "Aeronautics and space"	www.ad4-project.com	This paper
ATC-Wake	Integrated Air Traffic Control wake vortex safety and capacity system	FP5 – IST – KA1 – Systems and services for the citizens	www.nlr.nl/?id=502	This paper
CAATS II	Cooperative approach to Air Traffic Services	FP6-AEROSPACE – Aeronautics and Space – Priority Thematic Area 4 (PTA4)	www.caats2.isdefe.es	In future TRS if reports become available
C-ATM Phase 1	Co-operative Air Traffic Management, Phase 1	FP6-AEROSPACE – Aeronautics and Space – Priority Thematic Area 4 (PTA4)	none	This paper
EMMA	European airport Movement Management by A-SMGCS	FP6-AEROSPACE - Aeronautics and Space - Priority Thematic Area 4 (PTA4)	www.dlr.de/emma	This paper
EMMA2	European airport Movement Management by A-SMGCS, Part 2	FP6-AEROSPACE - Aeronautics and Space - Priority Thematic Area 4 (PTA4)	www.dlr.de/emma2	This paper
SINBAD	Safety Improved with a New concept by Better Awareness on airport approach Domain	FP6-AEROSPACE - Aeronautics and Space - Priority Thematic Area 4 (PTA4)	none	In future TRS if reports become available

Sub-theme 6: Air Traffic and Airport Management				
Project acronym	Project title	Programme	Project website	Coverage
SPADE	Supporting Platform for Airport Decision-making and efficiency analysis	FP6-AEROSPACE - Aeronautics and Space - Priority Thematic Area 4 (PTA4)	http://spade.nlr.nl	This paper
SUPER-HIGHWAY	Development of an Operationally Driven Airspace Traffic Structure for High-Density High-Complexity Areas, based on the use of Dynamic Airspace and Multi-Layered Planning	FP6-AEROSPACE - Aeronautics and Space - Priority Thematic Area 4 (PTA4)	www.sh.isdefe.es	In future TRS if reports become available

Remark: the projects listed in the annex are those that have had the focus on the theme Transport Management. On the TRKC portal www.transport-research.info it is possible to use the “advanced search” functionality, with the option “transport management”, and find all research projects, EU-funded and national, which have treated, to a variable extent, aspects related to the theme.