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DG Mobility and Transport**

**Specific Support Action
Transport Research
Knowledge Centre**

**Thematic Research
Summary:**

Safety and Security

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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 the European Commission and a representative group of research users.

This Thematic Research Summary deals with Safety and Security in transport, although the emphasis of the current issue is on safety, due to the fact that security is quite a new theme and research results in this area are not yet available. 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

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.

The first issue of this TRS paper was externally reviewed by Dr Dietmar Wurzel of ECTRI.

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, as its predecessor project EXTR@Web, is to collect, structure, analyse and disseminate transport research results. It 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 a major update of 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 “safety and security”.

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 “safety and security” theme deals with aspects such as:

- The level of danger that is socially acceptable in a real-life situation, taking into account other factors such as efficiency, cost, liberty and comfort;
- systems, rules and procedures aimed at preventing, discouraging and detecting negligent, irresponsible or malicious human acts which threaten safety;
- systems and procedures to prevent, detect or mitigate mechanical or technological failures or natural phenomena which could threaten safety and security; and
- systems and procedures to protect people (transport users, transport personnel and third parties) as well as goods, infrastructure and vehicles from harm.

Key policy developments at EU level draw on legal means to establish a framework and introduce measures in the field of road safety, provided by the Maastricht and Lisbon Treaties. In addition to ongoing long-term activities in the railway and aviation sectors, the Transport Advisory Group provided safety and security inputs into the European Commission’s FP7 work programme for Transport (including Aeronautics).

The second part includes a synthesis of the main findings and policy implications from research projects and is concluded with an overview of the implications for further research. The research projects synthesised are EU-funded projects, from the Fifth and the Sixth Framework Programmes that have results publicly available. Projects that had been reviewed in the related paper produced within the predecessor project EXTR@Web are briefly summarised.

Eight sub-themes are considered in the synthesis. The following are the main achievements for seven of the sub-themes where project results have been available. For the eight sub-theme concerning security no results are available.

In the first sub-theme, concerning reporting and common guidance:

- Road sector research has identified the requirements of all stakeholders towards online services helping to reduce casualties, defined an overall framework architecture for open telematics, and came up with a common validation plan.

In the second sub-theme, concerning assessments:

- Research on the options for deciding on the best ways for implementing safety measures has stressed the criteria of correct safety evaluation, implementation costs of safety measures, the use of systematic "ex-ante" studies, the inclusion of typical scenarios for usual evaluation practice, the categorisation of cases for cost-benefit analyses, and the focus to be put on projects with safety-dedicated budgets; and
- A research study analysing the socio-economic effects of intelligent safety systems in road vehicles found that intelligent safety systems have already proven to be promising instruments with the capability of reducing the number of accidents and their severity.

In the third sub-theme, concerning transport operation, research on the safety design of automotive vehicles successfully demonstrated the integration of several new and important control functions for higher levels of system automation.

In the fourth sub-theme, concerning transport infrastructure and vehicles:

- An evacuation study for large double-deck passenger aircraft showed that handling more passengers in emergency situations is a demanding task for cabin crew with the likely panic among passengers being understood to have major impact on the achievable evacuation times;
- research with a view to establishing a European culture of safe road engineering came up with a road safety index used for assessing and monitoring aspects addressing road safety, a catalogue of ranked, performance-based road safety recommendations, and interactive application of the catalogue; and
- research in the maritime sector has produced a set of advanced tools for ship design, developed an approval process and risk acceptance criteria for risk-based ship systems and functions, and applied these design criteria to eight novel ship designs of which two were chosen for further detailed design.

In the fifth sub-theme, concerning driver, passenger and non-user safety:

- Research in the field of crash testing using frontal impact dummies identified the principal occupant injuries in frontal impact car crashes, and new biomechanical data, leading to the design of a new generation prototype frontal impact dummy; and
- studies on safety applications contributing to road safety have highlighted the need to consider advanced communication technologies, new sensorial devices, lane-keeping support systems, concepts for sensors and communication, active 3D sensor technology, location and classification of obstacles, concepts for advanced sensors, safety-enhanced digital maps for ADAS applications, and generic impact assessment for all functions.

In the sixth sub-theme, concerning qualifications and behaviour:

- A comprehensive package of training and communication measures aimed at training novice and senior car drivers to follow the idea of environmentally friendly driving without comprising safety; and
- a European-wide survey among professional bodies and end users in twelve countries gathered knowledge about the awareness of safety problems, the cultural meaning of safety and of safety technologies, expectations on a cognitive and emotional level, fairness of anticipated implementation processes, behavioural adaptation to new technologies, the willingness to pay, and the willingness to use new applications.

In the seventh sub-theme, concerning working conditions:

- Research in the automotive sector has dealt with the issue of getting accident risk estimates that incorporate both a driver's state and driving performance as expressed in commonly used parameters like speed and lane positioning accuracy;
- has successfully tested the prototype of a traffic information service providing real-time information on driving conditions, accidents, congestion and road works to drivers via their in-vehicle devices or via smartphones and PDAs; and
- an innovative, lower cost acoustic alert system with a reach of up to 5 nautical miles supporting air traffic controllers, based on two passive phased array microphone antennas, has been developed and tested.



Abbreviations and acronyms used

ASC	Adaptive Speed Control
ADAS	Advanced Driver Assistance Systems
CEC	Commission of the European Communities
CO ₂	Carbon dioxide
ERA	European Research Area
EU	European Union
DGMOVE	Directorate General Mobility and Transport (European Commission directorate from January 2010)
DGTREN	Directorate General Transport and Energy (former European Commission directorate, until December 2009)
EATMS	European Air Traffic Management System
ERTMS	European Rail Traffic Management System
EXTR@Web	Exploitation of Transport Research via the Web (EU FP5 dissemination project, predecessor to TRKC)
FLR	Forward Looking Radar
FP4	EU Fourth Framework Programme for R&D (1994-1998)
FP5	EU Fifth Framework Programme for R&D (1998-2002)
FP6	EU Sixth Framework Programme for R&D (2002-2006)
FP7	EU Seventh Framework Programme for R&D (2007-2013)
GSM	Global System for Mobile telecommunications
GPS	Global Positioning System
ICT	Information and Communication Technologies
ISA	Intelligent Speed Adaptation
ITS	Intelligent Transport Systems
MANPAD	Man-Portable Air Defence system (shoulder-launched guided missile)
NO _x	Nitrogen oxide
RTD	Research and Technological Development
TEN / TEN-T	Trans-European Networks / Trans-European transport Network

TRKC Transport Research Knowledge Centre
TRS Thematic Research Summary
UNECE United Nations Economic Council for Europe

Table of Contents

1. INTRODUCTION	10
2. SCOPE OF THE SAFETY AND SECURITY THEME	13
3. POLICY CONTEXT.....	15
3.1 SAFETY IN LAND, WATERBORNE AND AIR TRANSPORT	15
3.2 SECURITY AGENDA.....	16
4. RESEARCH FINDINGS	18
4.1 INTRODUCTION	18
4.2 SUB-THEME 1: REPORTING AND COMMON GUIDANCE	22
4.2.1 BACKGROUND	22
4.2.2 RESEARCH OBJECTIVES.....	22
4.2.3 RESEARCH RESULTS	24
4.2.4 POLICY IMPLICATIONS	25
4.3 SUB-THEME 2: ASSESSMENTS.....	26
4.3.1 BACKGROUND	26
4.3.2 RESEARCH OBJECTIVES.....	26
4.3.3 RESEARCH RESULTS	27
4.3.4 POLICY IMPLICATIONS	28
4.4 SUB-THEME 3: TRANSPORT OPERATION	29
4.4.1 BACKGROUND	29
4.4.2 RESEARCH OBJECTIVES.....	30
4.4.3 RESEARCH RESULTS	31
4.4.4 POLICY IMPLICATIONS	32
4.5 SUB-THEME 4: TRANSPORT INFRASTRUCTURE AND VEHICLES	34
4.5.1 BACKGROUND	34
4.5.2 RESEARCH OBJECTIVES.....	34
4.5.3 RESEARCH RESULTS	37
4.5.4 POLICY IMPLICATIONS	41
4.6 SUB-THEME 5: DRIVER, PASSENGER AND NON-USER SAFETY	43
4.6.1 BACKGROUND	43
4.6.2 RESEARCH OBJECTIVES.....	44
4.6.3 RESEARCH RESULTS	44
4.6.4 POLICY IMPLICATIONS	45
4.7 SUB-THEME 6: QUALIFICATIONS AND BEHAVIOUR	45
4.7.1 BACKGROUND	45
4.7.2 RESEARCH OBJECTIVES.....	46
4.7.3 RESEARCH RESULTS	46
4.7.4 POLICY IMPLICATIONS	47
4.8 SUB-THEME 7: WORKING CONDITIONS	47
4.8.1 BACKGROUND	47
4.8.2 RESEARCH OBJECTIVES.....	48
4.8.3 RESEARCH RESULTS	48
4.8.4 POLICY IMPLICATIONS	49
4.9 SUB-THEME 8: SECURITY.....	49
4.9.1 BACKGROUND	49
4.9.2 RESEARCH OBJECTIVES.....	50
4.9.3 RESEARCH RESULTS	50
4.9.4 POLICY IMPLICATIONS	51
4.10 IMPLICATIONS FOR FURTHER RESEARCH	51

5. REFERENCES	53
ANNEX: LIST OF PROJECTS BY SUB-THEME.....	58

1. Introduction

This paper provides a structured review of the research relating to safety and security in transport, carried out in EU-funded transport research projects. “Safety and security” is one of the 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 www.transport-research.info/web/projects/transport_themes.cfm.

The TRKC project has produced final versions of the TRSs for 28 of the 30 themes during 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 are low numbers of contributing projects and where similarities exist between the themes. This is the final version of the TRS on Safety and Security and replaces the first version issued in December 2008.

A large number of research projects have dealt with the theme addressed by this paper. The TRS “Safety and security” produced in the predecessor project EXTR@Web (EXTR@Web project, 2006), reviewed research from European projects belonging to the Fourth Framework Programme (FP4), the Fifth Framework Programme (FP5) and selected national projects. The present paper adds new projects, mainly European projects from FP5 and the Sixth Framework Programme (FP6).

The research reviewed in this paper does not represent the entire range of research dealing with safety and security aspects 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 reported on in the 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, a list of projects from FP6 which are on-going or which, although completed, have not yet made results publicly available, is also provided.

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 a brief overview of the relevant policy developments 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 projects. The section is structured according to sub-themes to make the broad area of research which has dealt with safety and security more manageable.

The following eight sub-themes are considered:

- sub-theme 1: reporting and common guidance;
- sub-theme 2: assessments;
- sub-theme 3: transport operation;
- sub-theme 4: transport infrastructure and vehicles;
- sub-theme 5: driver, passenger and non-user safety;
- sub-theme 6: qualifications and behaviour;
- sub-theme 7: working conditions; and
- sub-theme 8: security.

For each sub-theme, overall research objectives are presented and research findings are synthesised. A special focus is given to the policy implications of research results. Section 4 concludes with a brief overview of the perceived implications for future research, based on the findings from the projects reviewed. Sources for section 4 are documents available from the projects and reporting on their achievements, essentially the project final reports.

The Annex includes the list of the EU-funded research projects for each of the eight sub-themes. Addresses of the websites of the projects reviewed 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 Safety and Security theme

Safety implies freedom from danger. The ultimate level of safety would be a situation without any risk of personal accident, injury or material damage. In reality, this is impossible because a widespread set of dangers cannot be avoided completely. So safety generally refers to the level of danger that is socially acceptable in a real-life situation, taking into account other factors such as efficiency, cost, liberty and comfort.

In the case of transport safety, risk arises when human beings are exposed to any part of the transport system. Different levels of risk attach to different modes and to different activities. The acceptable level of risk is judged according to the choices made by individuals – as operating staff, drivers or passengers.

The safety performance of a technical system is the measurable consequence of the extent to which it behaves as expected, with and without the interaction of human beings. The objective is to come as close as possible and reasonable to the ideal safety performance.

Security is the undertaking to protect human beings, transport means and transport infrastructure against unauthorised and unexpected actions of any kind. It generally refers to systems, rules and procedures aimed at preventing, discouraging and detecting negligent, irresponsible or malicious human acts which threaten safety.

Safety issues concern the means of transport (such as vehicles) and the infrastructure of transport (such as roads), as well as human beings involved directly or indirectly in any transport operation. When the transport safety system, or the infrastructure on which the transport system operates, fails to behave as designed, there are often serious consequences. Such failures also decrease the efficiency of a transport system.

Elements of transport systems have to be tested and validated, concerning their ability to fulfil their functions and the consequences of malfunctions and failures. Safety issues affect operations, requiring ongoing organisation and expenditure to maintain levels of safety. Safety must be described in terms of the risks to different categories of transport users, as well as non-transport users who are in proximity to the transport system or suffer from the consequences of transport. Safety is often measured in terms of the numbers of fatalities, injuries and material damage by distance travelled (passenger-km or freight tonne-km), or the risk of serious injuries in percentage terms, or perceived safety in qualitative terms.

Safety is a high priority issue within the transport sector across all modes. All European countries provide some guidelines for achieving similar goals:

- Safer transport systems;
- technical standardisation; and
- improved training.

Major topics to categorise safety aspects are:

- Transport means;
- transport infrastructure; and
- human performance and behaviour including operation.

The topic can be structured in terms of the affected groups of users and non-users.

Safety and security of users and systems

- Staff of transport undertakings (drivers, pilots, crew, terminal and maintenance staff etc);
- private individuals in control of a vehicle, vessel or aircraft (e.g. car drivers or private pilots);
- passengers;
- goods being transported; and
- security of transport infrastructure and systems.

Safety of non-users

- Drivers and passengers of other vehicles (or vessels or aircraft);
- other modes; and
- general public.

Besides standardisation and regulation, improved safety procedures, and safer design, the implementation of Intelligent Transport Systems can contribute to overall safety in transport, e.g. through telematics based traffic control and driver assistance. Within the freight transport area, a further safety topic is the transport of hazardous goods.

The above summary of topics describes the principal breakdown of technical, organisational and managerial aspects that come under the theme, whereas Section 4 of this document reflects sub-themes according to actual priorities in transport research policy.

Though responsibility for taking measures to halve the number of road deaths by 2010 will fall chiefly to the national and local authorities, the European Union too needs to contribute to this objective, not just through the exchange of good practice, but also through action at three levels:

- Promotion of new technologies to improve road safety;
- Pursuing safety-related standardisation and legislation within its areas of competence; and
- Harmonisation of penalties and cross-border enforcement.

To that respect, the 2006 mid-term review of the Transport White Paper (CEC, 2006) stresses that concerted action to further improve vehicle design and technology, including technologies for accident avoidance and vehicle infrastructure co-operation ("e-Safety"), and road infra-structure and driver behaviour must be taken.

Concrete actions to reach the road safety targets are hence:

- Implementation of an integrated approach to road safety which targets vehicle design and technology, infrastructure and behaviour, including regulation where needed;
- Organisation of awareness efforts, such as annual road safety days;
- Review and completion of safety rules in all other modes; and
- Strengthening the functioning of the European safety agencies and gradually extending their safety-related tasks.

The FP7 Cooperation work programme 2007-2008 stressed that ensuring the level of safety and security of the transport system will respond to the increasing mobility demand and crime emergence is of major importance:

- The focus in aeronautics research will hence be on active and passive safety measures with special emphasis on the human element; and
- The key aim of research for sustainable surface transport will be on establishing a common foundation for a common control/command system for urban rail transport and a common approval process at European level with regard to safety and security.

3.2 Security agenda

The Transport Advisory Group (a group of experts which provides advice to the European Commission¹) in its FP7 work programme 2008 "Safety and security in Transport" in

¹ http://ec.europa.eu/research/transport/news/article_4305_en.html

addition proposed research on specific aspects of safety and security in transport, identifying the priority areas:

- Technologies for accident avoidance (e-Safety); and
- Technologies to confront the sustained terrorist threat concerning all modes of transport, i.e. civilian aircraft, passenger ships, rail and other forms of public transport.

The September 2001 terrorist attacks in the USA have spurred several activities related to the security of the European transport system. Legislation and the introduction of quality control schemes have since boosted security levels in aviation and the maritime sector. However, the extension of security rules to land transport, including urban transport and railway stations, and intermodal logistics chains is still pending. As a secondary aspect, a level playing field among all modes of transport needs to be ensured where the costs of security measures must not distort competition.

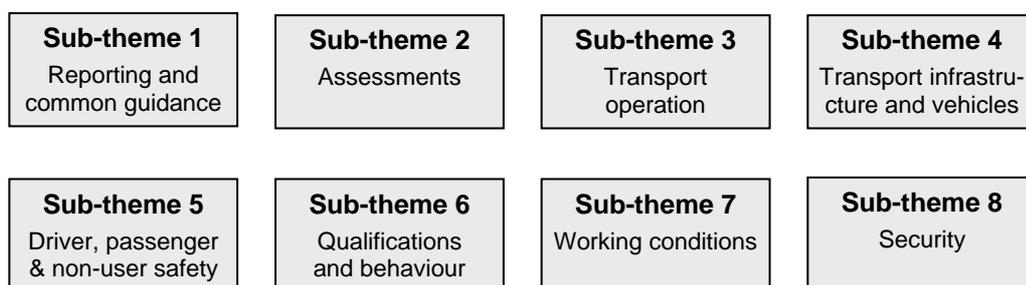
The 2006 mid-term review of the Transport White Paper (CEC, 2006) hence proposes the following actions in the field of security:

- Examination of the functioning and costs of current security rules in air and maritime transport, and proposing adjustments where needed on the basis of experience and in order to avoid distortion of competition; and
- Reflection on the need to extend security rules to land and intermodal transport and critical infrastructure.

4. Research findings

4.1 Introduction

The research which is reviewed in this paper deals with eight sub-themes, as illustrated below:



The first sub-theme deals with **Reporting and (common) guidance**. In this area research aims to understand the different reports and protocols for handling accidents within Europe, with a particular focus on the maritime and road sectors. Based on this knowledge, a common framework for unified reporting is under development. This should provide the basis for deriving specific safety measures, such as an onboard "black box" systems like those long established for commercial aircraft.

The second sub-theme deals with **Assessments**. In this area methods are being analysed and developed to assess safety impacts of emerging technologies, or to provide risk analyses, mostly supported by simulations. In the context of the Single European Sky initiative this concerns future air traffic management concepts and technologies, as well as comparable approaches in the waterborne sector. In the road sector, two EU-funded initiatives – EuroNCAP for vehicle assessment and EuroRAP for road risk assessment – cover a wide range of safety aspects.

The third sub-theme deals with **Transport operation**. This area comprises one of the principal aspects of active safety where research aims to specify, develop and demonstrate a range of components and measures. Factors such as maintenance and life-cycle considerations also fall under this sub-theme. Prominent examples for the implementation of advanced operational schemes are the European Air Traffic Management System (EATMS), and the European Rail Traffic Management System (ERTMS).

The previous EXTR@Web paper (EXTR@Web project, 2006) reported on findings from a total of 46 projects originating from the Fourth and Fifth Framework Programmes as well as national research initiatives. These projects contributed to the first seven sub-themes mentioned above, while no security-related research findings were available at the time the paper was completed.

This final issue of the thematic research summary on Safety and Security draws on findings from 50 completed projects, four of which belong to the Fifth Framework Programme while the others belong to the Sixth Framework Programme or other European programmes.

The following table provides reference to all projects potentially contributing to the theme of Safety and Security, however, on the practical assumption that at least a Project Profile has been available allowing for the allocation of 140 projects to the eight sub-themes.

Sub-theme	Contributing projects
Reporting and common guidance	<p><u>Projects covered in this paper:</u> AERONEWS; AIRNET; ASPASIA; B-VHF; EASIS; e-Scope; GST; HASTAC; HEAVYROUTE</p> <p><u>Projects to include if reports become available:</u> ADELINE; ADHER; ASSIST; iFly; NEWSKY; PEGASE; SKY-Scanner; STAR</p> <p><u>Projects covered by EXTR@Web paper:</u> DUMAS; HALTI; S-CBB; VERA2</p>
Assessments	<p><u>Projects covered in this paper:</u> ROSEBUD; SEISS; SUSTAINABLE BRIDGES</p> <p><u>Projects to include if reports become available:</u> AISHA; Episode 3 (EP3); ILDAS; ISAAC; SELCAT; TRANSPower</p> <p><u>Projects covered by EXTR@Web paper:</u> ADVISORS; BOJCAS; CHAMELEON; SAFET; SAMNET; SEAM; SUNFLOWER</p>
Transport operation	<p><u>Projects covered in this paper:</u> ASAS-TN2; EURAMP; MARNIS; MISS; POP&C; PROMIT; SAFEICE; SPARC; SPREEX</p> <p><u>Projects to include if reports become available:</u> ALERT; ART; CHINOS; COFCLUO; CREATING; CREDOS; EUDDPLUS; FLAGSHIP; FLYSAFE; GIFT; INOUI; INTERGAUGE; LANDING; OPTIMAL; RESET; SAFE OFFLOAD; SINBAD;</p>

Sub-theme	Contributing projects
	<p>SOFIA</p> <p><u>Projects covered by EXTR@Web paper:</u> ESCUGIBRI; NAUPLIOS; NOPSEURA; S240B; SAMRAIL; SIMTAG; THEMES; The study of relations between telematics and road safety</p>
<p>Transport infrastructure and vehicles</p>	<p><u>Projects covered in this paper:</u> AUTOCOM; CAATS; EMMA; ERTRAC; EURNEX; FAR-Wake; INTRO; I-WAY; RANKERS; REPOSIT; RIPCORD ISEREST; SAFEDOR; SAFETEL; SafetyNet; SAND.CORE; SPICYCLES; TURNOUTS; USE HAAS; VERRES</p> <p><u>Projects to include if reports become available:</u> AC-DC; ADLAND; ADVICE; ANASTASIA; ARCHES; ARTIMA; ASICBA; AVITRACK; BEARINGS; CAATS II; CELPACT; CESAR; COCOMAT; DATAFORM; ERTRAC II; FIDELIO; HYSYS; IMPROVE; IN-SAFETY; LIGHTNING; MARSTRUCT; MESEMA; MODURBAN; POMEROL; POSSEIDON; REACT; SAFE-RAIL; SCOUT; SENARIO; SICOM; SIRENA; SMIST; TATEM; UFAST; URBAN TRACK; VISIONS; VULCAN</p> <p><u>Projects covered by EXTR@Web paper:</u> COMPOSIT; FUIRORE; INDICATORS; LIIKUTUS; PODS IN SERVICE; RESPONSE 2; S205Q; The promotion of walking and cycling on village roads</p>
<p>Driver, passenger and non-user safety</p>	<p><u>Projects covered in this paper:</u> FID; IM@GINE IT; PREVENT</p> <p><u>Projects to include if reports become available:</u> APROSYS; APSN; HELISAFE TA; ONBASS; PISa; SAFECRAFTS; SAFEINTERIORS; SIM</p> <p><u>Projects covered by EXTR@Web paper:</u> 212034: Extending CabinAir; DENSE TRAFFIC; ECBOS; GOING-SAFE; IMMORTAL; S101D; Air travel & venous thrombolism; Review of research on school travel; Safety of children in road traffic in connection with child safety equipment in motor vehicles</p>
<p>Qualifications / behaviour</p>	<p><u>Projects covered in this paper:</u> ECODRIVEN; SAFETY-TECHNOPRO</p> <p><u>Projects to include if reports become available:</u> 2TRAIN; CAST; DRUID; TRAIN-ALL</p> <p><u>Projects covered by EXTR@Web paper:</u> ESSAI; R000238497; S214G; S224J; TRAI-NER; VIRTUAL; The long-term effects of hands free legislation on mobile phone use</p>

Sub-theme	Contributing projects
Working conditions	<p><u>Projects covered in this paper:</u> AIDE; ATENAA; HIGHWAY; SAFE-AIRPORT</p> <p><u>Projects to include if reports become available:</u> HILAS; ROTIS II; SAFEDMI; SAFETOW; SECURCRANE</p> <p><u>Projects covered by EXTR@Web paper:</u> LOCOPROL; TALIS; VINTHEC II</p>
Security	<p><u>Projects covered in this paper:</u> None.</p> <p><u>Projects to include if reports become available:</u> CASAM; OPTAG; SAFEE; COUNTERACT</p> <p><u>Projects covered by EXTR@Web paper:</u> None.</p>

For full project title and further details on individual projects, please refer to the Annex.

4.2 Sub-theme 1: Reporting and common guidance

4.2.1 Background

Research reported in the EXTR@Web paper (EXTR@Web project, 2006) in the field of reporting and (common) guidance covered results of projects related to the following:

- An Urban Safety Management (USM) framework for the design and assessment of urban safety initiatives;
- The issue of cross-border enforcement in the road sector has been addressed by drafting the text for a future Directive, and by devising the eNFORCE concept for an organisational network to facilitate cross-border enforcement;
- The discussion of options for conducting automatic speed enforcement through the involvement of police, municipalities and road authorities; and
- Devising the functional architecture of a secured cargo black box application which allows tracking and tracing of vessels at all times.

4.2.2 Research objectives

As a contribution to the eSafety action plan, targeting a 50% reduction of road fatalities, the creation of a horizontal market for deployment of online services based on open standards has been the objective of one EU research project (GST project, 2007).

In addition, a specific support action has been initiated aimed at monitoring and stimulating progress of the eSafety initiative by providing an easily accessible and up-to-date resource of online information on the priority eSafety topics (eScope project, 2005).

Research in the automotive sector aimed to support the market introduction of integrated safety systems for cars and heavy goods vehicles through developing and validating a highly dependable, modular in-vehicle hardware and software architecture putting particular focus on the demanding requirements in terms of safety, reliability, availability and security (EASIS project, 2007).

A research project targeted the application and combination of existing and newly developed systems, technologies, databases and models to develop an advanced management and route guidance system for heavy goods vehicles with a particular view to user requirements in terms of fleet management, innovative route guidance and driver support (HEAVYROUTE project, 2009).

The development of a next generation VHF broadband channel system is intended to replace ageing legacy systems, targeting increased efficiency and reliability for future aeronautical communications needs while focusing on an initially parallel deployment concept with existing VHF systems (B-VHF project, 2006).

As an exploitation of advanced materials developments, research into micro damage inspection and fatigue monitoring aimed at the long-term integrity of airframes and engines made of advanced materials with a view to improved vehicle and passenger safety (AERONEWS project, 2008).

Another aviation research project focused on low cost solutions for deploying apron movement guidance and control systems based on the EGNOS satellite navigation platform at small and medium size European airports (AIRNET project, 2006).

The benefits of airborne separation assistance system applications employing available satellite communication platforms was to be assessed by looking into performance and reliability of four test-beds related to the automatic dependent surveillance broadcast (ADS-B) scheme (ASPASIA project, 2008).

The development of a new generation of air data computers and related sensor technology, suitable for fixed wing and rotary wing aircraft, was anticipated to give significantly improved altitude accuracy capabilities over current systems, thus also supporting existing aircraft traffic collision avoidance systems (HASTAC project, 2007).

4.2.3 Research results

Research concerning the creation of innovative ITS services helping to reduce casualties in road transport (GST project, 2007) has:

- Identified the requirements of users, car manufacturers, control centre operators, middleware providers, terminal manufacturers, and service providers;
- Defined an overall framework architecture for open telematics across the 7 sub-projects, as well as specifications for the key interfaces; and
- Developed a common validation plan to ensure that the site validation results can be aggregated and compared at the project level.

Suitable for several kinds of vehicles, a platform for software-based functionality in vehicle electronic systems has been defined, providing common services upon which future applications can be built. Supporting the requirements of integrated safety systems in a cost effective manner, an on-board electronic hardware infrastructure, methods and techniques for handling critical dependability-related parts of the development lifecycle, and an engineering process and a suitable tool chain have been defined. In a further step validation was achieved by realising a telematics gateway and a commercial vehicle test bench (EASIS project, 2007).

The 2005 eSafety forum paved the way for acceleration of the development, large-scale deployment and use of active safety systems in the road sector by involving industry, industrial associations and public sector stakeholders. Dissemination and knowledge exchange activities have been set up to promote state-of-the-art Intelligent Integrated Safety Systems, the adaption of regulatory and standardisation provisions, and the removal of societal and business obstacles. A web based observatory has helped bringing together all stakeholders from the road sector (eScope project, 2005).

The development of more than 800 sensors in 40 different versions, allowing to identify the potential causes for drift mechanisms in electronic equipment, has been achieved contributing to enhanced know how in avionics systems. In addition, a project succeeded in involving Eastern European manufacturers as alternative suppliers of avionics' grade materials (HASTAC project, 2007).

Heavy vehicle operations across Europe's road network have been successfully supported by providing the necessary tools, systems, data collection and interpretation processes drawing on electronic mapping systems. Three main applications were developed based on vehicle/infrastructure interaction models together with detailed data on the vehicle itself,

the infrastructure and the traffic, in particular allowing for pre-trip route planning, real-time driver support, and monitoring and management of heavy goods vehicles at bridges (HEAVYROUTE project, 2009). An enhanced prototype measurement and diagnosis concept allowing for non-destructive testing (NDT) of new materials, components and structures in aeronautics has been provided. Based on extensive modelling of wave propagation, non-linear wave modulation, impact modulation, and non-linear reverberation spectroscopy a protocol for micro crack diagnostics has been developed (AERONEWS project (2008).

A demonstrator validated the sound implementation of the A-SMGCS concept, and added further features with a view to efficient airport services to the scheme. The demonstrator approach has been positively reviewed by stakeholders such as air traffic controllers and airport operators (AIRNET project (2006).

An assessment platform focusing on fully integrated surveillance applications of communication satellites has specified the requirements of GS/AS applications and the overall SatCom architecture, showed how to design and implement application test beds, implemented validation platforms, performed a cost-benefit analysis, and contributed to system validation (ASPASIA project, 2008).

4.2.4 Policy implications

Safety in road transport as a major challenge for society has been addressed by devising safety services through exploitation of existing European, national and corporate research, with a particular view to enabling specifications and standardisation proposals.

The findings of the research project on future VHF technology became valuable inputs to the future communications study jointly launched by Eurocontrol and the US Federal Aviation Administration (FAA). Further it became part of the Eurocontrol datalink policy discussions as a technology for the VHF band and L-band, respectively.

Knowledge gained in the field of ultrasonic non-destructive testing equipment, proved to have a significant impact on sectoral applications, such as aeronautical and civil engineering, marine and rail transport, materials' manufacturing, the inspection of pharmaceuticals, and the food industry.

The involvement of end-users such as airports in the scheme to deploy A-SMGCS systems has proven to help gain good knowledge and understanding of current European legislations related to air transport, as well as a good knowledge of the operational methods and procedures currently being used.

Research into further enhancements of silicon structures for altimetry systems has already been launched as part of a follow-on FP7 activity aiming to also exploit the usage of the technology in other transport sectors.

4.3 Sub-theme 2: Assessments

4.3.1 Background

Research reported in the EXTR@Web paper (EXTR@Web project, 2006) in the field of assessments covered results of projects related to the following:

- Development of a global, though flexible and non-restrictive approach to tunnel safety incorporating both performance based and prescriptive approaches;
- Development of a risk analysis method based on failure mode analyses and applied to behavioural, legal and organisational risks of a set of Advanced Driver Assistance System (ADAS) subsystems;
- The potential to improve car restraint systems, through definition of a concept of pre-crash applications, implemented in a demonstrator car;
- Road safety programmes in Sweden, the United Kingdom and the Netherlands were found to have generally similar approaches but different ways of implementing policy measures for the three categories of vehicle, road and road user;
- Advanced airframe technology, design guidelines for primary composite bolted joints based on analyses and tests, and basic research information on the behaviour of composite bolted joints has been compiled;
- Implementation issues related to the Railway Safety Directive have been addressed by a thematic network aiming to build consensus on issues where opinions differ by organising debates and formal discussions on these issues, and by proposing common positions and identifying needs for further action; and
- Research in the maritime domain has identified hazards and collected related data for three key issues: ballast water management, anti-fouling paints, and quality of fuel and emissions.

4.3.2 Research objectives

One EU project (ROSEBUD project, 2006) aimed at providing policy makers with a sound basis for making judgements on the most effective, efficient and sustainable ways for implementing safety schemes.

An exploratory study aimed to provide a survey of current approaches to assess the impact of new safety functions, and to develop a methodology for assessing the potential impacts of intelligent safety systems. The focus was on typical measures for increasing the effectiveness used to quantify safety performance including aspects such as overall accident rates, the accident fatality rate, the accident injury rate, and health care costs (SEISS project, 2005).

A rail research project aimed at exploiting the load capacity of existing railway bridges through changes in maximum allowable axle loads and train speeds with a view to optimised service lives, maintenance and repair schemes (SUSTAINABLE BRIDGES project, 2007).

4.3.3 Research results

Research on the options for deciding on the best ways for implementing safety measures (ROSEBUD project, 2006) has come up with the following recommendations:

- Databases on safety measures should cover implementation costs in order to allow for comprehensive assessment of options;
- A handbook should be developed comprising best practice examples on the evaluation of safety effects, and international experience gained in that area allowing for the performance of correct and systematic "ex-ante" studies;
- Inclusion of typical scenarios is considered useful for testing the sensitivity of results, and should become common for the usual evaluation practice;
- For standardised cost-benefit analyses it is considered useful to elaborate on the categorisation of cases, indicating the types of impacts relative to the category of measures; and
- It is suggested to focus efficiency assessments with regard to safety impacts on projects with safety-dedicated budgets and on projects aiming at improving safety.

A research study analysing the socio-economic effects of intelligent safety systems in road vehicles found that intelligent safety systems have already proven to be promising instruments with the capability of reducing the number of accidents and their severity. It comprised an overview of safety-based systems and characteristics of the market, identified key variables, and developed methods for the assessment of socio-economic impacts (SEISS project, 2005).

Comprehensive data along with guidelines have been provided through a research project that addressed the needs of engineers, owners and operators of railway bridges across

Europe. The four specific outputs comprised guidelines on inspection and condition assessment, load and resistance assessment, monitoring principles, as well as on repair and strengthening concepts for railway bridges. These were complemented by an overall project guide providing support to railway engineers, operators or managers in using the technical guidelines and reports developed with a view to finding relevant technical information for specific operational or maintenance activities. Those guidelines are understood to help evaluate the number of possible approaches and methods to upgrading existing railway bridges for higher speeds and loads, or with the aim of extending their service lives (SUSTAINABLE BRIDGES project, 2007).

4.3.4 Policy implications

To foster a broader basis of expertise in efficiency assessment across all modes it has been proposed to launch an international education and training campaign, based on a harmonised syllabus and the use of multi-media tools, in order to contribute to the harmonisation of methods and procedures for structured data collection and efficiency assessment. An internet portal is seen as the logical solution to disseminate data and knowledge on implementation costs of safety schemes.

A brief policy guidance note by the Commission on the broad vision, interest, and high-level goals for urban transport has been published clarifying actions needed at the European level, such as monitoring, benchmarking and specification of harmonised data collection standards for certain indicators. Complementary, local, regional and national authorities are encouraged to employ methods, such as public perception surveys to address public involvement and public views with regard to urban transport policy development.

Study work helped compile a survey of current approaches to assess the impact of new safety functions, developed a methodology to assess the potential impact of intelligent safety systems in Europe, provided criteria for estimating the socio-economic benefits resulting from the application of intelligent road safety systems, and developed a framework for exploring market deployment scenarios.

Research into the status quo of railway bridges has identified a need for further collaborative work in relation to masonry arch bridges, where knowledge of structural behaviour and monitoring are less advanced than for other typical constructions. Moreover, the findings should also be of interest to the highway sector.

4.4 Sub-theme 3: Transport operation

4.4.1 Background

Research reported in the EXTR@Web paper (EXTR@Web project, 2006) in the field of transport operation covered results of projects related to the following:

- An in-depth maritime demonstration project has evaluated new long range surveillance services that could benefit from the implementation of the Galileo satellite services;
- A comprehensive framework of safety assessment and management for waterborne transport has been devised to facilitate adoption of good safety practice in the industry;
- A commonly agreed structure for the Safety Management System (SMS) regarding the implementation of the Rail Safety Directive has been proposed comprising a number of different elements, specifying requirements and guidance for each element;
- A rail study has looked into enhancing and sharing knowledge about electrical systems compatibility among all players in the railway community with the aim to improve safety and operational reliability;
- A research study on various intelligent transport systems has clearly confirmed positive impacts on traffic safety both in urban environments and on highway networks;
- The effect of vehicles' mean speed on the accident frequency on rural roads in the UK has been investigated which confirmed that e.g. a 10% increase in mean speed results in a 26% increase in the frequency of all injury accidents;
- Passive and active driver support tools have been investigated which proved that a recording Intelligent Speed Adaptation (Recording ISA) system can be a good and cost-effective safety measure which may be taken into operation fairly quickly; and
- A web portal has been set up to help access services specialising in hazardous cargo combined with information about the exact location and status of cargo.

4.4.2 Research objectives

A research and technical development project (SPARC project, 2007) aimed at:

- Development of an accident-avoiding vehicle using a Decision Control System (DCS) compensating for driver failure probability;
- Describing and validating clear software / hardware interfaces for automotive redundant control systems thus combining results from other related European projects;
- Extending the modular concept devised for heavy goods vehicles to full tractor-trailer combinations;
- Validating the scalability of the concept by transferring it from heavy-duty trucks to small passenger cars through completion of four validation vehicles; and
- Ensuring European technology leadership for x-by-wire vehicles.

A thematic network aimed at accelerating the take-up of ADS-B applications envisaged to boost airspace capacity and safety in European skies (ASAS-TN2 project, 2008).

Improvements of, harmonisation and promotion of ramp metering control measures on European highways were targeted by a research project comprising four case study sites looking into improved safety and increased efficiency of traffic flows EURAMP project, 2007).

Another road research project aimed at integrating the tasks and knowledge of urban police, civil protection agencies and road service authorities into one harmonised operational scheme promoting efficiency and safety of road networks (MISS project, 2007).

In the maritime domain, two activities addressed the issue of oil spills from sea-going oil tankers. One research project aimed at delivering a framework and suitable tools for the methodological assessment of risks related to the operation of oil tankers which had caused severe oils spills in international waters over the last decades (POP&C project, 2006). A second project aimed at improving oil spill response schemes by creating synergies among parties involved such as authorities, regulators, end users, universities and researchers (SPREEX project, 2007).

A broader research project looked into the economic, operational, legal and organisational aspects of sea transport with a particular view to improved safety, security and environmental protection (ARNIS project, 2008).

Concerns surrounding maritime operations in ice-covered waters were addressed by a research study aiming to establish a semi-empirical data basis for assessing ice classes, their impact on ship structures as well as their influence on operational scenarios for icebound vessels (SAFEICE project, 2007).

A dissemination activity aimed at supporting the implementation of intermodal freight transport technologies and procedures through creating awareness of innovations, best practices and intermodal transport opportunities for potential users, as well as politicians and researchers. More specifically, the project aimed at establishing an information and coordination platform for intermodal logistics, and at developing an overall promotion strategy and action plan for intermodal transport solutions (PROMIT project, 2009).

4.4.3 Research results

Research on the safety design of automotive vehicles (SPARC project, 2007) successfully demonstrated the integration of several new and important control functions for higher levels of system automation, such as secure vector, co-pilot assistance, electromechanical wedge brakes, a fault-tolerant processing architecture, and intelligent energy distribution and management. A key output was the developed scalable road vehicle platform supporting the integration of x-by-wire and active safety systems.

The ASAS Thematic Network has helped boost the introduction of ASAS/ADS-B applications and operations, providing valuable input to the European SESAR and the US NextGen master plans for future air traffic management systems. Furthermore, the two biggest aircraft manufacturers – Airbus and Boeing – have now explicitly put ASAS functionality on their respective agendas (ASAS-TN2 project, 2008).

Research into ramp metering on main road systems has proven substantial socio-economic benefits, cautioned excessive ramp metering on motorways, and showed that coordinated metering is superior to local metering strategies and that substantial additional benefit can be gained from the coordination (EURAMP project, 2007).

Bus lane infringements can be significantly reduced through the introduction of a monitoring system allowing to identify car owners misusing dedicated bus lanes (MISS project, 2007).

An intermodal study has analysed various national incentives with a view to improving safety and security of land and waterborne transport, and came up with a summary of best practise examples supporting sustainable transport (PROMIT project, 2009).

A so-called e-maritime concept has been drafted integrating Maritime Operational Services (MOS), Electronic Port Clearance (EPC), Port Community Systems (PCS) and a maritime broadband platform (MARNIS project, 2008).

Risk reduction through the implementation of a computer-based online early warning system for grounding avoidance in maritime tanker operations has proven its potential to mitigate the environmental and safety impacts of incidents. An enhanced decision support tool should be drawing on already available information coming from ECDIS systems (POP&C project, 2006).

Research into icing conditions and their impact on various maritime vessels has compiled a database of ice load and ice damage data for five types of ice-going ships allowing to come up with ice building scenarios relevant for the estimation of ship hull loading. In addition, current ice service and icebreaking practices in the northern hemisphere have been surveyed (SAFEICE project, 2007).

Research has emphasized that coordinated response to oil spills in maritime transport has to be pro-active and has to incorporate all existing technologies for spill mitigation, drawing on experience and data from past incidents (SPREEX project, 2007).

4.4.4 Policy implications

Research has paved the way for the homologation of certain smart automotive features to be followed up by future x-by-wire research activities.

The uptake of ASAS applications will be boosted if the International Civil Aviation Organization (ICAO) joins Eurocontrol and the US Federal Aviation Administration (FAA) in emphasizing the development of related procedures and standards.

The novel e-maritime concept will potentially affect the tasks and responsibilities of the various authorities involved with maritime transport operation, including not only maritime safety but also enforcement of customs controls and immigration. In order to clarify and support the interaction between all authorities and actors involved, a European Maritime Directive, describing the legal structure, is recommended.

With a view to physical infrastructures for intermodal transport, there is much to be done before generic, competitive solutions can be achieved, thus more research and coordination activities by the European Commission are anticipated for rail and waterborne transport.

In the maritime sector a vision is urgently needed for related research in Europe leading to a strategy deriving greater benefits from the RTD framework programmes, avoiding duplication, closing gaps and creating synergies. The strategy should include mechanisms for optimising coordination, cooperation and dialogue between the European Commission and policymakers, industry and scientific communities in member states and third countries.

4.5 Sub-theme 4: Transport infrastructure and vehicles

4.5.1 Background

Research reported in the EXTR@Web paper (EXTR@Web project, 2006) in the field of transport infrastructure and vehicles covered results of projects related to the following:

- A thematic network on fire safety related to the future use of composite materials in the transport sector has found possible areas of collaboration for the aerospace, automotive and rail industries;
- Recognising the differences in transport policy objectives and priorities among Member States, a typology of goals and objectives has been refined, establishing relationships between the goals, objectives, and measurements of transport system performance;
- Consolidating specialist knowledge on energy and fuels, powertrain technologies and complete vehicle aspects an Automotive R&D Technology Roadmap has been elaborated;
- A broad infrastructure scheme in the UK trialled a total of 24 different measures for improving road junctions;
- Following a national development plan for the main road network helped reduce the overall number of persons injured by focusing on the worst road sections where cost-effectiveness can be best achieved;
- A human factors centred Code of Practice (CoP) for speeding up market uptake of ADAS technology has been proposed that would provide guidance during the design and validation process, promote the safety benefits of new systems and eventually would contribute to reducing accident rates across Europe; and
- The recent introduction of podded propulsors on large ships prompted a full scale monitoring campaign on-board four vessels, employing three different makes of podded propulsion units.

4.5.2 Research objectives

The aspect of post-accident passenger and crew survivability on large commercial aircraft has been aimed at by an evacuation study (VERRES project, 2003), comprising evacuation exercises as well as computer simulations.

The development of scientifically sound guidelines on road infrastructure safety, enabling optimal decision-making by road authorities in their efforts to promote safer roads and eradicate dangerous road sections has been the key objective of one EU project (RANKERS project, 2008). The anticipated user group for this research were road operators who would be most interested in having available a set of practical recommendations to avoid the constitution of accident cluster zones through preventive identification mechanisms and remedial measures ranked according to cost-effectiveness criteria.

A research project (SAFEDOR project, 2008) targeting safety enhancements through innovation to strengthen the competitiveness of the European maritime industry aimed to:

- Develop a risk-based and internationally accepted regulatory framework to facilitate first principles approaches to safety;
- Develop design methods and tools to assess operational, extreme, accidental and catastrophic scenarios, accounting for the human element, and integrate these into a design environment;
- Produce prototype designs for European safety-critical vessels to validate the proposed methodology and document its practicability;
- Transfer systematically knowledge to the wider maritime community and add a stimulus to the development of a safety culture; and
- Improve training at universities and aptitudes of maritime industry staff in new technological, methodological and regulatory developments in order to attain more acceptance of these principles.

A single partner activity aimed at establishing the Automotive Controls Research Group (ACRG) at Istanbul Technical University as a centre of excellence for active safety, clean and efficient road vehicles, thus ensuring deeper involvement in EU RTD schemes (AUTOCOM project, 2008).

A road research study aimed at better utilising the wealth of already existing road surface databases, real-time outputs from sensor-equipped road infrastructures and information from in-vehicle sensors in order to significantly increase road capacity and safety (INTRO project, 2008).

Exploiting the technological know-how and scientific knowledge in the field of interoperable communication tools, a project aimed to enhance drivers' perception of the road environment and improve their responses in time-critical situations by providing real-time information from other vehicles in the vicinity and also from effectively located roadside equipment (I-WAY project, 2009).

Another road sector research project aimed at the integration of relative GPS applications with wireless vehicle-to-vehicle communications supporting existing collision avoidance systems, particularly longitudinal and intersection systems (REPOSIT project, 2007).

Targeting improved road design, road safety audits and inspections as well as safety management of road networks, research aimed at providing best practice guidelines for the mentioned topics, and more specifically a safety manual for the design of secondary roads (RIPCORDER ISEREST project, 2008).

Research further aimed at developing a production environment specific to surface transport based on the innovative use of advanced design and manufacturing technologies with a particular focus on the robustness of vehicles against electro-magnetic disturbances (SAFETEL project, 2006),

In support of all aspects of road and vehicle safety policy development at European and national levels, establishing the framework of a European road safety observatory was another research focus following the Road Safety Action Plan conceived in 2003 (SafetyNet project, 2008).

Increasing the modal share of cycling has been on the agenda of a research study that comprised that participation of six case study cities which would evaluate the impacts of a set of four specific actions with a view to energy consumption, emissions, changes in attitude, local stakeholders' involvement, and the integration with transport/spatial planning (SPICYCLES project, 2008).

Within the huge amount of research into advancing air traffic management (ATM) systems, the coordination of processes and methodologies across all research activities related to safety, human factors and validation is understood to be vital for the success of future ATM systems during the deployment phase. Hence a project focused on producing best practice manuals, and looked into the identification of research gaps in the ATM domain (CAATS project, 2006).

In recent years quite some research has gone into developing advanced guidance and control systems (A-SMGCS) helping to increase capacity and safety of European airports. With a view to the implementation of those concepts, a research project aimed at bringing together all relevant stakeholders needed to pave the way for the operational deployment of A-SMGCS (EMMA project, 2006).

Targeting wake turbulence hazards limiting the number of aircraft movements during landing and take-off phases, a research project aimed at establishing a fundamental knowledge base of wake vortex dynamics, in the future allowing for more effective countermeasures and – in addition – real-time prediction tools of wake vortex behaviour to be used by ATM (FAR-Wake project, 2008).

Another aviation research activity aimed at analysing and evaluating the state-of-the-art in high altitude aircraft and airships, as well as mission profiles, requirements and applications in order to be able to come up with a strategic research agenda in this field (USE HAAS project, 2006).

Post-accident survivability for passengers of very large commercial aircraft has been the subject of a research study with the particular focus on investigation into evacuation issues of these type of aircraft (VERRES-VLTA project, 2003).

The fragmentation of the European rail research landscape has been targeted by research aiming at bundling research activities, promoting the rail sector's contribution to sustainable transport policy, and improving the principal competitiveness and economic stability of the rail industry (EURNEX project, 2007).

Enhancing safety and efficiency, reducing maintenance costs, increasing useful life-cycles and limiting noise of urban rail transit systems has been the aim of research into improved vehicle-track interaction of turnout systems (TURNOUTS project, 2007).

The application of advanced sandwich structures in vehicles across various transport modes was the aim of a research project that started with looking into the implementation of novel sandwich solutions in the maritime sector for the design of roll-on/roll-off ships, however, on the understanding that know how transfer e.g. to the rail sector would help foster the market potential for these new materials and technologies (SAND.CORE project, 2006).

4.5.3 Research results

Triggered by the development of the double-deck Airbus A380 aircraft, an evacuation study (VERRES-VLTA project, 2003) showed that handling more passengers in emergency situations is a demanding task for cabin crew, even though the proportion between crew and passengers is anticipated to be the same as for smaller aircraft. Evacuation from the upper deck of very large aircraft likely leads to passengers hesitating

at emergency exits, though the exercises performed didn't provide consistent results here. In any case, the likely panic among passengers in the event of an emergency is understood to have major impact on the achievable evacuation times.

Research with a view to establishing a European culture of safe road engineering (RANKERS project, 2008) came up with the following key results:

- A road safety index used for assessing and monitoring road safety addressing aspects such as human / driver behaviour, vehicle response and infrastructure;
- A catalogue of performance-based road safety recommendations ranked according to their efficiency; and
- An interactive application of the catalogue – available via the internet – extended to urban vulnerable road users.

Research in the maritime sector (SAFEDOR project, 2008) delivered the following key findings:

- A set of new tools and significant enhancements to existing tools were developed, addressing transient flooding, structural integrity, dynamic intact stability, collision, grounding and fire;
- Development of a high-level approval process for risk-based ships and related risk acceptance criteria;
- Development of an approval process and risk acceptance criteria for risk-based ship systems and functions; and
- Implementation and application of a new process for eight novel ship designs (i.e. two cruise ships, three ropax, one gas tanker, one oil tanker and one container vessel) from which two designs have been selected for further detailed design.

In the course of three workshops, bilateral consultations with experts from Europe's automotive industry and other networking activities, the Automotive Controls Research Group (ACRG) at Istanbul Technical University has gained considerable research know how. Upgrading of computer hardware, driving simulators, instrumentation and the research centre's vehicle dynamics and engine modelling software helped pave the way for becoming a centre of excellence in active road safety (AUTOCOM project, 2008).

Another validation exercise in the air traffic management (ATM) domain compiled a Best Practices Manual covering operational ATM concept validation relevant to all EC and Eurocontrol funded research activities, and showcased promising emerging safety technologies and key safety elements to be further developed. A guideline has been drafted supporting effective management of validation, safety and human factors in ATM (CAATS project, 2006).

The efficient implementation of A-SMGCS for use in all-weather conditions has been supported by test-bed installations at three major airports, by several real-time simulations and by on-board installations. Complementary long-term testing of the already operational A-SMGCS at Paris CDG airport has been successfully undertaken (EMMA project, 2006).

Integrating the European rail research community has been achieved by founding a long-term integrated network of excellence in rail research, technology innovation and knowledge management. A set of decentralised corporate services have been defined and further developed comprising the virtual rail university EURail, a rail knowledge library, neutral support for harmonised product qualification methods, railway testing and simulation, gender equality promoting skilled women for leading positions in rail research, launch of the mentor-trainee programme, as well as management, business and acquisition support (EURNEX project, 2007).

Aeronautics research has generated systematic results and physical understanding concerning previously unresolved issues of aircraft trailing wakes, including the role of vortex instabilities, the influence of engine jets and fuselage wakes, and ground effects. Apart from consolidating knowledge about the means to mitigate wake turbulence hazards, improved tools for real-time prediction of wake vortex behaviour have been developed (FAR-Wake project, 2008).

A new method for estimating travel time from unidentified probe vehicle data has been developed, showing – as part of simulations – that the new approach generally performs better compared to existing piece-wise continuous vehicle profile method, drawing on data fusion as an appealing data processing technique taking into account data quality and imperfections of each source (INTRO project, 2008).

A road research project has developed a set of in-vehicle modules featuring a vehicle sensing module, a data acquisition module, a mobile interface for vehicles, a situation assessment module, and a communication module handling the real-time exchange of data among vehicles and between a specific vehicle and the Road Management System (I-WAY project, 2009).

Another road research activity developed algorithms and produced an integrated simulator for vehicle-to-vehicle communications, real-time satellite-based positioning and collision avoidance warnings. The latter module proved to have sufficient accuracy for lane detection and proper detection of the collision time instant (REPOSIT project, 2007).



Supporting the EU's road safety targets, best practice tools and guidelines for road infrastructure safety measures concerning accident prediction models, road safety inspections, and black spot management, as well as tools for cost-efficiency assessment of road safety infrastructure measures have been established. Furthermore, on the understanding that half of all road traffic fatalities and injuries in rural areas in Europe occur on secondary roads, specific software tools and a handbook for local road authorities have been developed (RIPCORN ISEREST project, 2008).

In order to be able to assess the functional safety of vehicles in their entire operational environment comprising influence from vibration, temperature and humidity, the detection theory has been introduced which firstly takes measurements, and then estimates in which of a finite number of states an underlying system resides. Performance degradation of components and equipment due to aging and production imperfections are also included in the functional safety concept, however, the main focus was put on determining the immunity of vehicles against external disturbances (SAFETEL project, 2006).

A comprehensive, relevant statistical framework for road accident data collection in EU countries has been devised allowing for compatible statistics from the Member States, as well as assisting new Member States to make their national accident data compatible with the CARE system, i.e. development of appropriate statistical outputs based on CARE data, establishment of a common accident data collection set, and methodology and estimation of the real number of road accident casualties. Further aspects comprised a detailed analysis of safety performance indicators for road safety throughout the EU, the build-up of a European Road Safety Information System (EuroRIS), and the launch of the awareness raising European Road Safety Observatory website (SafetyNet project, 2008).

A best practice guide on the use of sandwich structures for the maritime and rail sectors compiled a comprehensive overview on general types of sandwich structures, on aspects and techniques concerning their design, manufacturing, joining, assembly and outfitting, inspection and repair, and on legislation and approval. Complementary benchmark studies have been carried out which led to new and optimised design solutions, while evaluating their costs and benefits (SAND.CORe project, 2006).

A couple of pilot cities have successfully implemented dedicated transport policies promoting cycling, e.g. by means of new bicycle highways and advanced bike-counting systems. Several communication and awareness raising initiatives have supported the build up of public bicycle systems, in some cases relying on exemplary local partnership models (SPICYCLES project, 2008).

Research has helped advance design and manufacture of turnouts for conventional light rail systems such as trams. Two computer models supported the design of several low cost, maintenance friendly and safe turnout designs for application in urban light rail, industry rail and tram systems. In addition, recommendations have been made to improve the steel welding process for certain types of turnouts (TURNOUTS project, 2007).

Analysis and evaluation of existing high altitude aircraft and airships showed potential for a wide variety of applications such as very long endurance and high altitude missions, and fields where multi-mission flexibility is essential. The study also identified airworthiness certification of vehicles, and air traffic management and radio spectrum allocations as critical issues to be solved before market deployment of these novel vehicles (USE HAAS project, 2006).

A major evacuation exercise for very large commercial aircraft proved the growing workload for cabin crew, the tendency of passengers to hesitate at emergency exits on the upper deck of aircraft, and generally lower exit flow rates than for standard large emergency exits. However, some of the data was deemed inconclusive due to the trial character of the evacuations lacking the expected panic behaviour of passengers (VERRES-VLTA project, 2003).

4.5.4 Policy implications

For aviation research it has been recommended to perform further trials regarding enhanced flight crew / cabin crew communication in the event of accidents or incidents, and precautionary situations. Also, the location of cabin crew onboard large passenger aircraft should be investigated in experiments with special attention being on panic mitigation and passenger flow redirection. Furthermore, passenger safety information concepts should be revisited with a view to the use of certain media, and their timing.

In road infrastructure, research has proposed to fully revise existing guidelines in order to improve and harmonise future EU standards with a particular focus on new criteria for road signs and infrastructure.

In the maritime sector research has paved the way for a risk-based regulatory framework aimed at developing a high-level description of the whole approval process in case of risk-based designs for selected ship types, including all major accident scenarios.

The European-wide deployment of A-SMGCS technology in order to increase safety, capacity and efficiency of airports is understood to support the SESAR initiative during its definition phase.

Cooperative systems allowing communication between infrastructure and vehicles and from vehicle to vehicle will contribute to reaching the anticipated road safety targets.

In order to help mature advanced onboard systems including digital maps and in-vehicle sensors for collision avoidance, a demonstrator application using real vehicles validating simulations against real world situations is proposed. A complementary road map for industry, regulators, car manufacturers, and end-users has identified possible ways to speed implementation of these systems. The drafted safety handbook for secondary roads, outlining organisational and implementation aspects of road safety, has provided local road transport policy makers with a valuable tool that should be compared with road safety goals defined by regional and national policymakers.

Because safety implications are becoming increasingly important, car manufacturers have to respond to market demand by addressing the required improvements of detection algorithms for failure or malfunction mechanisms, and improvements of test signal monitoring techniques. More specifically, car manufacturers must become aware of the importance of thorough EMC testing of equipment.

Drawing on a set of recommendations for transparent and independent road accident investigation, a future common European accident investigation methodology is viewed as the main target.

The potential of high altitude vehicles providing a variety of monitoring, remote sensing and scientific applications can only be exploited if additional research and development activities help pave the way for commercial and operational sustainability of these new technologies.

Further computer modelling and real-world trials of passenger evacuation from very large aircraft will have to focus on a better understanding of passenger behaviour and the interactions between passengers and cabin crew in the vent of emergencies.



4.6 Sub-theme 5: Driver, passenger and non-user safety

4.6.1 Background

Research reported in the EXTR@Web paper (EXTR@Web project, 2006) in the field of driver, passenger and non-user safety covered results of projects related to the following:

- A UK study has monitored a BAe146 regional jet and a Boeing 737 narrow-body jet during real flight trials with a view to the cabin air quality of modern aircraft;
- A research study on air travel and venous thrombolism confirmed the information in previous medical literature on travellers' thrombosis and the causal mechanisms, stressing seated immobility as a key risk factor independent of the form of travel;
- Optimisation of the design of a new aircraft seat featuring 3-point shoulder harness, backrest, an energy absorbing device, spreaders, seat pan, front beam, rear and front legs and fittings;
- Development of a second generation Forward Looking Radar (FLR) sensor which is essential for implementing Adaptive Speed Control (ASC) systems;
- A statistical accident analysis exploiting governmental databases, studying the main injury mechanisms according to crash type derived from detailed accident reconstructions, themselves drawing on component tests and gave recommendations to amend existing regulations and directives, and suggest new regulations, respectively;
- A study on the use of drugs in car driving has confirmed that the proportion of drugged drivers has increased and that mixed consumption of alcohol and drugs has become more frequent;
- A British study with a focus on the analysis of road safety interventions for children living in rural areas compared to measures in built-up areas has shown that there were considerably fewer accidents to children in non-built up areas and that the majority of child casualties in non built-up areas were car passengers;
- Another study reviewed other UK and international research on travel to school published since 1995; and
- Promotion of the case of child safety equipment in cars, a study has tested child restraint systems against UN ECE Regulations No. 44 and 16.

4.6.2 Research objectives

One project (FID project, 2003) aimed to contribute to a further reduction of the amount of injuries and fatalities in frontal car collisions through the introduction of an improved frontal impact crash test dummy with realistic movements and injury indicating measurements for future automotive crash testing fatalities.

A further research effort (PREVENT project, 2008) in the road sector aimed at:

- Developing, demonstrating, testing and evaluating preventive safety applications, using advanced sensor, communication and positioning technologies integrated into on-board systems for driver assistance;
- Assisting technological development and integration as well as decreases component costs;
- Contributing to the rapid market penetration by helping to overcome major barriers including risk assessment and liability issues in introducing such systems; and
- Creating greater awareness of the active safety approach leading to increased user demand for preventive and active safety.

In the intermodal transport domain, a research project aimed at supporting seamless and safe travel in Europe through providing vehicle drivers with personalised services to adapt accordingly to alerts and information coming from onboard systems monitoring the vehicle's status and road conditions. The focus was to be on minimising the workload of the driver by drawing on real-time risk assessments provided by these onboard systems (IM@GINE IT project, 2006).

4.6.3 Research results

Research in the field of crash testing (FID project, 2003) using frontal impact dummies identified the principal occupant injuries in frontal impact car crashes, and new biomechanical data concerning the behaviour of the human thorax/shoulder, pelvis/femur/knee and the lower leg during frontal impacts. Based on these findings a new generation prototype frontal impact dummy, drawing on the existing THOR-Alpha design, has been built, assisted by a computer model of the THOR-Alpha crash test dummy.

Research on safety applications contributing to road safety (PREVENT project, 2008) has produced the following:

- Communication technologies to improve the detection, locating and evaluation of hazards;
- New sensorial devices integrating obstacle detection and communication;
- Lane-keeping support systems for situations with poor road and environmental conditions;
- Concepts for sensors and communication aimed to road markings and crossing traffic recognition;
- Active 3D sensor technology for pre-crash and blind spot surveillance;
- Location and classification of obstacles, such as cars, pedestrians, and bikes;
- Concepts for advanced sensors & sensor data fusion;
- Safety-enhanced digital maps for ADAS applications; and
- Generic impact assessment for all functions.

An IT project developed a set of user interfaces and modules providing access to personalised transport services for car drivers and passengers alike. Most of these software modules were targeted at smartphones and PDAs, however, web-based front ends and server-side applications were also developed (IM@GINE IT project, 2006).

4.6.4 Policy implications

The prototype instrumented frontal impact dummy developed is understood to be suitable for inclusion in the so-called Frontal Directive as a successor of the currently used Hybrid-III dummy.

Road safety improvements have been supported through integrated research activities undertaken by the European automotive industry in order to develop and demonstrate preventive safety applications and technologies.

The provision of advanced personalized transport service information in the pilot stage highlighted the need to define new guidelines and standards for implementing these.

4.7 Sub-theme 6: Qualifications and behaviour

4.7.1 Background

Research reported in the EXTR@Web paper (EXTR@Web project, 2006) in the field of qualifications and behaviour covered results of projects related to the following:

- A UK study on the behaviour of 10 and 11 year old youngsters has revealed changes in travel patterns, most notably a decline in the number of trips around made unaccompanied by adults;
- training 'safe place finding', 'roadside search', 'gap timing' and 'perception of intentions' skills in a British study has proven to be very beneficial for three groups of children between 6 and 10 years of age;
- another UK study targeted the safety training for pedestrian skills of 7 to 9 year olds, devising a 'visual timing and gap selection' test and a 'safe place crossing location' test;
- development of an interactive, multimedia training tool and two modules of a driving simulator (static and semi-dynamic one), paying attention to their cost-effectiveness;
- the inclusion of virtual reality techniques in car driving simulators has been demonstrated in a three-step approach;
- an investigation into the implications of the use of hands-free mobile phones during car journeys following the recent tightening of related legislation; and
- Situational awareness and threat management in aviation have been investigated in depth starting with a literature review adopting the view that situational awareness is an activity or skill rather than the 'mental state' of humans involved.

4.7.2 Research objectives

An initiative aimed at promoting safer and more energy-efficient operation of cars, vans, heavy goods vehicles and buses targeted to address at least 2.5 million drivers of those vehicles (ECODRIVEN project, 2008).

In the framework of the eSafety initiative, research aimed at encouraging end-user acceptance of advanced car information systems such as ADAS and IVSS. In order to achieve this, a training scheme was to be devised allowing professionals to effectively pass on information about safety benefits of available driver support systems to their clients (SAFETY-TECHNOPRO project, 2008).

4.7.3 Research results

A comprehensive package of training and communication measures involving examiners, instructors, candidates and accompanying persons aimed at training novice car drivers and senior car drivers to follow the idea of environmentally friendly driving, dubbed 'eco-driving', without comprising safety (ECODRIVEN project, 2008).

A European-wide survey among professional bodies and end users in twelve countries gathered a lot of knowledge about the awareness of safety problems, the cultural meaning of safety and of safety technologies, expectations on a cognitive and emotional level, fairness of anticipated implementation processes, behavioural adaptation to new technologies, the willingness to pay, and the willingness to use new applications. In a second step, a training scheme has been devised to promote the acceptance of various ADAS and IVSS applications by professional bodies (SAFETY-TECHNOPRO project, 2008).

4.7.4 Policy implications

Some 'eco-driving' knowledge should become essential in training schemes for novice drivers, however, on the clear understanding that safe driving should always take precedence over environmentally driving.

Awareness of ADAS and IVSS applications with respect to end-user acceptance and adoption is key to road safety promotion in the European Union. Hence, methodologies and tools increasing public awareness of such systems are anticipated to rank high on the road safety agenda.

4.8 Sub-theme 7: Working conditions

4.8.1 Background

Research reported in the EXTR@Web paper (EXTR@Web project, 2006) in the field of working conditions covered results of projects related to the following:

- Development of a new multi-technology satellite based train location system combining fail-safe on-board track mapping and interlocking;
- Advancing the whole array of information services available in the aircraft cockpit, a concept has been conceived of global, interoperable and dynamic availability of services such as traffic information service in contract mode, innovative weather service, and applications for increased pilot situational awareness; and
- Understanding the implications of shared Situational Awareness in aircraft operation, a study has investigated critical Crew Resource Management skills.

The prototype of a traffic information service providing real-time information on driving conditions, accidents, congestion and road works to drivers via their in-vehicle devices or via smartphones and PDAs, has been successfully tested on a major motorway link in Finland (HIGHWAY project, 2006).

With a view to commercially deploying advanced network architectures onboard aircraft, the applicability of standard protocols for networking management, the applicability of standard protocols for transmission, the frequency allocation of new transmitter/receiver units, and safety certification, e.g. for optical links, have been identified as key areas for further attention (ATENAA project, 2007).

An innovative acoustic alert system with a reach of up to 5 nautical miles supporting air traffic controllers, based on two passive phased array microphone antennas, has been developed and tested. The new technology proved to be lower cost and emission free compared to existing radar systems, and can optionally be operated autonomously for smaller airports, or may be integrated with standard control systems of larger airports (SAFE-AIRPORT project, 2005).

4.8.4 Policy implications

A project consortium comprising many key players in the automotive sector has made sure all relevant findings are properly disseminated across the industry through partnerships with e.g. ERTICO, including key members of European ITS industry and national governments, and the EUCAR SGI (Systems Group Interaction) group, which focuses on coordinating the EUCAR research and development activities in the human/machine interface area.

European aircraft manufacturers have gained considerable know how regarding the development and implementation of advanced airborne network architectures, thus fostering competitiveness of the aviation industry against the US competitors.

Three complementary research activities into innovative alternatives to costly radar systems have shown the technical and cost-saving potential of emerging technologies for air traffic control operations at a variety of airports.

4.9 Sub-theme 8: Security

4.9.1 Background

Security has indeed become a major topic of FP6 and FP7 addressing a couple of specific objectives mainly in the air and maritime sector, such as:

- Tightening air security, aiming at the prevention of illegal acts in the field of aviation;
- Introducing tougher controls at airports, and improving training and co-ordination of the staff responsible for security;
- Elaborating international standards on the reinforcement of cockpit doors for commercial aircraft;
- Enhancing ship and port facility security, i.e. controls on ships prior to and on entry to a port; and
- Allocating new responsibilities for maritime security to the European Maritime Safety Agency and the Committee on Safe Seas and the Prevention of Pollution from Ships.

4.9.2 Research objectives

Addressing air transport safety and security, a research project aimed at developing a reliable protection system against attacks of civil aircraft from man-held missile launchers, focusing on laser-based jamming technology being appropriate for use in the vicinity of airports (CASAM project, 2008).

A complementary project focused on the implementation of onboard threat detection systems – ensuring air/ground exchange of threat level information – and the provision of reliable threat information to flight crews (SAFEE project, 2008).

Surveillance, monitoring and targeting of individuals potentially posing an economic or security threat to effective airport operations have been aimed at by research into compact far-field radio frequency identification tagging, high-resolution, panoramic imaging systems, and systems eventually supporting augmented surveillance and monitoring (OPTAG project, 2009).

On a broader scale, a research activity aimed at improved security strategies against terrorist threats targeting public passenger transport, intermodal freight transport, energy production and transmission infrastructures (COUNTERACT project, 2009).

4.9.3 Research results

Projects to include if reports become available:

- CASAM – Civil aircraft security against MANPADs; FP6. Status: Project profile available.
- COUNTERACT – Cluster of user networks in transport and energy relating to anti-terrorist activities; Other. Status: Project profile available.
- OPTAG – Improving airport efficiency, security and passenger flow by enhanced passenger monitoring; FP6. Status: Project profile available.
- SAFEE – Security of aircraft in the future European environment; FP6. Status: Project profile available.

4.9.4 Policy implications

No contributing projects yet.

Note. While quite some emphasis has been put on launching security related research activities in the course of FP6 and FP7, and inclusion of the sub-theme security in this thematic research summary has indeed been requested by various interest groups, the lack of publicly available research findings is apparent. This may be due to restricted or even classified outputs of research projects. Also, most security projects at the EU level are within FP7 and are still ongoing.

4.10 Implications for further research

Road infrastructure safety is a topic that has recently received more attention from research activities because the perception of a lack of knowledge in the field, and / or a lack of comprehensive data being available for basing reliable design and safety recommendations prevails. Hence it has been suggested in the course of recent research to collect more data on the performance of the same (design and safety) countermeasures in different accident situations. Also, information on infrastructure and maintenance costs of various design and safety measures would need to become more easily available.

Eventually, known tools such as road safety inspections should be re-assessed in order to demonstrate the benefits they can provide to road safety improvements.

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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GST project (2007) – Global system for telematics. FP6 IST. www.gstforum.org

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HEAVYROUTE project (2009) – Intelligent route guidance of heavy vehicles. FP6 SUSTDEV-2. heavyroute.fehrl.org

HIGHWAY project (2006) – Breakthrough intelligent maps and geographic tools for the context-aware delivery of e-safety and added-value services. FP6-IST. www.ist-highway.org

IM@GINE IT project (2006) – Intelligent MobilityAgents, advanced positioning and mapping technologies, integrated interoperable multimodal location based services. FP6-IST. www.imagineit-eu.com

INTRO project (2008) – Intelligent roads. FP6-SUSTDEV-3. <http://intro.fehrl.org>

I-WAY project (2009) – Intelligent cooperative system in cars for road safety. FP6-IST. www.iway-project.eu

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MISS project (2007) – Monitor integrated safety system. FP6-SUSTDEV. www.missproject.net

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REPOSIT project (2007) – Relative positioning for Collision Avoidance Systems. FP6-IST.

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Annex: List of projects by sub-theme

Sub-theme 1: Reporting and common guidance				
Project acronym	Project title	Programme	Project website	Coverage
ADELIN	Advanced air-data equipment for airliners	FP6	www.adeline-aero.org	if reports become available
ADHER	Automated diagnosis for helicopter engines and rotating parts	FP6	adher-project.org	if reports become available
AERONEWS	Health monitoring of aircraft by non-linear elastic wave spectroscopy	FP6	www.kuleuven-kortrijk.be/AERONEWS	this paper
AIRNET	Airport network for mobiles, surveillance and alerting	FP6	www.airnet-project.com	this paper
ASPASIA	Aeronautical surveillance & planning by advanced satellite-implemented applications	FP6	www.aspasia.aero	this paper
ASSIST	Alpine safety, security and informational services and technologies	FP6	www.assist-gmes.org	if reports become available
B-VHF	Broadband VHF – Aeronautical communications system based on MC-CDMA	FP6	www.b-vhf.org	this paper

Sub-theme 1: Reporting and common guidance				
Project acronym	Project title	Programme	Project website	Coverage
SKY-Scanner	Development of an innovative LIDAR technology for new generation ATM paradigms	FP6	www.sky-scanner.it	if reports become available
STAR	Secure ATM CDMA software defined radio	FP6	www.ist-star.eu	if reports become available
VERA2	Video enforcement for road authorities 2	FP5	www.ist-world.org/ProjectDetails.aspx?ProjectId=b66e821773124d82ba88e27f5e126f7b	EXTR@Web paper

Sub-theme 2: Assessments				
Project acronym	Project title	Programme	Project website	Coverage
ADVISORS	Actions for advanced driver assistance and vehicle control system implementation, standardisation, optimum use of the road network and safety	FP5	www.crfproject-eu.org	EXTR@Web paper
AISHA	Aircraft integrated structural health assessment	FP6	www.aishaproject.info	if reports become available
BOJCAS	Bolted joints in composite aircraft structures	FP5	www.smr.ch/bojcas	EXTR@Web paper

CHAMELEON	Pre-crash application all around the vehicle	FP5	www.crfproject-eu.org	EXTR@Web paper
Episode 3 (EP3)	Single European Sky Implementation Support through validation	FP6	www.episode3.aero	if reports become available
ILDAS	In-flight lightning strike damage assessment system	FP6	ildas.nlr.nl	if reports become available
ISAAC	Improvement of safety activities on aeronautical safety complex systems	FP6	www.cert.fr/isaac	if reports become available
ROSEBUD	Road safety and environmental benefit-cost and cost-effectiveness analysis for use in decision making	FP5	partnet.vtt.fi/rosebud/	this paper
SAFET	Safety in tunnels thematic network	FP5	www.safetunnel.net	EXTR@Web paper
SAMNET	Safety management and interoperability thematic network	FP5	samnet.inrets.fr	EXTR@Web paper
SEAM	Assessing concepts, systems and tools for a safer, efficient and environmentally aware and friendly maritime transport	FP5	seam.mettle.org	EXTR@Web paper
SEiSS	Exploratory study on the potential socio-economic impact of the introduction of intelligent safety systems in road vehicles	FP5	www.vdivde-it.de/SEiSS	this paper

SELCAT	Safer European level crossing appraisal and technology	FP6	www.levelcrossing.net	if reports become available
SUNFLOWER	Comparative assessment of safety strategies in Sweden, Britain, and the Netherlands	FP5	sunflower.swov.nl	EXTR@Web paper
SUSTAINABLE BRIDGES	Assessment for future traffic demands and longer lives	FP6	www.sustainablebridges.net	this paper
TRANSPower	Supervised implementation of sustainable urban transport concepts	FP6	www.transpower-rp6.org	if reports become available

Sub-theme 3: Transport operation				
Project acronym	Project title	Programme	Project website	Coverage
ALERT	Assessment of life-cycle effect of repairs on tankers	FP6	alert.ncl.ac.uk	if reports become available
ART	Advanced remote tower	FP6	adv.remote-tower.net	if reports become available
ASAS-TN2	Airborne separation assistance system – Thematic Network II	FP6	www.asas-tn.org	this paper
CHINOS	Container handling in intermodal nodes – optimal and secure	FP6	www.martrans.org/chinos/	if reports become available
COFCLUO	Clearance of flight control laws using optimisation	FP6	=	if reports become available
CREATING	Concepts to reduce environmental impact and attain optimal transport performance by inland navigation	FP6	www.creating.nu	if reports become available
CREDOS	Crosswind-reduced separations for departure operations	FP6	www.eurocontrol.int/eec/credos	if reports become available
ESCUGIBRI	ESC UserGroup and InfoBank to support rail interoperability	FP5	–	EXTR@Web paper
EUDDPLUS	European Driver’s desk advanced concept implementation – contribution to foster interoperability	FP6	–	if reports become available
EURAMP	European ramp metering project	FP6	www.euramp.org	this paper

Sub-theme 3: Transport operation				
Project acronym	Project title	Programme	Project website	Coverage
NOPSEURA	Telematic speed control systems in motor vehicles	project from Finland	–	EXTR@Web paper
OPTIMAL	Optimised procedures and techniques for improvement of approach and landing	FP6	–	if reports become available
POP&C	Pollution prevention and control-safe transportation of hazardous goods by tankers	FP6	www.pop-c.org	this paper
PROMIT	Promote innovative intermodal freight transport	FP6	www.promit-project.net	this paper
RESET	Reduced separation minima	FP6	www.reset.aena.es	if reports become available
S240B	Rural speed management	project from UK	www.dft.gov.uk/rmd/project.asp?intProjectID=10064	EXTR@Web paper
SAFE OFFLOAD	Safe offloading from floating LNG platforms	FP6	–	if reports become available
SAFEICE	Increasing the safety of icebound shipping	FP6	www.tkk.fi/Units/Ship/Research/Safelce/Public	this paper
SAMRAIL	Safety management in railways	FP5	www.samnet.inrets.fr	EXTR@Web paper
SIMBA	Transforming road transport through worldwide cooperation	FP6	www.simbaproject.org	this paper

Sub-theme 4: Transport infrastructure and vehicles				
Project acronym	Project title	Programme	Project website	Coverage
EURNEX	European rail research network of excellence	FP6	www.eurnex.net	this paper
FAR-Wake	Fundamental research on aircraft wake phenomena	FP6	www.far-wake.org	this paper
FIDELIO	Fibre laser development for next generation LIDAR onboard detection system	FP6		if reports become available
FURORE	Future road vehicle research – a roadmap for the future	FP5		EXTR@Web paper
HYSYS	Fuel-cell hybrid vehicle system component development	FP6	www.hysys.de	if reports become available
IMPROVE	Design of improved and competitive products using an integrated decision-support system for ship production and operation	FP6		if reports become available
INDICATORS	TEN-T Performance indicators	EC DGTREN-funded project		EXTR@Web paper
IN-SAFETY	Infrastructure and safety	FP6	www.insafety-eu.org	if reports become available
INTRO	Intelligent roads	FP6	intro.fehrl.org	this paper
I-WAY	Intelligent cooperative system in cars for road safety	FP6	www.iway-project.eu	this paper

Sub-theme 4: Transport infrastructure and vehicles				
Project acronym	Project title	Programme	Project website	Coverage
LIGHTNING	Lightning protection for structures and systems on aircraft utilising lightweight composites	FP5		if reports become available
LIIKUTUS	Cost-effectiveness of road investment projects from the road safety perspective	project from Finland		EXTR@Web paper
MARSTRUCT	Network of excellence on marine structures	FP6	www.mar.ist.utl.pt/marstruct	if reports become available
MESEMA	Magnetoelastic energy systems for even more electric aircraft	FP6	www.mesema.info	if reports become available
MODURBAN	Modular urban guided rail system	FP6	www.modurban.org	if reports become available
PODS in SERVICE	Safety and reliability of podded propulsors under service conditions	FP5		EXTR@Web paper
POMEROL	Realizing enhanced safety and efficiency in European transport	FP6		if reports become available
POSSEIDON	Progressive oil sensor system for extended identification on-line	FP6		if reports become available
RANKERS	Ranking for European road safety	FP6	rankers.desk02hosting.be	this paper
REACT	Realizing advanced safety and efficiency in European road transport	FP6	www.react-project.org	if reports become available
REPOSIT	Relative positioning for collision avoidance systems	FP6	www.ist-reposit.org	this paper

Sub-theme 4: Transport infrastructure and vehicles				
Project acronym	Project title	Programme	Project website	Coverage
RESPONSE 2	Advanced driver assistance systems: from introduction scenarios towards a code of practice for development and testing	FP5		EXTR@Web paper
RIPCORDEREST	Road infrastructure safety protection – core research and development for road safety in Europe	FP6	ripcord.bast.de	this paper
S205Q	Junction improvements for vulnerable road users	project from UK		EXTR@Web paper
SAFEDOR	Design, operation and regulation for safety	FP6	www.safedor.org	this paper
SAFE-RAIL	Development of an innovative ground-penetrating radar system for fast and efficient monitoring or rail track substructure conditions	FP6		if reports become available
SAFETEL	Safe electromagnetic telecommunications on vehicles	FP6	www.safetel-project.com	this paper
SafetyNet	The European road safety observatory	FP6	www.erso.eu	this paper
SAND.CORE	Coordination action on advanced sandwich structures in the transportation industry	FP6	www.sandcore.net	this paper
SCOUT	Sustainable construction of underground transport infrastructures	FP6		if reports become available

Sub-theme 5: Driver, passenger and non-user safety				
Project acronym	Project title	Programme	Project website	Coverage
APROSYS	Advanced protection systems	FP6	www.aprosys.com	if reports become available
APSN	Network of excellence on advanced passive safety	FP6	www.passivesafety.com	if reports become available
DENSE TRAFFIC	A forward looking radar sensor for adaptive cruise control with stop & go and cut in situations capabilities implemented using MMIC technologies	FP5		EXTR@Web paper
ECBOS	Enhanced coach and bus occupant safety	FP5		EXTR@Web paper
FID	Improved frontal impact protection through a world frontal impact dummy	FP5	–	this paper
GOING SAFE	Addressing technical and human factors involved in the implementation of 3-point shoulder harnesses, on all seats, in passenger's aircraft	FP5		EXTR@Web paper
HELISAFE TA	Helicopter occupant safety technology application	FP6		if reports become available
IM@GINE IT	Intelligent MobilityAgents, advanced positioning and mapping technologies, integrated interoperable multimodal location based services	FP6	www.imagineit-eu.com	this paper

Sub-theme 5: Driver, passenger and non-user safety				
Project acronym	Project title	Programme	Project website	Coverage
–	Review of research on school travel	project from UK		EXTR@Web paper
–	Safety of children in road traffic in connection with child safety equipment in motor vehicles	project from Czech Republic		EXTR@Web paper

Sub-theme 6: Qualifications/Behaviour				
Project acronym	Project title	Programme	Project website	Coverage
2TRAIN	Training of train drivers in safety relevant issues with validated and integrated computer-based technologies	FP6	www.psychologie.uni-wuerzburg.de/methoden/forschung/projekte/railhumanfactors/2train.php.en	if reports become available
CAST	Campaigns and awareness-raising strategies in traffic safety	FP6		if reports become available
DRUID	Driving under the influence of drugs, alcohol and medicine	FP6	www.druid-project.eu	if reports become available
ECODRIVEN	European campaign on improving driving behaviour, energy efficiency and traffic safety	Intelligent Energy Europe Initiative		this paper
ESSAI	Enhanced safety through situation awareness integration in training	FP5		EXTR@Web paper

Sub-theme 6: Qualifications/Behaviour				
Project acronym	Project title	Programme	Project website	Coverage
R000238497	Changing patterns of everyday mobility	project from UK		EXTR@Web paper
S214G	Computer-based child pedestrian training	project from UK		EXTR@Web paper
S224J	Effects of road engineering modifications on child pedestrian skill development	project from UK		EXTR@Web paper
SAFETY-TECHNOPRO	Training system on new safety technologies for road transport addressed to professional bodies of the automotive sector	FP6	www.safety-technopro.info	this paper
TRAIN-ALL	Integrated system for driver training and assessment using interactive education tools and new training curricula for all modes of road transport	FP6		if reports become available
TRAINER	System for driver training and assessment using interactive evaluation tools and reliable methodologies	FP5	www.trainer.iao.fraunhofer.de	EXTR@Web paper
VIRTUAL	Virtual reality systems for perceived ergonomic quality testing of driving task and design	FP5		EXTR@Web paper

Sub-theme 8: Security				
Project acronym	Project title	Programme	Project website	Coverage
COUNTERACT	Cluster of user networks in transport and energy relating to anti-terrorist activities	FP6	www.counteract.eu	if reports become available
OPTAG	Improving airport efficiency, security and passenger flow by enhanced passenger monitoring	FP6	–	if reports become available
SAFEЕ	Security of aircraft in the future European environment	FP6	www.safee.reading.ac.uk	if reports become available

Remark: the projects listed in the annex are those that have had the focus on the theme Safety and Security, as well as those who have addressed safety and security as secondary topics to some extent. On the TRKC portal www.transport-research.info it is possible to use the “advanced search” functionality, with the option “safety and security”, and find all research projects, EU-funded and national, which have treated, to a variable extent, aspects related to the theme.