DECOMOBIL Roadmap for research on Human Centred Design of ICT for clean and safe mobility. Deliverable 2.2

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Roadmap for research on Human Centred Design of ICT for clean and safe mobility

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Executive summary

The DECOMOBIL roadmap activity aims at identifying main trends and priorities in the area of road transport in terms of societal challenges, industrials and manufacturers roadmaps, technology maturity, and defining main research priorities in the area of Human Centred Design of ICT for clean and safe mobility based upon the vision of the main actors regarding the components of the coming decades.

A scientific seminar on *"Roadmap of Information & Communication Technology design for clean and efficient multimodal mobility"* has been organized by the 28th of May 2013 in Munich, Germany. In addition, 5 scientifc seminars have been organized in order to discuss on specific topics and allowed external key stakeholders to share their knowledge and their view on focus areas crucial for the understanding of ecomobility main factors, context and bottlenecks.

This report presents firstly a synthesis on the roadmaps set up by main stakeholders allowing to have a vision of the future European technological, societal and industrial context and secondly research priorities in the area of ICT design for clean and efficient multi-modal mobility based upon main European projects and bodies vision in addition to the output from the seminars organised by the DECOMOBIL project.

Finally, research topics considered as priorities by the DECOMOBIL consortium are finally described in terms of Content and scope, Targeted Outcome, Key research challenges to be addressed and Expected Impact.

I. Introduction

In the framework of the DECOMOBIL project, contribution to acceptability and usability of ICT for cleaner and safer mobility has been made through animation of discussion with relevant stakeholders involved in this area and dissemination of updated data in Human Machine Interaction and Human Centred Design areas towards the ITS community at a European and international level. During the running of the project, several main events have been organized: 2 International conferences on “Human Centred Design for Intelligent Transport Systems” (held in Valencia, Spain in 2012 and in Vienna, Austria in 2014), 5 scientific seminars “Eco-driving methods: design and training” in Thessalonique, Greece, “Long-term impact and effects on ITS” in Vienna, Austria, “Nomadic transport services for multimodal mobility: issues and perspectives” in Lyon, France, “Electric mobility system in different scenarios: individual user, car sharing and fleet”, in Munich, Germany, “Human centred design for safety critical transport systems”, in Lisbon, Portugal, and 1 workshop dedicated to discussion about the specific topic of “Roadmap of ICT design for clean and efficient multimodal mobility” in Munich, Germany, with key stakeholders from various main organizations representing industrials, academic researchers, associations involved in this domain.

Objective of the work conducted in the DECOMOBIL “Roadmap” Work Package 2 is to develop a synthesis on the perspectives of research focused on the specific area of ICT design for clean and efficient multi-modal mobility based upon European technological, societal and industrial context and perspectives, in order to, firstly, identify key issues for future research and innovation activities in the area of clean and efficient multi-modal mobility in Europe and, secondly, set up priorities of research and innovation activities in relation to identified scientific bottle necks, lack of knowledge in some areas and priorities at European level.

In this purpose, the first part of this report will gather roadmaps defined by main key European organisations and industrials consortiums, such as for example “ERTRAC”, “EUCAR”, “European green car Initiative” defining roadmap context in terms of technology maturity and perspectives in implementation. Setting up and understanding this context is crucial. Indeed, roadmaps and perspectives linked to the human centred design of ICT for ecomobility is strongly dependent upon maturity of technology, European industry and public authority roadmaps, priorities in road safety and modalities of implementing sustainable transport at the European level. So, an overview and a better understanding of the current points of view of the main stakeholders from this point of view is fundamental to be able to set up research priorities in the framework of the DECOMOBIL project.

In the second part of the report, will be conducted an overview of the main European projects and initiatives relevant in terms of defining future research priorities for safe and sustainable transport, such as the European projects “PROS” and “Instant Mobility”, “iMobility Working Groups”, “ECTRI association”, and involved in the setting up of future

roadmaps in the domain of transport, road safety, ecomobility and information and communication technology systems. Then, a wrap up of the main discussions related to research perspectives conducted during the DECOMOBIL scientific seminars will be summarized and the main research priorities identified will be developed in detail.

II. Roadmaps and perspectives in transport and ecomobility: Overview of the main trends

1. Context

Transport in Europe provides for the movement needs of over 700 million people and associated freight. With growing freight and passenger transport, pollution and congestion risk is increasing and the European Commission is working towards a form of mobility that is sustainable, energy-efficient and respectful of the environment.

First of all, from an environmental point of view, the following main trends would be expected in the coming decades:

- CO2 emissions, climate change and environmental handling – are widely recognized concerns. While the debate on their magnitude, the sources, the impact is ongoing GHG reduction targets for emissions have been established in many places. For EU the 30% and 80% reduction targets for 2030 and 2050, respectively, correspond to a 95% decarbonisation for transport.

- Demand and price of energy and resource is foreseen to continue to increase, although there are different views on how much, when and which resources are affected. OECD-countries' much higher demand compared to non-OECD is foreseen to remain, even if an actual decrease is estimated.

- Increased connectivity is a result of the rapid deployment and development of new solutions. It is estimated that over 50 bn "things" will be connected in 2025.

Furthermore, the perspective in transport will present a real societal challenge due to the following main phenomenon at the worldwide level:

- Population growth – the world population is heading towards 8 bn in 2030, while Europe will be hovering around today's 740 M.

- Demographic Changes – the median age is increasing, in particular in non-OECD

countries, increasing the proportion of the population older than 65 years to 12% in 2030 globally, vs 8% in 2010. In Europe this increase is even faster – 22% in 2030, up from 16% in 2010.

- Urbanization will continue. In 2025, 2/3 of the world's population will live in cities, compared to today globally, and over 60% in Europe.

- Cities are growing fast, and there will be an increase in cities with more than 10 M inhabitants. This is especially pronounced in Asia, and to some extent Africa and Latin America.

Transportation of people and goods will increase and will continue to be a key driver for energy and fuel consumption with also increase in intermodality.
In terms of traffic systems & Infrastructure, green corridors will mature over the next decade and would contribute to enhanced safety and efficiency.
Congestion is expected to continue, or even increase, and usage fees may be seen. The high expectations on ICT (Information and Communication Technologies) include interoperability, harmonised Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communications, intelligent traffic systems for VRU, and safe mobility management and cooperative systems are expected to contribute to road safety and security, and automated roads.
Entirely new roads are likely to be built up mainly in emerging markets. Nevertheless, in EU and US, there are concerns about lacking maintenance of existing roads. In general, there is a substantial concern about the need and availability of investment and funds.
Conventional cars with internal combustion engines are expected to be around at least until 2050. Connectivity is seen as an enabler for fuel economy and safety improvements, including emergency handling and e-call. New Car Assessment Programs are expected also in emerging markets. Decade of Action sees this as a tool to encourage increased safety performance and penetration of safety systems (PROS project, Deliverable 1.3, 2012).

It is clear that there will be more road users, and that the proportion of elderly road users will increase in the coming decades. Population may as well be more mobile and healthy, as more fragile. It is also expected that the numbers of two-wheelers will increase – both powered, and pedal driven.

2. Roadmaps of key stakeholders in transport

Based upon this vision of perspectives and clear trends, the research in transport has to define priorities and roadmaps relevant to overcome these societal challenges in terms of efficiency, safety and ecomobility.

In this objective, the range of potential highly relevant transport research topics is broad. However, there are three overriding challenges facing the development of a competitive and sustainable transport system, which are absolutely crucial, and particularly hard to solve and

where research therefore should be prioritised as an essential part of the solutions (Vision from Horizon 2020, Copenhagen Research Forum, 2012, VERA Forward Visions on the European Research Area):

- **Smart**: Congestion due to overexploitation of system capacity;
- **Green**: Greenhouse gas emissions from transport's oil dependency;
- **Integrated**: A modally divided and vulnerable transport system.

Technological innovation will still be of paramount importance as development of novel and more efficient technologies will be pivotal for reaching the main European transport policy goals:

• Cleaner and safer vehicles for all modes;

• Cost-effective alternative fuels, (electric) drives, propulsion technologies, battery and chemical storage of energy and new materials for vehicle construction;

• Advanced ICT for personalised real-time travel information with modal integration, metropolitan traffic management and smart payment systems; to highlight a few exceedingly important areas which will require massive investments in R&DI towards 2020 and beyond.

A significant change of modal split away from cars is necessarily an essential part of the solution. This will also make cities more livable, but it will require both sticks and carrots to achieve, e.g. urban road pricing schemes accompanied by more competitive public transport and facilities for cycling and walking. Expectations for increasingly scarce funding for infrastructure improvements highlights the need for cross-modal integration as a means to improve overall efficient and sustainable mobility rather than effectiveness at modal level. Further development and implementation of concepts such as door-to-door mobility, seamless connectivity, and global interoperability can contribute to more customer-oriented services. In the future, transport may be more vulnerable to extreme events, and this calls for research in resilient systems. Finally, traffic is still responsible for a death toll in the EU of about 35,000 annually and many more serious injuries. Hence, in spite of dramatic improvements in traffic safety over the last four decades, substantial research efforts are still indispensable. Reaching the 'close to zero' vision will require a paradigm shift toward a holistic system approach.

In this framework, The European Commission has published several communications related to this area (COM(2011) 144, White Paper 2011 "Roadmap to a Single Transport Area - Towards a competitive and resource efficient transport system" ; COM(2010) 186, "A European strategy on clean and energy efficient vehicles" ; COM(2010) 2020, "Europe 2020 - A strategy for smart, sustainable and inclusive growth").

2.1 Roadmap from the Research & Innovation European automotive manufacturers (EUCAR)

The Strategic framework for Automotive Research & innovation has been analysed by EUCAR's members, in order to set out a future vision for performing research and innovation (R&I) activities (EUCAR, 2011).
The following schema represents the strategic out-look in the domain of Safe and Integrated Mobility and the priorities Research and Innovation for the automotive sector, identified by the European automotive manufacturers through their collaborative activities in EUCAR.

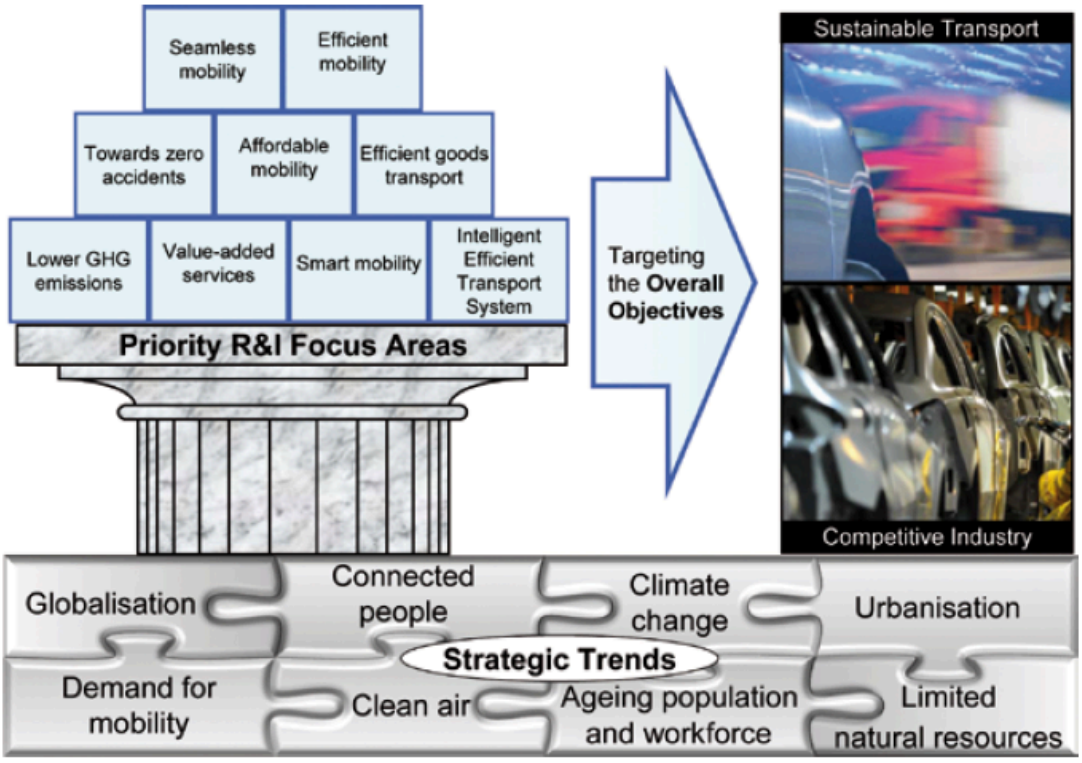
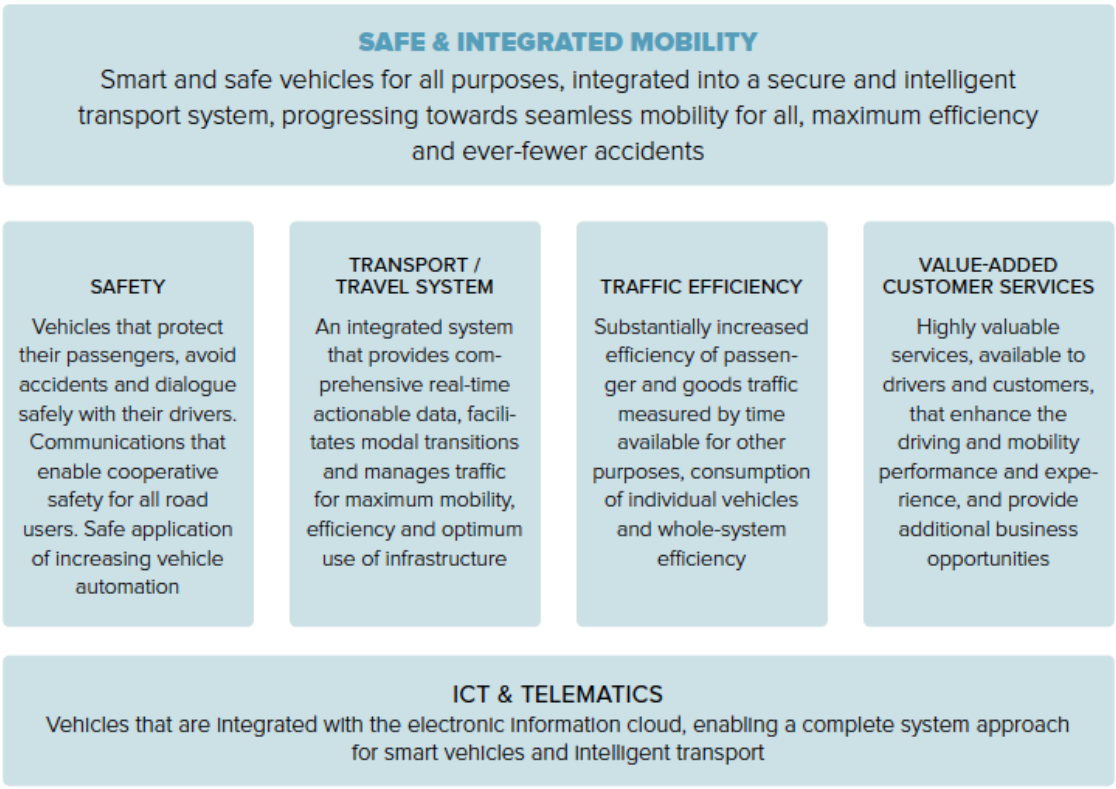


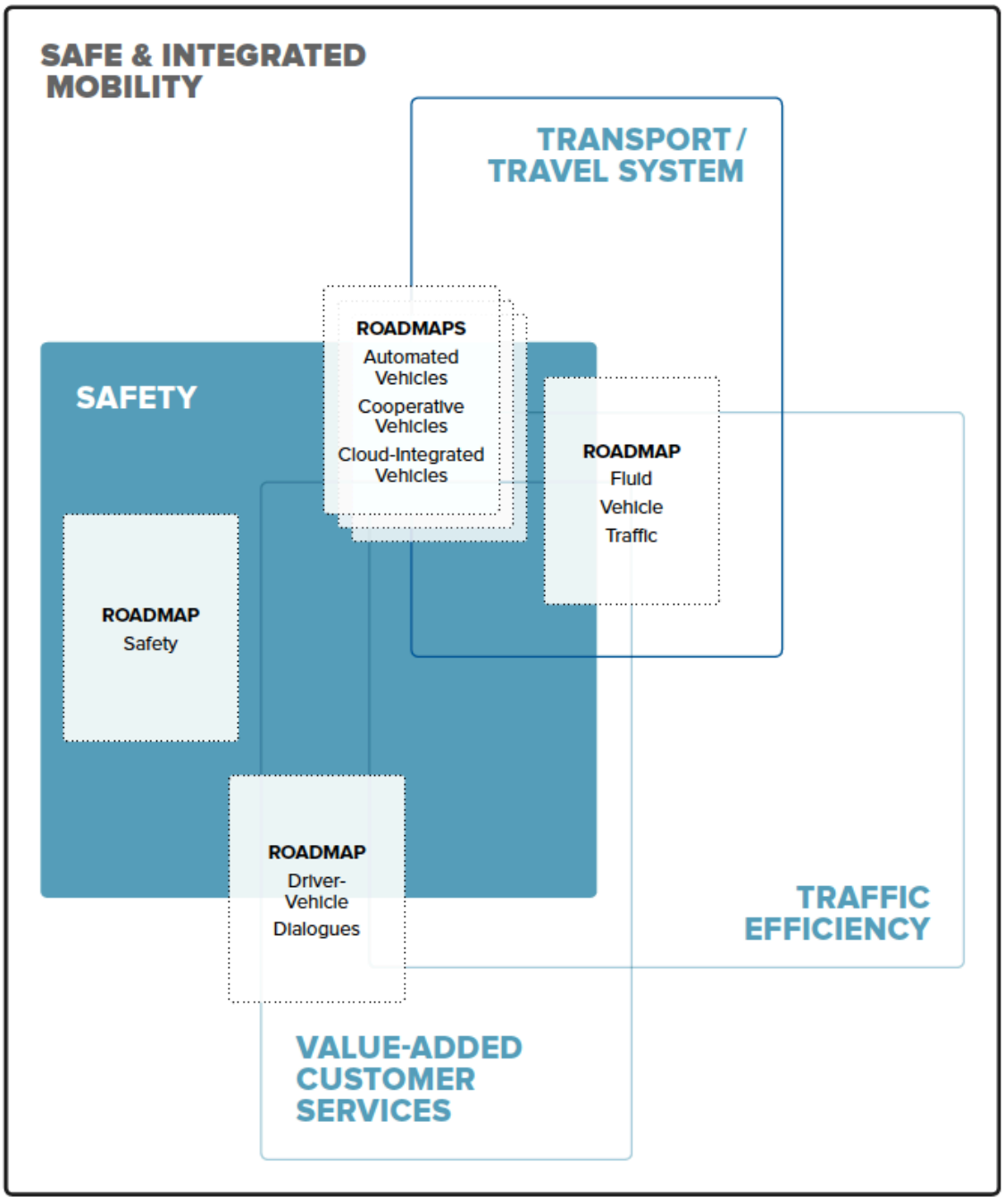
Figure 3: Stretegic framework of R&I priorities by EUCAR

This vision takes into account the phenomenom of the ageing population as a strategic trend to consider in terms of priority R&I focus by the car manufacturers. In their recommendations for research priorities, DECOMOBIL insists on taking into account the wide heterogeneity of the population with a specific focus on senior users and drivers, as it will be on the main challenge to face for designing an efficient and safe environment in the coming decade.

Derived from the above strategic framework, the following statements represent the strategic vision of the European automotive manufacturers in the domain of Safe & Integrated Mobility. The statements include an overall vision statement for Safe & Integrated Mobility and five statements, each representing the strategic vision for part of the domain. This subdivision indicates the breakdown of the Safe & Integrated Mobility domain from the automotive manufacturers' point of view into four vertical themes "Safety" and "Transport/Travel System", "Traffic Efficiency" and "Value-Added Customer Services". For each of these themes, one or more EUCAR R&I roadmaps has been compiled. The horizontal theme "ICT & Telematics" is a key element of the Safe & Integrated Mobility domain which feeds the vertical domains.



Regarding the ICT & Telematics, based upon the vision of car manufacturers on vehicles integrated with electronis information cloud, DECOMOBIL proposes investigations on the use of social network for drivers with the potential consequences in terms of benefits for ecomobility and safety (widespread at low cost of smartphone applications using social networks for drivers informing about alerts and danger, road congestion, ride sharing) but also potential consequences in terms of increase of ciritcal road situations links to an increase use of smartphones applications while driving.



Research priorities identified by DECOMOBIL are perfectly fitting with roadmaps identified by the car manufacturers in the area of safety: acceptability and usability of automated vehicles and cooperative vehicles, potential benefits of cloud-integrated vehicle services and potential consequences for road safety, modalities of Human Machine Interaction regarding driver-vehicle dialogue with development of design recommendation s and criteria guidelines to support the development of the developers and manufacturers.

2.2 Roadmap from the European Green Cars/Vehicles Initiative

Following dialogues between the European technology platform and the European commission, propositions have been made related to a set of perspectives and recommendations based upon consultations involving industrial and academic stakeholders from diversified relevant technology domains (European Green Cars/Vehicle Initiative reports, 2008, 2013; *note: after 2013, "European green car initiative" become the « European Green Vehicles Initiative » corresponding to an extension of the scope, more efficient in the perspective of sustainable transport).*
In this framework have been set up long terms roadmaps and strategic research agendas, shared commitments and visions between EC and industrials leading to a common strategy regarding improvement for a sustainable transport and electrification strategy (Figure 5).

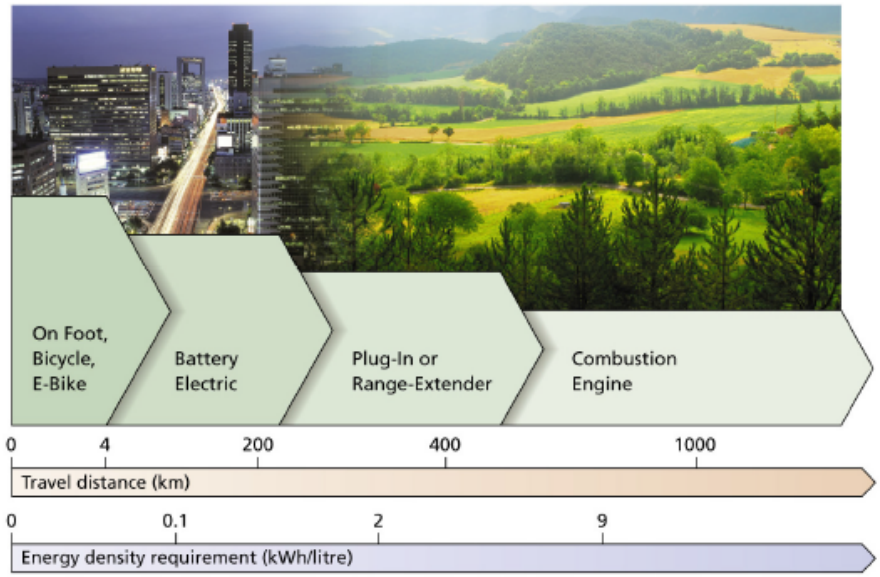


Figure 5: Principle for electrification of road transport (European Green Cars Initiative)

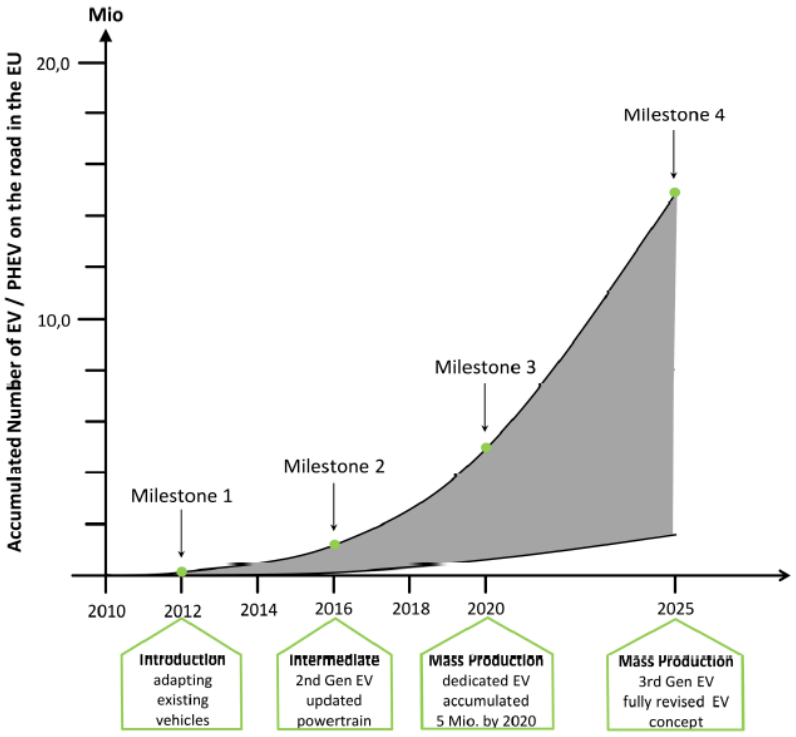


Figure 6: Milestones of the European Industry Roadmap for Electrification of Road Transport, ERTRAC, EPoSS, Smartgrids report, 2012.

This figure displays roadmaps regarding Electric Vehicle introduction and mass production till 2025. The expectation is that fossil-based fuels will still dominate the energy pool for road transport in 2030.

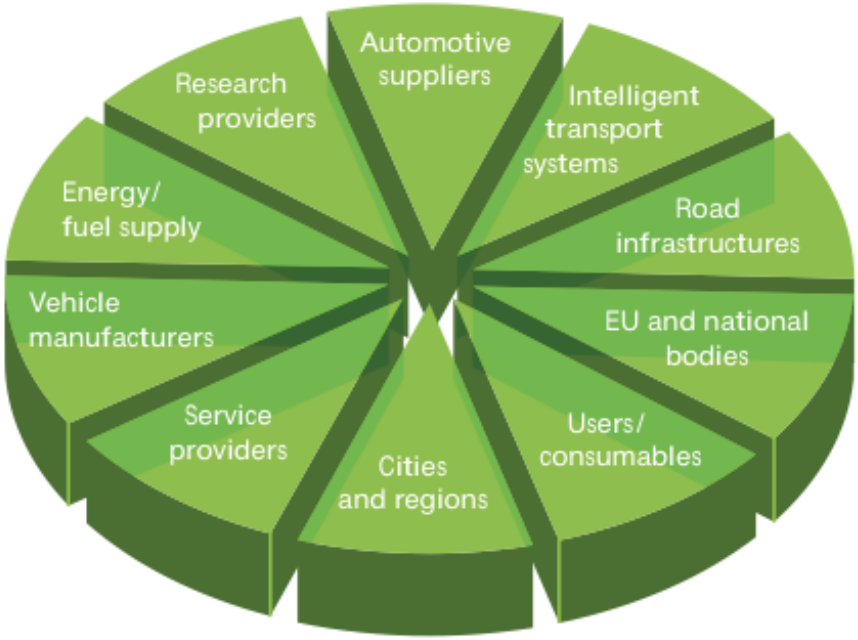
The future electric vehicle of the third generation can be envisioned as an energy efficient, safe, comfortable and adaptable electric vehicle. Essential enabling functionalities to develop this 3rd generation electric vehicle are being provided or facilitated by communication technologies and smart systems. For instance, regarding the user's range anxiety as well as cost of ownership, both decisive barriers for the mass introduction of electric vehicles, ICT may greatly contribute to the solution. The replacement of mechanics by electronics e.g. through drive-by-wire will lead to reductions in weight which will complement future advances in battery performance, and also lower the cost of the electric vehicle. This will be further supported for instance by driver assistance systems providing for efficient, comfortable and safe driving, and by ITS providing prediction and connectivity.
Hence, in order to tab the full potential of the electric vehicle regarding resource and energy efficiency, emission reduction and user comfort relevant ICT devices and ITS services have to be developed or refined and implemented. The growing number of ICT in the vehicle must not lead to more complexity, but even more simplicity, thus a completely revised ICT reference architecture is required. Thus, the need for a roadmap detailing the research needs in ICT is inherently apparent.

Priorities of R&D prposed by the industrials in this area are clustered around safety, driver assistance and convenience, energy efficient and environment friendly smart power trains and subsystem. In the electric vehicle the following functionalities will be provided by smart systems: management of energy storage systems, intelligent power electronics, active control of motors and wheels, functional safety of chassis and power train systems, smart integration of range extenders, and advanced vehicle to grid connection systems.

So research on Human Centred Design has still to consider and to investigate the two concepts till this date in addition to the safety and acceptability issues raised by the mixing of the two types of vehicle concepts on the road and in the city. DECOMOBIL proposes a research topic entirely devoted to the criteria of social acceptation of the electric vehicles.

2.3 Roadmap from the European Road Transport Research Advisory Council (ERTRAC)

The European Road Transport Research Advisory Council (ERTRAC) is a European technology platform which brings together road transport stakeholders to develop a common vision for road transport research in Europe.



Stakeholders and public bodies represented in ERTRAC

ERTRAC develops Strategic Agendas for research in road transport that are very interesting as they represent the holistic vision of diversified key stakeholders involved in this area.
The approach taken by the Strategic Research Agenda of ERTRAC recognizes, in particular, the societal demand for decarbonization, reliability and safety of the road transport system from a user's perspective (ERTRAC, 2010). For each of these societal needs, clear indicators have been selected, each with specific guiding objectives towards 2030 (see Figure 1).

Combined, these indicators provide a plausible reference to the headline perspective of a 50% more efficient road system. Each indicator displays improvement as a target considering the 2010 baseline.

By 2030 Road Transport is 50% more efficient than Today

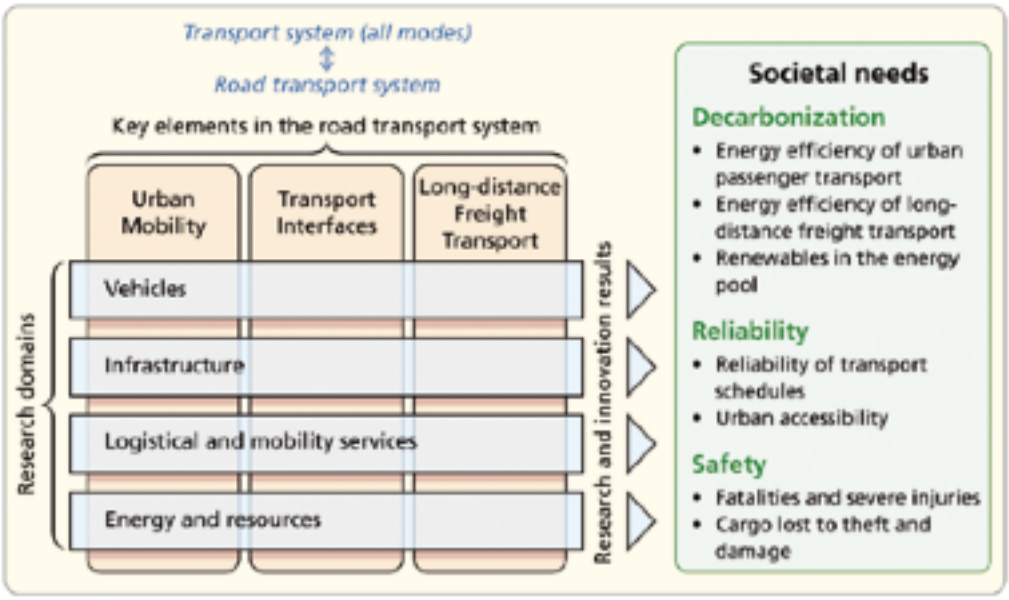
	Indicator	Guiding objective for 2030
Decarbonisation	Energy Efficiency: Urban Passenger	**+80%**
	Energy Efficiency: Long Distance Freight	**+40%**
	Share of Renewables	Biofuels: **25%** Electricity: **5%**
Reliability	Reliability of transport times	**+50%**
	Urban Accessibility	Preserve Improve where possible
Safety	Accidents with fatalities and severe injuries	**-60%**
	Cargo Lost to Theft and Damage	**-70%**

Table 1. Clear guiding objectives for Decarbonisation, Reliability and Safety in Road Transport.
The mission of '50% more efficient Road Transport' is articulated in leading indicators on Decarbonisation (3), Reliability (2) and Safety (2). Each indictor is furnished by a guiding objective for 2030 either indicating the improvement versus a 2010 baseline, indicated with '+' or '-' sign or an absolute level as is the case with 'Share of Renewables'.

Figure 1: Summary of guiding objectives of ERTRAC " A strategic research agenda aiming at a 50% more efficient road transport system by 2030 (ERTRAC 2010).

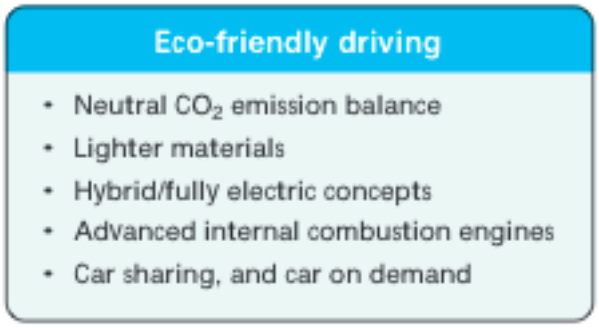
To achieve these identified and ambitious guiding objectives for 2030, the strategic research agenda proposed a comprehensive and consistent "systems approach". The figue 2 displays the approach involving the road transport system as it is used and experienced by the consumer, end-user and citizen, completed by an approach involving the global competitiveness of the European automotive production system.

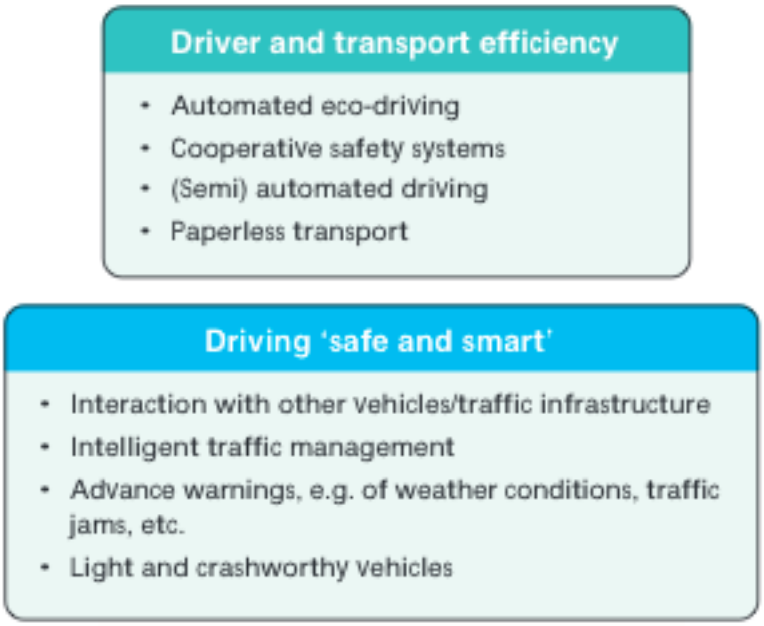
Figure 2 A systems approach to achieving a 50% more efficient road transport system



Linked to the need of a sustainable road transport system, the ERTRAC strategic agenda identified some of the priorities in targets to achieve directly impacting Human Centred Design approach and activity covered by DECOMOBIL scope:

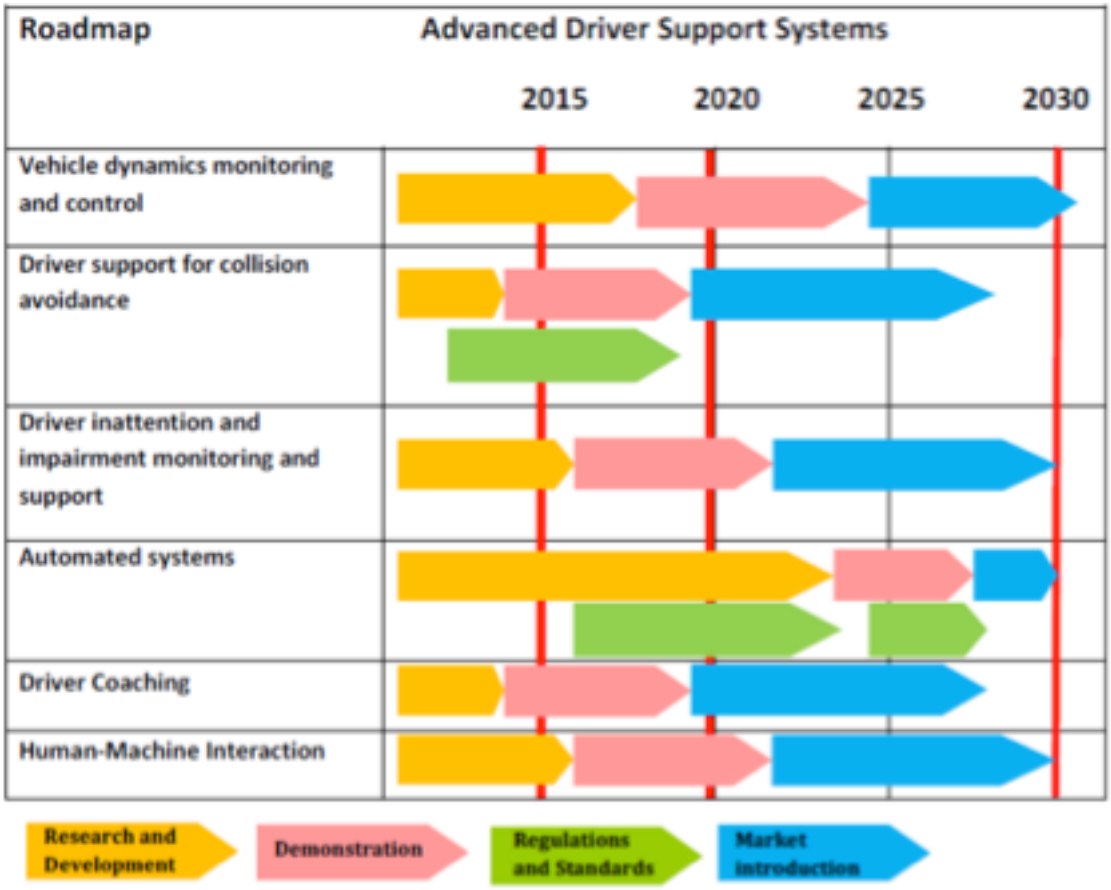
- *eco-friendly driving*: DECOMOBIL identified research priorities related to car sharing and studies about acceptability among users of this principle.
- *driver and transport efficiency:* DECOMOBIL includes investigation on framework of usability regarding automated eco-driving, studies on safety of automated and semi-automated driving, with the sharing of responsabilities and understanding of the vehicle control between the driver and the automatic systems, studies on impact of cooperative systems to road safety
- *driving safe and smart:* DECOMOBIL proposes research topics on human centred design of advance warning messages towards drivers in order to optimize legibility and understanding of the messages





ERTRAC Strategic Research Agenda covers dedicated actions towards improvement of safety (ERTRAC, 2011).

This roadmap covers all actions related the improvement of road safety on the vehicle, on the infrastructure, promoting a better driver behaviour, and the organization of the transport system.
In this paragraph are presented roadmaps covering the area of «advanced driver support systems» and « safety of vulnerablre road users ».



In-depth accident analysis and naturalistic driving studies have consistently demonstrated that the great majority of road accidents involve some form of driver error, in particular related to inattention. The key purpose of advanced driver support systems is to prevent such errors or mitigate their consequences by providing drivers with information or warnings on potential hazards, or even intervening by automatic steering and/or braking. In addition, some functions partly automate the driving control task. Also, enhanced logging capabilities have enabled driver coaching functions that provide drivers with performance feedback, during or after the trip, with the general purpose to obtain long-term behavioural change. Today, several advanced driver support systems have entered the market but the penetration rate is still relatively low.

To accelerate deployment, it will be of key importance to reduce development costs. This will require an increased level of integration both on the sensor and on the actuator/HMI side. Future technological developments will include improved perception capabilities, also utilising short-range communication enabled by cooperative system technologies. This will also enable a higher level of automated driving, which will require new regulatory frameworks. Increased integration of the suspension, braking, steering and propulsion systems will enable new forms of vehicle dynamics support functions. There are also key challenges for the design of the humanmachine interface to manage the rapid growth of functions interacting with the driver, minimise distraction and ensure a high level of acceptance and adoption of new functions.

Driver support for collision avoidance

Today, several types of collision warning systems exist on the market, primarily in premium segment vehicles. Recently, vehicle manufacturers took the next step to further enhance safety by introducing systems like Automatic Emergency Braking which autonomously takes control over the brakes when necessary to mitigate rear-end collisions. In the near future, active safety will be increasingly deployed in lower-cost segments. To achieve this, research needs to be directed at systems with multiple functions, with high accuracy / reliability, and reduced cost.

Deployment in heavy goods vehicles and buses will be accelerated by 2013/2015 legal requirements on mandatory CMbB and LDW systems.

On the sensor side, accuracy and reliability will be further enhanced, in particular regarding the detection of vulnerable road users. Moreover, in the near future, short-range communication technologies (V2V, V2I) will function as additional sensors. In combination with digital maps and e-Horizon, this will substantially enhance the robustness and predictive capacity of today's collision warning systems, thus minimizing false warnings and enabling automatic intervention across a wider range of scenarios. Enhanced predictive capabilities is also essential for systems supporting green driving, so synergies between those two application areas may be exploited. The development of integrated information, warning and intervention (IWI) strategies for multiple functions is another key challenge. Yet another future trend will be proactive information (e.g., based on digital maps, traffic information and/or V2V, V2I communication) supporting drivers' anticipation of potentially critical events, thus enabling more "foresighted" driving. Finally, there will be a trend towards increased integration of active and passive safety functions where, for example, collision prediction is used to optimise protection systems prior to impact.

Driver inattention and impairment monitoring and support

Driver inattention and impairment monitoring systems have started to appear on the market. These systems analyse different information on driving behaviour (lane keeping, steering and braking patterns, etc), and/or information from a interior cameras, to mitigate inattention (e.g., eyes off road) or physiological impairment (e.g., alcohol intoxication or drowsiness). In the case of alcohol, solutions that will disable the possibility to use the vehicle are foreseen. This may even include stopping a vehicle in motion, which requires a high level of accuracy and reliability.

Of key importance will also be to reduce the intrusiveness of some technologies (e.g., alco-locks), and to increase the real-world detection accuracy and reliability of others (e.g., distraction and drowsiness mitigation). Future inattention and impairment detection systems will combine signals from multiple (driver-, environment- and vehicle) sensors. Moreover, inattention and impairment monitoring systems will integrated into the general onboard perception platform and used for enabling a wide range of functions including inattention warning, driver coaching as well as driver state-adaptive collision avoidance.

Driver state monitoring will also be important for ensuring that the driver is in the loop during mode transitions in semi-automated driving.

Automated systems

From a technological perspective, fully automated driving is a reality today. However, the deployment of fully automated road vehicles will require more precise, reliable and extended environment perception and situation understanding. Here, positioning and

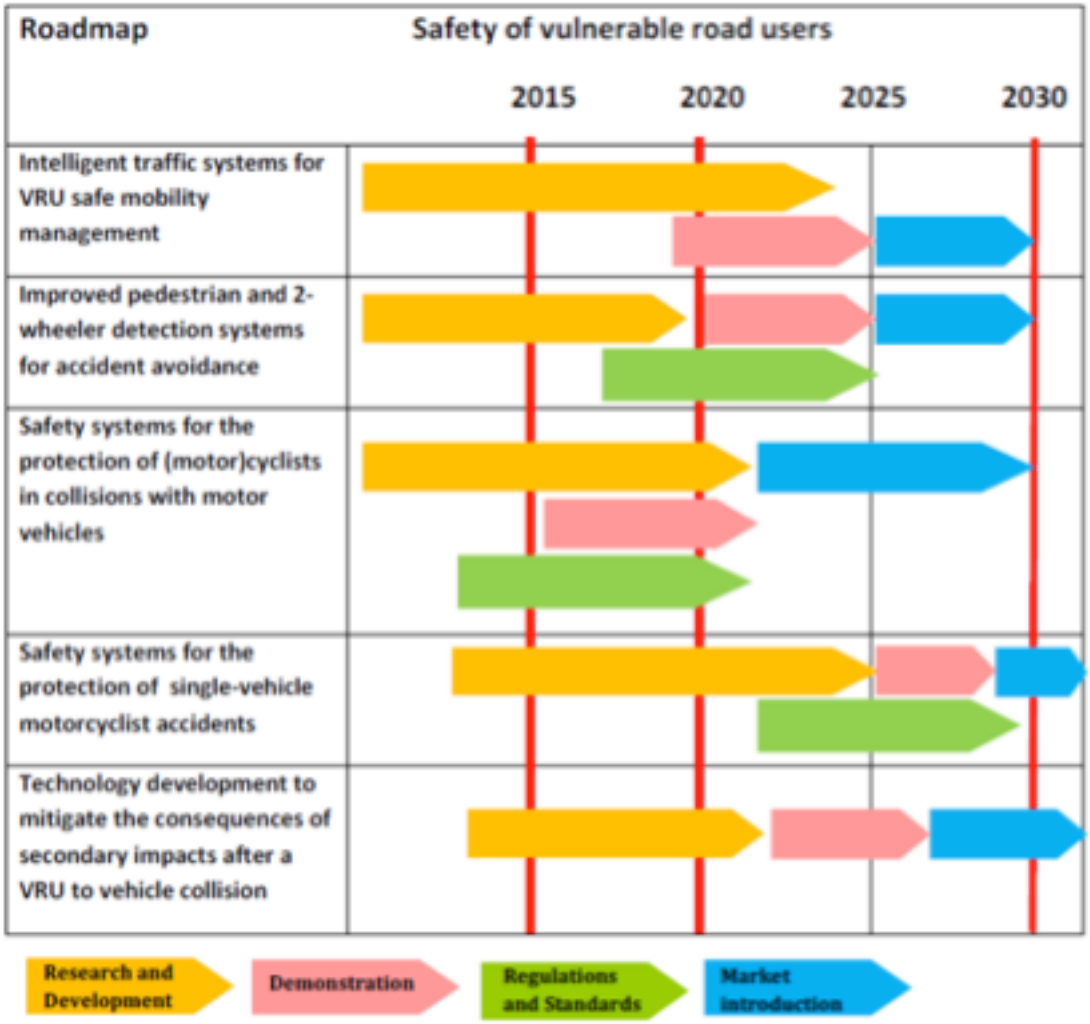
qualified map data and short-range communication (V2V and V2I) will be of key importance. It may be foreseen that, within the time-frame of the present roadmap, full automation will be limited to specific contexts (e.g., platooning or dedicated lanes) where the driver will maintain the overall responsibility for safe driving, although in a monitoring role. A key issue here is thus the development of automation strategies, e.g., for handling transitions between automatic and manual control modes. As discussed in Section 4.5, the infrastructure design will also play a key role in enabling automated driving and a systems perspective needs to be adopted.
Finally, legal and regulatory frameworks for automated driving need to be developed in order to enable large scale deployment.

Driver Coaching
The general idea behind driver coaching is to improve driving performance by means of feedback. This may involve improvements in safety as well as driving efficiency, and performance feedback may range from immediate feedback provided while driving to post-trip reports summarising performance over a longer time period (e.g., a drive, a week or a month). Driver coaching may be based on relatively cheap aftermarket video data recorders or more advanced onboard logging and communication systems which are also used for other purposes (such as vehicle uptime monitoring, vehicle optimisation and accident/incident analysis). These systems log inappropriate behaviours (e.g., hard braking, speed violations, close following, drowsiness/distraction episodes) and this information may then be used by a fleet manager to coach the driver towards safer and/or more efficient driving behaviour, using different forms of incentives. For private drivers, the information may be linked to incentives such as reduced fuel consumption or insurance premiums.
As the required logging technologies are relatively mature today, the main challenge As the required logging technologies are relatively mature today, the main challenge for future development of driver coaching concerns the implementation and deployment strategies. A critical issue is incentive schemes sufficient to motivate long-term behavioural change. For commercial fleets, it may be foreseen that driver coaching will to an increasing degree form part of general safety management strategies, and be combined with other measures, such as driver education and training. Technologically, driver coaching system will merge with other driver support systems. For private driving, new business models will emerge involving incentives, possibly linked to insurance and dynamic pricing (e.g., pay-as-you-drive). Another potential application, of increasing importance due to current European demographic trends, is the coaching of elderly drivers. Finally, as the level of automation increases, so will the requirement for driver coaching. Future systems may thus focus more on drivers' monitoring, as opposed to operational driving, performance.

Human-Machine Interaction
Drivers experience advanced driver support functions through the human-machine interface. Hence, the Human-Machine Interaction (HMI) design critically determines the level of usern acceptance and adoption and is thus key factor for successful deployment.
A general future challenge for automotive HMI design is to handle the rapid growth of functions interacting with the driver. In addition to factory-fitted and aftermarket functions, this will soon include cooperative system functions as well as downloadable third-party applications. Today, driver support systems are still, to a large extent, interacting with the driver independently of one another, but this situation will quickly become infeasible as the

number of functions increases. Thus, there is a need for more holistic approaches to automotive HMI design.
In-vehicle HMI technologies will develop towards increasingly intuitive and distraction-free driver support systems, involving in particular more advanced speech-based interfaces, based on natural speech understanding, which minimise the need to take the eyes off the road. A key concern today is the great distraction potential of consumer electronics systems not designed for use while driving. To some extent, integration of third-party applications into the vehicle HMI is already available in modern premium vehicles. This development is expected to continue towards increasingly seamless integration solutions. This may also involve more advanced methods for workload management, including, for example, dynamic scheduling and lock-out of information. A key step for enabling this development is new business models involving vehicle OEMs, consumer electronics OEMs and application developers. Due to the ageing of the European population, a further important topic concerns the potential to adapt the in-vehicle HMI to better suit elderly drivers.

DECOMOBIL proposes to develop holositic methodologies adapted to system functionalities aiming at the evaluation of the safety of advanced driver support system based upon the needs and the requirements of the users. These methodologies allow to gather human factors data such as driving performance, attentional demands, visual strategies, mental workload,… for systems supporting the driver activity as well as for automated systems. These methodologies will be useful to guide the development of the prototypes and avoid misconceptions at an early stage as well as at the demonstration phase to evaluate the final product.



Vulnerable Road Users (or VRU) are defined as those participants in traffic that are not protected by any mechanical system: pedestrians, motorcyclists, bicyclists, and users of mopeds. This includes road users with impairment, e.g. using a mobility aid, or children playing on the road. Car occupants, even when this refers to impaired people, senior people or children do not belong to the category of VRU according to this definition. Although the total number of fatalities and severe injuries due to traffic accidents is decreasing, e.g. as a result of the introduction of passive and active safety systems, the number of VRU that are killed and wounded in traffic tends to decrease in a much slower pace . Measures to decrease the number of VRU casualties in traffic are dedicated to influence driver and road users to show more safe behaviour, to make infrastructure more forgiving and intuitive in order to decrease the number of accidents and accident severity, and to make motor vehicles more safe e.g. by means of driver warning systems or full autonomous safety systems as to reduce the impact of accidents on injury levels of vulnerable road users. Influencing road user behaviour is outside the scope of this roadmap, except for advanced driver assistance systems which are integrated in vehicles and used in a timeframe prior to the crash at a moment that the driver is fully in control of the situation. Autonomous systems have to take over from the driver at the time that any response from the driver is too late to avoid a potential collision, or when the driver is no longer capable to deal with

the information flow regarding a potential critical situation. Intelligent systems are required that not only give information to the driver on the possible collision risk in the continuously changing environment of the vehicle, but also estimate the driver state in order to judge whether the driver is still capable to cope with the ever increasing amount of information to use this information to avoid critical situations.

Improved pedestrian and 2-wheeler detection systems for accident avoidance

Current developments in pedestrian and 2-wheeler detection systems aim at in vehicle sensors, such as a combination of camera's, radars, contact sensors and other sensor types, as these are desperately needed to avoid accidents with VRU. Developments are required to reduce the cost of these sensor systems, to make sensors smarter as to be able to identify the type of road user, and to reduce the number of false positives. There is a major concern about the growing thickness of the A-pillars for car structural resistance and the blind spots generated by the same.

Reducing the weight of structural materials might even increase the problem.

In order to have sensors to provide information that add to the drivers view, the information streaming towards the driver becomes important, especially in inner cities with high numbers of road users, including VRU. When a warning is given to the driver, does the driver have the possibility to digest this information, and is he/she capable of acting accordingly? Accident avoidance systems therefore also require an estimation of driver behaviour (capabilities), and driver state, to predict delayed reactions due to fatigue or increasing age. Using this information, the trigger for autonomous action by the car could be adapted.

Apart from in-vehicle sensors, detection could be enhanced by providing pedestrians and 2-wheelers with some sort of transmitter, whose signal is easily picked up by in-car or road side systems. This could especially be used in the protection of young children, that have little notion on the dangers of traffic or for bikers approaching a heavy vehicle with important areas falling under blind spots.

The regulatory framework is very essential for a successful market introduction of accident avoidance systems, especially in the case of autonomous actions of in-car systems. Current legislation has not yet an answer to upcoming questions on responsibility for autonomous acting vehicles. Besides the developments of such systems, the regulatory frameworks well as test procedures for such systems need to be installed.

Vulnerable Road Users have been identified as a priority by the DECOMOBIL consortium, due to the high level of accidents registered nowadays. The safety of this population represents a societal challenge for the coming decade, ITS functionalities can bring several intelligent solutions and have a great positive impact in this area. In addition to the technological development agreed by the car manufacturers following the roadmap above, human centred design approach should be developed in parallel to ensure about the usability and the acceptability of these functionalities among the various targeted users, VRU as well as drivers.

III. Roadmaps and perspectives in Human Centred Design of Intelligent Transport Systems for ecomobility and safety, Priority of research topics

1. Priorities of iMobility systems, intelligent vehicle and infrastructure systems (iCarSupport)

In order to identify priority in research topics on Human Centred Design for ITS, it is first required to better understand what are the Information and Communication systems considered as priority by the industrials, systems that will be developed and implemented in the vehicles or related to the infrastructure in the coming decade.

To answer to this issue, there is the interesting database of the iMobility that has been compiled by iCarSupport in order to maintain the state-of-the-art knowledge of different iMobility systems or intelligent vehicle and infrastructure systems (iMobility effects database, iCarSupport, http://www.esafety-effects-database.org/index.html). The criteria of priority are based upon both safety and environmental effects of these systems. The database is based on studies, conference papers and articles concerning the effects of iMobility systems, and particularly their effects on safe, smart and clean road mobility. The database is structured according to type of system or application.

Safety and environmental effects

iMobility priority systems	Other systems
• Adaptive headlights • Blind spot monitoring • Dynamic navigation systems • Dynamic traffic management (Variable Message Signs) • eCall • Eco-driving assistance • Emergency braking • Extended environmental information (extended FCD) • Lane keeping support • Local danger warnings • Obstacle & collision warning (including ACC)	• Alcohol (inter)lock • Anti-lock braking system (ABS) • Automatic speed enforcement • ESC • Seat belt reminder

• Real-time traffic information • Speed alert	

Blind spot monitoring

Description
At both sides of a vehicle normally there are some blind spots, if using a mirror for back ward view. Different systems can either provide better vision into the blind spot area or supplemental information regarding an obstacle being there, e.g. by warning signals. Wide angle side mirrors reduce the blind spot area. If the mirrors are heated, the vision in bad weather conditions is optimised further on. Camera techniques with image processing or radar sensors can give addition information about the situation in the blind spot. An adequate HMI solution is generally a prerequisite for an effective system.
Impacts
No reliable safety estimates yet exist. The system should affect side collisions i.e. collisions of vehicles in parallel lanes by making the drivers better aware of vehicles in close proximity.

Dynamic navigation systems

Description
Dynamic navigation utilizes current traffic event and transport network status data for adjusting the routing process in electronic navigation systems. This enables users to avoid routes with accidents, roadworks, road closure, and congestion in “real time”. The Traffic Message Channel (TMC) is mostly used to provide the basic traffic event information countries in Europe using RDS radio communications. More enhanced and individually sourced content is used to improve the standard TMC services in terms of accuracy and quality. These kinds of services are being provided via cellular networks.
Impacts
With the help of dynamic navigation, users reach their destination via a personally optimal route, which means that the whole transport network is being utilised more efficiently. Due to reduced congestion and quicker reaching of destination, the system is also reducing fuel consumption and emissions. The current overall estimate of the reduction of fuel consumption and CO2 emissions is 2% on the European level. Dynamic navigation is also very likely to have a positive impact on traffic safety as drivers are better informed about hazardous situations such as a tail of congestion, ghost drivers, or the overall high traffic volumes.

Dynamic traffic management

Description
Dynamic traffic management systems and local danger warnings are used to increase the

safety and flow of traffic in cases of disturbance caused by incidents, congestion and adverse weather. Dynamic traffic management systems may also be used to implement hard shoulder running to increase road capacity locally during peak hours. The systems are operated automatically, semi-automatically or manually from traffic control centres based on fixed monitoring systems or mobile sensors (FCD etc.) on location. The systems employ Variable Message Signs or VMS to give the information to the drivers. Three categories of VMS exist based on the types of messages given: 'regulatory messages', 'danger warning messages' and 'informative messages'. The dynamic traffic management systems usually use regulatory messages, sometimes accompanied by danger warning and informative messages.

Impacts

MostThe systems improve road safety by harmonising traffic flow and managing vehicle speeds according to the prevailing conditions. The impacts of the system depend on the quality of the traffic management system and the level of traffic volumes. Current evidence from accident studies indicates that the systems reduce all injury crashes by -5 to -20% and all fatal crashes by -10 to -25%. In addition, the systems improve the efficiency of the transport system, reduce congestion, increase driver comfort and decrease energy consumption and greenhouse gas emissions by harmonising traffic flow. Hard shoulder running improves road capacity locally where it is implemented.

Eco-driving assistance

Description

Eco-driving assistance assists and encourages the driver to Eco driving by providing information to the driver about the current fuel consumption, energy-use efficiency and appropriate gear selection taking into account engine and transmission efficiency, vehicle speed and rate of acceleration etc. Apart from displaying instantaneous and mean fuel consumption on the instrument panel (from the on-board computer), there can be an Eco Drive Indicator, which indicates when the vehicle is being operated in a fuel efficient manner with respect to driveline efficiency. The measure also informs the driver when a gear shift is appropriate.

Impacts

Eco-driving assistance applications affect the gear and speed choice of the driver as well as accelerating and decelerating behaviour. Current estimates for reduction in CO2 emissions are between -3% and -11%. Eco-driving assistance system can include also speed alert functionality and those eco-driving assistance systems can be expected to have safety effects similar to speed alert. Other types of eco-driving assistance systems improve safety through likely lower speeds but the effect is smaller than in case of speed alert. Simulator studies carried out so far on drivers having multiple goals simultaneously such as time saving and energy efficiency have not indicated any adverse effects on safety.

Extended environmental information (extended FCD)

Description

The idea of Floating Car Data (FCD) is to monitor individual vehicles to gather data

concerning the traffic situation on the whole road network. The in-vehicle equipment records the location of the car, speed and possibly other information such as acceleration or deceleration, and sends the recorded information to the central system or to other cars. The central collected data can be used as content for different applications and services. Floating car data can also be implemented as a decentralised system as in the German FleetNet project.

Impacts

No reliable safety estimates yet exist. The safety and other benefits from extended environmental information will follow from the user services utilising the information collected. Hence, the system should affect especially accidents in adverse conditions.

Real-time traffic information

Description

"Real-time Traffic and Travel Information" includes all information which is relevant to organize and to optimize traffic flow and which can give advice to the mobile user, usually the driver, and to contribute to road safety and efficiency. The eSafety goal is to provide the majority of drivers with actual intra-urban traffic information and to get adequate urban traffic information in 50% of all major metropolitan areas in the EU.

RTTI contains

- · the collection of relevant traffic data,
- · the interpretation of that information and prepare it for further use and distribution,
- · the application of that information to operate infrastructural installations such as traffic lights or moving traffic signals,
- · the wireless transmission of the RTTI to the mobile user by public or private broadcast and/or two-way systems.

Impacts

No reliable safety estimates yet exist despite the long-time availability and use of the systems. Real-time traffic information about problems and hazards on the road network to drivers before and during the trip to in-vehicle receivers enable the drivers either to avoid the problem by e.g. changing their route or to be better prepared for the problem by increasing their awareness and alertness. The system should affect especially accidents in adverse conditions and pile-ups. Effects on fatalities and injuries are currently estimated as lower than 10%. The positive effects on congestion, transport network efficiency and driver comfort are considerable.

Speed alert

Description

The system alerts the driver with audio, visual and/or haptic feedback when the speed exceeds the locally valid legal speed limit. The speed limit information is either received

from transponders in speed limit signs or from a digital road map, requiring reliable positioning information. Some open questions exist such as:

- Voluntary or mandatory equipment of vehicles
- Type of speed limits to be included: General regulations, local speed signs, temporary speed limits (e.g. "70" between 07.00 - 10.00h), dynamic speed limits depending on traffic and other conditions
- Road categories to be included: motorways, rural highways, urban roads
- General deployment for selected road categories or equipment of specific parts of road networks, such as accident black spots, tunnels, bridges
- Types of vehicles to be equipped: all vehicles, passenger cars, lorries, hazardous goods transports, buses,
- Categories of road users to use speed alert: all drivers, young/aged drivers, drivers under rehabilitation, commercial companies/drivers, other specific groups
- Definition of architecture (e.g. dynamic speed limits require infrastructure link)
- Legal relevance of speed alert for e.g. enforcement
- Availability and update procedure for European-wide database of legal speed limits that is standardised, certified and reliable
- Business model for the system including its whole life cycle

Impacts

The reduced speeds due to the system decrease the risk and consequences of road crashes. Existing study evidence indicates that an obligatory speed alert system in all automobiles would reduce fatalities in urban areas by 20% and energy consumption as well as emissions considerably. Obligatory system would most likely reduce the number of fatal accidents by 13-30% with full fleet penetration. The effects of a voluntary system are smaller and for the part of energy consumption and emissions, partly contradictory.

1. Priorities considering scenarios of advanced internet technologies for mobility (Instant Mobility project)

In the next decades, internet technology is going to play a crucial role in the mobility, as every travelers and drivers will have the possibility to be inform “anytime” “anywhere”, with potential high benefits in terms of ecomobility (wide spread of services such as ride sharing, low cost application of ecodriving, traffic congestion avoidance, optimization of trips for the drivers and high quality efficiency related to information for the public transport, encouraging to use this mode in the city).

In the framework of the project Instant Mobility, a quite complete review of possible scenario regarding consequences of internet on mobility has been set up in the coming decae, offering a very interesting background for research topics roadmap from this point of view (Instant Mobility, Deliverable 3.4, 2012).

2.1 Internet for Transport and Mobility Services

Multi-modal travel made easy offers a traveler seamlessly a wide range of travel and transport options, according to the user's preferences, for all the stages of a trip that may use various modes including public transport, car and non-motorised means, e.g. bicycles.

End-to-end itinerary planning

Traveller can choose preferred modes; online service provides optimised end-to-end itineraries, e.g. quickest, cheapest, least Green house Gas (GHG) modes.

Real-time itinerary monitoring

Online service monitors execution of itinerary on all modes, calculates actual versus planned service quality, identifies and notify service incidents and degradation as support services.

Continuously updated travel time information

Service provides continuous journey/arrival time estimate based on real reported journey times of all connected travellers.

Disrupted service assistant

Service detects disruption to any part of planned itinerary, identifies and offers best alternatives to traveller

Interchange & en route assistance

For multi-modal trips, provides specific information and guidance at mode-to-mode interchanges, and during each leg informs about stops/stations, connections etc.

On-the-spot POI & tourism information

During the journey, service delivers relevant point-of-interest (POI) or tourism information, at the right spot.

Special-needs travel support

Service for travellers with reduced mobility, guiding along fully accessible transport means and arranging for real-time support as needed, e.g. interchange. It will offer voice (for blind) or text (for deaf) information.

Ticketless mobile fare payment

Online service offers single account payment for multiple journey legs, so no need to purchase tickets; especially valuable for tourists and occasional users. Proof of payment provided via traveller's handset.

Bicycle sharing

Online service informs of bike and docking space availability, and allows multi payment on single account. It can accept reports of defective equipment etc.

The sustainable car provides travelers who choose the use a car for at least part of their journey with the best route i.e. that with least delay, least CO2, shortest travel time or lowest cost etc. via a number of interactive online information services based on future internet technologies.

Personalised route guidance

This service is enhanced with real-time recommendations for avoiding congestion, while interacting with a service that optimises each individual trip while optimising the overall traffic system.

"itinerary booking" service

This online service allows drivers to reserve "slots", departing at arranged time and following recommended route, and receiving limited traffic signal priority. Internet service pools all requests and allocates itineraries.

Real-time traffic & route information

Probe vehicle data from all fleets are gathered on internet, integrated with other sensor data to give real-time traffic conditions over full road network. Online traffic info services are available to drivers, and support other travel services.

Car sharing plus

Online service to locate, book and pay for a shared vehicle (small or large car; electric car; scooter; van…) for short-term use; may be offered as "mobility service" by vehicle manufacturer; may receive eco-incentive. The service can be delivered via mobile handset.

Ride sharing

Requests and offers of ride sharing from various social-networks are combined in online database, and mashed-up together to give greatest choice of time, location, type of person etc.

Congestion charging

Online service to monitor users' vehicles and apply variable charges according to location, time of day, vehicle type etc; can include negative charges, i.e. bonus for avoiding congested times and locations. It can be combined with service to suggest eco-friendly alternative easy to travel.

Parking assistance

Online services to provide parking space availability, booking, guidance and payment. Also social-network crowd-sourcing service to notify real-time availability of on-street parking spaces.

Collective transport 2.0 expresses a vision where transport operators in the future will use Internet to sense passengers' presence at stops and to register their destination, to offer innovative online services flexibly matching the vehicles, timetables and routes to the actual demand.

Floating passenger data collection

Sensors at stops and passengers' mobile devices provide location and destination information; when mashed up with route and service information this enables real-time operational optimisation.

Demand-responsive service coordination

Online service to receive passengers' requests and optimise operators' offer for demand-responsive transport (e.g. taxis, dial-a-ride, special transport services).

Flexible schedule adaptation

Based on real-time vehicle monitoring, operator uses online passenger demand information to adapt service route and timetable, and to inform passengers of service modification.

Adaptive collective transport priority

Internet service adapts traffic light timing to offer green light to bus & other collective vehicles, provides speed recommendation to vehicle driver.

Ticketless fare collection

Operator uses Internet to collect fares via users' mobile devices, and to connect to mobile ticket inspectors. E-ticket payments are mashed up with passengers' other mobility services and added to monthly account; internet used for inter-operator payment clearing.

Driver & passenger security monitoring

Real-time or stored video of vehicle interior is sent wirelessly to web service that automatically identifies problems (driver or passenger) and alerts security services.

Taxi sharing

Taxis can pick up and drop off additional passengers along the route through online service to match potential users with actual shared taxi availability (location and destination, number of places etc.)

2.2 Future Internet in transport: services & technologies

Crowdsourcing services

In a world where reaching and connecting with consumers gets increasing complex every single day, Internet is driving a new trend for searching and retrieving information which is crowdsourcing.

"Crowdsourcing is a distributed problem-solving and production process that involves outsourcing tasks to a network of people, also known as the crowd. This process can occur both online and offline."3 In the case of Transport and Mobility services, crowdsourcing will be supported by all transport resources: vehicles, drivers, travellers, road infrastructures especially using Internet of Things technologies based on sensors and actuators and all ICT technologies required for connectivity.

The required interoperability between all professional actors is the first pillar of the expected collective intelligence to complete business-related tasks that companies could usually perform but deliver only pieces of information to transport users.

The idea of soliciting travellers and drivers inputs seems not really new but the way theses services are developed today provide only from time to time few information and people are more consumer than producer of information, especially for traffic issues. If people are involved in multimedia content production, there are not providing some basic data that are relevant for transport and mobility services. This is the second pillar which requires easiness and automaticity, but always following privacy rules.

The complexity of Transport and Mobility area is represented by a fully distributed system with a very complex and extended value chain. But in the same time, Information and Communication technologies have also distributed computational resources in small components and provide a well-defined connectivity. These distributed powerful resources are the third pillar which will support Transport and Mobility crowdsourcing services.

Social Networks

Internet has largely supported online social networks for which websites are commonly used. These websites are known as social sites. Social networking websites function like an online community of users. Depending on the website in question, many of these online community members share common interests in different subjects. Once you are granted access to a social networking website you can begin to socialize. This socialization may include reading the profile pages of other members and possibly even contacting them.

The friends that you can make are just one of the many benefits to social networking online. Another one of those benefits includes diversity because the internet gives individuals from all around the world access to social networking sites and their related shared contents. This means that although you are in the Italy, you could develop an online friendship with someone in Denmark or Spain. Not only will you make new friends, but you just might learn and share things about local issues.

As mentioned, social networking often involves grouping specific individuals or organizations

together but few enterprises could really take benefits from these communities of users or consumers.
While there are a number of social networking websites that focus on particular interests, there are few which are focusing on Transport and Mobility concerns. Some of them appear recently more through small applications on devices and to share a very specific need: traffic information, car-sharing… No concrete community exists to share all transportation concerns and habits.
New interfaces are available to interact easily with devices but developments are required to merge human interaction with small business process automation which could be hosted by several type of devices (personal devices, on-board devices).

Security and privacy services
As future services include real-time location and need to share lots of data the two main topics regarding security and privacy are:

- Access right management
- Anonymous mechanisms

These two critical technical issues could be completed by strong mechanisms to avoid networks attack as all people and vehicles will be connected.
In a first step, Future Internet technologies will provide profiles management tools where profiles will be associated to different transport services or how people expect to use differently services depending of the context. Based on this set of profiles, access rights will be managed cooperatively locally, as close as possible of the users, and in a central way for large numbers of citizen using the same type of profile. This dual approach will enable new policy rules and support some automated actions based on access right delegation.
Anonymous mechanisms is a more challenging issue especially because to manage this services close to the user ICT technologies required computational resources which are not really available today. Some technologies are available to manage anonymous mechanisms in a central way but this approach required strong network security and certified third parties.
Future Internet technologies are quite far to support repudiation services where citizen will be able to define how long the data they agree to provide will survive in the network before to disappear.

2. Priorities for Road Safety Research in Europe (PROS project)

A commonly agreed priorities in road safety research has been developed in the framework of a pan-European network (the PROS project: Priorities for Road Safety Research in Europe) allowing to overcome the current fragmentation in relevant stakeholder groups. This network follows an integrated approach covering human, vehicle and infrastructure aspects and all phases from preventive to post-crash safety.

Following are key words and statements made by the PROS consortium regarding mobility perspectives that are important to consider in future roadmaps in the domain of road safety (PROS project, Deliverable 2.2, 2014), (these statements have been selected from the overall document as they were in direct connection with the Human Centred Design research priorities):

• *Older road users* – taking into account that this may mean both more fragile road users, but also more healthy and mobile persons at a given age.

• *The increased connectivity* – both the connected person and connected things – to be handled in a systemic way, beyond technologies and singular V2V, V2I-activities.

• *The growing city* – urban area focus, including possible increased density of cities.

• *Road users beyond drivers and car population* need to be taken into account, such as passengers on public transportation, and vulnerable road users.

• *A more diverse traffic mix* – private/public and collective/individual transportation; new energy vehicles, different transport modes, city freight, etc.

• *Effects resulting from efforts to meet the CO2 emission reduction targets*, which is a major focus area for the transportation sector, including new energy vehicles, new materials, transport modes, etc.

• *Time for penetration of new technologies into the transportation system.*

• *Activities that can be applicable also in other geographies and should not be sub-optimized for Europe*.

Based upon these statements, the following recommendations for future research priorities in safety have been identified by PROS project:

- Behaviour in traffic – *Making us safer road users Specific challenge*
- Improving protection in crashes – *Counteracting our fragility*
- Technological leadership in safe future vehicles – *From assisted to automated driving*
- Technological leadership in safe future vehicles – *Improving protection in crashes*
- Vehicle technology for two-*wheeler safety*
- Safe roads design – *Making them self-explaining, forgiving and interactive for the benefit of all road users*
- *Enhancing safety through advanced road maintenance concepts*
- Innovation in ITS infrastructure for road safety – *Making use of the connected world*
- *Traffic management for road safety*
- *Understanding what is happening on the road and linking it to measures*
- *Evaluating impact of safety concepts*

3. Priorities in cross-modal challenges for an integrated transport system (ECTRI)

Priorities of research topics for an integrated transport system and relevant for design of ecomobility have been identified by the European Conference of Transport Research Institutes (ECTRI, 2014).

Among cross-modal challenges for an integrated transport system identified as priorities, some of them directly linked to Decomobil scope:

1. **Forecasting socio-economic and technological developments**
   To address the significant current and future transport-relevant challenges such as global warming, energy supply and the ageing population, long-term systems thinking is required addressing both the social and the technical aspects of future developments. We need to better understand the capability of technology with a long-term (50 year) and very long term (70-80 year) view and to develop visions and scenarios taking full account of different stakeholder perspectives and economic realities. Opportunities created by the analysis of Big Data could improve forecasting and planning within both, personal and freight transport.

2. **Achieving sustainability-friendly mobility**
   The future will see a strong need for new vehicle concepts, reoriented urban design and a shift in land use for sustainable environment and energy efficiency. However, the decision making in achieving this includes numerous stakeholders, conflicting goals and multi-level political processes and most important - individual private mobility decisions. A holistic network-wide approach is necessary to ensure that mobility issues are not simply transferred from one mode to another. Effective sustainable mobility needs further research to address all three components: economy, society, and environment. A further challenge is to understand the compatibility between future mobility systems, current and alternative decision processes – including individual private mobility decisions – and the development of sustainability-friendly mobility.

3. **Ensuring resilient and secure transport systems**
   European cohesion, economic growth and improved quality of life are depending on well-functioning and efficient transport chains, which are affected by a rising number and extent of threats and hazards. Moreover, the existing transport infrastructure is frequently under-maintained due to lack of funding or to a lower priority level. Concerning transport infrastructure, a number of measures for protection have been developed. However, the critical combination of measures and their cross-effectiveness has been left out. It is essential to use an integrated approach to protect the EU transport systems from hazards and keep the most important goods moving. This calls for in-detail analysis of threats and categorization of effects and impacts for supply chains and affected transport modes as well as for further development and trialling of maintenance and upgrading technologies through demonstrators on a European scale. Another important aspect is to develop flexible information and decision systems concerning the current capacities and performances of

different transport modes in real-time.

4. Priorities on Human Centred Design for ICT and ecomobility (DECOMOBIL project)

The running of the DECOMOBIL project has been a great opportunities to discuss and debates of these main issues and societal challenges leading to identification of research priorities in the area of road safety, ecomobility, ICT Human Centred Design based upon technology maturity, automotive and manufacturers roadmaps. Several of the debates have been conducted in the framework of the scientific seminars and the international conferences organized by DECOMOBIL with key external stakeholders bringing their expertise and their vision.

5.1 Discussion from DECOMOBIL seminars and roadmap workshop

During the 3 years running of the project, 5 scientific seminars have been organized on the following topics (only 4 of them are presented in this report, as the last one will be organized after the publishing of this document):

1. Eco-driving methods and training
2. Possible long term impacts of ITS to support Green Driving and Clean mobility
3. Human centred design for Nomadic transport services in multi-modal mobility
4. Electric mobility system in different scenarios: individual user, car sharing and fleet
5. Human centred design for safety critical transport systems

In addition, a specific workshop on the topic of Roadmap have been also organised :

- Roadmap of ICT design for clean and efficient multimodal mobility

In the following section, main ouputs and conclusions of these seminars are presented. They are written the way the rapporteur transcribed them for each seminar.

DECOMOBIL Seminar " **Eco-driving methods and training », Thursday, December 1, 2011, Thessaloniki, Greece**

- Eco-Driving: Definition and State of the Art, D. Margaritis,, CERTH/HIT
- Eco-Driving ITS and EU initiatives, E.Bekiaris,, CERTH/HIT
- Using mobile technology for on-board and off-board Eco-Driving schemes, R. Montanari, RELAB
- Training methodologies and interactive tools in Eco-Driving. Research priorities stemming from DETRA., S. Nikolaou,, CERTH/HIT
- Evaluation of truck Eco-Driver training delivered through simulation A. Stevens, TRL
- Acceptability of Eco-driving functionality by bus drivers A. Pauzie, IFSTTAR
- Interactive discussion on future research in Eco-Driving methods,, emerging technologies and training, Chaired by E. Bekiaris, CERTH/HIT

Following the presentations, some main points for future research and policy actions have been highlighted:

Traffic Management policies and algorithms and their potential towards improving eco-driving and CO2 emissions reduction through practices or cooperative systems.

Which are the effective ways to develop micro and macro simulation models to assess the effects of Eco-driving?

Eco-driving and relation to PTWs?

Incentives for Eco-driving promotion (for bus, truck, elderly drivers, …).

Convince/ involve the OEM's and relation/ convergence of EU policies?

Clean car racing events organised under the auspices of FIA in member countries, providing accuratepoint-to-point fuel consumption. Could such actions increase the awareness of the public to Ecodriving?

Which are the enablers and which are the limiters?

Training costs? Acceptance issues? Legal issues especially those related to intervention actions?

Eco-driving as a pre-requisite to the success of clean vehicles' market penetration, and especially electric ones.

The discussion resulted in the following conclusions:

Major stakeholders/ promoters:

Energy providers (promoting energy saving to support their clients).

OEM's of clean vehicles.

European associations or agglomeration of transportation companies pushing the industry to have Eco-driving systems as standard options to their vehicles and highlighting their interest for specific functions.

European Commission and politicians providing economic and non-economic incentives.

International standardisation initiatives.

Eco-Driving Enablers:

Need for range extension by OEM's of clean vehicles, thus need for less fuel consumption.

New technologies on nomadic devices (i.e. iPhone gateway).

Personal mobility ecological footprint algorithms and devices trend.

Engine modification services for alternative fuels and need of driver behaviour adaptation.

Economic crisis, leading to importance of any fuel savings.

Eco-Driving Limiters:

Lack of standardisation.

Cost of training or in-vehicle application.

User acceptance because of legal implications.

Safety of application, to avoid enhancing the driver workload.

Key areas for Market penetration :

Incentives that will focus more on identifying the state-of-the-art and test the available technologies in short and medium-term.

ITS/cooperative systems and their relation to Eco-driving to be studied through implementation scenarios useful for any cooperative project of the future (i.e. macro level -> city level).

Eco-driving training is an issue that needs further research funds to be standardised. The research should currently focus on validity, evaluation frequency and ways of monitoring Eco-driving. Training could be defined, through requirements stemming from such pilot studies.

Eco-Driving Training :

Training for eco-driving can be at three different levels:

Information feedback to the driver (either real-time or post-drive);

Recommendations in real-time depending on driving conditions, etc;

intervention between the driver and vehicle (according to pre-selected levels).

***DECOMOBIL Seminar "* Possible long term impacts of ITS to support Green Driving and Clean mobility", April 19th & 20th, 2012, Vienna, Austria.**

- **Impulse presentations**
- Can intelligent transport systems support green driving??, Ralf Risser, Factum
- How green is green driving ? Potentials of the driving style compared, *Harald Frey, Vienna University of Technology, Institute of Transportation – Research Centre of Transport Planning & Traffic Engineering*
- **Small group work**
- Think of the intelligent systems that you know by now and that are in effect à what green driving aspects are supported by those systems
- **Impulse presentations**
- Assessing driver behaviour with respect to medium and long term developments, *Juliane Haupt, FACTUM*
- Brave new world? Hopes and fears concerning ITS and Green Driving, *Rob Methorst, Dutch Ministry of Transport (Rijkswaaterstaat), Centre for Transport and Navigation*
- **Small group work**
- What endangers positive outputs and positive outcomes of those systems that you know today?
- What new ITS can or could you think of that would fulfil the goals achieving green driving without unwanted side-effects?
- Address different groups of drivers and what systems help them
- Green driving could also be green mobility; plus harmful effects that are barriers to achieving the goal

Start the process with discussing higher levels of behaviour (life style, strategic issues; see models of Michon and Hatakka) and proceed to the lower levels stepwise. It seems to be obvious that the highest potential for greener & cleaner mobility lies in the life styles and in the strategic decisions of people.

Still it is not useless to take initiative on the lower levels. Measures that support intelligent strategic use of the car and that enhance the use of other modes in addition to car use, initiatives to improve driving style towards a more eco- _and socially friendly one, and also systems that help minimise energy investment and optimise efficiency of the car in a technical sense can be considered positively.

However, also side effects are known to appear on all levels of deployment. The discussion of possible side effects should thus be led at all stages of implementation: Do not strive for a terminal problem solution in this respect, but consider the fight against side effects a continuous process where we steadily learn.

Level of deployment	**Type of support**	**Type of system**	**Evaluation methods**
Optimum sustainability, mobility as a life style issue, choice of living place that makes car use unnecessary	Support use of alternative modes, support changing of habits, provide security connected to changes of habits (old persons or commuters giving up driving etc), provide relevant information	Platforms making use of internet and mobile phones, information systems for walking, cycling, public transport and all kinds of combinations	Narrative approaches, longitudinal design, repeated studies: Qualitative interviews, heuristic procedures; assess mobility patterns with the help of verbal data – but also smart phones could be used!
Strategically intelligent car use	Support part use of the car viz. the car in the frame of an intermodal chain, support compa-nies/professional drivers in reducing length of trips etc.	Intermodal information and navigation systems, Park & ride information, Public transport information connected to congestion info, last-mile information that makes parking further away from ones goal less of a problem	Counting vehicles in park houses & distribution; measuring sums of trip lengths, time on the road, fuel consumption, but also narrative approaches etc. (see above)
Tactic and operational level (driving style, equipment in use)	Measures to improve the driving style towards a more eco-_and socially friendly one, systems that help minimise energy investment and optimise efficiency of the car in a technical sense	Dynamic route guidance, speed limiters, ACC, parking information, econometers, etc.	Behaviour observation & behaviour registrations with different degree of structuring, measuring driving cycles and calculating exhaust, fuel consumption etc. on basis of this

The assessment of the behaviour at the higher levels is more complex, though. Empirical access is limited and one has to rely more on verbal data, results are most often more of a qualitative type. This may be one reason why higher level issues in connection with the introduction/implementation of ITS are not so well researched, as quantification is always asked for, almost like a reflex. In contrast to this, it seems necessary to demand that we learn better use of qualitative methods in order to be able to better understand and influence higher level behaviour processes. At the moment, however, most of the research is done, with very high investments (FOT, NDR), on the operational and tactical level of behaviour.

***DECOMOBIL Seminar "*Human centred design for Nomadic transport services in multi-modal mobility", 15 November 2012, Lyon, France**

- **Session on human centred design of nomadic**
- Issues on human centred design of nomadic for multimodal travel, A. Pauzié, Ifsttar/LESCOT, Mobiville project
- Issues on nomadic services to improve mobility of impaired people, M-F Dessaigne, Ergonomos, University iParit descartes, LATI, Infomoville project
- Issues on design of nomadic devices in Brasil, M. Quaresma, PUC-Rio University/LEUI, Rio de Janeiro
- Issues on guidelines and recommendations for nomadic design, A. Stevens, TRL, ESoP
- **Session on future of nomadic services: ecomobility**
- From exclusive car use to combination of urban mobility services through nomadic tools, J-L Gauducheau, CityWay & J Coldefy, Grand Lyon, Optimod'Lyon project
- Field operational tests of aftermarket and nomadic devices in vehicles, A Morris, University of Loughborough, TeleFOT project
- Design and Development of mobile service for ecodriving, G. Saint Pierre, Ifsttar/LIVIC, ecoDriver project
- Acceptability of ecodriving via nomadic device, P. Minot, Nomadic Solutions, Ecogyser system
- Acceptability and social community issues for ridesharing and multimodal success, N Dubus, Orange & A. Attour, Ecole des Mines de Nancy, Instant Mobility project
- Round Table with all the speakers

Main comments and statements :

- Even if technical solutions exist in order for the information on nomadic devices to be accessed easily, the type of information relevant to be delivered in relation to the localization of the travelers/drivers, and the way to display it, still needs to be investigated, especially according to the context (urban, peri-urban, interurban) and the type of user (novice, professional drivers, elderly or impaired traveler).
- Usability and legibility of information on nomadic devices is a challenge in terms of human centred design, due to the size of the screen and the mode of dialogue (tactile screen, small keyboard,…).

- Needs and requirements specific to elderly travelers in terms of trips typicality and motivation, in addition to characteristics of their perceptive, cognitive and motor abilities have to be integrated in the design of multimodal transport services on nomadic devices, as this population will increase in the coming decades and as mobility of this population is an important issue for the society, previous studies showing that it impacts on the level of senior good health.
- Success in being able to attract drivers out of their vehicles in urban area by offering high quality information on other modes of transport (public transport real time schedule and guidance to location of stops and stations, availability and location of parking, availability and location of self service bicycle stations) is closely linked to a better understanding of drivers' needs and requirements, in addition to habits of use in order to support nomadic applications development.

1. Future priorities

Following the workshop, a short questionnaire has been sent to all the participants to get feedback about their opinion and their view in terms of future research perspectives based upon their expertise and the discussion run during the workshop (instructions and full questionnaire in annex 2).

The main answers received following this survey are summarized in the following paragraph:

1- Nomadic Research issues related to safety *(priorities, bottlenecks, lacks, future focus in development, positive and negative impact, integration with other systems,…)*

Priority of research:

- driver's safe use of Nomadic Devices during driving (functions, type of interaction): this research is a priority due to the widespread of these mobile devices and the increase number of available functionalities.
- rider's safe use of Nomadic Devices during riding (functions, type of interaction): this research is a priority has the riding task is very different from driver task, and almost no knowledge available about the specific context of PTW and the riders' behavior.

Lack of research

- Nomadic researches still need to be conducted on the consequence of the use of such systems on attentional focus and resources. For instance, it would be interesting to complete the study driven by M. Quaresma on visual interruptions while using nomadic system by a measure of the orientation of attentional focus. Indeed, as previously demonstrated by Posner (1980) the visual focus does not strictly correspond to the attentional one.
- Future focus on research understanding complex relationships between driver's attention (level of fatigue, experience in driving,) and nomadic system use (purpose of application, mode of dialogue…) could be useful to (1) improve driver security while using (reading, tapping, talking with, hearing, etc..) this kind of system; (2) improve the recommendations to drivers when they have to use them.

- Related to vehicles, the integration of different nomadic devices and the combined usage of IVIS and ADAS is an interesting issue for the forthcoming years (especially, for the evaluation of workload and, more in general, possible negative outcomes on road safety).
- The positive impact of the systems on some categories of drivers (elderly and novice but not only) should be evaluated through long-term research, which appropriately takes into account the possibility of behavioural adaptations to occur.
- Lack of research on impacts of attention and distraction for the drivers using nomadic devices, needs to set up adequate measures for drivers' workload adapted to this context
- International discussion and agreement by ad'hoc organisations such as IHRA-ITS or ISO have to be conducted to have an international consensus about criteria to take into consideration in order to define overload and distraction unsafe level for the driver using ND.
- Lack of knowledge on the mobile transport applications users' trust regarding information transmitted via social network supporting ridesharing. Travelers and drivers privacy due to personal information sharing has to be investigated in order to allow ridesharing to be fully efficient in urban and inter-urban trips. A better understanding of social acceptability would have a positive impact on reducing the number of vehicles on the road, for the benefit for ecomobility and the reduction of traffic congestion.
- Relevant metrics related to, for example, user engagement and travel choice influence, have to be defined in order to better understand the impacts of social media access on mobile devices.
- Good comprehension is needed about which services are currently used in car, their frequency and motivation of use in relation to targeted population such as novice and experience drivers, professional drivers, elderly, commuters, tourists and in relation to the context such as urban, peri-urban, motorway, countryside.
- The concrete modalities of integration of nomadic devices in a global cooperative information and communication system should be identified for sustainable transport in a perspective of implementation.
- Methodologies to assess safety use of smartphone applications while driving need to be developed and validated in order to be easily applied with low cost by developers for testing their services.
- Concrete specifications for hierarchy and logic of displays for several functionalities/applications simultaneously used in the same device have to be developed, based upon criticality and comfort in relation to transport context and type of user, in order for the mobile services to be used safely while driving and/or traveling.

Bottleneck:

- NDs will be used by different user groups inside the vehicle (driver; passengers).
  - needs and requirements towards safety are different for these user groups (i.e. safety requirements from a driver's perspective are different to those from a passenger' perspective)

- the owner of a ND will often switch between the different user groups (i.e. the owner may be a driver for a certain time, then change to the role of a passenger, then back a driver again, and so on),
- the ND has to meet different safety requirements and should be able to adapt to the different safety strategies needed for the different user groups. The "car mode" principle seems to be not sufficient, if the different user groups inside the vehicle are not taken into account.

2- Nomadic Research issues related to maturity of technology *(priorities, bottlenecks, lacks, future focus in development, positive and negative impact, integration with other systems…)*

Priority of research:

- Development on technical solutions to display the ND content on integrated screen of the vehicle (e.g;: mirror link technology) will allow:
  - a better legibility as, usually, in-vehicle screen have visor to protect against reflection and high ambiance lighting,
  - an improved environment in case of crash for driver and passenger safety as, nowadays, the ND fixing support is not efficient in this type of critical context
  - a control of the display location as, for the moment, the ND can be fixed anywhere by the driver with sometimes very bad choices of location.
- Due to their spread out among population and the high number of available applications, ND are increasing safety risks for the driver unless integrated in the vehicle. Technical solutions to have an automatic link between the two systems (connection between the smartphone in the driver's pocket with the in-vehicle screen as soon as the driver sit into his/her vehicle) have to be fully operational, not costly and implemented in all the future vehicles.
- Robustness of ND vocal recognition capacities needs to be improved as it is a good mode of interaction between driver and system, allowing to keep the eyes on the road.

Lack of research

- Future technologies linked to Mobility issues such as Big data, contextualized data, NFC (Near Field Communication), Geolocation, Crowdsourcing and Machine To Machine need to be investigated for beneficial implementation in the specific area of transport mobile services.
- Standardization activities and commercial business models need to be developed in the area of communication between nomadic devices and the vehicle.
- Research should be conducted on the development of adaptive interface for nomadic device, taking into account the wide heterogeneity of users, and more specifically drivers, in terms of functional abilities, cultural background and experience.
- Creation of technological solutions that would allow avoiding driver mental overloading: modalities of optimization of the design and the features of the HMI taking into account the quickly evolving maturity of the nomadic technology.
- Modalities of integration of the nomadic functionalities with the other functionalities available in the vehicle.

- Research to develop a “supra-system”, or « intelligent manager system » like the “K2000 voice”, which would manage all the services used by the driver during his trip, including nomadic device functionalities, and delivers the information regarding to driver availability. Some prototypes related to this concept have been already developed, showing that the principle is relevant and efficient; additional development would deserve to be conducted taking into account maturity of the technology in this promising direction.

Bottleneck:

- Exchange of safety related data with vehicle-based systems.
- Development of nomadic device safe fixing in the car, able to resist to crash kinetic.

3- Nomadic Research issues related to guidelines and design recommendations *(priorities, bottlenecks, lacks, future focus in development, positive and negative impact, integration with other systems,…)*

Priority of research:

- Development of verification procedures and criteria for NDs related to the ESOP recommendations.
- Structuring recommendations and guidelines useful for designers, industrials and European working groups in order to improve next generation of mobile services, especially the one used in driving context.

Lack of research

- Educational programs about the use of nomadic systems while driving need to be developed taking into account the fact that more and more functionalities are going to be available through ND, with some of them supporting the driving task or at least relevant in this context (ecodriving, ridesharing, alert information, navigation, traffic information, parking location,…).
- Identification and adaptation of relevant guidelines and standards available for in-vehicle systems to be applied to mobile services used while driving.
- Providing recommendations including ethical and personal security guidelines for the design and the operation of social media sites to support transport applications such as ridesharing or “driver or traveler generated content” for alert messages, for example. This can encompass delivery channels and multiple hardware platforms.
- Setting up design criteria and recommendations build up following human centred design process, considering heterogeneity of drivers population, including novice and elderly, to be used by designers/developers of nomadic devices, in order to prevent misconception, and with the objective of a safe use of nomadic devices into the vehicle.
- Developing guidelines on appropriate affective, that is to say attractive, and persuasive HMI principles for eco-driving support design, with the objective to encourage the driver to maintain his/her ecodriving behavior at middle and long term perspective.

- Covering issues of short versus long- term behavioral adaptation effects of different eco-driving schemes and HMI's, as well as propose certification methods for eco-driving schemes assessment.
- Investigating legal issues and need for standardisation for mobile services and nomadic devices.
- Developing guidelines for ND design in relation to ESoP as a good basis for mobile functionalities but taking care of not being too quantitative and prescriptive with the potential consequences of reducing scope for innovation and progress, especially in this area where technical features are rapidly evolving.
- International agreement on regulations about in-vehicle usage of non-integrated nomadic devices, as nomadic devices can be a source of danger for the driver and the passengers seating in the car (for instance, in the event of a crash in relation to a poor fixing ND support).

Bottleneck:

- Agreements between ND manufacturers to respect the ESoP or any recommendations about ND design and fixation in the car that would be relevant for road safety.

4- Nomadic Research issues related to ecomobility *(priorities, bottlenecks, lacks, future focus in development, positive and negative impact integration with other systems,…)*

Priority of research:

- Investigation about impact on public transport and self-service bicycle use through development and widespread of nomadic multimodal transport service.
- Modalities of integration in the same user friendly interface of the several ecomobile functionalities available on ND: updated information to the driver about alternative routes with the subsequent advantage of reducing fuel consumption and decrease congestion, information about driving style in terms of fuel consumption and emissions, and suggestions to change towards a more eco-friendly driving one, driver information about alternative transport means to reach final destination (for example, metro, bus, walking) and about the respective environmental impact associated to each of those transport mean. Objective is a single device for different information in different contexts and different modes of transport.

Lack of research:

- Assessment of usability and usefulness of transport services (all kinds, all modes) available on mobile phone.
- Development of multi-modal and eco mobility functionalities for nomadic service that would be user friendly and easy to access through, for example, development of ergonomic mock-ups (to support designers and developers processes).

- Definition of information content being communicated any time any where for an optimized use according to sub-group of the population: drivers, pedestrians, passengers of public transport, young or old travelers…
- Identification of needs of information for diversified population of travelers in the context of multimodal transport (pre-trip, on-trip) when considering multi-modal transport (public transport, self-service bicycles, car-sharing,…).
- Gathering knowledge on social media linked to transport and its potential for influence of sustainable travel choices and ecodriving practices.
- Investigation of long term learning effects of an eco-driving system presenting affective and persuasive HMI characteristics and their potential impacts on decrease of CO2 production and fuel consumption.
- Setting up design recommendations for mobile services beneficial for ecomobility that would allow supporting Small and Medium Enterprises and companies designing and developing mobile services and ICT solutions for sustainable transport, making them more efficient in developing accepted services then more competitive in an international market.
- Experimentation of ecomobility services usage cases in cities (e.g. FOT focusing on ridesharing, ecodriving functionalities on ND).

Bottleneck:

- Adaptability and usability of ND functions, especially for elderly users, so there is no category of population excluded from using ecomobility ND services for an optimized global impact in addition to ethical aspects fulfillment.
- Transfer of favorite settings (functions, links, display settings etc.) to a new device generation, in order to get the new device quickly adapted to personal requirements and reduce time for learning the new system.

DECOMOBIL Seminar " **Electric mobility system in different scenarios: individual user, car sharing and fleet »**

- **Keynote speaker** - Andreas Keinath (BMW), User-centered design of electric vehicles: from customer requirements to HMI refinement
- **Session 1 (session chair: Margaret Harris)**
- The user perspective on electric vehicle range, Thomas Franke (TUC)
- Integrating the driver into the energy management of an electric vehicle, Marcus Schmitz (WIVW)
- Modelling the take-up of electro-mobility incorporating user needs, Alan Stevens (TRL)
- **Session 2 (session chair: Peter Cocron)**
- Adoption by design: shaping user-vehicle interaction to enhance comprehension, Helena Strömberg (CHALMERS)
- Supporting driver for a safe and efficient electric mobility, Corinne Brusque (IFSTTAR)

- Adapting to electric vehicles, Mark Burgess, Margaret Harris & Sarah Mansbridge (Oxford Brookes University)
- Session 3 (session chair: Roman Vilimek)
- Silent driving in urban traffic – long-term experiences of electric vehicle drivers, Peter Cocron (TUC)
- An analysis of electric vehicle driving and recharging behaviour from the North East of, England SwitchEV trial, Myriam Neaimeh (Newcastle University)
- **Discussion and Wrap up (Angelos Bekiaris)**

In conclusion, importance of emotional and cognitive components for purchase decisions of EV has been emphasized. A combination of individual experience (e.g. through fleets and car sharing) and incentives appears to be essential. In this context, early adopters play an important role. These are the pioneers who show their EV to other people and are helpful in convincing other people to switch to EVs. As central tasks for the future Angelos Bekiaris discussed that not only wealthy early adopters need to be convinced. The text target group would be technologically minded people who consider financial aspects more in their purchase decisions. Potential marketing strategies could emphasize the special characteristics of EVs through better interior, innovative HMI and an appealing design. Angelos Bekiaris also stressed that political initiatives are necessary to convince energy suppliers in investigating in charging infrastructure and that strategies for recycling batteries need to be developed.

***DECOMOBIL Seminar "*Roadmap OF ICT DESIGN for clean and efficient multimodal mobility », May, 28th 2013, Munich, Germany**

- HUMANIST Virtual Centre of Excellence, a vision toward 2020, ***Angelos Bekiaris****, President of Humanist, CERTH/HIT, Greece*
- European projects on ecomobility, ***Jean-Charles Pandazis****, Head of Sector EcoMobility, ERTICO, Brussels*
- ICT for Clean and Efficient Mobility, ***Luca Pascotto****, Mobility Director, FIA Region I, Chair of the WG iMobility, Brussels*
- Priorities for Road Safety Research in Europe, ***Peter Urban****, Coordinator of the PROS project, FKA, Germany*
- Perspectives on PTWs contribution to ecomobility*, **Dr. Veneta Vassileva**, Safety Coordinator of ACEM, Brussels*
- Cross-modal considerations on Safety and Human Factors*, **Dr. Simone Pozzi**, Coordinator EXCROSS project, Italy*
- Perspectives on sustainable driving/riding training aiming at a safe and cost efficient behavior**, *Stella Nikolaou****, CERTH/HIT, Greece*
- Design, integration and safety of mobile service for ecomobility, ***Dr. Annie Pauzie****, Ifsttar/LESCOT, France*
- Cooperative service concept and human Service Interface: innovative approach for a sustainable transport system***, Prof. Jose Menendez****, UPM, Spain*

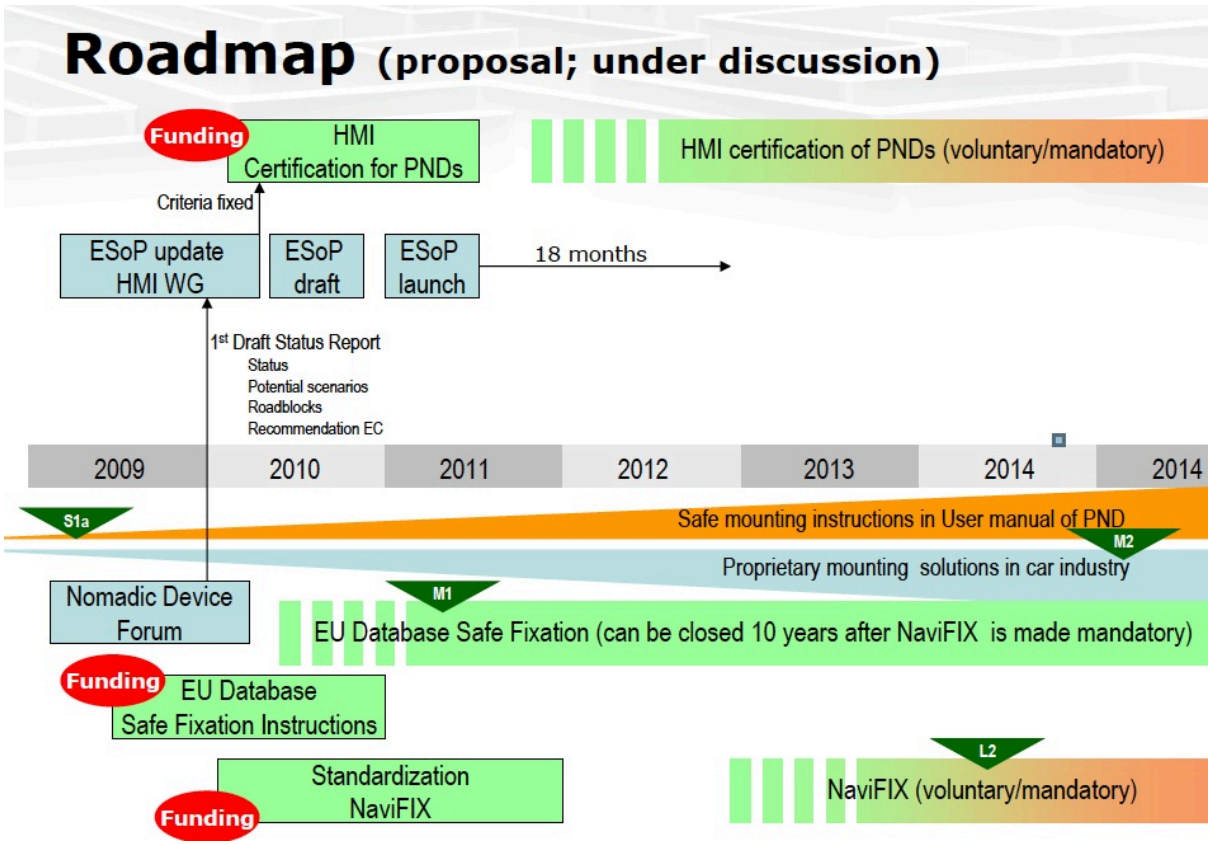
- Round Table with all the speakers, chaired by ***Erik Bessmann**, DAEI/Ifsttar*

Example of the widespread of smartphone use while driving and the issue of integration in the vehicle:

There is an increase access to multi-modal transport information for citizens due to the spreading out of a diversity of informative media and devices, with availability of complex functionalities such as internet access and geolocation on these mobile devices (smartphone) and the wide ratio of equipped travelers and drivers in the population of citizens. Then, an important part of the population of travelers and drivers can be informed "**anywhere**" and "**any time".**

Smart phone market grew, with several applications for transport. For example, there is an increase ratio of smart phone use for navigation in comparison with personal nomadic device and original equipment these last years. All the population including senior drivers uses these applications.

The widespread use of mobile services in transport can have negative impact in terms of road safety with potential distracting effect of mobile phone use while driving or riding (increase critical situations for road safety), poor fixing systems for mobile device inside the vehicle (increase of potential driver/passenger injury in case of crash).



There are technical solutions to integrate mobile phone in the vehicle where the driver can keep hands on the wheel, with a visual interface more accessible and with less screen

reflections, a safer fixation in case of crash. Furthermore, applications may be forced to meet defined driver distraction guidelines.

The roadmap for research in these transport mobile services should cover activities linked to **design**: creation of design guidelines for usability and legibility of information on smart phone to be defined taking into account size of the screen and mode of dialogue (tactile screen, small keyboard, vocal recognition…) and on **evaluation**: setting up of efficient methodologies for safety evaluation of mobile transport services use (balance between positive effect linked to cognitive support and negative effect linked to distraction and workload).

There is also a need of future research in understanding **requirements and functional abilities of elderly travellers/drivers** to be integrated in mobile transport applications design, knowing that there is an increase of this population and that the quality of mobility impacts on the level of good health. Furthermore, development of **technical solutions** for mobile safe use while driving still need to be further explore, with setting up of modalities of information to deliver in relation to context and drivers/riders workload and specificity (novice, senior, professional), integration of the device in the vehicle and with the other on-board functionalities coming from IVIS/OBIS and ADAS/ARAS.

Several issues on roadmap and priorities of ICT design for ecomobility have been raised.

Some are agreements or statements, some are questions:

Agreements/Statements:

- There is a consensus on the purpose of ecomobility objective, with health, clean air, noise avoidance, energy efficiency, greenhouse gas emission reduction and individual cost savings.

- Campaigns should be deployed to promote the combination of the use of non motorized means of transport with the use of public transport to allow people to move in their local environments without utilizing privately owned motor vehicles, especially in urban areas.

- Collective taxis use is frequent in some member states and culturally not admitted in some others, which is a shame has it is an added value for ecomobility in urban areas, in addition to less costly trips for users.

- There is a need in a close future to develop knowledge and awareness through training courses on specific aspects of mobility using ITS functionalities for increase ecomobility among drivers of private cars but also, and even more importantly, among professional drivers such as taxis, express delivery, commercials… and also among truck drivers. Indeed, this professional population has a high mileages and improvement could have an important impact on the overall ecomobility.

- A long term strategy of ecodriving truck companies should be developed in order to produce effective results over a long period of time. It has to take into account human factors aspects

and drivers need to understand the aim of the training to adopt it as the drivers' motivation is fundamental in the success of training and, on a long term run, to achieve fuel savings.

- Several applications for smartphones are directly impacting ecomobility: ecodriving (inform the driver about his fuel consumption on real time so he can adapt his driving style), anticipation of traffic lights timing (inform the driver how to approach the next traffic light so he can adapt his style and speed). Roadmap for these applications design has to be set up to identify and overcome potential distracting effects on the driver and to optimize benefits in terms of ecodriving.

- The number of stops on a network has a real big impact on CO2 emissions and that is why it's important to reduce the number of decelerations and stops. The next step in research is to develop systems such as system giving advice to the driver regarding behavior before intersections, based upon the timing of the red light for example.

- Social networks and smart phone allow connecting drivers and passengers for an optimized ridesharing, in advance and instantaneous, but there is still bottlenecks and reluctance to use this way of transport, so a need to investigate what are the problems blocking acceptance and security and how to overcome them.

- Priorities to develop user friendly mobile and web applications that enable users on the move and at home to easily plan and organize their trip, no matter if they walk by foot or use public transport, a motorcycle, car or bike.

- Take into account the diversity of the population and include seniors in the design recommendations to get friendly interfaces and functionalities for all while designing ICT in transport, especially for drivers due to road safety issues.

- Devices and services capable of giving information about driving and fuel consumption are already on the market but in the near future this data will have to be combined with information coming from the surrounding infrastructure.

- Evaluating real impact of ecomobility measures and implemented systems at a European level is complex, several projects are working on this issue, developing sophisticated methodologies and raising debates. It is already a hot topic in aviation, where several key words are taken into account: safety, performance, ecology, efficiency, ending up with a business case point of view which is not fully satisfying, translating all the issue in a single matrix in terms of cost and benefit. In transport, the process is to work with business cases, comparing with and without systems to evaluate impact assessment. Nevertheless, it is not because the system is good that the overall consequences in the city will be positive for pollution. Furthermore, each system needs its own methodology, cooperative systems will not be assessed the same way than informative systems.

- Ecomobility and safety do not have exactly the same priorities nor the same constraints. Synergies between safety and ecomobility is necessary. So, ecosolutions will have to be safe and not impact negatively road safety.

Questions :

- How far the cross-sectoral partnership has to go for an integrated promotion of ecomobility in terms of walking, cycling, wheeling and passengers in public transport?
- What is the role of the European community and the state members in the process?
- How to get harmonization at a European level? How to coordinate effort at a global level, including other countries in the world?
- Is there any conflict for the driver's behavior to be adopted between ecodriving purpose and road safety purpose? How the roadmap for road safety integrated the future goals of ecomobility? Is there any European initiative (such as iMobility WG) studying and connecting the two roadmaps?
- Urban Mobility is a key area today for ecomobility facing chronic demands for faster commutes, safer roads, more space, and cleaner air, and local governments face increasingly difficult decisions about mobility issues and land use policies in their communities. What is the next added value of ITS in this context in terms of functionalities to be implemented and deployed?
- What are the methodologies and the tools available to assess current EcoMobility performance and to evaluate the effectiveness of policies and actions to achieve a more sustainable transport system in terms of environment, accessibility, safety, and equity? What is the method for ecomobility improvement resulting from ITS deployment? Which ITS for which ecomobility target?
- Existing ecoNavigation application, which consists in finding the most efficient fuel/CO2 emission route. How to widespread its use and to motivate drivers to use it?

5.2 DECOMOBIL Research priorities

Following these debates, after discussions and consensus among the consortium and based upon the general context of perspectives and priorities identified by the key stakeholders, are presented in this paragraph some main research priorities relevant in the area of Human Centred Design of ICT for clean and safe mobility:

- Fully electric vehicles in a multimodal transport system
- Social media for ecomobility

- Sustainable driving/riding training aiming at safe and cost efficient behavior enabled
- Design, integration and safety of mobile services for ecomobility
- Cooperative service for a sustainable and resilient mobility
- ICT for Cooperative Systems for Powered Two Wheelers enhancement
- Safe Road Transportation of Dangerous Goods addressing all types of infrastructures
- Holistic safety principle of children safety enhancement in road transport

Research Topic: Fully electric vehicles in a multimodal transport system

Content and scope

The development of alternative fuel vehicles is posing new challenges to road transport. The human factors aspects have to be considered if an efficient uptake of alternative fuel vehicles is aimed to accelerate the decarbonisation of transport. The intrinsic characteristics of fully electric vehicles might impose changes to the driving task. These changes are not only at an operational level but also at a strategic one, as a way to overcome the limited energy resources. The decisive factors influencing the acceptance of such vehicles are to be tackled, together with the mechanisms to promote its adoption. The main safety concerns must be analysed and the collection of critical incidents while driving and handling these vehicles serve as a basis for studying causation and mitigating problems. Fully electric vehicles will be one element in a connected multimodal transport system. New technology will be necessary for the integration of different mobility systems together with infrastructure.

Target outcomes

- To accelerate the market penetration of electric vehicles several barriers have to be addressed. Some are technological but others involve potential customers who might be sceptical in changing to electric vehicles. Research should investigate what factors are decisive for people to switch to alternative fuel vehicles, especially fully electric and hybrid vehicles. Once these barriers have been identified, solutions should be deducted to support a quick uptake, considering acceptance and adoption criteria. The interest in sustainable technology and the way it impacts the willingness to use an electric vehicle should be taken into consideration. Mechanisms to develop positive attitudes towards electric mobility are to be investigated.
- Fully electric vehicles possess certain features, which could have an impact on traffic safety (high voltage, lightweight structures, low noise emission). Research should investigate how the new vehicle features change the driving task and verify how drivers integrate these features in their daily driving. The possibility of drivers being supported through in-vehicle-systems to avoid critical situations is to be considered. Long-term studies should investigate naturalistic incidents with fully electric vehicles, analysing its causation, consequences and how to mitigate them. Field data from several European countries will allow the detailed assessment of safety critical incidents and will also quantify the extent of such issues. Based on long-term

assessment periods, it will be possible to collect statistics for Europe regarding incidents of electric vehicles (on the road, while charging, maintenance, etc). Guidelines for accident handling are to be deducted.

- Due to the dependency on the progress in battery research, early customers of fully electric vehicles will need to adapt to limited range. In order to minimize such barriers for potential customers, drivers need to be optimally supported in range utilization. Research should investigate the most adequate way of providing this support. Different layouts of energy saving systems (such as regenerative braking) need to be tested to allow for maximum energy efficiency. The potential of in-vehicle driver assistance systems and training approaches is to be addressed. New concepts, innovative solutions and technologies should emerge to define which tools and modalities promote a higher energy-saving behaviour.
- Due to limits in range and size the need to combine fully electric vehicles with other transport modes is crucial. For increasing acceptance it will be necessary that access to public transport or combustion engine powered cars is provided in order to cover the full range of trip length and trip purposes. Algorithms and software applications (mostly for smart-phone hardware) will be necessary for traffic information, reservation and payment. In parallel new business models will have to be developed.

Expected Impacts:

- widespread and facilitate acceptance of electric vehicles
- develop appropriate solutions for minimizing uptake barriers of electric vehicles
- quantification of the safety critical incidents for electric vehicles
- accelerating the development and deployment of adequate support systems for supporting electric vehicle drivers
- supporting more sustainable usage patterns in terms of range utilization and energy-efficiency

Research Topic - Social media for ecomobility

Content and scope

Social media is a chaotic and still developing phenomenon. Channels such as Twitter and Facebook are becoming ubiquitous and are highly popular with many younger people who could also be considered as good “targets” to influence towards multi-modal mobility as well as ecodriving. Social media can provide not only information but could help to enhance motivation, through shared social values, to embrace ecomobility such as use of public transport and participation in car-sharing or in eco-driving practices.

This objective explores how social media can affect ecomobility and identifies how it can be influenced and supported to induce positive behavioural changes toward more sustainable travel choices including ecodriving without any negative impact on safety.

Targeted Outcome:

Fostering the use of social media linked to ecomobility to promote choice of eco-friendly modes and, when the car mode is involved, increasing the use of car sharing and ecodriving techniques.

Providing support for sponsors, designers and moderators of social media forums. This will include: ethical & personal safety guidelines, best practice experience and design & operational support.

Key research challenges to be addressed:

- Gathering knowledge on social media linked to transport and its potential for influence of sustainable travel choices and ecodriving practices
- Identifying user wants and preferences and studying factors (external and personal) that most influence positive ecomobility choices.
- Constructing relevant metrics such as user engagement, and travel choice influence in order to better understand the impacts of social media.
- Providing recommendations including ethical and personal safety guidelines for the design and operation of social media sites to support more sustainable travel choices. This can encompass delivery channels and multiple hardware platforms.
- Investigating the role of social media as an influencing channel to exercise consumer power towards providers of transport

Expected Impact:

- Greater engagement of travel provider organisations in social media channels of communication as well as independent providers
- Greater awareness from citizens of sustainable travel options
- More power with travellers to influence travel providers
- Increased use of public transport and green travel modes
- Increased car sharing
- Reduction in travel demand

Research Topic – Sustainable driving/riding training aiming at safe and cost efficient behavior enabled

Content and scope

This objective focuses both on the combined use of ICT and driving simulators for training of all road driver/rider categories and the training of all types of drivers/riders on optimal use of ICT tools that support drivers/riders or are used by them during driving/riding. New simulation tools are expected to be developed for motorcycle riding and passenger car (both for novices and emergency drivers/riders), as well as truck driving.

Target Outcomes

- **Training and assessment of novice passenger car/motorcycle drivers** on vehicle control and basic traffic participation skills, as well as on new ICT-based technologies, such as ADAS/ARAS, IVICS/OBIS, cooperative systems (V2V, V2I, I2V). Emphasis is expected to be given on critical driving scenarios for the young drivers/riders, combining the emerging vehicle technologies, where special care should be given to

their simulated HMI elements and functionality. Dynamic changing of scenarios elements and story, taking into account the individual driving style of each driver/rider is of strong significance. A modular training curriculum for drivers/riders, fitted to the needs of each driver, should be developed and used. Computerized assessment methods should define in detail the level of skills of each driver/rider.

- **Training and assessment of professional drivers/riders** according to their needs. For example, interaction scenarios (such as multi-drivers scenarios) are crucial for emergency drivers/riders. Also, cooperative systems are a key aspect for professional drivers. As in objective a), common and personalised training and assessment protocols and curricula should be developed.
- **Continuous training of experienced drivers/riders to new vehicle technologies.** The focus is on lifelong training of experienced drivers/riders that can benefit from training to new vehicle technologies and ICT.

Work should include the development of an open simulation tool for simulating the functionality and user interface of a wide range of ADAS/ARAS, IVICS/OBIS and cooperative systems. It should be supported by appropriate use interface, allowing its users (mainly driving instructors and researchers) to easily change the functionality and user interface layers and construct alternative scenarios of use.

Emphasis should be given to the simulation of the operation of clean vehicles (hybrid and electric cars, trucks and motorcycles) as stand-alone and in combination to the use of various ADAS/ARAS, IVICS/OBIS and cooperative systems, taking into account their space and power limitations as well as particularities of use (i.e. silent operation).

The developed simulator kits should also allow clean vehicles and vehicles equipped with various ITS (consultory or intervening) of all types (trucks, cars, motorcycles) to be modeled and used as other road participants in any simulator scenario, supported both by specific libraries and by freely established menu, using user created vehicle behaviour models.

Expected Impact

Improvement of elementary, continuous and professional driving training in order to stimulate road users towards a more responsible or, when needed, professional behaviour. More specifically, the following benefits are expected:

- Road safety enhancement by reduction of accidents due to poor on-road training.
- Road safety enhancement by training on the use, benefits and of ICT in-vehicle support technologies.
- Road safety enhancement with the possibility to train drivers/riders in dangerous scenarios (risky traffic conditions, adverse weather conditions, etc.) that is not often possible not safe to be anticipated in real traffic.
- Contribution to green environment through reduction of traffic volume and pollution in cities by less on-road training as well as through ecological/economical training promotion by the new training tools.

- Creation of statistical record of drivers' behaviour through key data storage by the ICT-based tools.
- Reduction of the stress levels of trainers and trainees, induced by actual on-road training of complex situations.
- New employment opportunities and competitive advantage for the European driver training schools industry.
- Reduction in training time and cost.

Research Topic - Design, integration and safety of mobile services for ecomobility

Content and scope

Easy access to information through nomadic devices has high potential benefits for a clean and efficient multi-modal mobility: incentive to use public transport and self-serve bicycles, avoidance of traffic congestion, encouraging and supporting ridesharing, low cost service of eco-driving…

This objective explores how to turn mobile devices and mobile applications toward a more sustainable transport context by inducing behavioural positive changes of citizens toward ecomobility without any negative impact on safety.

Targeted Outcome:

Fostering the use of mobile applications linked to ecomobility without creating an increase in critical and unsafe driver's behaviour with deterioration of road safety.

Integration modalities of nomadic devices in the vehicle and study of combined effects with Advanced Driver Assistant System (ADAS) and In Vehicle Information System (IVIS) in terms of effective interaction with the driver. The effectiveness of nomadic services linked to ecomobility in combination with other support systems (existing under development) has to be addressed.

Setting up support for developers by creating design recommendations and guidelines for nomadic applications adapted to the diversified needs and requirements of users, including elderly citizens.

Key research challenges to be addressed:

- Gathering knowledge on users needs and acceptance related to ecomobility mobile services in relation to context requirements in order to develop adaptive and personalised integration of nomadic applications into the vehicles
- Enhancing user acceptance of mobile services beneficial for ecomobility and impacting reduction in fuel consumption.
- Setting up design criteria and recommendation build up following human centred design process, considering heterogeneity of the drivers population, including novice and elderly, to be used by designers/developers of nomadic devices, in order to prevent misconception, and with the objective of a safe use of nomadic devices into the vehicle.

- Developing Guidelines on appropriate affective, that is to say attractive, and persuasive HMI principles for eco-driving support.
- Investigation of long term learning effects of an eco-driving system presenting affective and persuasive HMI characteristics.
- Identifying the concrete modalities of integration of nomadic devices in a global cooperative information and communication system for sustainable transport in a perspective of implementation.
- Covering issues of short versus long- term behavioral adaptation effects of different eco-driving schemes and HMI's as well as propose certification methods for eco-driving schemes assessment.
- Examining business cases and investigating specific applications both personal and commercial ones
- Investigating legal issues and need for standardisation for mobile services and nomadic devices

Expected Impact:

- Contributing to ecomobility by the development and the widespread of user-friendly mobile services to encourage bicycles and public transport use for travellers and ecodriving for drivers
- Developing efficient ridesharing mobile services based upon understanding of travellers and drivers needs/requirements for sharing the same ride.
- Safe combination of eco-driving with the concurrent use of other telematic applications (ADAS and IVIS), based on contextual, driving-style based and integrated prioritization.
- Improving sustainable reduction of CO2 emissions and fuel consumption by ecofriendly adaptation of driving style of several driver cohorts considering mobile ecodriving application.
- Supporting developers and designers of mobile applications for user-friendly and safe mobile services by producing guidelines hand books and recommendations
- Creating new employment and increasing competitiveness linked to the development of mobile services and nomadic devices in Europe
- Widening the market of mobile ICT for transport services linked to ecomobility

Research Topic - Cooperative service for a sustainable and resilient mobility

Content and scope

Cooperative Systems have the capacity (at short, medium or long range) to communicate some data to obtain specific road traffic service. The sensoring capabilities of almost any type of data or needed information are evolving very quickly, at the same speed as the Internet of Things, where any device may be permanently and ubiquitously connected to Internet, requesting or providing information. This implies the possibility to collect a huge amount of information related to different aspects, such as people location, weather conditions, pollution, status of traffic, status of public transport, energy consumption, etc.

Properly processed, this huge amount of information may provide relevant services to the Smart and Connected City, in particular, services related to Mobility.
These sensoring capabilities, together with the communications and processing ones, bring up the concept of **Cooperative Service**. This is a horizontal service, covering different aspects, such as mobility in the city, low energy consumption and pollution reduction in particular areas, parking reservation, infotainment, etc., or a combination of all the previous. A cooperative service may be provided to users according to their needs and profiles, including personal and/or professional data. It is clear that the amount of data has to be processed and filtered in order to provide the user with exactly what she/he needs, at the right moment, at the right place, and with the most appropriate Human Service Interface.

Target outcome

This objective focuses on the research in Cooperative Service as a horizontal service covering different aspects, such as safe and sustainable mobility, low energy consumption and pollution reduction in particular areas, parking reservation, infotainment, etc., or a combination of all the previous.
Based on the concept of Cooperative Service, the research fosters the evolution of data processing from the more simple current systems to more advanced intelligent ones.
Besides the collection of real data from complex traffic systems, innovation is continuously evolving towards more advanced intelligent systems that will be able to monitor complex situations, react, learn from the evolution of those situations, and even predict. This leads to the need of using behaviour understanding systems, which cannot replace a human, but may help to some extent in the hard task of situation assessment and decision making.
Additionally, a strategy towards Resilience within the transport system should be developed integrating technological innovation and the related users' needs for optimising safety and efficiency of transport. Thus, the necessary mechanisms to create foresight to recognise, anticipate and prevent paths to failure that may arise as the system and the technology evolve should be developed.

Key research challenges to be addressed:

- The development of cooperative service based on the understanding of a new reality, in which interaction and cooperation processes involve the entire transport system: the human, the environment, the vehicle and in-vehicle technologies, as well as traffic management systems and decision support tools.
- The development of the most appropriate Human Service Interface resulting from the amount of processed and filtered data to be provided to the user according to his/her needs, at the right moment and at the right place.
- As the service is horizontal, embedding different areas, some particular research should be developed on the proper elements and procedures that may be used to provide the required information to the user, with the right channel, at the right place and time instant.
- New ways of interaction have to be researched, that may even vary according to the user situation (i.e., the same information may be provided through different channels according to the place/time or user's needs).

- The development of a Distributed Interactive Simulation platform (DIS) based on Virtual Reality to support human-centred design of dynamic scenarios for the evaluation of users' behaviour in different mobility contexts. This platform should become the main research tool for the analysis of human behaviour in virtual mobility environments involved in a particular simulated cooperative service.
- Successful innovative approaches applied within other safety critical systems where people deal with uncertainty should be explored in order to develop appropriate methodological approaches and success cases.

Expected impact

- Improved users' safety and transport efficiency within a sustainable and controlled environment.
- Human-centred design and deployment guidelines for a cooperative service so that it enhances safe behaviour, improves transport efficiency fostering anticipation and thus becoming more tolerant to uncertainty and human variability.
- Identification of training needs of particular users groups towards a safe and sustainable mobility within specific transport contexts and environments.
- The development of a safety culture as the basis for the design and evaluation of sustainable and cooperative mobility systems.

Research Topic: ICT for Cooperative Systems for Powered Two Wheelers enhancement

Target outcome

- ICT research in **Cooperative Systems** for enhancing motorcycle safety via vehicle-to-vehicle and vehicle-to-infrastructure communication for critical scenarios such as intersections, rural roads, etc. Through the design and development of motorcycle-based Advanced Rider Assistance Systems (ARAS) and On-Bike Information Systems (OBIS) functionalities and their combination with deployed accurate positioning systems, smart infrastructures and automotive active safety systems, it is expected to minimize the increasing number of motorcycle accidents, with special emphasis to novice and elderly riders. Special focus should be given to the further research and integration of the eCall system in motorcycles, focusing on the complexity of motorcycle accidents, where the vehicle and the rider are separated. Research should include the design and/or adaptation of rider-friendly Human-Machine Interaction and decision support systems that will communicate prioritised information from all ARAS/OBIS and other services to the rider, through advanced safety warning strategies, considering the complex and weighed riders' workload.
- **Coordination and Support Actions** through the framework of the iMobility Forum, for promotion and training activities of ICT technologies for riders, clustered per category of motorcycle type (L1, L2, L3) and user group (novice, elderly, advanced).

Expected impact

- Common pan-European architecture, standards and deployment model for ARAS/OBIS and co-operative systems for motorcycles.

- World leadership of Europe's motorcycle industry in the emerging area of Co-operative Systems .
- Significant improvements in safety, comfort and sustainability of motorcycles. This includes contribution towards the H2020 objectives of 50% road fatalities by 2020 and zero fatlities by 2050, and a contribution to a significant reduction in the energy consumption and congestion in road transport through the introduction of safer motorcycles in the road network.

Research Topic - Design, integration and safety of highly autonomous driving

Content and scope

Autonomous vehicles have the potential to make a significant difference to the safety and efficiency of transportation. The research focus thus far has been on making autonomous vehicles systems that operate safely and effectively with less consideration given as to how humans interact with such systems. The use of driving simulation is becoming increasingly prevalent in the development of advanced driver assistance systems ; simulators are becoming more realistic in the way they present the simulated environment to the user, they can integrate complex simulated inputs such as those from radar and camera, it is cheaper and simpler to make small changes to software code and re-test in the simulator than to make changes to real vehicles and repeatedly test at track facilities and complex traffic scenarios can be created that might be impractical and/or unsafe to create in the real world.

This objective explores the human factors issues in highly automated driving both for the driver of the automated vehicle (particularly in hand-over) and for the drivers of non-automated vehicles that will share the same roadspace.

Targeted Outcome:

Foster the safe development and deployment of increasingly automated systems without creating an increase in critical and unsafe driver's behaviour with deterioration of road safety.

Increasing trust, acceptability and understanding of increasingly automated vehicles amongst potential purchasers and users.

Setting up support for developers by creating design recommendations and guidelines for human interaction with highly automated vehicles.

Key research challenges to be addressed:

- Understanding of system modes, trust and acceptability of highly automated driving modes
- Human factors in hand-over, hand-back and driver response to unexpected events and system failures

- Understanding driver behaviour and modifications to travel patterns caused by automated vehicles for all types of the travelling population
- Understanding the impact on drivers of non-automated vehicles, particularly "carry-over" effects, transfer of behaviour. The automated vehicle types to be considered include both single vehicles and platoons of vehicles.
- Identifying traffic implications of highly automated vehicles through modelling studies that incorporate realistic driving behaviour.
- Investigating legal and liability issues issues and need for standardisation

Expected Impact:

- Contributing to safety and ecomobility by the development and the widespread use of increasingly automated vehicles
- Supporting developers and designers of highly automated vehicles by producing guidelines and clarifying liability issues

Research Topic - Safe Road Transportation of Dangerous Goods addressing all types of infrastructures

Target Outcomes

Cooperative, dynamic and seamless services for Dangerous Goods transportation by road, making innovative use of the technologies, solutions and concepts that have been so far developed. These services and applications should aim to the optimal routing and re-routing of Dangerous Goods addressing maximum safety, security, environmental friendliness and cost-efficiency, as well as hybrid optimal guidance by weighted combinations of the above criteria. Relevant services should make optimal use of all types of existing and emerging communications and sensors, from autonomous to V2I, I2V and V2V.

All components featuring the Dangerous Goods transportation, namely the transferred cargo, the vehicle and its critical components, the driver and all actors of the logistics chain (the infrastructure operators, the clients, the transportation companies, etc.) as well as external environmental factors (weather conditions, traffic conditions, etc.) should be addressed.

A Pan-European architecture and ontological scheme, supporting cross-border transportation monitoring and control of Dangerous Goods, with emphasis on European corridors. The Architecture should also address multimodal issues of Dangerous Goods transportation by other transport modes.

Decision making systems and technologies, in combination with cooperative fleet management and monitoring systems, should be the basis for the integrated services and solutions to be delivered, that should be interfaced from all actors of the logistic chain upon concretely defined authorization rights that fit to the business and social goals. Case studies should cover all contexts of road transport (urban, peri-urban, rural, highways, critical

infrastructures like bridges and tunnels). At least three of the most dominating types of vehicles carrying Dangerous Goods and at least three different categories of Dangerous Goods should be addressed. All the above should serve as key parameters in decision making.

Emphasis should be put on appropriate stakeholders Human Machine Interfaces to support all of the transportation chain, such as Dangerous Goods vehicles' drivers, infrastructure and Traffic Management Centre controllers, dispatchers and Logistic Centres personnel, clients of the goods, etc.

Expected Impact

Although Dangerous Goods vehicles constitute a rather small number of the vehicles in circulation and correspond to a small number of accidents (as a ratio to the total number of road accidents), their accidents can be particularly lethal and polluting due to their cargo, as well as pose security menaces, while they can bring about a considerable human and economic loss. In this sense, the cooperative services and solutions to be delivered will aim to be a profitable venture for:

- the Dangerous Goods logistics chain, in the sense that they will maximise efficiency and minimise loss of cargo and vehicles;
- the infrastructure operators, which will have considerable less damages in their infrastructure and will benefit of optimised rescue operations in case of an accident;
- the authorities, since they will enhance traffic safety, public security and environmental protection;
- the European economy, by more cost efficient transportation of Dangerous Goods and the creation of jobs in new services and products, and,
- the Society as a whole, which will become safer, more secure and cleaner.

Research Topic - Holistic safety principle of children safety enhancement in road transport

Content and scope

Several EU and national projects have been working on the prevention of accidents with vulnerable road users through new or improved intelligent transport systems (ITS). One of the areas where further improvement is still to be done is the application of ITS for children, as vulnerable road users.

Advanced vehicle safety systems, infrastructure based ITS and cooperative systems based on communication from vehicle-to-x or infrastructure-to-vehicle/user have to be implemented to enhance safety among children as passengers, pedestrians, bicyclists and PT users. Integrated and co-operative systems need to be developed to cover the children and enhance their safety throughout their whole route with multimodal transport modes. Additionally, the safety and comfort of children as passengers in private vehicles, as well as the minimization of their parents distraction while driving, need to be taken under consideration, using innovative technologies within the vehicle.

The work should include:

- Enhancement of safety and comfort of children as pedestrians, bicyclists, PT users, as well as passengers in cars and co-riders in PTWs, throughout their whole route from the origin to destination.
- Development of cooperative ITS based on communication from vehicle-to-x or/and infrastructure-to-vehicle/user that will be used by children, parents, car drivers, infrastructure planners and authority.
- Focus on children as vulnerable road users, particularly in urban and sub-urban environments and during embarkation/disembarkation from various vehicles (cars, motorcycles, PT).
- Specific attention to the development and operational use of Human-Machine-Interface (HMI) responding to the needs of children, while within a transportation mode, at a transportation hub or at their way to/from it.
- Design of innovative HMT for the infotainment of children as car passengers, to minimize driver distraction.

Expected impact

- Increase safe walking, cycling and use of public transport by children.
- Enhance the safety and comfort of multimodal mobility (pedestrian, bicyclist, and public transport) of children of all ages.
- Make the road infrastructure more user friendly and intuitive for children as vulnerable road users.

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Abbreviations

Abbreviation	Meaning
ADAS	Advanced Driver Assistance System
ACC	Advanced Cruise Control
ECTRI	European Conference of Transport Research Institutes
EPoSS	European Technology Platform on Smart Systems Integration
ERTRAC	European Road Transport Research Advisory Council
ESC	Electronic stability Control
ESoP	European Statement of Principles
EUCAR	European Council for Automotive R&D
EV	Electric Vehicle
FCD	Extended Floating Car Data
GPS	Global Positioning System
HMI	Human Machine Interaction
ICT	Information and Communication technology
ISO	International Standardisation Organisation
ITS	Intelligent Transport System
IVIS	In-vehicle Information System
NFC	Near Field Communication
ND	Nomadic Device
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
PROS	Priorities for Road Safety Research in Europe
POI	Point-of-interest

PTW	Powered Two Wheelers
RDS	Radio Data System
TMC	Traffic Message Channel
V2V	Vehicle-to-Vehicle
V2I	Vehicle-to-Infrastructure
VERA	Visions on the European Research Area
VMS	Variable Message Signs
VRU	Vulnerable Road Users

ANNEX 1

iMobility Forum Recommendations, research needs

(17/12/2013, Lina Konstantinopoulou (ERTICO)

The iMobility Forum came up with 18 recommendations covering the whole spectrum ofICTfor Safe, Smart and Clean Mobility.The recommendations areon the following areas:

1.Accident Causation Data

2.Impact Assessment

a) **Consolidate and refine methodologies for an integrated approach to assess the potential impact of ICT for safe, smart and clean mobility.**
b) **Consolidate and refine a coordinated validation framework for operational tests in the Member States addressing ICT for safe, smart and clean mobility**
c) **Promote and carry out large scale evaluation and validation of priority safe, smart and clean mobility systems through Fields OperationalTests FOT or reuse of data from previous FOTs, in order to define future deployment actions.**

3.Human-Machine Interaction

a) **Development should be monitored such that the ESoP can be re-visited periodically (at least every 3 years) providing a balance between current relevance and stability.**
b) **Develop robust assessment procedures and safety-relevant criteria where practicable starting with safe fixing (including field of view) for nomadic devices.**

4.Implementation Road Maps

a) **Continuously identify the priority systems, their potential to improve safe, smart and clean road mobility, and update regularly Road Maps (including the monitoring of implementation of intelligent integrated systems) with technical steps and economic implications for the introduction of safe, smart and clean systems in Europe.**
b) **Set up and maintain a good-quality quantitative process for monitoring the vehicle penetration and road infrastructure coverage of priority systems**

Priority System	Priority System Name	EU 27 Deployment Rate 2010	EU 27 Deployment Rate 2011
PS 1	Blind Spot Monitoring	0,566%	0,965%
PS 2	Adaptive Headlights	9,701%	11,908%
PS 3	Obstacle & Collision Warning	1,767%	2,775%
PS 4	Lane Keeping Support	0,547%	0,896%
PS 5	Emergency Braking	0,335%	1,060%
PS 6	Eco Driving Support	4,479%	16,203%

5.Cooperative Mobility systems and services

a) **Move forward international co-operation in the development and deployment of cooperative mobility systems and services.**
b) **Establish mechanism and processes to agree on pathway towards deployment of cooperative systems to achieve minimum level of market penetration to start the services as well as to achieve maximum sustainable interoperability and ease the provision of new services in line with market demand**

- Real-time traffic modelling and prediction made on floating car data3.
- Open vehicle platform
- User acceptance study of C-ITS services
- Marketing strategy
- Elderly mobility
- Climate change effects on transport with C-ITS services
- Research on biofuel
- Multimodality including personal vehicles running on renewable fuel motors or electrical vehicle
- Multimodal travel planning according to age and health factors
- Advance traffic management services
- The analysis of need for traffic rules adjustments (Vienna Convention and national/international adaptions)
- Long-term operation (backward-compatibility) - compatibility roadmap
- Intersection safety research regarding vulnerable road users
- 3research on integrating personal device in to C-ITS
- Privacy regulation and ownership of data
- Security issue
- Communication technology compatibility and adaptation
- The need for HMI standardisation and distraction aspects related to C-ITS
- Ergonomics
- The process of communicating the results of all C-ITS eu funded projects
- Cooperative electro-mobility
- Research on business models
- Research on public transport and emergency vehicles with RSU like traffic light
- Identifying road side provider's needs and stationary vehicles
- Study the effect of different deployment models

Cooperative ITS needs (Paul Kompfner & al., 2013, Comsafety2 report)

6.Digital Map
7.In vehicle 112 emergency call (eCall)
8.Real-Time Traffic and Travel Information
9.Legal issues (privacy by design, security, liability) related to ICT for transport
10.Standardisation and interoperability
11.European large scale actions
12.Spectrum allocations
13.Stimulate demand and use
14.Nomadic/after-market devices
15.Preparation and updating of the Strategic Research Agenda on ICT for Safe, Smart and Clean Mobility

- **With the support of the major stakeholders, analyse the specific needs and define the priorities for RTD actions on ICT for Intelligent Mobility in particular on: Sustainable Road Transport; Sustainable Urban Mobility: Road Safety; ICT and the Decarbonisation of Transport; Deployment; and the Horizontal Issues.**

16.ICT for EE in mobility
17.Vulnerable Road Users
18.Automation in Road transport