Strategic Research Agenda
ICT for Mobility – update 2007/08
RTD Working Group of the eSafety Forum

Ljubljana, Slovenia 25 April 2008

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Recommendations on forthcoming R&D in FP7 ICT for Mobility

Introduction

During 2006 the eSafety Forum WG RTD developed a Strategic Research Agenda (SRA 2006) for the Intelligent Car Initiative. Recommendations were given on R&D topics to be addressed with short time horizon (0 – 2 years) and others to be addressed thereafter, preferably in the ICT for Mobility part of FP7.

Since then the FP7 program is launched, the results of the initial calls are known and other calls are announced. Thereby the fulfilment of the short-term priorities of the SRA 2006 can be evaluated vis-à-vis the outcome of submitted and accepted proposals. Additionally, new priorities have entered into consideration and need to be weighted in comparison to those priorities as seen in mid 2006 when the SRA 2006 was adopted by the eSafety Forum.

During the autumn 2007 the eRTD has evaluated the outcome of the initial calls of FP7 ICT for Mobility, considered old and new priorities. The outcome of this evaluation is reported in the following pages, where remaining and new R&D needs are formulated and a set of recommendations on R&D topics for FP7 ICT for Mobility is given.

At the eSafety Forum Plenary 25 April, Ljubljana, Slovenia, this report was adopted as the update of the SRA 2007/08 ICT for Mobility.

Content

Executive Summary of R&D Recommendations

The eSafety Forum working group RTD (eRTD) has reviewed the SRA 2006 in the perspective of the outcome of the first and second call of FP7, considering old and new challenges and priorities. As an outcome of this process the eRTD has formulated the following recommendations for future research in the area of ICT for mobility:

i. **Urban and Inter-Urban Mobility of People and Goods.**
Clean, Safe, Secure and Efficient
The transport system (people and goods) is a large energy consumer creating high load on the environment through air and noise emissions. Furthermore, the level of safety in the transport system is still far from acceptable. Additionally, security is of growing concern due to increased criminal acts (thefts, terrorists) and the handling of dangerous goods. It is foreseen that reduction of energy consumption and environmental impact, increased safety and security can be achieved in the traffic and transport network by advanced ICT/ITS information and management systems applied both urban and inter-urban.

ii. **Intelligent Vehicles and Infrastructures towards Cooperative Systems.**
For wide spread deployment of ADAS and ICT/ITS systems, also into small and medium class vehicles, there is a need for high integration, cost reduction and reliability increase of these systems.

To achieve the next step in safety and efficiency it is absolutely necessary that the infrastructure accelerate its development and deployment for improved sensing, analysis and management of the traffic network as well as delivery of accurate and relevant information to the network users.

With these advancements in vehicle and infrastructure significant steps are taken towards Cooperative Systems where the driver-vehicle-infrastructures are connected enabling safety and efficiency applications to be realised.

iii. **Field Operational Tests.**
Field Operational Test (FOT) was introduced in the FP7 as a mean to gain experience, collect "figures and facts", conduct impact assessment of ICT/ITS, create awareness etc. FOT projects are presently launched for

methodologies developments and tests on autonomous systems. Next generations FOTs should focus on the connection of travellers-vehicles-infrastructure using cooperative systems and on situation specific scenarios (intersection safety; vulnerable road user protection …).

In the process of reviewing the R&D priorities the dimension and needs of International R&D Collaboration have also been considered. The resulting recommendations are reported under each of the SRA 2006 areas on the following pages.

In addition to the above general preferences the WG eRTD recommends that the FP7 ICT for Mobility address within the coming years specifically the below selection of high priority R&D topics.

A. Mobility of People and Goods: Clean, Safe, Secure and Efficient

a) Data collection and analysis of the state of the mobility network
b) Integrated traffic and travel information
c) Integrated networks
d) Interoperability and standardization
e) Security systems for people and goods
f) Clean and efficient goods transports

B. Mobility and Transport in Urban Areas

a) ICT tools for all modes and inter-modality of transport
b) Decision support tools with extended and general traffic modeling
c) Urban goods transports: Sensing, models, strategies, management
d) Integrated payment systems

C. Intelligent Vehicles and Infrastructures towards Cooperative Systems

a) Intelligent delivery vehicles and infrastructure support systems for safe and secure goods transports.
b) HMI:
    i. Warning and automation strategies
    ii. Functional HMI integration, including flexibility, individualization
    iii. Nomadic device integration

c) Advanced Driver Assistance Systems
   i. Full collision avoidance systems
   ii. Vulnerable road users protection systems
   iii. Applications and systems for driver support at intersections and merging manoeuvres, covering vulnerable road users
   iv. Green driving support, e.g. eco-driving, "green traffic management".

d) Technologies
   i. Architecture for and highly integration of safety and efficiency functions and systems for cost reduction, reliability etc.
   ii. Multi-functional on-board unit with secure integration of multi-tasking applications (e.g. fleet management, tolling, tachograph).
   iii. Enhanced dynamic maps, sensors, actuators, data fusion and extended communication platform
   iv. Production technologies to reduce cost and increase reliability

D. Field Operational Tests (FOT)

a) FOT on Intelligent Vehicle Systems and Nomadic Devices
b) FOT on Cooperative Systems:
   i. Urban Traffic
   ii. Intersection safety
   iii. Motorway Driving
c) Naturalistic Driving Observation
d) FOT Methodology: Internationally agreed and shared

E. Horizontal Issues

a) Methods and metrics for driver behaviour assessment.
b) Assessment of ICT/ITS systems impact on green, clean, safe, efficient transport
c) Accidentology
d) Business Model, Deployment, Legal, Liability aspects of ICT/ITS systems
e) Training and Education

Coverage of SRA 2006 topics' in the first phase of the ICT 2007-2008 Work programme.

Major topics of the 2006 Strategic Research Agenda "ICT for Mobility" were addressed in the challenge "ICT for Mobility, Environmental Sustainability and Energy Efficiency" of the ICT work programme 2007-2008. This work programme had **two strategic objectives**:

- ICT for Intelligent Vehicles and Mobility Services and
- ICT for Co-operative Systems and FOTs.

The first Strategic Objective in Call 1 addressed three areas:

- Intelligent Vehicle Systems,
- Mobility Services for People and
- Mobility Services for Goods.

This was complemented by coordination and support actions primarily addressing preparatory measures for the Field Operational Tests.

The response to the call was good; more than 80 proposals were submitted of which 78 were eligible. 31 proposals met the evaluation thresholds. An overall budget of 57 million EURO was made available for funding. Due to the budget limitation only the best 15 of these 31 proposals above threshold could be selected for funding.

The proposals' majority addressed the Intelligent Vehicle Systems (IVS); seven proposals (including one Integrated Project addressing automated driving applications) in this area were retained. A good coverage was achieved for Mobility Services for Goods; where three proposals (including one Integrated Project addressing the Intelligent Cargo concept) were retained. Although 25% of the eligible proposals addressed Mobility Services for People, only one support action was highly ranked. Two other highly ranked proposals were relevant to the topic but not in their entirety. It is important to investigate why the topic attracted so few proposals of quality, and also to assess the continued relevance of the topic. A more thorough analysis with the stakeholders is needed to establish the best approach for future work.

One proposal for the ramping-up of Field Operational Test was retained covering the need of this area. Other support actions covered interoperability of fare management systems in public transport and awareness raising actions.

While IVS was effectively covered by well-ranked proposals in both research instruments, one aspect of the Work Programme, "the integration of independent safety systems" was only marginally addressed. This activity would advance the widespread, timely take-up of ADAS, with significant consequences for road safety and the environment through energy efficiency. It would also be a key enabler for

the cooperation of the European automotive industry's main players and an important opportunity to confirm Europe's global leadership in IVS/ADAS technology. Therefore the objective "integration of independent safety systems and their interaction with the driver" should be considered for the 2009-2010 Work Programme.

The second Strategic Objective in Call 2 addressed the two areas:

- Cooperative Systems and
- Field Operational Tests.

This was complemented by coordination and support actions. 65 proposals were submitted.

The first part of the evaluation revealed already the overall good quality of the proposals submitted; 28 of them passed evaluation thresholds. An indicative budget of 48 million Euro will be available for project funding. The second phase of the evaluation, the hearings prioritized the four Integrated Project proposals in Field Operational Tests, and it is expected that two of them will get funding. One NoE, in the area of Co-operative Traffic Management, was also considered in the hearings. The implementation plan for Call 2 will be prepared before the end of 2007.

The projects, which are expected to be funded on the basis of these two calls, will address the majority of short-term research areas proposed in the 2006 Strategic Research Agenda "ICT for Mobility", although some of them will need further consideration, e.g. the area of Mobility Services for People. In the area of Intelligent Vehicle Systems, vehicle perception aspects, actuator performance and dependable vehicle infrastructures are well addressed. In the Mobility Services for Goods area the exploitation of RFID technology and smart tags was covered as well as urban distribution logistics whereas e.g. security issues still remain open for further research. A more integrated multimodal approach is nevertheless still needed when addressing the problems related to mobility in urban and rural area. The area of field operational tests has raised great interest at Member State, academic, research and industrial level. It will need more emphasis in the future also focusing on specific scenarios and on cooperative systems.

Further research needs in ICT Work programme 2009-2010

The ICT Workprogramme (WP) 2009-2010 should be substantially more long-term oriented than the WP for 2007-2008, focusing on higher risk research with impacts in the 2020 timeframe. By then, more than 10 years from now, the global ICT/knowledge infrastructure-networks, devices and services, as well as market structures, value chains and business models are likely to have changed considerably from today's situation. Therefore, the research should explore more innovative options than before, involve new players, be more multidisciplinary, and especially for applied research focus on system issues, applications and services that drive innovative ICT developments while addressing the existing and emerging socio-economic challenges.
In the area of ICT for Mobility, the growth of transport within the EU, at a rate of 2.8% per year for goods and 1.9% for passenger transport represents a pervasive socio-economic challenge for our region. The environmental cost of transport is estimated at 1.1% of GDP, while the increasing congestion costs the EU an additional 1% of GDP. Safety has improved considerably especially in road transport where fatalities have declined by more than 17% since 2001; however, with around 41 600 deaths and more than 1.7 million injured in 2005, road remains (in absolute numbers) the least safe mode of transport. The measures envisaged so far will not be sufficient on their own to contain the negative impacts of transport growth. Therefore, a broader, more flexible set of systematic measures is needed, including wider use of technological innovations.

In the long term, the challenge will be to continue to support innovation and research in intelligent transportation systems and services which are safe, green and efficient, capable of meeting the growing demand for mobility and transport in Europe, support economic growth, are environmentally sustainable, meet the needs of all tiers of the society, providing access to all and are capable of accommodating and enduring future uncertainties and shocks.

For this vision, new ICT solutions and new mobility concepts need to be developed, and the existing ones need to be adapted to future requirements. Therefore, the ICT for Mobility Challenge should be re-oriented for the WP 2009-2010 to give priority to research in technologies, systems and services for all transport modes which:

- Supports sustainable economic growth, while increasing safety and security of the mobility systems for persons and goods.
- Exploits the potential of ICTs for increased energy efficiency and reduced

environmental impact of the transportation systems, thus contributing to the reduction of CO2 and pollutant emissions from transport.

- Develops and experiments on enhanced and new sustainable transportation system concepts, urban and inter-urban, moving towards autonomous systems.

These additional priorities should however not take away the momentum achieved through the FP7 WP 2007-2008 priorities and therefore research should continue to address Intelligent Vehicle Safety Systems, Cooperative Systems and Mobility Services.

The main RTD challenges to be addressed in 2009-2010 should be substantially more long-term and more challenging, requiring new innovations and new partnerships, and should cover:

- Smart sensors, sensor networks, data fusion and communication platforms, including use of Dynamic Maps and RFID technologies
- Intelligent Vehicle technologies for safety and energy efficiency: Safe, Clean and Smart Vehicle
- Technologies enabling cooperative driving systems to enlarge its operation from restricted to open traffic environments
- Development of Adaptive Intelligent Co-operative Systems which automatically adjust to the traffic safety situation and the mobility and environmental needs
- Information infrastructure for smart mobility and adaptive co-operative systems, including technologies to access very large amounts of information and unlimited networked computational power
- New urban mobility concepts, such as micro-mobility, personalised urban transport, virtual mobility, telepresence, combining location-dependent and location-independent spaces.

Review of R&D Priorities for the SRA 2006 R&D Areas.

Six areas of R&D were introduced in the SRA 2006. On the following pages these areas are reviewed regarding new medium and longer term R&D priorities. In particular, the importance and potential contributions of R&D in these areas to road safety, energy efficiency and environmental load in the urban and interurban traffic and transportation networks is addressed.

1. Mobility Services for People

The introduction of intelligent vehicles and cooperative systems create the opportunity to move towards integrated mobility and network management of people and goods. With increasing availability of real-time multi-modal transport and traffic information and better interoperability between services and systems in the transportation networks enable the provision of personalized urban transport services to all users. Today's emerging technologies, systems and solutions enable the use of scarce resources in the most optimal way and with minimal environmental impact.

Research needs to be pursued in several complementary areas in a coordinated manner in order to develop further concepts for urban mobility, and transportation solutions which support the transport policy goals. The following research topics need in particular to be given high priority:

1. Urban Mobility: Systematic and Holistic Approach

Urban mobility has often been addressed in an uncoordinated and fragmented way, leading to incompatibility between different sub-systems (e.g. data collection and decision support tools). For more efficient urban network management and control it is necessary to view the system and its sub-systems in an integrated way, and to assure interoperability and availability of multi-modal interfaces. Research topics which are needed for this approach are outlined below:

A. Data collection and analysis of the state of the transportation network

- R&D in technologies for sensing, data collection and data mining: traffic data collection, collation and distribution, including data fusion and synthesis, for the whole traffic and road network and for all modes, including soft modes and public transport, with the objectives to:

        - Estimate the status of the transportation network
        - Predict the impact and consequences of interventions, including the behavioural changes of travellers
    - Data protection, public acceptability and privacy.

B. Integrated transportation networks

Integrated traffic and travel information

- System architecture for connecting various sub-systems together in a multimodal service overlay networks
- Advanced digital maps: standardised and used by all involved actors, for providing and sharing information between public transports, taxis, logistic operators, service providers, local authorities.
- Support systems for integrated traffic and travel information services and for decision making for individuals as well as at system (network management) level for traffic management and control

Integrated payment systems

- Common, integrated and standardised method for road, parking and public transport charging, with interoperable fare and fee management systems

Integrated intermodal networks

- Intelligent intermodal transport interchanges and interfaces.
- ICT for seamless journeys supporting intermodality and the continuity of services.
- Integration between urban and strategic inter-urban road networks, infrastructure to infrastructure interfaces.

Interoperability and standardisation

- Interoperability and standardisation of intelligent information, payment/charging and communication systems and infrastructures

ICT tools for all modes of transport

- New ICT solutions for public transport, soft modes and enhanced collective use of vehicles (car sharing, car pooling, etc.)
- ICT in transport for combating social exclusion and providing access to all
- Mobility concepts for future requirements including advanced new concepts for demand management

Integrated network management also enables the provision of new services and solutions for seamless journeys. Common, integrated charging and ticketing schemes would simplify intermodal interchanges. Interoperability and standardization of information, management, payment and charging systems would accelerate their deployment.

C. Decision support tools with extended and general traffic modelling

- Research in improved network forecasting, simulation and modelling tools
- Research in decision support systems for the implementation of advanced network management strategies and in modelling tools, with specific attention to:
- Models for special event and emergency planning and response
- Models for overloaded network management and mitigation; dynamic traffic management strategies which adapt to special conditions
- Business Models for public-private partnerships

Improved and new support tools and improved traffic models are needed to handle the increasing information which becomes available, and to generate precise forecasts for short terms (a few hours) needs. Optimal solutions will be investigated, exploiting the flexibility of the transportation systems to guarantee the level of service expected by the users. Decision support tools are also required in order to ensure that transport policy goals are achieved, and in particular that the developed solutions contribute to efficiency and reduce the environmental impact of urban mobility. An integrated network management should provide optimal solutions for all type of users.

2. Security

- security of transportation systems
- security of critical infrastructures.

The security of transportation systems is a critical aspect of future integrated network management strategies, where all modes need to play their part. The use of ICT can contribute greatly to increase the security of transportation systems by providing means to limit the consequences of criminal acts, to improve the perception of security, and to minimize the risk of terrorist attacks. Other critical infrastructures are also exposed to these risks and can also be better protected by the development of new ICT tools.

3. International R&D Collaboration

- Integrated micro and macro mobility models based on data on people and goods rather than vehicles.
- Cost effective data collection, management, analysis systems and decision support tools.
- Research in systems and services managing the environmental impact of urban transport, (collaboration with Latin America, Asia, emerging economies)

Innovation and research on these topics is advancing fast in other areas of the world and international collaboration is necessary to allow Europeans (industry and public authorities) to exploit research results quickly and to adapt them to the regional requirements. International collaboration on these topics would allow also using the experience of European cities for the industry to develop systems adapted to the needs of emerging countries in some cases.

Recommendation on near term R&D

1. Technologies for sensing, data collection, data fusion which covers the whole traffic and road network
2. Advanced digital maps
3. Tools and models for estimation and forecasting of transportation network status
4. System architecture for connecting various road network subsystems
5. Decision support and traffic management systems for integrated network management strategies aimed to increased transport efficiency and congestion reduction
6. Integrated real-time traffic and travel information systems
7. Integration between urban and strategic inter-urban road networks, including infrastructure to infrastructure interfaces
8. Business Models Public-Private Partnerships in ICT/ITS system for transportation networks

2. Mobility Services for Goods

Introduction

The major challenges for Mobility Services for Goods identified in the SRA 2006 are still valid. The demand for freight transport in the EU is continuously growing, with a foreseen 50 % increase in freight transport by 2020 and its consequences for congestion, accidents, noise, oil dependence, pollution and climate change. Additional research efforts are needed to cope with this situation.
Optimisation in the management of the transport chains, exploitation of new technologies (such as RFID and Smart Tags, advanced ICT platforms and common application architectures), promotion of co-modality and exploration of the potential of advanced urban logistics solutions for sustainability remain on the top of the research agenda, other areas have been identified, but not promoted with the necessary emphasis yet. Besides security issues in general and hazardous goods transportation more specifically international cooperation in global supply chains and advances in ICT services for freight collection and delivery need to be addressed in the near future.

Security

Armed robbery of vehicles becomes more and more a challenge to logistics industry – for economic reasons in case of theft, but also in terms of public security in those cases where large vehicles are misused as weapons, e.g. for terrorist attacks. To develop appropriate countermeasures, research should focus on solutions which detect criminal acts automatically, in real time and without the involvement of the driver;
- avoid or minimise related damages by triggering appropriate measures, e.g. stopping the vehicle and
- allow police intervention before the freight will be transhipped on another vehicle.

Hazardous goods transportation

Any incident in hazardous goods transportation bears the risk of high negative impact on public security and environment. To minimise this risk research should focus on new technologies and solutions which
achieve very high level of driving safety (driving monitoring, safe distance enforcement, etc.);
- track the vehicle along its route to detect any anomalies in space and time
- monitor the freight conditions and
- minimise the risks along the route.

Freight delivery and collection

More than on long haul transport, the logistics core processes of picking up, handling and delivering goods bear a high potential for more efficient and sustainable operations supported by tailor made ICT solutions. Research projects therefore should address

- Logistics organization optimizing urban goods transports regarding efficiency and environmental impact
- ICT for consolidation strategies for urban goods deliveries and pick ups
- Mapping and modelling of the goods transport flows
- ICT for planning and performing green efficient goods transport
- Data collection on goods distribution and freight operators to build models for advanced cooperative routing
- Traffic information for route planning and guidance considering environmental impacts and restrictions, e.g. in Low Emission Zones
- Infrastructure to Infrastructure interfaces (multiple operators, intermodal)
- Awareness raising towards the use of ICT for improved freight delivery, targeting all stakeholders: sales and retail, distribution, vehicles manufacturers, local authorities, etc.
- Common and standard methods and measurements of the efficiency and the environmental impact of goods transport solutions

International R&D collaboration

International R&D collaboration – especially in ICT research for transport – is inevitable in a global economy. Cargo monitoring is not limited to regions or continents, but has to be available for cross-continent transport as well. To achieve this, communication protocols for international cargo monitoring needs urgently be harmonised.

Growing demand for goods transport generates an emerging market for low-power / low-cost devices for tracking and tracing of goods, and there is a need for global harmonisation of the communication interfaces used by such devices. The primary target regions for collaboration are the Americas and Asia.

Recommendation on near term R&D

1. **Urban Goods Transports**
    a. Data collection on goods distribution and freight operators to build models for goods transport flows and advanced cooperative routing
    b. ICT for consolidation strategies for urban goods deliveries and pick up.

2. **Clean and Efficient Goods Transports**
    a. Infrastructure-to-Infrastructure interfaces (multiple operators, inter-modal)
    b. ICT for planning and performing green efficient goods transport
    c. Business models for green transports.

3. **Intelligent vehicles and secure goods Transportation**
    a. Secure vehicles.
    b. Safe and secure hazardous goods transportation
    c. Harmonisation of communication protocols for cargo monitoring.

3. Intelligent Vehicle Systems

Introduction

The Strategic Research Agenda published in 2006 (SRA 2006) covers the following topics for Intelligent Vehicles Systems:

- Vehicle environment perception systems
- Human Machine Interface for intelligent vehicle systems
- Vehicle architecture for data flow. Dependable vehicle infrastructure
- Faster and smarter actuator performance.

These topics are still very relevant for the future work programme.

Human Machine Interaction (HMI)

Many intelligent vehicle systems essentially achieve their functions by means of influencing driver behaviour, e.g. by redirecting the driver's attention in critical situations or alerting the driver on future potential hazards. Other functions automate parts of the driving task, which may also have important implications for driver behaviour. Thus, RTD on HMI is of key importance to ensure the desired impact of intelligent vehicle technologies. Some key topics are listed below:

- Warning and automation strategies:
  This involves the development of suitable strategies for how to warn the driver and/or automate the driving task. This could also be aided by research on driver modelling and simulation.
- Functional HMI integration for driving assistance:
  RTD should address how different warning and automation functions, with different purposes and targeted to different traffic situations, could be integrated to a functional whole, optimising synergies and preventing interference between functions (e.g. in terms of conflicting warnings).
- Acceptance and individualisation:
  While acceptance in general is a natural part of the RTD proposed in the two previous bullets, a further issue of special interest is the possibilities to enhance acceptance by means of tailoring functions to the individual driver.
- Human-machine interface flexibility and configurability:
  RTD is needed on how to achieve a higher degree of flexibility and configurability of the in-vehicle HMI. A key motivation for this is the different life cycles of in-vehicle- and consumer electronics. RTD on this topic should target solutions that (1) reduce hardware and integration costs and (2) allow for seamless interaction between the driver and external functions implemented e.g. on nomadic devices or accessed

online (i.e. through communication with other vehicles, infrastructure-based systems or service centres).

- Nomadic device integration:
  In addition to the more general issues relating to HMI flexibility addressed in the previous bullet, there is a more specific need to explore the potential and quantify the risks involved in using nomadic devices while driving, with the ultimate target of determining guidelines for integrating nomadic devices in vehicles.

Advanced Driver Assistance Systems including Collision Avoidance

The future research on Intelligent Vehicles should focus on highly integrated and price worthy solutions for driver assistance systems to reach wide deployment and achieve increased traffic safety and efficiency and reduced environmental impact.

- Advanced Collision Avoidance Systems:
  Next generation ADAS should extend collision mitigation toward full collision avoidance systems introducing further active intervention strategies and integration of functions with a focus on cost breaking, user acceptance, reliability, synergies, and wide deployment in small and medium sized cars.
- Green and Safe Driving:
  Beside safety aspects, new dimensions should be added with the extension of the driver support for driving more economically and more efficiently using the same information platform. This could include driver coaching or co-piloting assisting the driver in their primary tasks.
- Situation Specific Autonomous Driving:
  Autonomous driving applications should be considered for specific situations such as motorways, intersections, urban and rural roads. Each of the specific situations will require different levels of automation and assistance for green, safe and more efficient journeys but should use common Information technology platforms.
- Vulnerable Road Users Protection:
  In addition, specific solutions for the protection of the vulnerable road users in urban environment should be emphasised. This includes new affordable techniques to detect and classify vulnerable road users and extended cooperation between all road users.

Technologies

- Advanced maps, sensors, actuators, platform for data fusion:
  New innovative solutions should include the integration of the information

from different sources to improve overall perception of the environment around and inside the vehicle fusing data from sensors, static and dynamic maps, vehicle-to-vehicle and vehicle-to-infrastructure communication. New items to be considered are the wireless sensor networks and the use of the 3D information available in future digital maps.

- Integration:
  Highly integration of safety and efficiency functions and systems to improve reliability of the solutions, reduce the cost and impact on the vehicle, to allow the extension of the market to the medium and small, low cost, vehicles.
- Architectures:
  All-by-wire architectures to extend vehicle safety to new levels, since the vehicle could then follow in the optimal way the driver decisions expressed through the primary commands (steering, braking, etc). Research is needed to develop architectures to reach the reliability and safety level required, including embedded data security, without excessive extra costs.
- Technologies to overcome cost and frequency limits:
  The wide diffusion on small/medium size cars is heavily limited by the cost of the devices, in particular for radar sensors. New processes to reduce the sensor cost are needed together with solution to optimize the utilization of the available frequencies.

International R&D collaboration

Harmonisation of the next generation digital maps.

Although digital map technology can be considered relatively mature, further international harmonisation is needed to speed up deployment. Specific collaboration topics include maintenance, qualification and certification of eSafety road attributes and new sources of data for map production and maintenance. The most important regions to target for this collaboration are North America (US DOT, Transport Canada, the private sector) and Japan (Japan Digital Road Map Association, private sector).

Harmonisation of methods and metrics for driver behaviour assessment.

Assessment of driver behaviour (e.g. reaction time and lane keeping performance) is essential for evaluating intelligent vehicle functions. A wide variety of methods and metrics have been developed in projects worldwide. However, so far there is little harmonisation beyond specific ISO standardisation. The main target region is North America, where

several initiatives in this area have already been taken, e.g. the Driver Metrics Workshops and the Driver Wikipedia (developed by University of Iowa). However, there is also a strong interest from Australia and Japan in this area

Recommendation on near term R&D

All above described topics are recommended for the near term R&D.

4. Cooperative Systems

There is a need to deploy already mature technologies developed for cooperative systems to establish clear benefits to end users, road operators as well as a viable business case for suppliers. There is also a need to further develop basic technologies and applications, and to investigate key enabling factors for cooperative systems such as those outlined in the text below.

Intelligent intersections
The development and application of systems to improve traffic safety and clean and efficient mobility, requires new research on traffic and requests the existence of coordinated intersections, making use of V2I, V2V and V2M (vehicle-to-mobile device) communication. New applications should be developed for driver information and support at intersections covering also vulnerable road users, and during merging manoeuvres.

Network management strategies based on cooperative systems
Develop and apply innovative cooperative system technologies and applications to improve clean and efficient traffic, including the integration of multiple road operators and transport modes, based on both in-vehicles as well as roadside systems. Also the integration of individual with public transport as well as freight transport with logistics and production processes should be envisaged.

Penetration rate for functional effects
Study the potential effects of cooperative systems on traffic safety and clean and efficient mobility, including dependence on penetration rate of in-car and road-side systems, based on traffic simulation models of cooperative systems including driver response modelling.

Business and organisational models
Analyse service value chain of cooperative systems. Evaluate business and organisational models of cooperative services and develop automatic modelling schemes, contributing to its easy system orchestration in order to ensure effective and faster time-to-market with those services and systems.

Deployment strategy assessment
Address barriers and opportunities identified in existing implementation road maps

and action plans, including legal aspects, liability, awareness, regulation, incentives. Develop benchmarks and identify best practice.

Technologies

Develop the following technologies in support of above referred subjects:

- Ad hoc networks
- Mobile devices (e.g. smart phones) as a part of the Cooperative Systems world, to support mobility oriented applications required
- Enhanced sensors for data collection and extended communication systems (e.g. WiMAX, 4G, digital broadcast)
- Local Dynamic Maps and enhanced positioning
- Simulation and assessment methods and software for Cooperative Driving
- Enhanced HMI for cooperative driving support and driver-initiated communication
- Multi-functional on-board unit with secure integration of multi-tasking applications (e.g. fleet management, tolling, tachograph).

International R&D collaboration

International collaboration with North America and Japan in the Cooperative Systems area has already started to some extent. It is strongly suggested that these efforts are continued. Specific suggested collaboration topics include the following:

- Architectures and communication protocols for V2V and I2V
- Assessment programs (both technical and impacts)
- Deployment strategies, business models
- Optimal quality of V2V and I2V information
- Strategies for using Cooperative Systems in traffic management.

As already mentioned, the key target regions are initially North America and Japan.

Recommendation on near term R&D

Develop and apply innovative cooperative system technologies and applications to improve safe, clean and efficient traffic, including the integration of multiple road operators and transport modes, based on both in-vehicles as well as roadside systems.

1. Enhanced sensors for data collection and extended communication systems
2. Local Dynamic Maps and enhanced positioning
3. Applications and systems for driver information and support at intersections and merging manoeuvres, covering also vulnerable road users
4. Multi-functional on-board unit with secure integration of multi-tasking

applications (e.g. fleet management, tolling, tachograph)

5. Study the potential effects of cooperative systems on traffic safety and clean and efficient mobility
6. Develop automatic business and organizational modelling schemes, contributing to its easy system orchestration in order to ensure effective and faster time-to-market with those services and systems.

5. Field Operational Test (FOT)

Introduction

The SRA 2006 covered well the topics of FOT, and in the first two calls the methodology of FOT has been addressed, together with the first proposal of specific FOTs. But further activities are needed. It must be considered that FOTs are an essential tool to test several ICT systems in real environment and thus give the opportunity to evaluate their combined impact on drivers' behaviour and on the transport system.

They also aim at supporting decision-making of end-users and of public authorities that are in charge, in most of the EU countries, of transport and mobility. Therefore European FOTs should bring together both the industry and public authorities, including local governments, in order to ensure that the necessary relevant partners are contributing to the evaluation of the systems.
It is also necessary to strengthen the links between European, national and local experimentation programmes.

As the needs for more intermodality will grow even more in the future in order to face environmental and societal challenges, FOTs should also include experimentation of ICT-based systems dedicated to the articulation of private and public transport modes. The intelligent car will have to be in the future part of an integrated intelligent mobility system. FOT should support the preparation of such systems.

FOT on Intelligent Vehicle Systems and Nomadic Devices

The second call of FP7 could only partially cover these types of FOTs, further initiatives are needed to have a complete coverage on these systems, looking at the impact in term of safety, efficiency and reduction of environmental effects. Examples are collision warning / mitigation / avoidance systems, enhanced ESP with steering intervention, eco-driving assistance and dynamic eco-routing.

FOT on Cooperative Systems

These types of Field Operational Tests were only mentioned in the SRA 2006, since the Cooperative Systems in general are presently not mature enough. Based on the results of the ongoing projects, SAFESPOT, CVIS and COOPERS, FOT on cooperative systems should in a few years be feasible. The following scenarios have to be analysed as relevant for FOTs on Cooperative Systems.

Urban Traffic

Impact of traffic safety, pedestrian protection, fuel consumption and travel time.

Intersection safety

Impact on safety and traffic flow (efficiency, fuel consumption)

Motorway Driving

Impact on safety, efficiency and fuel consumption

Naturalistic Driving (ND) Observation

Naturalistic driving studies involve the unobtrusive collection of driver behaviour and vehicle data in naturalistic settings, often in the subjects' own vehicles. Naturalistic driving data provide a high level of detail of the driver behaviour in the pre-crash phase and is thus highly useful as a complement to traditional accidentology approaches, such as statistical data base analysis and in-depth on-site studies. In addition, it provides important information on successful avoidance behaviour in near-crash situations. Naturalistic data are thus highly useful as the basis for the development of preventive safety systems and could also be used as baseline data for FOTs on such systems. In addition, naturalistic data could be used to study driver behaviour related to clean and efficient driving and, thus, as the basis for the development of eco-driving solutions.

Support Actions

In order to optimise the impact of these tests and FOTs at EU level they should be, coordinated with the activities at the local test sites at Member State level.

International R&D collaboration

There are many benefits from global harmonisation of FOTs and naturalistic driving studies, in terms of comparing results and sharing best practices.
Major efforts on FOTs for Intelligent Vehicle- and Cooperative Systems are currently being invested in Europe, North America as well as Japan. Moreover, several large-scale naturalistic driving studies focusing on accident causation, have been concluded, or are ongoing in the US and Japan (though nothing has so far been done in Europe). Both the US and Japan are generally ahead of Europe, so much can be learned from their experience. Specific suggested topics for harmonisation include:

- Methodology (FOT: e.g. safety benefit estimation; ND: e.g. accident and incident classification)
- Implementation (sharing experiences on best practices)
- Determination of application priorities for FOTs

The main target regions and partners are: North America (US DOT, VII, and partners involved in the various FOT and ND activities, especially UMTRI, Virginia Tech. etc.) and Japan (Smartway, partners involved in the various FOT activities).

Recommendation on near term R&D

All previous R&D topics are recommended for the near coming years.

6. Horizontal issues incl. generic International R&D Collaboration

Assessment of ICT/ITS systems impact on Green, Clean, Safe, Efficient Transport
Development of methods and procedures to assess the contribution (impact) of ADAS and ICT/ITS systems to greener, cleaner, safer, secure and more efficient transport systems.

Accidentology
For evaluation and assessment of FOTs, HMI and CBA of IVIS and ADAS and cooperative systems it is necessary to have available accident and pre-accident data scientifically collected and structured. There is also a need to have real accident data such as those obtained by Japanese NPA through the equipment of a test bed of 300 digital cameras at intersections or merging areas.

Business Model, Deployment Aspects

- Development of technologies and definition of standards to promote new insurance model based on vehicle location.
- Outlining of road maps, business models, deployment and partnership aspects of ADAS and Cooperative Systems as part of the over-all business model for transport ICT systems.

Legal and Liability issues
Special need for research arises at present in the scope of ADAS features (but also TTI systems and data collection techniques) that requires the processing of personal and private data of an individual. Due to the improvement in terms of telecommunication possibilities and computing power, it is now possible to develop Vehicle-to-Vehicle and Vehicle-to-Infrastructure communication as well as security functions, In-Vehicle-Information-Systems (IVIS) and comfort related functionalities that require not only processing of personal data, but even the storage of such data. It may even prove necessary, to transmit personal data to achieve the goal of an enhancement of safety for other drivers, once a danger has been detected by another vehicle. This approach to ADAS (but also TTI systems and data collection techniques) has a great relation to HMI aspects, which can be traced back to data collection, which is strictly a HMI-topic. Awareness of the boundaries of data protection law is essential for HMI-design and the development of any system that is based on the transmission or utilisation of personal information.

Quality standards

- Development of methods and procedures to assess the impact of vehicle and infrastructure related ITS functions with a view to possibly developing certification procedures.
- European benchmark and trends of infrastructure-vehicle technologies aimed at traffic information and traffic management.
- European benchmark and trends of vehicle and infrastructure-vehicle technologies aimed to improve road safety.

Training and Education

- To develop a European training curricula for drivers considering new ITS systems and driver information processing capabilities
- To adequate the training tool to driver behaviour and specific ITS functionality
- To migrate from theoretical training and road testing towards interactive multimedia training and driving simulators: Examining the potential of ITS to train the drivers and testing its usability.
- Towards the previous objective, the development of Virtual Reality (VR) / Augmented Reality (AR) / Mixed Reality (MR) driving simulators where the user interacts with real vehicle environment and receives the visual feedback from a Virtual Environment (VE).
- To define ITS training modalities adapted to specific population such as professionals, elderly, and disabled.
- To validate the developed training methods and tools and analyse the results.
- To prepare a best practice handbook for training different driving groups on ITS use.
- Prepare the next generation of focused ICT/ITS research scientists for industry and academia.

International R&D Collaboration; Horizontal R&D topics

Harmonisation of accident statistics

An understanding of accident causation is essential for the development of safety and support functions, in particular for the assessment of their impact. Existing national accident databases are often structured differently, which makes aggregation of data difficult. There is a general need for global harmonisation with

the goal to obtain comparable data from different regions. The main target regions are North America, US, Japan and Australia.

Business models

The business model is a key issue for the deployment of ICT systems. A key issue concerns how reduced "costs" in terms of e.g. lives saved and CO2 reduction, could be re-allocated in monetary terms to the stakeholders making the investments. Since the general business models are similar in all free economies there is a clear benefit in developing a common approach. The key target regions for collaboration are North America, Japan and Australia.

List of Contributors

The persons listed below have given active contributions to this document, mainly through their participation in the eSafety Forum WG RTD. They are all acknowledged and their efforts are well appreciated.

To those contributors forgotten, and missed in the list, we also like to express our appreciations.

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eSafety Support is a European Commission funded project assisting the eSafety initiative in its goal of reducing the number of fatal road accidents in Europe.

The project's main tasks are to stimulate and monitor the activities, progress and results generated by the eSafety initiative. It offers assistance to the eSafety Forum and its Working Groups, keeps all stakeholders up-to-date on eSafety progress and findings, and promotes the benefits of Intelligent Vehicle Safety Systems to the general public.

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