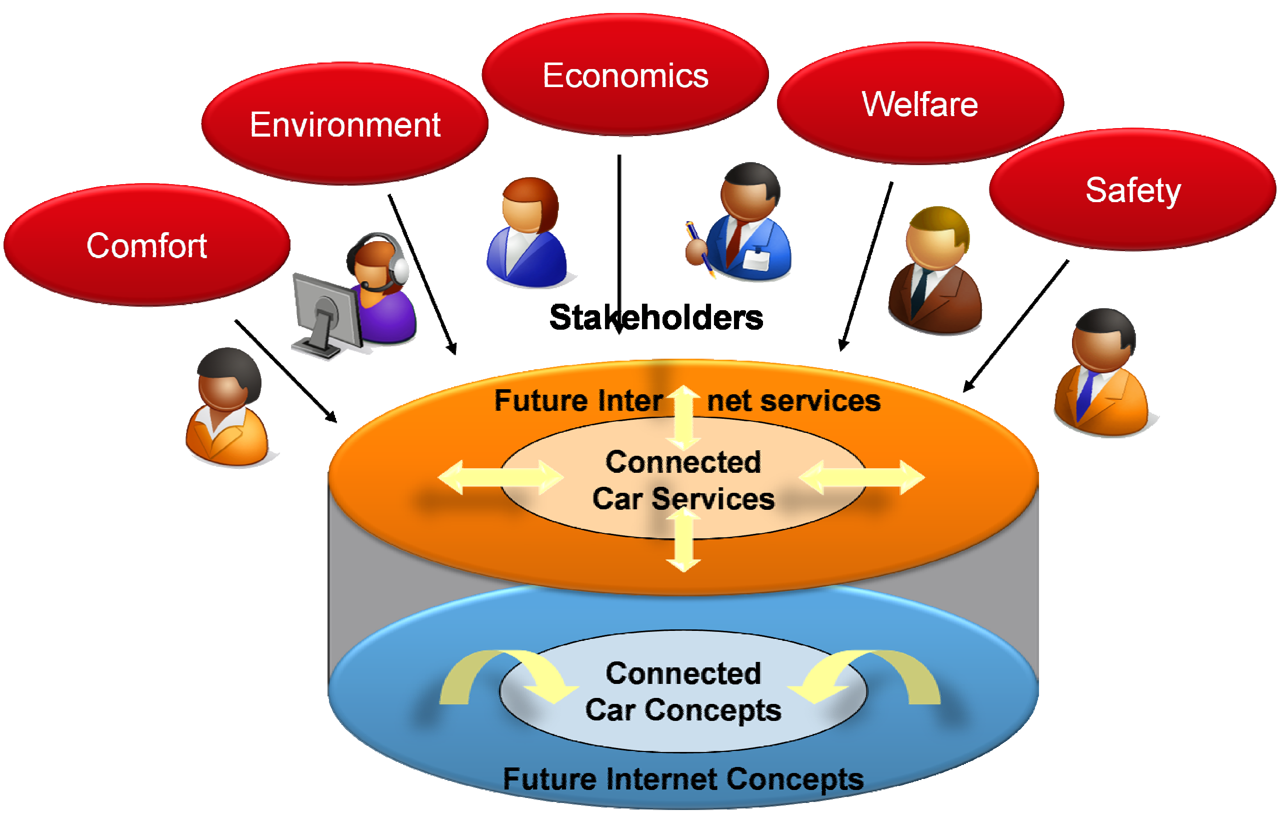
TNO, TRL

New services enabled by the connected car

SMART 2010/0065



New services enabled by the connected car

SMART 2010/0065

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Abbreviations

3G	Third generation mobile telecommunications service
3.5G	Interim mobile telecommunications service, between 3G and 4G
4G	Fourth generation mobile telecommunications service
ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance Systems
API	Application Programming Interface
CALM	Communications Access for Land Mobiles
CAN	Controller Area Network
Cox	CO and CO2 emissions
CVIS	Cooperative Vehicle Infrastructure Systems project
DAB	Digital Audio Broadcasting
DRM	Digital Rights Management
DSRC	Dedicated Short Range Communication
DVB-T	Digital Video Broadcasting Terrestrial
EGCI	European Green Cars Initiative
ELSA	European Large Scale bridging Action
ETA	Expected Time of Arrival
EV	Electric Vehicle(s)
EWSP	European Wide Service Platform
FI	Future Internet
FIA	Future Internet Assembly
FOSS	Free and Open Source
FOT	Field Operational Test
GIS	Geographical Information Systems
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile communications
HGV	Heavy Goods Vehicle
HMI	Human-Machine Interface
HUD	Heads Up Display
I2V	Infrastructure to Vehicle
IaaS	Infrastructure as a Service
ICT	Information and Communication Technology
IoT	Internet of Things
IRL	In Real Life
IT	Information Technology
ITS	Intelligent Transport Systems
LDM	Local Dynamic Map
LTE	Long Term Evolution
mp3	MPEG-1 or MPEG-2 Audio Layer III
OEM	Original Equipment Manufacturer
OSGi	Open Services Gateway initiative
PAYD	Pay As You Drive
PDA	Personal Digital Assistant
PHYD	Pay How You Drive
PoI	Points of Interest (service)
PPP	Public–Private Partnership
QoS	Quality of Service
RFID	Radio-Frequency Identification
RTD	Research and Technical Development

SaaS	Software as a Service
self-*	self-organisation, self-optimising, self-healing, …
SLA	Service Level Agreement
SOA	Service-Oriented Architecture
TMC	Traffic Message Channel
TPEG	Transport Protocol Experts Group
UMTS	Universal Mobile Telecommunications Service
V2G	Vehicle-to-Grid
V2V	Vehicle to Vehicle
VAS	Value Added Service(s)
VRN	Vehicle Registration Number
WiMAX	Worldwide Interoperability for Microwave Access

1 Executive summary

1.1 Background

Transport represents one of the most serious socio-economic challenges we face in Europe today. A low-carbon economy, a sustainable transportation system and achieving dramatic improvements in (road transport) safety and security are main topics on the agenda. The EU has recently set very ambitious targets to its transport sector, and responding to these, the European Commission has initiated a number of actions to address them. The ITS Action Plan has proposed a number of measures for promoting safer and more sustainable transport in Europe by the wide-scale deployment of Intelligent Transport Systems in Europe. Decarbonisation of transport will also be a transport policy goal, on an equal footing with safety.

The Commission Communication "Sustainable future for transport" [EU-COM279] proposes intermediate policy objectives to address the emerging challenges in the transport sector. To speed up the achievement of specific societal goals the Communication "A Strategy for ICT R&D and Innovation in Europe: Raising the Game" [EU-COM116] proposes to support the development of modern pan-European service infrastructures in a set of focused projects of significant scale and duration that cut across the innovation cycle. Innovation and research based on testing and validating innovative ICT solutions for sustainable transport is one of the potential areas for such an initiative.

New technologies and especially Information and Communication Technology (ICT), have a key role in meeting the European transport objectives. The "Connected Car" combined with the opportunities created by Future Internet and Cloud Computing developments can play a pivotal role in successfully reaching these objectives. Future Internet technologies and services enable better use of infrastructure and vehicles to be made, increasing safety and security, enhancing reliability of transport, increasing fuel saving, improving logistics, supporting multi-modal travel and reducing the environmental impacts of mobility, thus supporting public, private and industry needs.

The convergence of the worlds of Intelligent Transport Systems and Future Internet is complicated by the fact that these developments take place in a fragmented industry.

1.2 Goal

The objective of this study is to identify and analyse the needs of both the public and private sectors for the services enabled by the paradigm shift to the connected car to all road users. Necessary technologies and services, which are expected to be facilitated by the concept of the European Wide Service Platform (EWSP), as identified in the ELSA in Transport Report [ELSA] will be identified. The study defines the functionality of such a platform and of the potential services enabled by the connected car.

The results provide the basis for a common understanding amongst all stakeholders of the concept of the EWSP and the public and private services enabled by it. The results of the study can be used as input in defining the strategic research needs in this domain, e.g. it will be used as input for the programming of FP8 "Future ICT for Transport" and also FP7 Calls 8 and 9 with respect to the technical elements and objectives of the EWSP.

1.3 Approach

In this study the developments in Future Internet and Future Mobility technologies and services come together with the needs of both public and private stakeholders, providing a common understanding of the services enabled by the paradigm shift of the connected car.

This study starts with providing an overview of developments, both Future Internet in the ICT domain, and ITS and cooperative systems services in the mobility domain. The demands of future services in the transport sector and how they can benefit most from the mainly autonomous developments in the Future Internet world are identified. A 2025 vision on new services and technologies has been created, based on six scenarios for new services enabled by the connected car to be facilitated by the EWSP, namely: Eco-Centric Motoring, Active Safety Protocols, Smart Transportation, Mobility Integrated Services, Cooperative Traffic Intelligence and Agile Navigation Systems. Roadmaps for the take-up of new services in each scenario have been developed.

Research challenges have been derived from the stakeholder consultation, the future developments and the scenarios and roadmaps, focussing on those issues specifically relevant for the use of Future Internet technology and services for the connected car.

1.4 Conclusions and recommendations

The advance of new services enabled by the "Connected Car" will be driven by developments in Future Internet technology and services combined with developments in the transport domain, like Intelligent Transport Services and Cooperative Systems.

The "Connected Car" can play a pivotal role in supporting the public and private needs in the transport domain: better use of infrastructure and vehicles, increasing safety and security, enhancing reliability of transport, increasing fuel saving, improving logistics, supporting multi-modal travel and reducing the environmental impacts.

In order to realise the Connected Car vision, further developments are required. The results of this study provides a list of research issues that can used as input for the programming of FP8 "Future ICT for Transport" and also FP7 Calls 8 and 9 with respect to the technical elements and objectives of the EWSP. This study also supports the definition of other Commission actions, including those supporting deployment such as standardization, field operational tests, pilots and public procurement.

The following is a summary of the high level topics for the research challenges derived from the stakeholder consultation, future developments, scenarios and roadmaps.

I. Establishment of communication infrastructure for connected car services

The establishment of V2I infrastructure becomes increasingly an issue that is critical and specific to the introduction of connected car services and creates new technical challenges that require further RTD. The deployment of connected car services requires significant investment in wireless communication infrastructure that is suitable for use on the road. The communication requirements imposed by future connected car services will probably require the combination of two or more wireless data communication technologies to be used for I2V communication as no 'one size fits all' solution exists for cooperative applications.

II. Enabling connected car services using Future Internet technologies

Future connected car services will be supported by the Future Internet service enabling infrastructure. The European Wide Service Platform enabling connected car services is expected to be an integral part of the Future Internet infrastructure. The development of the Future Internet service enabling infrastructure presents research challenges that without doubt will be addressed by generic RTD on Internet technologies and services. The transport sector and connected car services however, constitute a specific domain that can help advance the innovation and use of Future Internet. However, it also might require specific solutions. As a consequence there is a need for RTD on Internet technologies which is specifically applied to connected car services.

III. Integration in the in-vehicle environment

Standards for integration of smart personal devices in the in-vehicle environment are critical. The resolution of standards for achieving this, in a manner that the OEM business interests are being considered seems therefore crucial for the speed to market of the connected-car services. HMI integration is also essential for avoiding driver distraction. The development of sophisticated and integrated interfaces, potentially become more viable as more cooperative systems become available.

IV. Interoperability and openness

With a range of different OEMs and other suppliers providing competing products, a wide range of technologies could appear in some niche markets for connected car services. Without interoperability and open specifications or standards it is much harder for these to reach the required adoption rate. Interoperability and openness of (hardware) systems, services, and service management and provisioning will be addressed in generic RTD on Future Internet, but additional standardisation of interfaces for services and systems specific to the transport sector is required.

V. Business models

The market for connected car services is characterised by a large network effect and its take-off requires a minimum critical mass. This makes it challenging to build compelling business cases for deploying such systems. Future Internet connected car services are characterised by a value chain that involves several entities which must have clear responsibilities and liabilities. Cooperation of multiple entities, a prerequisite for aggregated connected car services, should be based on mutual profit.

VI. Security, privacy protection, and user acceptance

Security is an issue for most safety services since most services need some open interfaces. The potential when leveraging internet technologies through which the user (car driver or traveller) also becomes a provider of relevant road-, traffic – and travel data is enormous. Users may prove wary about sharing their personal data, especially if they are seen as a first step towards new taxes, enforcement or commercial exploitation. It will be critical that the people understand the privacy issues that affect them and will have control over their personal data. The model of Internet driven connected car services is based on voluntary participation of the users, industry and service providers and public authorities and road operators.

VII. Liability and trust

Trust and confidence will be critical for adoption in the mobility domain. Future Internet connected car services will often be aggregated by combining and integrating a variety of self-describing, and self-contained 'cloud' services. This makes the quality and reliability of the information a key issue for connected car services. Since future Internet connected car services will become aggregated services with a value chain that involves several entities that are not necessarily (most likely) not business partners, each entity must have clear responsibilities and liabilities. It will be critical to provide liability models that make clear what the risks of integrating and using a specific cloud service are.

1.5 Policy Recommendations

It is recommended that the results of this study are used as input in defining the strategic research needs for the programming of FP8 "Future ICT for Transport" and also FP7 Calls 8 and 9 with respect to the technical elements and objectives of the EWSP and in line with projects under the PPP FI for the mobility usage area.

It is recommended that the research programme is aligned with the research areas for Future Internet developed by FISA [FISARoadmap] and keep a global architecture view showing the whole picture which relates the relevant elements in this picture to for example the FIA roadmap.

It is recommended that large scale field operational tests and and Future Internet and Living lab environments are aligned. The FIRE - Future Internet Research and Experimentation - Initiative from the European Commission is addressing the need of early experimentation and testing in large scale environments for the construction of the Future Internet. Combining FIRE and FOT activities will contribute to the objectives of both activities and facilitates the use of Future Internet technology in the connected car.

For RTD on future ICT for transport it is recommended that expertise from the transport sector together with expertise from the generic Internet RTD world be combined. This implies broader participation in Future Internet development beyond the transport and even beyond the ICT sectors.

It is recommended that an open RTD community focusing on leveraging open Future Internet technologies for connected car services with special attention for the end-users who become prosumers in the vision on connected car services is established. There is a need for multi-disciplinary oriented research at the technical and the social, economic and organizational levels addressing the research issues as mentioned in the previous section.

It is recommended that the connected car vision and future internet technology is applied for EV, by including research activities for the development of the connected car is combined with the European Green Car Initiative. Connected car technology and services and high quality real time information will be imperative for the rapid and large scale deployment of EV.

It is recommended that pre-commercial deployment (improving the market conditions) is addressed, developing and demonstrating working trust and privacy models etc. in Large-Scale Test Beds thus building the bridge between research and full-scale deployment. For this type of RTD the decisions for investment are being made and the dynamics play on a national or regional level (already the FOTs tend to become national or regional projects and the closer to a real market deployment, the stronger this tendency will become). The RTD therefore could focus on scientific RTD, guidelines, statements of principles, models and certification tools which are being developed through cross-EU work. However, biggest chunk should go to pre-commercial activity which is more national or even regionally oriented.

2 Introduction

2.1 Background and challenge

Transport represents one of the most serious socio-economic challenges we face in Europe today. A low-carbon economy, a sustainable transportation system and achieving dramatic improvements in (road transport) safety and security are main topics on the agenda. The EU has recently set very ambitious targets to its transport sector, and responding to these, the European Commission has initiated a number of actions to address them. The ITS Action Plan has proposed a number of measures for promoting safer and more sustainable transport in Europe by the wide-scale deployment of Intelligent Transport Systems in Europe. Decarbonisation of transport will also be a transport policy goal, on an equal footing with safety.

The Commission Communication "Sustainable future for transport" [EU-COM279] proposes intermediate policy objectives to address the emerging challenges in the transport sector. To speed up the achievement of specific societal goals the Communication "A Strategy for ICT R&D and Innovation in Europe: Raising the Game" [EU-COM116] proposes to support the development of modern pan-European service infrastructures in a set of focused projects of significant scale and duration that cut across the innovation cycle. Innovation and research based on testing and validating innovative ICT solutions for sustainable transport is one of the potential areas for such an initiative.

New technologies and especially Information and Communication Technology (ICT), have a key role in meeting the European transport objectives. The "Connected Car" combined with the opportunities created by Future Internet and Cloud Computing developments can play a pivotal role in successfully reaching these objectives. Future Internet technologies and services enable better use of infrastructure and vehicles to be made, increasing safety and security, enhancing reliability of transport, increasing fuel saving, improving logistics, supporting multi-modal travel and reducing the environmental impacts of mobility, thus supporting public, private and industry needs.

The convergence of the worlds of Intelligent Transport Systems and Future Internet is complicated by the fact that these developments take place in a fragmented industry. In this study the developments in Future Internet and Future Mobility technologies and services come together with the needs of both public and private stakeholders, providing a common understanding of the services enabled by the paradigm shift of the connected car. This involves topics like what services are required, how can they be deployed, what stakeholders are involved and how is the value chain?

This study will make it possible to overcome the "blind spots" of ITS and cooperative systems experts by starting a fundamental analysis (out of the box) of state of the art and developments of ICT technologies and the Future Internet. Global evolution of technologies and standards can help to reduce fragmentation and encourage innovation.

The study identifies which areas of critical R&D and pre-commercial activity need to be the focused on. Through a process of consensus building among multiple stakeholders on the definition of the European Wide Service Platform (EWSP), the study will identify how the EWSP can help to exploit the full potential of ICT and Future Internet developments for Connected Car services in Europe.

2.2 Objectives

The objective of this study is to identify and analyse the needs of both the public and private sectors for the services enabled by the paradigm shift to the connected car to all road users.

This is achieved by producing scenarios for the take-up of new services enabled by the connected car. The scenarios include relevant concepts, applications, services and Future Internet technologies (incorporating Internet of Services, Internet of Things and Cloud Computing). Also other Future Internet concepts are considered that are currently not applied in the transport domain, like web megaservices, intelligent context aware services, etc.

With each scenario a roadmap is proposed for the development and deployment of the necessary technologies and services, which are expected to be facilitated by the concept of the EWSP, as identified in the ELSA in Transport Report [ELSA]. The study defines the functionality of such a platform and of the potential services enabled by the connected car.

The results provide the basis for a common understanding amongst all stakeholders of the concept of the EWSP and the public and private services enabled by it. The results of the study will be used as input in defining the strategic research needs in this domain, e.g. it will be used as input for the programming of FP8[1] "Future ICT for Transport" and also FP7 Calls 8 and 9 with respect to the technical elements and objectives of the EWSP. Also, the study will be used in defining other Commission actions, including those supporting deployment such as standardisation, field operational tests, pilots and public procurement.

2.3 Scope

The scope of this study covers both the *what* and *how* questions:

- What is the future connected car?, and:
- How can this vision be realized?

The study focuses on road transport (both passengers and freight) together with its interactions with other modalities. Only interactions from road transport to other modalities will be taken into account, i.e. 'co-mobility' is in scope, multi-modal transport is out of scope.

2.4 Methodology

The methodology of the study is graphically presented in Figure 2.1.

[1] Currently, the EC is working on a successor of FP7, the Seventh framework program. The exact name of this new program is not yet known. Throughout this report, this new program is indicated with the name FP8.

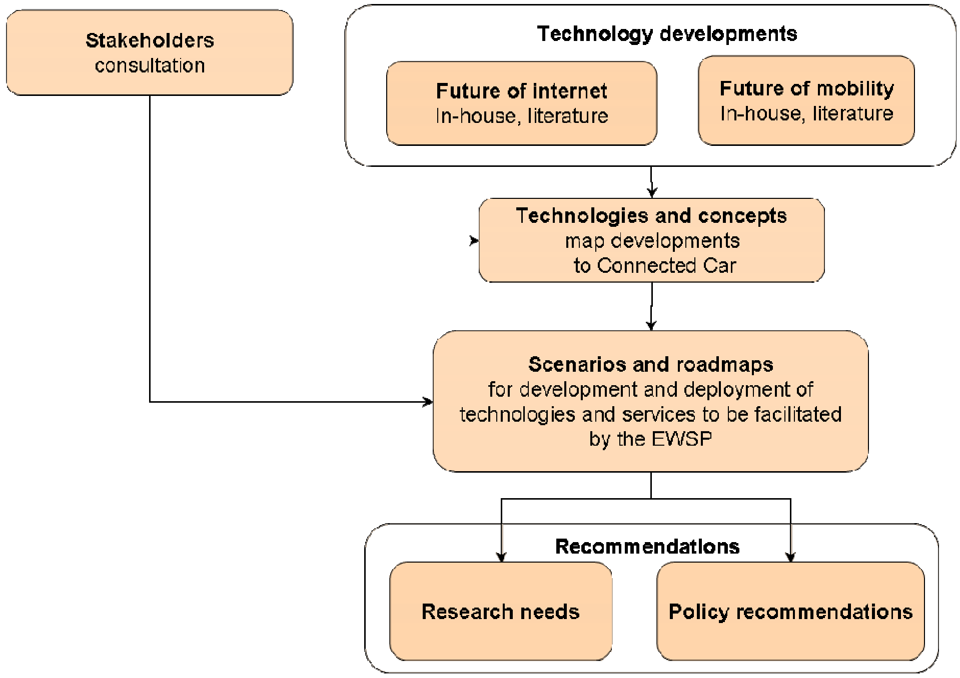

Figure 2.1: Graphical representation of the methodology of the study.

The methodology contains the following steps:

- Providing an overview of current state-of-the-art and future developments, both Future Internet in the ICT domain, and ITS and cooperative systems services in the transport domain.
- Identifying the demands of future services in the transport sector and how it can benefit most from the mainly autonomous developments in the Future Internet world.
- Election of appropriate services from these demands and producing scenarios for new services enabled by the connected car to be facilitated by the European Wide Service Platform.
- Creation of a roadmap for the take-up of new services in each scenario.
- Consultation of a selected group of stakeholders, including:
    - public service providers (including Member States, Road Operators and Road Authorities);
    - commercial service providers and industry (including vehicle and equipment manufacturers, service suppliers (e.g. in-vehicle services);
    - road users (private individuals, freight industry).
- Identify research needs to realize the take-up of the services, focussing on those issues specifically relevant for the use of Future Internet technology and services for the connected car.
- Provide policy recommendations to support the use of Future Internet technology and services for the connected car.

2.5 Contents of the report

Following the methodology as explained in the previous section, the remainder of this report has the following structure. Chapter 3 provides an overview of existing developments on future internet and future mobility services. Chapter 4 describes the results of the stakeholder consultation. Next, Chapter 5 provides a year 2025 vision on new services and related technologies for the connected car. This includes the different scenarios. Chapter 6 presents roadmaps and extracts research challenges. Finally Chapter 7 derives conclusions and recommendations.

3 Future internet and mobility services developments

3.1 Introduction

New developments in technology, and especially in ICT, have a key role in meeting the European transport objectives. The "Connected Car" combined with the opportunities created by Future Internet developments can play a pivotal role in successfully reaching EU policy objectives as expressed in [EU-COM116] and [EU-COM279] to address the emerging challenges in the transport sector. Future Internet technologies and services will enable better use of infrastructure and vehicles to be made, increasing safety and security, enhancing reliability of transport, increasing fuel saving, improving logistics, supporting multi-modal travel and reducing the environmental impacts, thus supporting public, private and industry needs.

This chapter analyses developments in future internet technology, services and applications and developments in future mobility services and enabling technologies in the transport domain. A more detailed description of enabling concepts and technologies is given in Appendix A. In Chapter 5 these future internet and mobility developments come together with the needs of both public and private stakeholders, providing a vision of new services for the connected car.

3.2 Future internet developments

The Internet is playing a prominent role in today's world. It has not only become a commodity for people both at home and at work, but it is now increasingly common for people to remain connected while on the move. New internet applications and services are rapidly emerging, often in an unexpected way. We are shifting from the internet that connects information sources, via the 'Web 2.0' with social networking connecting people and the Semantic Web that connects knowledge, to 'Web 3.0', the Metaweb connecting intelligence. In the connected world everything will be connected, including the "Connected Car".

The Internet supports economical and societal activities. The use of Internet technologies and services in society is growing rapidly and the impact on different societal sectors is large. New developments are taking place in Europe and worldwide. The European Commission through its Seventh Framework Research programme dedicates about 20% of the budget for research related to the future internet, corresponding to more than a billion Euros funding [FIABook2010]. Future internet developments are aimed at supporting sectors like health, energy, mobility and enterprises towards a sustainable economy and society.

What is the Future Internet? The Future Internet is a concept, a vision on how the future internet should or could look. A possible definition is given by the Future Internet Architecture Group [FIArch2010]:

The Future Internet (FI) is expected to be a holistic communication and information exchange ecosystem, which will interface, interconnect, integrate and expand today's Internet, public and private intranets and networks of any type and scale, in order to provide efficiently, transparently, timely and securely services (including essential and critical services) to humans and systems, while still allowing for tussles among the various stakeholders without restricting considerably their choices.

Although the aims are apparent, it is nearly impossible to predict how the future internet will look like in say the year 2025. Unexpected and disruptive developments in markets, services and technologies can lead to a yet unforeseen future. Therefore, various projects and research institutes have applied scenario development methodologies to get an insight in possible 'future internet worlds' (e.g. [Leva2009], [ISOC2010]).

The PARADISO project has published a forward-looking analysis to identify new innovation paths for the Future Internet [Paradiso2011]. With respect to ICT and Future Internet developments, this document predicts that:

- Speed and storage capacity will continue to increase rapidly;
- Transaction costs should continue to decrease;
- Mobile devices should confirm their supremacy as central consumer devices while an 'Internet of Things' should rapidly expand;
- Surprising applications will continue to pop up while some of today's innovations should become well established (wireless endoscopy, intelligent clothes, safe driving, robots and so on);
- The potential negative impacts and risks associated with ICT and the Internet should increasingly become a key issue to address (privacy and security issues, the digital divide, artificial intelligence and so on);
- Environmental issues should have an increasing impact on the ICT sector, because of the need to mitigate the impact of ICT, for example, and through the development of ICT-based approaches to limit resource use and reduce environmental impacts.

The vision for the future internet core platform is that it will be a common platform for smart applications and integrated functionalities. The limitations of the current internet with respect to robustness, security, trust, flexibility, scalability, mobility and energy efficiency will be addressed in developing the future internet.

In comparison with the current internet, functionalities and facilities will be added, for example: integration and orchestration of polymorphic systems; self-management; capability for activating a new service on-demand; high-level integration between services and networks; orchestration of security, reliability, robustness, mobility, context, service support, and management; mobility of networks, services, and devices; support of quality of service and service level agreements; trust management and security; privacy and data-protection mechanisms; seamless use of the physical context information to enhance and improve existing services and to create new ones [FIABook2010].

3.2.1 Future Internet research areas

Although the future internet infrastructure, the so-called core platform, can be seen as a basis, the future internet is not only about the infrastructure. It is also about future internet services and applications of these services in different societal sectors addressing socio-economic challenges and developments. The Future Internet Assembly (FIA) has developed a roadmap for research with research priorities for the Future

Internet [FIAResearch]. The FIA Research Roadmap aims to gather the collective insight of the FIA research community to identify those big challenges to contribute to shaping the Framework 8 research programme. The following picture provides an example of possible future internet research areas [FISARoadmap].

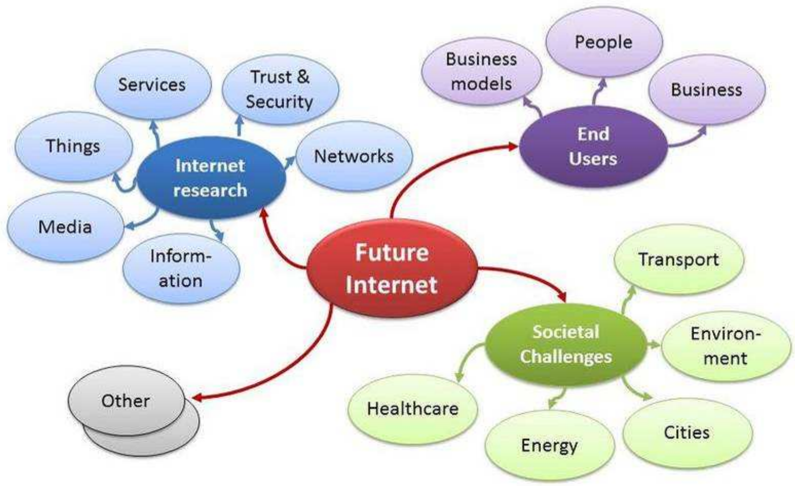

Figure 3.1: Examples of Future Internet research areas [FISARoadmap].

Future internet research with respect to the infrastructure is aimed at issues regarding architecture (including manageability and scalability), networks, trust, identity and security, content and media, information semantics, energy awareness and search and discovery, internet of things and services.

The FIA Research Roadmap [FIAResearch] defines three research issues for enabling the Future Internet infrastructure:

- *Beyond converged infrastructure*: Polymorphic networks, expanding the cloud, building 'smart systems' at the edges. The internet infrastructure beyond 2020 brings new capabilities and capacities.
- *Networked data*: The organisation, exploitation, and governance of the raw material of services and applications. Exploiting the internet's natural resource.
- *Internet security*: Securing networks, networked systems and networked citizens. Maintaining the security of the internet and its users online.

Future internet usage areas are expected to provide input to the definition of the future internet core platform. This input will consist of defining usage area-specific functionalities that are required to enable a medium- to large-scale pilot. The field of future internet technologies is rich and in full scale development. Generic developments in this field will be confronted with usage area-specific developments. A number of these generic concepts are listed below:

- Ambient intelligence and location based services;
- Internet of Things, sensor networking and machine-to-machine communication;
- Cloud computing and data mining;
- Mobile application platforms, such as provided by app stores;
- Next generation cellular networks;
- User generated content and social networking;
- The semantic web;
- Device agnostic services and personalisation of services;

- Virtualisation of resources and applications including self-* properties for manageability.

The FIA Research Roadmap [FIARoadmap] names three research issues for supporting the use the Future Internet:

- *Networked interaction*: New interfaces and modes of interactions with networked systems and devices, with people and communities, with data, through new interfaces, new modalities, new combinations of devices and new perspectives. People interacting with each other, with information, and with cyber-physical worlds.
- *Networked augmentation*: Moving from an Internet of Things towards an Internet Doing Things.
- *Networked innovation*: Future and emerging applications and services – Internet-style. The internet as an innovation ecosystem, supported by architecture, policy and invention.

Furthermore, the FIA Research Roadmap addresses the need to be 'open' (experimental, architectural and scientific) in the approaches to the Future Internet research.

Figure 3.2 gives an overview of Future Internet development areas.

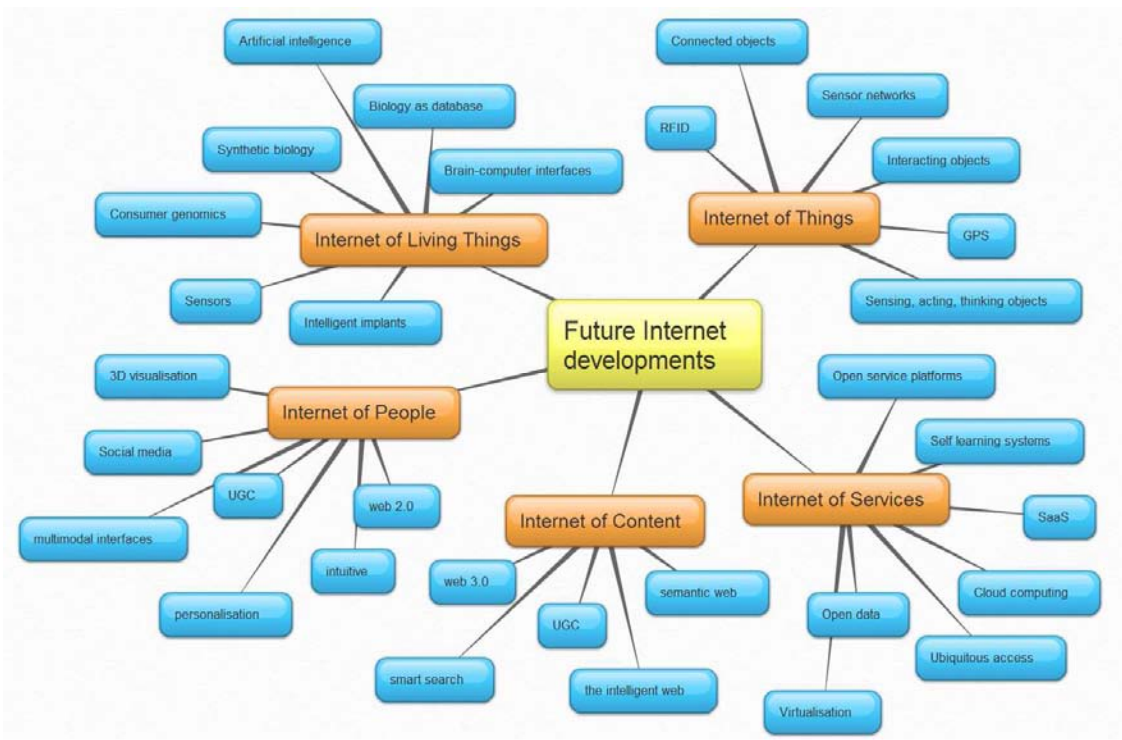

Figure 3.2: Future Internet developments.

The Future Internet can be seen as the Internet of People, Internet of Content, Internet of Services, Internet of Things and even an Internet of Living Things.

Research areas around end user and socio-economic aspects include the need for appropriate incentives, viable business models, legal and regulative issues, and the need for security and privacy. These aspects are influenced by societal, economic, environmental and cultural trends, like identified by ISTAG [ISTAG2009]:

- The Individual:
  - From isolation towards integration;
  - From local citizens towards the global village;
  - From the consumer towards the prosumer[2].
- Society:
  - From government to governance;
  - From resource-intensive living to a sustainable lifecycle;
  - From geographically based economies to virtual communities.
- Business:
  - From local players towards global competition;
  - From piecemeal products to end-to-end solutions.

Future internet is about structural involvement of ICT and internet technology in many usage areas. Current "autonomous" Internet developments create serious opportunities for many sectors, however, parallel designs exist. There is no clear (de facto or de jure) standard (yet). Future internet application areas address societal and business challenges and are aimed at sectoral and trans-sectoral advances, like:

- Smart transport;
- Smart cities;
- Smart energy;
- Smart healthcare;
- Smart enterprises;
- Smart factories;
- Smart living.

A Smart Living Lab approach can create both momentum for development of generic functionalities (the future internet core platform) as well as sector-specific realisations, e.g. Smart Transport.

An important programme for Future Internet innovation is The Future Internet Public Private Partnership (PPP FI). PPP FI aims to advance Europe's competitiveness in Future Internet technologies and systems. The PPP FI is aimed to increase the effectiveness of business process and of the operation of infrastructures supporting applications in sectors such as transport, health, or energy. The PPP FI Instant Mobility project will create a concept for a virtual "Transport and Mobility Internet", a platform for information and services able to support radically new types of connected applications. The project will define requirements for Future Internet technology tools and enablers, so that all these services will be available to any Internet-connected user, whether using a portable, vehicle-based or fixed terminal [InstantMob].

3.2.2 A clustering of Future Internet developments

There are different possible ways to cluster the Future Internet developments as indicated in the previous section. For the sake of this study we adopt a similar categorisation[3] of developments as introduced by the Information Society Technologies Advisory Group [ISTAG2009]:

Table 3.1: Overview of development categories used to describe the Future Internet developments.

Category	Description
Infrastructure	From an incompatible loosely coupled infrastructure to the 'Future Internet'

[2] The term prosumer indicates that the role of producers and consumers blur and merge, where end users become producers.
[3] Please note, that this categorisation contains a certain overlap in developments between the different categories.

Category	Description
Smart things, devices and systems	From one device to interconnected intelligent embedded systems and artefacts
User	From a computer-focused to a computer-served perspective
Systems	From dedicated computing facilities to computing-as-a-service (Cloud) From centralised and hierarchical to distributed autonomous systems
Applications	From stand-alone to end-to-end

The following paragraphs sketch the future internet developments in these interrelated clusters.

Infrastructure

Future internet infrastructure developments are aimed at taking away the limitations of the current internet. New services pose new requirements with respect to reliability, robustness and availability. The increasing use of multimedia content and applications calls for innovations in flexible capacity and quality of service support. The future internet core platform is envisioned to be a common platform for smart applications and integrated functionalities. *'The future internet architecture will be flexible enough to support a range of application visions and business models in a dynamic way, ensuring convergence between technology, business and regulatory concerns'* [ISTAG2010].

Advances in communication networks will enhance the support for connectivity in the future internet. The future internet will be mobile on a large scale: mobile devices, mobile apps, application stores, smart phones and smart devices. The convergence between wired and mobile networks and the convergence between media and communication are important for the development of future mobile internet services [Mosquito]. The infrastructure will consist of a network of networks. Developments in high-capacity fixed networks will support the increasing bandwidth demands. Developments in mobile and wireless communication networks will further improve mobile connectivity in the future internet, e.g. enabling new services supported by the connected car.

The FIArchitecture Group has indicated the following interrelated fundamental limitation areas with respect to the internet architecture: processing/handling, storage and transmission of 'data' and control of processing, storage, transmission of systems and functions. For the future internet architecture, improvements in each dimension combined with a holistic approach of the problem space are needed [FIArch2009].

The Future Internet will support trust management and security. Privacy and data-protection mechanisms will be further developed and improved. Use of physical and other context information, e.g. from the network, will enable new services and enhance existing services. However, there may be a trade-off between preserving privacy and making available personal information to enable delivery of an enhanced user service (e.g. user preferences).

Smart things, devices and systems

The future internet vision is that things, devices and systems will be increasingly interconnected, thus becoming smart and by so creating ambient intelligence. This can be called the Internet of Things, which can be defined as [IoT2008]:

Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts.

This network of interconnected objects within the future internet will offer specific object-identification, sensor and connection capability as the basis for the development of independent cooperative services and applications [CASAGRAS]. Sensors, actuators and processors will be embedded in products and things. On the other hand objects themselves can play a role as sensor, e.g. 'the car as a sensor' (or as a mobile communication platform with sensors). The Internet of Things results in information about the state of the objects in their world (self-aware capabilities) and about their environment (context aware capabilities).

Autonomous self-organizing networks of sensors and things adapt autonomously to changing requirements and reduce the reliance on centrally planned services. For instance, self-organizing traffic lights with their own connected sensors can autonomously smooth the flow of traffic, without relying on commands from a remote traffic control centre. Sensing systems in cars and the infrastructure sensing systems can be employed in self-monitoring automatic traffic control systems. Smart connected devices can play a significant role in e.g. energy efficiency in the use of transportation to deliver goods [ISTAG2009].

Furthermore, new services to end-users can be based on information collected and sent to the interconnected objects, like for instance cooperative driving with smart cars or real-time traffic and road status services with smart roads using distributed sensors in the road.

User

With the advance of social media the user already has become an important driver for the Internet of People. The Future Internet will become more user-centred. People producing their own user generated content and services become more personal and context aware.

Intelligent context aware services empower the user. Services become more aware of the preferences and context of the user, e.g. a user who is currently on the move needs different support than somebody who is at the office or at home [ISTAG2009]. The future internet will change the way that those producing or offering products and services and those adopting and using them interact with each other. This could be businesses and their consumers or non-commercial organisations and citizens. Advanced social networking, the emergence of the internet of things and developments in the field of the semantic web will mean that traditional marketing and product development activities will change beyond recognition.

Further developments in user interfaces will make interaction with user devices and systems more natural and intuitive to the user, like multi-touch screens, the use of natural language (particularly spoken) and real-time semantic search. Visualisation techniques like augmented reality and 3D enhance the user interaction. Services in the car for example will be aware of the activities and context of the driver and adopt the interaction mode and information to be exchanged accordingly.

Systems: Cloud

A Future Internet development is the move from dedicated computing facilities and resources to Computing as a Service using a 'cloud' of computing facilities and resources. 'Cloud Computing' enables scalability, reliability and adaptability in the future internet. Cloud Computing is not a specific technology, but is rather a concept that can be realised by employing different types of technologies and concepts like a service-oriented architecture and open service platforms. A 'cloud' can be defined as follows [Cloud2010]:

> *A 'cloud' is a platform or infrastructure that enables execution of code (services, applications etc.), in a managed and elastic fashion, whereas "managed" means that reliability according to pre-defined quality parameters is automatically ensured and "elastic" implies that the resources are put to use according to actual current requirements observing overarching requirement definitions – implicitly, elasticity includes both up- and downward scalability of resources and data, but also load-balancing of data throughput.*

Another definition developed by Vaquero et al (FP7/ICT RESERVOIR project) is [FInES]:

> *Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs.*

The facilities or resources 'in the cloud' can be storage facilities, computational resources, software applications or service components. These facilities or resources are provided 'as a service' to the users through the internet. Users do not have to be aware of the underlying technology and physical network topologies that supports the services. By providing proper interfaces and standards, both technical and semantic, computing, storage, infrastructure capabilities and software can be offered as services. However, it should be noted that the major Cloud suppliers have deliberately made their systems proprietary and specific (for commercial competitive reasons) thus precluding at present a universal cloud virtual environment with interoperation across Cloud supplier offerings. These services are offered individually, or in a "mash-up" of various service components. For example, the following types of facilities and resources can be provided as a service to the user based on Cloud Computing [Cloud2010]:

- Infrastructure as a Service or Resource Clouds: provide managed and scalable resources: data and storage, computational resources;
- Platform as a Service: provide computational resources via a platform upon which applications and services can be developed and hosted.
- Software as a Service or Service or Application Clouds: provide applications / services using a cloud infrastructure or platform.

Current examples of Cloud Computing are [Cloud2010]:

- Data centres providing secure data storage and maintaining high scalability and increased availability;
- Web server farms automating and stabilising a number of servers, e.g. to support websites;
- In house attempts to balance resources over the business solutions;
- Application Service Providers offering use of software applications.

Telstra and Mercurien partner to develop cloud-based traffic management solutions

Telstra and Mercurien – developing the market for cloud-based traffic management transaction solutions

3 May, 2011 - Australian transaction software company, Mercurien Limited, and Australia's leading telecommunications company, Telstra, today announced that they have signed a Memorandum of Understanding (MOU) to jointly investigate and develop local, cloud-based transaction solutions for the transport sector.

With major Australian cities suffering from a broad range of transport issues, from traffic congestion to parking availability, there is a compelling need for both private and public sector enterprises to be able to deploy effective and scalable transport management transaction solutions.

The MOU emphasises both companies' commitment to developing transportation market solutions that take advantage of the latest transaction processing technologies and benefits of cloud-based operating services. Areas to be investigated include: toll-road use, congestion and traffic-flow management.

The new solutions would use Telstra's Infrastructure-As-A-Service solution and the Telstra Next IP™ network to deliver Mercurien's world class, web-based transaction platform.

John Paitaridis, Executive Director, Telstra Enterprise and Government said: "Transport management is one of the biggest challenges for local governments today, and also a major focus for private infrastructure enterprises across Australia.

"We will be working closely with Mercurien to investigate new markets for the transport management sector that can best utilise Telstra's cloud infrastructure and deliver flexibility, scalability, coverage and ease of use for the transport management industry. This is a great example of Telstra enabling market innovation and solutions for one of the most important sectors in Australia's economy."

Figure 3.3: An example of cloud computing developments in the transport sector.

An example of a European research project in the cloud computing area is the BonFIRE project [BonFIRE]. The BonFIRE Project will design, build and operate a multi-site cloud facility to support applications, services and systems research. The facility will give access to large scale virtualised compute, storage and networking resources with the necessary control and monitoring services. The facility is targeting the Internet of Services community and provides experimentation of systems and applications.

Systems: Distributed, autonomous and self-organising

An existing trend that is expected to be developed further towards the Future Internet is the move from centralised and hierarchical systems to distributed autonomous systems. Distributed, autonomous and self-organising systems exhibit promising features and capabilities such as modularity and scalability, low cost, robustness and adaptability [ISTAG2009].

The trends underlying these concepts boil down to the increase of so-called "self-*" capabilities in the infrastructure (self-*: self-organisation, self-optimising, self-healing, …), the realisation of cognitive capabilities in mobile and nomadic devices, and services on top of linked content and data. The self-* capabilities are required to lower the involved expenditure required to operate the network and manage the systems, but also to increase the resilience (reliability) of the network in case of failures.

Smart semantic web search capabilities will be developed in order to provide services based on distributed data. Networked media will allow co-operative and collaborative practices enabling users to contribute to the production of the new media [EU-NM].

Applications

Applications will move from stand-alone to end-to-end. Instead of 'stovepiped' applications and services for one specific use, applications and services become more and more 'networked'. Stand-alone processes are increasingly linked to be able to quickly adapt existing processes and compose new end-to-end processes in order to interlink in the network of business partners [ISTAG2009]. Future internet enterprise systems will enable enterprises to build partnerships, deliver new products and services, and become more cost efficient [FInES].

The Future Internet will be the Internet of Things, the Internet of Services and the Internet of Content. The previously mentioned developments will enable services to be dynamically composed of different service components. Composed services can be provided as a service.

Content will play an important role in the Future Internet. Content and data is generated by numerous sources, ranging from content providers and users to distributed networks of sensors. Services will build upon these data resulting in web megaservices or mash-ups. A related development is that of open (linked) data. Governments and business will provide open data, e.g. road traffic information or public transport schedules and real-time information, to third parties to create novel services, in turn creating wealth and improving the quality of life.

3.3 Future mobility services developments

Future mobility services for the connected car are strongly related to Intelligent Transport Systems and, more specifically, Cooperative Systems. Overviews of current services and developments have been made in several projects (COMeSafety, Safespot, CVIS, SPITS) and a standardised list of services has been defined by ETSI [ETSI ITS]. However, to be able to make the link with future internet developments, the scope of connected car services has been extended for this study. Based on the categorizations available from the aforementioned projects, the categories in Table 3.2 will be used here to describe future mobility developments.

Table 3.2: Overview of service categories used to describe the future mobility developments.

Service category	Description
Safety	Services focussing on improving road safety
Traffic Management	Services focussing on managing and controling the traffic flow on the road infrastructure
Eco services	Services focussing on reducing the impact of (road) mobility on the environment
Pricing	Services focussing on payments related to when, how, and where you drive. This includes both road pricing and commercial pricing services
Transport and logistics	Services specifically targeting the transport and logistics sectors

Service category	Description
Traffic information and navigation	Services providing traffic and travel information to road users
Other information	Services providing other information to road users
Entertainment	Entertainment services for road users

3.3.1 Safety

Safety related services[4] aim at reduction of the overall number and the severity of road traffic accidents. A number of large national and international projects ([COMeSafety], [Safespot], [CVIS], [PReVENT], [SPITS]) has defined a long list of safety services for the connected car. Most services have at least been implemented in a few cars to prove the concept of the service. Only a few have reached the phase of deployment, e.g. the speed limit violation warning on some navigation systems.

A set of safety services provides benefits to the driver of the car. The uptake of these services depends on the type of benefit:

- A driver/owner is willing to invest in safety services with direct benefits, i.e. where he can immediately profit from the benefits. Services where the implementation can be based on sensors in the car, like *Pre-crash sensing* or a limited version of *Speed and distance advice*, belong to this group. Also in this group is *Speed limit violation warning*, implemented as an add-on in some navigation systems, but only as a static service, rather than a cooperative service. In general these services are implemented first in high-end cars and trucks, and it takes time to get them also in the low-end cars.

The willingness to invest in services where the benefits materialize only after the service reaches a minimum penetration level is low. Like the videophone in the 1980s: no breakthrough due to lack of persons to videophone with. Services that need to look ahead (far) beyond than the next car, like the *incident situation handling*, *Cooperative merging assistance* and the more advanced *Speed and distance advice*, belong to this group.

A number of safety related services depend on regulation. Typically these services provide a higher benefit to other stakeholders than the driver/owner of the car. Examples are *Vulnerable road user warning* and *Emergency vehicle warning*.

A set of the safety services rely on an accurate picture of the geographical environment of the connected car (the local dynamic map, LDM). For the situation near the car the state of the art services use on-board sensors. For information regarding the situation further away the services have to rely on mobile communication which is inherently unreliable and limited in bandwidth.

The communication is either I2V (Infrastructure[5] to Vehicle) or V2V (Vehicle to Vehicle). A high degree of standardization of the information to be exchanged and the communication channels used is required. Work in this area is ongoing in ETSI [ETSI] and ISO. The Communications Access for Land Mobiles (CALM) framework is an ISO TC204 initiative to define a set of wireless protocols and interfaces using a wide range of physical channels to provide a reliable wireless data link for I2V and V2V communications.

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[4] This text uses “service” as the generic term where others also use the terms “application” or “system”. The applications and systems are providing a service to one or more stakeholders (driver, road manager, road authority, emergency service, …).
[5] Where the infrastructure either gathers information from own sensors or collects data via V2I communication.

The roadmap for safety related services is based on the uptake mechanism combined with the need for standardization or high service penetration:

- First wave: services with a direct user benefit based on own sensors (non cooperative).
- Second wave: cooperative services which require standardization but no significant penetration.
- Third wave: cooperative services which require standardization and significant penetration.
- Any time: services where introduction depends on legislation (cooperative and non-cooperative).

The table below gives an overview of cooperative safety services.

Table 3.3: Overview of cooperative safety services.

Preventive Longitudinal services	Preventive lateral services	Other preventive services	Corrective services
Speed and distance advice	Overtaking vehicle warming	Stop sign violation warning	Crash preparation service
Car breakdown warning	Lateral collision warning	Red traffic light violation warning	eCall
Traffic jam ahead warning	Lane change assistant	Speed limit violation warning	Accident reconstruction
Slow vehicle warning	Cooperative flexible lane change	Intersection collision warning	Post accident warning
Ghost driver warning	Cooperative merging assistance	Left (right) turn collision warning	
Hazardous location notification	Emergency vehicle warning (blue wave)	Vulnerable road users warning	
Cooperative glare reduction			

3.3.2 Traffic flow and traffic management

Traffic management involves steering of the traffic flow to improve safety and promote efficient use of the road infrastructure. The efficiency is reflected in shorter and more predictable travel times, but also in the environmental footprint of the transport sector. It is typically a Public Authority service. A limited number of European projects and pilots exist with a specific focus on traffic management. The most important European project through which road operators of different Member States work together is the EasyWay project [EasyWay].

Current deployments of traffic management services are not based on the connected car. Services like dynamic lane management, variable speed control, ramp metering, hard shoulder running, HGV overtaking ban and incident warning are implemented based on road side sensors (loop detectors, camera's, etc.) and actuators, e.g. traffic lights, variable message signs, LED road markers, etc. Systems are mainly autonomous, but supervised by a Traffic Control and Management Centre.

At the basis for traffic management is an effective and efficient backbone infrastructure for data exchange, which is a key element for European ITS services between operators and at cross-border levels. Data standards are developed by ISO, CEN and national standardization bodies.

Several concepts for connected car based traffic management have been developed. Connected cars can be used as an information source on which traffic management can be based. Car as a sensor concepts are already in use in travel information and navigation services, but are not yet used as a basis for traffic management services. It is also possible to provide the traffic management and control information in car. Several pilots with in car traffic management information have been conducted, or are currently under way, e.g. Dynamax in Car, Green wave speed advice [Freilot].

If both the car as a sensor and in car traffic management information is deployed at the same time, a paradigm shift could occur, where a distributed form of traffic management could be developed, e.g. based on agent technology, in stead of the current centralized approach. Although described here from a services point of view, such a paradigm shift will be influenced by and have significant influence on the stake holder models for traffic management. The difference between traffic management and traffic information and navigation will become less distinct and the role of the Road Authority and Operator could change significantly.

3.3.3 Eco services

Eco services contribute to the (European) goal of creating a sustainable transport system with lower carbon emissions. This can be realized by either optimizing the transport system as whole or by using more efficient vehicles. Within the context of this study, the first category relates to a further connectivity between transport systems and the second category to electrical (and other future technology) vehicles.

These two categories of Connectivity and Electric Vehicles are in line with the distinction made within the European Green Cars Initiative [GCI]. Their roadmap comprises three pillars: 1) electrification of road transport, 2) long distance transport, and 3) logistics and co-modality. The second pillar mostly relates to vehicle efficiency and the driveline and shows overlap with third pillar when “connected car” possibilities are discussed. Therefore pillar 1 is related to the Electric Vehicles section within this study and pillars 2 and 3 are related to the Connectivity section within this study.

Electric vehicles (EVs)

A major trend within low or even zero emission vehicles is the uptake of EVs. These introduce a whole new range of potential challenges where ICT can and must play a vital role. The limited range of the batteries used in EVs imposes serious bottlenecks that need to be addressed. The connected car (including the ICT infrastructure) can provide significant solutions for the range issue. As an example, low capacity batteries can be used in combination with a higher density of charging stations. Here, the use of quick charging may prove valuable, e.g. using induction instead of using physical sockets. The use of many quick charging actions requires a good management of route planning and availability of charging stations. There are various inductive charging pilot schemes taking place across the world such as an electric bus using inductive charging in Turin, Italy or a tram in Augsburg, Germany that uses inductive power transfer in 0.8 km section of the line.

A more intelligent way to cope with the range issue is done by coupling real time route navigation based on the actual traffic situation with the battery status and the vehicle’s powertrain. This needs to be managed for the individual vehicles, but also on a system level to make sure “congestion” at the charging stations is minimised. This uses the full potential of ICT development with the connected car. In the Sentience project [SENT] a version of such a system has been developed, although not connected to real time information yet.

The European 7th framework project ELVIRE [ELVI] is aiming to solve acceptance issues stemming from the Electric Vehicle's limited range.

When EVs are massively rolled-out, new ways of providing and managing the energy infrastructure is required to cope with short peaks of high demands. To cope with such demand, a flexible and smart management of the infrastructure (smart grids) is required, where the connected car may provide solutions, based on Vehicle-to-Grid (V2G) communication.

Green zones typically refer to the situation where the goal is to achieve a good air quality in a specific area. This can be implemented by only allowing vehicles with low-emission while they are in the green zone. The air quality depends on the number and (pollution) type of vehicles in the area, but also on weather conditions. EV could have an advantage here, but the effect depends strongly on the type of vehicle, the development of the combustion engine and the speed at which electric vehicles will penetrate the market.

Connectivity

Many services that enable a more efficient transport system also contribute to energy and CO_2 reduction. For example, road pricing might stimulate the use of cleaner methods of transport like public transport. Another example is the dynamic navigation aid, since this stimulates throughput but simultaneously also reduces CO_2 emissions. As an example, take the overview as provided by the Connected Urban Development initiative [Kim2008], illustrated in the figure below. This figure provides an overview of services that relate to a connected and sustainable mobility. Many services that are shown in this figure are already described in other sections of this report. This section covers the services that are not covered within other sections, and that in particular related to the connected car and future internet developments.

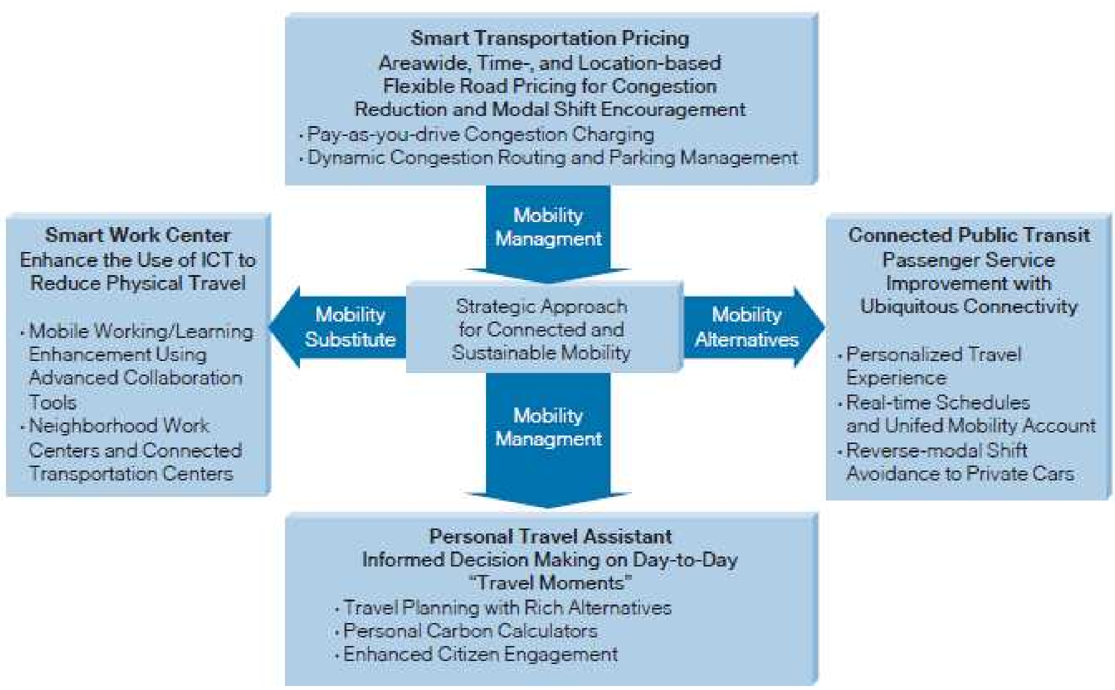


Figure 3.4: Classification of connected and sustainable mobility (From [Kim2008]).

A shift away for owning private cars towards car sharing, car pooling, car hiring and/or vehicle leasing can be enabled by a better connectivity and logistics. This might result in fewer cars on the road and the application of low-emission vehicles.

Multiple mobility services can be employed that enable a more personalized travel experience that makes use of a combination of different travel modalities, for example via train, tram and cars. Incentives could be to avoid traffic jams, to enable the most cost or time efficient route. An incentive could also be to operate climate efficient or even neutral.

The European Green Car Initiative (EGCI) makes a distinction between several aspects of logistics where the connected car can play an important role to improve the efficiency of the logistic system:

- *City logistics*: This is defined by the EGCI as "transport and logistics activities in geographically concentrated or densely populated areas where the organization requires to move large amounts and different sized volumes of parcels or goods". Together with the introduction of EV's there is much to gain here in terms of environmental impact (both pollution and noise levels).
- *Green hubs and corridors*: Green hubs are efficient interfaces in the transport system and green corridors are hubs for long-distance freight transport.
- *e-freight*: This can be understood as the integration of information across supply chains and logistic systems. This concept of bundling freight flows controlled by goods operators necessitates common platforms for information and business exchange. This in turn requires standardization of messages and documents and measurement frameworks on transport performance.

3.3.4 Pricing

For pricing services a distinction can be made between road tax services imposed by governments and pricing services by private organisations like insurance companies. Traditionally, road tax is charged directly to the car owners, via gasoline, and as a tax on the purchase and/or ownership of vehicles. Tolling systems are in use on highways and other main roads in various European countries, including France, Spain, Italy, and Austria. Tolling for special locations like bridges and tunnels exists in many countries. Both stop and go toll booths and free flow toll booths exist, where a communication system based on DSRC allows vehicles to be registered without stopping.

In Portugal, Austria, Germany and Norway electronic tolling systems are in place that charge based on (combinations of) location, distance travelled, type of vehicle, emission category.

Commercial pricing services are currently being piloted and in development in various locations. This includes insure-how-you-drive, car-rental, and taxi services. Although the functional requirements are similar to those from road pricing services, the differences in market models and incentives to the users, mean that much simpler systems can be used to implement these services.

3.3.5 Transport and logistics

Within transport and logistics services we distinguish fleet management services, cargo related services and a few miscellaneous services for trucks:

- The fleet management services are mostly concerned with efficient planning of routes for a fleet of cars/trucks. The 'connected truck' brings some additional options for efficiency gains to the classical fleet management, in particular in relation to multi-modal transport [HeavyRoute].

- Around cargo another group of activities will benefit from the connected truck. There is a movement from cargo related IT (transport documents) to intelligent cargo, where RFIDs and agent technology are used as part of electronic transport documents.
- Finally there are services in other categories that can be extended for trucks/fleets.

In transportation and logistics, a number EU funded projects have worked, or are working, on the development of IT frameworks (e.g. [Freightwise] and [e-Freight]). They work on paperless freight transport processes where an electronic flow of information is linked to the physical flow of goods. Though e.g. e-Freight notes that "*developments are expected to lead in the future to 'Intelligent Cargo', meaning that goods will become […] connected to a wide range of information services thus automating further the transportation management process*", the services are not yet defined in terms of the connected car.

A view on cargo in the context of the Internet of Things is provided by projects like Euridice and its successor iCargo [Euridice]. These projects focus on efficient and environmentally friendly logistics through tagging cargo using agent technology combined with passive and/or active RFIDs. These tags communicate directly, e.g. with customs officers at inspection of the cargo, or indirectly, via the connected car/truck. The cargo agents plus the truck agent set up an ad-hoc network. The truck agent acts as a transfer point to the internet.

A number of EU funded projects have a focus on secure logistics, e.g. Integrity [Integrity] and Smart-CM [Smart-CM]. The deliverables of these projects are the basis for a Common Framework for interoperability in freight and logistics [PPK] as a future development, including e-Customs [e-Customs]. Within GS1, the standardization and organization for supply chains, a first version of potential scenarios for warehousing and road transportation is being developed [GS1]. Though relevant for connected truck services, the current view is strong in information technology and limited in communication technology.

A list of fleet management services is provided below. Note, that many services described in other categories are also relevant for transport and logistics. Most services have no implementation yet. The *Tracking and tracing service*, implemented in other domains (e.g. document and small parcel tracing), is in Proof of Concept phase for general logistics and transport [Traser].

Table 3.4: List of fleet management services.

Fleet management services	
Delivery window warning	This service gives a warning of if the ETA for (elements of) the load will not be met, e.g. to be used to update the route. This service is expected to grow in importance, since a) more and more multi-modal transport will work with delivery and pick-up windows; and b) freight transport in urban areas will be regulated by means of delivery windows
Route update service	Reasons for changes in the route might be additional cargo/passengers to be picked-up/delivered or it might be the result of a Delivery windows warning
Drive change service	Service for vehicles with dual-drive indicating that a change from electric to diesel/petrol or vice versa is needed.
Rest area service	Service provides information on safe and secure rest areas for truck drivers.

Intelligent cargo services	
Transport document service	This service provides access to all cargo information. In a basic version of the service the documentation is uploaded to the vehicle by the dispatcher; in an advanced version the communication between RFIDs of the cargo and the vehicle trigger the composition of the documentation.
Cargo warning service	This service warns the driver that the transport conditions, e.g. stability of the load or temperature of the cargo, are not okay.
Communication hubbing	This service provides intelligent cargo the means to exchange messages with parties in the logistics value chain through the long range communication provided by the connected vehicle, e.g. GSM or satellite communications.
Miscellaneous services for trucks	
Resting time violation warning	Extension of the Traffic rule warning service, warning if the resting time rules are (about to be) violated.
Temporary height/weight/axle load restriction warning	Service warns the driver for tunnels with a temporary height restriction and bridges with a temporary weight restriction. This service can also be considered an extension of the Traffic rule warning service.
Vehicle, cargo (and driver) location service	This security and safety service gives a warning to the dispatcher when a vehicle deviates too much from the expected route and/or when the vehicle and cargo get separated at another than the unloading position, to reduce theft of cargo and vehicles.
Tracking and tracing service	Detailed tracking and tracing of cargo as a service from the transport provider to other parties in the logistics value chain.
Cargo discharge and take-over	This service supports the process at unloading and the signalling of problems in this process (e.g. warehousemen not accepting cargo).

3.3.6 Traffic information and navigation

Travel and traffic information services are a key service for private Service Providers in creating added value for the end-users. Travel information service providers provide pre-trip route planning and on the basis of the user’s profile and real-time traffic information can send updates on the expected travel time. The level of personalisation in this type of services is still very limited. Most common are the telecom broadcast techniques (on the radio such as TMC, or digital barrier such as TPEG) used for these services. As a consequence the information provided covers a large area and misses local detail.

The most common data sources for traffic information services are the detection cameras and loops in the road infrastructure of the road operators. State of the art collection of traffic information on the basis of the Floating car data and GSM techniques are being applied by a number of service providers and is offered as supplementary service to the user. Although a significant fraction of the today’s car drivers use pre-trip route planning and navigation services, only a minority make use of these supplementary high(er) quality traffic information services.

Traffic information on the roads is often limited to semi-static data. Real time information on road conditions hardly exists. Recent improvement have been made by Member States to improve (often through centralisation) access to data on road constructions and works.

More real-time traffic information services (from pre-trip to on-trip), often embedded in the navigation service, are currently being developed by the market. The traveller/car as sensor is a principal concept facilitated by technical enablers as map-agnostic location referencing standards and car2infrastructure communication techniques. It is expected that a large market introduction for the car as a sensor for the generation of traffic information, and possibly for provisioning of network cloud services, payment and charging standards will be required as well as telecom-infrastructure agnostic charging/counter standards and privacy-protection protocols. New telecom techniques, especially those that are Internet focused (e.g. see the difference between LTE and WiMAX approach) will further strengthen this development and require charging counters that are telecom infrastructure agnostic. It is expected that the market uptake of mobile Internet and flat rate fees will make this small development grow exponentially. This development will make it possible to provision travel information services that are more personalised and context aware. Because of the enormous potential increase of detailed (and personal) traffic information and the distributed user platform capability (in-vehicle integrated, phone, PDA, etc.), the integration of the HMI of these smart devices in the car-environment requires further attention[6].

The integration of traffic management information, which has been derived for optimisation of the collective transport, into commercial services that are optimised for the individual customer should be addressed; standards will be needed that allow easy access to and authentication and integrity of public safety-related information.

For travel information services that interface with modalities other than the road car traffic (air, train, bus, metro, pedestrian) the number of traffic information services (iTravel, Cooperative cities, Intime) is growing, however in general they are mostly poorly integrated and not personalised. Furthermore, almost all are inaccessible to the traveller during the journey itself (either technically, or for safety and poor HMI reasons). None of these services detect and proactively inform the user of disruptive events relevant to the traveller's specific journey, let alone propose appropriate trip options. The underlying data sources are often constrained to static (planned) travel data and the access to real-time traffic data on the other modalities is still poor.

Content providers have difficulty reaching out to more than a small number of potential end users, while ensuring that their commercial and licensing terms are enforced. Service providers need to find and negotiate separately with a huge number of potential content providers in order to offer a comprehensive end-to-end service to travellers.

New technologies will also be needed [iTravel] to support the traveller services platform as well as an appropriate marketplace for traffic and travel information content. The aim will be to elaborate a platform for the exchange of information between content suppliers and service providers, allowing the provision of context-aware, mobile, on-trip event-based information and trip re-scheduling to travellers. For this development, the establishment of travel ontology that has multi-language support is required. Furthermore it is expected that a basic IT infrastructure including a content directory, basic security, and SLA management should be put in place as an initial step of such a market development. Service publication and discovery technologies must become available as widespread open standards.

As well as these technologies, organizational models and commercial tools are needed to support the integration of suppliers' and buyers' systems.

[6] The high penetration of navigation systems has been a major reason for the quick increase in market interest in traffic information services. However, for a continued expansion of the quality and detail of these information services the HMI integration of these PND's and smart phone in the car-environment requires further attention.

3.3.7 Information

Information services can be divided into the following, not mutually exclusive, categories:

- Services initiated by the vehicle;
- Location based services;
- Internet services.

Services initiated by the vehicle are based on the car management system signalling a problem. The current implementation is a light on the dashboard and the driver is supposed to take action. The connected car implementation is through connection via the internet to a service provided by the garage or dealer. For some high-end cars this service has already been implemented.

Location based services are the hype of 5 years ago. The Points of Interest (PoI) services are currently implemented as part of navigation systems: fuel stations, restaurants, etc. can be shown on the map if desired. The perspective of the connected car is that these PoI services can be extended from static information to real time information: when closed, the fuel station, restaurant, museum, etc. is not shown on the map, nor is a hotel with no vacancies. Other relevant information such as prices, the menu of a restaurant, and so on can be shown in addition to the location. PoI services with actual information are not yet offered, mainly due to lack of a service platform and business model. Internet services to some extent currently fill the gap between PoI services with permanent and dynamic information: the real time dynamic information is fetched via internet browsing[7]. The lack of integration, however, requires a passenger to do the fetching.

Internet services include services like browsing, e-mail and social networking[8]. Developments in reading out e-mail (text to speech technology) make it possible to read e-mail while driving, though concerns about the distracted driver remain, and it is possible these types of services will be legislated against, at least for the driver.

In social networking the two big questions are *where are you?* and *what are you doing?* Providing the user's own location (i.e. the vehicle location) and obtaining the location of travelling friends allows for meeting friends or obtaining suggestions for restaurants, hotels, and so on.

iThe interconnection of the vehicle communication system (telephone, internet and ITS communication) with the smart phone of the driver to access contact lists, internet preferences and settings (e.g. e-mail provider) and other personal profile information is important for the information services. Even if the vehicle has no GSM/UMTS/4G network access, the vehicle can access these communication channels, using (an application on) the smart phone as an information agent.

Information services for the connected car have been demonstrated, mostly in national projects. Concerns about the connection to internet and malware infiltrating the vehicle's software, thus causing unsafe situations, do exist. A secured connection to a controlled service platform is considered the best way to counter these concerns.

The following information services for the connected car have been identified.

[7] Other uses of internet browsing are considered to be entertainment.
[8] Many of these services are not targeted towards the driver, but (also) to the passengers and/or co-driver.

Table 3.5: Information services for the connected car.

Vehicle initiated services	
Maintenance notification service	This service forwards maintenance notifications beyond self-service to garage or dealer. The dealer/garage sends a schedule proposal to the driver based on the own planning, availability of replacement vehicle, …
Remote diagnostics service	Service where the vehicle management system sends a request for remote diagnostics. This might result in a maintenance notification or a change of engine settings[9].
B-call	The breakdown call (B-call) service is the mild version of the E-call service (see Safety services). A request for assistance, including the location of the vehicle, is sent to a road side assistance service. Combined with the Remote diagnostics service it allows the road side assistance service to come well-prepared to the breakdown location.
Location based services	
Point of Interest service (static data)	Service provides limited PoI information based on permanent data
Point of Interest service (transient data)	Service provides extensive PoI information based on the current state of transient data
Friends location service	Service provides the location of the vehicle to social network(s), allows to find friends and be found by friends, and signals nearby friends (with the meaning of 'friends' in social networks).
Internet services	
Internet browsing service	Depending on usage this is an Information service or Entertainment service, hence often listed as "infotainment".
E-mail/chat (readout) service	Access to e-mail/chat from the connected car. With voice control and text-to-speech this service can even be used by the driver, although safety concerns remain.
Personal device interconnection service	Service "integrates" the (smart) phone or computer of the driver into the in-car network (either using cable or wireless, e.g. Bluetooth). The purpose of the interconnection is usage of profile information (e.g., internet settings, contacts and preferences) and/or the wireless network connections of the personal device.

3.3.8 Entertainment

Entertainment services can be divided into broadcast and personal entertainment. Broadcast entertainment focuses on traditional radio broadcasting. However, in high end vehicles and for the aftermarket, digital radio and DVB-T based video systems are also available. Personal entertainment is currently mostly realised via connecting personal devices to the in-car systems, or as stand-alone after market systems. Examples are analogue or digital audio connectors for personal music players. Systems also exist to connect an USB memory stick or hard disk with (mp3) music to play on the in-car audio system. Video content can be played via stand-alone DVD players.

[9] Example: for some Volvo trucks the engine settings can be optimized to "urban transport", "long flat trips" or "long mountainous trips". Optimization lowers wear and fuel consumption (thus lowering emissions).

Few connected services are currently available, although general purpose GPRS/UMTS modems for Internet connectivity can be build in: no dedicated service offerings are in wide use. This also allows for online gaming, although the types of games that can be played is limited by the quality of the data connection.

The use of personal in-car entertainment is expected to follow the use of personal entertainment on mobile devices like smart phones, and will enter the vehicle by integration of connected personal devices in vehicles, or via dedicated in-vehicle devices based on similar technology.

An important issue for connected car entertainment is the life cycle mismatch between vehicles and the entertainment systems and devices. The developments in encoding standards, communication standards and connectors is changing much more rapid than the typical life cycle of vehicles, which means that entertainment systems have to be changed during the vehicle life cycle to keep supporting the emerging entertainment solutions. Furthermore, digital rights management (DRM) of online entertainment is not at all standardized, resulting in a fragmented market for commercially available content. It is not at all clear where DRM will ultimately end up; in games and to a lesser extent films it is well established and circumvented only by the determined, while in music it has failed almost completely and digital music is now substantially DRM free. Furthermore, new business models (e.g. Spotify) may disrupt the status-quo.

3.4 Concepts and technology developments enabling future mobility services

Mobility services are enabled by specific concepts and enabling technologies. An overview of these concepts and enabling technologies are given in the table below.

Table 3.6: Overview of enabling categories used to describe the future mobility developments.

Concepts			Enabling Technologies		
Architectures	Information management	Organisation	(V2X) communication	Service platforms	HMI

An *ITS communication architecture for cooperative systems* [COMeSAFETY] has been defined by the EC-funded project COMeSAFETY in a joint effort with the EC-funded projects COOPERS, CVIS, SAFESPOT, GeoNet and PRE-DRIVE C2X and in cooperation with the Car2Car Communication Consortium, ETSI, IETF and ISO and with input from the IEEE and SAE.

With respect to information management a (Local) Dynamic map for safety and other cooperative applications has been defined in the SAFESPOT project which was further elaborated on in the CVIS project.

In a variety of European projects, research has been carried out on the relation between market needs and enabling technologies in the traffic and travel information services sector (iTravel, INSPRIRE, InTime, CVIS, Safespot, COOPERS). This research was focused on the collection and generation of road traffic and travel data, aggregation of and providing access to or broking data and legal and liability issues.

(V2X) communication channels concern the transport and access layers of the ITS station architecture. For the connected car, a mix of general standards and ITS specific standards are in use or in development.

Service platforms are used for the deployment of services and to enable interaction of services with each other or with standardized components in the service platform itself. The GST project has set the standard for service platforms for cooperative systems.

With the further uptake of the connected car, more and more in-car driver applications and services will become available that help the driver with his driving task. The effectiveness and efficiency of using these functionalities strongly depends on the Human Machine Interface (HMI).

A detailed description of concepts and enabling technology developments enabling future mobility services is given in Appendix A.

3.5 Conclusions

Future internet developments will address the limitations of the current internet like robustness, security, trust, flexibility, scalability, mobility and energy efficiency. The Future Internet can be seen as the Internet of People, Internet of Content, Internet of Services, Internet of Things and even an Internet of Living Things.

The Future Internet core platform will support smart applications and integrated functionalities. Future Internet usage areas, like transport, are expected to provide input to the definition of the Future Internet core platform.

Future mobility services for the connected car are strongly related to Intelligent Transport Systems and Cooperative Systems, more specifically.

The scope of future mobility services has been extended for this study in order to facilitate a good link with future internet developments. The resulting categorisation of new services enabled by the connected car is summarised in Figure 3.5.

Figure 3.5: Service categories for connected car services.

Safety, traffic management and eco services can be seen as mainly focused on public goals, pricing and transport and logistics services on business goals and traffic information and navigation, other information and entertainment services on personal goals.

The Future Internet is about structural involvement of ICT and internet technology in many usage areas. Current "autonomous" developments in Future Internet create serious opportunities for many usage areas, including mobility. The combination of developments in Future Internet and in future mobility services provides opportunities for new services enabled by the connected car. In order to identify how these developments can be exploited, a vision in the Connected Car will be elaborated in Chapter 5.

4 Stakeholder Consultation

4.1 Introduction

The objective of stakeholder consultation is to identify in broad terms the views, requirements and priorities which the various stakeholder groups have for services enabled by the connected car based on a European Wide Service Platform.

The following stakeholders groups were asked to take part in the consultation:

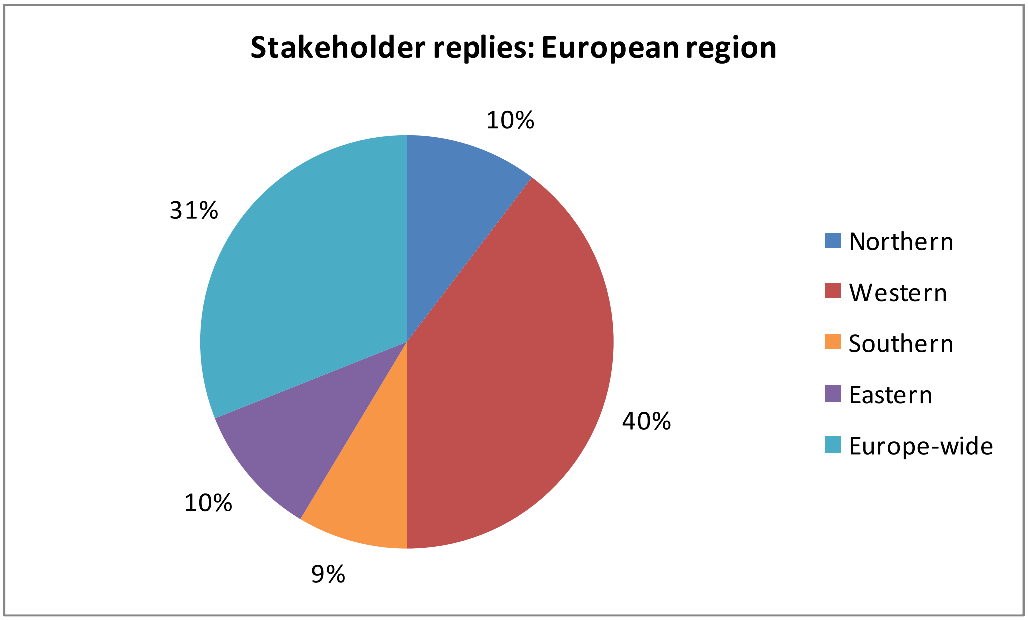
- Public service providers (including Member States, Road Operators and Road Authorities);
- Commercial service providers and industry (including vehicle and equipment manufacturers, service suppliers (e.g. in-vehicle services));
- Road users (representatives of private individuals, freight industry, fleet managers).

Views were sought from different areas of Europe at different stages of ITS deployment (e.g. North West Europe, Southern Europe and Eastern Europe represent different phases of maturity in ITS development).

To identify relevant representatives of the various groups of stakeholders, the following sources were used:

- Working Groups and other initiatives listed on the iCar Support web site;
- Future Internet Partnership members;
- ELSA Task Force members;
- EasyWay Working Groups;
- Web sites for relevant organisations, projects and initiatives;
- Personal contacts by members of the project team.

A total of 358 stakeholders were invited to take part in the consultation. All those invited were asked to pass the survey on to colleagues and, if appropriate, members of working groups and industry bodies. The figure below gives an overview of the respondents of the stakeholder consultation.



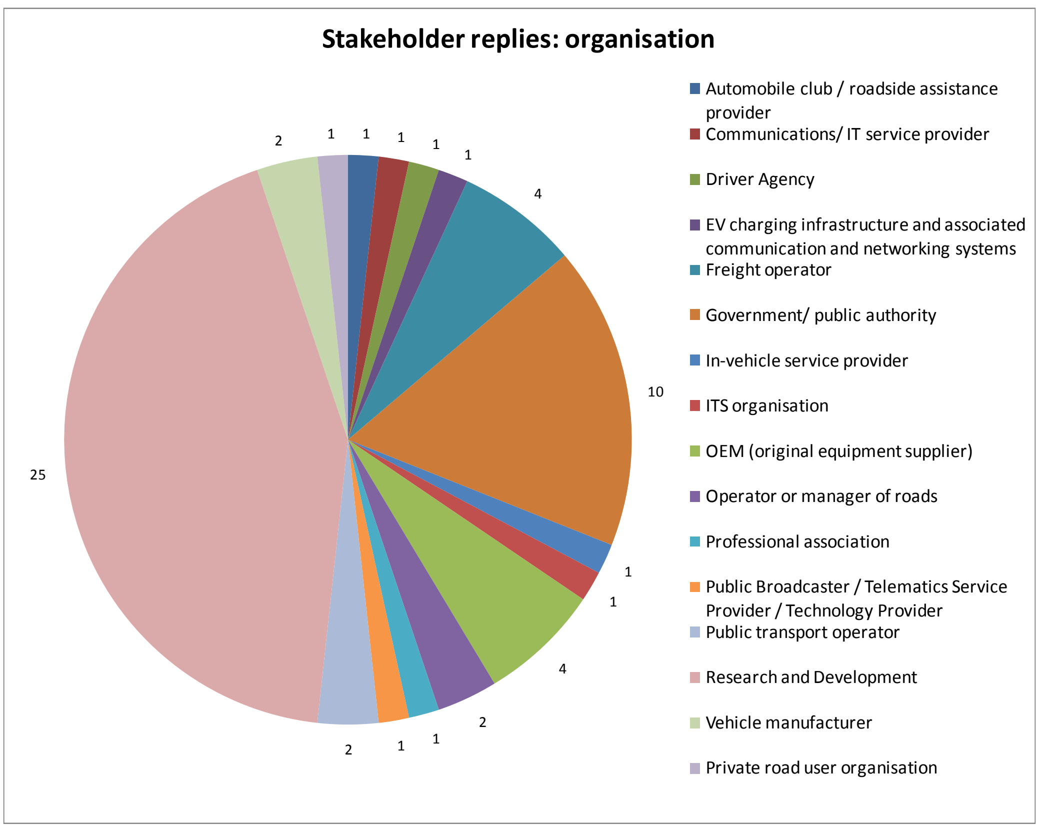


Figure 4.1: Overview of the geographical distribution (top) and type of organisation (bottom) of the respondents of the stakeholder consultation.

4.2 Main results

The details of the stakeholder consultation can be found in Appendix B. Here, a summary of the most important results is presented.

4.2.1 Relative importance of potential new services

A list of 22 potential new services for the connected car in 2025 was derived from the service developments as described in Chapter 3. Stakeholders were asked to say how important these were to their organisation. Figure 4.2 shows the 22 services, grouped according to the type of service, and the proportion of people who thought the services were 'very important' or 'important' to their organisation.

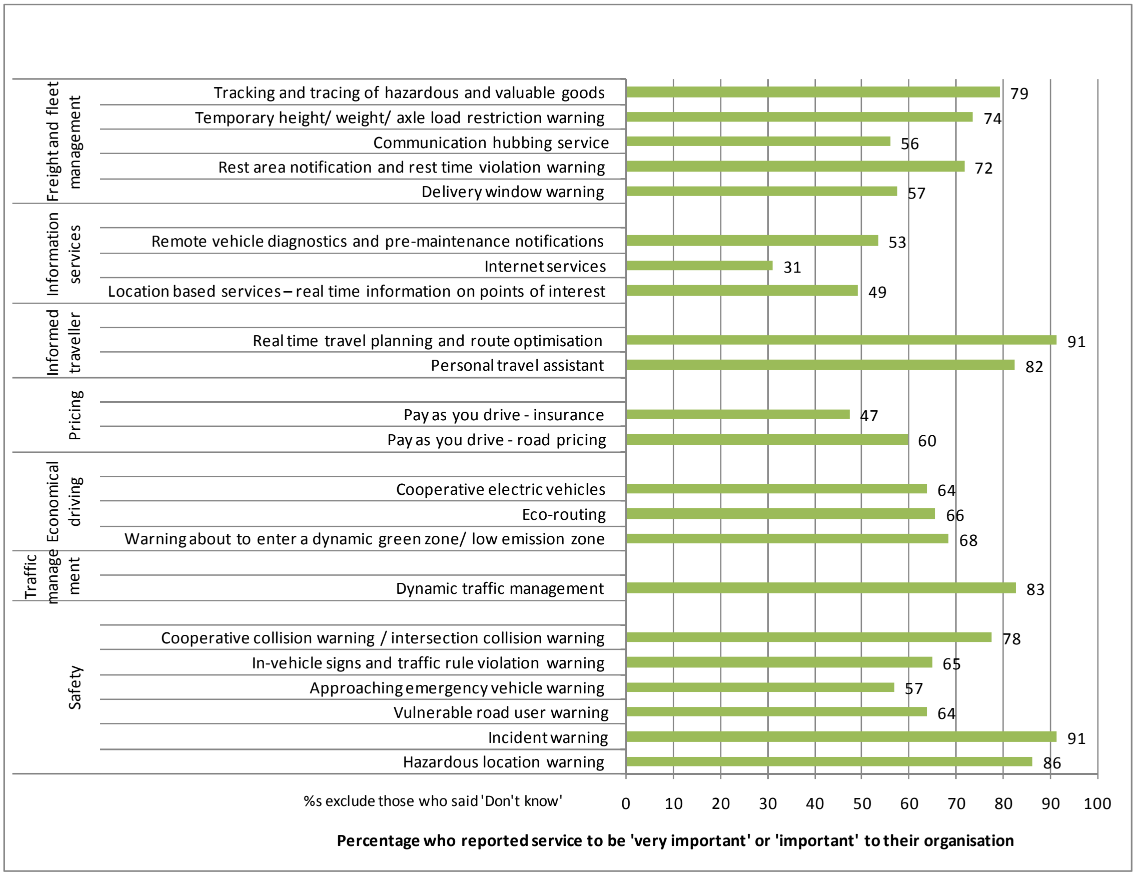


Figure 4.2: Percentage of stakeholders who thought each service was 'very important' or 'important' to their organisation, by type of service.

Two ranking mechanisms where used to determine the importance of the services. The following services ranked in the top ten in both cases:

- Real time travel planning and route optimisation;
- Incident warning;
- Hazardous location warning;
- Dynamic traffic management;
- Personal travel assistant;
- Tracking and tracing of hazardous and valuable goods;
- Cooperative collision warning/ intersection control warning.

One service was ranked as being least important according to both methods of ranking:

- Internet services (internet browsing, email chat readout, social media).

4.2.2 Key requirements for success and challenges

Stakeholders were asked to identify key requirements for success in the potential new services which they had described as 'very important' or 'important'. They were also asked to identify problems, challenges and areas for further research. The comments made were wide ranging, covering technical elements, service characteristics, user aspects, organisational and institutional issues.

Many of the points made by stakeholders are relevant to specific services. However there were also common themes in requirements which apply to many of the services:

- Services free of charge to users and accessible to as many users as possible;
- A high rate of penetration of equipped vehicles;
- Interoperable systems;
- Reliable and fast communications to specified standards;
- Accurate position information;
- Relevant, reliable, validated, real time data, covering all of the road network; some stakeholders said that centralised databases are a key requirement for some services;
- Security of information;
- Services should avoid distracting the driver from the primary driving task with good HMI design; standards for information presentation in cars are needed.

The problems, challenges and areas of research identified tended to vary between different stakeholder groups. The main themes in the comments are listed below.

OEMs and vehicle manufacturers:

- Business models;
- Organisational and institutional arrangements;
- User acceptance (especially in the context of data protection);
- Availability of and access to real time data;
- Safety and HMI issues;
- Technology and communications issues.

In-vehicle service providers, communications, and IT services:

- Integration;
- Standardisation;
- Data exchange;
- User education and trust;
- Market penetration and take up;
- HMI and driver distraction;
- The role of mandatory systems;
- Technical aspects of service operations.

Road operators:

- Interoperability;
- Market penetration;
- Operating model;
- Cooperation between service providers and road operators to encourage desirable outcomes;
- Certification.

Governments and public authorities:

- Market penetration;
- Business models;
- Information on impacts;
- Reliability and data quality;
- Design of systems and HMI;
- European centralisation and harmonisation of services;
- Specific features of services.

Road user groups (freight, public transport, and automobile clubs):

- Driver information and training;
- Driver behaviour issues (e.g. tampering, response to alerts);
- Integration of systems in vehicles;
- Internet security.

R&D organisations:

- Information flows;
- Attitudinal change;
- Willingness of governments to invest;
- Information for users e.g. on costs and consequences;
- Legal issues;
- Privacy;
- Standards for HMI and driver distraction;
- Gathering and fusing large quantities of information.

4.2.3 Need for legislative action

Stakeholders were asked whether there is a need for legislative action to foster harmonised implementation of services enabled by the connected car.

- 66% of those who replied said 'yes', there was a need for legislative action;
- 19% said 'no';
- 15% said 'don't know'.

Those who thought that legislative action will be needed were asked to give details of legislation required for up to five of the services discussed in the previous questions. The main themes of the responses were:

- Ensuring that services are pan-European with full coverage; guidelines for harmonised implementation;
- Common definitions, specifications, quality of service levels;
- Certification of organisations operating in the value chain;
- Definition of roles and responsibilities for collecting, providing and sharing information;
- Requirement for road users to be involved (e.g. as probe vehicles);
- Compliance and enforcement;
- Access to data, data protection and privacy, exploitation of information;
- Human Machine Interface design, compatibility, common designs;
- Liability;
- Use of in-vehicle data as evidence in sensitive situations (e.g. accident).

4.2.4 Need for standardisation

Stakeholders were also asked whether there is a need for further standardisation to foster harmonised implementation of services based on vehicles having an internet connection.

- 69% of those who replied 'yes' there was a need for further standardization;
- 12% said 'no';
- 19% said 'don't know'.

Those who thought that further standardisation will be needed were asked to give details of standardisation required for up to five of the services discussed in the previous questions. The main areas of standardisation covered in the responses were:

- Ensuring that services are pan-European with common interfaces and procedures to ensure interoperability;
- Communications and protocols, harmonised message sets, data formats, definitions (e.g. of events, eco-level for routing recommendation), data exchange;
- Technologies and in-vehicle equipment;
- Certification and conformance testing of organisations operating in the value chain, enforcement;
- Human Machine Interface design, symbols, compatibility of symbols between in-vehicle and roadside;
- Ensuring that existing standards are used and extended.

4.3 Conclusions

The stakeholder consultation exercise involved a very wide range of stakeholders. While the responses to which services were considered most important was varied, covering safety (incident warning, hazardous location warning) convenience (real-time travel planning, personal assistant) and business applications (route optimisation, dynamic traffic management), there was a strong opinion that the challenges to be overcome lie strongly in the area of standardisation and legislation. This makes sense as future cooperative services will be significantly enhanced by ensuring the interoperability is maximised. The challenge for future standards and legislation will be to ensure that this is achieved without stifling innovation.

The results of the stakeholder consultation have been used as an input to other parts of this study. It is however necessary to use the stakeholder input with care. As the principal aim of this study is to provide guidance for areas of future EC promoted and funded research, the stakeholder views must be filtered to ensure that recommendations align with the strategic aims of the Commission. So for example the view that "Services free of charge to users and accessible to as many users as possible" will only be appropriate for some (typically safety and environmentally driven) services, whereas convenience services may be more appropriately driven forward by market mechanisms. In general however, the outputs of the stakeholder consultation align with the results of the other parts of this study.

5 Vision on new services and technologies for the connected car

5.1 Introduction

A vision on future services for mobility has been developed in different projects and programmes, for example, the CVIS project, the RTD Working Group [SRA2010] and the ELSA in Transport Task Force of the eSafety Forum [ELSA]. The services are aimed at realising the socio-economic transport objectives: better use of infrastructure, enhancing reliability of transport, increasing safety, reducing the environmental impacts, etc. Elements in these visions are:

- Fully connected travellers, vehicles and infrastructure;
- Large scale deployment of cooperative systems, both vehicles and infrastructure;
- Open interoperable platforms;
- Seamless information exchange, e.g. about traffic flows, road works, accidents, intermodal travel options;
- Advanced driver support by online services with flexible Human Machine Interfaces.

The LTE Connected Car of the ng Connect Program showcases a seamless extension of the always-on network enabling access to network- and cloud-based applications.

BMW's ConnectedDrive concept - intelligent networking of driver, vehicle and the outside world - addresses safety, infotainment and convenience.

Figure 5.1: Examples of visions on the connected car from the ng Connect Program and BMW AG ConnectedDrive (sources: www.ngconnect.org and www.bmw.com).

The ELSA in Transport vision states that Future Internet technologies may completely change the connected car paradigm, if the relevant enabling technologies are mature enough, and if the relevant enabling framework exists [ELSA]. This chapter further elaborates this vision.

New services for the future connected car will be enabled by developments in Future Internet and Future Mobility services and technologies. These developments (as described in Chapter 3), together with the views, requirements and priorities of various stakeholder groups (as described in Chapter 4), form the basis for the Connected Car vision 2025.

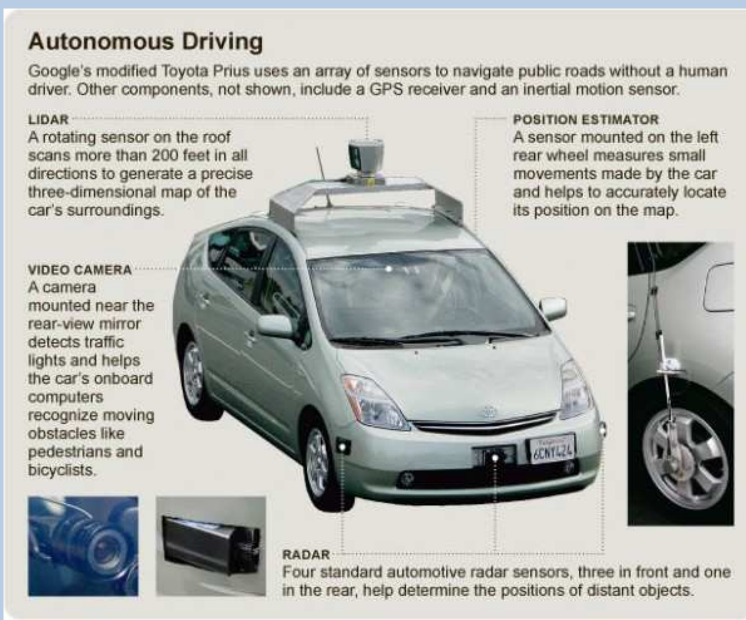
In order to obtain a view on the future of new services enabled by the connected car, different scenarios for the year 2025 have been developed based on future internet and mobility services developments. These scenarios are described in Paragraph 5.3.

Firstly, Paragraph 5.2 presents an overall vision on new services enabled by the connected car.

5.2 Overall Connected Car vision 2025

The Connected Car vision is broader than just the connected car. The Connected Car is part of the Connected World, with Connected People and Connected Things. The Connected Car moves on Smart Roads and in Smart Cities.

We are moving towards a Connected World with “everyone and everything connected”. The impact of Future Internet developments on transport could be comparable to the impact that Internet has on other sectors, e.g. telecom and media. Different actors from the telecom and internet world will enter the automotive world. New service providers will emerge.



Google’s experimental self-driving car (source: The New York Times; Google).

Figure 5.2: An example of an actor from the ‘internet world’ in the ‘automotive world’.

The roles of stakeholders will change. New value chains and business models will emerge. The entrance of new stakeholders will result in a no longer completely “controllable world”. The focus will shift from infrastructure to services.

The connected car of 2025 is a smart vehicle that can share information and services with its surroundings. This includes e.g. information on the driver, co driver and passengers, and its freight, but also information on the traffic state, information on surrounding cars, context information, and all kinds of other information from many different sources. The connected car becomes part of the Future Internet via this context, see Figure 5.3.

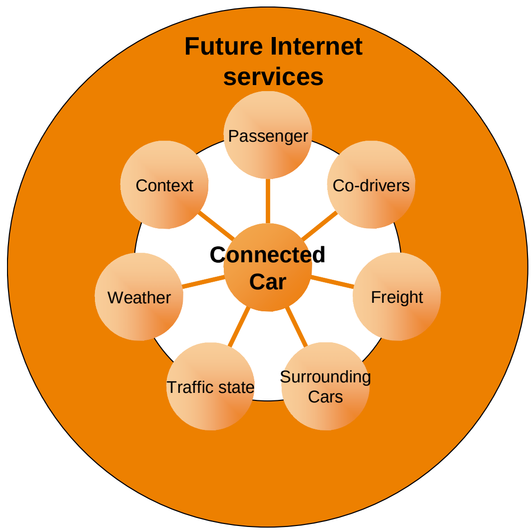


Figure 5.3: The connected car is connected to the information from its surroundings, being part of the Future Internet.

The connected car makes use of services in the Future Internet and vice versa. New services enabled by the connected car form an integral part of the Future Internet services. These services aim at providing demands from societal needs, like environmental, safety, economical, welfare and other needs. The stakeholders drive the development of these services, see Figure 5.4.

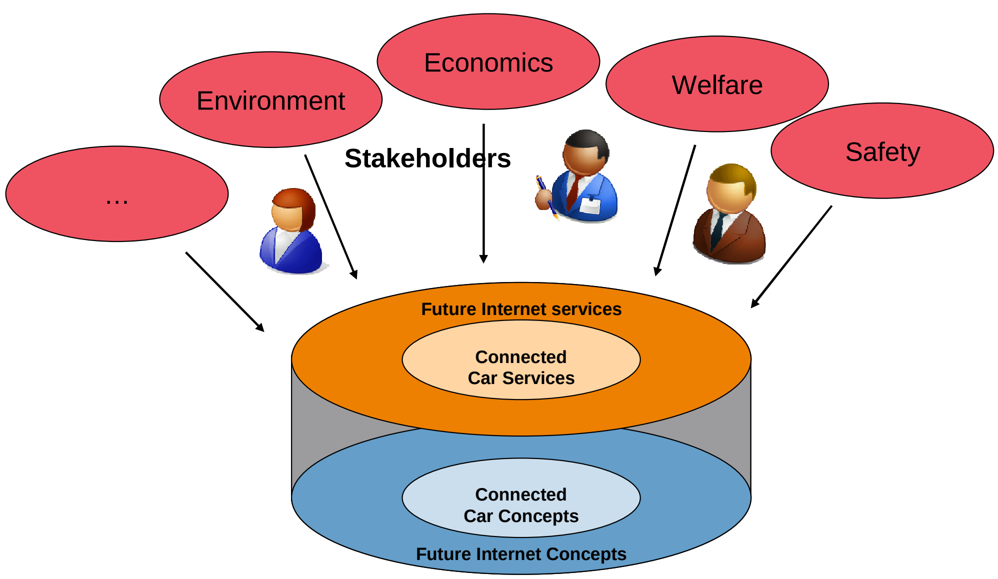


Figure 5.4: Connected car services aim at fulfilling societal needs via stakeholder requirements.

The services of the connected car are supported by technologies and concepts, in the same way as the services of the Future Internet are supported by Future Internet technologies and concepts.

The enabling of the connected car by Future Internet will take place at two levels. At the services level, the connected car services will interact with the (other) Future Internet services via information exchange. At the concepts level, Future Internet technology can be used to realise the required connected car concepts, see Figure 5.5.

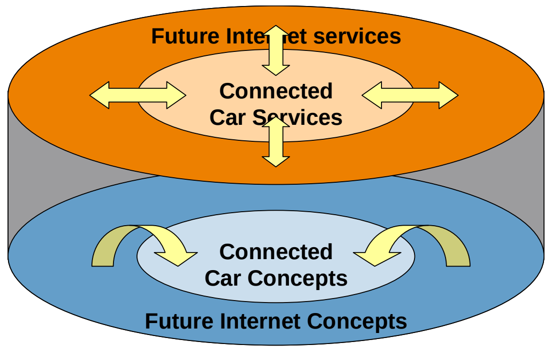


Figure 5.5: Connected car services interact with other Future Internet services, while Future Internet concepts are used to realise the required Connected Car Concepts.

5.3 Connected Car scenarios 2025

This section contains the description of six scenarios developed as part of the study. Through these scenarios an assessment is being made of the potential (realistic though not necessarily most likely) impact that developments in Future Internet and mobility services can have on the EU society.

The scenarios as such are a tool for rather than an outcome of this study. The presentation in this chapter therefore focuses directly on the results of each scenario analysis:

- Potential impact on society and policy relevance;
- What the enabling technologies are;
- What challenges and risks must be addressed?

At two project team workshops, help respectively on the UK and the Netherlands, the applications, services and service enablers which are expected to become available in the timescale covered by this study were identified. This identification process used the outputs of WP2 (future internet developments) and WP3 (future mobility services) as described in section 3 as a starting point, together with the project team's joint expertise, and the initial results of the stakeholder consultation. A complete list of the services is given in Appendix C.2.

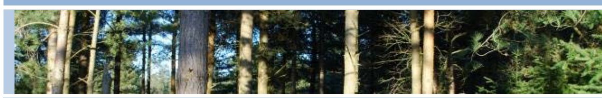
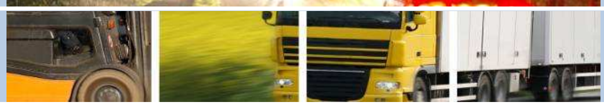
The scenarios were developed by clustering the identified services and service enablers and mapping them to different real world situations, as envisaged in a possible 2025 timeframe.

The scenarios have been developed based on the future internet and future mobility services developments. ICT services for the connected car were brainstormed to identify common theses. These included:

- The ever increasing importance of environmental issues in motoring;
- The pervasive use of data and social network even into the mobility field;
- Data mining and AI in the use of distributed systems;
- Open source and open architectures;
- The slow emergence of CVHS systems, and potential explosion of these systems as technology opens up;
- The significant benefits to be accrued from using distributed vehicles as a mesh sensor network.

The scenarios were then finalised by exploring which combinations represented the highest level of interdependency. The final selections are shown in the following table.

Table 5.1: The six Connected Car scenarios 2025.

Connected Car scenario 2025	
1. Eco-Centric Motoring	
2. Active Safety Protocols	
3. Smart Transportation	
4. Mobility Integrated Services	
5. Cooperative Traffic Intelligence	
6. Agile Navigation Systems	

5.3.1 Scenario 1: Eco-centric motoring

Description

Description	In this first scenario the focus is upon driving and driving practices that focus on eco-centric aims such as the reduction of fossil fuel consumption and reduction in carbon emissions. Services in the eco centric area are focused on reducing carbon and other emissions from vehicle traffic as well as promoting sustainability. They come under two areas; there are those that are sold directly to consumers for individual benefit, and those that are organised at national or regional levels to reduce the impacts of pollution and global warming. By 2025 it is proposed that the price of oil, both at the well head and on the forecourt, has risen significantly, yet not to the point where regular consumers cannot afford it at all. The market penetration of hybrid, electric and low carbon vehicles will be much greater than present and vehicles are designed and sold more frequently on the amount of fuel they burn. Vehicle buyers are worried about spending money on petrol and on increasing global warming. People are more likely to make long term decisions to use other modes. Highway operators aspire to further reduce emissions overall and to tackle specific hotspots

Service Functionality and Enabling Technologies

Societal impact and functional gains	Driving aids built into the connected car help the driver use the vehicle more economically by smoothing acceleration, as well as modifying engine, drive train and battery management to increase fuel efficiency, potentially at the expense of journey time. Connected car services help better planning of the journey and improve navigation, avoiding congestion and many kilometres of needles driving (e.g. for finding parking places, ...). Eco management of vehicles has stepped up in this scenario, with eco-based road pricing a serious option for managing access to road networks and allowing network managers to monitor and affect fuel efficiency across the vehicle fleet and through Europe. Real time and ubiquitous access to road access, price and eco characteristics enable the citizen to dramatically reduce its eco-footprint. It also provides electronic information available for the establishment of an e-market of transport capacity where market developments compete for lowest price while external costs can become internalised.

	Effective management of energy for electric vehicles through collection control services has enabled Smart Grids that increase the effective delivery of national power networks by intelligently (dis)charging vehicles. Connected car services also constitute a major tool providing battery reservation and quick replacement as a service. As such, the connected car services help to overcome one of the biggest concerns of the EV market in early stages (stopped vehicles that run empty battery) and as such play a critical role for a successful market introduction of electrical vehicles.
Enabling Technologies	The concept of the Internet of things and sensors can be applied for the collection of high quality eco data that comes from sensors that monitor vehicle parameters such as actual emissions and external air quality. Vehicles are monitored on board for performance and efficiency, technology that already is well established in the bulk of the vehicle fleet by 2025 and can be integrated in the connected car services on the basis of Vehicle to Infrastructure (V2I) infrastructure. Services are underpinned by sophisticated emissions sensors built into vehicles passing data back up into the cloud. The wide use of Internet clouds allow the aggregation of eco probe-data and help to predict short term future emissions and air quality. Real time measures can be published into the cloud through V2I and related privacy and security protocols. Modifiable in-vehicle information and control dashboard permit eco focused drives to mount fuel efficiency driving aids into their displays, pulling predictive data from the wider cloud infrastructure.

Challenges and risks

Challenges and risks	The commercial viability of eco services continues to be hampered by the challenge of developing strong business cases for services, especially when competing with safety based services for limited connected car bandwidth. Sufficient availability of bandwidth for mobile V2I communication needs to be guaranteed. The integration of HMI of personal smart devices in the in-vehicle environment is crucial for the speed of innovation and market deployment of connected car services. Eco services outside a single care require data sharing (collecting individual probe data in a coordinating cloud service) in sufficient quality and volume. There is a need to develop infrastructure and agreements enabling vehicles sharing this data. For intelligent cargo, the procedures and organisational framework should evolve from micro management to management across different operators. This requires projects that envisage pre-commercial pilots and concept agreements. Data on which basis route planning and navigation recommendations

	are being derived need to be of indicated authenticity and quality. Trust and security must be provided through technologies and appropriate organisation. Such a trust organisation (such as a PKI infrastructure) does not yet exist. The (above mentioned) data available through cloud services must be understood by all vehicles in a pre-defined manner; there is a need to design standards for data structures (format / semantics) that do not yet exist.

5.3.2 Scenario 2: Active safety protocols

Description

Description	As standardised methods for Cooperative Vehicle Highway Systems appear a range of new services become established that directly increase safety through direct control of vehicular systems and dynamics. By 2025 eCall is in full force and has become a high profile success for the ITS community. The next generation of successors to eCall are under serious consideration and are likely to be deployed more swiftly following this first success, and protocols for active safety systems are beginning to align across Europe. Systems such as collision avoidance and convoy management which significantly increase safety, are available (use is limited to the need) almost everywhere. Active safety services continue to work on individually equipped vehicles, and over time as penetration of upgradable connected vehicles increases these services expand to include small clusters of vehicles and eventually full road network corridors. Through the application of standards and legal support for liability models that facility the use of non-dedicated systems for mission-critical services, the process mentioned above can be accelerated critically and Europe has become frontrunner in the world in cooperative safety services and ICT application in the transport sector. Commercial focus on using safety to sell vehicles is transient, with a current focus on automatic breaking technology. Insurers are now on side – vehicles without auto-braking now carry higher insurance premiums.

Service Functionality and Enabling Technologies

Societal impact and functional gains	**Driver Safety Services** Systems such as driver monitoring track a driver's performance with a focus on health warning provided to the driver (for example driver fatigue) as well as facilitating external control and monitoring. Top end cooperative systems such as adaptive headlight aiming and cooperative glare reduction have spread into the top tier of the fleet. Driver information services provide users with location and situational safety awareness including speed limit information, traffic rule information and road condition warnings.

Vehicle condition monitoring allows vehicle OEM and retailers to track degradation of performance and inform their customers when parts require servicing or have become unsafe, so reducing the number of incidents resulting from purely mechanical failures.

Corridor Safety Services

As technology penetration increases, more vehicles are connected and contributing to the pool of available information in the cloud. With multiple vehicles transmitting localised information, corridor based services become possible through application of ITS based decision logic.

Using near real time information services such as weather condition alerts, intersection warning, emergency vehicle warning, vulnerable road user warning and congestion warning all become accurate enough to increase safety. Even slow moving vehicles that are not connected to the cloud will still be identifiable from the reactions of other road users and the message passed up stream to alert other vehicles to the potential risk.

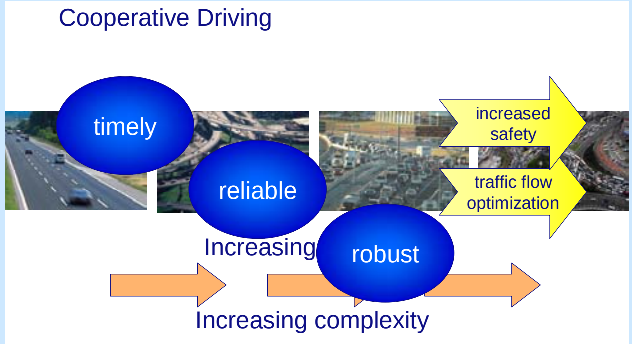
Active safety systems that actually help drivers manoeuvre their vehicle and mitigate longitudinal and lateral risk, controlling vehicles in concert. When applied to incident management situations, cooperative cloud technologies will help to reduce the rate of secondary incidents caused by vehicles unaware of an incident scene ahead.

Supplementary Services

With the development of linkages between the local dynamic map, in-vehicle inertial sensors and GPS, the application of data fusion techniques will provide drivers and driving systems with hyper accurate position and speed information. Though primarily used to drive other safety critical systems this technology will have secondary benefits such as tracking driving style and reducing high risk behaviours.

Cooperative Driving

Further to cooperative collision avoidance, general cooperative driving systems will also improve safety. By ensuring more consistent and smoother traffic flow, as well as by reducing the scope for human error, the number of incidents will be reduced using cooperative driving systems.



Cooperative driving technology using dedicated or virtual hardware, dedicated communication channels, certified applications and strictly managed interfaces to "the outside world" will result in connected technologies that balance safety and security with flexibility and capability.

Enabling Technologies	The technology to drive active safety systems starts with sensing and awareness of vehicle dynamics, linking that sensor data together, processing it and then acting on it. Key sensing technologies, such as the Local Dynamic Map and pre-crash sensors, use advanced technology (such as laser and radar based detectors) to determine when events are likely to happen. This is calculated and re-calculated at a high frequency, and the information is then piped out from the connected car to wider area cloud networks as well as to other vehicles (V2V) over peer to peer networks and communications subsystems (V2I and V2X). For this communication, appropriate network protocols are being used implementing addressing schemes that are fast, resilient and do not require centralised networking services. As such the vulnerability of these connected safety services for failure of or attacks on central telecommunication networks can be minimised. The responsiveness depends on the speed of the nodes themselves, resulting in a scalable service architecture that is insensitive for overloads. The exchange of data that is used by connected safety services is following standards that define without ambiguity a minimum set of data, its format and its (semantic) meaning. The integrity of the data is not only being technically realised, also by authentication, non-repudiation and trust schemes (and corresponding trust organisation, the validity of the data is being guaranteed.

Challenges and Risks

Challenges and risks	Despite efforts made by industry such as priority schemes in the protocols and redundant system implementation and system sanity monitoring, the availability of the data or the communication bearer can never be guaranteed for 100%. Market introduction is being facilitated by European wide agreements, legally supported, on liability schemes.

The market for active safety systems is characterised by a large network effect and its take-off requires a minimum critical mass. This makes it challenging to build compelling business cases for deploying such systems, especially when compared with more traditional ITS and civil engineering based safety solutions. Achieving the technology penetration threshold is likely to require additional stimulation beyond free market forces. For example, ensuring that proprietary cooperative driving systems are interoperable with all other makes and models will reduce the challenge for reaching technology penetration.

Monitoring technologies, which can contribute to connected safety services, affect the privacy of the users. EU wide privacy guidelines are required that are backed by a legal basis and that on one hand protect the EU citizens' privacy and on the other hand and reduce obstacles and risks for market development of monitoring safety services.

Operational and technical definitions and standards are required to enable vehicle systems to act on this information. Vehicle OEM safety solutions will be build on clearly defined and universally recognised operating procedures, and data exchange and management is achieved using documented open standards which must be agreed (not only specified) at a European or global level.

While raw computing power has tended to follow Moore's law, communications bandwidth has not. The management of local communications bearers will need to be carefully managed to ensure that safety critical systems are not compromised. System security and resilience to intentional and unintentional interference will need to be built to highly secure standards.

With new equipment fitted into connected cars, and a massive growth in user services for non-safety based reasons, active safety systems will need to compete for resources including and in addition to bandwidth, such as CPU cycles, system memory or communications ports.

New systems will also require driving behaviours to change, and driver training will need to reflect best use of new safety applications. Legal litigation issues for these safety systems also come into play, ensuring autonomous and semi-autonomous system remain road legal.

When implemented, next generation active safety systems will be complex. Unexpected emergent behaviours may occur, similar to motorway shock waves that produce new aggregate phenomena that decrease overall efficiency or safety of road transport. EU supported pre-deployment testing and assessment is required for reducing risks to an acceptable level for private investment in this sector.

5.3.3 Scenario 3: Smart transportation

Description

Description	In the 2025 timeframe vehicles themselves can act as communications hubs, allow digital devices within the cargo to connect to internet, providing a range of Fleet Management and Intelligence Cargo services. This integration of information reaches across the supply chains and logistics chains. Connected systems enable the next generation of road freight management, integrated across corporate and national boundaries. All private corporations with mobile workforces continuously track, monitor and optimise fleet location for performance and duty of care purposes. All incident responders know the value and risk of all cargo spilled anywhere on the network instantly.

Service Functionality and Enabling Technologies

Societal impact and functional gains	Outside of the logistics section, Smart Transportation allows sophisticated management of emergency responder fleets. Moving beyond GPS location control, the use of standardised metadata structure enables the right vehicle to be dispatched for the right job. Based on a centralised communication hubbing service mounted on the connected vehicle it becomes possible for logistics firms to track not only the vehicle but also the specific cargo. Route designations, such as "Heavy Routes" for good vehicles allow for fine tuned control, and control of these routes is dynamically managed and occasionally over-ruled centrally as the need arises. Pushing information out of the vehicle, communications hubbing provides enhanced services to goods vehicle drivers. Continuous route update services, based on load weights and vehicle dimensions, reduce the risk of delays from wrong turns or temporary restrictions. This also provides a new degree of customer awareness in terms of in-transit visibility and facilitates wider access to services such as fleet optimisation. Enhanced vehicle data (such as driver's hours on tachograph or fuel range) are facilitated through an always-on connection between vehicle navigation systems and a cloud based management layer, making freight more accountable to rules and regulations. Management or driver change over at off site locations and the location of rest areas and overnight parking are more effective, and navigation systems are

	integrated with rest time regulation and backed up by resting time violation warnings. E-documentation services stream lines taxations and handling efficiency. Transport documentation and manifests are automatically aligned, and customs managed without even needing to stop the vehicle. Delicate cargos, fitted with basic sensors, can alert the driver or recipient when the package is incorrectly stacked or provide evidence for the cause of any damage in transit. In addition, protocols are in place for sharing cargo information in near real time, allowing third party applications such as incident responders to access cargo manifests and destinations before even reaching the scene. Cloud services can access logistic data in a manner that business interests are protected while cross operator optimisations can be realised.
Enabling Technologies	The use of positioning technology and the exploitation of electronic horizons in freight management are already advanced by 2011. By 2025 these has grown to include relative positioning technologies through embedded Geographical Information Systems (GIS) and systems that automatically suggest new efficiencies such as the dynamic planning and allocation of freight to vehicle and delivery schedules, even working between different logistics carriers to provide more cost effective delivery networks. Enabled by communications hubbing services, cargo2infrastructure, cargo2vehicle and V2I infrastructures, smarter logistics chains enable a range of new connected car and cargo services. The application of the Internet of Things concept on cargo in combination with cloud based information services provide real-time, accurate data that is not available today. Centrally managed asset registers of high value, high risk and of abnormal configuration (such as extremely large deliveries like boats or temporary buildings) empower network managers and emergency services. Cross operator logistics data through cloud services where demand is searching for capacity enables significant efficiency benefits. The business interests (such as confidentiality) are being safeguarded through the application of privacy-protecting (anonymity) frameworks that implement integrity, authentication and confidentiality protocols.

Challenges and Risks

Challenges and risks	Many of the benefits to be achieved from smarter logistics are based on increased collaboration and integration of national logistics infrastructure and suppliers. As these services are driven by private corporations rather than governments there is a significant challenge in making these development economically attractive to the suppliers. The willingness of private business, as well as private individuals, to open up this increased level of information will be challenging to achieve.

RTD and validation by pre-commercial deployment of confidential cloud services for cross-operator logistic optimisation and emergency responsiveness can help overcome this obstacle.

On a wider note, all connected vehicles acting on behalf of business are likely to be monitored as part of the recognised duty of care and to ensure efficient execution of business duties. There is a risk of a popular or cultural rebellion against this "always on" culture and the need to demonstrate privacy-protecting technologies and procedures during pre-commercial stages.

The business interests in the logistics sector are enormous and challenges on the area of privacy and confidentially need to be overcome before critical data will be made available. Specific sector business needs must be further investigated and pre-commercial deployment will be required for validation of proposed models. Internet technologies are very open by design objective. RTD should include procedural and organisational aspects for securing business trust in connected vehicle services in this market.

Interoperability of cloud services must be established to constitute cross operator and cross-nation logistic planning services.

5.3.4 Scenario 4: Mobility integrated services

Description

Description	This scenario includes services such as social networks as well as location based information and recommendations *into the mobility environment*. These types of services accelerated rapidly with the emergence of consumer friendly nomadic devices. It is proposed here that a similar rapid growth will occur once flexible consumer friendly equivalent systems become available in the car, tied together with the idea of a persistent online identify for private technology users. This is underpinned by the new "apps bubble", driven by commercial innovation. For the user there is an almost invisible transition from home to car to office to car to other modes of transportation. User experience is customisable.

Service Functionality and Enabling Technologies

Societal impact and functional gains	At its most fundamental, the connected car is a vehicle with an (almost) always on internet connection, much like private household broadband. This immediately turns the car into a mobile Wi-Fi hotspot, and allows passengers in the vehicle to make use of Wi-Fi devices such as laptops, tables and smart phones. Building on this, the connection will bring social networking services. The connected car will be able to share user location, status and activities, to help people streamline their work and private lives as well as to be more responsive and flexible. Smart Human Machine Interface such as Text to Speech and Heads Up Displays make using these services on the move safe and seamless. To ensure consumers are directed to services of maximum interest further advances in "Personal Preference Engines" are achieved. These provide meta-models of individual likes and dislikes that provide coherent recommendations across different platforms. The integration of social and work systems will be tied together through integrated personal planning applications and intelligent calendars that can predict, to some level, the users next destination. The evolution of social media, web3.0 and next generations will further strengthen 'community' applications. Mobility services will become integrated in such community platforms and services as car sharing.

	Car pooling will help reducing the demand for transport. Detailed information on the environmental impact and real-time travel information in combination with social media will further influence the travel behaviour of what used to be road users. Within this scenario, the traveller becomes a probe who collects and shares data with the community citizens, as such generating a wealth of traffic and road data enabling better planning of the journey and management of the transport network.
Enabling Technologies	Initial service penetration is likely to be driven by integration over services with nomadic devices and possibly through vehicle mounted Wi-Fi connections. Advances in Human Machine interfaces will enable drivers to consume more information where it is safe to do so. Technology such as windscreen mounted Heads Up Displays (HUDs) will be able to display more real time location based information projected directly onto the windscreen. Open software architectures, based around the concept of fleet wide IP enabled cars, provide the vehicle platforms and communications protocols through which to exploit services. Cars become connected through the personal service platform of its users. Cloud technologies and the establishment of next generation web social media establish information services that include data on the mobility needs, experiences and constraints of individuals. The web based information infrastructure which is established by the integration of mobile smart devices in daily life extends the capability of the car itself; by appropriate interfacing of these smart devices in the vehicle-environment and interoperability between the community cloud services (including the privacy and confidentiality schemes) and the OEM or transport operator cloud services the connected car services are extended by the personal Webx.0 services. To ensure seamless consumer experiences, contactless payment systems are embedded into the connected car and can be activated in multiple ways. These systems are kept secure using integrated security and encryption layers managed through cloud Public / Private key systems. Any necessary content DRM rides on top of these technologies.

Challenges and Risks

Challenges and risks	Non-mobility critical services are fundamentally about bringing new services and information into the driving experience. This carries significant risk of driver distraction, as was witnessed when the cell-phone became widely used by drivers. Overcoming these risks will involve development of sophisticated and integrated interfaces, potentially become more viable as more autonomous systems become available. The ability to leverage OEM in-vehicle displays will play a key role in this, and will rely on third party access to the relevant interface standards and formats. A new generation of driving offences may emerge similar to laws across the EU banning driving while using a

mobile phone. This would significantly hamper the value and uptake of mobility integrated services.

The process of building stable functionality in the cloud that is able to follow users through multiple transport modes and operating states (such as at work, at home, at play) will require complex services and solving of concepts such as geo-netting. Synthetically generated personal preference engines will require significant research to reach a mature and market ready state.

Sophisticated HMI integration and functional integration of smart personal devices (in the current terminology called 'smart phone') in the in-vehicle environment, allow the evolution of these services run at the pace of the consumer industry instead of the typical OEM life cycle speed. As these systems build on proprietary in vehicle control systems and dashboards, standards for access to these systems is critical.

Vehicles are by their nature highly proprietary technology, suggesting a risk of potential lock in to technology from the same supplier. Commercial arrangements between content providers and vehicle manufacturers could increase the dominance of single monopoly providers.

As with GPS navigation systems, vehicle users may become dependent on new services and then hampered when they fail. Stranded motorists attempting to signal for help may discover the connected car communications channel has failed, and have to result to alternative ways of calling for help. This should be addressed in pre-commercial deployment projects. The market introduction is further being facilitated by European wide agreements, legally supported, on liability schemes addressing this issue.

5.3.5 *Scenario 5: Cooperative traffic intelligence*

Description

Description	In this scenario the central concept is that of the Car as a Sensor. In 2025 the majority of vehicles on the network are instrumented, collect data and transmit it into the cloud in some manner. This data is somewhat compartmentalised, is held by different organisations and can be difficult to access. There is as yet no single dominant reseller of this information, and consumers are still making use of fragmented data sets tied to specific applications or platforms. Highway operators make extensive use of all data but hold only limited use rights negotiated on a case by case basis. The use of vehicle based data has become common in legal defence against civil prosecution, and there has been at least one high profile case of abuse of vehicle based data by an authority or hacker, resulting in increased distrust in these systems by consumers. The use of cooperative traffic data to monitor and control highways has been hotly debated in the media, and tight access control / usage restrictions are in place as a result. Use of performance data for personal driving style appraisal is widely available but used only for certain functions, such as parents monitoring children for speeding in the family car. One or two major academic discovers have been made by crowd sourcing data provided by vehicle on-board sensors, collected through the cloud from commercial repositories.

Service Functionality and Enabling Technologies

Societal impact and functional gains	Travellers are now provided with large amounts of data about their personal travel habits. This information is widely used by traffic management centres to make better management decisions for traffic control systems. It not only reveals the most busy spots in the road network but more importantly, the origin/destination data is a critical basis for improving the planning of public transport services. It also finds use in the insurance industry for providing insurance based on specific driving patterns and styles. Tolling systems are low cost and highly accurate. The live element of the cooperative vehicle data allows any stolen

vehicle to be tracked immediately even when the police have not been notified by spotting unusual usage patterns, much as credit cards are tracked for fraud. Vehicles that stop unexpectedly in dangerous places can be flagged for recovery without the driver needing to alert the recovery team.

Cooperation between vehicles and vehicles and roadside infrastructure has become widespread and cover the whole network. From a traffic management perspective, complex expensive (in 2011) and rather centralised systems can be implemented with cheaper and more scalable cooperative solutions. Tolling systems are low cost and highly accurate.

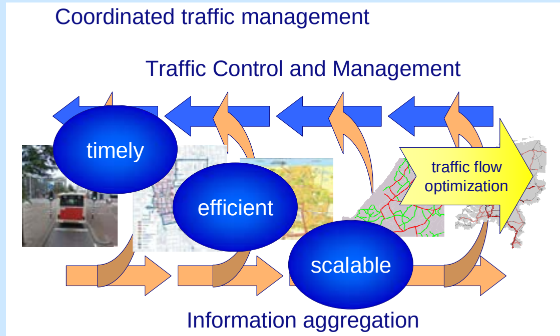
Techniques such as layered traffic management lead to automation of established traffic control systems such as ramp metering and dynamic lane management with a reduced infrastructure. A higher dependence on connected cars responding to virtualised control systems even allows for self optimising travel network routing that will enable traffic management authorities to establish the balance between personal travel time and network wide travel time.

Inside the vehicle, this cooperative data achieves several control advantages. In vehicle traffic signs reduce the need for roadside clutter, and cooperative adaptive cruise control and congestion avoidance are all facilitated by cloud control. The use of autonomous and in vehicle signalling is common place. Non critical road side signage is in the process of being phased out as the penetration of signage within vehicles has reached critical mass and development is focusing on remaining steps to remove fixed road side signage entirely.

Elements of the physical road network also implement the concept of the ‘Internet of Things’ and transmit self-status to the road operators and possibly (real time degradation / ice / ...) to the vehicles.

Analytical services mounted in the cloud provide continuous network monitoring functions that are supplemented with techniques such as data fusion. Services based on these functions are resold both to traffic management centres and private users, and rely on advanced pattern matching engines to warn used of congestion before it occurs. Incident handling and management based on this real time data sourced from the cloud to local platforms is prevalent.

Highly sophisticated systems such as Local Traffic Management that has been initialised by road users is still unavailable, but under considerable research in this time frame.



Enabling Technologies

A range of data is available from the connected car. Vehicle locator information from both native and nomadic devices supplements information about traveller intent, providing a picture not just of the present but the near future as well. Speed, acceleration and performance are available as near real time data across significant proportions of the fleet. Higher end vehicles have more advanced sensors, such as road surface condition detector or weather sensors that act as a nationwide sensor network to support a number of government and private industry functions.

Scalable cloud based databases and analytics provide the IT systems needed to support flexible and scalable traffic management systems. These rely heavily of data exchange standards which continuously evolve to meet new functional requirements.

Services are underpinned by personal devices and sensors in and outside the vehicle, passing data back up into the cloud. The wide use of Internet clouds allow the aggregation of these data enabling real time measures communicated over the V2I and V2V infrastructure.

There is a need for privacy-protecting protocols and procedures that can be applied uniformly across Europe and for which a legal basis is provided. Personal privacy and market interests can be safeguarded through the application of privacy-protecting (anonymity) frameworks that implement integrity, authentication and confidentiality protocols.

Challenges and Risks

Challenges and risks

With the growing potential for crowd sourced data to feed traffic management and advisor systems, governments will only be one of many information providers. Low quality data provided by the lowest cost supplier could come to dominate the market, reducing the benefits on a regional level.

In cases where some traffic is rerouting on a long route in order to improve the network overall, traffic routing advice will be ignored as selfish behaviours dominate resulting in lower overall system performance. Mechanisms are needed through which the traveller, market parties and road operators can share information and interact (such as through a 'community' and/or marketplace of road, traffic –

and travel information) and derive guidelines or pricing mechanisms that facilitate individual journey optimisations that are in support of collective mobility objectives.

The privacy issue is again a risk for these services. Road users may well see sharing personal travel data as intrusive, providing evidence of the Governments' desire to monitor their citizens' behaviour, and the first step towards road user pricing. Early evidence indicates this is low (in 2011 there are already commercial services collecting such data from users of navigation systems), but it may only take one major international news event to swing public opinion the other way.

Finally, secondary services based on using data sourced from connected cars would become vulnerable to that data stream. Traffic control systems would then be highly vulnerable to roadside communications black spots or data network failures.

5.3.6 Scenario 6: Agile navigation systems

Description

Description	In the 2025 timeframe the rollout of Satellite Navigation systems into cars has reached nearly 100%. Some of these systems are relying on crowd sourced traffic data rather than traditional infrastructure sourced data. Free SatNav applications are prolific and most include some sort of ability to predict congestion and reroute drivers around degraded sections of the road network. Some navigation systems are integrated with the main traffic management control systems, with instructions and advice being patched directly into the service. These systems become increasingly popular with logistics firms and firms with large private vehicle fleets, and allow for external management of mobile workforces. Navigation systems now take a wide range of variables into account when calculating a route, include driver preferences of route type, places to stop, specific roads or services. Premium paid for services will continue to exist and be bundled with new purchase vehicles. Ongoing subscription rates are still poor, and many users prefer the free alternatives provided through the internet for reduced quality. The integration of traffic restraint information within the vehicle is consistent. The argument to reduce roadside sign clutter gathers strength due to growth of in vehicle options. Governments are looking for ways to move to a sign-free future, but technology penetration is not yet sufficient to warrant full removal of signage, even for temporary works. One or more EU nations are looking at using navigation systems to shape traffic demand through road user charging, road tax reductions or congestion charging.

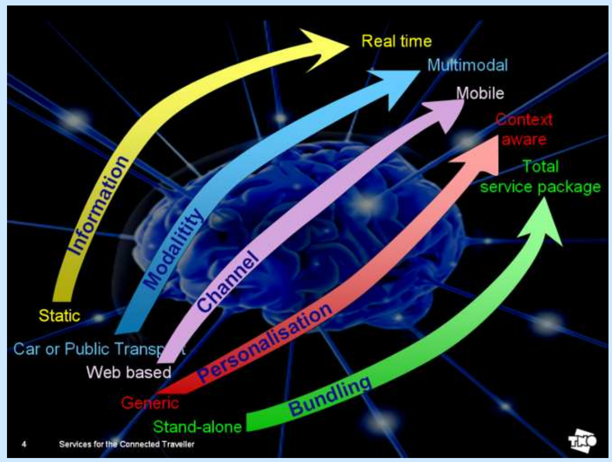
Service Functionality and Enabling Technologies

Societal impact and functional gains	Traveller information systems in vehicles are now present in all newly manufactured vehicles at the basic specification. The applications mounted in these devices straddle different platforms; a route plan devised on a desktop computer is automatically transferred to associated nomadic devices and the in car navigation. The most complex navigation tools move into trip planning and incorporate accommodation reservations, rest stop planning and

	restaurant reservations. These applications can identify changes to the underlying plan (for example, rebooking cancelled hotel reservations). For those vehicles mounted with highly accurate differential GPS system it will be possible to report lateral position alerts and driving style advice. Some Free and Open Source Software (FOSS) alternatives exist which are built upon crowd source maps (such as OpenStreetMap) and crowd sourced traffic data. These data sets are sometimes recognised as inferior to commercially available set, especially in terms of information on other available services or the sophistication of the software interface. Top end commercial applications are integrated with social networking technology and personal preference engines to provide advice on where to stop along the route for supplies, entertainment or meals. Specific sub services are integrated into these navigation systems. These include guidance on car sharing, car pooling, car hiring and car leasing. Multimodal travel advice is integrated into navigation systems, especially for services mounted on nomadic platforms. Real time information services, such as parking spot availability, are widely used and trusted. There is a comprehensive marketplace for traffic and travel information, content and applications. These combine a range of both navigation services and infotainment, including specialist driving tours aimed at the tourism market. This infotainment includes point of interest services and navigational waypoints. Through integration with nomadic devices the uncertainty and complexity of some modal interchange is removed. From finding a parking space to finding and navigating an interchange on foot to using the new mode are all integrated into navigation applications, and supported by commercial services such as prepaid parking reservation services integrated into the application.
Enabling Technologies	Accurate, constantly updated maps are the cornerstone of any navigation system. The car-as-a-sensor (vehicle probe data is being pushed in the network) is generating data which becomes accessible as cloud service enabling route planning and navigation services providers in deriving real-time high quality advice. Standardised and commonly held definitions of the locations of roads, various designations and designation of roads and routes (such as routes suitable for Heavy Goods Vehicles (HGVs)) will be commonly shared and updated over the cloud network. Events and other type of messages are being standardised for exchange between different stakeholders and technologies. Standards are highly extensible and based on varieties of Internet technologies bridging the gap between automotive and transport specificities and the wealth of Mobile application building blocks.

A number of data and metadata standards such as DATEX will be maintained and updated to facilitate coherent information transfer between navigation systems of different generations and capability and between different (interoperable) cloud services and traffic management data centres.

Supporting the range of commercial navigation systems will be a set of commonly held algorithms defining the best practice for navigation and routing. Held in the cloud, individual services will interact with these global algorithms which return optimal solutions to client services.



The use of advanced visualisation systems, heads up displays and augmented reality will be integrated with advanced navigation systems providing highly enriched contextual information to the service user and enabling a more efficient transfer of information.

Navigation systems will have direct connections to traffic control systems. This will permit layered traffic management to send specific instructions such as routing guidance or hazard alerts to suitably equipped vehicles.

Challenges and Risks

Challenges and risks

The collection and storage of traffic information in the cloud will require innovative business plans to fund the data collection. Crowd sourced data may provide one alternative which may in the long term outperform commercially available solutions. Maintaining the continued growth of the open source communities that develop these applications will be critical to ensuring the long term maintenance and upgrade path for the most popular applications.

The loss of control of traffic routing resulting from better informed travellers may have unexpected and undesirable side effects. Increased use of short cuts along inappropriate roads could make residential streets less safe. At large public events where event traffic is being strategically routed through longer, higher capacity routes, the shorter routes will still become congested with drivers trying to beat the crowds.

There is a need for quality monitoring and certification services on top of crowd source traffic data cloud services.

Community platforms should be investigated and pre-commercially deployed learning and assessing how travellers, private market and authorities can find the appropriate models, agreements and procedures for business models, quality monitoring and creating synergies between collective mobility objectives and individual journey advice.

Technologically, high refresh rate navigation systems will require the use of communications bandwidth for the connected car as well as large amount of processing power, potentially mounted in the cloud, to perform continuous routing assessments. In the case that video feeds are used to support navigation, these will require significantly more bandwidth and could potentially impinge on other connected car services. In areas of poor network coverage (depending on the type of network) these types of services will be discontinuous.

New and more complex routing algorithms will need to be developed to take account life style choices, energy use, user preference, safety and overall needs of the traffic network. Specifically, user preference waiting factors and the willingness to pay will be critical variables in developing these new algorithms.

5.4 Potential benefits

The previous sections describe six Connected Car scenarios for the year 2025. The new services enabled by the connected car, as sketched in the scenarios, can lead to the following societal and business benefits that are given below. A prerequisite is that the challenges and risks mentioned are properly addressed (See Section 6).

Potential societal and business benefits:

- Reduced reliance on fossil fuels:
  - Reduced fuel consumption.
  - Acceleration of market deployment of electric vehicles.

- Increased competitiveness:
  - Reduced fuel consumption reduces overall cost of products and services.
  - Market driven approach for cheapest mobility solution does not disturb the mechanism of a market economy.
  - Driving innovation.
  - Reducing travel times, increasing security and as such the indirect costs for products and labour.
  - Increase EU competitiveness; the reduction of barriers for the application of social media Internet services through consumer devices in the mobility sector, can significantly accelerate the speed of innovation and market deployment of new services.
  - European-wide economic growth and innovation further fuelled by emergence and diversification of a new market segment.
  - Reduced congestion result in higher economic efficiency (lower product and service costs).

- Sustainable transport, considering the expected increased transport demand:
  - Increased efficiency of HGV traffic is critical policy objective addressing the expected transport needs in Europe by 2020.
  - Higher efficiency in logistics and rerouting for the freight industry reduces the expected increase of demand for transport capacity the next decades. The EU is expecting a significant increase in cargo transport and the management of this increase as well as the development of solutions for higher capacity of the transport infrastructure is high among the policy priorities.

- Sustainable mobility, environmental friendly:
  - Enabling internalising external costs such as the environment footprint can help using market mechanisms for realising public collective policy objectives.
  - Real-time personal information services allow the citizen to make conscious travel planning decisions and can help trigger voluntary change of travel behaviour.
  - More efficient use of transport capacity to reduce the COx production.
  - Cloud services facilitating macro coordination of logistics planning (across micro management) help reduce the demand for transport.
  - More efficient use of the transport network can be realised through proper informing the traveller (who on a voluntary basis decides how to use this information) or through increased steering by authorities (on a mandatory

basis). The creation of a community where the traveller, the private operator and the road operator interact can shift the balance of steering towards informing and help overcome efficiency obstacles and user acceptance obstacles.
  - The application of personal cloud data for mobility services provide road operators with a clearer picture of the behaviours and desires of travellers, resulting in more efficient land use and travel planning.
  - Reduced increase of travel and traffic demands through high integration of work and life ('new way of working').
  - More efficient traffic management.

- Increased safety, saving lives:
  - Safety improvement in the transport sector (50% reduction fatal accidents, European White Paper on Transport policy [EU-COM370]).
  - More efficient and effective management of emergency services and the environment on approaching emergency services increase safety and reduce costs.
  - Reduced impact by accidents on the traffic flow results in increased overall reliability of the road network.
  - The ability of private industry to deliver a higher level of duty of care to their employees. Safety and security is a policy priority. For several years the tracking of animal transport and cargo transport have been considered as key objectives for safety and security increase.
  - Incident responders provided with a clearer view of the materials and cargos present at the scene of an incident. The deployment of eCall is priority for the EU. In this context, the management of emergency services in case of accidents of HGV could improve significantly the safety impact in terms of reduced casualties.

5.5 European Wide Service Platform enabling connected car services

As described in Section 3.4, mobility services are enabled by specific concepts and enabling technologies, namely architectures, information management, organisation, (V2X) communication, service platforms and Human Machine Interfaces (HMI).

In order to realise the vision as sketched in the scenarios, enabling technology and concepts have to be developed. One of the concepts, defined in the ELSA in Transport Report [ELSA] is the European Wide Service Platform.

5.5.1 Description of the EWSP

The European Wide Service Platform (EWSP) is a platform for the delivery of cooperative systems enabled services into vehicles. It has been identified as one of the target outcomes of Objective 6.7 (Cooperative Systems for energy efficient and sustainable mobility) of FP7, call 8. A potential vision of the EWSP [ELSA] is shown in Figure 5.6.

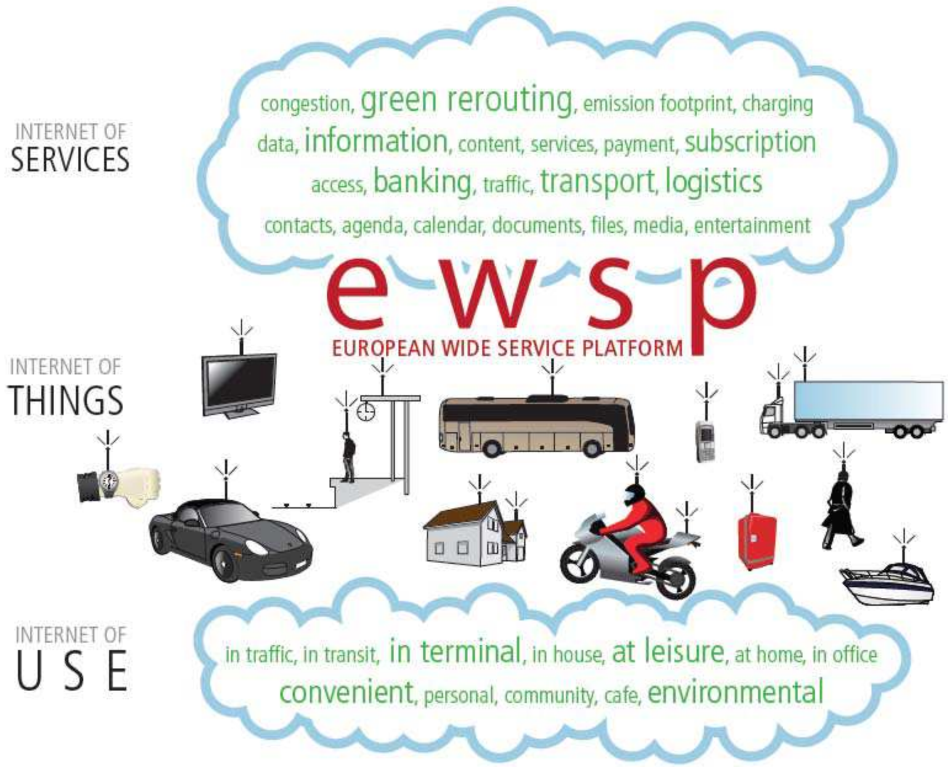


Figure 5.6: A vision of the EWSP (From: [ELSA]).

The EWSP has been identified as an important element for the delivery of cooperative services; indeed in the ELSA Report of the Thematic Working Group for the Visby Conference 2009 [ELSA], it is stated that "Global and local access to the wealth of mobility applications and services needs the development of a European-Wide Service Platform, as the enabler of the mobility of the future"

Service platforms similar to that envisaged by EWSP have been created in the FP7 Integrated Project EURIDICE and in the CVIS project.

Conceptually the EWSP is relatively simple: It is 'platform', available to all users, on which mobility services run. The 'platform' will be connected to the Internet, and provide functionalities like service development, service offerings, service discovery, authorisation/authentication, subscriptions/identification, payment/billing and CRM. However beyond this conceptual level, there are considerable issues which make the realisation of this type of platform a significant challenge.

In practice the EWSP will not be one physical platform, but a set of distributed enablers for new services with open interfaces. According to the vision given in this study, this enabling platform should be part of the Future Internet infrastructure.

5.5.2 Potential implementation models for EWSP

An EWSP could be implemented in a number of different ways, some of which are described below. The development of manufacturer-proprietary, standalone platforms has not been considered as this would not meet the requirements for an EWSP.

- *Standard Platform*: A dedicated, standardised hard and software platform is mandated to be installed in all new vehicles. This provides a simple mechanism for ensuring that a common set of service can be delivered to all vehicles. While the platform will need to be updated regularly to keep up with technological developments, this upgrade path will be able to be carefully managed to ensure backward compatibility. Only approved applications will be run on the platform, with strict priority rules to ensure that (for example) safety related applications take precedence over infotainment applications.

  This model has the advantages of being simple, easy to implement, secure and potentially reliable. It also provides a rigorous upgrade path. For certain applications (e.g. road pricing), it has the potential to provide the most secure implementation.

  It does however have significant disadvantages. There is little or no scope for innovation (and hence market advantage) from individual manufacturers. It is unlikely that any design of this type will be cutting edge. Imposing a solution of this type will certainly attract strong resistance from vehicle manufacturers and industry.

- *Minimum Specification with Standardised Interfaces:* A standard is published specifying the minimum performance requirement for EWSP, together with required interfaces (external and internal, hardware and software). The manufacturer can build in any desired enhancements, as long as the minimum performance specification is maintained.

  It is possible in this model that certain core components could be specified (for example a trusted element to maintain security and privacy).

  All implementations of this model would need to be certified to ensure that the minimum requirements are met. This model is similar to the GSM telecommunications standard.

- *The "Cloud" model:* Here the level of specification is minimised to a web interface (e.g. HTML5) and an HMI interface to the vehicle. All applications are run within the web browser. The platform would be required to provide a minimum computing performance.

  This model allows maximum flexibility for the manufacturer. It also allows a high level of upgradability for the user.

This model would be unlikely to provide a suitable platform for safety applications without significant security specific enhancements.

- *The "nomadic device" model:* Much of the computing, connectivity, security and location awareness capability required within the EWSP is currently already available in smart-phones. This model allows the EWSP to become part of the user's personal digital persona.

  This model would require an interface to be made available in the vehicle. The details of the interface could vary from simple (power only) to complex (power, vehicle sensor inputs, CAN bus, output to vehicle's HMI).

As future connected applications are expected to increasingly rely on cloud computing concepts, it is reasonable to expect the EWSP to become a cloud component; indeed, it is possible that the EWSP would become the primary means by which the vehicle becomes a cloud component. It is important to note that while to be part of the cloud a vehicle will require an internet connection, it is extremely unlikely that, even in 2025, it can be guaranteed that a vehicle would be able to maintain a permanent internet connection as envisaged by cloud "purists". At best, a vehicle will be able to maintain a regular but unreliable, variable speed internet connection, and hence the EWSP, will always be required to retain a local storage and computing capability, and be able to operate independently of the internet for extended periods, including start-up and shut-down. This is similar to the limitations experienced by smartphone users today.

A number of future scenarios require the services are tightly coupled to the vehicle. If we look for example at the scenario described in Section 5.3.1 'Eco-centric motoring', this assumes services which interface directly in to the vehicles management systems to derive the maximum benefit from the future services. This type of tight coupling will be difficult to achieve as described below.

There are two significant conflicts which need to be addressed with respect to the EWSP:

- *Technology timescale differences* between the ICT technology refresh cycle and the automotive technology refresh cycle. Cutting edge technologies (for example smart phones) have a short model lifespan, typically less than a year, and can be obsolescent within 3-5 years. Lifecycles in the automotive industry are far longer; it is not unusual for a decade to pass between design-freeze and the final production for a model of vehicle (usually with a mid-life upgrade), and the on-road lifespan of a vehicle can be a further decade. This means that a significant proportion of vehicles in regular use incorporate technology more than 20 years old. This is combined with a very long "tail" in the use of vehicles where it is possible and legal to continue using vehicles for decades after production ends.

  It is reasonable to expect that any service platform providing ICT services into the vehicle will evolve at the rate of the background technology, hence it is reasonable to expect that in future decades, vehicles equipped with service platforms of multiple generations will be in service.

  A possible mitigation for this would be to require the EWSP to be easily and relatively cheaply upgradable, both in terms of hardware and software. This in turn could then be in conflict with the rigorous integration procedures required of motor manufacturers which make technology upgrades time consuming and expensive.

- *Proprietary vs. standardised solution*: In order to provide a certain level of services into the vehicle, it is necessary that the EWSP must provide standardised application interfaces. On the other hand, manufacturers prefer proprietary solutions to enable them to achieve a competitive advantage over their competitors. Standardised solutions can also stifle innovation, slowing down the rate of technological progress.

Already vehicles are incorporating EWSP-like functionality, but these are of course proprietary to the manufacturers and their suppliers. Examples include the Microsoft Auto operating system, as used in the Fiat "Blue&Me" infotainment system and the Ford Sync system, and the BMW Connected Drive concept. While currently focussed on infotainment and convenience services, they already include emergency assist services, as well as vehicle-centric services like vehicle health reports.

As manufacturers increasingly include connected car services, there will be increasing resistance to externally imposed additional, but parallel services.

5.6 Conclusions

Six scenarios for the future new services enabled by the connected car have been described together with the potential benefits. These scenarios will be used in the following section to develop roadmaps for reaching the potential described within these scenarios. It is from these roadmaps that challenges and recommendations will be developed.

Enabling technology and concepts, including a concept of a European Wide Service Platform, have to be developed in order to realise the vision of the scenarios.

It is reasonable to expect that the EWSP becomes part of the Future Internet infrastructure, consisting of a set of distributed enablers for new services with open interfaces. The EWSP can be defined as framework that brings the technical open specifications, standards, procedures for publication, registration, service discovery, together. This framework provides tools as privacy guidelines (or statement or principles), certification tools. The framework also includes the organization that is responsible for the evolution of all agreements, standards and tools.

There are two significant conflicts which need to be addressed with respect to the EWSP:

- The technology timescale differences between ICT and automotive, for which a possible mitigation would be for the EWSP to be easily and relatively cheaply upgradable.
- Proprietary vs. standardised solution. This will require considerable further research and consultation with suppliers and standards bodies to resolve. A possible mitigation would be for the EWSP to provide standardised interfaces.

6 Roadmaps and definition of research issues

6.1 Introduction

The scenarios developed in the previous chapter provide six possible views of how the connected car will operate in a 2025 timeframe. On the premise that these are desirable operating regimes, the next step is to assess both what are the necessary steps to reach this scenario, and how they would be met without EU intervention by using a Roadmapping approach. By revealing in this way the challenges which will not be met by the power of global market forces, recommendations are made for potential EU interventions that will facilitate and accelerate development of connected car services.

6.2 Interaction between Future Internet and Future Mobility

The scenarios show that a mutual interaction is expected between the developments towards the Future Internet and the developments in ICT technologies and services for mobility. The intertwining of these developments will lead to new services enabled by the connected car in 2025. In the roadmap towards 2025 several hurdles have to be crossed in order to realise the ultimate Connected Car vision.

On the one hand, connected car services will influence the developments of Future Internet technology via the requirements they impose on the underlying technology. On the other hand, Future Internet technology, concepts and services will be used to enable new services for the connected car. It is foreseen that this process will initially be realised most readily through the more personal services. However, via the personal services, technology will also find its way towards the more public type of services, as depicted in Figure 6.1

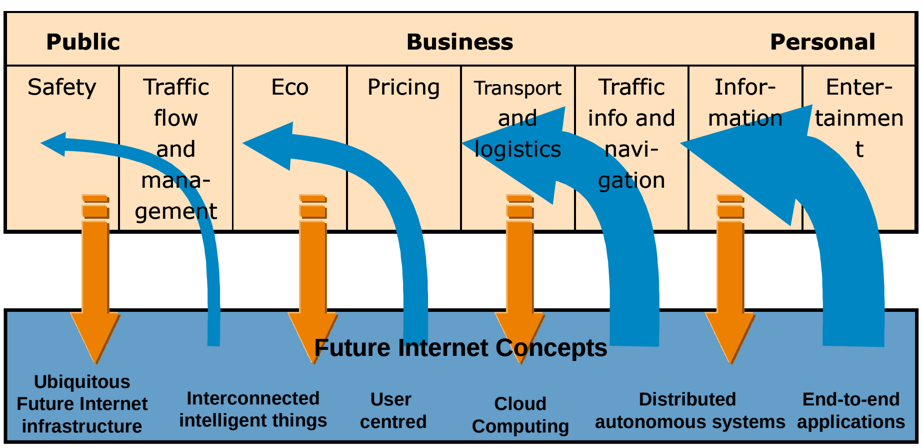


Figure 6.1: Connected car services will influence the developments of Future Internet technology via the requirements they pose on the underlying technology. At the same time, Future Internet concepts and technology will be used for connected car services.

The details of the Roadmapping process are provided in Appendix C. The following paragraphs present the approach and results of the Roadmapping process, leading to research challenges for new services enabled by the connected car.

6.3 Roadmapping approach

Roadmapping has been used to map the identified services for the connected car to each of the six identified Scenarios. This provides an idea of the order in which services may appear, and allows for identification of the expected challenges arising from their interactions. The result is a roadmap with services per scenario.

For each of the six scenarios there are multiple ways they could come to fruition. For each of the roadmaps, three waves were identified as ways in which the end vision of the scenario might come about. These waves are effectively routes by which that scenario might be achieved. The waves have been created to be as mutually exclusive as possible, in this way presenting differing routes to the scenarios' ultimate vision.

The overall Roadmapping and alternative waves method used to produce recommendations in this study is shown in Figure 6.2 below.

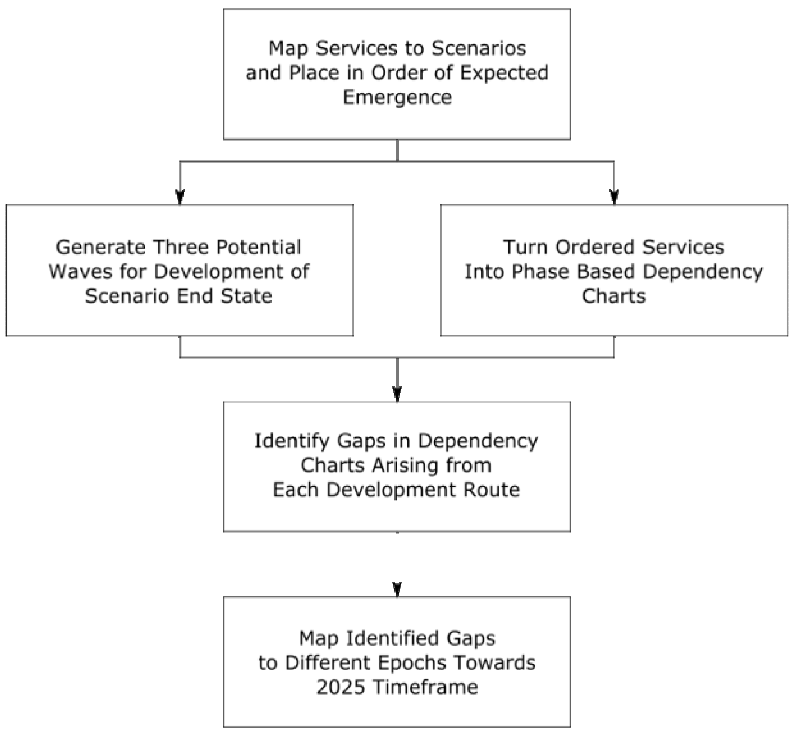


Figure 6.2: Overall Roadmapping Process.

A more detailed description of the Roadmapping approach is given in Appendix C.3.

6.4 Scenario specific roadmaps and development waves

The scenario specific roadmaps were developed by taking the complete set of connected car services discussed in Section 5 and listed in Appendix C.2, and mapping them to each scenario. They were then ordered into linear sets that described how generic capabilities grew from simpler, existing systems into more sophisticated future technologies. These were then mapped in a roadmap fashion to shown the interconnectivity and changes over time.

The six roadmaps developed are shown in the following paragraphs as developed with explanations. Where the text refers to "clusters", it is referring to groupings within the roadmaps that form a progression from left to right; a cluster ends when the next row starts again at the left most column.

Each section concludes with a picture of three different development waves to achieve the respective scenarios. More details on the development waves are given in Appendix C.4.

6.4.1 Eco Centric Driving

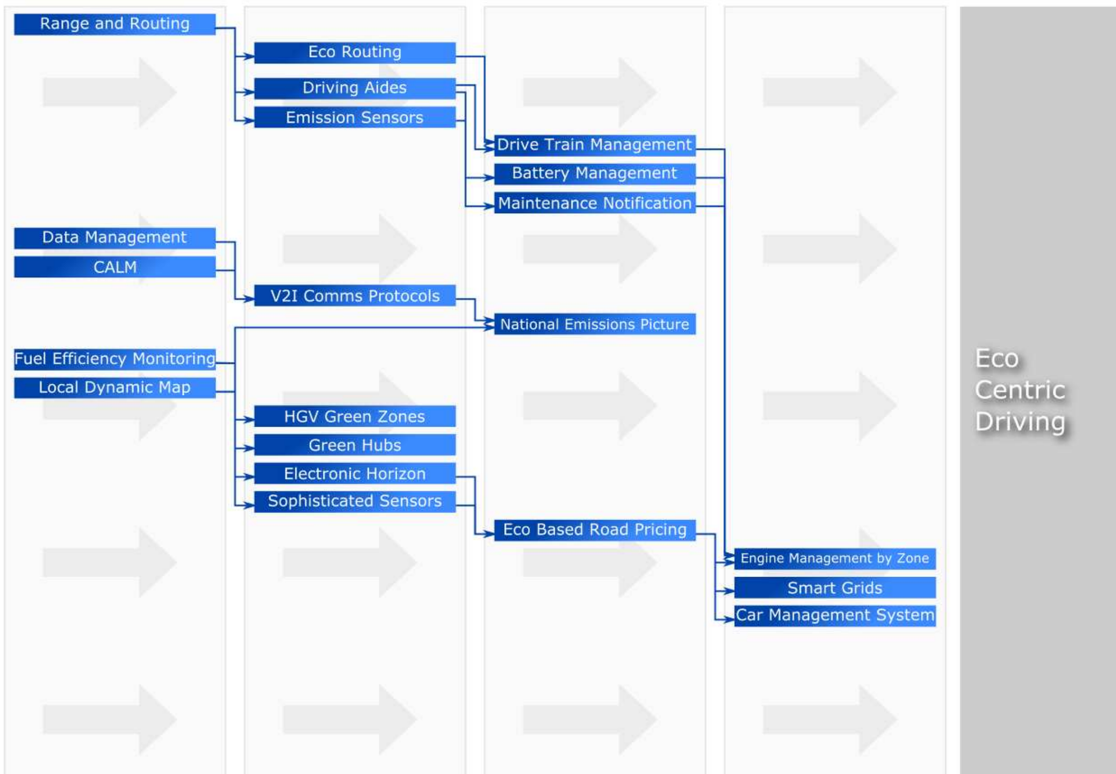


Figure 6.3: Services roadmap for Eco-Centric Driving scenario.

This roadmap is structured around applications for the driver, applications for network managers and applications focused on delivering EU environmental policy.

The first cluster, starting with E-Range estimation and ending on Maintenance Notification Service, focuses on services that are provided to motorists to help them reduce their fuel use and emissions while increasing their fuel efficiency, including use of electronic or hybrid vehicles.

The second cluster shows the build of data transfer and management that underpins nation-wide traffic management initiatives. By building a comprehensive National Emissions Picture more effective management of emissions can be achieved.

The final cluster set starts with Fuel Efficiency Monitoring and ends with Car Management Systems. This set builds on user focused and management focused services to provide services for influencing the patterns of use of eco impacting behaviours. These build into the final three services of Engine Management in Green Zones, Smart Grids and Car Management Systems which provide a very high level and comprehensive set of tools for actively reducing the overall level of vehicle emissions and for targeting specific areas for improvement.

The three waves by which the scenario vision could be achieved are shown in Figure 6.1 below.

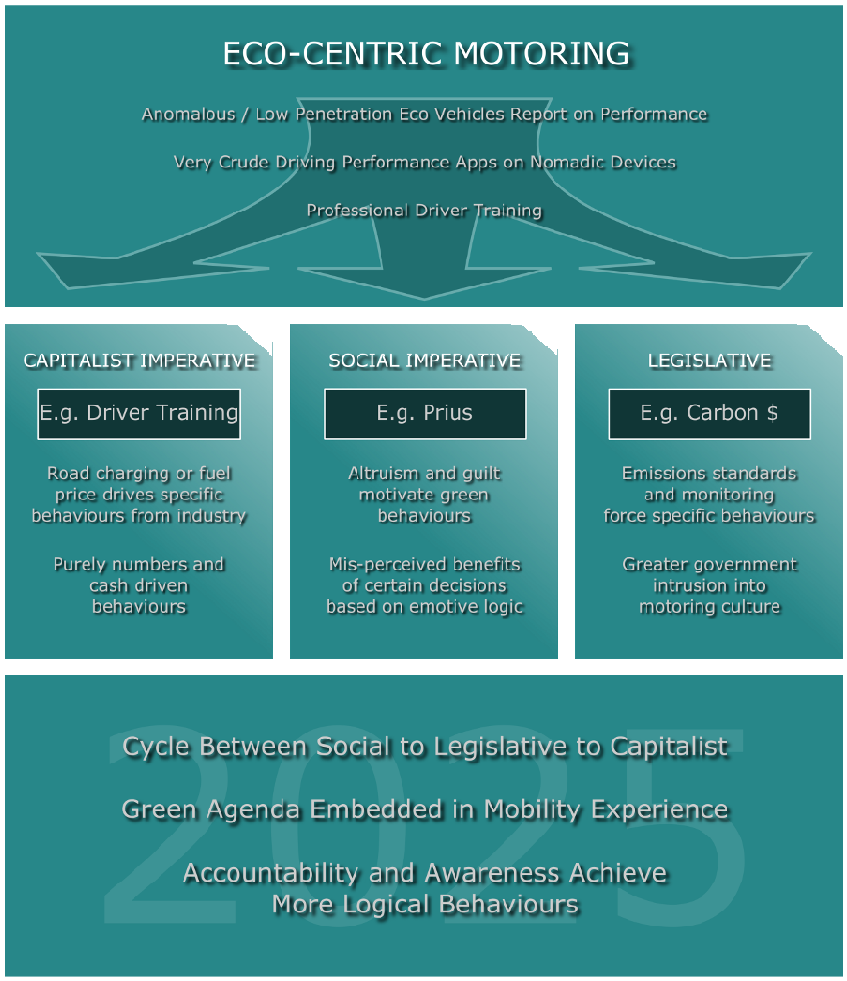


Figure 6.4: Envisioned development waves for Eco-Centric Driving scenario.

A gap analysis as described in C.6 was undertaken to identify the research challenges to be addressed. These are discussed in 6.5.

Similar analysis for the other scenarios is described in 6.4.2 to 6.4.6 below.

6.4.2 Active Safety Protocols

Figure 6.5: Services roadmap for Active Safety Protocols scenario.

This roadmap is made up of three clusters. The first is focused on delivering in-vehicle services to the driver that enable safer driving. The second is focused on connected cars receiving local information to help them anticipate emergent risks. The third cluster looks at bringing together disparate technologies to achieve the longer term goal of true cooperative driving where connected cars are continuously talking to one another to predict and manage risk.

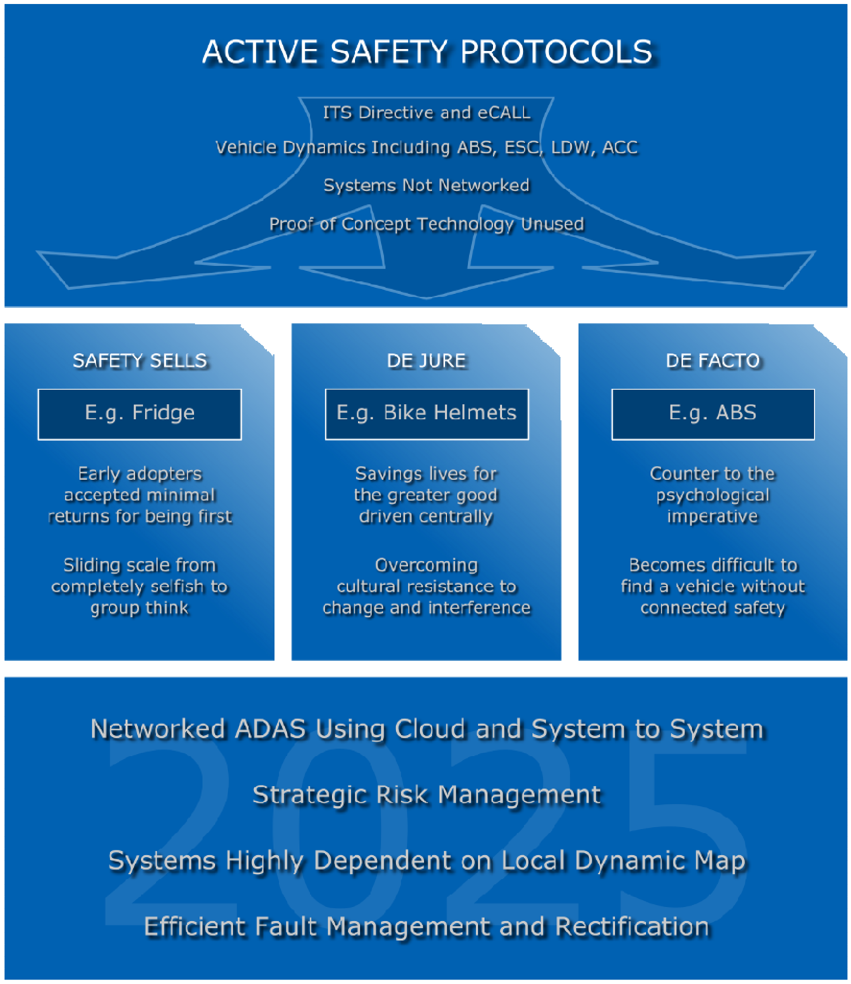


Figure 6.6: Envisioned development waves for Active Safety Protocols scenario.

6.4.3 Smart Transportation

Figure 6.7: Services roadmap for Smart Transportation scenario.

This roadmap is formed of two clusters, focusing first on standardised services and secondly on more advanced services.

The first cluster describes how, with the advent of a live cloud connection to an in-transit package itself (rather than just a manifest), several key new services become possible such as accurate cargo location tracking and Delivery Window Warning, both focused on providing receivers of logistics services to actively manage the arrival of cargo loads.

The second cluster is more complex. Starting with fundamental technology services such as Electronic Horizon and Travelling Salesman Optimisation, these build to a range of six services aimed directly at heavy goods vehicles drivers and the companies that manage them. Services such as Resting Time Violation Warning and Rest Area Service will increase the overall safety of road freight. The second half of the cluster then builds on these technologies to build aggregate services that make the whole EU freight network more efficient, including Electronic Customs services and Intelligent Cargos that manage their own routing and delivery.

Figure 6.8: Envisioned development waves for Smart Transportation scenario.

6.4.4 Mobility Integrated Services

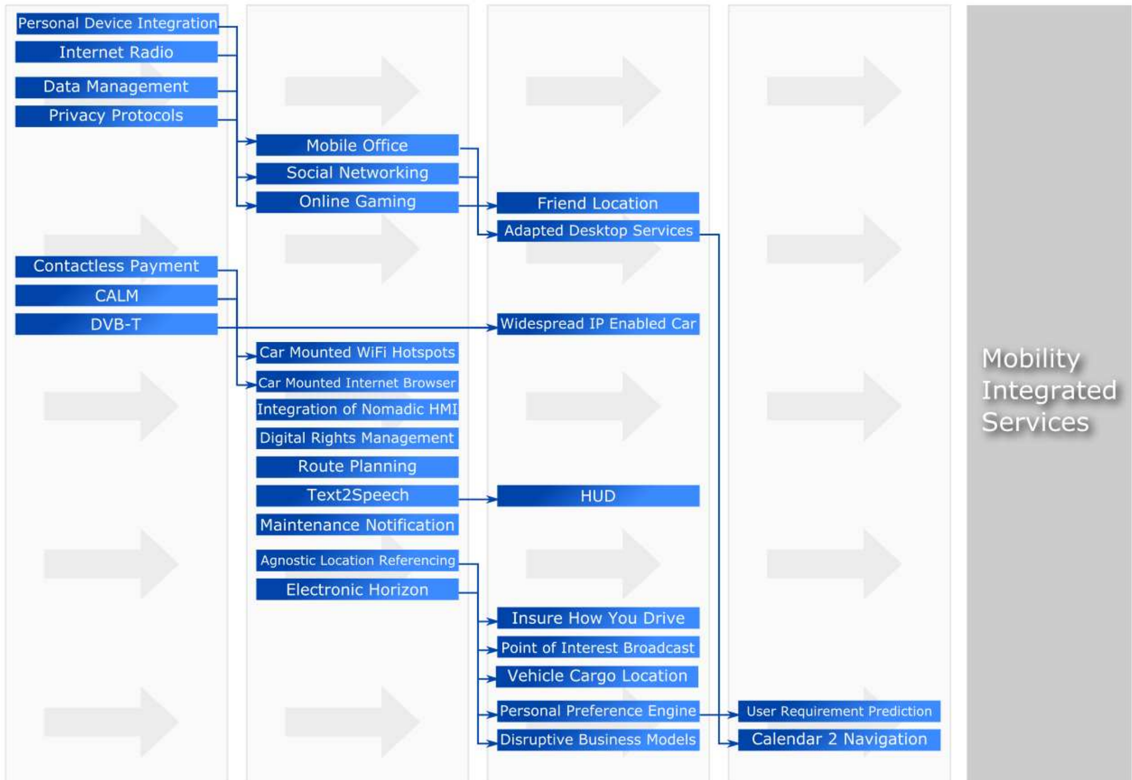


Figure 6.9: Services roadmap for Mobility Integrated Services scenario.

This scenario contains two clusters. The first builds upon personal data to develop services aimed at personal productivity in both business and social spheres. By aggregating various data streams and building upon existing commercial platforms, the connected car will be able to provide a comprehensive set of Adapted Desktop Services which enable the vehicle user to access the same services as on fixed Internet terminals and so achieve a moderate level of productivity.

The second cluster builds on a set of enabling services such as Route Planning and Text2Speech which enable more sophisticated services such as specialist insurance and vehicle cargo services. At the very top end, advanced preference engines (potentially driven by pattern matching or artificial intelligence) can suggest and recommend ideas to the driver including potential destinations, activities and plans.

Figure 6.10: Envisioned development waves for Mobility Integrated Services scenario.

6.4.5 Cooperative Traffic Intelligence

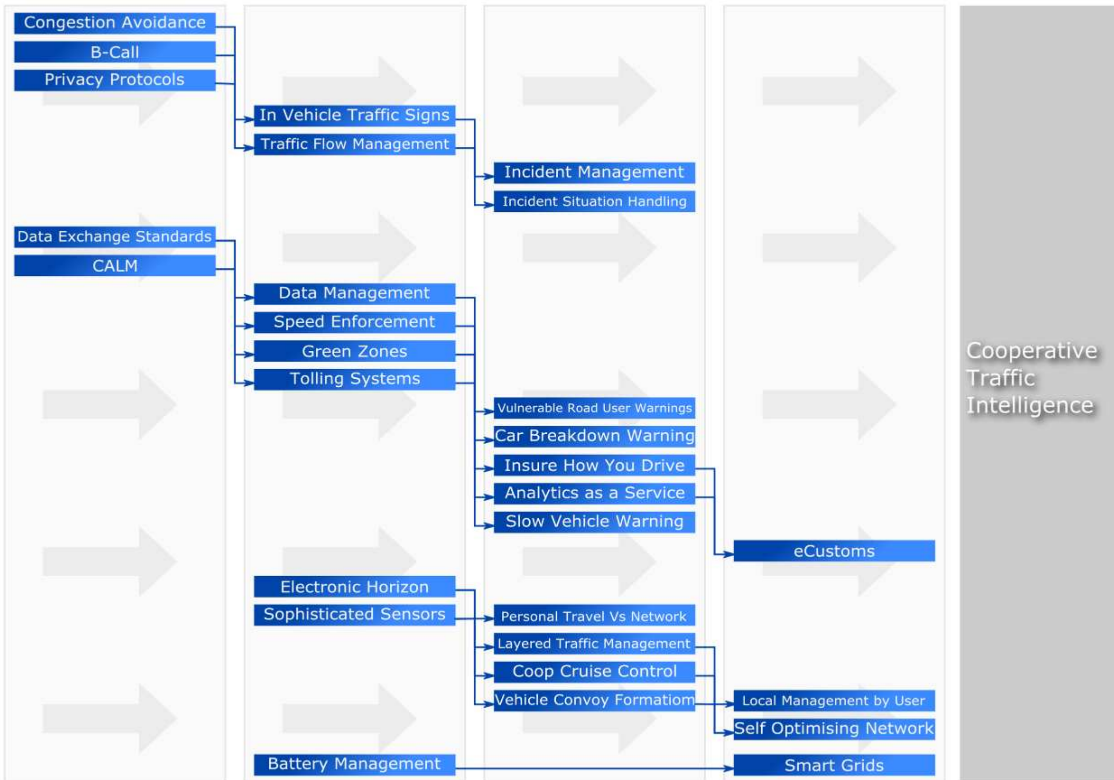


Figure 6.11: Services roadmap for Cooperative Traffic Intelligence scenario.

This roadmap is split into three separate clusters of interdependencies. The first cluster involves services that use fundamental connected car services to inform centralised network management and incident management functions.

The second cluster is built upon concepts of data exchange services that allow consumers and companies to interact more effectively. This results in market services such as Insure How you Drive and Analytics as a Service that become both feasible and commercially viable. These culminate in the eCustoms service which enables significant cost savings for movement of goods using the traffic network.

The final cluster, starting with Electronic Horizon and ending with Smart Grids, focuses on services that maximise transport efficiency through effective use of data and an understanding of traveller intent. Services such as Layered Traffic Management and Vehicle Convoy Formation all require highly sophisticated uses of data in line with established protocols. By applying these services cooperatively across a highway network they can be achieved effectively and safely.

Figure 6.12: Envisioned development waves for Cooperative Traffic Intelligence scenario.

6.4.6 *Agile Navigation*

Figure 6.13: Services roadmap for Agile Navigation Systems scenario.

This roadmap consists of four clusters which address Nomadic Devices, Traffic Management, Data Networks and Enhanced Services.

The nomadic devices cluster focused on the integration with current and future mobile devices (primarily mobile phones and smart phones) with the equipment mounted in vehicles. This moves beyond simple mounting of the device towards integrated syncing and shared, smarter services.

With connected and agile navigation systems a range of new top down traffic management service become available such as the ability for a diversion (for example in response to a network incident) to be transmitted directly to in car systems from a traffic control centre.

While the third cluster is straight forward, the fourth is more complex. By building upon standardisation technologies, such as common digital definitions of networks and scheduling protocols, more complex services become available. For example, live infotainment services can only work if there is a standardised way of updating interest information and understanding when, where and how that information should be shared with motorists. The combination of back end data systems and definitions with front end delivery mechanisms (such as Heads Up Displays) allows these services to be delivered safely and efficiently.

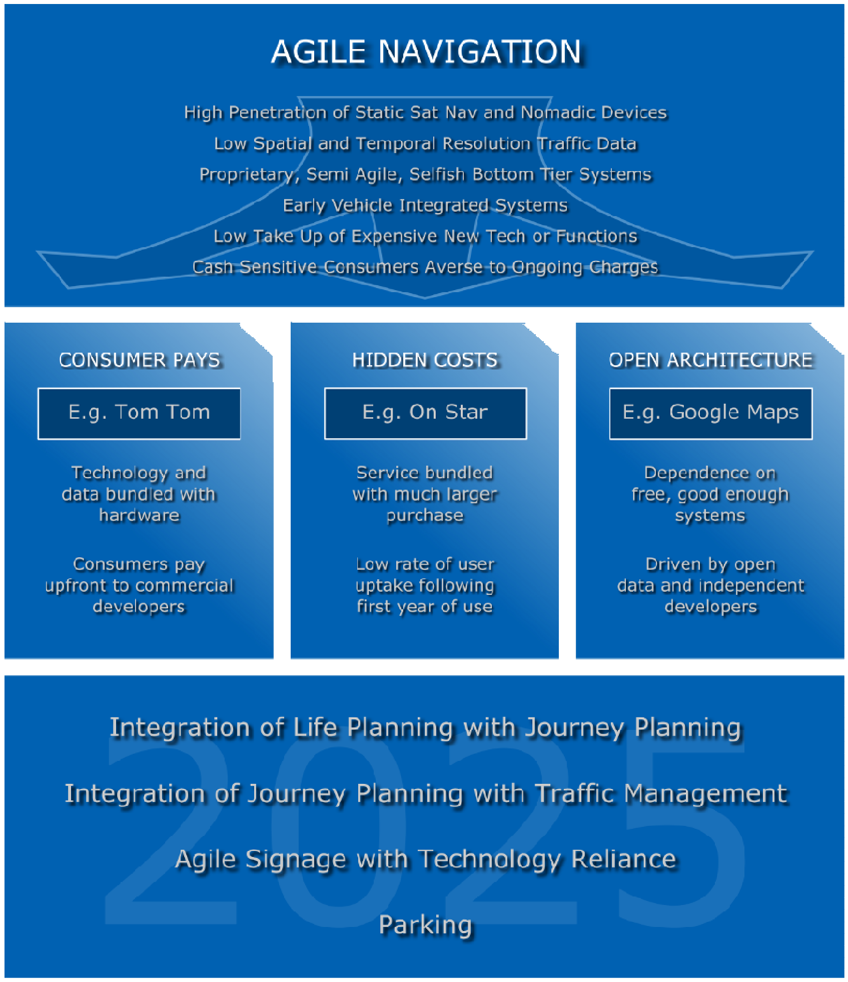


Figure 6.14: Envisioned development waves for Agile Navigation scenario.

6.5 Research challenges

This section lists the research issues derived from the stakeholder consultation, future developments, scenarios and roadmaps. These challenges have been combined with the gaps identified in the roadmaps analysis (a more detailed table with the gaps identified by the roadmaps is given in Appendix C.6) to produce the comprehensive list of research challenges detailed below.

I. Establishment of communication infrastructure for connected car services

The deployment of connected car services requires significant investment in wireless communication infrastructure that is suitable for use on the road.

Future Internet services will create a vastly increased demand for bandwidth. If these technologies can be leveraged by the mobility market, the proliferation of connected car services will further increase this demand.

Further to this, the communication requirements imposed by future connected car services will create additional bandwidth demand. As analysed and concluded in the SMART063 study [Smart63], it is likely that a combination of two or more wireless data communication technologies will be used for I2V communication as no 'one size fits all' solution exists for cooperative applications. The existing telecom infrastructure is therefore not expected to meet the specific requirements imposed by connected car services.

In the Future Internet (Internet of Things and Internet of Services) ever more smart mobile devices at the edge of the networks will become pervasive and capable, constituting in itself a significant part of the Future Internet. The inclusion of numerous smart devices at the edges of the future Internet provides potential solutions (e.g. by adding additional communication bearer capacity, providing local execution environments required for real-time applications,..) while at the same time it creates challenges of interoperability across polymorphic networks.

Mobile operators have built their business cases on cellular mobile communication. With the migration from 3G towards 4G (such as LTE) the focus remains on technologies that can serve a circular area with Internet connectivity, with no special provision for following the road infrastructure and optimising for connected car services. The deployment of dedicated connected car telecommunications infrastructure therefore cannot be expected as part of existing business models. Currently, mobile operators are investigating how flat rate models should be replaced by service charges. These service charges then would also apply to connected car services. This development will in the short term oblige connected car services stakeholders to identify a business models that pays for the telecommunication costs, (and independently whether or not investment in dedicated telecom infrastructure is required).

The establishment of V2I infrastructure therefore increasingly becomes an issue that is critical and specific to the introduction of connected car services, it directly affects the business of incumbent operators, and it provides technical solutions and creates new technical challenges that require further RTD.

Research challenges with respect to communication architectures enabling new services for the connected car are:

- To what extent a specific automotive technology is required for V2V and V2I (e.g. 802.11p) and to what extent 'standard' bearers (4G and beyond) will (or be required to) accommodate connected car services? Issues to be considered include: Car communications enabled by fixed infrastructure and ad-hoc networks; Mesh networks to provide data collection, asset history and communications; Local Wi-Fi hotspots from vehicle allowing autonomous networks to be formed and provide local services; The connected car as part of the telecommunication network.
- What QoS is required for future connected car services, and how can Internet technologies / common bearer technologies meet these expected requirements?
- How to distribute service information flows over different channels and how to prioritise within communication channels if the required bandwidth for al services exceeds the available bandwidth.
- Interoperability standards across different (polymorphic) networks for connected car services. How different networks can be combined to meet the capacity (bandwidth) requirements, to meet service requirements and to facilitate networking with different smart mobile devices and connected cars. Aspects including costs, QoS and performance need to be addressed.
- The use of EV charging points as a hub for downloading info e.g. traffic info from a central service and uploading vehicle data to a central service.
- Pre-commercial deployment, business assessment of communication infrastructure for connected car services. What communication infrastructure provides a basis for market development of connected car services (SMART063 concludes at the minimum two networks will be required). Considering the type of

connected services and the societal benefits that could be realised, the effect of Public Authority investment in communicating road-side infrastructure needs to be trialled.

- Promote development of infrastructure that transmits self status data into the cloud through development and maintenance of standards and facilitate exploitation of existing live data source APIs into public domain.
- Monitoring, evaluation and forecasting of the network performance can be carried out meeting connected car services' requirements. Applications that are aware of the actual performance of the infrastructure. Smart infrastructure allowing applications to adapt to the real time performance.

II. Enabling connected car services using Future Internet technologies

Future connected car services will be supported by the Future Internet service enabling infrastructure. The European Wide Service Platform enabling connected car services is expected to be an integral part of the Future Internet infrastructure. The development of the Future Internet service enabling infrastructure presents research challenges that without doubt will be addressed by generic RTD of Internet technologies and services. The transport sector and connected car services however, constitute a specific domain that can help advance the innovation and use of the Future Internet. However, it also might require specific solutions. As a consequence there is a need for RTD of Internet technologies which is specifically applied to connected car services.

Research challenges with respect to Future Internet technologies enabling new services for the connected car are:

- What are suitable deployment models of connected car services: service publication, provision, service discovery, development of mash-up services using information from different sources, etc. as part of the future internet (cloud) services.
- How can the enormous amount of context-sensitive (and therefore location-sensitive) be presented and used for connected car services? How to guarantee the correctness and accuracy (in space and time) of the data? Is the Local Dynamic Map (LDM) a suitable concept for this, but how should different layers[10] be standardised to allow the data from different sources to be merged into a usable LDM (where 'usable' has a different meaning for different services)?
- Integration of EVs with the Smart Grid. Eco-driving requires a complete new (set of) service(s): information regarding loading points (and times), road status, green zones, etc. Optimal route planning involves not only the road segments to be followed, but also the propulsion, based on the actual situation.
- Integration of different types of (information) services, multi-modal, social media, community services, business applications, entertainment services in vehicle signage, etc. The integration/combination should be flexible and be based on the personal profile of the driver/traveller, resulting in personalised services like overall dynamic travel planning, dynamic car sharing or big social interactions. The integration should also allow for different platform: car based or personal device.
- How data from road sensors and V2I communication should be consolidated, prepared and distributed. What are suitable concepts for data fusion: traffic flow,

[10] The LDM in the connected car consists of at least four layers: 0) The static map of nearly permanent data (roads, charging/fuelling points, green zones, speed limits, …); 1) The direct surroundings - where information is most likely provided by the on-board sensors (minimal delay); 2) The near surroundings - where information is most likely provided by V2V communication (limited delay); 3) The traffic and road situation ahead - where information is most likely provided by I2V communication (relatively long delay). Layer 3 includes changes (mostly temporary) to the static map (extended green zones due to smog, road works, temporary speed limit changes, …).

static sensors, floating vehicles? And what are suitable concepts for data mining (historic data) and fusion with real time data?

- Data available through cloud services, when being used for mission critical services (such as safety services or tolling) must be understood by all vehicles in a pre-defined manner; there is a need to design standards for data structures (format / semantics) that do not yet exist.
- The car as a sensor providing traffic, situational and environmental information. Vehicles used as smart nodes providing: real time travel info; map changes. Self-* sensors, self-* sensor networks, leading to relevant, timely information.
- The development of a whole environment that senses and communicates allowing the generation of the traffic and travel context information.
- The use of Service Oriented Architectures (SOA) and the semantic web for logistics, road-, traffic and travel information. How to ensure services can become interoperable, self contained and self describing?
- Critical common understanding; standards on formats and semantics: data available through cloud services, when being used for mission critical services (such as safety services or tolling) must be understood by all vehicles in a pre-defined manner; there is a need to design standards for data structures (format / semantics) that do not yet exist.

III. Integration in the in-vehicle environment

The challenges discussed in this section assume that nomadic devices will be used to provide Future Internet service into the vehicle, this being a possible way of addressing the vehicle/ICT development timescales differences.

Sophisticated HMI integration and functional integration of smart personal devices (in today's market these are smart phones, tablet computers and personal network devices) in the in-vehicle environment, allow the evolution of connected car services run at the pace of the consumer industry instead of the typical OEM life cycle speed. As these systems need to build on proprietary in vehicle control systems and dashboards, standards for integration with these systems is critical. The resolution of standards for achieving this, in a manner that the OEM business interests are also considered seems therefore crucial for the speed to market of the connected-car services. It is expected that the EU statement of principles for HMI caters insufficiently for anticipated developments on mobile and connected services that are used inside a vehicle.

HMI integration is also essential for avoiding driver distraction. The development of sophisticated and integrated interfaces, potentially become more viable as more cooperative systems become available. Safety related services can especially be hampered by the amount of safety (and other) services competing for the attention of the driver. The set of services in the connected car will become increasingly rich. In particular all services asking attention of the driver need to be managed to avoid information overload leading to unsafe situations.

In particular information and entertainment services might draw the attention of the driver away from e.g. safety services. Information overload is a threat, intensified by (location based) push information services. A challenge is to protect the driver by an intelligent human-machine interface (HMI) with knowledge of the relative importance of services[11] (much like the existing HMI where the car's radio is muted when a mobile phone call starts). This involves both HMI and legal aspects.

Research challenges with respect to integration of smart devices with the vehicle environment and HMI aspects are:

[11] Service meta-data can be used to provide the service priority level. Certification might be needed to prevent misuse.

- How to manage the attention demand of the ever growing set of services? Is prioritisation by the vehicle and/or the smart device of the active service a solution? Can a driver be protected against information overload by an intelligent human-machine interface (HMI)? And what are the legal aspects?
- What would be suitable interaction models supported by rich displays, interfaces and haptics? And are there generic requirements that should be imposed on any connected service when interacting with the driver?
- To what extent can the 'EU statement of principles for HMI' be applied to connected car services and to what extent would further specification or even standardisation and certification of HMI aspects be required. How should the application thereof be organised? Is it required to have dedicated HMI guidelines or requirements for services that interact with the driver, co-driver or passenger (tactile)?
- Can HMI prioritisation and bandwidth prioritisation provide part of the solution and if yes can they share priority mechanisms? If so, how?
- How could rapid evolving smart phone (devices) be leveraged for the evolution of connected car services; how to integrate the mobile device in the automotive environment (HMI, data exchange, processing or service exchange)?
- Vehicle OEM hardware and software for vehicle management and integrated (safety) services are nowadays (nearly) closed systems. The need to share/exchange data between the vehicle OEM system and third party (Future Internet) connected car services should be investigated. And if there are clear needs, what could working models be: what technical standardisation of interfaces and data, what security protocols and how can the business interests of the OEMS meet those of the service providers?
- How will the disparity between the technology lifecycle and the automotive lifecycle be addressed? This has a number of wide ranging implications around technology refresh timescales, provision of new services into older vehicles, computational load, etc.

IV. Interoperability and openness

With a range of different OEMs and other suppliers providing competing products, a wide range of technologies could appear in some niche markets for connected car services. Without interoperability and open specifications or standards it is much harder for these to reach the required adoption rate. With poor uptake due to ineffectiveness, support for these technologies from OEMs could dwindle. Furthermore, early adopter patience would likely wear thin resulting in a gradual abandonment of these systems before they can gain a foothold. Interoperability and openness will be addressed in generic RTD on the Future Internet, but the transport sector will require additional standardisation of interfaces. A RTD question is the extent to which technologies should be open or proprietary:

- A market that goes across/beyond borders could constitute just the minimum critical size for market parties to invest; it would also be particularly important for a cooperative connected services market where the network effect is large.
- Comprehensive standards could help a market to grow so creating an incentive for costly mass production and cost optimisations. However a protected (proprietary) market is needed to create an environment for initial RTD and investments.
- Instead of systems that are proprietary, consider introducing the stability and flexibility of a European standard that allows road operators, market parties and Member states to predict and control costs and functionality.
- Incorporate standardised interfaces that allow re-usability of standard components for a range of applications, increasing the speed of innovation.

- To avoid the requirement for the user/traveller to install and use different boxes in his vehicle when crossing borders.

From an 'Internet' point of view, the software and hardware implementations that exist in the mobility domain can be considered as legacy software, an important barrier to the take-up of Future Internet technologies in this domain. With a range of different OEMs and first tier suppliers providing competing products, a wide range of technologies could appear in some niche markets for connected car services. A balance between early market deployment and more closed/proprietary systems for risky investments must be established. The technical interoperability and these services remain a challenge with is not solved.

Research challenges with respect to interoperability and openness for enabling connected car services are:

- What standards will need to be in place to ensure maximum effective deployment without hindering market forces? What is the appropriate balance between proprietary vs. openness and can open Internet technologies be applied in a controlled manner facilitating business models in the mobility domain?
- Creating standards for the *meaning* of traffic information is a challenge and a prerequisite for real time traffic and travel information based on open linked data over standardised interfaces.
- What are the technical interoperability requirements for aggregating future Internet services into connected car services? And are the interoperability requirements for 'nice-to-have' Internet services sufficient for connected car services; and for connected safety services?
- For the logistics documents related services the challenge is to create a standardised semantic that connects the various parties in the value chain/net. This is a prerequisite for co-modal information exchange across the connected supply chain. With production moving to non-European countries, this co-modal information exchange grows in importance.
- Business models for collection of traffic information (the vehicle as sensor), reuse of data and payment for reliable traffic information are needed. The challenge is the role of the various stakeholders coming from different worlds: OEMs versus the internet.
- Entertainment services are driven by the entertainment/internet industry: There are several possible scenarios for the integration of entertainment services with the other services. A challenge is to find integration scenarios, and associated business models, that influence new services enabled by the connected car in a positive way.

V. Business models

The market for connected car services is characterised by a large network effect (value of services increase with increasing number of users) and its take-off requires a minimum critical mass. For many life-saving connected safety services it is even more important that all cars participate (are equipped with the required technology and services).

This makes it challenging to build compelling business cases for deploying such systems. Part of the solution might lie in the market deployment of Internet enabled roadside infrastructure and in-vehicle platforms for a variety of services that follow realistic business cases and can act as a catalyst for the market introduction of connected-car safety services for which the business case is insufficient. It is therefore critical to address challenges that exist for applying Internet technologies that often are being used for nice-to-have applications for mission-critical services and/or those that are being used for mandated services in a captive market (such as road charging could be).

Future Internet connected car services are characterised by a value chain that involves several entities which must have clear responsibilities and liabilities. Instead of today's telematics market, where a single service provider is responsible, Future Internet connected car services will be aggregated by combining and integrating a variety of self-describing, and self-contained 'cloud' services[12]. Models for authorship and IPR (who has the commercial and intellectual ownership) that meet the requirements for aggregating cloud services into connected car services therefore become essential. The issue of 'authorship' is made even more difficult by the fact that consumers become prosumers, i.e. the user of the service becomes himself one of the main drivers for Internet content that is used by others and third parties.

Cooperation of multiple entities, a prerequisite for aggregated connected car services, should be based on mutual profit. For safety services the advantage for cooperation is clear (although perhaps not sufficient in financial terms), but many cooperative connected car services would need the availability of micro payment mechanisms that can be used independently from the communications bearer and the other enabling technologies.

Mutual profit is a principle that also counts for coordinating traffic management (steering) and traffic information (informing) services. In cases where some traffic is rerouting on a long route in order to improve the network overall, traffic routing advice will be ignored as selfish behaviours dominate, resulting in lower overall system performance. Mechanisms are needed through which the traveller, market parties and road operators can share information and interact (such as through a 'community' and/or marketplace of road, traffic – and travel information) and derive guidelines or pricing mechanisms that facilitate individual journey optimisations that are in support of collective mobility objectives.

The typical 'Internet'-style RTD is characterised by innovation that happens at the edges of the network. This innovation is driven by cooperation between sectors, business and public sector and increasingly with the users' community 'empowered' and in control of opportunities to innovate. Of course 'open' does not mean 'free' and through RTD the right conditions must be created to make the adoption of 'open' Internet technologies in the connected car domain thrive.

More specifically, research challenges that address the conditions for a thriving market where open Internet technologies can be adopted and cloud services can be aggregated for connected car services include:

- How will services which require a high level of penetration to be effective be rolled out to initial users who will not necessarily benefit? What deployment models can overcome the challenges imposed by the network effect and required minimum mass of connected car services? How can the advent of Internet technologies deployed in other market sectors be leveraged?
- What role can the entities (network operators, prosumers, public authorities, road operators, service providers, OEMs, industry) be expected to play in the RTD and in the deployment of aggregated connected car services? What eco-system can be found, and what are the incentives for participation? Is there a need for coordination (e.g. for certification with respect to HMI, privacy, guidelines etc), is there a need for pre-commercial investment by authorities? How can the increase

[12] It is even expected that the market will evolve in a manner that the value of these 'cloud' services will no longer be measured by the functionality but by its ability to integrate with its surrounding environment.

in value that takes place as more users and smart devices are connected to the Internet ecosystem be capitalised in mobility services?

- Battery management and integration with smart grids for electric/hybrid vehicles is needed. The challenge is to build business models that stimulate eco-driving and balance individual and collective (dis)advantages. These business models have to operate in a complex value network with many stakeholders.
- What models will be required for authorship and IPR / DRM (who has the commercial and intellectual ownership) that meet the requirements for aggregating cloud services into connected car services, ultimately becoming essential. And what pricing mechanisms and standards would be required to adopt open internet technologies and aggregate into connected car services?
- Different pricing systems and different (micro) payment technologies within Europe are foreseen. The challenge of one Europe is to create a single, open standard that supports these differences. Pricing, in particular road pricing, could be a tremendous enabler for other services (driver for an on-board unit (OBU) in every vehicle), provided integration with other services can be done in a secure and fraud resistant way. The challenge is to convert the potential threat of open interfaces into an opportunity.
- How to build an ITS business model/value network/ecosystem that promotes global optimisation?
- Business models for collection of traffic information (the vehicle as sensor), reuse of data and payment for reliable traffic information are needed. The challenge is the role of the various stakeholders coming from different worlds: OEMs versus internet.

VI. Security, privacy protection, and user acceptance

Security is an issue for most safety services since most services need some open interfaces. The safety services depend for instance on the weather conditions and need some integration with the CAN (e.g. for automated braking). The willingness of, among others, OEMs is required for innovation and standardisation at these interfaces, where security on the open interfaces will need substantial attention, is a huge challenge anyway.

Security and the protection of business assets will become more crucial the more open the implemented technologies will be. For HGV vehicles themselves to act as communications hubs, allowing digital devices or tags within the cargo to connect to internet, providing a range of Fleet Management and Intelligence Cargo services, confidence must exist in the security mechanisms. As these services are driven by private corporations rather than governments there is a significant challenge in making these developments economically attractive to the suppliers. The willingness of private business, as well as private individuals, to open up this increased level of information will be challenging to achieve and the technologies, organisation and procedures for trust and security will be critical.

Security is also more crucial as the mobility of a society makes more and more use of open Internet-based technologies and services. Failure of the latter could, without prevention, result in a 'heart attack' of the complete transport infrastructure.

The potential when leveraging internet technologies through which the user (car driver or traveller) also becomes a provider of relevant road-, traffic – and travel data is enormous. The wide use of Internet clouds would for example allow the aggregation of eco probe-data and help predict short term future emissions and air quality. Real time traffic management measures could be published into the cloud through Vehicle to Infrastructure (V2I) channels. Traffic data would be generated and exchanged by the travellers themselves.

Users may prove wary about sharing their personal data, especially if they are seen as a first step towards new taxes, enforcement or commercial exploitation (although the sentiment in 2011 for the latter still is very tolerant). Public authorities have a stake themselves in the adoption of these technologies and user acceptance is crucial. Experience so far teaches us that internet based mobile services are highly innovative and functional but privacy regularly returns as a challenge that remains unresolved (at best). It will be critical that the people understand the privacy issues that affect them and will have control over their personal data. The model of Internet driven connected car services is based on voluntary participation of the users, industry and service providers and public authorities and road operators. All have a role in the establishment and operation of what in this report is called the EWSP. This will only be feasible if the end user will be able to choose his level of exposure through available and agreed privacy policies which have identical meaning and scope throughout Europe (and from the user's perspective across different service providers) and which has a legal basis. There is therefore a need for privacy-protecting protocols and procedures or policies that can be applied uniformly across Europe to match the market needs.

More specifically, research challenges that address the conditions for a thriving market where open Internet technologies can be adopted while protecting people's privacy and preserving user acceptance have been identified:

- Investigate user requirements for an online privacy model that can be used for providing highly personal data as a networked service (to other users and to third parties)?
- Investigate if the existing EU privacy legislation is sufficiently clear for industry and service providers for designing and investing (estimating and managing risks) in new connected car services on the basis of open Internet technologies throughout Europe? In this context, investigate requirements for providing third party access to personal data that is gathered.
- Provide EU industry and service providers with the means to implement the data management and data provisioning infrastructure for connected car services which meets the user requirements and legal requirements.
- Develop and demonstrate organisational models (and procedures) that allow users to remain anonymous to parties that have personal data.
- Develop EU wide policies and models that can be implemented by industry and service providers. Develop certification processes for privacy friendliness of connected car services.
- Some connected car services will be more or less mandatory because of legislation or simply because critical safety applications require the existence of such services on any vehicle. Does this create special privacy requirements/concerns with respect to future internet services and how could such requirements best be addressed?

VII. Liability and trust

Future Internet technologies will not be fully deployed across all market sectors: there will be laggards and there will be leaders. This report shows how crucial it is that connected car services in the mobility sector can leverage the capabilities of Internet technologies. Trust and confidence therefore will be critical for adoption in the mobility domain. The question of whether you can trust the service if you do not know who or where it is being provided from, or what other services and entities are relying on it, becomes very important.

In the Future Internet, the boundaries between the telecom infrastructure, the data centres, the service usage platforms and the service provisioning layers become blurred.

Increasingly the enabling technologies will be provided as services. Instead of as in today's ICT market, where a single service provider is responsible for a specific service or application, future Internet connected car services will often be aggregated by combining and integrating a variety of self-describing, and self-contained 'cloud' services[13]. This makes the quality and reliability of the information a key issue for connected car services. The quality and reliability refers to:

- The correctness and accuracy of the data. What are trusted sources (what authentication and trust schemes can be used);
- How to recognise quality and validity over time;
- The completeness of data;
- How old, and hence relevant is the data.

Data from different sources, and therefore with different quality and reliability, needs to be fused. Data from different sources might be conflicting and some sources might, temporarily, not be available. Despite efforts made by industry such as priority schemes in the protocols and redundant system implementation and system sanity monitoring, the availability of the data or the communication bearer can never be 100% guaranteed. Market introduction is being facilitated by European wide agreements, legally supported, on liability schemes. The quality and reliability of data is therefore:

- A technical challenge: how to generate a failsafe solution that adapts to the reliability of the available data and how can the quality of the available data be defined.
- A communication capacity challenge: does the communications infrastructure have the capacity to deliver the data on time?
- A liability/legal challenge: who is responsible for the accuracy of the data, and hence liable should the accuracy fall short?

As already mentioned, the liability issue is also essential for setting the market conditions right. Since future Internet connected car services will become aggregated services with a value chain that involves several entities that are not necessarily (most likely) not business partners, each entity must have clear responsibilities and liabilities.

The question is who will be responsible for the damage when a connected car service provides the wrong information because of a failure in a smart device, or because a local telecommunication beacon is overloaded and the cellular network does not cover the spot, or because a cloud service that used to be provided on a voluntary and for-free basis starts to be offered on a subscription basis?

For these Internet technologies and services to be exploited for connected car services it will be critical to provide liability models that make clear what the risks of integrating and using a specific cloud service are. And that reduces the risks for the provider of such cloud services (for being held liable for impact usage can have on the integrated connected car service).

More specifically, research challenges that address the trust aspects for a thriving market where open Internet technologies can be adopted and cloud services can be aggregated for connected car services include:

- How services for monitoring, evaluating, and predicting of network and data performances can help create the required trust and confidence.
- How trust between the large variety of actors operating and cooperating can be established through standards and agreements on performances, SLA's and interoperable QoS.

[13] It is even expected that the market will evolve in a manner that the value of these 'cloud' services will no longer be measured by the functionality but by its ability to integrate with its surrounding environment

- How can identity and authentication be realised online for trust? How can services and enabling services be certified?
- How can critical infrastructures be protected/guaranteed? What are fail-safe concepts that could be applied for securing the mobility? What are the resilience, failure and tolerance requirements?
- How Internet driven security mechanisms can be applied to connected car services / what security would be required to control the exchange of and access to critical data for connected car services?
- Mechanisms (technical, procedural and organisational) for confidential cloud services for cross-operator logistic optimisation and emergency responsiveness. Validation and pre-commercial deployment of a security/confidentiality framework.
- What organizational model (responsibilities/liability) should support a cloud network of services (on the basis of service oriented architecture) to accommodate for connected car services?

6.6 Conclusions

The roadmaps described in this chapter describe a vehicle, and indeed a mobility scenario of the future that will be significantly enhanced over what is available today. While the capabilities of modern vehicle continues to improve, often at an increasing pace (vehicles today are safer, more comfortable, more reliable, and more economical than even a few years ago, and these developments show no sign of slowing down), the additional potential of the connected car could provide a whole new dimension to mobility. However this dimension in many ways lies outside the comfort zone of both vehicle manufacturers and infrastructure owners/operators, using as it does technology that is new and requiring interfaces to third parties they are not familiar with.

It is clear from the discussions above that the paths to the future will require a number of challenges to be addressed. This will require the development of new ways of working, international cooperation and the involvement of the entire transport industry in the decision making process.

Technological development will not stand still; new services and applications will be developed, with or without the help of the EC. However, some technological developments may not provide sufficient economic advantage for manufacturers to pursue, and the EC can play a key role in ensuring that these are addressed.

Some of the biggest challenges are not technology related, but relate to the interchange and sharing of data. This raises significant issues on the ownership of data which need to be addressed.

Many specific challenges have been identified in the roadmaps above. The main research challenge categories derived from the future developments, scenarios and roadmaps are as shown in the following table.

Table 6.1: Research challenge categories.

Research challenges for new services enabled by the connected car	
I.	Establishment of communication infrastructure for connected car services
II.	Enabling connected car services using Future Internet technologies
III.	Integration in the in-vehicle environment

Research challenges for new services enabled by the connected car	
IV.	Interoperability and openness
V.	Business models
VI.	Security, privacy protection, and user acceptance
VII.	Liability and trust

These recurring challenges should be seen as the research themes to be addressed over the next several years.

7 Conclusions and recommendations

7.1 Introduction

The advance of new services enabled by the "Connected Car" will be driven by developments in Future Internet technology and services combined with developments in the transport domain, like Intelligent Transport Services and Cooperative Systems.

The "Connected Car" can play a pivotal role in supporting the public and private needs in the transport domain: better use of infrastructure and vehicles, increasing safety and security, enhancing reliability of transport, increasing fuel saving, improving logistics, supporting multi-modal travel and reducing the environmental impacts.

The Future Internet is about structural involvement of ICT and internet technology in many usage areas. Current "autonomous" developments in the Future Internet create serious opportunities for many usage areas, including mobility. If these Future Internet technologies cannot be applied to mobility services, it will be fairly impossible to meet the policy objectives as formulated today. In this study the developments in Future Internet and Future Mobility technologies and services come together with the needs of both public and private stakeholders, providing a common understanding of the services enabled by the paradigm shift of the connected car.

In order to realise the Connected Car vision, further developments are required. The results of this study provides a list of research issues that can used as input for the programming of FP8 "Future ICT for Transport" and also FP7 Calls 8 and 9 with respect to the technical elements and objectives of the EWSP. This study also supports the definition of other Commission actions, including those supporting deployment such as standardization, field operational tests, pilots and public procurement.

In this study, scenarios and roadmaps were drafted to provide a basis for a common understanding amongst all stakeholders on the connected car concept and the public and private services enabled by a European Wide Service Platform.

The scope of future mobility services has been extended for this study. The resulting categorisation of new services enabled by the connected car is summarised in Figure 7.1.

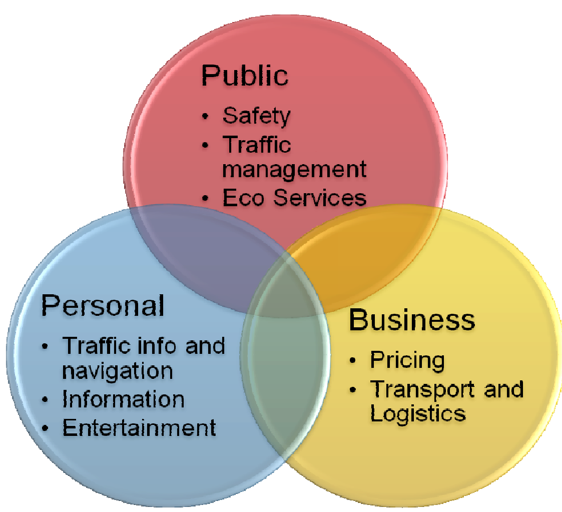


Figure 7.1: Service categories for connected car services.

The following paragraphs give the conclusions and recommendations.

7.2 Vision on new services enabled by the connected car

Future Internet developments will accelerate the introduction of connected car services in two ways:

- Future Internet services will be connected with connected car services, providing extra information relevant for the connected car services;
- Future Internet technology will be used as enabling technology for connected car services.

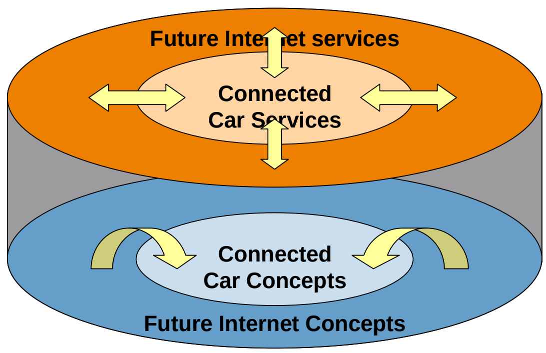


Figure 7.2: Connected car services interact with other Future Internet services, while Future Internet concepts are used to realise the required Connected car Concepts.

The rate and intensity these processes will take place, will depend on the type of category. On a scale running from safety to entertainment services, the entertainment side will be fully dominated by the future internet developments, whereas on the safety side a strong, independent ITS development dominate the development. However, technology will not only from future internet technology to connected car technology and vice versa, but technologies used in one category will also migrate to other categories. In this way, Future Internet technology will still play an important role in the connected car services.

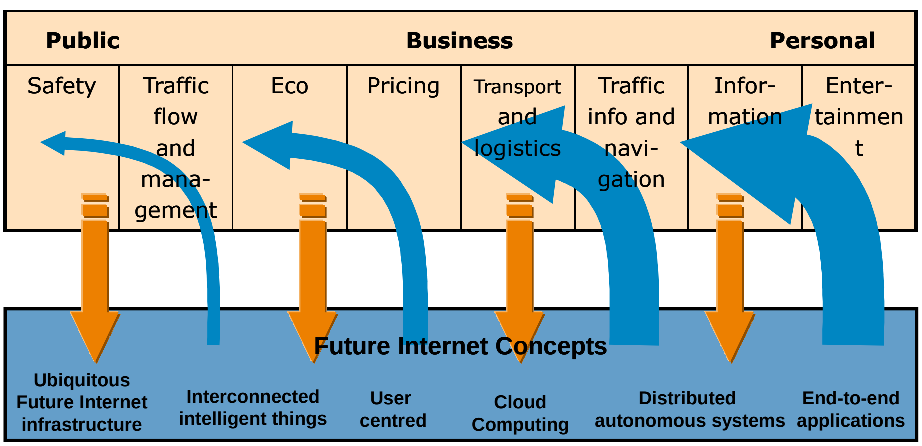


Figure 7.3: Connected car services will influence the developments of Future Internet technology via the requirements they pose on the underlying technology. At the same time, Future Internet concepts and technology will be used for connected car services.

The results of a stakeholder consultation were used to draft a Connected Car vision and scenarios. The Connected Car vision is meant to provide the basis for a common understanding on the concept of the EWSP and the public and private services enabled by it.

As part of the Connected Car vision six Connected Car scenarios for the future new services enabled by the connected car have been described together with the potential benefits.

Table 7.1: The six Connected Car scenarios 2025.

Connected Car scenarios 2025	
1.	Eco-Centric Motoring
2.	Active Safety Protocols
3.	Smart Transportation
4.	Mobility Integrated Services
5.	Cooperative Traffic Intelligence
6.	Agile Navigation Systems

The scenarios show that a mutual interaction is expected between the developments towards the Future Internet and the developments in ICT technologies and services for mobility. The intertwining of these developments will lead to new services enabled by the connected car in 2025. In the roadmap towards 2025 several hurdles have to be taken in order to realise the ultimate Connected Car vision.

Enabling technology and concepts, including a concept of a European Wide Service Platform, have to be developed in order to realise the vision of the scenarios. The EWSP will consist of a set of distributed enablers for new services integrated in the Future Internet infrastructure. It is reasonable to expect the EWSP to become a cloud component; indeed, it is possible that the EWSP would become the primary means by which the vehicle becomes a cloud component.

The EWSP can be defined as framework that brings the technical open specifications, standards, procedures for publication, registration, service discovery, together. This framework provides tools as privacy guidelines and certification tools, including the organization responsible for the evolution of all agreements, standards and tools.

7.3 Research challenges

To realize the vision of the connected car a number of research challenges have to be addressed. These research challenges can be used to set up the 'ICT in transport' research programme in FP8 and last Calls of FP7.

This study shows that specific RTD is required to be able to adopt Future Internet technologies in the transport sector and to be able to leverage technologies, systems and services that will be deployed in other market segments for mobility challenges. The two categories of RTD are:

- RTD that addresses the gaps in the transport sector that must be bridged to be able to use Future Internet technologies for building and operating connected car services;

- RTD that is part of the overall Internet RTD but that specifically takes into account the characteristics of connected car services.

The following is a summary of the high level topics for the research challenges derived from the stakeholder consultation, future developments, scenarios and roadmaps.

I. Establishment of communication infrastructure for connected car services

The establishment of V2I infrastructure becomes increasingly an issue that is critical and specific to the introduction of connected car services and creates new technical challenges that require further RTD. The deployment of connected car services requires significant investment in wireless communication infrastructure that is suitable for use on the road. The communication requirements imposed by future connected car services will probably require the combination of two or more wireless data communication technologies to be used for I2V communication as no 'one size fits all' solution exists for cooperative applications.

II. Enabling connected car services using Future Internet technologies

Future connected car services will be supported by the Future Internet service enabling infrastructure. The European Wide Service Platform enabling connected car services is expected to be an integral part of the Future Internet infrastructure. The development of the Future Internet service enabling infrastructure presents research challenges that without doubt will be addressed by generic RTD on Internet technologies and services. The transport sector and connected car services however, constitute a specific domain that can help advance the innovation and use of Future Internet. However, it also might require specific solutions. As a consequence there is a need for RTD on Internet technologies which is specifically applied to connected car services.

III. Integration in the in-vehicle environment

Standards for integration of smart personal devices in the in-vehicle environment are critical. The resolution of standards for achieving this, in a manner that the OEM business interests are being considered seems therefore crucial for the speed to market of the connected-car services. HMI integration is also essential for avoiding driver distraction. The development of sophisticated and integrated interfaces, potentially become more viable as more cooperative systems become available.

IV. Interoperability and openness

With a range of different OEMs and other suppliers providing competing products, a wide range of technologies could appear in some niche markets for connected car services. Without interoperability and open specifications or standards it is much harder for these to reach the required adoption rate. Interoperability and openness of (hardware) systems, services, and service management and provisioning will be addressed in generic RTD on Future Internet, but additional standardisation of interfaces for services and systems specific to the transport sector is required.

V. Business models

The market for connected car services is characterised by a large network effect and its take-off requires a minimum critical mass. This makes it challenging to build compelling business cases for deploying such systems. Future Internet connected car services are characterised by a value chain that involves several entities which must have clear responsibilities and liabilities. Cooperation of multiple entities, a prerequisite for aggregated connected car services, should be based on mutual profit.

VI. Security, privacy protection, and user acceptance

Security is an issue for most safety services since most services need some open interfaces. The potential when leveraging internet technologies through which the user (car driver or traveller) also becomes a provider of relevant road-, traffic – and travel data is enormous. Users may prove wary about sharing their personal data, especially if they are seen as a first step towards new taxes, enforcement or commercial exploitation. It will be critical that the people understand the privacy issues that affect them and will have control over their personal data. The model of Internet driven connected car services is based on voluntary participation of the users, industry and service providers and public authorities and road operators.

VII. Liability and trust

Trust and confidence will be critical for adoption in the mobility domain. Future Internet connected car services will often be aggregated by combining and integrating a variety of self-describing, and self-contained ‘cloud’ services. This makes the quality and reliability of the information a key issue for connected car services. Since future Internet connected car services will become aggregated services with a value chain that involves several entities that are not necessarily (most likely) not business partners, each entity must have clear responsibilities and liabilities. It will be critical to provide liability models that make clear what the risks of integrating and using a specific cloud service are.

7.4 Policy recommendations

It is recommended that the results of this study are used as input in defining the strategic research needs for the programming of FP8 "Future ICT for Transport" and also FP7 Calls 8 and 9 with respect to the technical elements and objectives of the EWSP and in line with projects under the PPP FI for the mobility usage area.

It is recommended that the research programme is aligned with the research areas for Future Internet developed by FISA [FISARoadmap] and keep a global architecture view showing the whole picture which relates the relevant elements in this picture to for example the FIA roadmap.

It is recommended that large scale field operational tests and and Future Internet and Living lab environments are aligned. The FIRE - Future Internet Research and Experimentation - Initiative from the European Commission is addressing the need of early experimentation and testing in large scale environments for the construction of the Future Internet. Combining FIRE and FOT activities will contribute to the objectives of both activities and facilitates the use of Future Internet technology in the connected car.

For RTD on future ICT for transport it is recommended that expertise from the transport sector together with expertise from the generic Internet RTD world be combined. This implies broader participation in Future Internet development beyond the transport and even beyond the ICT sectors.

It is recommended that an open RTD community focusing on leveraging open Future Internet technologies for connected car services with special attention for the end-users who become prosumers in the vision on connected car services is established. There is a need for multi-disciplinary oriented research at the technical and the social, economic and organizational levels addressing the research issues as mentioned in the previous section.

It is recommended that the connected car vision and future internet technology is applied for EV, by including research activities for the development of the connected car is combined with the European Green Car Initiative. Connected car technology and services and high quality real time information will be imperative for the rapid and large scale deployment of EV.

It is recommended that pre-commercial deployment (improving the market conditions) is addressed, developing and demonstrating working trust and privacy models etc. in Large-Scale Test Beds thus building the bridge between research and full-scale deployment. For this type of RTD the decisions for investment are being made and the dynamics play on a national or regional level (already the FOTs tend to become national or regional projects and the closer to a real market deployment, the stronger this tendency will become). The RTD therefore could focus on scientific RTD, guidelines, statements of principles, models and certification tools which are being developed through cross-EU work. However, biggest chunk should go to pre-commercial activity which is more national or even regionally oriented.

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A Concepts and technology developments enabling future mobility services

A.1 Introduction

Mobility services are enabled by specific concepts and enabling technologies. An overview of these concepts and enabling technologies are given in the table below.

Table A.1: Overview of enabling categories used to describe the future mobility developments.

Concepts			Enabling Technologies		
Architectures	Information management	Organisation	(V2X) communication	Service platforms	HMI

A.2 Architecture

An *ITS communication architecture for cooperative systems* [COMeSAFETY] has been defined by the EC-funded project COMeSAFETY in a joint effort with the EC-funded projects COOPERS, CVIS, SAFESPOT, GeoNet and PRE-DRIVE C2X and in cooperation with the Car2Car Communication Consortium, ETSI, IETF and ISO and with input from IEEE and SAE.

The ITS station reference architecture explains the functionality contained in ITS stations which are part of ITS sub-systems, see Figure A.1.

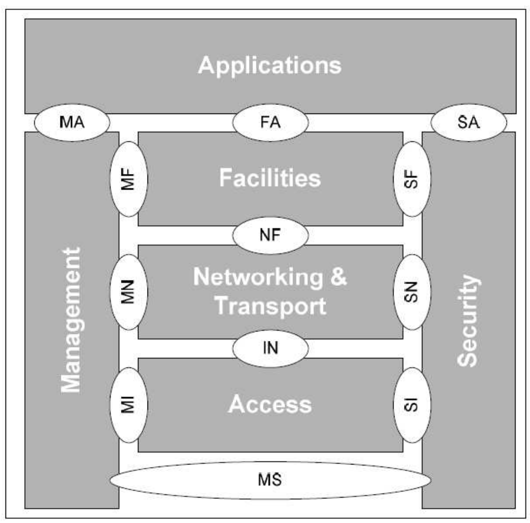


Figure A.1: ITS station architecture (From [comESafety]).

An ITS station consists of one of more of the architectural building blocks. Enabling technologies are realised in the facilities layer, e.g. the Local Dynamic Map. Various generic and ITS specific networking protocols are defined in the network and transport layers, taking care of the interconnection of ITS stations and/or other networked devices. These include protocols like georouting and CALM Fast. Different access networking technologies exist in the Access functional building block, e.g. ITS specific technologies like 802.11p, DSRS, or CALM-IR and generic technologies like GPRS, UMTS, 802.11a/b/g/n ("WiFi"), or 802.3 (Ethernet). The management component is responsible for the management of the various components, and for the interworking with management components of other ITS stations, while the security component includes all security related functionality.

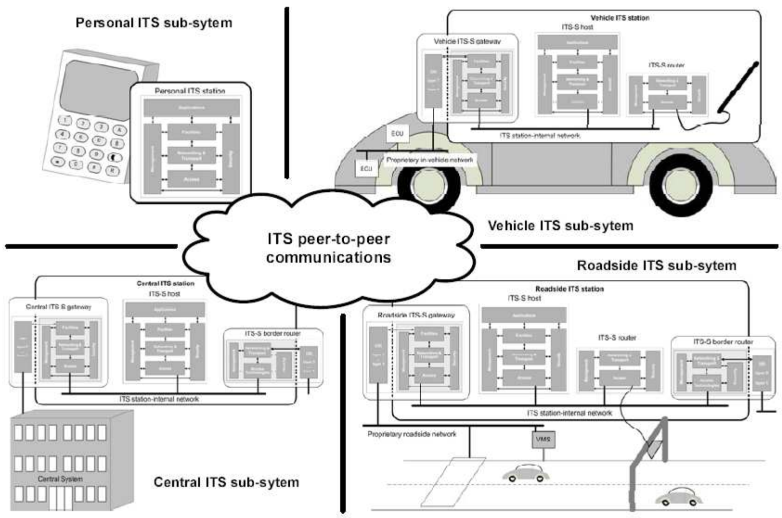


Figure A.2: Interaction of various ITS stations (From [ETSI ITS]).

Figure A.2 shows how various ITS station implementations in personal devices, in vehicles, in back offices, and in road side systems can interact with each other. Note that multiple ITS stations exist at these locations, some of them implementing only a small part of the overall ITS station architecture.

The i-Travel project has developed an architecture focussed on travel information in combination with a personal travel assistant. In this architecture, the emphasis is on the information management and information exchange, taking into account the roles that have to be filled in and could be filled in by different stakeholders. An overview is given [iTravel].

An architecture for telematics services, later also used in projects like CVIS, has been developed by the GST project, see [GST] for more details.

A.3 Information management

For safety and other cooperative applications, the concept of a (Local) Dynamic map has been defined in the SAFESPOT project which was further elaborated on in the CVIS project. A Local Dynamic Map (LDM) can be defined as [SafespotLDM]:

> *A Local Dynamic Map is a database concept that reflects all relevant static, temporary and dynamic information in the perception vicinity of a stationary object (road side unit) or moving object (vehicles and other road users).*

The LDM is specified as a four layer structure with increasing dynamics: (1) the static (semi-permanent) digital map database; (2) similar static information that is not (yet) incorporated in the digital map database; (3) temporary and dynamic information (like weather and traffic conditions); and (4) dynamic and highly dynamic information concerning moving objects (vehicles, vulnerable road users and animals).

A.4 Organisation

Research has been carried out in a variety of European projects on the relation between market needs and enabling technologies in the traffic and travel information services sector (iTravel, INSPRIRE, InTime, CVIS, Safespot, COOPERS).

The collection and generation of road traffic and travel data

Traditionally this has been an element in a vertically integrated value chain of traffic information provision by public authorities, road operators or public transport operators. The collection of the data in this model serves the direct objective of informing the traveller on characteristics of that specific traffic/road network/modality. The collection is carried out by the same actor who manages the road network or public transport.

Today, public authorities frequently outsource the collection of traffic data, or simply buy the traffic data from private actors. Although private actors collect data with the primary objective to enrich the information and navigation services that they sell to the traveller, gradually a market model evolves where the collection of traffic and road data becomes a core business. Private Service Providers for this data collection, use innovative technologies not only along the roadside (such as Bluetooth) but also as part of the vehicle platforms as floating car data and part of the wireless communication network capabilities (cellular phone positioning). The floating car data concept particularly has the potential to evolve into cloud computing enabling technologies where the traveller and his connected car becomes a sensor for traffic and road conditions (software as a service) and a forwarding or routing hub (infrastructure as a service). Since these concepts have potential for enabling data collection with far higher quality, coverage and lower costs this evolution is likely to happen. The time this will take will depend on how a number of issues can be addressed.

For the traveller (in his connected car) to become a fundamental element in the value chain, a pricing or charging technology is required. This charging mechanism should be based on a counter that is independent from the underlying technologies such as the bearer (as is nowadays often the case) and it should allow for a variety of different business models (such as open community, auction, market place, service aggregator model, etc.).

If the traveller becomes a sensor providing data to a network of information aggregators and service providers, there is a need for secure and privacy-protecting technologies; at the same time, there is a need for quality standards and there might be a need for authentication and non-repudiation techniques. These conflicting requirements should be resolved either by technology or by the procedures and organisation behind.

In general part of the value of data collected following this concept, is in the knowledge of the absolute or relative position of the object referenced by the data. For this, geo-referencing / spatial dataset discovery techniques will be needed. Furthermore the value will be determined by the market and a large understanding (semantics/ontology) and service (SaaS/IaaS). Publishing/offering/discovery mechanisms will be key conditions for this evolution. Especially for decentralised service provisioning and consumption (imagine a local and self-organising communication network and information market place by connected vehicles) these mechanisms are not yet available.

For aggregation of and providing access to or broking data

Obstacles are seen [iTravel] in quality and standards of provided data as well as the management of ownership of data. Current national developments (InTime and the National traffic Data Warehouse in the Netherlands) show a strongly centralised approach where a gateway hides the heterogeneity of the meaning/formatting and quality of the different data and takes care of the charging aspects. However, a clear development is identified (RTD) towards an e-Marketplace. This e-Marketplace is a virtual online market where organisations register as buyers or sellers to conduct business-to-business e-commerce over the Internet. Different business models and companies will join and comprise many different types of e-Marketplaces and can be operated in many different ways from being controlled by a single entity as the controlling force or by a consortium of members acting for a industry sector.

E-Marketplaces, especially in their advanced forms enabling transactions, are often set up and run by neutral third parties, the e-Market operators. The role of the latter may vary. Accordingly, an e-Market platform can facilitate the contact between counter-parties but it can also undertake a more active role in the operation and conclusion of the transactions made in the platform. If the e-Market operator is responsible for establishing the exchanges process ("rules of the game") its intermediation may enhance the participants' trust in the operations conducted on the trading platform. Terms and conditions drawn up by a neutral "middle-man" appear less likely to discriminate or disadvantage certain e-Market participants or a certain category of e-Market participants (sellers / buyers). In this regard, the involvement of the e-Market operator can enhance the equality and transparency on the trading platform.

Legal and liability issues

Especially for safety applications, the shift from using information collected by a vehicle’s own sensors to information provided via communication channels implies a significant change in safety, security, and liability. First of all, wireless communication channels are inherently unreliable, so any safety related application must take into account that up to date information is not always available. Furthermore, the currently used closed systems approach to guarantee safe operations of vehicles has to be opened up to some extent to be able to use information in the connected car from outside. Apart from the technical issues, the legal and liability implications this will have has to be determined. In short: who is to blame in a connected world if something goes wrong.

When companies operating in e-Marketplaces conclude electronic transactions, they depend on the validity of a contract, including the recognition of contracts provided by electronic means, electronic signatures, taxation, provision of a service by electronic means, electronic payment and finally marketing and advertising activities.

The lack of full harmonization also applies to privacy as the protection of personal data, has to be implemented differently in different Member States, which places barriers for organizations to operate European wide data systems even as a virtual organization. The first report in the implementation of the directive confirmed that there are differing implementations across member states which resulted in the incorrect implementation of the directive, and although the European Commission has continued its efforts to harmonize the implementation of the directive there will continue to be divergences on the implementation.

A.5 V2X Communication channels

Communication channels concern the transport and access layers of the ITS station architecture. For the connected car, a mix of general standards and ITS specific standards are in use or in development. The generic standards include IP communication, with a strong focus on IPv6 in various research projects. On the access layer, general cellular networks are in use, evolving with the developments in cellular networks. These migrate from GPRS, to UMTS, to LTE standards, increasing bandwidth and reducing delay times.

Dedicated communication standards are in development for cooperative systems. At the access layer, a convergence towards the IEEE 802.11p standard can be observed. Several (prototype) implementations exist and are used in demonstrations and pilots. Standardisation on the network and transport layer is still in progress. IP communication can be used on top of 802.11p, but the highly dynamic character of the network due to the movement of the vehicles and relatively short communication distances, dedicated standards have been developed and are being standardised by ISO and ETSI. ISO has developed the ISO IS 29281 Non-IP networking standard, also known as CALM Fast. This standard has been used in e.g. the CVIS and SPITS project.

Another approach for the Network and Transport layer is geonetworking, standardized in ETSI TS 102 636 GeoNetworking. This is based on work of the Car2Car Communication consortium, and has been used in e.g. the pre-Drive project. It is currently not yet clear how the final communication stack will be standardized and what will be used in deployments.

A.6 Service platforms

Service platforms are used for the deployment of services and to enable interaction of services with each other or with standardized components in the service platform itself. The GST project has set the standard for service platforms for cooperative systems, which is used as a basis for in other projects like CVIS and SPITS[14]. These service platforms are based on OSGi, a java based platform for service lifecycle management and deployment. Several open source and commercial implementation exist. Many enabling services have been standardized as well, and also for these multiple implementations are available. The service platforms defined in ITS projects are all based on OSGi and define sets of standardized services as mandatory, augmented with dedicated ITS service definitions.

[14] The SPITS project uses an OSGi platform as the basis for the road side unit, where as an Android platform is used for the on board units

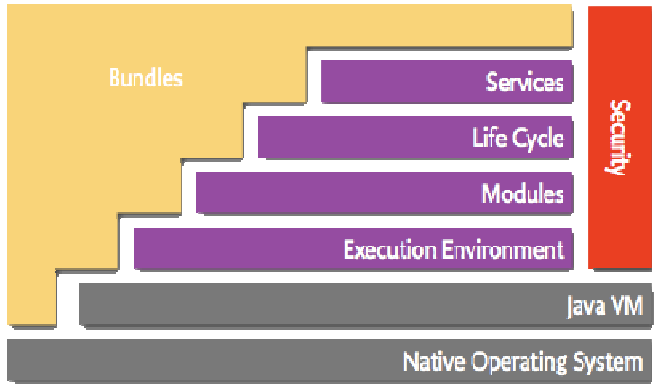


Figure A.3: Overview of an OSGi platform (from [OSGi]).

OSGi is specified in terms of Java virtual machines, classes and interfaces, which ensures that OSGi platforms are always executed in a java environment. This is considered an issue for low performance devices, which might be required to address mass markets, and for services that have stringent real-time requirements, like safety services.

Several other service platforms exist that have gained popularity rapidly. Especially the service platforms for mobile devices and tablets are relevant in this context. Apple developed the service platform iOS for the iPod, iPhone and iPad, combined with the App Store market place for applications. Another popular service platform is Android, which is open source, combined with Android Market, developed and promoted by Google. The SPITS project uses the Android as a basis for the On Board Unit.

A.7 Human Machine Interaction

With the further uptake of the connected car, more and more in-car driver applications and services become available that help the driver with his driving task. The effectiveness and efficiency of using these functionalities strongly depends on how drivers deal with these systems, especially when used while driving.

The aim of in-car applications is that they support the driver with his driving task. They do this by presenting information to the driver. Depending on the current workload of the driver in his dynamic driving task, this information might come at a bad timing (i.e. he is busy with a complex manoeuvre) or too much information may come at the same time. Information overload may arise and bottlenecks may arise in the driver's ability to control the different systems requiring action at the right moment leading to a decrease in safety. An information manager can be helpful in the right timing and prioritization of the information coming from in-car applications and services. To reduce the workload if necessary by prioritizing the main important tasks and reducing the information flow to the driver (driver demands), it is necessary to assess real-time the amount of workload the driver experiences throughout his driving task.

Currently, the difficulty of adding new applications and services to an existing in-vehicle system often means that stand-alone solutions are introduced, each with its own Human Machine Interface (HMI). Therefore as the number of new intelligent services increases, so do the number of human-machine interfaces. This may lead to potentially dangerous situations given that each application competes for the driver's attention and that the driver may be distracted by the HMI's blinking, beeping or speech. In current practice, services provide information to the driver automatically. In other words, the driver cannot decide whether information comes in at the appropriate moment. That is, at a moment that will not cause distraction and when the primary driving task has a sufficiently low workload. Secondly, not all information is equally essential at the same time.

To guarantee that driver's workload is kept low enough to allow safe driving, there is the need to design and develop an on-vehicle multimedia HMI, able to harmonize the huge volume of messages coming from the new and traditional functions for the driving support. At the same time the HMI should be able to control and manage all the different input and output devices of the vehicle in order to provide an optimized interaction between the driver and the vehicle.

A central management system like this should manage the information data flow coming from the different in-car tasks, according to the current traffic and environment assessment and to the driver's state in terms of distraction, fatigue and alertness.

B Stakeholder consultation details

B.1 Process and approach

A self-completion questionnaire was designed to elicit stakeholder views, requirements and priorities. It included a mixture of pre-coded questions and open-ended questions which provide opportunity for wide-ranging comments. The questionnaire was written in English. The topics to be covered were defined using outputs from Work Packages 2 and 3. Once the survey had been designed, it was converted into a web format so that it could be completed on line. A copy of the questionnaire, adapted from the online version, is available at the end of this Appendix.

In order to prepare the stakeholders to take part in the consultation, they were provided with background information about the project and the issues that are being addressed. A briefing note was written to introduce the survey, explaining the purpose of the project and the reasons why it is important to gain the views of a wide range of stakeholders with different perspectives and requirements. This was used in the email inviting responses and on the first page of the survey itself.

The analysis reported here is based on the replies received within the first 34 days after the email invitation which launched the survey. A reminder was sent after the end of the first week to increase the response.

Tracking and recording stakeholder consultation

A spreadsheet tool was used to record the stakeholder contact details and track progress with making contact and gathering information. It included details of organisation, the type of organisation (e.g. Member State, User group, Vehicle industry, Service supplier, ITS organisation, Road Authority/ Operator, Project/ initiative), the country and area of coverage (where known - European, national, regional, local). The email address list from the spreadsheet was imported into the web survey tool which tracked and recorded the responses.

The distribution of stakeholders invited to participate in the survey between different types of organisation is shown in Figure B.4. Many are from universities and research institutes, and will have a range of interests spanning those of the other types of organisation.

Figure B.5 shows the spread of countries in which stakeholders are based includes Southern, Eastern and Northern Europe, with the largest share in Western Europe. A significant proportion is from organisations which have a Europe-wide remit.

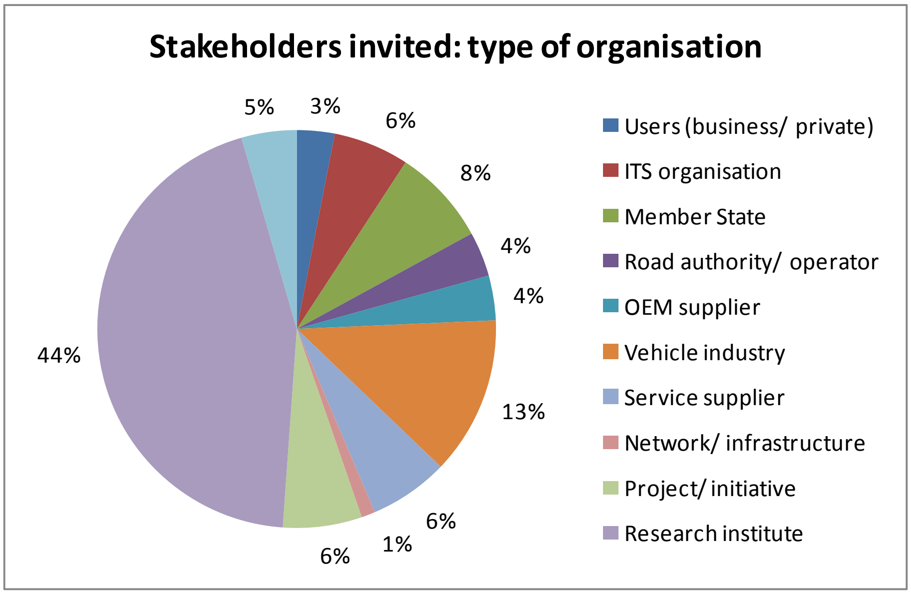


Figure B.4: Stakeholders invited to respond to the survey: type of organisation.

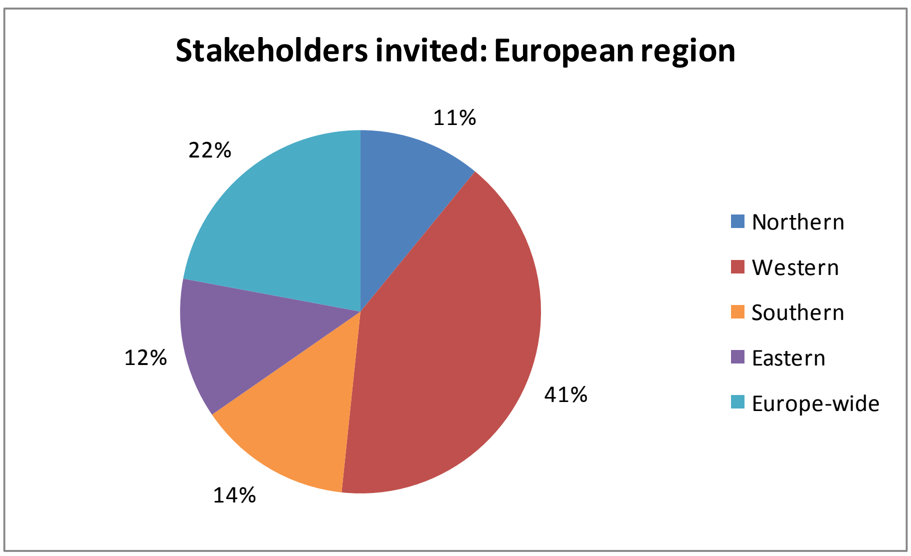


Figure B.5: Stakeholders invited to respond to the survey: Region of Europe covered.

B.2 Results

B.2.1 Coverage of stakeholder groups

A total of 58 useable replies were received. Figure B.6 shows the number of responses received from different types of organisation, using the categories describing organisations which were selected by the respondents. Some of those who described their organisation as R&D work in the vehicle industry or for service suppliers, rather than independent research institutes or universities.

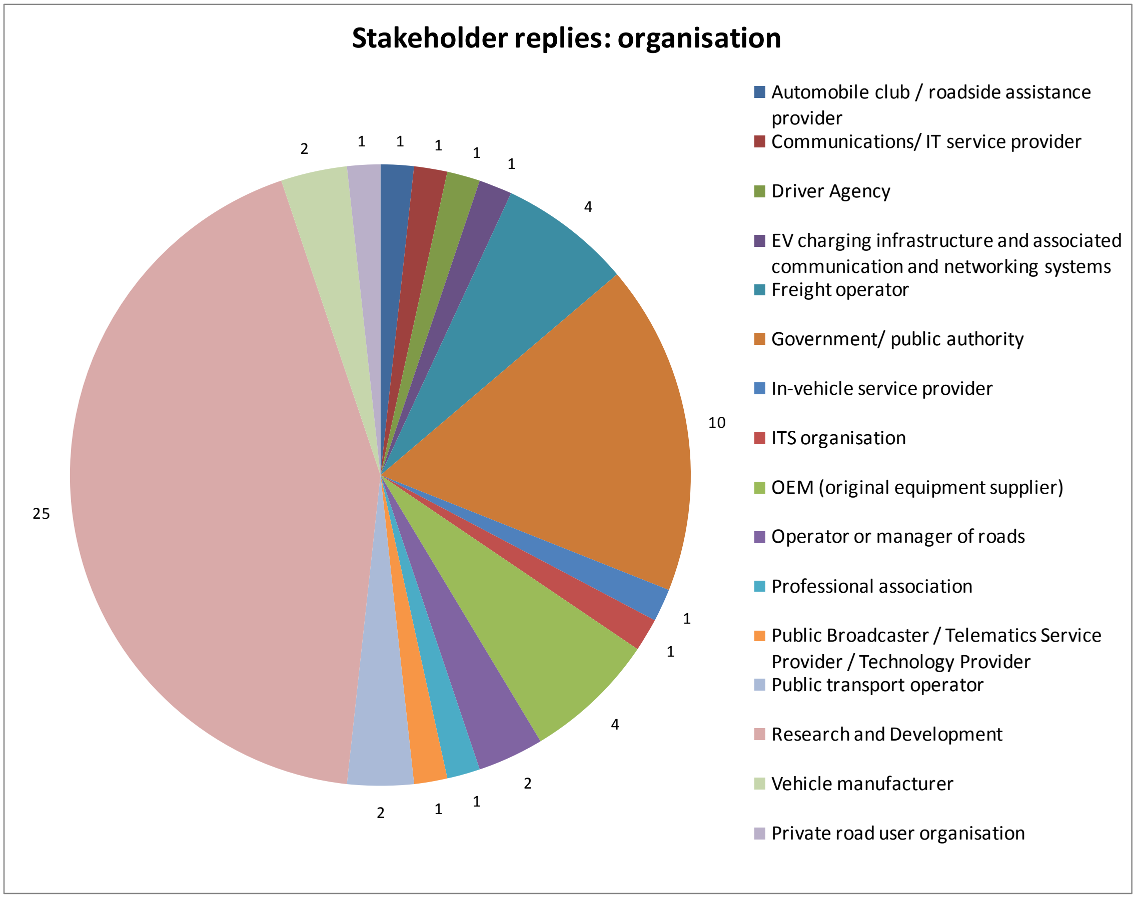


Figure B.6: Stakeholders who replied to the survey: type of organisation.

shows that replies were received from organisations with local, regional and national remits. World-wide and pan-European organisations were well represented.

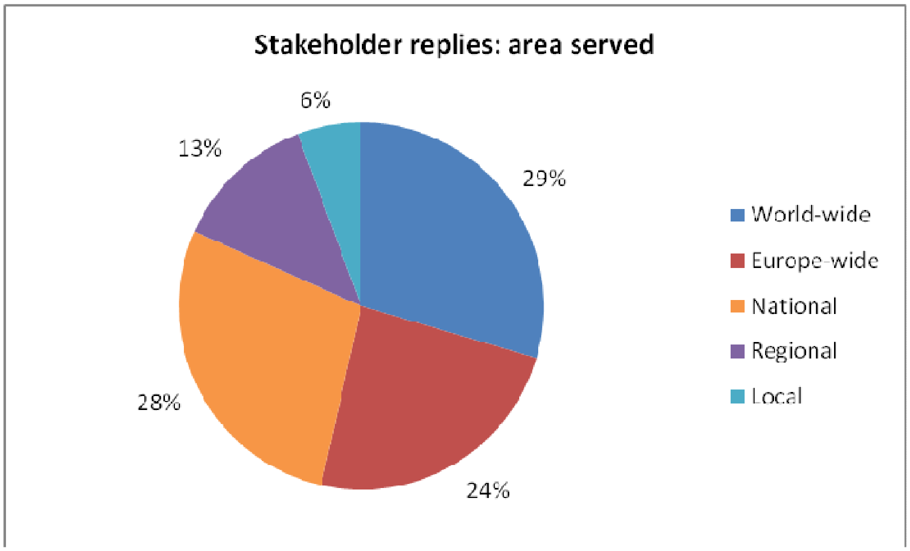


Figure B.7: Stakeholders who replied to the survey: area covered.

Figure B.8 shows that the countries represented included a range from northern, western, eastern and southern Europe, but Western Europe dominated the replies (largely Belgium, France, Germany and the UK). The proportion of replies from Southern and Eastern Europe was slightly lower than the proportion of people contacted who were based in these areas; it is possible that the response rate there was affected by the fact that the questionnaire was in English.

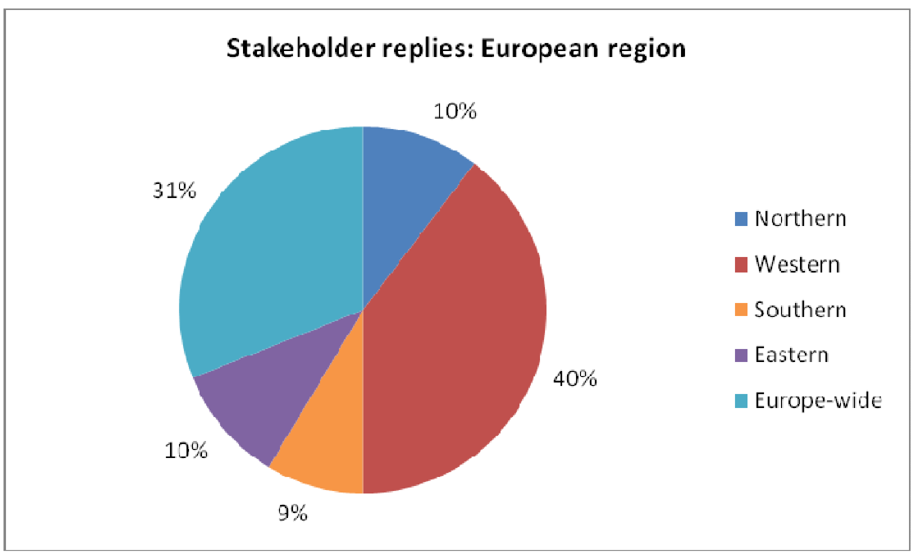


Figure B.8: Stakeholders who replied to the survey: area covered: Region of Europe covered.

About half of the replies came from organisations with over 1000 employees, but small and medium-sized organisations were also represented (see Figure B.9).

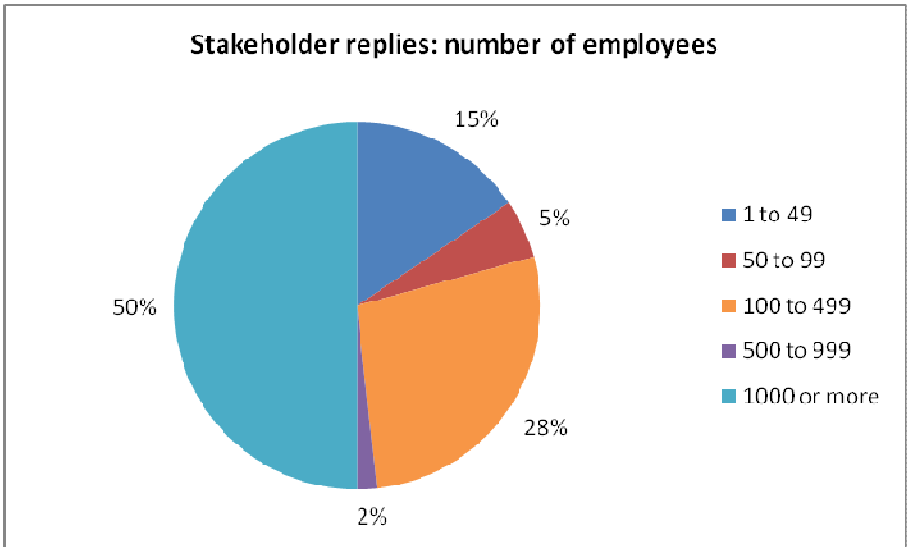


Figure B.9: Stakeholders who replied to the survey: number of employees in organisation.

B.2.2 Relative importance of potential new services

A list of 22 potential new services for 2025 based on having internet access in vehicles was derived from the services identified in WP2 (see Chapter 3). Stakeholders were asked to say how important these were to their organisation. Figure B.10 shows the 22 services, grouped according to the type of service, and the proportion of people who thought the services were 'very important' or 'important' to their organisation.

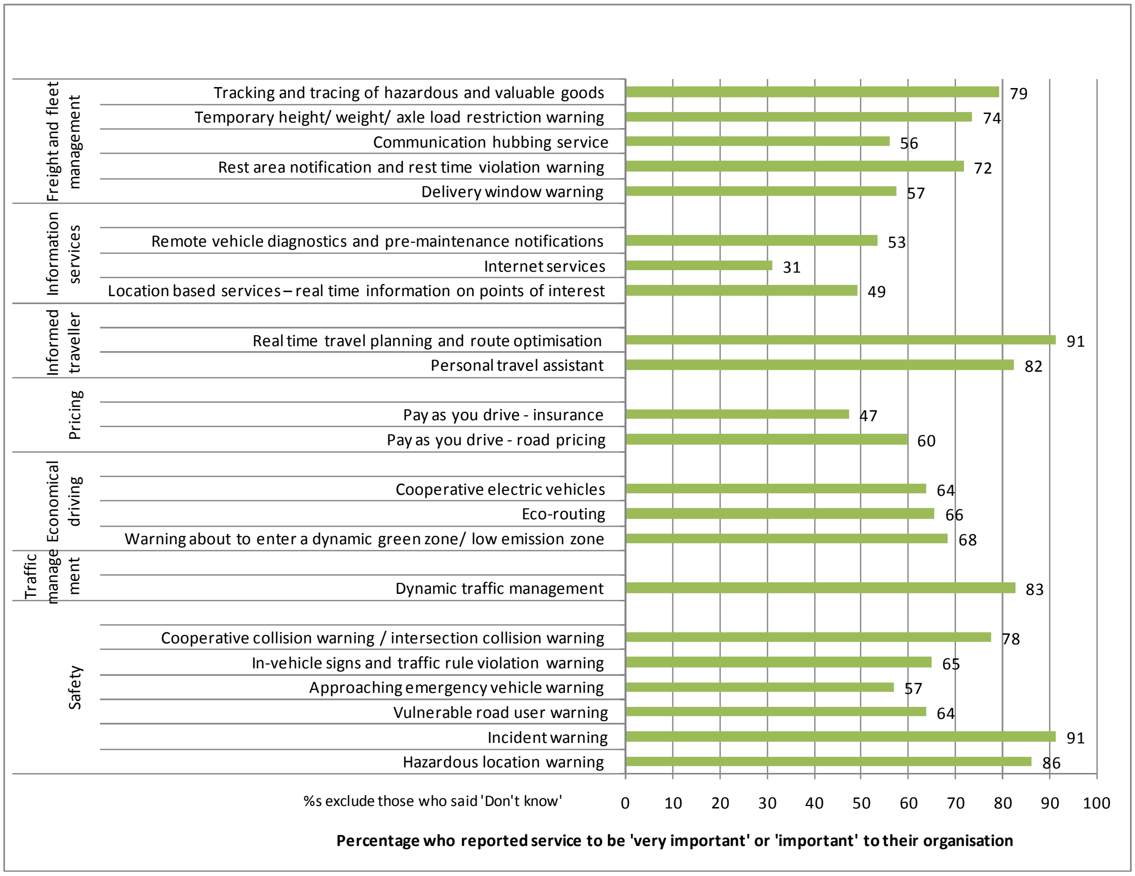


Figure B.10: Percentage of stakeholders who thought each service was ‘very important’ or ‘important’ to their organisation, by type of service.

The responses to these questions were used to provide an overall ranking of the relative importance of these 22 services to European stakeholders. The figure below shows the services ranked in order of the proportion who thought the service was ‘very important’ or ‘important’ to their organisation. It also shows how the proportion of ‘very important’ and ‘important’ responses varied, and that ranking according to the proportion who thought the service is ‘very important’ would result in a different set of services being at the top of the list of priorities.

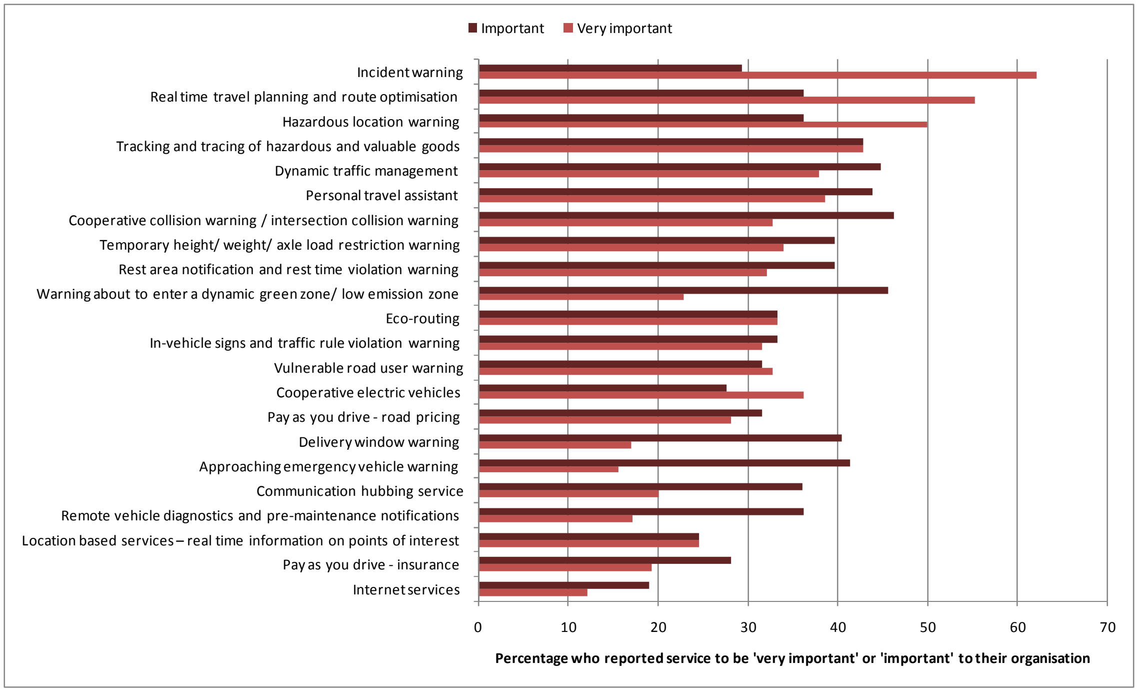


Figure B.11: Percentage of stakeholders who thought each service was ‘very important’ or ‘important’ to their organisation (ranked by total important + very important).

Figure B.12 shows the services ranked by an overall average score on level of importance.

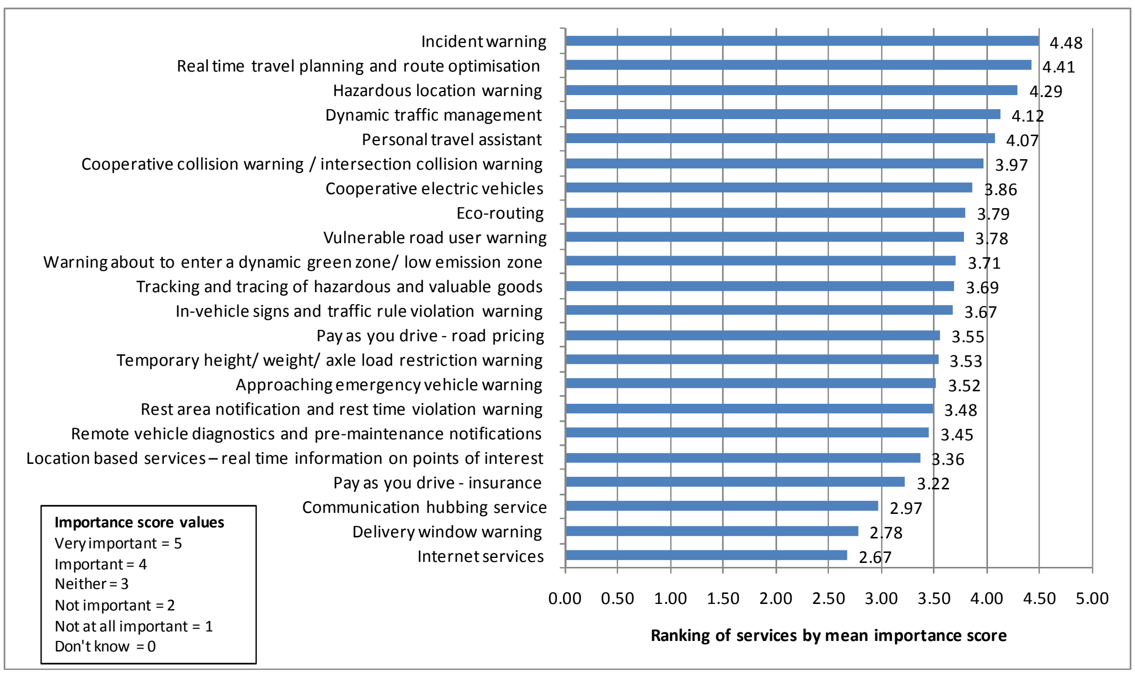


Figure B.12: Overall ranking of services by importance score.

Comparing these methods of identifying the most important service shows that although there were small differences in rank, the following services ranked in the top ten in both cases:

- Real time travel planning and route optimisation;
- Incident warning;
- Hazardous location warning;
- Dynamic traffic management;
- Personal travel assistant;
- Tracking and tracing of hazardous and valuable goods;
- Cooperative collision warning/ intersection control warning.

One service was ranked as being least important according to both methods of ranking:

- Internet services (internet browsing, email chat readout, social media).

The following additional potential new services were identified (that were not explicitly included in the list of 22 services):

> *"New mobility solutions: dynamic car sharing, car pooling…"* (OEM)
>
> *"Vehicles are an extension of the home and will be shared. Internet services will help users to feel like in their own vehicles if their preferred radios, music, navigation setting could automatically be downloaded and if they could interact easily for other family members"* (R&D, Western Europe)
>
> *"Streaming media"* (R&D)
>
> *"Vehicles can be equipped with sensors and all these sensors be networked. Internet services could also help a lot to inform people about a coming tsunami, locate people in damaged vehicles, and also set up ad hoc multi-hop networks when all the infrastructure is broken"* (R & D, Western Europe)
>
> *"Interfaces with product tracking systems"* (Freight operator, Western Europe)
>
> *"Van fleet utilisation visibility"* (Freight operator, Western Europe)
>
> *"Behavioural Smart Charging"* (R & D)
>
> *"Powertrain optimization"* (R&D)
>
> *"Panic alarm and connection to the authorities especially with high value cargo on board"* (Freight operator, Western Europe)

B.2.3 Key requirements for success of potential new services and problems, challenges and areas for further research

Stakeholders were asked to identify key requirements for success in the potential new services which they had described as 'very important' or 'important'. They were also asked to identify problems, challenges and areas for further research. The comments made were wide ranging, covering technical elements, service characteristics, user aspects, organisational and institutional issues.

Many of the points made by stakeholders are relevant to specific services. However there were also common themes in requirements which apply to many of the services:

- Services free of charge to users and accessible to as many users as possible;
- A high rate of penetration of equipped vehicles;
- Interoperable systems;
- Reliable and fast communications to specified standards;
- Accurate position information;

- Relevant, reliable, validated, real time data, covering all of the road network; some stakeholders said that centralised databases are a key requirement for some services;
- Security of information;
- Services should avoid distracting the driver from the primary driving task with good HMI design; standards for information presentation in cars are needed.

The types of requirements mentioned tended to vary between groups of stakeholders. The main themes in the comments by the main groups are listed below.

OEMs and vehicle manufacturers:

- Security of communications and privacy;
- System integrity;
- Communications specifications;
- Internet specifications;
- Data exchange protocols;
- Availability of real time information.

In-vehicle service providers, communications, and IT services:

- High market penetration and accessibility for all;
- Reliability and accuracy of systems and data;
- Combining data from different providers;
- Machine readability;
- Language independence;
- Compatibility with existing services;
- No cost to individual users.

Road operators:

- Interoperability;
- Operational models acceptable to relevant stakeholders;
- Quality of service;
- Certification of service providers;
- Common HMI;
- Resolution of legal and liability issues.

Governments and public authorities:

- High market penetration and accessibility for all;
- Reliability and accuracy;
- Complete coverage;
- Specific characteristics and features of individual services.

Road user groups (freight, public transport, and automobile clubs):

- Quality of service;
- Basic services free of charge to users;
- Specific features of services.

R&D organisations:

These comments were the most wide ranging and covered all of the elements mentioned above, with the addition of:

- HMI and usability aspects, driver distraction;
- Clear benefits for individual and society;
- Business models.

Several of these points were also identified as problems, challenges and areas for research. Other common themes in the points raised under this heading were:

- Liability and legal issues;
- Commercial problems;
- Business models.

The problems, challenges and areas of research identified also tended to vary between different stakeholder groups. The main themes in the comments are listed below.

OEMs and vehicle manufacturers:

- Business models;
- Organisational and institutional arrangements;
- User acceptance (especially in the context of data protection);
- Availability of and access to real time data;
- Safety and HMI issues;
- Technology and communications issues.

In-vehicle service providers, communications, and IT services:

- Integration;
- Standardisation;
- Data exchange;
- User education and trust;
- Market penetration and take up;
- HMI and driver distraction;
- The role of mandatory systems;
- Technical aspects of service operations.

Road operators:

- Interoperability;
- Market penetration;
- Operating model;
- Cooperation between service providers and road operators to encourage desirable outcomes;
- Certification.

Governments and public authorities:

- Market penetration;
- Business models;
- Information on impacts;
- Reliability and data quality;
- Design of systems and HMI;
- European centralisation and harmonisation of services;
- Specific features of services.

Road user groups (freight, public transport, and automobile clubs):

- Driver information and training;
- Driver behaviour issues (e.g. tampering, response to alerts);
- Integration of systems in vehicles;
- Internet security.

R&D organisations:

- Information flows;
- Attitudinal change;
- Willingness of governments to invest;
- Information for users e.g. on costs and consequences;
- Legal issues;

- Privacy;
- Standards for HMI and driver distraction;
- Gathering and fusing large quantities of information.

The replies are listed in Table B.2 to Table B.23 below for each of the 22 potential services; these are in general direct quotes, but some have been re-worded slightly for the sake of clarity. In some cases, respondents found it difficult to distinguish between key requirements and problems, challenges and areas for research and some provided the same answer to both questions. In considering the future research programme, it is recommended that responses listed under key requirements and problems, challenges and areas for research should be considered.

Table B.2: Hazardous location warning (weather and road surface conditions): key requirements, problems, challenges, areas for research.

Key requirements for success	
General requirements	*Necessary to have a rather [high] level of equipment for significant results.* *The cost of this service has to be affordable for the road operators (or traffic managers) (communication cost)* *Being potentially linked with crisis situations, there is a need a very level of availability (issue of concurrent access to telco)* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.*
Organisational/ institutional	*All vehicles equipped* *Accessible to as much as possible road users* *If only a part of all vehicles has Internet-based info-system, the highway operators have to install enough (more than now) displays for drivers without such equipments.* *Display of information on HMI in common way across brands* *The application, IT communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *Provision by certified service providers only* *Compatibility to existing broadcast telematics services, e.g. TPEG.*
Service characteristics	*Icy patches, other vehicles stuck and blocking the road. Road surface conditions should seldom be a hazard in Europe* *This service should be free-of-charge* *Weather warnings which can indicate whether road ahead is passable with care in winter weather.* *The information/warnings have to be presented to the driver in such a way that driving safety is not affected.* *Quality of service* *Information provided must be reliable and accurate* *high quality* *reliability of information* *It may be of interest in case the road signalling it is not in place.* *Availability and accuracy of information: nowadays, one of the main*

	problems in achieving drivers follow traffic recommendations or warning is the accuracy of the and the availability, which make drivers don´t trust most of the time the information published. *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *Black Ice; Pot hole; Debris on Road; Hazardous material on road; Short visibility* *Full and relevant Real time data* *real time information*
Technical	*V2I, V2V* *link with navigation, link with ADAS system* *comparable transmission performance like UMTS* *cost neutral data transmission (should be covered by standard phone contracts)* *feedback from vehicle ECUs (ABS, ESP --> road surface condition) as input for the warning to other vehicles* *Will need Internet-based communications and thus IPv6 would be required.* *Communication between vehicles or with a road side unit is important at the local level...* *Communication standard: 802.11p* *v2i and v2v communications* *Fitted in some vehicles for v2i and all vehicles for v2v* *Precise GPS positioning* *Adherence estimators (function of ABS / ESC)* *Machine readability* *language independence.* *Standardization of communication protocol for provider this warning. Reception of warning should be independent of providers and receptor manufacturers, making the reception more efficient.*
Problems, challenges and areas for further research	
General requirements	*In Hungary the fast changing weather conditions - mainly in summer or winter - could cause a dangerous, slippery road surface. The POSSIBLE - positive - effect of this information on drivers' behaviour COULD decrease the number of serious accidents. It's an interesting question: How strict the coherence between this information and the traffic safety.* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *Challenge to convince transport operators to use these services* *Good in case of roads that do not have signalling* *Necessary to have a rather level of equipment for significant results.* *The cost of this service has to be affordable for the road operators (or traffic managers) (communication cost)*

	Being potentially linked with crisis situations, there is a need a very [high] level of availability (issue of concurrent access to telco)
Organisational/ institutional	*Related liability issues (in cases of malfunction) must be centrally clarified to provide a stable legal framework for such services* *provision only by certified service providers* *common display across brands needed* *Harmonisation on message sets* *The application, IT communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *Examine how incentives could be created for operators willing to use these services* *Definition of hazardous location warning, so that the incidents signalling are the same in the European Union*
Service characteristics	*Availability of accurate and reliable real time data* *Reliability of the service needs to reach close to 100% (users get very much accustomed to comfort functions and may - -even there are disclaimer messages - not expect the function to suddenly not work in some cases)* *Clear and easy to understand indication to driver.* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *Nature of the danger* *Road side equipment*
Technical	*How to provide the information to different vehicle types early enough for meaningful action to be action to make investment in the system worthwhile.* *Improved forecasts for road sections. Currently forecasts are based on point observations and they are often not generalizable to longer sections of the road.* *Sensors* *Road sensors, C2C, C2I* *Will need Internet-based communications and thus IPv6 would be required.* *Detection* *Precise GPS positioning* *Communication standard* *Standards for data exchange and collection, decentralised infrastructure.*

	How to combine weather, road maintenance and traffic info *Gathering high-quality and detailed information* *Recommended action (speed, seperation between cars)* *Vehicle capability/admissibility, e.g. Bridge too low for Truck, Chains on wheels are required, etc.)* *Standardization of data exchange.*

Table B.3: Incident warning (breakdown, queue, accident, wrong way driver): key requirements, problems, challenges, areas for research.

Key requirements for success	
General requirements	*Must cover 100% of the road network.* *In 2025 all vehicles must have technical and electronic equipments that assure them the communication in case of accidents and damages, or access to databases that will assure the fast communication with the authorities concerning the weather, roads conditions etc* *It may be of interest as long as the road signalling is not in place.* *At the same time most of the vehicles fleet should be endowed with such facilities.* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *Incident warning should be a key service in order to prevent traffic jumps, accidents, etc, but its success depends on the number of vehicles able to access the service.*
Organisational/ institutional	*Accessible to as much as possible road users* *display of information on HMI in common way across brands* *provision by certified service providers only* *privacy respected, anonymous data handling assured* *vehicle localization and onboard information available* *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *an appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *Compatibility to existing broadcast telematics services, e.g. TPEG*
Service characteristics	*This service should be free-of-charge* *Accident, wrong way driver, breakdown, slow moving vehicle* *be able to intentionally switch on/off these services* *free for use (no time dependent charges for service availability)* *Very important in particular for coach drivers who will need to make decisions whether they can remain legal within their hours and be able to inform passengers of expected delays in reaching destinations, hotels or catching ferries.* *dense coverage, also including small streets* *heavily increased fleet of FCD probe cars*

	lost time compared to planned journey time; alternative route solution cost; cost of delay; *Usefulness in terms of no distraction from primary task* *These services must be reliable* *Real time information* *validation of real time information (alternative source of information)* *HMI oriented on safety* *Lane recommendation;* *expected delay* *recommended alternative road. (This should be allocated so not all drivers get off the freeway and take the same road). e.g. car 1-20 should take Rout A, car 21-40 should take route B, etc.* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *Reduce pollution* *High quality, short delays in sending the info* *Reliability and detail of information* *Distinction has to be carried out according to event:* *- some events are nor very relevant (breakdown on hard shoulder) instead of some others (unprotected accident)* *- some events require a very small latency (ghost drivers)*
Technical	*The information/warnings on incidents should be distributed so that not all (or not even most) drivers will reroute on alternative routes that might not be able to handle significant amounts of traffic.* *Relevant and reliable real time data* *Link with navigation for alternative route calculation* *Require combination of GeoNetworking (V2V) and Internet-based communications (Centre to Vehicle)* *Specific detection systems must be deployed to collect the information especially wrong way driver...* *Communication standard: 802.11p* *v2i and v2v communications* *fitted in some vehicles for v2i and all vehicles for v2v* *precise GPS positioning* *adherence estimators (function of ABS / ESC)* *Secure communication* *Machine readability, language independence* *System interoperability (agreed standards for system interfaces).* *Fast information, clearly and immediately visible and understandable*
Problems, challenges and areas for research	
General	*How to provide the information to different vehicle types early enough for meaningful action to be action to make investment in the system*

	worthwhile. *Good in case of roads that do not have signalling* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *Challenge to convince transport operators to use these services.* *Real time detection of this kind of incident depends nowadays on the number of sensor and in with areas. This kind of warning should be providers not only by the road sensors, but also and main by sensors installed on vehicles.*
Organisational/ institutional	*Standards for information presentation in cars necessary, but not yet available* *Examine how incentives could be created for operators willing to use these services* *Business models for both establishment, operation and maintenance* *Mandatory installation of the service in all vehicles*
Service characteristics	*Some countries already provide delay information on traffic events, some focus more on incidents. What the driver finally wants is only delay information. There is no need to know what actually happen on that location, but it is important, how the travel is impacted. This is valid for "fast" and for "eco" routing.* *Reasonable and "self explaining" prices for the users* *Visibility into expected delays because of incident; ability to plan another route quickly; trigger of mail/ text alerts back to base/ recipient Client details.* *Alerts should be send and some information about crimes in the area* *User - friendly: distraction problems* *Road side equipment* *In the vehicle .. must be a display including a map with the incident warning* *What is missing now for this point as also the other ones is to add information giving to users the concrete data on social costs of each alternative* *Nature of the danger;* *Recommended speed;* *Recommended lane;* *Expected delay;* *Recommended alternative (This should be allocated so not all drivers get off the freeway and take the same road). e.g. car 1-20 should take Rout A, car 21-40 should take route B, etc.* *Distinction has to be carried out according to event:* *- some events are not very relevant (breakdown on hard shoulder) [compared with] some others (unprotected accident)*

	- some events require a very small latency (ghost drivers)
Technical	*More comprehensive real-time information on incidents. This could be provided by social traffic applications or sensor vehicles as well as improved traffic information from the authorities.* *Availability of accurate and reliable real time data* *C2C, C2I, not only warning but combine with advice (rerouting, slow down...) and even automatic control of the car* *Detection and communication in a short time (which medium?)* *precise GPS positioning* *communication standard for v2i and v2v* *Data quality* *Solution that could cover 100% (challenges could eg be topography, seamless handover)* *Cooperative systems* *ad-hoc network* *Complete roadside and vehicle information system that provides all necessary data* *Existing, extensible standards need support (TPEG), avoid development of new redundant standards.* *There is system interoperability (agreed standards for system interfaces).* *How to predict consequences of incidents* *Gathering high-quality and detailed information*

Table B.4: Vulnerable road user warning (cyclist, pedestrian): key requirements, problems, challenges, areas for research.

Key requirements for success	
General requirements	*The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.*
Organisational/ institutional	*Should be mandatory such as seat belt* *Accessible to as much as possible road users* *Provision by certified service providers only* *display of information on HMI in common way across brands* *All the vehicles will have equipped with technical equipment that inform the drivers about the roads where the vulnerable users are more than usual* *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *Business models, widespread deployment of cooperative systems*
Service characteristics	*Route planning to avoid congestion.* *User friendly - prioritisation of warnings, especially in darkness* *Real time information* *No individual costs for users.* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *Lane recommendation;* *expected delay;* *recommended action* *Localisation of other users*
Technical	*Embedded camera, link with ADAS system so that the vehicle may automatically react if the driver doesn't* *From the perspective of an urban public transport operator, with drivers continually surrounded by vulnerable road users, this will require cheap and energy efficient devices on the vulnerable road users* *It's important for car makers (embedded radars) => to avoid collision* *Reliability and detail of information*
Problems, challenges and areas for research	
General	*If regularly using an equipped car, then there is a latent risk to rely on it*

	even in unnoticed not equipped cars
Organisational/ institutional	*Problem concerning car makers*
Service characteristics	*Providing cheap and energy efficient devices to the vulnerable road users* *User - friendly: distraction problems, extremely important* *Display with the areas where the vulnerable road users are more than usually* *Nature of the danger;* *Recommended speed;* *Recommended lane;* *Time to intercept, e.g. 2 minutes, one minute etc.* *Alert the driver with figures about accident with bikers and pedestrians*
Technical	*Detection, warning of the car driver, warning of the vulnerable user* *Best location for sensors to detect vru's* *Activated enabled device. How to reach.* *Gathering high-quality and detailed information* *Common standard for cooperative systems*

Table B.5: Emergency vehicle warning: key requirements, problems, challenges and areas for research.

Key requirements for success	
Organisational/ institutional	*Law that such a feature has to be implemented.*
Service characteristics	*User friendly - prioritisation of warning and driver profile adapted* *Lane recommendation;* *Speed recommendation;* *Expected intersection time (2 minutes behind you etc.)*
Technical	*Strong authentication of emergency vehicles is needed in order to avoid mis-use.* *Send wifi warning* *Reliability and detail of information*
Problems, challenges and areas for research	
Service characteristics	*User - friendly: distraction problems* *Emergency vehicle type;* *Recommended speed;* *Recommended lane;* *Expected delay;* *Recommended alternative (This should be allocated so not all drivers get off the freeway and take the same road). e.g. car 1-20 should take Rout A, car 21-40 should take route B, etc.*
Technical	*Require strong authentication of the emergency vehicle by other vehicles* *Gathering high-quality and detailed information*

Table B.6: In-vehicle signs and traffic rule violation warning (speed limit, stop sign, red signal): key requirements, problems, challenges and areas for research.

Key requirements for success	
General requirements	*In 2025,all the vehicles must have technical equipment to warn the drivers about all restrictions on roads that they drive* *There is sufficient fleet penetration to allow reduction in roadside signs.* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *OK for speed limits (static and dynamic)* *Stop signs shall be handled like other prohibition or obligation signs. No specific behaviour, that could encourage stop sign violation.* *Red signals shall be evaluated very carefully in terms of pros and cons (fear of unfair behaviours = speeding)*
Organisational/ institutional	*Privacy must be considered (no automatic transmission of rule violence information to traffic enforcement authorities)* *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *legislative barriers are obvious* *liability of the service provision has to be analysed*
Service characteristics	*Speed limit* *black spots* *Alcohol control* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *User friendly - distraction problems*
Technical	*V2I* *Would need a realtime database* *Traffic signs possibly should transmit the information electronically to the vehicle, rather than a camera having to detect the traffic signs.* *Requires efficient HMI or other type of notification to the driver.* *Accurate databases with information and legislation* *They must be reliable - in function everywhere.* *Machine readablitiy, language independence.* *Compatibility to existing broadcast telematics services, e.g. TPEG.*

	There is system interoperability (agreed standards for system interfaces). *Reliability and detail of information*
Problems, challenges and areas for research	
General	*OK for speed limits (static and dynamic)* *Stop signs shall be handled like other prohibition or obligation signs. No specific behaviour, that could encourage stop sign violation.* *Red signals shall be evaluated very carefully in terms of pros and cons (fear of unfair behaviours = speeding)* *Could electronic traffic signs (stored in authority databases) replace physical sign boards in the far future?* *Yes to avoid non respectful persons* *All vehicles must have speed limit* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *Challenge to convince transport operators to use these services.* *There is sufficient fleet penetration to allow reduction in roadside signs and technology (incl. detection and enforcement).*
Organisational/ institutional	*Liability question* *Examine how incentives could be created for operators willing to use these services* *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.*
Service characteristics	*Speed limit* *Accident - location* *Traffic jam* *walker at crossing* *User - friendly: distraction problems*
Technical	*Real time database* *Normative and auditing reliability. Need to assure that information has been presented to the driver. Clearly Human-Machine impact.* *Databases of very good quality* *There is system interoperability (agreed standards for system interfaces).* *Gathering high-quality and detailed information*

Table B.7: Cooperative collision warning / intersection collision warning (for potential collision with vehicle on same road or opposite 'arm' of junction): key requirements, problems, challenges and areas for research.

Key requirements for success	
General requirements	*Accessible to as much as possible road users* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *In 2025,all the vehicles must have technical equipment to warn the drivers about the roads where the cooperative collisions are more like usually* *High penetration rate.*
Organisational/ institutional	*All cars be equipped mandatory* *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.*
Service characteristics	*This would be particularly useful on "single track" and narrow roads. In these cases, a system that included all larger vehicles (which have more difficulty in passing) would be of great benefit. If the system could control entry into these sections of road so that vehicles never met where they could not pass, so much the better.* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *Warnings must be given well in advance of potential event in order to give sufficient time for re-action* *User - friendly: distraction problems*
Technical	*Reliable communication and real time data* *infrastructure ITS station fully deployed and able to communicate either with car embedded systems or with nomadic devices (smart phone , PND,..)* *car to car or car to infrastructure communication* *no special requirements for internet connection yet* *we judge collision warning as a topic for Car-to-Car communication* *Fast communication* *Communication standard: 802.11p* *v2i and v2v communications* *precise GPS positioning*

	reliability and detail of information *Real time traffic information*
Problems, challenges and areas for research	
General	*Please see the recommendations of EU funded project SAFESPOT*
	The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers. *Challenge to convince transport operators to use these services.*
Organisational/ institutional	*Examine how incentives could be created for operators willing to use these services* *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.*
Service characteristics	*User - friendly: distraction problems* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *On the roads must be installed display with the intersection collision warning*
Technical	*Availability of accurate and reliable real time data* *C2C + C2I* *As long as the majority of cars does not have the ability to support this function via C2C communication, detection systems on intersections (via camera etc) could detect and provide such information to featured vehicles.* *precise GPS positioning* *communication standard for v2v* *Gathering high-quality and detailed information*

Table B.8: Dynamic traffic management (lane management, variable speed limit, metering of entry ramps): key requirements, problems, challenges and areas for research.

Key requirements for success	
General	*Accessible to as much as possible road users* *Dense coverage – for a certain area all lane information / variable speed limit / metering must be provided, to avoid algorithms to detour to uncovered road elements, which seem to be faster due to missing limitation information* *DTM should have clear private as well as societal benefits.* *High market penetration* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *There is sufficient fleet penetration to allow reduction in roadside signs and technology (incl. detection and enforcement).*
Organisational/ institutional	*Consider also autonomous intersection control and non-technical barriers related to the implementation of numerous manufacturers, which do not provide interfaces between their proprietary systems or are not willing to cooperate at all* *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.*
Service characteristics	*Variable speed limit* *reorganization of the traffic flow at an accident - line management* *Useful only in combination with dynamic congestion charging* *user friendly design* *User - friendly: distraction problems* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *Proactive traffic management*
Technical	*Availability of reliable real time data and accurate localisation data* *Accurate position* *The accuracy of the location of the vehicle (given by GPS) is important to give information to the driver in accordance with road signs.* *- Communication standard: 802.11p*

	- v2i communications *- precise GPS positioning* *They must be reliable - in function everywhere.* *Machine readablitiy, language independence.* *Compatibility to existing broadcast telematics services, e.g. TPEG.* *System that delivers these services is provided by the market.* *There is system interoperability (agreed standards for system interfaces).*
Problems, challenges and areas for research	
General	*Market penetration* *There is sufficient fleet penetration to allow reduction in roadside signs and technology (incl. detection and enforcement).* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *Challenge to convince transport operators to use these services.* *How to be proactive*
Organisational/ institutional	*Communication between systems and organizations* *upkeep* *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *Examine how incentives could be created for operators willing to use these services* *Change of the traffic signs*
Service characteristics	*The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *User - friendly: distraction problems*
Technical	*Availability of accurate and reliable real time data* *Reliability* *Reliability of positioning service* *Problem of location of the vehicle on the carriageway (for dynamic lane mgmt for instance)* *- precise GPS positioning* *- communication standard for v2i* *Traffic detection*

	Databases of very good quality *HMI - good system design* *Guideline-/design studies that focus on the combination of physical road design and flexible use of the road based on ITS - it must be a robust combination* *Effects of incomplete information (e.g. data only for highways, but not for other roads is a problem)* *There is system interoperability (agreed standards for system interfaces).*

Table B.9: Warning that you are about to enter a dynamic green zone/ low emission zone with access restriction: key requirements, problems, challenges and areas for research.

Key requirements for success	
General requirements	*The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.*
Organisational/ institutional	*Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others)* *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *Business models, common policies through Europe*
Service characteristics	*Warning must be given at points were an alternative route exists so that drivers wishing to avoid the green zone can take alternative route.* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *User - friendly: distraction problems* *Prevent entry*
Technical	*Locating system must be reliable and of good quality* *No "sharp" border lines, but border corridors,* *They must be reliable - cover 100%.* *Security of communication, Privacy Management, System integrity, Realtime, Infrastructure (Availability, Coverage)*
Problems, challenges and areas for research	
General	*User acceptance (data protection)* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *Challenge to convince transport operators to use these services.*
Organisational/ institutional	*The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and*

	the costs involved. Incentives for the employment by users should be included in the business plan.
Service characteristics	*The main challenge is to link such a warning with potential suggestions for alternatives to avoiding the zone, or ways to enter it with emissions under the specified limit (e.g. suggestion for speeds below a certain level)* *Examine how incentives could be created for operators willing to use these services* *User - friendly: distraction problems* *HMI - good system design*
Technical	*Databases of very good quality* *Definition/design and distribution of road maps that easily routes the vehicles that are denied access to "acceptable" roads/routes*

Table B.10: Eco-routing (route choice determined by environmental criteria): key requirements, problems challenges and areas for research.

Key requirements for success	
General	*High market penetration* *Roadside and central infrastructure available* *vehicle status, trip conditions and possible negotiation factors are known* *It will be of interest in case of and in places where the taxation for such issue is introduced*
Organisational/ institutional	*Road traffic information, geometric characteristics, must be centralised to give the right route for the driver* *Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others)* *Common policies for Europe*
Service characteristics	*Very important. Consider the differences and impacts of a) restricting a zone/area because it is already polluted and b)providing the least-polluting route (the results are different)* *Eco-routing and delivery windows* *Real time information would be a value added (for air quality for example)* *Visibility into time impact of different route solutions by eco route banding/ criteria; transparency into vehicle type & payload weight on eco routing options;* *Route determined plus energy supply according to the driving style* *Difficult, what elements are or should be included* *User - friendly: distraction problems* *Display results of calculation of pollution and noise levels with warning on health damage*
Technical	*This is more judged to be a feature of a navigation SW in an on- / off-board / hybrid solution. It should not depend a lot on connected internet services.* *Requires ITS and V2V and V2I. Common communication protocols are key* *Security of communication, Privacy Management, System integrity* *Real time, Infrastructure (Availability, Coverage)* *Full ADAS map database coverage* *Standard access to different data source: such kind of service need to combine different data from different sources in order to achieve the service efficient. This data is most of the time getting from different provider. If we have to develop an efficient standard service the access to that data should be standardized.*

Problems, challenges and areas for research	
General	*Impact on traffic flow*
	Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others) *- One of the main challenges in this area is to educate citizen in Eco - Routing and public transportation use. This is one of the services, which success depends almost only on the participation of users, following recommendation.*
Organisational/ institutional and technical	*Will become increasingly important in future due to fuel costs and range limitations of EV's. Inherently linked to traffic conditions, terrain etc. Infrastructure need to become smart. Traffic lights for example need to adopt "green lane" optimisation to minimise stop start. Investment to infrastructure is key and a willingness to progress by government.*
Service characteristics	*Give information of where there is a eco-route and if the eco-route is faster/longer than a route that is not a eco-route* *Difficult, who decides the criteria, what included?* *User - friendly: distraction problems* *Infrastructure and vehicle specific driving profiles available* *overall traffic management system with online monitoring capabilities* *Need data on social costs of each alternative route*
Technical	*Criteria definition, database constitution & real time update* *Eco routing mainly depends on the vehicle itself, the driver and the used road network. All these three can be already combined in an existing car navigation device. There may be not a lot of impact by internet services. Even with routing as off-board solution a car can provide vehicle and driver information to the off-board server. The off-board solution itself is an independent issue from eco routing.* *Clarity around true eco performance of vehicles and driver behaviour; is CO2 to be the only measure?* *Knowledge of the traffic status, characteristics on other eco-friendly itineraries* *Full ADAS map database coverage* *Full off board active safety*

Table B.11: Cooperative electric vehicles (range estimation, vehicle to grid communication, book charging points, payment): key requirements, problems, challenges and areas for research.

Key requirements	
General	*Not clear electric vehicles will be mainstream in 2025.* *Penetration of smartphone and NFC*
Organisational/ institutional	*new commercial and legal concepts for energy exchange: vehicle-vehicle, vehicle-energy supplier, and vehicle-local grid* *Behavioural monitoring of driving patterns and a suitable charging pricing based on degree of information you share.* *Data protection* *Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others)*
Service characteristics	*Easy GUI !* *Location of charging points and pre booking* *Top up system with bonus for good drivers* *User - friendly: distraction problems*
Technical	*Standardised communication protocols for interaction of vehicles* *We provide many of these services from the charging infrastructure end, so it is important that the EVs are sufficiently capable of utilising them.* *V2I, V2V,* *remote access to data and remote control would help* *Main issue will become the reliable booking of charging points, to ensure the maximum usable range for EV.* *Will need Internet-based communications and thus IPv6 would be required.* *Smart Grid technology is key.* *Security of communication, Privacy Management, System integrity,* *Real time, Infrastructure (Availability, Coverage)* *Full ADAS map database coverage* *Battery technology and lifecycle* *C2C and C2X communication available* *service provider with all infrastructure information operational*

Problems, challenges and areas for research	
General	*Requires flow of behavioural information from the customer regarding their likely destinations, usage patterns and range expectations. If customer shares this information the Smart grid can deliver their optimised power requirements and vehicle can act as an energy store to feed back into the grid when charge is not needed. Change of attitude (cost or society standing influence) is required.* *This is dependant on LGV having range ability* *Full training of all staff in using systems and understanding what is being communicated*
Organisational/ institutional	*Data protection user acceptance* *Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others)* *Energy provider that can handle all the necessary tasks with respect to available power and charging stations*
Service characteristics	*[Our company] is prepared to offer live availability and live booking of charging bays. We can also offer services such as range calculation and identifying optimum charging points.* *In order for this technology to become effective we need larger scale take up of EVs by drivers. We also need the capability to use these systems to become common place in vehicles.* *There are so many options for payment methods that it is hard to say exactly what is required to make this work. But when sufficient volumes of EVs are driven we expect that revenue collection will happen using existing technologies.* *As well as vehicle to grid communication we offer important features such as charge scheduling in our home charging units, ensuring EVs are charged during off peak periods, where the is the maximum spare capacity in the grid.* *The main issue here is for efficient - clear - and user friendly interfaces with the driver.* *Not clear charging points will be dominant technology - could be battery swapping stations.* *User - friendly: distraction problems*
Technical	*Harmonization of the technical solutions, remote access to data and remote control / planning* *Data security* *Full ADAS map database coverage* *Full off board active safety* *Battery technology and lifecycle*

Table B.12: Pay as you drive – road pricing: key requirements, problems, challenges and areas for research.

Key requirements for success	
General	*The pricing technology and service should be possible to implement in all vehicles that the coverage of the pricing scheme is as close to 100% as possible.* *Not clear road pricing will have gained public acceptability by 2025.* *Commercial*
Organisational/ institutional	*new approaches for privacy protection* *complete change of paradigm concerning taxes related to the transport system* *In addition, privacy issues have to be dealt with in such a way that the pricing service is accepted by road users.* *Provider with secure payment methods operational* *The scheme can be designed to be both palatable to the public and politicians and provides a flexible and effective demand management tool.* *The appropriate operating model for the road operator is in place.*
Service characteristics	*If road pricing shall be accepted and introduced as the EC and other desire smooth payment is needed. A recent survey for the EC showed that information about today's road pricing and environmental zones is very difficult to find, especially if you are on the move and approach an unknown city* *It has to be indicated where you drive (kind of road) and when (peak hours or not) you drive* *Road pricing to be variable depending on the user incomes* *Clear continuous information about charges occurred so far.* *linked into the type of roads/ weather/ time of day/ mpg info/ day of week/ actual transit time vs ideal; vehicle stop times/ durations (for deliveries/ collections); conversion rates across currencies; ability to transpose cost per litre of fuel- regional variations on fuel costs/ sources; vat transparency; driving skills- i.e. optimum driving behaviour impact on cost per mile.* *Alert on amount before entry*
Technical	*reliably locating* *Security* *There is system interoperability (agreed standards for system interfaces and on-board units).*
Problems, challenges and areas for research	
General	*Systems must be accepted in a broad sense by road users, politicians, media etc. . If not the technical solutions don't matter. More research about how the get the message across about "fair and efficient pricing" is needed* *Necessary toll collect infrastructure for all roads available*

	The scheme can be designed to be both palatable to the public and politicians and provides a flexible and effective demand management tool.. *Introducing the boxes on-board the vehicles could be a good choice in reducing waiting time and queues, etc.*
Organisational/ institutional	*On countries and areas where road pricing is not used there can exist a strong resistance to the idea on a matter of principle. Privacy issues need to be addressed to allay any concerns relating to the appearance of a big brother spying on citizens and their movements.* *Legal issues* *Commercial problems* *The appropriate operating model for the road operator is in place*
Service characteristics	*Information on where (what roads you drive on) and when (peak hours or not) you drive. The drive must get information on if he is driving on an expensive time/road or not.* *Must provide continuous information on amount paid. Must indicate exit routes in case driver wishes to exit road pricing zone.* *How to control driver behaviour so as not to fudge the system; transparency into what you are paying for as a driver- is there a link possibly behind road tax for vehicles that is dynamic based on miles driven as opposed to flat fixed fee; understanding more around the toll road pre paid chips- lesson learned from this so you pay for entering zones.*
Technical	*Availability of accurate and reliable real time data* *There is system interoperability (agreed standards for system interfaces and on-board units).*

Table B.13: Pay as you drive – insurance: key requirements, problems, challenges and areas for research.

Key requirements for success	
General	*Sound interesting, however we don't see the applicability while the insurance has to be bought for longer periods*
Organisational/ institutional	*Commercial* *There is cooperation between insurance providers and road opertors to ensure that unwanted changes to traffic and travel patterns are avoided and desirable ones encouraged.*
Service characteristics	*Has to take into consideration when and where you drive + who is driving and the condition of the driver* *Clear insurance price reduction for low km usages* *Give all the tariffs on the market and info about the competitors*
Technical	*The reliability of the PAYD technology has to be close to 100% (redundancy, tamper-resistance).*
Problems, challenges and areas for research	
General	*Would be of interest in case of changing the insurance habits of the insurers*
Organisational/ institutional	*Privacy issues are also important* *Commercial problems* *There is cooperation between insurance providers and road operators to ensure that unwanted changes to traffic and travel patterns are avoided and desirable ones encouraged.*
Service characteristics	*The insurance company and driver must get information on the drivers behaviour- driving too fast, don't use winter tyres, the driver is under influence of alcohol etc.* *Amount of incentives*
Technical	*The wider adoption of PAYD insurance is a challenge. Redundancy of positioning methods and resistance to tampering are key issues to be handled.*

Table B.14: Personal travel assistant (informed decision making on inter-modal journeys in real time): key requirements, problems, challenges and areas for research.

Key requirements for success	
General	*Car user and PT users are too often seen as completely different species. There is of course park and ride but more intermodality needs better info* *Personal travel assistant may be useless in the case the vehicle can be self driven*
Service characteristics	*The assistant should be mobile so it can be used in all modes of transport. Ease of use is also a key issue.* *A system that told motorists they could complete their journey faster by parking their car and switching to public transport would be extremely useful to us.* *The aggregation of the information from all transportation means to propose a true real time multi modal journey is key* *Need to be comprehensive and accurate.* *Give the generalised costs of different alternatives* *Can be adjusted to my preferences, high quality information, always up to date* *This is fine, but not ad hoc. If the vehicle is moving, the driver should pull over to arrange for the assistant, unless it automatically recommends changes because of conditions and then the driver can approve or reject.* *Equipped nomadic devices. Basic data from all transport modes.*
Technical	*Reliable data and real time updating* *Position (indoor/outdoor)* *Will need Internet-based communications and thus IPv6 would be required.* *V2V, VII and common interfaces and protocols* *They must be reliable - cover 100%.* *Complete inter-connection of mobile devices (PDA) and cloud-computing* *Machine readability, language independence.* *Compatibility to existing broadcast telematics services, e.g. TPEG.*
Problems, challenges and areas for research	
General	*Is a pan-European system what we should aim for? Will this become a monster? Can we define regional "markets"?* *My main concern is that the drivers will treat the service for late planning. Such service should be dependent on previous planning AND offers alternatives only in case of an emerging condition. Otherwise, driver must be parked to use the service. Brain busy in making decisions should not be in the head of the driver. The passenger maybe, but not the driver* *No need*

	More intelligent and connected public transport to deliver real time information and avoid waiting times for public transport.
General	*Full connection and exchange of individual and global needs* *Basic information from the transport system*
Organisational/ institutional	*Willingness of all actors to share and aggregate databases in order to provide a real real time inter-modal information, constitution and management of the database*
Service characteristics	*HMI - good system design* *Get real-time info also on traffic flow status, preferably forecasts of it*
Technical	*Access to information on all modes of transport is the central issue. Interfaces to the information / data need to be provided so that services can be implemented taking advantage of the information.* *Availability of accurate and reliable real time data* *Ability to fuse enormous quantity of information and produce accurate information to the user* *Databases of very good quality* *Standards like TPEG and organisations like TISA need to be strengthened.*

Table B.15: Real time travel planning and route optimisation: key requirements, problems and areas for research.

Key requirements for success	
General	*Extensive amount of equipped vehicles* *We foresee this being useful to people travelling on public transport, probably with their own devices interfacing with the on-board systems.* *Need clear private and societal benefits* *Penetration of smartphone and NFC* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *Most vehicles equipped and a lot of basic data from the transport system* *if paid service then also a free-of-charge basic content*
Organisational/ institutional	*Real time travel information in terms of inter-modal travel requires EU wide standardized information interfaces / formats. A SW can include also information only when it is provided via the same interface / format all over EU (Paris, Berlin and London,...)* *Real time traffic service information available via a common portal and communication means. Infrastructure information is key. TomTom HD traffic is a good model to look at for zero infrastructure investment delivering high quality data.* *We have to think global travel planning: the driver's route optimisation is generally made by information coming from other modes (public transports, planes, boats, trains, metro, parking availability...). So databases must be interconnected!* *The application, IT communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others)*
Service characteristics	*Need traffic info + multi modal info* *route optimisation could be optimized depending on personal criteria (economic, ecologic, time...)* *Very important to arrive at location within a 15 minute window* *link into the vehicle load- the SLAs of the product on board linked into influences on the transit time- accidents/ road delays; visibility into deliveries made/ due to be made and collections due/ actioned (especially*

	for multi-drop events). *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use* *User - friendly: distraction problems* *Overall traffic management system with roadside and vehicle information collection possibilities* *Add also information on environmental impacts (social costs) of the different alternatives*
Technical	*Real-time information on incidents as well as traffic and weather conditions is required.* *Availability of accurate and reliable real time data* *Service must be combined with a good and solid short term prediction algorithm to take account of the traffic conditions ahead of the time of the message at the alternative route.* *Will need Internet-based communications and thus IPv6 would be required.* *They must be reliable - cover 100%.* *Security of communication, Privacy Management, System integrity, Real time, Infrastructure (Availability, Coverage) Standard API, data fusion* *In present and for the future will be necessary the same electronic requirements for the travel planning* *Machine readablitiy, language independence. Compatibility to existing broadcast telematics services, e.g. TPEG.* *High quality data, always up to date, real time incident info* *- Route optimization and time travel planning success may only be successful if drivers follow the recommendations and this will only be possible if the service provide ALWAYS good recommendation. This kind of services have a strong dependency on the quality of the traffic data used to perform the optimization/planning, so the service me only be successful if the data has a high accuracy and availability level.* *Real time traffic data available, quality of data*
Problems, challenges and areas for research	
General	*Route optimisation for inter-modal transport is challenging.* *The vehicles must be equipped with technical equipment that shows the optimal route and the conditions for a good and real time travel* *Basic information for the transport system* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *Challenge to convince transport operators to use these services.* *Service successful if all vehicles have the service because the route optimization has not effect if only a part of the vehicles can be driven to*

	the optimized route.
Organisational/ institutional	*Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others)* *Examine how incentives could be created for operators willing to use these services* *The application, IT communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *Privacy.*
Service characteristics	*a) Possibility to optimise under different criteria* *b) possibility to enter personal characteristics of the driver and take them into account in the planning and optimisation algorithms.* *User - friendly: distraction problems* *Knowledge of all the information to travel from A to B in each mode of transport* *HMI - good system design* *- Making drivers trust information given by the service.* *- Designing device that not disturb drivers in receiving the instructions.*
Technical	*Availability of accurate and reliable real time data* *Be able to gather all needed information real time (multi-modal, traffic, weather...)* *Standardization for interfaces / formats* *Getting sufficient information about the road network in order to provide efficient recommendations* *Not enough real time information* *Infrastructure communication and mapping are key here. Also bringing collaborative anonymised data on route times and allowing the public access to this data.* *Databases of very good quality* *standardisation* *Both infrastructure (e.g. by traffic cameras) and vehicle communication in real-time operational* *Negotiations agents and route planning programs for overall optimization process* *How to predict traffic situation ahead*

In case will supersede the present software

Table B.16: Location based services – real time information on points of interest: key requirements, problems, challenges and areas for research.

Key requirements for success	
General	*Able to enhance services to passengers and potential passengers* *Penetration of smartphone and NFC*
Organisational/ institutional	*Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others)*
Service characteristics	*Dynamic information (opening hours, prices, availability...) would give a real value added* *This topic is mainly moving towards the internet, so requirement is to have full Internet search capability in the vehicle* *This information is already available and is in operation now via smart phones. Key is to present it in a valid and useable form to the driver.* *On the vehicles board must be a display which show them the map with the interesting services locations* *Not only location, but also detailed info on the service quality and characteristics*
Technical	*More accurate positioning methods in urban areas are required for LBS.* *Availability of accurate and reliable real time data* *Position* *They must be reliable - cover 100%.* *Security of communication, Privacy Management, System integrity, Real time, Infrastructure (Availability, Coverage)*
Problems, challenges and areas for research	
General	*Bringing information to the traveller is challenging - many competing platforms exist (smartphones, PNDs, in-vehicle systems, tablets).* *When using the full internet in the vehicle, this part will evolve through the Internet itself.* *Already available for smartphones, needs a way to present it to driver*
Organisational/ institutional	*Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others)*
Service characteristics	*HMI - good system design* *On the roads and highways must be installed emergency phones with displays that show the appropriate maps with the services locations that help the drivers in dangerous cases/accidents.*
Technical	*Challenge is for this to be easily placed on systems which are being used in vehicle rather than add ons to mobile phones.* *Availability of accurate and reliable real time data* *Obtain dynamic location based information and update it real time,*

Databases of very good quality

Table B.17: Internet services (internet browsing, email chat readout, social media): key requirements, problems, challenges and possible solutions.

Key requirements for success	
Technical	*Wireless broadband* *A great selling point for public transport. It is already becoming available, including on some local buses, but if people knew you could always get connected on PT this would work to our advantage.* *Need to understand how they can be adapted for a safe and relevant in-car usage* *- simply unlimited internet access in the vehicle (aligned with driver distraction regulations)* *- use of internet functions similar as on smart phones possibly via the smartphone sim or via connected smart phone*
Problems, challenges and areas for research	
General	*Find the relevant services for in-car usage*
Organisational/ institutional	*find the right business model*
Service characteristics	*find the way to adapt it safely and conveniently (HMI)*
Technical	*Take a smartphone of tablet PC* *Dock it into a car and there is nothing more to add for Internet services in the vehicle. Bandwidth will evolve with future mobile networks.*

Table B.18: Remote vehicle diagnostics and pre-maintenance notifications: key requirements, problems, challenges and areas for research.

Key requirements for success	
Organisational/ institutional	*Should be driven by car manufacturers (additional feature aspect)* *Need a real implication of the OEMs and car dealers*
Service characteristics	*Together with [this service] it is imperative that a safety recall service is included which should have a mandatory priority,*
Technical	*Standardized data exchange protocol for all car manufacturers*
Problems, challenges and areas for research	
General	*Essential especially with temperature controlled equipment*
Organisational/ institutional	*Find the right business model, decide who is owner of the vehicle information, real willingness of the OEMs and car dealers to provide a value added service*
Technical	*Automotive technology* *This is available now on TC units diagnostic, buzz cam should be able to analyse the fault code and push this forwards to enable a resolution swiftly*

Table B.19: Delivery window warning: key requirements, problems, challenges and areas for research.

Key requirements for success	
General	*Might be good by reducing the waiting times*
Organisational/ institutional	*Commercial*
Service characteristics	*Tell the driver when there is a delivery window open* *Audible alert, 15min pre alert; ability to flag 'back to base' which drops are at risk* *Priority for freight vehicles*
Technical	*Must be integrated in commercial fleet management software*
Problems, challenges and areas for research	
Service characteristics	*There must be a supply system of delivery windows and the system must give information to the driver when there are disruptions. The driver must also give information to the delivery system when he is behind time or want to have earlier delivery window than he/she is booked for.* *For multi-drop events having meaningful alerts will be the challenge- to many alerts in too broad a time window will become business as usual response from a driver.*
Technical	*Forecasting traffic flows and taking into account incidents on the road*

Table B.20: Rest area notification and rest time violation warning: key requirements, problems, challenges and areas for research.

Key requirements for success	
General	*Just in case the on-board device doesn't do that* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *This service may only be successful if all vehicles are equipped to operate the service and if violations of rest time warning can be pursuit and penalized.*
Organisational/ institutional	*The application, IT communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.*
Service characteristics	*Given the complexities of EU drivers hours regulations it is important for Drivers to know when the hours are in danger of being contravened* *Could be linked with driver monitoring for more efficiency (not only respect of the law)* *Location and real time driving time to reach rest area in accordance with Driving time regs* *Sensible addition allows better planning also secure parking points??* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *User - friendly: distraction problems* *Information inside the vehicle (autonomous)* *On line (pre-trip and on-trip) booking of rest place* *integration of intelligent truck parking systems with planning and monitoring fleet systems*
Technical	*Reliability* *Developed standard for access control and common booking system*
Problems, challenges and areas for research	
General	*Drivers willingness* *Availability of rest areas* *Secure parking facility* *Challenge to convince transport operators to use these services.* *The application must to the largest possible extent remain voluntary.*

	Operators must maintain freedom of choice when selecting equipment and application suppliers. *Reducing the number of fines*
Organisational/ institutional	*Law* *Examine how incentives could be created for operators willing to use these services* *The application, IT communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.* *Business model*
Service characteristics	*This needs to work in connection with digital tachograph cards and have an audible alarm to alert the driver his time is up.* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *User - friendly: distraction problems* *Information of parking availability is a must but how to collect and transmit this information in real time to the driver?* *Successful if and only if trunk drivers follow the instructions, and this can be only achieved including in the services a penalty system, i.e. devices bounded to the vehicle and surveillance of the accomplishment of the recommendations.*
Technical	*Accuracy of real time info* *Exchange data standards and procedure between traffic centres, local centres, on-board units and other mobile equipments* *Smartphone applications and integration in information systems*

Table B.21: Communication hubbing service – intelligent cargo communicates with parties in the logistics chain: key requirements, problems, challenges and areas for research.

Key requirements for success	
Organisational/ institutional	*Commercial*
Service characteristics	*Able to improve planning of delivery services efficiently thereby saving time and fuel.* *User - friendly: distraction problems* *Costs info* *Integrated systems with logistic systems*
Problems, challenges and areas for research	
General	*Challenge is to integrate this with planning software and create these locations at areas which do not require additional road building or green field sites being built on.*
Service characteristics	*User - friendly: distraction problems* *The challenge is to have all the information needed to really schedule at best the trip, including social costs* *Connection to logistic chain*

Table B.22: Temporary height/ weight axle load restriction warning: key requirements, problems, challenges and possible solutions.

Key requirements for success	
General	*This is extremely important for road user and passenger safety especially given the number of times vehicles hit low bridges and trees* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *Accessible to as much as possible road users*
Organisational/ institutional	*The application, it communications and data protocols must be standardised, harmonised and interoperable.* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.*
Service characteristics	*Would need navigation for rerouting* *Location of temp restriction and re route to avoid* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *User - friendly: distraction problems* *It's necessary that on the roads and on the board vehicles, too, there are electronic equipments which display the dates included at the point u)*
Technical	*Availability of accurate and reliable real time data* *All these restrictions must be in a reference database (national from authorities) where service providers can use to offer services to HGV drivers* *They must be reliable - cover 100%.* *There is system interoperability (agreed standards for system interfaces).* *Basic and up to date information about the road network*
Problems, challenges and areas for research	
General	*Challenge to convince transport operators to use these services.* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.*
Organisational/ institutional	*National database must be set and updated via a specific procedure (local level to national level)* *Examine how incentives could be created for operators willing to use these services*

	The application, it communications and data protocols must be standardised, harmonised and interoperable. *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan.*
Service characteristics	*User - friendly: distraction problems* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use.* *HMI - good system design*
Technical	*Challenge is to develop software which cuts into vehicle engine systems which reduces speed and applies the brakes to stop the vehicle before it hits a bridge or be driven if overweight.* *Availability of accurate and reliable real time data* *Real time database* *Databases of very good quality* *The main problems which shall overcome are, first of all, the cost of kinds of those vehicles connected on internet and then the electronic program which serves them, which must be optimised for all the users.* *There is system interoperability (agreed standards for system interfaces).* *Basic and up-to-date road data*

Table B.23: Tracking and tracing of hazardous and valuable goods: key requirements, problems, challenges and areas for research.

Key requirements	
General	*Essential to know where these are and potential hazards which could be encountered and therefore planned to be avoided ensuring safe delivery of the hazardous loads.* *Accessible to as much as possible road users* *Yes for instance nuclear or chemical goods* *Will be necessary that all the operators' services in the transport area to have equipments which offer them the possibility to oversee provisions of point v)* *This service may only be successful if all vehicles are equipped to operate the service and if violations of the traced route can be penalized.*
Organisational/ institutional	*A catalogue of the types of goods (hazardous, confidential, animals, food, etc.) must be set at the European level...*
Service characteristics	*on-line risk assessment based on the route's features (e.g. tunnels, bridges, etc)* *Feature connected to the licensing of the specific vehicle movement (no tracking mechanism no license).* *Ability to view product in transit but through a secure web solution; deviations off route flagged;* *Lane Recommendation;* *Distance to keep from vehicle;* *Things to look out for when near hazmat truck* *User - friendly: distraction problems* *Adaptive routes info in case of problems*
Technical	*Secure positioning* *Would need the use of technology such as RFID tags...* *Two way communication with the tracked vehicle* *Reliability* *security* *They must be reliable - cover 100%.* *Privacy issues need to be solved*
Problems, challenges and areas for research	
General	*It depends on the type of good. Not necessary to track all the types...* *Road side equipment*
General	*Not really necessary* *Successful if all hazardous and valuable goods have the service.*
Organisational/ institutional	*It is useful to build a central European point that will supervise hazardous and valuable goods*

	Follow the recommendations/route traced by the service should be mandatory
Service characteristics	*Must try to connect the tracking and tracing service to a thorough route planning and licensing service that will seek to give advice, control, and monitor the whole transport from the planning phase to execution.* *User - friendly: distraction problems* *HMI - good system design*
Technical	*How to develop software which can track the vehicles and send it to the customer and delivery operator* *Trustful technology* *Security around visibility into these loads- going web based gives opportunity for hackers to get visibility into thief attractive goods.* *eSecurity* *Databases of very good quality* *Privacy issues solved*

B.2.4 Need for legislative action

Stakeholders were asked whether there is a need for legislative action to foster harmonised implementation of services based on vehicles having an internet connection.

- 66% of those who replied said 'yes', there was a need for legislative action;
- 19% said 'no';
- 15% said 'don't know'.

Those who thought that legislative action will be needed were asked to give details of legislation required for up to five of the services discussed in the previous questions. The main themes of the responses were:

- Ensuring that services are pan-European with full coverage; guidelines for harmonised implementation;
- Common definitions, specifications, quality of service levels;
- Certification of organisations operating in the value chain;
- Definition of roles and responsibilities for collecting, providing and sharing information;
- Requirement for road users to be involved (e.g. as probe vehicles);
- Compliance and enforcement;
- Access to data, data protection and privacy, exploitation of information;
- Human Machine Interface design, compatibility, common designs;
- Liability;
- Use of in-vehicle data as evidence in sensitive situations (e.g. accident).

The responses received are listed in Table B.24 under the service to which each comment refers.

Table B.24: Requirements for legislation suggested for connected vehicle services.

Approaching emergency vehicle warning

Determine which are the vehicles that could be considered as 'emergency vehicles'.

Communication hubbing service – intelligent cargo communicates with parties in logistics chain

Data protection- penalties for hacking

Cooperative collision warning / intersection collision warning (for potential collision with vehicle on same road or opposite 'arm' of junction)

Legislation to permit recording of situations in case of an accident occurring.

communication standard (802.11p);

Fitment of communication devices;

User's data protection

In order to achieve full coverage across Europe

Will only work if most vehicles are fitted, and may give a false sense of security if some are not fitted, and / or the system is not working.

Cooperative electric vehicles (range estimation, vehicle to grid communication, book charging points, payment)

Cooperative electric vehicles drive every other part of the infrastructure. Start here and everything else will follow. Sadly the government history on implementing this is pathetically slow. For example: eCall.

Data protection

Eco-routing (route choice determined by environmental criteria)

Define system interfaces to ensure interoperability.

Hazardous location warning (weather and road surface conditions)

Certification of service value chain needed; certification of service provider needed; HMI common design across brands

Local public authority responsible to centralize the information and disseminate it through media

Not following service recommendations should be penalized by law

Smart phones need to support this service.

Obligation for entities collecting data to freely exchange and share this data

Some specification for a warning system similar with safety belt warning system

Communication standard (802.11p);

Fitment of communication devices

Guidelines for harmonised implementation

Incident warning (breakdown, queue, accident, slow moving vehicle, wrong way driver)

Some specification for a warning system similar with safety belt warning system

The application must to the largest possible extent remain voluntary. Operators must have freedom of choice when selecting equipment and application suppliers.

The application must to the largest possible extent remain voluntary. Operators must *maintain freedom of choice when selecting equipment and application suppliers.*

The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use

An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains

The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan

Communication standard (802.11p);

Fitment of communication devices

Certification of service value chain needed; certification of service provider needed;

HMI common design across brands

Guidelines for harmonised implementation

Network operator responsible for real time detection, forecasting of likely effects and dissemination of anticipative information

Broadcast and internet based services shall be compatible (same standard).

All information of that kind must be certified. So, legislation must decide which parties are authorized to provide such information. For instance, a company like Google shouldn't, unless they apply for such an authorization and obey the rules.

Liability

Internet services (internet browsing, email chat readout, social media)

Not compatible with the driving task; must be not implemented on the dashboard (legislation for car makers)

In-vehicle signs and traffic rule violation warning (speed limit, stop sign, red signal)

Legislation to oblige road authorities and Member States to collect (speed limits, stop places, ...) in a formatted way and the need to provide information to the service providers

No legalisation now; Iit needs standard and rule

Obligation for road authorities for data collection and exchange;

Consistent HMI with roadside display

Guidance around what role the internet diagnostics would have in the event of an accident-would the info be used to prove negligence?

Liability

Standardize all road safety items

Enforcement, as for example other car features, like mirrors...

The application, it communications and data protocols must be standardised, harmonised and interoperable.

The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.

The application should support all stakeholders in the transport chain to maintain the

	freedom of choice for the means of transport they use
	An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains
	The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan
	Guidelines for harmonised implementation
Location based services – real time information on points of interest	
	Win-Win Business Model, also for sparsely populated areas (Telco, OEM, others); roaming charges, data plans
Pay as you drive - insurance	
	Similar to that of road pricing
	There is a need for legislation to accept the needed monitoring of people and cars
	privacy management; certified billing system
	Legislation required on location privacy and the exploitation of the information the insurance could get.
Pay as you drive - road pricing	
	Guidelines for harmonised implementation
	Where would the money go; rules around base costs/ mark up matrix
	Legislation to authorise payment by month, year, via bank or other payment means of choice of the driver, etc
	There is a need for legislation to accept the needed monitoring of people and cars
	Data protection
Personal travel assistant (informed decision making on inter-modal journeys in real time)	
	Access to data;
	Infrastructure Quality of Service level and real time update
	Smart phones and devices need to support standards like TPEG.
	Intermodal transport will become easier if the public transport side was more connected
	Some specification for a warning system similar with safety belt warning system
	Standardization of inter-modal information and facility signalling
Real time travel planning and route optimisation	
	Every car to become a probe for real time traffic (sending anonymized data for traffic flow analysis)
Remote vehicle diagnostics and pre-maintenance notifications	
	Determine which are the actors that could have access to remote diagnostics. These should not only be the car-manufacturers otherwise the users would be bound to them and a monopoly would be created on car maintenance.
	Legislation must ensure, that any market player, not only car makers (OEMs), but also Aftermarket suppliers, independent service providers etc. will get access to and can use vehicle diagnostic data at customer's choice.

Rest area notification and rest time violation warning
Not following service recommendations should be penalized by law *Some specification for a warning system similar with safety belt warning system* *The application must to the largest possible extent remain voluntary. Operators must have freedom of choice when selecting equipment and application suppliers.* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan*
Tracking and tracing of hazardous and valuable goods
Harmonisation on legal understanding when it comes to incidents (thefts) that occurred on parking locations due the fact that driver had to stop to adhere to EU driving and resting regulation. Every country is ruling differently, sometimes in favour of carrier, sometimes in favour of industry. Within EU we need a clear direction what is seen as negligent and what not. Tracking of risk cargo might open the door for stronger legal discussions about liability and responsibilities. *Privacy issues* *Data protection* *Guidelines for harmonised implementation* *Classification of 'valuable' goods* *Legislation to make it compulsory for vehicles to register to the service and get permit based on following the tracking services rules and features mentioned earlier* *The application must to the largest possible extent remain voluntary. Operators must have freedom of choice when selecting equipment and application suppliers.* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan*
Vulnerable road user warning (cyclist, pedestrian)
Law enforcement necessary so that vulnerable users are equipped. This could be a component of a mobile phone, so the law enforcement may not directly affect the vulnerable road users but the device manufacturers, like mobile phone producers.

Public authorities and public broadcasters shall provide the service infrastructure free of charge for end users. *Some specification for a warning system similar with safety belt warning system*
Warning that you are about to enter a dynamic green zones/ low emission zones with access restriction
Harmonization of visual signs *The application, it communications and data protocols must be standardised, harmonised and interoperable.* *The application must to the largest possible extent remain voluntary. Operators must maintain freedom of choice when selecting equipment and application suppliers.* *The application should support all stakeholders in the transport chain to maintain the freedom of choice for the means of transport they use* *An appropriate level of confidentiality of commercial data should exist when used in multimodal transport chains* *The necessary training of all stakeholders should be included together with a solid business plan, proving to all stakeholders what benefits exist and the costs involved. Incentives for the employment by users should be included in the business plan*

B.2.5 Need for standardisation

Stakeholders were asked whether there is a need for further standardisation to foster harmonised implementation of services based on vehicles having an internet connection.

- 69% of those who replied 'yes' there was a need for further standardisation;
- 12% said 'no';
- 19% said 'don't know'.

Those who thought that further standardisation will be needed were asked to give details of standardisation required for up to five of the services discussed in the previous questions. The main areas of standardisation covered in the responses were:

- Ensuring that services are pan-European with common interfaces and procedures to ensure interoperability;
- Communications and protocols, harmonised message sets, data formats, definitions (e.g. of events, eco-level for routing recommendation), data exchange;
- Technologies and in-vehicle equipment;
- Certification and conformance testing of organisations operating in the value chain, enforcement;
- Human Machine Interface design, symbols, compatibility of symbols between in-vehicle and roadside;
- Ensuring that existing standards are used and extended.

Some specific requirements for standardisation were identified for cooperative electric vehicles, pay as you drive insurance and personal travel assistant:

- Cooperative electric vehicles: smart grids, charging points, charging technical solution, charge data sharing, charge point booking, and vehicle to grid communication;
- Insurance: transfer tariffs and policies between insurance companies;
- Personal travel assistant: a single database covering all modes.

The responses received are listed in Table B.25 under the service to which each comment refers.

Table B.25: Requirements for standardisation suggested for connected vehicle services.

Approaching emergency vehicle warning
Ensure existing Standards like e.g. TPEG is used and extended.
Cooperative collision warning / intersection collision warning (for potential collision with vehicle on same road or opposite 'arm' of junction)
Uniform warnings required across Europe.
Communication channel standard, message structure standard
Standardize e.g. data formats and procedures to ensure European-wide compatibility.
HMI
Cooperative electric vehicles (range estimation, vehicle to grid communication, book charging points, payment)
Smart Grids, charging points and charge data sharing need standardisation.
technical solution for charging
Standardization for booking of charging points; Additional legislation action: there should be no EV without this function.
V2G
Delivery window warning
Standardisation of message and equipment
Dynamic traffic management (lane management, variable speed limit, metering of entry ramps)
All vehicles able to read information; Information in real time
Define system interfaces to ensure interoperability.
Standard equipment in the car
Standardize e.g. data formats and procedures to ensure European-wide compatibility.
Use of symbols; HMI
Eco-routing (route choice determined by environmental criteria)
Standardisation of eco level for route recommendation; standardisation data exchange protocol
Standards for describing the eco-route
Directive or standard on calculation methods
Define system interfaces to ensure interoperability.
Hazardous location warning (weather and road surface conditions)
HMI design and display; Certification and service conformance testing
Ensure existing Standards like e.g. TPEG is used and extended.
Possibilities for vehicles providing their sensor information (ABS, ESP, ...) as input for the service to create warnings for other cars
Standardisation in the semantics of information message about the risky event + in the

diffusion process through selected media

Standardisation of the dialogue between vehicles and roadside units as well as between roadside units and traffic control centres; Standardisation of HMI and message management

Standardize e.g. data formats and procedures to ensure European-wide compatibility.

This is valid for all the services. The way to present the information to the drivers: messages and pictures need to be standardised and harmonised. A catalogue of messages and events need to be created and agreed; This is similar to what is doing people dealing with Variable Message Signs.

It should work in whole Europe

Type of messages, protocols for communication, the coverage area, the icon or symbol for every message

Incident warning (breakdown, queue, accident, slow moving vehicle, wrong way driver)

Message to be defined for the driver at the European level (information free for the user)

Type of messages, protocols for communication, the coverage area, the icon or symbol for every message

Use of symbols;

HMI

Standardisation of the level of warning and condition to give the warning; standardisation of data exchange protocol

HMI design and display;

Certification and service conformance testing

Ensure existing Standards like e.g. TPEG is used and extended.

Standardisation of the dialogue between vehicles and roadside units as well as between roadside units and traffic control centres.

Standardisation of HMI and message management

Define system interfaces to ensure interoperability.

Standardize e.g. data formats and procedures to ensure European-wide compatibility.

In-vehicle signs and traffic rule violation warning (speed limit, stop sign, red signal)

Define system interfaces to ensure interoperability.

Database - homogenous quality and descriptions.

HMI

V2X cooperative systems

Constitute a legal and real time database

Ensure existing Standards like e.g. TPEG is used and extended.

Standardisation of HMI and message management and consistency with road signing

Pay as you drive – insurance
Transfer tariffs and policies between insurance companies, (users, cars)
Standards for information to be collected
Pay as you drive - road pricing
It should work in whole Europe
One tag for all tolls
Standardised technologies needed, probably based on mix of GPS and DSRC.
Define system interfaces to ensure interoperability.
Standards for information to be collected
Personal travel assistant (informed decision making on inter-modal journeys in real time)
Data formats;
Service API;
Service level agreements
Aggregate information for all mobility actors to constitute a single database of inter-modality
Standardization to ensure: more legibility, easier and quicker understanding of information; - limitation of advertisements on information screens. So as to truly improve productivity of the information receiver
General standardization / enforcement of the standard. There are currently no real end-user applications / devices yet.
Standardised user interface.
Ensure existing Standards like e.g. TPEG is used and extended.
Type of messages, protocols for communication, the coverage area, the icon or symbol for every message
Rest area notification and rest time violation warning
EU Standardisation is required to provide a solid structure for all transport operators particularly when it comes to stopping a truck, as this is the most vulnerable time of a driver and cargo itself.
Type of messages, protocols for communication, the coverage area, the icon or symbol for every message
Real time travel planning and route optimisation
Data formats, interoperability, data pooling
Remote vehicle diagnostics and pre-maintenance notifications
Vehicles need to give correct info
Vulnerable road user warning (cyclist, pedestrian)
Type of messages, protocols for communication, the coverage area, the icon or symbol for every message

B.2.6 Other comments

The questionnaire provided an opportunity for commenting on other aspects which had not been included in other questions. A few people commented that they found the questionnaire too long. The following comments on connected vehicle services were received:

> *Links between car users and PT, "inter modal" services should be improved. ITS is too much focused on cars* (R&D, Northern Europe)
>
> *Location-based services in general will likely be widely used in the traffic domain in 2025. Here location-based services include social networking applications (i.e. Social Traffic)* (R&D, Northern Europe)
>
> *In public transport, internet connectivity should improve the systems that allow people waiting for buses or trams (or deciding when to go to the stop) to predict when a vehicle will arrive for their journey. This can also flow through to real time journey planning and analysis of performance against timetables* (Public Transport operator, Western Europe)
>
> *All the standards and most of the regulations must be pan-European.* (R&D, Western Europe)
>
> *In general standardisation is needed fo all new services to minimize the information flow.* (R&D, Northern Europe)
>
> *As far as the need for legislation is concerned, transport operators should maintain the free choice of using such applications or not. So, legislation should not impose a usage obligation on transport operators. Convincing transport operators should be done with sound business cases. However, legislation might be useful to ensure that the standardisation, harmonisation and interoperability are effectively being implemented.* (Private road user organisation)
>
> *I have very serious concern about permitting vehicle connectivity to serve other then Safety Tools. e-mail, chat rooms and social networks require interaction and they should be allowed only for trained drivers as it relates to the driving person and the type of training they receive for Driving and Communicating. A expects high driving skills and ability to use communication safely, then the level of communication permitted will decrease. Examples:*
>
> > *Class A: Police & Emergency workers to duty related communication*
> > *Class B: Delivery services big and small for work related dispatch delivery etc,*
> > *Class C: Business Drivers, Taxi Drivers etc.*
> > *Class D: Private vehicle driver, e.g. personal car, family car*
> > *Class E: Young Driver and New Driver (Only phone calls to/from parents and emergency services.* (R & D)
>
> *The services listed in this questionnaire are mixing up road safety, traffic efficiency and infotainment/comfort applications. The roadmap and timeline is not the same. Though urgency is of course safety followed by traffic efficiency, road safety will be the harder to deploy given the time-critical constraints of the applications and the need to fully validate and certificate these applications under high proportion of equipped vehicles. Traffic efficiency and infotainment/comfort applications could be deployed from now on, but it is better not to start their deployment before the ETSI/ISO/CEN standards are completed, otherwise it will derive some business and will prevent the deployment of the safety applications due to lack of available investment (road efficiency and infotainment/comfort type of application are added-value services that could help financing road safety application provided a compatible communication architecture is deployed for all types of applications).* (R&D Western Europe)
>
> *Please get in contact if you require further information. I have been working in Telematics, EV and Smart Grid research for several years.* (R&D)

Identifying the appropriate operational model that allows all parties to be part of the cooperative system value chain with the right business models and robust business cases is key to the successful deployment of cooperative services (Road operator, Western Europe)

B.3 The Stakeholder Questionnaire

New services for connected vehicles in Europe by 2025 – stakeholder consultation for the European Commission

The EC Project

In future it is expected that vehicles will be connected to the internet, and indeed become an active part of the internet "cloud". This will make it possible for vehicles to have access to additional services, for them to use current services differently, and for vehicles to collect information which will then be used in providing services.

The Transport Research Laboratory (TRL) and TNO in The Netherlands have been contracted by the European Commission to gain views from different types of organisations on new services for vehicles, based on internet technology, that could be available by 2025. The EC wishes to find out about views on the types of services that will be important, stakeholders' requirements for such services, and the challenges and issues that will be involved in implementing and using them. This will help the European Commission to design its future research programme to support developments in services for connected vehicles.

Stakeholder consultation

We are interested in the views of people in a range of transport-related organisations including road operators, vehicle and equipment manufacturers, fleet managers, freight companies, national and local government and others with a stake in future road transport services.

We would be very grateful if you could spare about 15 minutes to complete the questionnaire below to help shape the future research programme, and return it by 8th April if possible.

The results will be used for statistical analysis only. Opinions will not be attributed to individuals. Please be assured that your responses will be treated in strictest confidence.

If you have any questions or would like to clarify anything please contact Jean Hopkin on +44 1344 770 376 or jhopkin@trl.co.uk.

The questions start on the next page.

1 In the following list of services in vehicles, how important do you consider the following for **your organisation** around the year 2025?
Please assume that vehicles will have an internet connection that is appropriate to each of these services.

Please respond using a scale of 1 to 5 where 1 is not at all important and 5 is very important.

(insert a ✓ in each row below)

	Service	5 Very important	4 Fairly important	3 Neither important nor not important	2 Not important	1 Not at all important	0 Don't know
1a	Hazardous location warning (weather and road surface conditions)						
1b	Incident warning (breakdown, queue, accident, slow moving vehicle, wrong way driver)						
1c	Vulnerable road user warning (cyclist, pedestrian)						
1d	Approaching emergency vehicle warning						
1e	In-vehicle signs and traffic rule violation warning (speed limit, stop sign, red signal)						
1f	Cooperative collision warning / intersection collision warning (for potential collision with vehicle on same road or opposite 'arm' of junction)						
1g	Dynamic traffic management (lane management, variable speed limit, metering of entry ramps)						
1h	Warning that you are about to enter a dynamic green zone/ low emission zone with access restriction						
1i	Eco-routing (with route choice determined by environmental criteria)						
1j	Cooperative electric vehicles (range estimation, vehicle to grid communication, book charging points, payment)						
1k	Pay as you drive - road pricing						
1l	Pay as you drive - insurance						
1 m	Personal travel assistant (informed decision making on inter-modal journeys in real time)						

	Service	5 Very important	4 Fairly important	3 Neither important nor not important	2 Not important	1 Not at all important	0 Don't know
1n	Real time travel planning and route optimisation						
1o	Location based services – real time information on points of interest						
1p	Internet services (internet browsing, email chat readout, social media)						
1q	Remote vehicle diagnostics and pre-maintenance notifications						
1r	Delivery window warning						
1s	Rest area notification and rest time violation warning						
1t	Communication hubbing service – intelligent cargo communicates with parties in logistics chain						
1u	Temporary height/ weight/ axle load restriction warning						
1v	Tracking and tracing of hazardous and valuable goods						

2 Are there **ANY OTHER SERVICES** based on vehicles having internet connection that you think will be important for your organisation by 2025? If so please give details below (otherwise go to 3.)

3 Thinking about services in 2025 based on vehicles having an internet connection that are **important to your organisation**. Please list any **key requirements** that these services will have to meet so that that they can successfully contribute to your organisation's objectives. These could be commercial, functional, technical or other requirements.
(For example some services may only be successful if all vehicles are equipped to operate the service)

	The online version of the survey will automatically copy the services selected in Question 1 as important or very important into this area. For the off-line version the services have all been copied below for ease of completion. Only fill in requirements if services are important or very important to your organisation.	Key requirements for success
3a	Hazardous location warning (weather and road surface conditions)	
3b	Incident warning (breakdown, queue, accident, slow moving vehicle, wrong way driver)	
3c	Vulnerable road user warning (cyclist, pedestrian)	
3d	Approaching emergency vehicle warning	
3e	In-vehicle signs and traffic rule violation warning (speed limit, stop sign, red signal)	
3f	Cooperative collision warning / intersection collision warning (for potential collision with vehicle on same road or opposite 'arm' of junction)	
3g	Dynamic traffic management (lane management, variable speed limit, metering of entry ramps)	
3h	Warning that you are about to enter a dynamic green zone/ low emission zone with access restriction	
3i	Eco-routing (with route choice determined by environmental criteria)	
3j	Cooperative electric vehicles (range estimation, vehicle to grid communication, book charging points, payment)	

	The online version of the survey will automatically copy the services selected in Question 1 as important or very important into this area. For the off-line version the services have all been copied below for ease of completion. Only fill in requirements if services are important or very important to your organisation.	Key requirements for success
3k	Pay as you drive - road pricing	
3l	Pay as you drive - insurance	
3m	Personal travel assistant (informed decision making on inter-modal journeys in real time)	
3n	Real time travel planning and route optimisation	
3o	Location based services – real time information on points of interest	
3p	Internet services (internet browsing, email chat readout, social media)	
3q	Remote vehicle diagnostics and pre-maintenance notifications	
3r	Delivery window warning	
3s	Rest area notification and rest time violation warning	
3t	Communication hubbing service – intelligent cargo communicates with parties in logistics chain	
3u	Temporary height/ weight/ axle load restriction warning	
3v	Tracking and tracing of hazardous and valuable goods	

4 Thinking about services in 2025 based on vehicles having an internet connection that are **important to your organisation**. Please list the main **problems, challenges and areas for further research** that you think will need to be overcome before these services can be implemented.

	The online version of the survey will automatically copy the services selected in Question 1 as important or very important into this area. For the off-line version the services have all been copied below for ease of completion. Only fill in problems, challenges or areas for research if services are important or very important to your organisation.	Problems, challenges and areas for further research
4a	Hazardous location warning (weather and road surface conditions)	
4b	Incident warning (breakdown, queue, accident, slow moving vehicle, wrong way driver)	
4c	Vulnerable road user warning (cyclist, pedestrian)	
4d	Approaching emergency vehicle warning	
4e	In-vehicle signs and traffic rule violation warning (speed limit, stop sign, red signal)	
4f	Cooperative collision warning / intersection collision warning (for potential collision with vehicle on same road or opposite ‘arm’ of junction)	
4g	Dynamic traffic management (lane management, variable speed limit, metering of entry ramps)	
4h	Warning that you are about to enter a dynamic green zone/ low emission zone with access restriction	
4i	Eco-routing (with route choice determined by environmental criteria)	
4j	Cooperative electric vehicles (range estimation, vehicle to grid communication, book charging points, payment)	
4k	Pay as you drive - road pricing	

	The online version of the survey will automatically copy the services selected in Question 1 as important or very important into this area. For the off-line version the services have all been copied below for ease of completion. Only fill in problems, challenges or areas for research if services are important or very important to your organisation.	Problems, challenges and areas for further research
4	Pay as you drive - insurance	
4m	Personal travel assistant (informed decision making on inter-modal journeys in real time)	
4n	Real time travel planning and route optimisation	
4o	Location based services – real time information on points of interest	
4p	Internet services (internet browsing, email chat readout, social media)	
4q	Remote vehicle diagnostics and pre-maintenance notifications	
4r	Delivery window warning	
4s	Rest area notification and rest time violation warning	
4t	Communication hubbing service – intelligent cargo communicates with parties in logistics chain	
4u	Temporary height/ weight/ axle load restriction warning	
4v	Tracking and tracing of hazardous and valuable goods	

5a Do you think there is a need for legislative action to foster harmonised implementation of services based on vehicles having an internet connection?

(✓ one box)

Yes	
No	
Don't know	

5b **If yes**, please give details below, and list the services this would apply to. (**If no**, go to 6a)

The online version of the survey will provide drop-down menu for selecting up to 5 services *for which legislation is required. To complete this version, service descriptions can be copied from Question 1 into the boxes below.*

	Service		Further legislation required
5bi		5ci	
5bii		5cii	
5biii		5ciii	
5biv		5civ	
5bv		5cv	

6a Do you think there is a need for further standardisation to foster harmonised implementation of services based on vehicles having an internet connection?

(✓ one box)

Yes	
No	
Don't know	

6b **If yes**, please give details below and list the services this would apply to. (**If no** go to 7)

The online version of the survey will provide drop-down menu for selecting up to 5 services for which standardisation is required. To complete this version, service descriptions can be copied from Question 1 into the boxes below.

	Service		Further standardisation required
6bi		6bi	
6bii		6bii	
6biii		6biii	
6biv		6biv	
6bv		6bv	

To help us understand how requirements and challenges differ between different types of organisation, please could you provide some details about your organisation

7. What type of organisation is it? *(insert ✓ below)*

Government/ public authority	
Operator or manager of roads	
Vehicle manufacturer	
OEM (original equipment supplier)	
Communications/ IT service provider	
In-vehicle service provider	
Freight operator	

Public transport operator	
Fleet operator	
Private road user organisation	
ITS organisation	
Research and Development	
Project/ initiative	
Other (give details below)	

8. What area does your organisation serve? *(insert ✓ in all boxes that apply)*

World wide	
Europe	
National	
Regional	
Local	

9. If national, regional or local, which country does your organisation serve? Write details below

(The online version has a drop down menu from which a country can be selected)

10. How many employees are there in your organisation? *(✓ one box)*

1 – 49	
50 – 99	
100 - 499	
500 - 999	
1000 or more	

11. Please provide your name and contact details so that we can check who has replied to the survey.

Name	
Role	
Organisation name	
Email address	

12. Please add any further comments that have not already been addressed by this questionnaire.

Thank you for taking the time to complete the questionnaire.

C Roadmapping details

C.1 Introduction

This appendix contains the detailed workings behind the roadmap analysis. The main approach is outlined in Section 6. Contained here are the individual scenario specific roadmaps which details of how the various services are fitted into a dependency based timeline. Also included within this appendix are the scenario specific development Waves, which were used to assess the robustness of the roadmaps and extract specific recommendations for EU interventions that would maximise the potential of the connected car.

The final part of this appendix includes the list of services identified under each Scenario to Wave combination, and the reason that service was identified as falling short without a specific intervention. The final aggregation of these shortfalls forms the recommendations in the main body of the report.

C.2 Identification of Services

At two project team workshops, help respectively on the UK and the Netherlands, the applications, services and service enablers which are expected to become available in the timescale covered by this study were identified. This identification process used the overview of future internet developments and future mobility services as described in Section 3 as a starting point, together with the project team's joint expertise, and the initial results of the stakeholder consultation.

The services identified during these workshops were then used both in the scenario development (as described in Section 5) and the Roadmapping process detailed in Section 6 and this appendix. The complete list of services considered, listed by scenario and divided into service and service enablers is given below. Note that some services appear in multiple scenarios.

Mobility Integrated Services	**Service Enablers**
Friends Location	HUD
Purpose Comprehension	Disruptive Business Models
Calendar 2 Navigation	Personal Preference Engine
Vehicle Cargo Location Service	Electronic Horizon
Active PoI	Contactless Payment
Insure How You Drive	DVB-T
Maintenance Notification Service	Digital Rights Management
Internet Browsing	CALM
Route Planning	Agnostic Location Referencing
Social Networking	IP Enabled Car
Mobile Office	Privacy Protocols
Online Gaming	Adapted Desktop Services
Internet Radio	Text2Speech
Personal Device Interconnection	Integration of Nomadic Device HMI
	WiFi Hotspots
	Data Management

Active Safety Protocols	**Service Enablers**
Cooperative Driving	Peer2Peer Networking
Incident Management	Technical Standards
Car Breakdown Warning	Dynamic Map Linked to Vehicle Dynamics
Cooperative Glare Reduction	Pre-crash Sensing
Road Condition Warning	Local Dynamic Map
Intersection Collision Warning	Sophisticated Sensors
Manoeuvre Assistance	I2V Comms
Speed and Distance Advice	Car Management system
Remote Diagnostic Service	
Vulnerable Road User Warning	
Ghost Driver Warning	
Driver Monitoring	
Emergency Vehicle Warning	
Blue Wave	
Slow Vehicle Warning	
Traffic Jam Ahead Warning	
Hazard Location Notification	
Traffic Rule Warning	
Speed Limit Warning Service	

Eco-Centric Driving	**Service Enablers**
Engine Management in Green Zones	Smart Grids
Battery Management	Car Management System
Drive Train Management	Local Dynamic Map
Fuel Efficiency Driving Aides	Sophisticated Sensors
Eco Based Road Pricing	Electronic Horizon
Green Hubs	National Emissions Picture
Green Zones for Trucks	V2X Comms Protocols
Maintenance Notification Service	CALM
Fuel Efficiency Monitoring	Data Management
Speed and Distance Advice	Vehicle Mounted Emissions Sensors
E-Range Estimation and Route Planning	
Eco routing	

Smart Transportation	**Service Enablers**
Intelligent Cargo	Common Framework for Freight Interoperability
Fleet Management Services	Relative Positioning Technologies
eCustoms	Privacy Protocols
Tolling Systems	Electronic Horizon
Heavy Route	Communication Hubbing Service
Cargo Discharge and Takeover	
e-Freight	
Resting Time Violation Warning	
Temporary Restriction Warning	

Smart Transportation	Service Enablers
Rest Area Service	
Cargo Warning Service	
Drive Change Service	
Route Update Service	
Travelling Salesman Optimisation	
Delivery Window Warning	
Tracing and Tracking Service	
Vehicle Cargo Location Service	
Workforce Tracking and Accountability	
Transport Document Service	

Cooperative Traffic Intelligence	Service Enablers
Smart Grids	Layered Traffic Management
eCustoms	Personal vs Network Travel Optimisation
Local Traffic Management Initiated by User	Electronic Horizon
Vehicle Convoy Formation	Sophisticated Sensors
Cooperative adaptive cruise control	Tolling Systems
Self Optimising Travel Network Routing	Analytics as a Service
Battery Management	Green Zones
Ramp Metering	Data Management
Hard Shoulder Running	CALM
Dynamic Lane Management	Data-Exchange Standards
Slow Vehicle Warning	Privacy Protocols
Speed Enforcement	V2X Comms Protocols
Insure How You Drive	
Vulnerable Road User Warnings	
Car Breakdown Warning	
Incident Situation Handling	
Incident Management	
Traffic Flow Management	
In Vehicle Traffic Signs	
B-Call	
Congestion Avoidance	

Agile Navigation	Service Enablers
Infotainment Services	Augmented Reality
Lateral Safety Services	Verbal Read Out
Blue Wave	Verbal Recognition
Verbal Control systems	V2V Communication
Traffic Flow Management	Self Organising Traffic Protocols
Incident Situation Handling	Vehicle as a Sensor
Point of Interest Services	Accurate Vehicle Location
Real Time Semantic Search	4 Hz Local Dynamic Map
Range Management Systems	Differential GPS
Vehicle Performance	Common Network Definition
Sub Optimal Driving Conditions	Cloud Stored

Agile Navigation	Service Enablers
Road Status Services	Traffic Rule Definitions
Self Monitoring Traffic Control Systems	Common Scheduling Definitions
Traffic Management Services	Interchange Timetables
Dynamic Lane Management	Web 3.0
Access Control	Meta Data Structures
Support Service Status (EV Charge)	LTE / WIMAX
Hazardous Location Notification	4G Cellular Networks
Green Zones / PAYD	Communications Access for Land Mobiles (CALM)
Corridor Designation	Layered Traffic Management Concept
	Common Push Services (GeoRSS)
	Infrastructure Self Sensing
	Synching Systems
	Secure Data Exchange Protocols
	Nomadic Device Integration

C.3 Roadmapping approach

C.3.1 Roadmapping as a tool for capability gap identification

Technology Roadmapping is a widely used tool for exploring the benefits and shortcomings of technology development programmes across private and public sectors.

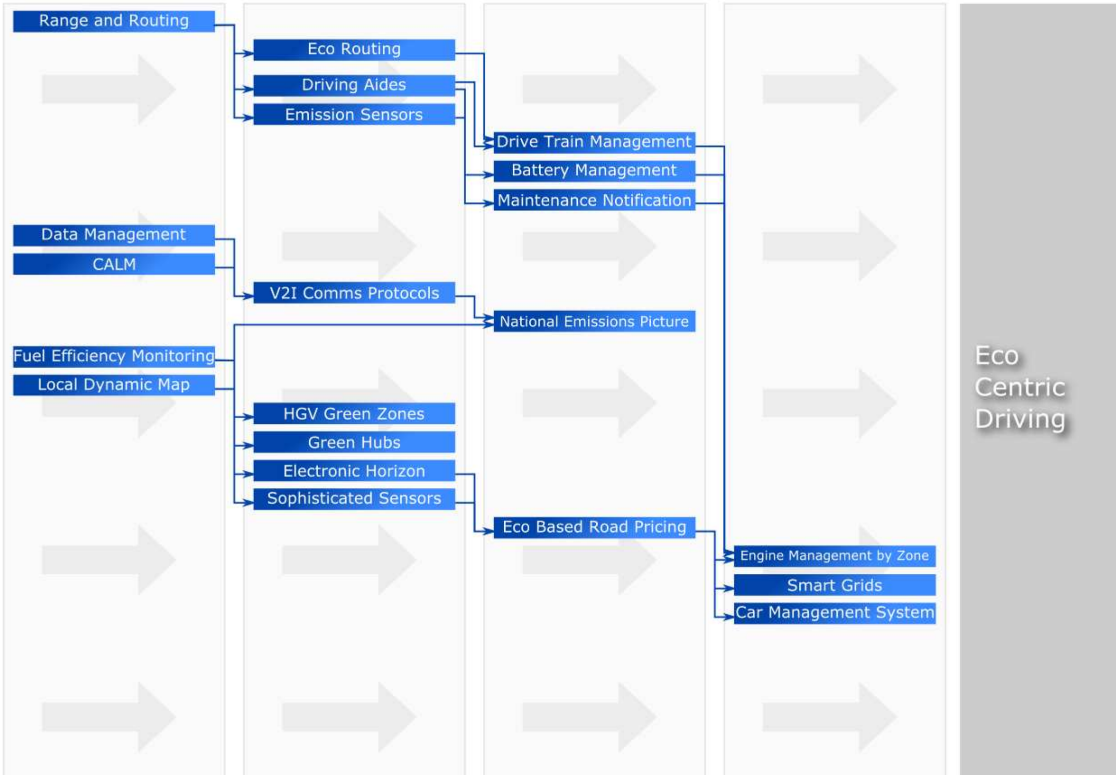
In essence, a roadmap is a time based plan for the interoperability and interdependency of discrete developments, often visualised as similar to a Gantt chart. By mapping estimated timeframes for when programmes will run issues of programme management and technology integration can be identified.

In this context Roadmapping has been used to map the identified services for the connected car to each of the six identified scenarios. This provides an idea of the order in which services may appear, and allows for identification of the expected challenges arising from their interactions. As so many of these services are expected to emerge from the global market, specific start and end dates cannot be stated; instead they have been separated into discrete time bundles. These are typically along the order of:

Timeframe 1: What is already starting to happen now;
Timeframe 2: What is expected to happen imminently;
Timeframe 3: What is probable to happen within the 2025 context;
Timeframe 4: What is possible to happen with the 2025 context.

In this way the services were mapped to the six Connected Car 2025 scenarios.

An example of how these services are mapped is shown below for the Eco-centric motoring scenario. This shows the four timeframes in the columns from left to right, and the various clustered services as they develop through the four timeframes.

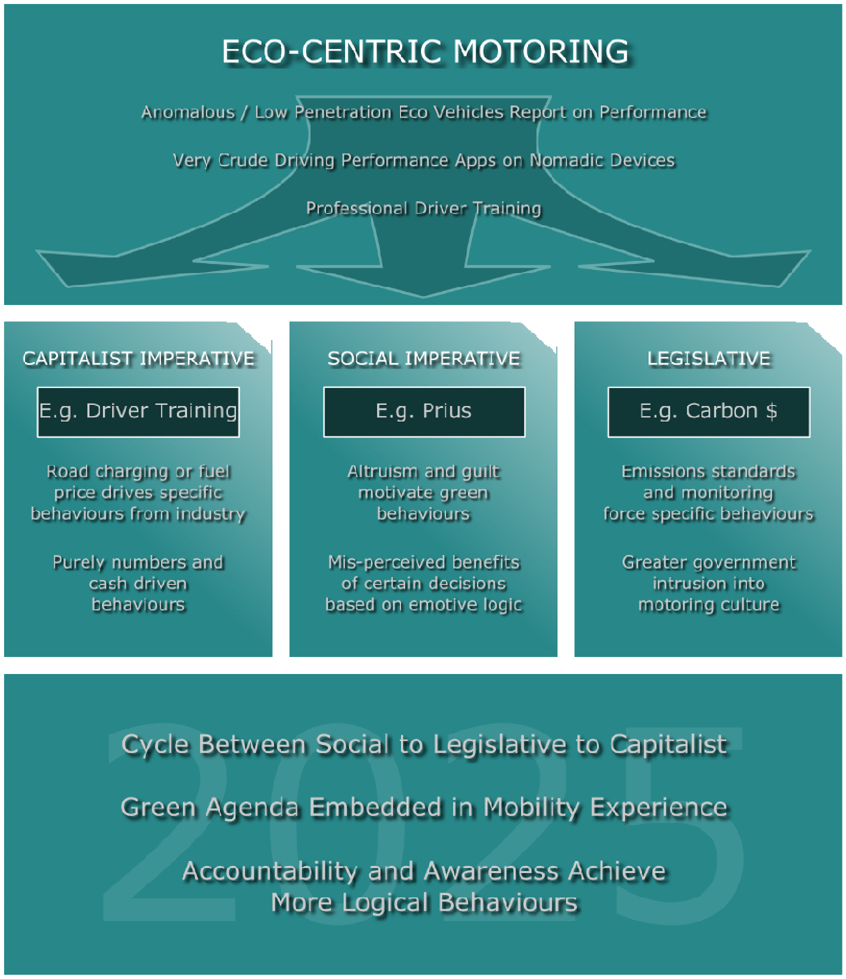


The challenges that arise from examining roadmaps are referred to here as Capability Gaps that could beneficially be met by a direct EU intervention. How these gaps are identified is flexible depending on the context. For the purposes of understanding the connected car, this study has used alternative routes to reach these scenarios described as Waves.

C.3.2 Exploring roadmaps using alternative waves

The alternative waves idea was developed to allow the roadmaps developed from the services and scenarios to be examined from multiple angles. For each of the six scenarios there are multiple ways they could come to fruition. It might be that the difference between closed and open source is critical, or whether technology is funded by Governments or Consumers.

For each of the roadmaps, three waves were identified as ways in which the end vision of the scenario might come about. These waves are effectively routes by which that scenario might be achieved. These have been documented as figures with supporting comments in the main body, section 6.4. An example for eco-centric driving is shown below.



With the paths complete, the final step in extracting recommendations from the roadmaps was to assess each roadmap for each wave. In this process, each service was considered under each wave as to whether or not it was likely to come into existence without influence or help from the EU or national centralised authorities. If a service was considered unlikely to come into existence under two or three of the waves then it was considered to be a serious potential risk to reaching the full potential of the connected car. These service overlaps were then turned into specific recommendations for consideration.

To summarise:

a) The Services were mapped to applicable scenarios;
b) For each scenario, the services were ordered into a roadmap;
c) For each scenario three possible development waves were identified;
d) The roadmaps were analysed for each wave to highlight services that would not be likely to appear under each wave;
e) Services that were not likely to appear in two or three of the waves were highlighted as requiring support from EU intervention.

C.4 Scenario specific development waves

The development waves were generated using an expert workshop at TRL to identify the three likely routes for development of each of the six scenarios.

For each scenario, a current point and an end point were identified, where the end point is the complete 2025 scenario. The three identified waves were than described conceptually as titles, backed up with examples and descriptive bullet points. This information was assembled into figures, with the Present Situation at the top of the figure, the 2025 Scenario at the bottom of the figure, and the three waves in the middle bridging the gap between the present and the future.

The six figures of 3 Waves for each scenario are shown here.

C.4.1 Eco-Centric Driving

In Eco Centric Motoring, the future is envisioned as a complex evolution of the ongoing interplay between Social, Legislative and Economic drivers that underline the environmental agenda. As the eco concept becomes ever more embedded into transport systems and transport planning, business and consumers make more effective choices for the reduction of emissions and consumption.

The three waves envisioned for this scenario are as follows.

- **Capitalist Imperative.** While many eco behaviours are driven by conscientious choice, some are made by economic imperative. The rising price of fuel, as well as increased vehicle and carbon taxes, will drive all users of the connected car towards more environmentally friendly solutions. For example, driver training by large logistics companies will become more popular to help save fuel costs.
- **Social Imperative.** The effects of peer pressure, public status symbols and general social norms will continue to shift towards environmental concerns. Much as recycling is very much the norm in 2011, so eco centric motoring will rise from continued societal changes. The classic example of this change has been the rise of the Toyota Prius as a status symbol in many EU societies.
- **Legislative.** Following in the footsteps of social change, legislative change driven both by the EU and globally will encourage and potentially enforce eco driving in certain situations. Carbon taxes are one example of this change.

C.4.2 Active Safety Protocols

The future case for the Active Safety Protocols is based around the benefits brought to safety systems from networked vehicles. Many of these systems will be extensions of existing concepts, such as ADAS, that scale with the network. Others will be more holistic and will involve risk mitigation and wider management of a big proportion of the EU vehicle fleet.

The three waves for this scenario are as follows.

- **Safety Sells.** There is a (possibly apocryphal) anecdote that a large car manufacturer once said that “Safety doesn’t sell”. This is clearly not true in 2011 when many brands and models tout their safety scores. If this trend continues, and driver consumer choices, then the markets will follow suit. The example here is Fridges, as in automated Fridges that order foods electronically through the internet when stocks run low. These are an example of an unexpected technology driven by a small group of determined early adopters that has very slowly grown over time, much as early safety interventions did.

- **De Jure.** In some cases safety systems have not been taken up by manufacturers and have instead needed to be mandated by law in a similar way to eCall. A common example of this is the legislative enforcement of motorcyclist crash helmets; often unpopular with riders these dramatically reduce the loss of human life in incidents involving motorcycles.
- **De Facto.** When features are very low cost to include in a product, or when they are desired by a large majority of consumers, manufacturers often support the feature in their whole product range. As such it is possible that by 2025 many of the new vehicles entering service will not only have connected car as standard but will also have active safety protocols as standard. As such buying a new vehicle without such systems would become much more difficult. An example of this is ABS braking systems, which are now common on the vast majority of all recently sold vehicles.

C.4.3 Smart Transportation

In the smart transportation scenario the focus of the 2025 scenario is around advanced logistics services that provide more information and capacity for the management of cargo, freight, delivery and asset tracking. The combination of these systems allows assets to be tracked for their whole life, from construction to decommissioning, changing how second hand equipment sales are managed.

The three waves identified were as follows.

- **Micro Management.** With very high resolution information always available about fleet operations, the fleet managers will have the ability to make micro decisions on individual vehicle activities such as suggesting rerouting options or monitoring unscheduled breaks, so increasing overall performance. An example of this comes from battlefield surveillance, where military commanders with real time uplinks to battlefield drones allows them to direct forces on the ground with minute detail.
- **Empowerment.** This wave is all about allowing users within the fleet itself to attempt to enhance their productivity by using the available data and services to find shortcuts and efficiencies in their activities, collaborating with other fleet members to best effect. An example of this would be Heathrow Airport in the UK where a novel system of self driving vehicles is being used to ferry passengers between the various termini. These enable passengers to draw upon the capacity of the system as and when required, enhancing their journeys in collaboration with the system.
- **System Directed Optimisation.** This final wave is about highly connected systems that are then optimised by a common (be it centralised or distributed) platform. In the case of connected cars this could take the form of sophisticated traffic management or freight cargo optimisation across different carriers. The example is that of a large supermarket chain using global optimisation techniques to provide just in time delivery of goods to a network of grocery stores.

C.4.4 Mobility Integrated Services

In the scenario of mobility integrated services the 2025 end state is based on a seamless consumer content experience where a wide range of services and electronic media are served up by the connected car through a continuous data stream. This future is also expected to be dominated by commercial sources platforms, potentially with complex shared ownership arrangements where modification of the Connect Car platform beyond manufacturer’s specifications is not only unadvisable but is actually against the law. A topical example of this is the Sony Playstation 3, where users have modified the device to circumvent Digital Rights Management.

The three waves are as follows.

- **Single Service Lock-in.** This wave is best demonstrated by example, in this case the online Facebook service. A single service provider has come to dominate a specific connected service to the exclusion of all others, and by retaining the backlog of information, data and preferences all within a proprietary system it is increasingly difficult for user to leave and move to a different service. A similar situation could arise with the connected car, especially as social networking is expected to play a significant role in the connected car experience.
- **Under Dog.** With many significant technologies and services (even beyond the internet), there is often a strong "Second Best" provider that attempts to increase market share and out innovate the market leader. A good example of this has been Microsoft's Bing internet search service, and attempt to take market share from the Google search engine by providing alternative feature set. Examples in the connected car could include alternative providers of engine management systems or replacement navigation applications.
- **Portable Persona.** A third more open development focuses on keeping systems and data portable. This empowers users to switch and change services based on the available options. This increases market competitively and innovation, at the possible expensive of decreasing the overall utility (especially true of socially orientated applications). The example here is Diaspora, an attempt to build a truly open social networking data exchange platform and associated client, in effect a competitor for Facebook (and until recently MySpace).

C.4.5 Cooperative Traffic Intelligence

In Cooperative Traffic Intelligence the 2025 end state assumes a Connected Car network where everything about every vehicle is known all of the time (100% Picture Completeness). This is coupled with navigational settings to predict vehicle destination, allowing network providers to respond decisively to traffic conditions before they occur, and is coupled with high quality data from a range of onboard sensors.

The three waves that allow this end state to be reached are as follow.

- **Avalanche.** With the emergence of some technologies there can be a sudden flow of many services all trying to reach the market simultaneously. Examples of this include the original Internet "Dot Com Bubble" and more lately the mobile phone "Apps Goldrush", where users have been suddenly overwhelmed with choice. In terms of available data for traffic intelligence, when connected cars become standard a sudden unleashing of this data could suddenly facilitate a similar burst of activity resulting from a single change.
- **Privacy Rules.** A number of landmark transportation projects have stalled or failed due to the public and government objections on the grounds of personal privacy. While technology solutions to the privacy issue do exist, their application and success has been variable. It is possible that the high value data generated by the connected car could fail to reach market as users are unwilling to let go of this information without economic incentive. An example would be a number of road pricing schemes around the world which have been cancelled on the grounds of the required technology proving invasive on personal privacy.
- **Sawtooth Evolution.** Some technology or approaches have only ever moved forwards because they have been driven by one or two high prominence individuals (typically government employees). These people provide the energy and backing to make these projects a reality. Because this approach is

inconsistent, this results in progress that is made in discrete increments as opposed to continuous development. A good example of this is variable mandatory speed control on highways, which has been made possible by key individuals driving for the procedural and legal changes required to make it a reality.

C.4.6 Agile Navigation

The final scenario focused on navigation systems based on the connected car concept. As the 2025 timeframe approaches it is expected that services will appear that integrate the transport planning experience across all modes and requirements. Systems will arise that anticipate journeys, plan them, integrate them with traffic management systems and provide the connected car user with all the service bookings and provisions (such as booking parking spaces) as required.

This future state can be reached in the three following ways.

- **Consumer Pays.** If the demand for a service is high enough, it can be trusted that within the EU the ability for free markets to deliver it will be sufficient to see it happen. With some connected car services, the value increases as the number of users increases (this is especially true of social enterprises). In these cases early technology adopters will tend to fund the technology, and the price lowers as uptake increases. In this way the users of the service directly pay for the development and delivery of the service over the course of its emergence. An example of this would be existing Satellite Navigation providers such as TomTom who charge users for a unit to retrofit a vehicle and an ongoing service charge to finance the ongoing delivery.
- **Hidden Costs.** An alternative funding method for navigation services within the Connect Car is for the costs to remain hidden in more expensive purchases, typically concealed as a part of the original cost of the vehicle. This is the case in a number of commercial vehicle examples, where the vehicle is shipped with the technology already installed and a fixed term of service provided for free. Once this term of service ends the customer is required to pay additional charges to continue; even if the user discontinues the service the technology has still been subsidised, driving growth and development of the connected service.
- **Open Architecture.** The final mechanism identified for the development of agile navigation is the growth of open source architectures. A very well know example of an open architecture is the Google Maps API, which allows many websites to use Google maps as the background for information display. One step further from this is the Open Source model, where communities such as the Open Geospatial Consortia develop standards and software with which developers can build their own navigation systems. This approach integrates well with crowd sourced information, providing potentially highly innovative services free to the consumer at point of install (potentially with charges for independent software or user support).

C.5 Service Limitations

With the roadmaps and the three wave diagrams completed the final step in the gap analysis was to cross compare the two, attempting to identify through judgement which of the services identified on each roadmap would be difficult to deliver under each of the waves. Then, for each scenario, if a service proved difficult to deliver under more than one wave it was highlighted as a gap and a recommendation was formed to meet it.

Presented here in this appendix is the complete listing of which services were identified as challenging under each Scenario to Wave pairing. This is presented as a tabulated list below.

Scenario	Path	Service Affected
Eco Centric Driving	Capitalist Imperative	Eco Routing
		Data Management
		CALM
		V2I Comms Protocols
		National Emissions Picture
		Electronic Horizon
		Sophisticated Sensors
		Engine Management in Green Zones
	Social Imperative	Vehicle Mounted Emissions Sensors
		Maintenance Notification Service
		V2I Comms Protocols
		National Emissions Picture
		Local Dynamic Map
		Electronic Horizon
		Sophisticated Sensors
		Smart Grids
		Car Management Systems
	Legislative	Fuel Efficiency Driving Aides
		Maintenance Notification Service
		Electronic Horizon
		Smart Grids
		Car Management Systems
Active Safety Protocols	Safety Sells	I2V Comms
		Blue Wave
		Vulnerable Road User Warning
		Road Condition Warning
		Intersection Collision Warning
		Technical Standards
		Peer2Peer Networking
		Cooperative Glare Reduction
		Incident Management
		Cooperative Driving
	De Jure	Car Management System
		Manoeuvre Assistance
		Driver Monitoring
		Ghost Driver Warning
		Technical Standards
	De Facto	I2V Comms
		Driver Monitoring

		Vulnerable Road User Warning
		Sophisticated Sensors
		Road Condition Warning
		Cooperative Driving
Smart Transportation	Micro Management	Travelling Salesman Optimisation
		Policy Protocols
		Resting time Violation Warning
		Cargo Warning Service
		Driver Change Service
		Intelligent Cargo
	Empowerment	Workforce Tracking and Accountability
		Communications Hubbing Service
		Travelling Salesman Optimisation
		Resting Time Violation Warning
		Common Framework Freight Interoperability
		Heavy Route
		Tolling Systems
		eCustoms
		Intelligent Cargo
	System Directed Optimisation	Workforce Tracking and Accountability
		e-Freight
		Tolling Systems
		Freight Management Services
Mobility Integrated Services	Single Service Lock In	Personal Data Interconnection
		Privacy Protocols
		Adapted Desktop Services
		Widespread IP Enabled Car
		Car Mounted WiFi Hotspots
		Car Mounted Internet Browser
		Integration of Nomadic Device HMI
		Agnostic Location Referencing
		Personal Preference Engine
		Disruptive Business Models
		User Requirements Prediction
		Calendar2Navigation
	Under Dog	Personal Data Interconnection
		Privacy Protocols
		Social Networking
		Online Gaming
		Friends Location
		Adapted Desktop Services
		Contactless Payment
		Widespread IP Enabled Car
		Integration of Nomadic Device HMI
		Digital Rights Management
		Text2Speech
		HUD
		Electronic Horizon
		Personal Preference Engine
		Disruptive Business Models
		User Requirement Prediction

		Calendar2Navigation
	Portable Persona	Privacy Protocols
		Mobile Office
		Contactless Payment
		Digital Rights Management
		Electronic Horizon
Cooperative Traffic Intelligence	Avalanche	Data Management
		eCustoms
		Electronic Horizon
		Personal vs Network Travel Optimisation
		Layered Traffic Management
	Privacy Rules	Breakdown Call (B-Call)
		Privacy Protocols
		Incident Situation Handling
		Speed Enforcement
		Tolling Systems
		Vulnerable Road User Warning
		Slow Vehicle Warning
		Electronic Horizon
		Personal vs Network Travel Optimisation
		Self Optimising Travel Network Routing
		Smart Grids
	Sawtooth Evolution	In Vehicle Traffic Signs
		Incident Situation Handling
		Data Exchange Standards
		CALM
		Data Management
		Insure How You Drive
		Electronic Horizon
		Vehicle Convoy Formation
		Local Traffic Management Initiated by User
Agile Navigation Systems	Consumer Pays	Nomadic Device Integration
		Corridor Designations
		Green Zones / PAYD
		Common Scheduling Definitions
		Common Network Definitions
		Vehicle as a Sensor
		Later Safety Services
	Hidden Costs	Corridor Designations
		Green Zones / PAYD
		Infrastructure Self Sensing
		Self Monitoring Traffic Control
		Layered Traffic Management
		Point of Interest Services
		Common Scheduling Definitions
		Common Network Definitions
		Incident Situation Handling
		V2V Comms
	Open Architecture	Corridor Designations
		Infrastructure Self Sensing
		Web 3.0

		4G Cellular Networks
		LTE / WIMAX
		Comfort Services
		Lateral Safety Services

C.6 Gaps identified by the roadmaps

The gaps identified from the Roadmapping process are shown in the table on the following pages. These capture the service and associated gap which it is proposed will require addressing to maximise the potential of the connected car. For each recommend an estimate is made of the implication of not following the recommendation, in effect the Impact of Inaction.

Table C.13: Recommendations from Roadmapping.

Services	Scenario / Roadmap	Capability Gap	Recommendation	Impact of Inaction
National Emissions Picture, Smart Grids and Car Management Systems	Eco Centric Driving	Development of large Eco centric schemes are not self funding and can fare poorly in cost benefit analysis	1. Facilitate economic viability of "Grand Green Schemes"	Large eco centric schemes do not manage to form, reducing chances of the EU meeting climate agreements such as Kyoto
Electronic Horizon and Sophisticated Sensors	Eco Centric Driving	Eco services outside a single car require sharing of sufficient quality and volumes of data	2. Develop infrastructure and agreements to enable vehicles to share user data between them	Innovative, high impact environmental solution services are hampered from entering the commercial market and disappear due to low take up
Road Condition Monitoring	Active Safety Protocols	Limited ability to harvest infrastructure condition information from the cloud	3. Promote development of Infrastructure that transmits self status data into the cloud through development and maintenance of standards and facilitate exploitation of existing live data source APIs into public domain	Road conditions continue to be repaired in the current reactive method, denying EU tax payers with potential tax savings from infrastructure maintenance
Vulnerable Road User Warning	Active Safety Protocols	Lack of networked picture of non infrastructure / non vehicle elements such as pedestrian locations and movements or debris	4. Facilitate development of W2V (World to Vehicle) – providing the connected car with information about the local world beyond standard highways infrastructure	Without these services potential reductions in risk to life will not be realised

Services	Scenario / Roadmap	Capability Gap	Recommendation	Impact of Inaction
Driver Monitoring	Active Safety Protocols	Lack of clarity in terms of what is socially acceptable or what motorists will accept in terms of driver monitoring by the vehicle	5. Define the *Right to Monitor* a driver, identifying the limits of acceptability	Services could end up invading user privacy and sharing too much personal information, facilitating identity theft. Or they may not share enough, resulting in less effective safety orientated services
Incident Management and Cooperative Driving	Active Safety Protocols	Partially developed standards and protocols are still in development	6. Continue to develop standards and protocols for true cooperative driving	Cooperative and partially autonomous safety orientated services cannot be delivered into the connected car
Intelligent Cargo, Travelling Salesman Optimisation	Smart Transportation	With individual operators conducting heterogeneous operations fully efficient cargo based services cannot be realised	7. Help logistics operators let go of total micro control, enabling final evolution of Intelligent Cargo	Freight continues to be sub optimal efficiency, and increasing demand for freight services results in ever increasing freight congestion and disruption
Intelligent Cargo	Smart Transportation	Duty of care legislation drives employers towards over cautiousness by default, removing ability to explore benefits of freer systems	8. Provide methods for quantifying soft benefits associated with privacy and autonomy to counter the risk of always-on micromanagement	Quality of life for EU workers reduces and increased ill health effects of stress resulting from over monitoring are recorded
Workforce Tracking and Accountability, Resting Time Violation Warning	Smart Transportation	Connected car systems will be subject to vandalism by drivers to negate personal disbenefits results from overall fleet benefits	9. Monitor progress of fleet to identify new methods of cracking and spoofing systems to subvert micromanagement and legislative oversight	Systems become wholly unreliable due to misuse, impacting the Connect Car platform universally

Services	Scenario / Roadmap	Capability Gap	Recommendation	Impact of Inaction
Digital Rights Management	Mobility Integrated Services	Multiple incompatible industry led DRM solutions will lead to a reduced consumer experience of the connected car	10. Development of a centralised, consistent and consumer orientated DRM solutions[15]	Innovative and commercially valuable services with would subsidise other services are not realised
Adapted Desktop Services, User Requirement Prediction	Mobility Integrated Services	Commercial systems often place functionality ahead of privacy which has resulted in a number of high profile information vulnerabilities. This has led to reluctance among consumers to input or share personal data	11. Build user trust in Connected Car privacy by facilitating and scoping generic privacy protocols and implementation to maintain public confidence in Connected Car solutions	Services default to minimal information and minimal compatibility, increasing the long term costs of developing the platform
User Requirement Prediction, Calender2Navigation	Mobility Integrated Services	Pattern matching based machine learning is not currently able to predict complex social behaviours	12. Development of AI and thinking machines for personal preference	Without these technologies the true value of self learning and adaptive infrastructure will never be realised in the highways environment
Adapted Desktop Services	Mobility Integrated Services	Smaller developers of services have difficulty accessing payment mechanisms, effectively awaiting a PayPal equivalent for the connected car	13. Develop payment mechanisms that are open to all levels of integrator / developer	Smaller service providers will be barred from the connected car market place, reducing overall innovation and increasing costs
Electronic Horizon, Self Optimising Travel Network Routing	Cooperative Traffic Intelligence	Lack of standard for what information will be required by cooperative systems from the electronic horizon	14. Scope limits of data requirements for the electronic horizon, what data is needed and how should it be encoded	Predictive systems remain only generalised estimates, reducing the ability of adaptive highway systems to predict and provide

[15] Commercial and proprietary DRM solutions have the potential to lock out the innovations delivered by Small and Medium Enterprises, slowing the rate of development of Connected Car solutions. There is also a risk that draconian DRM solutions will force users to modify their Connected Car systems to circumvent DRM, risking the integrity of other services including safety critical services.

Services	Scenario / Roadmap	Capability Gap	Recommendation	Impact of Inaction
Incident Situation Handling, eCustoms, Local Traffic Management Initiated by User	Cooperative Traffic Intelligence	Lack of clear definition of what personal information can benefit these services and what information security will be required	15. Scope limits of personal information that can be safely disseminated without breaching personal / identify security or privacy	Information with clear operational and market value remains unusable
Green Zones, Pay As You Drive	Agile Navigation Systems	Cloud mounted data services for connected cars lack a clearly defined data meta / semantic structure to facilitate zone based services	16. Design data structures to facilitate implementation green zones / PAYD through standardised encoding of connected car data storage including data resolution and formatting for emissions data	Simplified low cost route and demand management systems are not realised through the connected platform
Infotainment Services, Lateral Safety Services	Agile Navigation Systems	Long term crowd sourcing will solve a number of data issues, but in medium term sensors and data creators are limited	17. Plug medium term data gap for long term crowd sourced info	Navigation provision is limited to a small number of high price suppliers and boosts to tourism resulting from infotainment are not achieved
Lateral Safety Services	Agile Navigation Systems	Corridor definition on highways networks presently only defined longitudinally in many cases and lack resolution and data quality for infrastructure based services	18. Hyper fine corridor designation and management including parking	Services that rely on common accessibility to standardised description formats such as location based services are less efficiently realised

C.7 Radar style roadmap

As well as document the recommendations from the six scenarios, they have been prepared as a further radar style roadmap to shown when they are expected to appear, and how they cluster together. Four distinct categories of recommendations are made:

- Economic Facilitation where areas such as benefits estimation, deregulation and incentivisation are prevalent;
- Technology and Policy Facilitation where connected car services can be promoted through development of new policies of technology management doctrine such as standardisation through legislation;
- Core Developments where the development of new technology or infrastructure would be required to achieve the full benefits;
- Overwatch where areas are expected to diverge and cause emergent issues that require management over time.

The completed radar map is shown in Figure C.14 and maps the recommendations by Present Gap, Imminent Gap, Probable Gap and Possible Gap, all within the 2025 timeframe.

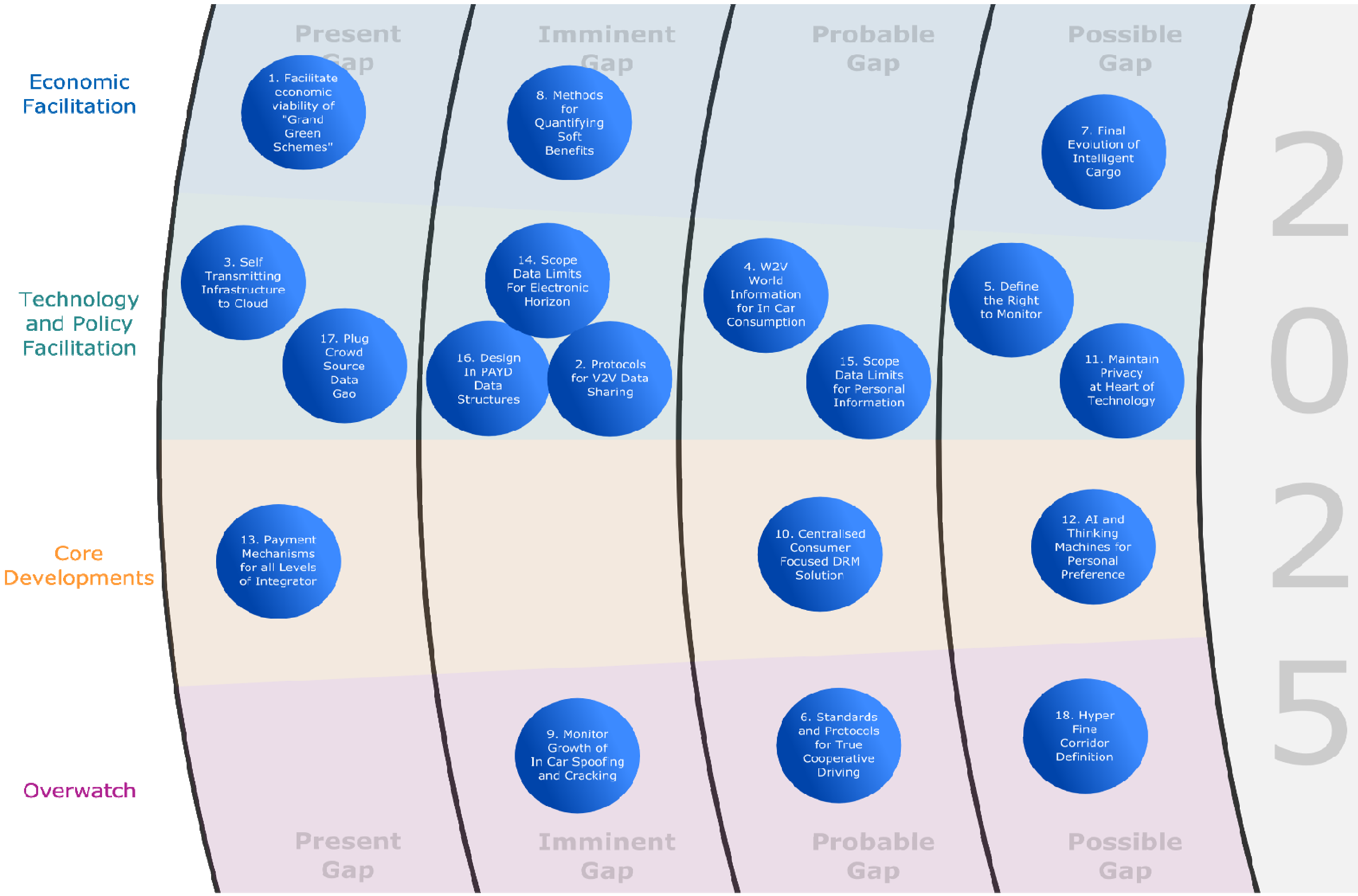


Figure C.14: Radar diagram of Roadmap.