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ITS Action Plan

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Action Area 4:

Integration of the vehicle into the transport infrastructure

Specific Action 4.1:

Adoption of an open in-vehicle platform architecture for the provision of ITS services and applications, including standard interfaces.

Final Report

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1 Executive Summary

Action Plan area and specific action

This report supports Specific Action 4.1 of the ITS Action Plan.

Action Plan Area 4: Integration of the vehicle into the Transport Infrastructure

Specific Action 4.1: Adoption of an open in-vehicle platform architecture for the provision of ITS services and applications, including standard interfaces

The challenge

There are many different European Union organisations, both in the public and private sectors, with an interest in deploying ITS services involving in-vehicle equipment. The public sector interest has increased in recent years, with new legal requirements for the deployment of several major pan-European applications involving such equipment. These deployments are facing significant implementation barriers and progress has been disappointing.

As part of the ITS Action Plan, the European Commission is exploring further measures which could facilitate the more rapid deployment of multiple applications within the vehicle by different stakeholders, by addressing the issues associated with in-vehicle architecture. The development of suitable business models and security considerations also play an important part in the future introduction of advanced location-based services.

The vision

It might be helpful to keep in mind what might the future look like for users if the various barriers to implementation could be overcome?

The user would ideally face the prospect of a future in which he could freely buy consumer-facing applications, such as Infotainment, Navigation and Payment Services, and connect these to any car regardless of vehicle type or model. With this "connectivity platform" these applications would seamlessly connect to the vehicle and make use of reliable and up-to-date vehicle information on location, speed, payment, etc.

The users of commercial vehicles could freely choose a certified Service Provider that would provide as a minimum regulated applications, such as the digital tachograph and EETS, ensure compliance with the rules, and achieve good quality and efficiency. This "regulatory platform" would be regarded as a service that enhances the productivity factor within the allowed framework of routes, driving hours, etc.

Furthermore, the user could experience progressively new ways of being assisted with driving through an increasing number of in-vehicle safety applications. This "embedded platform" of car-related applications would enable the car to communicate with other cars and the roadside environment, to be aware of its surroundings and to provide the driver with the most suitable support.

The study

This report contains the result of a study undertaken on behalf of the European Commission (DG MOVE B4) to provide an in-depth comprehension of the situation.

Review of existing knowledge and lessons learned

The study team has reviewed:-

- Eight EC funded projects working on in-vehicle platforms
- Eleven EC funded projects which were application related
- Four industry initiatives

Lessons learned have been grouped under:-

- Technical architecture
- Business architecture
- Security architecture

Technical architecture

There are many different technical architectures – indeed every project and initiative reviewed has proposed a technical architecture to match their specific requirements. Some projects focus more on the in-vehicle architecture, while others incorporate this into a wider architecture, including the roadside, central and potentially "personal"(i.e. hand-held) sub-systems.

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Some projects focusing on the vehicle platform are converging on the use of CALM, offering peer-to-peer functionality between the vehicle subsystem and other sub-systems (whether in the same or other vehicles) over IPv6. Such an approach leads to the possibility of different agencies providing the different components within the vehicle.

Other projects focus on the in-vehicle sub-systems and sensors, relying more on the CAN-bus for communication. These are more likely to be proprietary to the vehicle manufacturers and thus present obstacles when considering a unified in-vehicle architecture.

As a result of the lack of sufficiently standardised interfaces to in-vehicle systems, two approaches to the technical architecture remain – one being highly integrated to the vehicle, with devices potentially line-fitted during the vehicles' manufacturing, and the other one being a far more autonomous, retro-fit design (where sensors and devices like GNSS and GSM potentially are very likely to be duplicated with existing built-in vehicle devices).

Business Architecture

Comparatively greater emphasis has been put in recent projects and initiatives on the technical aspects of in-vehicle systems, with less focus on establishing and agreeing business architectures for cooperative projects. The EETS business model has created a strong precedent, being mandated in all Member States. In this model, EETS Providers provide a charging and payment service to users on behalf of all Toll Chargers.

This model has been adopted and extended in the GSC project and has become part of the GST/CVIS high-level role model. The model allows for further market opportunities whereby there may be many Service Aggregators who offer (different) packages of services and provide them to the Service Users using their own platform. Service Providers would deploy their service to each of the various Service Aggregators.

However there are some significant limitations to the service model. Being mainly commercially driven, little consideration has yet been given to potential avenues for introducing public services (like for example eCall), especially for the more safety critical applications (like those being looked at in SafeSpot and COOPERS) which are not of sufficient commercial attractiveness to end users to support strong business cases.

A second important distinction for business architectures for in-vehicle platforms is the different scenarios for commercial and private transport. Information flow and business requirements of freight transport are fundamentally different from those of private transport, where industry is currently leaning more towards provision of value added services, such as infotainment. It certainly will need more investigations into the different business drivers of those two groups to establish whether the same business architecture would be best suited for servicing both.

Security Architecture

The differences between public (sometimes also safety critical) and private requirements on the business architecture is made more complex by the different demands of freight and passenger transport. Safety enhancing systems (such as that researched in SafeSpot) or time-critical emergency services (such as eCall) will place a high priority on the availability and integrity of service, thus increasing the cost of the requirements on the technical architecture. Commercially driven consumer applications and services may deem authentication and confidentiality as more important, and be less stringent on integrity or availability (which may even become optional for some business cases), hence minimising the cost of the requirements on the technical architecture.

The main challenge for establishing an agreed security architecture for a standardised in-vehicle platform therefore remains in consolidating business cases and business models for regulated and consumer applications, projects such as EVITA and OVERSEE are contributing to solving this challenge. If no agreement can be reached then security considerations may make the introduction of parallel (even if very similar) platforms necessary – as can currently be observed in reality.

Legal provisions and requirements

The study has considered the approaches taken for:-

- Digital tachograph
- eCall
- EETS
- Transport of Dangerous Goods
- Transport of Livestock

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The deployment of these in-vehicle ITS and safety systems result from different legislative routes followed by the European Commission.

The implementation approach chosen for the Digital Tachograph has to date been the most successful in terms of the proportion of concerned vehicles equipped. The regulation mandates that the Digital Tachograph should be fitted to all new vehicles registered after 1st May 2006. As there was no requirement for the retrofitting to existing vehicles, it is anticipated that it will take over 10 years for the target vehicle fleet to be equipped. The Digital Tachograph legislation could provide an implementation path for an in-vehicle platform for ITS for Commercial vehicles - the technical requirements could be amended to require specific support for additional ITS applications.

The business model for EETS could become the basis for delivery of other services. However, there is no requirement for vehicles to be equipped with EETS and therefore the extent of takeup is as yet unknown.

The most ambitious initiative is the implementation of eCall in all vehicles - the Commission has been trying for the last six years to get stakeholder agreement to implement eCall in Europe. The Commission is now considering mandating eCall in all new vehicles from 2014 onwards. If a mandated introduction of eCall in all new vehicles is agreed then this could provide the basis for the implementation of an in-vehicle platform for ITS applications.

To summarise, the Digital Tachograph has a wide implementation but does not have a suitable specification or business model, EETS has a suitable business model but no specification or deployed base as yet, and eCall is still not agreed.

In-vehicle applications

The study has prepared an inventory of 20 in-vehicle applications. Application information is provided in the report on the applicable legislation, governance and certification, stakeholders and organisational framework, an overview of the global system architecture, system modules and functions, and specifying sensor, interface, application data, data communication, security architecture, data storage, and in-vehicle processing requirements for each of these.

The inventory of applications shows that in-vehicle applications vary considerably in terms of organisational and functional requirements, stakeholder roles and interests, market volume and maturity. Cross-correlation of the requirements indicates two main differentiators:

1. The level of regulation
2. The targeted market; private vehicles, commercial vehicles, or both

In-vehicle applications have similar functional requirements. Most need some form of positioning, data communication, data storage, and identification of vehicle or driver. This indicates that significant symbiosis could be achieved by adopting a common open in-vehicle architecture.

However, it is important to realise, that the deployment conditions can create contradicting requirements. Regulatory applications in general require secure positioning, fraud-proof data storage and communication for relatively small markets, often geographically fragmented on a Member State basis. Regulatory applications also are likely to require product life cycles which are often aligned with vehicle life-cycles.

Commercial applications for private cars can only be successful if the unit price is proportionate to the perceived benefits and the equipment and applications have life cycles calculated in months rather than years. This market is dynamic, leading to a continuous stream of innovations in hardware, software, content and applications.

Regulation on the in-vehicle equipment may hamper the development of commercial mass-market applications. In order to achieve a multiplication (or wide-variety) of in-vehicle applications, it is essential to keep these differences in mind and to carefully balance the interests of stakeholders in the four market segments.

Business models

A number of business models are used in the different in-vehicle application market segments. These are:

1. Sponsoring
2. One-off unit price
3. Subscription
4. Pay-per-use
5. Advertising

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The market of in-vehicle applications is currently divided into separate market segments. Although market developments are difficult to predict, it is certain that there will remain a clear separation between the under-the-hood and on-the-dashboard segments.

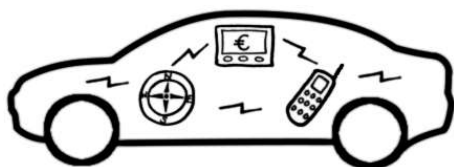
Key players in the under-the-bonnet segment will remain car manufacturers, OEM suppliers and public Regulators. Devices and applications in this segment require long life cycles and high reliability.

The on-the-dashboard segment will continue to be dominated by private business and consumer demand. This segment of fast moving consumer goods will continue to experience rapid growth and short innovation cycles. On-the dashboard devices should follow the recommendations of the ESoP.

The segmentation of the market does not stimulate the development of interoperability. All segments would however benefit from increased interoperability. Standardisation and policy development could drive these developments.

Recommendations

The study presents the following eight recommendations to the European Commission:



Recommendation 1: Steer the industry initiatives and encourage the development of standards on wired and wireless data communication between components and devices within the vehicle.

This would provide the technical basis for both OEM¹ and nomadic devices to be connected to any vehicle make and enable the driver to switch devices or vehicle without problem.

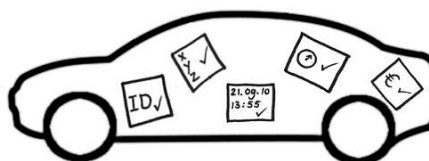


Recommendation 2: Encourage the development of standards on powering and mounting of nomadic devices within the vehicle.

The European Commission is recommended to encourage the development of standards on:

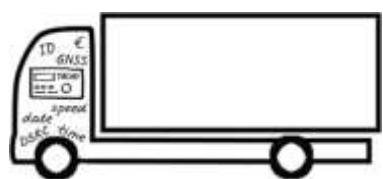
- Physical mounting of nomadic devices
- Powering solution
- Wired and/or wireless data connection (giving access to generic services and other in-vehicle devices)
- Audio connection to in-car stereo

Recommendation 3: Encourage the development of standards on generic in-vehicle services for the provision of reliable and up-to-date basic vehicle information (e.g. location, speed, date and time, etc.) by certified in-vehicle sensors and receivers.



The European Commission is recommended to encourage the development of standards on generic in-vehicle services that includes reliable and up-to-date basic vehicle information related to, among others:

- Location/GNSS
- Speed/accelerometer
- Date and time
- Vehicle ID
- DSRC
- Communication access
- Payment



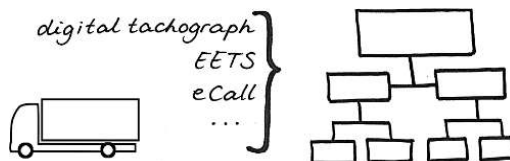
Recommendation 4: Use the opportunity of the revision of the tachograph specification (Council Regulation (EEC) No 1360/2002) to define the digital tachograph as essential core telematics element in the ITS station of the vehicle concerned.

¹ OEM - Original Equipment Manufacture

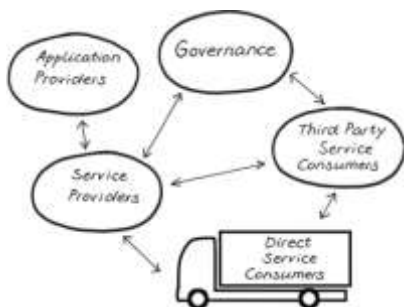
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The revision of the tachograph specification provides an opportunity for the European Commission to tackle the present disadvantages and to define the digital tachograph as the core telematics element in a (heavy) vehicle.

Recommendation 5: Use the opportunity to consolidate the regulatory framework and operational set-up in order to better align the governance across different (regulatory) telematics measures, such as the Digital Tachograph, EETS and eCall.



We recommend that the European Commission streamlines the regulatory framework and operational set-up in order to improve the alignment of the governance across different (regulatory) telematics measures for (heavy) vehicles (as a minimum: digital tachograph, EETS and eCall).



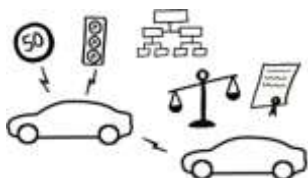
Recommendation 6: Consider a services model for regulatory applications and investigate whether applications, such as Digital Tachograph, EETS and eCall, can be migrated to a services model.

A services model is good for competition and promotes the Service Provider market, which will result in cost-effective service provision for the user.

A services model only needs to define the content and quality of the required data must be specified. The Service Provider would then have the freedom to provide a cost-effective solution.

Recommendation 7: Leave the implementation of eCall to the industry and not mandate eCall as an open platform for other applications.

We recommend that the European Commission leaves the eCall implementation to the industry and does NOT to advance further standardisation for specifying eCall as an open in-vehicle platform for other applications.



Recommendation 8: Create a supportive environment without any infrastructural, legal or institutional obstacles for the industry (vehicle manufacturers, service providers, road operators...) that allows for a stepwise introduction of co-operative systems.

We recommend that the European Commission leaves the technical development of co-operative systems to the car industry, but to create a supportive environment without any infrastructural, legal or institutional obstacles for the car industry that allows for a stepwise introduction of co-operative systems.

2 Introduction

2.1 Rationale and Aims of the Study

The use of Intelligent Transport System (ITS) components or systems are stipulated in several existing or planned legal acts and voluntary agreements applicable to European commercial and/or private vehicles. Examples include provisions on the transport of dangerous goods and live animals, the digital tachograph, electronic toll collection and eCall. So far most of these acts and agreements have evolved independently of each other, so there has been little synergy even when needs are similar.

These ITS components or systems are generally confronted with similar barriers regarding their implementation or enforcement in vehicles, such as:

- legal aspects: security/privacy, data protection and authentication;
- migration: progressive retrofitting of existing fleet and infrastructure with new technologies;
- harmonisation needs: if left to subsidiarity, there may be large variability between Member States' implementation of such applications;
- lack of standards and technical specifications: interoperability, security, protection against fraud/abuse...
- international aspects regarding non-EU countries and agreements/conventions.

An open in-vehicle platform architecture is expected to enable such barriers to be addressed in a coordinated manner. The platform would need to cater for both mandatory (enforced by legislation) and commercial applications, and be subject to international technical standards. According to the sensitivity of an application, data storage and exchange may require built-in protection and labelling mechanisms.

A streamlining and integration of these and other applications within a comprehensive open-system architecture is expected to result in better efficiency and reusability, reduced costs and enhanced extensibility and scalability, enabling "plug and play" integration of new or upgraded applications utilising advanced GNSS positioning and timing services, including those found in nomadic devices. This open system architecture would be implemented in an open in-vehicle platform, ensuring interoperability/interconnection with infrastructure based ITS systems and facilities. With this modular approach, additional functionalities could be progressively integrated for in-vehicle safety, personal mobility, logistics support and access to multimodal information and possibly electronic vehicle identification, and allowing safer HMI.

It may be appropriate to introduce this platform into commercial vehicles first. Positive reactions from professional users would speed up the uptake of integrated ITS applications in private vehicles, therefore stimulating a Europe-wide market for OEM and after-market in-vehicle products and services. On the other hand, the introduction of the pan-European in-vehicle emergency call service, "eCall", may foster the introduction of this platform in vehicles of category M1 and M2².

The development of vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and infrastructure-to-vehicle (I2V) co-operative systems is also progressing rapidly, and needs to be further promoted. Adoption of an open in-vehicle platform architecture for the provision of ITS services and applications, including standard interfaces, is among the actions proposed in this respect.

2.2 Terms of Reference for this study

In view of the future definition of an open in-vehicle platform architecture, the contractor for this study was asked to:

1. Check existing knowledge, R&D, identify and analyse available results of relevant studies, projects (like GST [Global System for Telematics], UOB [Universal On-Board Unit], cooperative systems [COOPERS, CVIS, SAFESPOT], intelligent cargo systems [EURIDICE] Monitoring the Implementation of the Digital Tachograph [MIDT], SMART digital tachograph, etc.), eSafety Working Group on Service Oriented Architecture (SOA) on main findings, achievements and proposed operational/ institutional frameworks
2. Liaise with the EC Joint Research Centre. The JRC has expertise in key issues like:
 - the digital tachograph (implementation: standardisation, type approval, interoperability, harmonisation);

² UNECE vehicle classes. Vehicles not exceeding 5 tonnes used for the carriage of passengers

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- transport of dangerous goods;
 - transport of animals and animal welfare in long journey;
 - data securing and encryption techniques;
 - technologies for GNSS applications and vehicle communications.
3. Analyse and assess legal provisions and requirements resorting from existing legislation including their impact on (data) security and privacy of data – in order to identify and document core elements, possible common specifications and a suitable architecture;
 4. Establish the detailed state of play on (system) architecture, technical progress, ongoing standardisation works; assess the difficulties facing the definition of a standard open in-vehicle platform architecture and the possible time frame for required standard development;
 5. For Commercial vehicles:
 - a. Analyse and assess legal provisions and requirements resorting from existing legislation for the most likely candidate applications: electronic tolling, eCall, transport of dangerous goods and live animals and digital tachograph. This will include their impact on (data) security and privacy of data – in order to identify and document core elements, possible common specifications and a suitable architecture, possibly enabling commercial applications (value added services) to be jointly delivered.
 - b. Identify the modules and their expected functionalities which should be reflected in the proposed (functional, technical, communication, system) architecture. This should include sensor requirements, interfaces and security architecture.
 - c. With a view to ensure concurrent deployment of regulatory and non-regulatory applications on the open in-vehicle platform, propose:
 - business architecture that allows for a secure delivery of both types of applications. The architecture shall include governance aspects as well as commercial aspects
 - an appropriate security architecture allowing this concurrent deployment without risk of interference.
 6. For the private car market:
 - a. Identify applications that most likely will be delivered by the in-vehicle platforms. Focus shall be on general traffic related applications, such as traffic information services but also safety related applications and cooperative systems-based services.
 - b. Identify the modules and their expected functionalities which should be reflected in the proposed (functional, technical, communication, system) architecture
 7. For both commercial vehicles and private car market, assess the risks factors associated with multiple applications sharing a common platform. Identify existing similar situations and evaluate portability of adopted solutions.

2.3 Structure of the report

The purpose of this report is to inform the European Commission on the actions foreseen in the ITS Action Plan relative to the definition of an open in-vehicle platform architecture for the provision of ITS services; and to present visions and proposals for the European Commission to take the work forward.

Following the introduction in chapter 2, the report provides (in Chapter 3) a state-of-the-art review of in-vehicle architectures within various relevant studies and projects. Chapter 4 analyses and assesses legal provisions and requirements resulting from existing legislation. A comprehensive overview of in-vehicle applications is given in chapter 5, including an application grouping according to similar technical, organisational and business case requirements relative to the open in-vehicle platform.

Chapter 6 identifies conditions, restrictions and success factors for the development of an open in-vehicle platform resulting from current market conditions and future market developments. The report offers potential platform architecture approaches in chapter 7. Five levels of platform specification are introduced to emphasise that the term platform is not restricted to a mere technical device or computing platform. The levels of platform specification range from a physical sensors and interfaces level to a business and service provision level. Chapters 8 and 9 summarise the findings of the previous chapters for commercial vehicles and private vehicles respectively.

The last chapter (chapter 11) describes a vision of an in-vehicle platform architecture when the recommendations are fulfilled.

3 State of the Art Review

This section gives an overview of the findings on in-vehicle architecture(s) within various relevant studies and projects. For each of them a brief overview will be provided to establish the context, descriptions of the architecture(s) in use are given in Annex 1: Relevant Projects.

3.1 Platform related EC Funded Projects

3.1.1 Cooperative Vehicle-Infrastructure Systems (CVIS)

The CVIS project created a unified technical solution to allow all vehicle and infrastructure elements to communicate with each other. The CVIS open architecture comprises central, handheld, roadside and vehicle subsystems. In the technical architecture transparency between the communications layer and the application layer is provided by a middleware layer.

This architecture was successfully demonstrated in form of a multi-channel terminal capable of maintaining a continuous Internet connection over a wide range of carriers.

3.1.2 European Field Operational Test on Active Safety Systems (euroFOT)

The EuroFOT project is establishing a comprehensive, technical, and socio/economic assessment programme for evaluating the impact of intelligent vehicle systems on safety, the environment and driver efficiency. The project is assessing several technically mature systems using vehicles that include both passenger cars and trucks. A variety of intelligent vehicle systems (IVS) are being tested on a large scale in real driving conditions. Some 1500 IVS-equipped vehicles will be tested on roads across Europe over the course of one year..

EuroFOT has just entered the active testing stage, hence lessons learned are expected to become available over the year.

3.1.3 E-safety vehicle intrusion protected applications (EVITA)

The objective of the EVITA project is to design, verify, and prototype an architecture for automotive on-board networks where security-relevant components are protected against tampering and sensitive data are protected against compromise when transferred inside a vehicle.

In July 2010 the project published a specification for a secure on board architecture and will develop a prototype demonstrator. The project is expected to be completed in June 2011.

3.1.4 GNSS Enabled Services Convergence Project (GSC)

The GSC project analysed and summarised the GST roles as Service Generator/Provider, Service Aggregator and Service User in the context of the CVIS architecture. It is based around the idea of an open market for services, based on content delivery, service deployment, service provisioning and service execution. This concept has been tested within the RCI project and is embedded in the EETS business model. GSC, however, also provided an alternative, "App Store" like business model, where the service aggregator hosts all services, whereas the service generator is responsible for creating a contract with the service user, leading to a multiple contracts, multiple invoice scenario.

The GSC project is expected to conclude in February 2011, with the above mentioned role and business model being already presented as interim findings.

3.1.5 GST

GST's vision was to create an open environment in which innovative telematics services can be developed and delivered cost-effectively. It comprised of four technology-oriented sub-projects and three service-oriented sub-projects. Each of them investigated potential architectures, that typically comprise of the following entities:- vehicle, telematics control unit, client systems management, service centre and authentication & authorisation entities.

In GST the communication between entities was based on a simplified OSI layer model, using IEEE 802.11p and IPV6.

3.1.6 Monitoring of the Implementation of Digital Tachograph (MIDT)

The MIDT project aims to support concrete implementation measures for the introduction of the digital tachograph in all Member States of the European Union (EU), the European Economic Area Countries and non EU-AETR Countries. The MIDT Platform has been set up in order to inform on the introduction and use of the digital tachograph and to support all stakeholders to implement Regulation (EEC) no. 3821/85.

Even though the Regulation allows for the Digital Tachograph platform to be used for other telematics services and applications, the currently deployed approx. 1m units do not offer such additional functionality.

The legislative experience with the Digital Tachograph has shown that the Regulation required a number of amendments over time to allow for lessons learned during the early implementation phase.

3.1.7 Open vehicular secure platform (OVERSEE)

The overall goal of OVERSEE project is to contribute to the efficiency and safety of road transport by developing the OVERSEE platform, which will provide a secure, standardized and generic communication and application platform for vehicles.

The idea of OVERSEE can be split in three main parts:

1. The *open platform* for the execution of OEM and non OEM applications,
2. the *secure* single point of access to
3. internal and external *communication* channels.

The project started in January 2010 and is scheduled to be completed in June 2012 and is expected to develop open vehicular IT platform that provides a protected standardized in-vehicle runtime environment and onboard access and communication point.

3.1.8 Universal On-Board Unit (UOBU)

The UOBU project concluded with a proposal for a platform that provides a minimum location, time, vehicle identification, power and communications through a common in-vehicle interface. Its design is open, cooperative, simple, secure and provides a framework for adding systems and services in a structured way later.

The UOBU project highlighted the need for platform interoperability and integration to support business cases for ITS applications, as well as options to consider on achieving installation of the UOBU platform on HGVs and LVs in Europe.

3.2 Application related EC Funded Projects

3.2.1 CO-OPERative SYStEmS for Intelligent Road Safety (COOPERS)

The COOPERS project was to define, develop and test new safety related cooperative systems, equipment and applications using two-way communication between road infrastructure and vehicles. The COOPERS architecture includes a COOPERS service centre, a Traffic Control centre, roadside units and the in-vehicle subsystem.

COOPERS has successfully demonstrated the viability of the CVIS architecture in a prototype implementation using existing components.

3.2.2 Extend FRAMEwork architecture for cooperative systems (E-FRAME)

E-FRAME is a Support Action project that will provide support for the creation of interoperable and scalable Cooperative Systems throughout the European Union. Among the principal objectives of the E-FRAME project are the extension of the European ITS Framework (FRAME) Architecture to include Cooperative Systems and to show how the Extended FRAME Architecture can be used to develop and implement Cooperative Systems in Member States, regions and projects.

The system requirements for the COOPERS, CVIS and SAFESPOT integrated projects have already been collated into a set of combined requirements in the format of the FRAME User Needs, thus

proving the concept of the Extended FRAMEwork architecture.

3.2.3 E-Safety Working Group on Service Oriented Architecture

The e-Safety SOA working group analyses the potential benefits of SOA in the e-Safety environment and applications, focussing on non-technical, business oriented aspects such as service types, main obstacles and identifying the best approach for introducing services SOA can offer to e-Safety.

3.2.4 EURIDICE

EURIDICE is building an information services platform centred on the individual cargo item and on its interaction with the surrounding environment and the user. It hence makes some abstractions regarding in-vehicle devices, reducing them into representations called "ecNodes". Since EURIDICE is cargo and not vehicle centred, little detail is available on in-vehicle architecture considerations. Communications are based on a secure peer-to-peer network.

EURIDICE thus demonstrates that the requirements, needs and views of the freight industry are fundamentally different from those of personal/passenger transport.

3.2.5 iMpleMEntation of GNSS tracking & tracing Technologies FOR EU regulated domains (MENTORE)

The key objective of MENTORE was to demonstrate the added value of EGNOS and GALILEO at the service of tracking and tracing applications. Capitalising on the results of previous European initiatives and using existing tracking technologies, MENTORE will help achieving a shared understanding of the regulatory and technological enablers supporting the widespread usage of GNSS as a tool to monitor and control the position of objects for safety, efficiency and traceability purposes.

In a final demonstration MENTORE showcased that their solution, using EGNOS Commercial Service, provides position guarantee and enhanced availability.

3.2.6 Preparation for Driving implementation and evaluation of C2X communication technology (PRE-DRIVE C2X)

PRE-DRIVE C2X develops an integrated simulation model for cooperative systems that enables a holistic approach for estimating the expected benefits in terms of safety, efficiency and environment. This includes all tools and methods necessary for functional verification and testing of cooperative systems in laboratory environment and on real roads in the framework of a field operational test. PRE-DRIVE C2X is part of the COMeSafety architecture task force and transferred the COMeSafety architecture description into a detailed specification.

PRE-DRIVE C2X put special focus on all key aspects related to security, privacy and identity management.

3.2.7 PReVENT

The Integrated Project PReVENT was designed to contribute to road safety by developing and demonstrating preventive safety applications and technologies. Preventive safety applications can help drivers to avoid or mitigate an accident through the use of in-vehicle systems which sense the nature and significance of the danger, while taking the driver's state into account. The project investigated a range of sensing, positioning and communication technologies integrated in safety applications.

While integrated sensors support preventive safety applications well and are almost ready for mass market, co-operative in-vehicle systems have been found to be technologies reaching further into the future.

3.2.8 SafeSpot

The SafeSpot project was setup to understand how intelligent vehicles and intelligent roads can cooperate to increase road safety. It aims to help prevent road accidents by developing a "Safety

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Margin Assistant" that detects in advance potentially dangerous situations and extends the "in space and time" drivers' awareness of the surrounding environment. It applies the CVIS architecture to this context.

SafeSpot highlighted the need for a dedicated frequency band for safety critical V2V and V2I communications in the 5.9 GHz range.

3.2.9 SeCuring the EU GNSS adoption in the dangerous Material transport (SCUTUM)

SCUTUM is a European Research & Development project, aimed at a wide adoption of Satellite Navigation EGNOS/Galileo based technology and services for the safe hazardous goods transport management. It plans to develop products and services ready for the commercial market. The outcomes of the SCUTUM trials support the launch of a technical standardisation, and an institutional validation, concerning the use of GNSS for dangerous goods transports management.

SCUTUM has recently started and is expected to learn from enhancing existing solutions to use EGNOS Commercial Service.

3.2.10 Traveller Information Services Association (TISA)

The Traveller Information Services Association (TISA) was established to ensure an international framework for market-driven, coordinated, proactive implementation of traffic and travel information services and products based on existing standards such as RDS-TMC and TPEG. It also works towards the development and deployment of future standards and services. TISA addresses traffic and travel information via TMC and TPEG, and also the development of any other supporting technologies. The travel information 'service chain' involves data collection, analysis and prediction, location referencing, the use of broadcast or other 'bearer' technologies and new and innovative ways of presenting and interacting with travel information. All these technological aspects are inside the scope of TISA's technology work.

TMC and TPEG demonstrate how capitalising on existing infrastructure and devices, combined with standardisation of protocols, can help introduce wide-spread ITS applications.

3.2.11 Vehicle-to-Vulnerable road user cooperative communication and sensing technologies to improve transport safety (WATCH-OVER)

WATCH-OVER examined the detection of vulnerable road users in the complexity of traffic scenarios in which pedestrians, cyclists and motorcyclists are walking or moving together with cars and other vehicles. The project carried out Research and Development activities with the aim to design and develop a cooperative system for the prevention of accidents involving vulnerable road user in urban and extra-urban areas. WATCH-OVER investigated the viability of short-range communication technologies for cooperative safety systems. It fed its results into the wider framework of SAFESPOT.

3.3 Industry Initiatives

3.3.1 AutoLinQ™

Continental Automotive introduced AutoLinQ™ as an open, end-to-end vehicle connectivity platform. AutoLinQ™ is based on the Android™ open source project, which offers an operating system as well as versatile software set for mobile devices. Continental has made available the AutoLinQ™ Software Development Kit, enabling Android™ developers to write applications. There are plans to create an application certification process to ensure application conformance to established safety standards. Certified applications will be available to download via an Application Store.

AutoLinQ™ is capitalising on existing technology from a non-transport field (telecoms) to speed up development and proliferation of its system concept.

3.3.2 AUTomotive Open System ARchitecture (AUTOSAR)

AUTOSAR is an open and standardised automotive software architecture, jointly developed by automotive manufacturers, suppliers and tool developers. It aims to establish a de-facto open

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industry standard for an architecture to host automotive applications.

AUTOSAR is an attempt within the automotive industry to agree a line-fitted standardised platform supporting their defined software architecture. This approach enables more reliance on and closer integration with in-vehicle sensors and systems than the retro-fit devices approach.

3.3.3 GENIVI

GENIVI is a non-profit industry alliance with over 90 industry members, committed to driving the broad adoption of an In-Vehicle Infotainment (IVI) reference platform. The GENIVI Alliance was officially launched in March, 2009 starting a new cooperation among vehicle manufacturers, suppliers and technology providers to streamline the development and support of In-Vehicle Infotainment or IVI products and services.

GENIVI is developing a reusable, open source IVI platform. And its mission is to drive the broad adoption of an open source development platform by aligning automotive OEM requirements and delivering specifications, reference implementations and certification programs that form a consistent basis for further open source and ISV development.

3.3.4 Next Generation Telematics Protocol (NGTP)

The NGTP is a new approach introduced by a cooperation between BMW, Connexis and WirelessCar to introduce a telematics protocol that is based on a standardised and highly flexible infrastructure. It is a technology-neutral protocol (allowing for different carriers like UMTS, WiFi, VoIP), that is divided into three main segments – the dispatcher, the vehicle's telematics unit and the telematics service providers.

With TMC and TPEG and ETSI standardisation efforts in mind it will be interesting to see how NGTP will be accepted by in-vehicle device manufacturers or the wider automotive industry.

3.3.5 Nomadic Devices Forum

To address the challenges of the integration of nomadic devices into vehicles the Nomadic Device Forum (NDF) was established by the Adaptive Integrated Driver-vehicle InterfacE (AIDE) integrated project (6th Framework Programme, eSafety Strategic Objective, co-funded by European Commission) to bring together representatives of the key stakeholders involved.

The aim of the Nomadic Devices Forum is to constitute a cross-sector working group to deal with all aspects of safe, effective and user-friendly nomadic device integration and use in the vehicle. The aims of the Forum are as follows:

- act as European consensus platform to reach cross-sector agreement on issues relating to nomadic device safety, technical harmonisation, in-vehicle integration and deployment
- define the principles for managing nomadic device-vehicle information exchange via a "Smart Vehicle-Device Interface"
- address key issues for nomadic devices, including specifications for in-vehicle docking/integration and installation, standardisation of interfaces and guidelines for nomadic device HMI and safety
- identify requirements for new work items in the appropriate standardisation bodies
- act as a bridge between the eSafety research projects on nomadic device issues and also between Europe and the rest of the world
- provide advice to the EC and support AIDE and other projects' work on nomadic devices issues

3.4 Lessons Learned**3.4.1 Technical Architecture**

Whilst naturally every research initiative and every project has come up with technical architectures to specifically fulfil their requirements, a certain set of commonalities exists.

On the highest level of abstraction, typically four entities/sub-systems feature in the technical concepts:

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- vehicle ITS sub-system; in cars, trucks, etc.,
- roadside ITS sub-system; on gantries, poles, etc.,
- central ITS sub-system; part of an ITS central system,
- personal ITS sub-system; in hand-held devices.

Each of these ITS sub-systems contains a so-called ITS station, i.e. the functionality described by the ITS station reference architecture - see section ITS Communications Architecture in Annex 1 (Page 114). The functionality of an ITS station may be implemented in a single physical unit or in several physical units. Some projects focus mainly on the vehicle sub-system, whilst on the other extreme, EURIDICE, for example, treats several components of all the above sub-systems conceptually as individual "nodes". However it is of high importance to consider not only the in-vehicle architecture or ITS station in isolation, but to ensure it fits into the context of a wider architecture.

For those projects focussed more on the vehicle platform, often great emphasis has been put into the communications link(s) between vehicle-subsystem and other sub-systems (or other vehicles). For this purpose it seems that the CALM approach is becoming the most widely accepted, offering peer-to-peer functionality over IPv6, whilst keeping the communications layer transparent to applications through a middleware layer. Of course GSM/GPRS and G3 communications continue to be relied on as an available commodity in most concepts.

The second layer of abstraction within the in-vehicle systems typically is put between the "host vehicle" and the (mostly proprietary) in-vehicle systems and sensors themselves. Here the concepts rely on the CAN-bus mostly, whilst introducing (typically purpose made prototype) communication gateways for collecting vehicle data. It has to be noted that this additional abstraction layer and the resulting interface so far has received less attention and publicity than CALM on the other end; vehicle manufacturers often introduce proprietary platforms, and hence it may remain a large obstacle for establishing a unified technical architecture and technical standards. The so far most promising approaches to this problem are the GST and the AUTOSAR initiatives.

As a result of the lack of sufficiently standardised interfaces to in-vehicle systems, two approaches to the technical architecture remain - one being highly integrated to the vehicle, with devices potentially line-fitted during the vehicles' manufacturing, and the other one being a far more autonomous, retro-fit design (where sensors and devices like GNSS and GSM potentially are very likely duplicated with already built-in vehicle devices). Lack of in-vehicle standardisation means that even seemingly trivial interfaces like a power connection can become an obstacle for retro-fit devices, often leaving the cigarette lighter as the only "standardised" interface one can (almost) universally rely on. On the basis of this experience, future scenarios will quite likely be receptive to arguments about antenna placement and sharing.

3.4.2 Business Architecture

Whilst comparatively greater emphasis has been put on the technical aspects of in-vehicle systems, less focus has been put on establishing an agreed business architecture in cooperative projects. With the EETS business model, however, a strong precedent has been created, where EETS Providers charge Users on behalf of Toll Chargers. This model has been adopted also in the GSC project and has become part of the GST/CVIS high-level role model.

In the GSC model there are three main roles:

- Service User
- Service Aggregator
- Service Provider

The model allows for an open market for servicing Users, where Service Providers are responsible for service deployment (to Service Aggregators) and service execution (with Service Users), while the Service Aggregators consolidate services on a platform and provide them to the Service Users.

In the EETS context this would mean for example that EETS Providers (who, at least during the take-up phase of EETS, will quite likely provide and be responsible for the EETS on-board equipment) are acting both as Service Providers and as Service Aggregators (potentially introducing additional telematics applications and services through their in-vehicle platform, either by themselves or from 3rd parties), and intermediating between its two distinct user categories: the Toll Chargers and the tolled road user.

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Service Providers can be integrated or the model described can be further extended through the addition of the role of Content Providers, who would deliver content to the Service Providers. This can be seen as a very similar business concept as the one introduced by the Entertainment Industry in cooperation with Apple's iPhone / iPod online store for applications and downloading entertainment content. This idea also seems to be favoured by AUTOSAR, NGTP and AutoLinQ™, where automotive suppliers are working on jointly developing a standardised open in-vehicle platform for telematics applications.

However there are some significant limitations to the breadth of investigations carried out under the abovementioned model. Being mainly commercially driven, little consideration has been given to potential avenues for introducing public services (like for example eCall), especially for the more safety critical applications (like those investigated within SafeSpot and COOPERS) which are not of sufficient commercial attractiveness to support strong business cases.

A second important distinction for business architectures for in-vehicle platforms is the different scenarios for freight and private transport. As EURIDICE has shown, the views of the freight industry tend to become more cargo-centric, with road freight transport (and the vehicles used for this purpose) becoming more of a conduit. Information flow and business requirements of freight transport thus are fundamentally different from those of private transport, where industry is currently more leaning towards provision value added services, such as infotainment.

It certainly will need more investigations into the different business drivers of those two groups to establish whether the same business architecture would be best suited for servicing both.

3.4.3 Security Architecture

The abovementioned differences between public (sometimes also safety critical) and private requirements on the business architecture, is made more complex by the different demands of freight and passenger transport. This becomes immediately apparent when investigating the security architectures for in-vehicle platforms. While for all models the underlying assumption still remains that the driver is fully responsible for piloting a vehicle, safety enhancing systems (such as that researched in SafeSpot) or time-critical emergency services (such as eCall) will place a high priority on the availability and integrity of service, thus increasing the cost of the requirements on the technical architecture. Commercially driven private applications and services may deem authentication and confidentiality as more important, and be less stringent on integrity or availability (which may even become optional for some business cases), hence minimising the cost of the requirements on the technical architecture.

Security considerations then also lead to different options for security architectures of in-vehicle platforms:

- Closed, purpose built system and security architecture
- Open, yet procedurally regulated system and security architecture
- Open system and unregulated security architecture

Currently the digital tachograph is an example for a closed, purpose built system with a rigid security architecture. Generally such platforms typically only support one, and rarely two applications and are inflexible to change. However their security architecture is a "perfect" match to the corresponding threat scenarios and can be heavily relied on, even for safety critical applications.

As an example of an open, yet procedurally regulated platform and security architecture, the concept of the UOBV can be mentioned. There the security architecture is seen as a "snapshot" against a defined set of hazards, making it possible to rely on the platform in similar ways as in the above example. The difference though is that since the technical architecture is kept "open", a framework of processes is required (in the business architecture) to support and adapt the security architecture when new requirements (and applications) are added. The AUTOSAR architecture and the GST role model could be embedded in such a framework, requiring Service Providers to go through a certification process for applications before they get published or accepted by Service Aggregators. Such an approach would be somewhat similar to what is witnessed with personal computers, where Service Providers can benchmark their products with the Service Aggregators compatibility requirements.

The third, open system and security architecture is currently only used in ICT within the Open Source community. Due to the uncertainties regarding liabilities it is seen as an unlikely candidate for a security architecture for in-vehicle platforms.

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The main challenge for establishing an agreed security architecture for a standardised in-vehicle platform therefore remains in consolidating public and private sector business cases and business models. If no agreement can be reached then security considerations may make the introduction of parallel (even if very similar) platforms necessary – as can currently be observed in reality.

3.5 Standards

International standardisation of ITS is overseen by CEN, ISO and ETSI. Those organisations work partly in parallel, partly in joint working groups. For particular information regarding the work programme and the produced work, the websites [1], [2] and [3] of those organisations can be consulted.

3.5.1 CEN/TC 278

The scope of CEN/TC 278 Road Transport and Traffic Telematics is defined as follows [1]:

"Standardisation in the field of telematics to be applied to road traffic and transport, including those elements that need technical harmonisation for intermodal operation in the case of other means of transport. It shall support:

- *vehicle, container, swap body and goods wagon identification,*
- *communication between vehicles and road infrastructure,*
- *communication between vehicles,*
- *in-vehicle human machines interfacing as far as telematics is concerned,*
- *traffic and parking management,*
- *user fee collection,*
- *public transport management,*
- *user information."*

In particular the following Working Groups are active in the context of in-vehicle ITS:

- CEN/TC 278/WG1 Electronic Fee Collection (see ISO TC204 WG5)
- CEN/TC 278/WG2 Freight and Fleet Management systems (see ISO TC204 WG7)
- CEN/TC 278/WG3 Public Transport (see ISO TC204 WG8)
- CEN/TC 278/WG4 Traffic and traveller information (see ISO TC204 WG10)
- CEN/TC 278/WG8 Road traffic data
- CEN/TC 278/WG12 Automatic Vehicle Identification and Automatic Equipment Identification (joint with ISO TC204 WG4)
- CEN/TC 278/WG13 Architecture and terminology (see ISO TC204 WG1)
- CEN/TC 278/WG14 After theft systems for the recovery of stolen vehicles
- CEN/TC 278/WG15 eSafety
- CEN/TC 278/WG16 Co-operative systems (see ISO TC204 WG18)

3.5.2 ISO/TC 204

ISO TC204 comprises the following working groups which are in particular active in the area of in-vehicle ITS:

WG1 Architecture

WG1 is preparing standards related to information and methods to be shared within the ITS sector—common use of terms, sharing of concepts, and unification of methods to describe documents and data.

WG3 TICS Database Technology

Many ITS services use geographical information. In particular, geographical information is of critical importance for the ever-growing field of car navigation services. In other services, geographical information is often necessary to give information and instructions. For this reason, WG 3 is studying standard plans for interfaces to exchange geographical information, considering various situations.

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WG4 Automatic Vehicle and Equipment Identification

WG 4 is in charge of standardisation of items necessary for interoperability between systems regarding AVI/AEI, an automatic identification system for vehicles and equipment through such simple media as tags. First, it discussed standardisation themes on surface transportation like trucks, and then added an intermodal AVI/AEI system as a theme.

WG5 Fee and Toll Collection

WG5 focuses mainly on Electronic Fee Collection (EFC) standards relates to EFC charging systems and information exchanges over the interfaces. EFC standards include the interface between the on-board and the roadside equipment, but also deal with the information data flows between operators. The standards primarily cover EFC systems based on Dedicated Short-Range Communication (DSRC), Cellular Network / Global Navigation Satellite Systems(CN/GNSS) and Integrated Circuit Card (ICC) technologies. EFC standards are fundamental to achieving national and international interoperability

WG7 General Fleet Management and Commercial/Freight Operations

Subject to this standardisation are data dictionary and message sets for supporting exchange of information on hazardous materials, and automatic identification and monitoring. This standard can possibly be applied to various forms of communication media, such as DSRC and cellular phones.

WG8 Public Transport/Emergency

WG 8 is working on standardisation of information related to public transport. Public transport includes buses, trains and trams. The reason for the adoption of the topic is that excessive dependence on automobiles for passenger and cargo transport is causing serious harm to our society and lives, and damages sustainability. To reduce the dependence on automobiles, it is necessary to increase the density of cities and make cities compact, and then to change transport modes from automobiles to foot, bicycles and public transport. It is effective to enhance the attractiveness of public transport in order to promote a shift to public transport. Toward that end, information has an extremely important role to play.

WG10 Traveller Information Systems

Traveller information systems, subject to standardisation by WG 10, constitute a core part of ITS. This working group has work items designed to study data dictionaries and message sets to provide information for drivers through various media, such as FM broadcasting, DSRC, cellular phones and digital broadcasting.

WG14 Vehicle/Roadway Warning and Control Systems

“Driver support systems control” means control technology on vehicles directly linked to drivers, and forms a central part of ITS. The purpose of this area is to reduce driver workload, improve convenience, and arouse awareness of dangers, as well as to avoid accidents and decrease damage by the use of advanced technologies. Examples of systems already on the market include adaptive cruise control (ACC) and forward vehicle collision warning.

Subject to standardisation are contents regarding “vehicle/roadway warning and control systems” with a view to international uniformity of systems. Specifically, the work covers wide-ranging areas from vehicle control, sensing of and communications with external information and interface with drivers.

WG16 Wide Area Communications/Protocols and Interfaces

Main work items consist of CALM (Communications Access for Land Mobiles) areas and probe areas. CALM stands for a set of ISO standards specifying an infotainment communications platform for Intelligent Transport Systems.

The CALM standards specify a common architecture, network protocols and communication interface definitions for wired and wireless communications using various access technologies including cellular 2nd generation, cellular 3rd generation, satellite, infra-red, 5 GHz microwave, 60 GHz millimetre-wave and mobile wireless broadband. These and other access technologies that can be incorporated are designed to provide broadcast, unicast and multicast communications between mobile stations, between mobile and fixed stations and between fixed stations in the intelligent transport systems (ITS) sector.

WG17 Nomadic Devices in ITS Systems

WG17 deals with in-vehicle interfaces for nomadic devices and open vehicle data interfaces to support ITS service and multimedia provision in vehicles.

3.5.3 ETSI TC ITS

The European Telecommunications Standards Institute has created a new Technical Committee TC ITS with the ToR to develop standards, specifications and other deliverables to support development and implementation of ITS Service provision across the network, for transport networks, vehicles and transport users, including interface aspects and multiple modes of transport and interoperability between systems. It has set up a liaison agreement with ISO/TC 204 to avoid duplicate standards. [3]

The TC ITS is organised within five working groups:

- WG1 - User & Application requirements and services.
- WG2 - Architecture and cross layer issues.
- WG3 - Transport and Networks.
- WG4 - Media & Medium related issues.
- WG5 - Security.

At present the ITS architecture developed at ISO (ISO 21217) and ETSI (EN 302 665) distinguish between the personal, vehicle, central and roadside ITS sub-systems. Gateways provide functionality to connect the components at the proprietary in-vehicle network to the standardised ITS station-internal network. [4]

4 Legislation

4.1 ITS Directive

Directive 2010/40/EU was adopted on 7 July 2010 and aims to provide a legal framework to support the actions required by the ITS Action Plan to accelerate the deployment of innovative transport technologies across Europe. This Directive is an important instrument for the coordinated implementation of ITS in Europe. It aims to establish interoperable and seamless ITS services while leaving Member States the freedom to decide which systems to invest in.

Under this Directive the European Commission is required to adopt within the next seven years specifications (i.e. functional, technical, organisational or services provisions) to address the compatibility, interoperability and continuity of ITS solutions across the EU. The first priorities will be traffic and travel information, the eCall emergency system, intelligent truck parking as well as linking the vehicle with the transport infrastructure. The latter also includes the definition of necessary measures to integrate different ITS applications on an open in-vehicle platform, based on:

- the identification of functional requirements of existing or planned ITS applications,
- the definition of an open-system architecture which defines the functionalities and interfaces necessary for the interoperability/interconnection with infrastructure systems and facilities,
- the integration of future new or upgraded ITS applications in a 'plug and play' manner into an open in-vehicle platform,
- the use of a standardisation process for the adoption of the architecture, and the open in-vehicle specifications.

4.2 Digital Tachograph

From the 1st May 2006 it has been obligatory in the EU to install the digital tachograph in new vehicles, having a mass of more than 3,5 tonnes (in goods transport) and carrying more than 9 persons (in passenger transport), whereas, the same will apply for vehicles performing international trips from the AETR³ as from 16 June 2010.

The digital tachograph is a more secure and accurate recording and storage device than the analogue tachograph. This device records all the vehicle's activities, for example distance, speed and driving times and rest periods of the driver. The system includes a printer for use in road side inspections and the driver has a card incorporating a microchip, which he must insert into the tachograph when he takes control of the vehicle.

At a European Level the key aspects of legislation are:

- Regulation (EEC) No 3821/85 of 20th December 1985 on recording equipment in road transport (also called 'Analogue Tachograph')
- Commission Regulation (EC) No 1360/2002 which provides details of the technical specifications for the Digital Tachograph
- Council Regulation (EC) No 2135/98 which amends Regulation (EEC) No 3821/85 and provides the basis for the digital tachograph.
- Commission Regulation (EC) No 68/2009 of 23rd January which amends 3821/85 for the 9th Time
- Commission Regulation (EU) No 1266/2009 which amends 3821/85 for the 10th time and included the requirement for corroboration of the vehicle motion information from the motion sensor from one or more independent sources.

The Digital Tachograph and associated smartcards are subject to a type approval procedure which is divided into 3 consecutive parts:

- **The Functional Certificate:** Every manufacturer will have to prove to national authorities in charge of the type approval procedures, that its product respects the technical requirements defined in the Annex IB of the Regulation (EEC) No 3821/85 as last amended.
- **The Security Certificate:** Every manufacturer will also have to prove that the security requirements defined in afore mentioned legal texts are respected. To do so, it will have to apply to an ITSEC authority.

³ European Agreement concerning the Work of Crews of Vehicles engaged in International Road Transport (AETR)

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- **The Interoperability Certificate:** Every manufacturer will have to prove the interoperability of its products with those already type-approved (a card manufacturer will have to prove that its tachograph card is readable by any other type-approved digital tachograph and vice versa. These tests shall be performed by the European Commission itself in its Joint Research Centre (JRC) in Ispra (Italy).

The combination of these three certificates allows a manufacturer to be granted with a type-approval certificate, which is then mutually recognised by each EU Member State, as well as by each AETR Contracting Party.

Any modification in software or hardware of the equipment or in the nature of materials used for its manufacture shall, before being used, be notified to the authority which granted type-approval for the equipment. This authority shall confirm to the manufacturer the extension of the type approval, or may require an update or a confirmation of the relevant functional, security and/or interoperability certificates.

Procedures to upgrade in situ recording equipment software shall be approved by the authority which granted type approval for the recording equipment. Software upgrade must not alter nor delete any driver activity data stored in the recording equipment. Software may be upgraded only under the responsibility of the equipment manufacturer.

Latest News

To date it is estimated that between 1 million and 2 million vehicles have been equipped with Digital Tachographs since May 2006 and by the end of 2008 over 4.6 million Digital tachograph cards have been issued in 32 countries.

On 23 December 2009, the European Commission has launched a public consultation on the Community legislation on the recording equipment in road transport.

The objective of the consultation is to seek opinions of interested parties on the possible review of the legislation on Council Regulation (EEC) No 3821/85 which defines the standards regarding the construction, installation, use and testing of the tachograph. The European Commission plans to issue a first proposal for Regulation amendments in the autumn of 2010.

4.3 eCall

The implementation of eCall was the highest priority for the European Commission led eSafety Forum, due to the potential for the service to contribute to the reduction of the 39,200 people killed, 3.3 million traffic accidents and annual costs in relation to traffic accidents of more than 180 billion Euros. The continuous support for the eCall implementation is listed in the ITS Action Plan and the ITS Directive.

The in-vehicle eCall is an emergency call generated either manually by vehicle occupants or automatically via activation of in-vehicle sensors. When activated, the in-vehicle eCall system will establish a voice connection directly with the relevant PSAP (Public Safety Answering Point), this being either a public or a private eCall centre operating under the regulation and/or authorisation of a public body. At the same time, a minimum set of incident data (MDS)³ will be sent to the eCall operator receiving the voice call.

Rather than introducing specific regulations to mandate the implementation of eCall across Europe a Memorandum of Understanding was released in 2004, with a call to stakeholders to sign up to the MoU. The MoU lists the necessary arrangements for implementation of the eCall action plan and sets out the measures to be taken by the European Commission, Member States, automotive industry, telecoms and insurance industries.

There have been a number of Communications from the European Commission related to eCall:

- COM (2009) 434 - 'eCall: Time for Deployment' (August 2009)
- COM (2007) 541 - Towards Europe-wide Safer, Cleaner and Efficient Mobility: The First Intelligent Car Report (September 2007)
- COM (2006) 3rd eSafety Communication: Bringing eCall back on track (November 2006)
- COM (2005) 431 - 2nd eSafety Communication - Bringing eCall to Citizens
- COM (2003) 2657 - Location-enhanced Emergency Call
- COM (2003) 311 - European Road safety Action Programme

To date twenty EU Member States (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Italy, Lithuania, Luxembourg, Malta, Portugal, Romania, Slovakia,

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Slovenia, Spain, Sweden and the Netherlands as well as three European Economic Area (EEA) countries (Iceland, Norway, and Switzerland) and more than 100 organisations have signed a Memorandum of Understanding setting common arrangements for implementing eCall. One EU Member State supports eCall and intends to sign the agreement. However six Member States have still not committed to sign the eCall Memorandum of Understanding (Denmark, France, Ireland, Latvia, Malta, and the United Kingdom) mainly due to cost concerns regarding the upgrading of PSAP infrastructure.

In 2009 the European Commission contracted an eCall Impact Assessment study to evaluate a regulatory approach by assessing 3 specific options:

- No EC action: eCall deployment just left to the market with no further action from the Commission/eSafety Forum.
- Voluntary approach: All EU vehicle manufacturers, Member States and the EC agree by mid-2010 to provide eCall by signing a MoU (Memorandum of Understanding) on eCall deployment by 2015. The MoU sets specific responsibilities and timelines for the stakeholders signing the MoU.
- Mandatory introduction: EC will produce an EU directive mandating eCall devices in all new vehicles by the end of 2015 and the member states to set up facilities for receiving and processing eCalls at PSAPs by the same date.

The study provided an estimate of the overall benefit-cost (B/C) ratio for the EU-27 and associated countries based on the casualty, congestion and other benefits identified for individual countries and the infrastructure costs for individual countries.

An internal study currently carried out by European Commission services is refining the eCall impact assessment in the context of a mandatory introduction of eCall: it would be introduced first in passenger cars and light commercial vehicles, and later in other vehicle categories. This refined impact assessment puts the CB ratio of a mandatory introduction at 0.53 in 2020 (similar to the external study) and 3.92 in 2030 (significantly higher than 1.31 in the external study).

	2020	2030
No EC action	0.06	0.08
Voluntary Approach	0.15	0.15
Mandatory Introduction	0.53	1.31 3.92

Table 4.1: Benefit-Cost Ratio.

The required standards for eCall in Europe have been developed by both CEN TC 278 WG 15 and ETSI/3rd Generation Partnership Project

CEN TC 278 WG 15 submitted the following eCall related standards to EN Enquiry ballot in January 2010:

- Pan European eCall Operating Requirements (Draft PrEN 16072) - The core operating requirements for the Pan-European eCall service defines the general functional and operational principles of the service
- eCall High Level Application Requirements - HLA (Draft PrEN 16062) - It specifies the protocols to put into effect the 'Pan European eCall- Operating requirements' using Public Land Mobile Networks (PLMN), and also identifies common elements that can be used in the link between third party services supporting eCall and 'Public Safety Answering Points'.
- MSD (Draft PrEN 15722) - The MSD includes important information to help send the services to the site of the incident and to speed up the response. The MSD enables the PSAP operator to respond to the eCall even without a voice exchange.

In addition The Third Party Support for eCall (TC 278 WI 00278244.6.34) was submitted to EN Enquiry ballot. This standard specifies the generic operational requirements for an eCall variant which includes the transmission of data to a third party service provider or TPSP, and the establishment of a voice call with this TPSP.

ETSI-MSG and 3GPP have approved the core technical specifications defining the protocols for sending the MSD from the vehicle to the PSAP operator. The solution that has been agreed is that the data will be transmitted via an in-band modem along with the voice call. It is an open standard and there will be no licence fees for using the in-band modem for the eCall service.

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Table 2 below provides an overview of the adopted ETSI/3GPP eCall related standards.

Description	Reference	Title
eCall requirements for data transmission	3GPP TS 22.101 ETSI TS 122 101	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects Service aspects; Service principles (Release 9)
eCall Discriminator Table 10.5.135d	3GPP TS 24.008 ETSI TS 124 008	3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Mobile radio interface Layer 3 specification; Core network protocols; Stage 3 (Release 8)
eCall Data Transfer - General Description	3GPP TS 26.267 ETSI TS 126 267	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; eCall Data Transfer; In-band modem solution; General description (Release 8)
eCall Data Transfer - ANSI-C Reference Code	3GPP TS 26.268 ETSI TS 126 268	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; eCall Data Transfer; In-band modem solution; ANSI-C reference code (Release 8)
eCall Data Transfer - Conformance Testing	3GPP TS 26.269 ETSI TS 126 269	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; eCall Data Transfer; In-band modem solution; Conformance testing (Release 8)
eCall Data Transfer - Characterisation Report	3GPP TS 26.969 ETSI TS 126 969	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; eCall Data Transfer; In-band modem solution; Characterisation Report (Release 8)
eCall Data Transfer - Technical Report - Characterisation Report	3GPP TR 26.969 ETSI TR 126 969	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; eCall Data Transfer; In-band modem solution; Characterisation Report (Release 8)

Table 2 Adopted ETSI 3GPP eCall related standards

In addition the 3GPP approved the eCall discriminator ('eCall flag'), included in Release 8 of the technical specifications with which the mobile telecommunications systems must comply. This discriminator will differentiate between 112 calls from mobile terminals and eCalls, and also between manual and automatically triggered eCalls.

4.4 EETS

Early in 2003 the European Commission launched a legislative programme to overcome the disparities in road user charging (RUC) systems within the Community. It was seeking to establish a European Electronic Toll Service (EETS) that would require charge scheme operators to make available a "single contract", a "single invoice" and an interoperable On-Board Unit (OBU) for hauliers and international coaches to use "all" electronic charging schemes in Europe. In the longer term this would be capable of being extended to all vehicles.

In April 2004 the European Directive (2004/52/EC) on the interoperability of electronic road toll systems in the community was adopted. This made reference to a future Commission Decision to

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further specify EETS and its technical elements. It was anticipated in the directive that EETS would be available in the following timescales following the publication of the Decision:

- 3 years for vehicles over 3.5 tonnes
- 5 years for all other vehicles

The original timetable for the publication of the Decision was 1st July 2006, however, due to discussions with the Member States this was only finally agreed and published on the 6th October 2009.

In addition, the Commission has currently developed an Application Guide which is intended to be a reference manual for all parties directly or indirectly concerned by Directive 2004/52/EC on the interoperability of electronic road toll systems in the Community and Decision 2009/750/EC on the definition of the European Electronic Toll Service (EETS) and its technical elements. The Guide should be read and used as a help for the implementation of EFC interoperability and EETS; it does not substitute Directive 2004/52/EC or Decision 2009/750/EC. It simply explains and clarifies some of the most important aspects related to the implementation of EFC interoperability and EETS.

4.5 Transport of Dangerous Goods

Directive 2008/68/EC establishes a common regime for all aspects of the transport of dangerous goods, by road, rail and inland waterways. It applies to the transport of dangerous goods by road, rail or inland waterway within Member States or between several Member States.

The Directive does not apply to the transport of dangerous goods:

- by vehicles, wagons or vessels belonging to or under the responsibility of the armed forces;
- by seagoing vessels on maritime waterways forming part of inland waterways;
- by ferries only crossing an inland waterway or harbour;
- wholly performed within the perimeter of an enclosed area.

The Directive references the requirements of the ADR (European Agreement concerning the International Carriage of Dangerous Goods by Road, concluded at Geneva 30th September 1957).

Whilst the Directive itself does not require vehicles that transport dangerous goods to be equipped with specific equipment to monitor its location and status, the ADR allows for competent authorities to conduct spot checks to verify whether the requirements concerning the carriage of dangerous goods have been met including security measures. These checks shall, however, be made without endangering persons property or the environment and without major disruption of road services.

Member States can apply additional provisions to vehicles engaged in the international carriage of goods as follows:

- Additional safety requirements or restrictions concerning vehicle using certain structures such as bridges, vehicles using combined transport modes such as ferries or trains, or vehicle entering or leaving ports or other transport terminals;
- Requirements for vehicles to follow prescribed routes to avoid commercial or residential areas, environmentally sensitive areas, industrial zones containing hazardous installations or roads presenting severe circulation hazards
- Emergency requirements regarding routing or parking of vehicles carrying dangerous goods resulting from extreme weather conditions, earthquake, accident, industrial action, civil disorder or military hostilities;
- Restrictions on movement of dangerous goods traffic on certain days of the week or year

4.6 Livestock Tracking

Council Regulation (EC) No 1/2005 on the protection of animals during transport and related operations, strengthened existing legislation on animal welfare during transport by identifying the parties involved, their respective responsibilities and put in place enhanced measures on authorisations, inspections and stricter rules for transport.

For all journeys exceeding 65 km, transporters must hold an authorisation issued by a competent authority in the Member State in which they are established or represented. To obtain this authorisation, applicants must demonstrate that they have sufficient and appropriate staff, equipment and operational procedures.

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For long journeys (exceeding eight hours), applicants must also provide:

- specific documents: certificates of competence for drivers and attendants, certificates of approval for the means of transport to be used, details of the procedures for tracing and recording vehicle movements, and contingency plans; and
- proof that they use a satellite navigation system, from 1 January 2007 for new vehicles and from 2009 for older vehicles.

These authorisations are valid for five years. They are issued in a standard European format and recorded in an electronic database accessible to the authorities of all the Member States.

Transporters carrying out long journeys between Member States must also possess a journey log drawn up by the transport organiser using a standard format and which contains information relating to the journey (identification of the animals and the persons in charge of them, place of departure and of destination, checks carried out at various stages of the journey, etc.).

Checks must be carried out by the competent authorities at key stages of the journey, including at exit points and border inspection posts. In addition, supplementary checks may be carried out at any stage of the journey on a random or targeted basis.

When carrying out checks, the competent authority must verify the validity of the authorisations, the certificates of approval and competence and the information recorded in the journey log. The official veterinarian must also check the state of the animals and their fitness to continue the journey. In the case of transport by sea, the state and conformity of the transport vessel must also be checked.

The Regulation sets out the following requirements for recording information about the transportation of animals by Road from 1st January 2009:

Ref	Text
Article 6, Paragraph 9	Transporters of domestic Equidae, except registered Equidae, and domestic animals of the bovine, ovine, caprine and porcine species over long road journeys shall use a navigation system as referred to in Annex I, Chapter VI, paragraph 4.2, as from 1 January 2007 for means of transport by road for the first time in service and as from 1 January 2009 for all means of transport by road. They shall keep the records obtained by such navigation system for at least three years and shall make them available to the competent authority upon request, in particular when the checks referred to in Article 15(4) are carried out. Implementing measures concerning this paragraph may be adopted in accordance with the procedure referred to in Article 31(2).
Article 11, Paragraph 1 (b) (iii)	details of the procedures enabling transporters to trace and record the movements of road vehicles under their responsibility and to contact the drivers concerned at any time during long journeys
Annex II, Chapter 3, Paragraph 3.3	Means of transport by road must be fitted with a temperature monitoring system as well as with a means of recording such data. Sensors must be located in the parts of the lorry which, depending on its design characteristics, are most likely to experience the worst climatic conditions. Temperature recordings obtained in such manner shall be dated and made available to the competent authority upon request.
Annex II, Chapter 3, Paragraph 3.4.	Means of transport by road must be fitted with a warning system in order to alert the driver when the temperature in the compartments where animals are located reaches the maximum or the minimum limit
Annex II, Chapter 4, Paragraph 4.1.	Means of transport by road must be equipped as from 1 January 2007 for means of transport by road for the first time in service and as from 1 January 2009 onwards for all means of transport, with the appropriate Navigation System allowing for recording and providing information equivalent to those mentioned in the journey log as referred to in Annex II, Section 4, and information concerning opening/closing of the loading flap.

Included in the regulation is a requirement for the Commission to submit to the Council, not later than 1 January 2010, a report on the implementation of the Navigation System referred to in paragraph 4.2, accompanied by any proposals it would deem appropriate, aimed in particular at

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defining specifications of the Navigation System to be used for all means of transport. This would give the opportunity to provide a common specification for equipment to support this Regulation.

4.7 Synthesis of Legislative Deployment Approaches

The European Commission has pursued a number of different legislative routes to the deployment of in-vehicle ITS and safety systems as illustrated in Table 4.3.

The implementation approach chosen for the Digital Tachograph, has to date been the most successful in terms of the proportion of concerned vehicles equipped. The regulation mandated that the Digital Tachograph should be fitted to all new vehicles registered after 1st May 2006. As there was no requirement for the retrofitting to existing vehicles, it is anticipated that it will take over 10 years for the concerned vehicle fleet to be equipped.

The Digital Tachograph legislation could provide an implementation path for an in-vehicle platform for ITS for Commercial vehicles - the technical requirements could be amended to require specific support for additional ITS applications.

The most ambitious initiative is the implementation of eCall in all vehicles, and the Commission has been trying for six years to get a stakeholder agreement to implement eCall in Europe. The Commission is now considering whether to mandate eCall in all new vehicles from 2015 onwards.

If a mandated introduction of eCall in all new vehicles is agreed then this could provide the basis for the implementation of an open in-vehicle platform for ITS applications.

Application	Legislative Deployment Approach	Publication Date	Vehicles	Implementation Date
Digital Tachograph	Council Regulation	June 2002	All new registered HGVs	May 2006
eCall	Commission Communication	2004	All Vehicles	Not fixed
EETS	European Directive and Commission Decision	April 2004 & October 2009	Optional initially for HGVs	October 2012
Transport of Dangerous Goods	European Directive	September 2008	N/A	June 2009
Transport of Livestock	Council Regulation	January 2005	Livestock transport vehicles	January 2009

Table 4.3: Summary of Deployment Approaches.

Impacts for Certification and Type Approval Regimes

If the in-vehicle platform is required to provide support the delivery of strategic pan European services such as EFC, eCall and the Digital Tachograph then there will be implications for the certification/approvals process for both the in-vehicle platform and the associated applications.

Currently each of these applications currently have separate in-vehicle unit certification/approval regimes. This raises the question whether, in the case where multiple applications might be provided on an in-vehicle platform, the in-vehicle platform would have to meet the requirements of each of the regimes separately and whether an additional certification regime for the in-vehicle platform would need to be defined?

The Digital Tachograph in-vehicle units are subject to a 3 part Type Approval regime:

- Functional Certificate
- Security Certificate
- Interoperability Certificate

The Interoperability Certificate is issued by the Digital Tachograph Laboratory currently operated by the Joint Research Centre.

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The eCall certification procedure is currently being drafted and is expected to include testing of conformity to standards in the following areas:

- eCall transport protocol conformance testing including the complete, integrated In-Vehicle eCall chain.
- eCall application protocol conformance testing including the complete, integrated In-Vehicle eCall chain.
- eCall in-vehicle performance conformance testing (e.g. Maximum time necessary to issue a 112 call following a crash detection or a manual action, and an MSD message following a 112 circuit switched establishment).

Relative to EETS there is a requirement for units to be certified because the Toll chargers across Europe need to trust that the EETS units are correctly calculating the charge due for the usage of the road service. It is currently expected that both EETS unit manufacturers and EETS Providers will have to demonstrate compliance with the EETS specifications in a number of specified test environments in Europe to demonstrate pan-European coverage and functionality.

The exact implications for the Certification and Conformity Regimes of existing Regulatory applications will be dependent on the scope of the in-vehicle platform.

5 Applications

A complete inventory of 20 in-vehicle applications has been compiled and described in detail, the detailed description of applications can be found in Annex 2: Application Description. Application information is provided on the applicable legislation, governance and certification, stakeholders and organisational framework, an overview of the global system architecture, system modules and functions, and specifying sensor, interface, application data, data communication, security architecture, data storage, and in-vehicle processing requirements.

To arrive at a business architecture that can cater for the proliferation of in-vehicle applications, it is important to understand the application requirements. This chapter provides an overview of the in-vehicle applications described in the Annex, and groups them into applications with similar technical, organisational and business case requirements relative to the open in-vehicle platform. The application grouping provides a framework for determining the strategy to facilitate and stimulate the deployment of the applications.

The term *application* is used as a generic term for functionality that is implemented on an in-vehicle platform and supporting roadside and central systems. The applications are described in functional terms only to avoid premature selection or discarding of hardware, software and deployment options.

The inventory includes existing, emerging and potential new applications and has been based on work of the Project Team 31 of CEN TC278 Work Group 1 on Value Added Services. The applications have been grouped based on the methodology defined in ISO 14813-1.

5.1 Application Overview

The applications are described in detail in the Annex 1. Here, the applications are described in accordance with the application classes as described in ISO 14813-1:

- Fleet management
- Entertainment
- Payment
- Co-operative road safety
- Driver assistance
- Communication access
- Navigation & Traffic information
- Regulatory applications
- Traffic Data Collection
- Road usage data

The Fleet Management class spans all applications that enable the user to manage vehicle investment, improve efficiency and reduce overall transportation costs. These applications are tracking and tracing, stolen vehicle tracking, vehicle performance monitoring, driver performance monitoring and fuel Management. Users of fleet management include a wide range of operators across both heavy vehicle and light vehicle sectors.

Applications within the Entertainment class include all those, which provide the driver and passengers with non-critical, non-mandatory information and entertainment. These applications are media download applications and personal data synchronisation.

Applications within the Payment class enable mobile transactions for services such as electronic toll fee collection (EFC), parking, ferries, drive-through restaurants and pay-at-pump refuelling stations. EFC represents the main form of payment application; others are drive-through payment and pay-at-pump applications.

Applications within the Co-operative road safety class are designed to improve traffic management control, increase the efficiency and effectiveness of road transport, and improve the overall driver experience. Applications include in-vehicle signage, intelligent speed adaptation, intersection management, lane change assistance and traffic light optional speed advice.

Applications within the Driver assistance class are designed to improve vehicle safety and road safety. Applications include adaptive cruise control, eco-drive assistance, lane deviation warning.

Applications within the Communications class provide transparent access from the vehicle to external information systems, and vice versa. Communication applications in general are instrumental to other applications only.

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Applications within the Navigation and traffic information class provide the driver with route guidance and other location-based functionality. These applications include route guidance, congestion alert and avoidance, points of interest, parking availability and traffic information.

Applications within the Regulatory applications class include all those required by law or developed to facilitate compliance by providing relevant data to the appropriate authorities. These include eCall, tachograph, hazardous goods monitoring and livestock transport tracking, access control, quota management and enforcement applications.

Applications within the Traffic data collection class provide authorities with valuable information for managing existing roads infrastructure and planning future projects by generating statistics on road usage over time. Traffic data collection can be carried out by road-side equipment or through the in-vehicle application general referred to as floating vehicle data.

Applications within the Road usage data class provide a driver's log by automatically collecting information on distance travelled, time of travel and potentially also route data. Applications include pay-as-you-drive insurance.

5.2 Requirements and Characteristics

The inventory of applications shows that in-vehicle applications vary considerably in terms of organisational and functional requirements, stakeholder roles and interests, market volume and maturity.

Cross-correlation of the requirements indicates two main differentiators:

1. The level of regulation
2. The targeted market; private vehicles, commercial vehicles, or both

The application requirements are correlated to these parameters. Figure 5.1 plots the different in-vehicle applications in relation to the two main differentiators.

Based on the analysis, four groups of in-vehicle applications can be distinguished with similar requirements that are described in the next sections:

1. Mandatory applications for commercial vehicles
2. Optional applications for commercial vehicles
3. Mandatory applications for private vehicles
4. Optional applications for private vehicles



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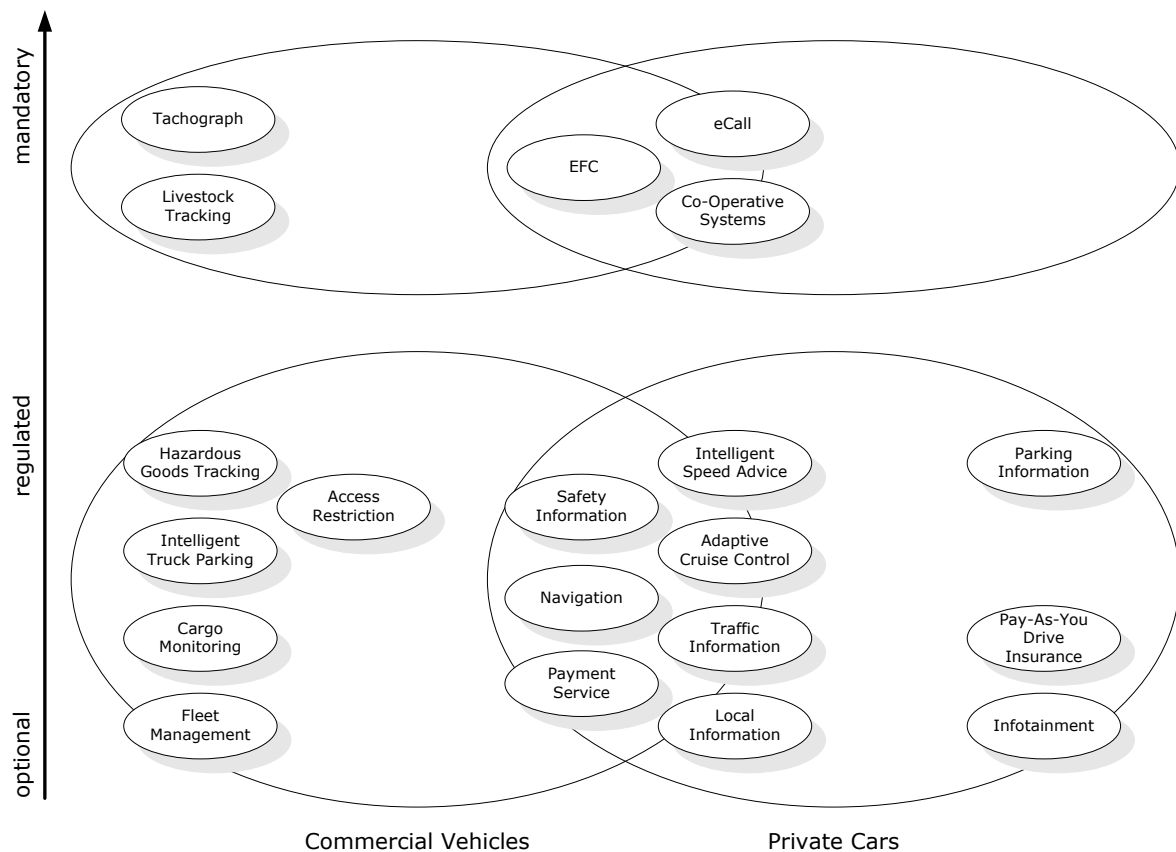


Figure 5.1: Application Classification.

5.3 Mandatory Applications for Commercial Vehicles

Mandatory applications for commercial vehicles require reliable identification of vehicle and/or driver and, secure positioning (with objective performance indicators for accuracy and reliability), and security and privacy protection. Public authorities control the functionality, implementation and product life cycle of these applications through policy development. Private parties are instrumental to the deployment. The market volume is limited to commercial vehicles that are forced to implement the application. The successful implementation and operational use of these applications requires balancing of the interests of the many stakeholders involved: the vehicle driver, owner and operator, service operators and equipment manufacturers, and road and enforcement authorities.

5.4 Optional Applications for Commercial Vehicles

Applications targeted at commercial vehicles that are not enforced through legislation in general require standard identification of vehicle and/or driver, positioning, and security and privacy protection. Private parties determine the functionality, implementation and product life cycle of these applications, based on market demand. Public authorities can stimulate the deployment of these applications through policy development. The market volume is limited to commercial vehicles.

5.5 Mandatory Applications for Private Vehicles

Mandatory applications for private vehicles require reliable identification of vehicle and/or driver and, secure positioning (with objective measures for accuracy and reliability), and strict security and privacy protection. Most applications mandatory for private vehicles are also mandatory for commercial vehicles. Public authorities control the functionality, implementation and product life cycle of these applications through policy development. Private parties are instrumental to the deployment. The market volume can potentially reach a mass-market, e.g. for eCall, but in the end is determined by the legislative coverage of the underlying policy. The successful implementation and operational use of these applications requires balancing the interests of the key stakeholders: vehicle drivers, service operators and equipment manufacturers, and the road and enforcement authorities.

5.6 Optional Applications for Private Vehicles

Applications targeted at private vehicles that are not enforced through legislation in general require some form of identification of the driver, and basic positioning functionality. Many of these applications are also useful for commercial vehicles. Private parties determine the functionality, implementation and product life cycle of these applications, based on market demand. Public authorities can stimulate the deployment of these applications through policy development. These applications in general target a mass-market.

5.7 Beneficiaries

In order to understand the context of the diversity of ITS applications, also a classification from a perspective of "who benefits" is helpful. A distinction is made between three beneficiaries:

Regulator

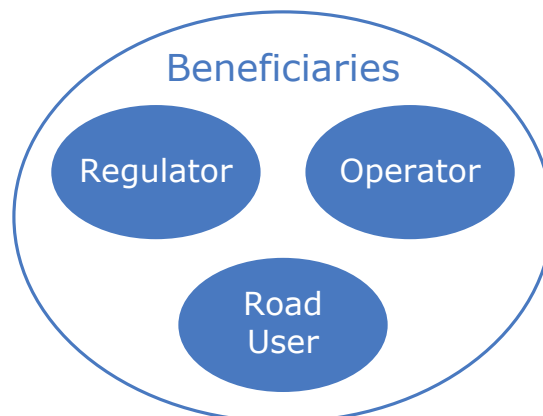
Several ITS applications are mandated by a regulator for the general benefit of society, especially regarding heavy vehicles. Such applications are the digital Tachograph, livestock tracking, diverse access control regimes to inner cities, and tolling for internalising the external costs of heavy vehicle traffic. Light vehicles are far less regulated. Manual toll payment is an option on all current systems. If the Commission decides to regulate the introduction of eCall then this will be the first regulatory application for light vehicles.

Operator

ITS applications for the benefits of the road or EFC operator have low visibility for road users since they are accomplished in the back office. Nevertheless the amounts involved can be comparatively large. Although heavy vehicles are usually more often equipped with IVE, data from light vehicles are more interesting to road operators for monitoring traffic, for traffic flow analysis and statistics for the purpose of prediction and infrastructure planning and for real time traffic information provision. Especially real time traffic information is an added value that can be deployed for the Service User as a visible benefit from his toll payments.

Road User

ITS applications that are addressing the road user cannot be considered as directed to a single homogeneous user group. Users might be drivers of private cars, truck drivers or even operators of vehicle fleets, be it a fleet of internationally operating trucks, a fleet of regional delivery vans, or a taxi fleet. Obviously this segment of the market is quite fragmented.



5.8 Synthesis

In-vehicle applications have similar functional requirements. Most need some form of positioning, data communication, data storage, and identification of vehicle or driver. This indicates that significant symbiosis could be achieved by adopting a common open in-vehicle architecture.

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However, it is important to realise, that the deployment conditions can create contradicting requirements. Regulatory applications in general require secure positioning, fraud-proof data storage and communication for relatively small and often geographically fragmented markets. Regulatory applications also require product life cycles which are often aligned with vehicle life-cycles.

Commercial applications for private cars can only be successful if the unit price is proportionate to the perceived benefits and the equipment and applications have life cycles calculated in months rather than years. This market is dynamic, leading to a continuous stream of innovations in hardware, software, content and applications.

Regulation of the in-vehicle equipment can hamper the development of commercial mass-market applications. In order to achieve a multiplication (OR wide-variety) of in-vehicle applications, it is essential to keep these differences in mind and to carefully balance the interests of stakeholders in the four market segments.

6 Existing Market Models

6.1 Introduction

The purpose of this chapter is to identify conditions, restrictions and success factors for the development of an open in-vehicle platform resulting from current market conditions and future market developments.

This chapter describes the current markets of in-vehicle applications. It describes different market segments and identifies their main differentiators, followed by a description of current and near-future market trends.

6.2 Business Models

A number of business models are used in the different in-vehicle application market segments. These are:

1. Sponsoring
2. One-off unit price
3. Subscription
4. Pay-per-use
5. Advertising

In the sponsoring business model, the in-vehicle applications are provided free of charge with the goal to sell another product or service. An example of such a model was used in the initial introduction of cruise control and ABS in high-end private cars. These applications were included in the purchase price of the vehicle rather than an optional extras to be used as a selling point to sell the car.

The one-off unit price is commonly used to sell personal navigation devices (PNDs), but is also used for lifetime service offers such as map updates to navigation devices. After purchasing the customer is entitled to unlimited use. It is also often used to sell add-on features, e.g. factory fitted in-dash navigation to a car.

In a subscription model the customer pays regular fees to use a product or service. The service is stopped or device rendered useless when the subscription ends. A subscription is often used not only to cover operational costs, but also to sponsor device costs, e.g. in many mobile phone subscriptions. It is also frequently used to sell add-on services, e.g. a traffic information service for PNDs.

In the pay-per-use model the customer pays only when using a product or service. This model is not commonly used for in-vehicle services. The charges for using a phone are an example.

In the advertising model, customers can use a product or service for free. Turnover is realised by presenting advertisements to the customer. This is not a business model commonly used for in-vehicle applications but it is expected to gain relevance with the emergence of free navigation.

A mix of Business Models can be found, such as "sponsoring/subscription", i.e. the free offer of a service during a limited period followed by the need to subscribe afterwards, which is commonly used in this sector.

The table below provides an overview of the business models, some examples, and their strengths and weaknesses.

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Business Model	Examples	Strengths	Weaknesses
Sponsoring	ABS (at the beginning, now a standard feature) Cruise control Nokia Ovi Maps & Navigation 3 months Live Services with Navigon PND Free speedcams with TomTom Go Free mobile phone with a Vodafone subscription	Costs not visible to customer Allows symbiotic between sold and sponsored product	Costs before returns Reduces perceived product value
One-off unit price	TomTom ONE Pioneer in-dash navigation	High customer Acceptance Quick return	No recurring revenues No direct relation to customer
Subscriptions	TomTom Traffic Navigon Live GM Onstar	Recurring revenues Strong customer relation	Low customer acceptance Low margins Administrative overhead
Pay per use	Phone use charges	High uncertainty on returns	Administrative overhead
Advertising	iPhone Ads	No costs to customer Cross selling opportunities	Mobile fragmentation User tolerance Immature environment Sales overhead

6.3 Existing Market Segments

The scope of in-vehicle applications that are the subject of this investigation is large and diverse. It includes applications such as cruise control, introduced in the 1960's, as well as free smart phone navigation, whose market has taken off in 2009. In this paragraph the different market segments that exist to date are described:

1. Vehicle manufacturers / OEM – factory fitted devices
2. After market devices – commercial applications
3. After market – regulated applications
4. Smart phone platforms – commercial applications

6.3.1 Vehicle Manufacturers / OEM – Factory Fitted Devices

For decades car manufacturers have been adding factory-fitted equipment for driver assistance as single-purpose closed-platform devices. Cruise control achieved mass-market in the 60s and 70s, ABS in the 70s and 80s.

In the 90s car manufacturers recognised the potential of delivering more advanced telematics services to their users to create brand differentiation to their competitors. One of the first examples of this was GM Onstar service, other examples are BMW ConnectedDrive, Fiat/Microsoft Blue & Me, Peugeot Connect, and Renault (TomTom) Carminat, typically customers purchased the telematics platform as an optional extra when the vehicle was purchased, in some cases such as OnStar a subscription model is used.

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Typically these platforms offered applications such as:

- Navigation
- Infotainment
- Remote diagnostics
- Emergency support

Vehicle manufacturers sought to establish proprietary Telematics service chains to support the provision of services to consumers. An important driver of these developments was the desire of car manufacturers to establish an after sales relation with their customers in order to increase brand value and loyalty.

The market for factory-fitted closed-platforms is dominated by global players; the car manufacturers and their suppliers. Main manufacturers of such equipment are Continental AG, Delphi Corporation, Denso Corporation, Hitachi, Nissan Motor, Robert Bosch, Automotive, Toyota Motor, TRW Automotive Holdings, Valeo, Visteon Corp., and WABCO.

Because products are sold as car parts their life cycles need to correspond to the long life cycles of cars. This requirement leads to relatively high production and installation costs, and hampers the fast-paced development characteristic of the market of personal navigation devices.

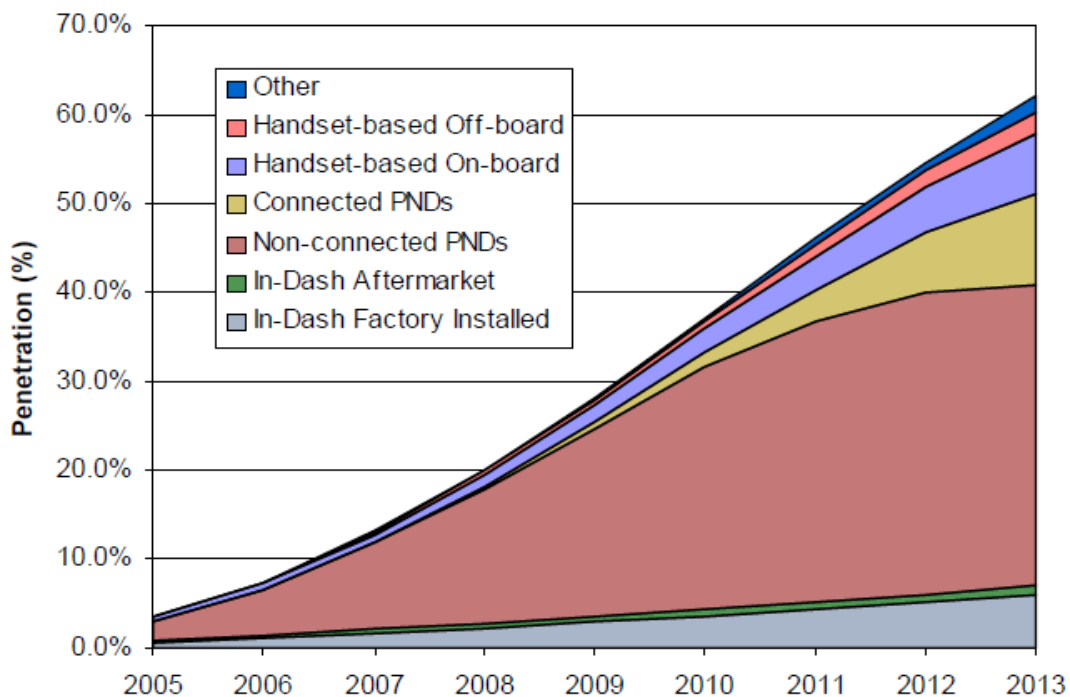


Figure 6.1: Navigation Devices and Systems In-Car Penetration by Type Western Europe.

Source: ABI research

Faced with increasing competition and resulting loss of market share to Aftermarket Devices in particular for Satellite Navigation, see Figure 6.1, vehicle manufacturers have started a number of initiatives to seek to develop 'Open' platforms for in-vehicle applications including:

- AUTOSAR project - which aims to develop an open and standardised automotive software architecture through the cooperation of automobile manufacturers, suppliers and tool developers.
- NGTP - which is a new approach for delivering telematics services to in-vehicle devices and hand sets alike, with the focus on open interfaces across the entire service delivery chain. It brings together BMW, Connexis, and WirelessCar to develop a new protocol, NGTP, based on a standardised and highly flexible infrastructure.
- AutoLinQ™ - which is an initiative by Continental to develop an in-vehicle platform with in-vehicle display and computing platform upon which certified applications can be run.
- Nomadic Devices Forum - which is a cross-sector working group to deal with all aspects of safe, effective and user-friendly nomadic device integration and use in the vehicle.

This market is in the development phase and the business model that in the end will prevail is

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unclear. Consumers can be charged for purchasing the platform or for installing applications. Revenues can also be generated through advertisements, or any combination of these business models.

6.3.2 After Market Devices – Commercial Applications

In the first decade of this century the strong reduction of unit prices of CPU, memory and GPS chips enabled the consumer electronics industry to manufacture low-cost personal navigation devices (PND). This market segment has experienced exponential growth since 2003, and quickly eclipsed the factory fitted market.

In Europe, following a peak in 2007 the PND market is decreasing, see Figure 6.2, as a result of the emergence of free smart phone navigation and the financial crisis. However, as seen from Figure 6.1, the PND market still has the largest penetration into the vehicle fleet.



Figure 6.2 PND Market Size Estimates.

The market of PNDs is characterised by continuous lowering of device retail prices, and fast-paced innovation of hardware and software. The emergence of the PND market has given a strong boost to the development of markets for map, POI, yellow pages and real-time traffic data.

The market still mainly relies on a business model for a one-off unit purchase price. The key players have launched online services. Revenues from these services are used to ramp up the margins as device prices decrease. The take-up rate of these services is still limited (about 30% of all connected devices), but these revenues will become more important as device prices keep falling and competition from smart phone navigation increases. Business analysts expect this market will move to business models based on subscriptions, pay-per-use or advertisement.

The market for Commercial aftermarket applications is dominated by Portable Navigation Devices (PNDs) and infotainment devices. The key players in Europe are TomTom, Navigon and Garmin, together they claim a market share of about 80%. Since 2007 a number of competing players have left the market. A further shake-out is expected as the growth rates decrease further and the key players strengthen their position through strategic data supplier and retail contracts.

TomTom has strategically positioned itself by becoming a traffic data supplier in the main European markets, and by incorporating TeleAtlas, one of the only two global road map data suppliers.

6.3.3 After Market – Regulated Applications

EU Regulated Applications

To date there are two safety and welfare related applications which require the mandatory fitting of in-vehicle units to vehicles at a EU level, these are:

- Digital Tachograph
- Tracking and Monitoring of the international transport of livestock

The Digital Tachograph legislation set out the technical specification and type approval procedure

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for in-vehicle units.

It is estimated that in total there are approximately 5.2 million vehicles which come under the scope of the Digital Tachograph legislation, and approximately 10% of the vehicle population is replaced each year which gives an annual market of 500,000 units per year.

To date there are four manufacturers which have developed and sell type approved in-vehicle units. Whilst the type approval requirements allow in-vehicle units to have additional functionality to support other ITS applications, no manufacturer currently uses the in-vehicle unit as the basis for a platform for ITS Applications.

It is currently estimated that only 6000 vehicles in Europe come under the scope of the legislation regarding the monitoring of international transport of livestock. The legislation currently sets out the information that must be recorded by does not set out specific technical requirements for the 'Navigation' (tracing) System.

Given the small size of the market it is unlikely that manufactures will develop specific commercial products to meet the requirements of the legislation.

National Regulated Applications

A number of countries in Europe have introduced HGV Charging Schemes which offer, require or mandate the use of specific satellite-based equipment within the vehicle:

- Switzerland Heavy Vehicle Fee – Mandatory in-vehicle unit for Swiss Heavy Vehicles (55'000 Equipped Vehicles)
- Germany LKW- Maut – Optional in-vehicle unit HGVs < 12.5t (650'000 Equipped Vehicles)
- Slovak Republic – Mandatory in-vehicle unit for all vehicles > 3.5t (150'000 Vehicles equipped at start of operation January 2010)

All of the above schemes have had public procurements for the supply of in-vehicle units and have either selected a single supplier or a single supplier with a secondary source. In the process of specifying the requirements for scheme specific devices the feasibility of supporting additional ITS applications is often eliminated.

In the case of LKW Maut in Germany, TollCollect was prevented from using the in-vehicle unit as a platform for ITS Applications due to anti-competition rules.

The France TPLN scheme, when it comes into operation, will be the first scheme in Europe requiring the mandatory use of in-vehicle equipment provided by an open market for Service Providers. It will be mandatory for all vehicles >3.5t using the charged network to be equipped – it is expected that 850,000 vehicles will be equipped at start of operation expected for 2012. It is envisaged that Service Providers will offer additional ITS Services to provide differentiation from competitors.

6.3.4 Smart Phone Platforms and Nomadic Devices – Commercial Applications

Recently Google, Nokia and Microsoft announced their entry into the market for Satellite Navigation. Both provide Satellite Navigation on Smartphone platforms at no extra costs to the user.

In February 2010 21.1 million consumers in five large European markets, (UK, France, Germany, Spain and Italy) used their cell phones for navigation, 68 percent more than a year ago. This compares to the total of 20.4 million personal navigation devices sold in those markets during 2008 and 2009.

Personal navigation device makers like TomTom and Garmin have seen in-car navigation as their stronghold, but cars are already the most common place to use smart phone navigation. With the use of assisted GPS in smart phones it has become feasible to offer similar functionality to premium services without the significant price tag. Nokia offers navigation on all new smart phones at no additional cost to the user.

The underlying business model is based on sponsoring by both the phone manufacturers and mobile phone network operators. Navigation will boost the mobile phone sales for phone manufacturers. The use of online (off-board) navigation will increase the amount of data communication from the mobile phone, thus raising return per user for the network operators. Offering navigation supportive services such as traffic information can further increase this benefit.

Google will most likely entirely base its business model on advertising. A number of phone manufacturers now offer customers the option to purchase and install certified applications on

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smart phone platforms some of which may have subscription or pay-per-use charges.

In an effort not to lose market share some traditional Personal navigation device makers have developed certified applications for smart phone platforms e.g. TomTom Navigation App for i-phone. Navigon entered a deal with T-Mobile Germany, providing customers of T-Mobile with free Navigon navigation.

It is expected that navigation will soon become a commodity functionality on mobile phones. The market for PNDs will not disappear but will likely see the emergence of business models based on subscriptions, sponsoring and advertising.

6.3.5 Market Segment Differentiators

Table 6.1 provides a brief summary of the main differentiators of the described market segments.

Market Segment	Life Cycle	Key Stakeholders	Market Drivers	Dominant business models
Factory Fitted Devices	10 year	Car manufacturer Customer	Unit costs	Sponsoring
After Market Commercial	< 1 year	Customer	Unit costs Product features Product add-ons	One-off unit price
After Market Regulated	10 year	Regulatory bodies	Regulation	One-off unit price Subscription
Smart Phone/ Nomadic Devices Commercial	< 1 year	Customer Network operator Phone manufacturer	Product features Product add-ons	Sponsoring Advertising

Table 6.1: Main Differentiators of the Market Segments.

Model 1 and 3 clearly have a good match when it comes to the product life cycle. Long life cycles translate into durable high quality products, a requirement for both market segments. For both market segments it is also true that the end-user has no direct influence on the product price, and only a limited say in the purchase decision. Another common denominator is the requirement of both segments that the equipment required for the applications is installed by certified installers including connection to vehicle sensors.

Models 2 and 4 seem to have different starting points. However, both are fast moving consumer electronics markets targeting the same customer group.

6.4 Market Trends

In general it is expected that the hardware costs for consumer electronics will continue to decrease as a result of technological innovation. This will affect sales margins, particularly in the after sales markets, and will push all segments away from One-off unit prices towards subscription, sponsor and advertising models. This can be observed in the segment for factory fitted equipment where various manufacturers have developed subscription based business models. Examples are AutoLinQ and GM Onstar.

It is likely that the market segments for commercial applications will merge into a market for multi purpose nomadic devices, moving to the sponsoring and advertising business models. Evidence of this development can be seen in recent market developments:

- PND manufacturer TomTom and mobile phone manufacturer Nokia both have incorporated one of the only two global road map data suppliers, i.e. Tele Atlas and NavTeq.
- PND manufacturer Navigon and network operator T-Mobile offer navigation for free to T-Mobile customers, i.e. a sponsoring model.

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- Apple announces iPhone Ads allowing (navigation) application developers to base their business model entirely on advertising.

Important to note is that two of the four market differentiators – life cycle and key stakeholders – are unlikely to change in short term for the described market segments. It is likely that at least two market segments will remain for the coming decade:

- A market for high quality components providing factory fitted and regulatory applications, in general installed by certified installers.
- A fast moving goods market of for nomadic devices providing navigation and other applications on the dashboard.

6.5 Fragmentation

At first sight the private car market would appear to be a diverse market given the broad spectrum of Users, however, private vehicles are used for a single common purpose which is to transport the driver and passengers to a given destination. To date in-vehicle applications for the private car market can be put into three main categories:

- Navigation and traffic information
- Infotainment
- Driver assistance systems

Given the size of the EU private vehicle park (234 Million Passenger cars EU27 2008), it only requires a very small percentage take-up across the vehicle fleet to sustain a viable commercial market for in-vehicle applications.

Within the commercial vehicle sector the overall market size is an order of magnitude less with a total of just over 800,000 buses & coaches and 33.9 million goods vehicles of which the majority of vehicles are less than 3.5t. As already mentioned in section 6.3.3 the total number of vehicles that come under the scope of the Digital Tachograph is 5.2 million vehicles and these are used for many diverse purposes from the international transport of goods to the transport of materials on construction sites.

The wide variety of the use of commercial vehicles leads to small markets for segment specific applications – for example it is estimated that a maximum of 6000 vehicles are involved in the transport of livestock which is insufficient to sustain a competitive market for this single application device.

The commercial vehicle telematics market is dominated by Fleet Management Systems which with the advent of mobile connectivity combined with improved mobile computing technology and vehicle, transport and driver management applications are able to deliver significant efficiency savings for operators.

Fleet management system suppliers have overcome the fragmentation of the commercial market by offering application specific bolt-ons to basic fleet management platforms. According to recent research⁴ it is expected that the number of fleet management systems in active use is forecasted to grow at an annual rate of over 20% from 1.5 million units at the end of 2009 to 4 million by 2014. The penetration rate in the total population of no-privately owned commercial vehicles is estimated to increase from 5.5% in 2009 to 14.8% in 2014.

6.6 Life Cycle

There are significant differences between the lifecycles of portable and aftermarket products such as Smartphones and PNDs compared with OEM factory fitted products which need to be tied into the vehicle lifecycle.

As a result OEM devices have relatively high production and installation costs due to reliability and product lifetime requirements. This provides a barrier to innovation and prevents the fast-paced development for OEM devices which is often seen in the PNDs and Smartphones.

Users expect the OEM navigation device that was sold with the purchase of the vehicle to work for the lifetime of the vehicle, this is to be contrasted with the expectations of users of smartphones who will expect to replace and upgrade the phone within 12 months to take advantage of the latest innovation.

If a common in-vehicle platform is to be defined then lifecycle considerations and the avoidance of obsolescence of technology will need to be considered in the specification of the in-vehicle

platform. In an ideal world the platform would combine the product quality of the OEM environment whilst supporting the fast paced development of commercial applications.

6.7 Market Entry Barriers

Europe has been leading the way in safety related factory fitted in-vehicle applications, navigation, and traffic information services. Still there are a number of factors that can be identified that stifle the further development on in-vehicle applications.

The EU market for in-vehicle applications is strongly fragmented. Some member states such as Germany lead the way in the development of ITS solutions and in-vehicle applications. While in particular smaller Member States on the periphery of the Union, there is virtually no deployment of in-vehicle applications.

This is caused by different circumstances:

- Market volume and purchase power; introducing products and services in smaller markets is less profitable.
- Road map data availability; in-vehicle applications often rely on map data. Although the main map data suppliers are expanding coverage rapidly, detailed map data is not available yet for some countries (e.g. Rumania, Bulgaria, Cyprus)
- Road traffic data availability; traffic information is an important in-vehicle application and an important enabler for other in-vehicle applications such as navigation. In many less developed markets the amount of traffic information available is limited or non-existent. Collecting traffic data requires substantial investments, while the consumers' willingness to pay for traffic information is low. Private parties that aggregate traffic data therefore rely on public traffic data, in general collected for traffic management purposes.

Currently the interoperability of in-vehicle applications and devices is limited in all market segments. Car manufacturers have established interoperability in the factory fitted devices through CAN. Functionality of CAN is however limited and it does not allow for the easy addition of new functionality. Interaction with dashboard mounted devices and devices under the bonnet is not standardised and requires costly installation by certified installers.

One of the major drawbacks of using PNDs and mobile phones as devices for in-vehicle applications is the lack of uniform mounting options. The most commonly used mounting method is the windshield suction cup holder, a solution that is cumbersome and that does not always provide a sturdy fix.

Another challenge for manufacturers of nomadic devices is the power supply in vehicles. The only standardised powering solution is the archaic cigarette lighter socket. The position of the cigarette lighter socket on the dashboard varies, requiring drivers to connect the nomadic device using a cable running over the dashboard.

The usability of nomadic devices for in-vehicle applications is further hampered by the lack of standardised access to the audio system, and sensory data of factory fitted devices under the bonnet.

6.8 Synthesis

The market of in-vehicle applications is currently divided into separate market segments. Although market developments are difficult to predict, it is certain that there will remain a clear separation between the under-the-hood and on-the-dashboard segments.

Key players in the under-the-bonnet segment will remain car manufacturers, OEM suppliers and public Regulators. Devices and applications in this segment require long life cycles and high reliability.

The on-the-dashboard segment will continue to be dominated by private parties and consumer demand. This segment of fast moving consumer goods will continue to experience rapid growth and short innovation cycles.

The segmentation of the market does not stimulate the development of interoperability. Both segments would however benefit from increased interoperability. Standardisation and policy development could drive these developments.

7 Options for Platform Architectures

This chapter deals with potential platform architecture approaches. The term platform not only describes a technical device or a computing platform, but rather an arrangement that, besides the technical components, also includes the business architecture, business model, governance, security, certification regime, specification and so on.

Architecture can be defined at different levels and from different points of view. For an accurate analysis later on regarding an in-vehicle platform, technical and business architecture are treated separately. Also it is shown on which levels a platform can be specified.

The analysis for the below stated options and the presentation of the visions regarding a platform for ITS services and applications will be done in the final report.

7.1 Options for Technical Architectures

The main purpose of the technical architecture or system architecture is to meet the functional requirements, which are primarily given by the applications. The objective for a good architecture design is a fair balance between "must have", "should have" and "like to have", as well as a flexible partitioning of the system in such a way different applications can coexist. There are many ways how to achieve such concerted approaches.

Figure 7.1 illustrates a simplified technical view of a generic (centralised) telematics In-Vehicle Equipment (IVE). At the bottom there are the interfaces for power, sensor data and communication data, either realised through a bus, point to point connections or (most likely) a combination of both. The data interfaces are physically connected with the system hardware, which includes at least a processing unit and some memory. Above this is the system software, which is designed to operate the system hardware and to provide and maintain an environment for running application software on top of the computing platform. It is this hardware/software co-design that enables applications to make use of system resources like computing power, storage space and interface data. Generally, applications, system software and hardware are combined in one physical device, often referred to as the computing platform (or processing environment), while sensors and communication modules can be mounted separately.

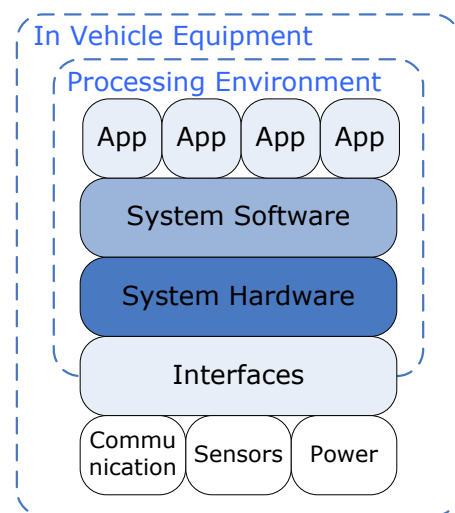


Figure 7.1: Generic (centralised) Technical Architecture of a Telematics IVE.

This is of course a very high-level conceptual view. In reality all those components consist of many further blocks. Moreover, there are no strict borders between different technical layers and it depends strongly on the overall system design how certain functionalities are realised. To give an example, a GSM communication module, over which an application transmits or receives data, can be integrated in the system hardware (together with the required software drivers) or implemented as a standalone communication component. In addition, it is possible to have multiple (autonomous) processing environments that communicate over the network (both in-vehicle communication and internet connectivity), resulting in a so-called distributed system. This is basically the approach used in the CVIS project, which is further described in annex 1.

For these reasons of complexity the underlying model does not intend to go too much into detail. Though, the generalisation will help when introducing different options on how to define a technical architecture. Thereby the focus is more on to what extend the technical architecture should be defined than on how exactly it will look like in terms of physical components.

7.1.1 Generic On-Board Services

The concept of generic on-board services is based on the universal on-board unit (UOBU) study sponsored by the European Commission and published in 2006. Such an architecture should not be seen as an all-in-one universal unit, but as an interface that serves applications by way of providing a set of data and services to a number of key applications (like for instance eCall, EFC, Digital Tachograph) in an open, safe and appropriately secure framework.

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The study introduces the idea of a common on-board interface, which is basically a small unit that provides the core services of the UOBU. The UOBU itself is more to be seen as the set of all technical components of the computing platform inside the vehicle. But the focus of the technical architecture is on standardising the interfaces as highlighted in Figure 7.2. Within the environment of the interfaces the requirements regarding the services available are specified in detail. This includes the type of data (e.g. vehicle position, vehicle identification, universal time), the format of the data (e.g. data types, data protocol) as well as availability, accuracy, security and reliability of the services.

In a vehicle with generic on-board services, applications can take advantage of a given interface infrastructure with specified technical and functional characteristics. The in-vehicle data flow is specified and as a consequence it is clear how to receive data and what kind of services can be used. The quality of the services is described in detail and includes control mechanisms, the ability to provide different priority to different applications and a certain level of performance to the data flow. Conversely, sensors and communication modules can be designed consistently, because it is exactly specified how to use those interfaces.

According to the UOBU study it would be in the responsibility of a vehicle manufacturer to provide and certify generic on-board services together with a vehicle bus (e.g. CAN-bus), which both meet the common minimum requirements. Applications would be designed to be "plug and play" so that vehicle operators would be able to purchase additional applications from different suppliers.

A similar approach with respect to the method of specification has been taken by BMW, which developed a new telematics framework and a technology-neutral next generation telematics protocol (NGTP). The protocol consists of an intermediary, called dispatcher, which connects the vehicle's telematics unit to Service Providers. In contrast to the UOBU study, BMW has gone a step further and describes also the technical interface from the vehicle to a back office which can be accessed by the various stakeholders and is basically the provision of generic on-board services to the outer world.

7.1.2 Standardised Box

The standardised box approach refers to a technical architecture with one or more mandatory applications embedded. To be more precise, such a framework would combine all the required sensors, modules and functions in order to achieve the requirements of compulsory applications like eCall or the Digital Tachograph. While sensors and modules as well as parts of the interfaces vary from vehicle to vehicle, the system hardware and software together with the applications on top (basically an OBU; highlighted in Figure 7.3) are specified in detail.

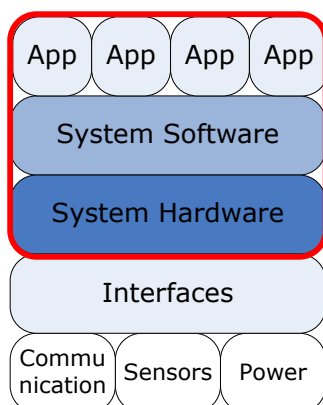


Figure 7.3: A Standardised Box defines the System Behaviour to enable specific Applications.

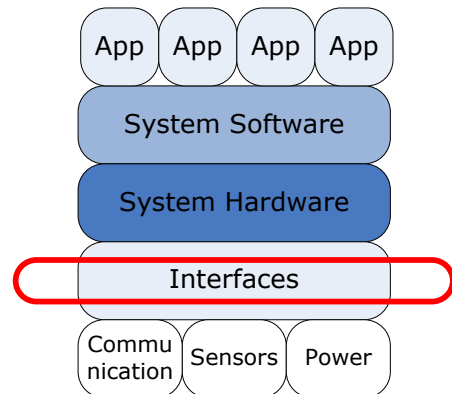


Figure 7.2: Generic On-Board Services standardise the Interface by way of providing a Set of Data to a Number of Applications.

Because the system is specified almost down to the smallest detail this makes the box easy to certify. The functional behaviour is given. Once installed in the vehicle, performance of the system and the properties at the interfaces are observable and therefore verifiable.

A standardised box is also very secure, simply due to the fact that a tamper proof environment is determined in order to run a mandatory application like the Digital Tachograph for example. It is a classic approach of designing a system in all its aspects. Once the technical and functional requirements and characteristics are standardised, the applications for which the the box was designed fulfil their purpose perfectly.

The integration of commercial applications is rather complicated. In case such optional functionalities are requested, they have to be incorporated in the standardisation process of the box. Two problems arise: First, it increases the complexity of the computing platform. More applications result in more standards, longer development times and most likely a more complex system architecture. And secondly, all applications running on the computing platform need to be

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specified. This is not feasible for most of the commercial applications, which are driven by the market. To give an example, a cargo monitoring application has to be adapted for different carriers. It can not be preinstalled on a device.

The main point of the standardised box is that once attached it remains immune from manipulation (except for maintenance reasons of course). What seems at first to be a drawback, in turn, can be recognised as an advantage. The concept of the standardised box describes indeed a inviolable device in terms of customisation (e.g. by numerous 3rd party applications). But the outward appearance (look and feel) is intended to be capable of full customisation through an easily accessible interface (e.g. Bluetooth). Furthermore, the data presented on this interface fulfils certain demands of high quality information because it is a certified device. For example, the GNSS position conforms to requirements as no other device probably does. This fact will be helpful when conceiving other computing platforms.

One possible implementation is the assignment of the Digital Tachograph as the basic device for the standardised box, while extending the functionality in such a way that other mandatory applications fit within one single box. This requires a unification of the legal backgrounds.

7.1.3 Common Platform

The term common platform stands for the adoption of a defined operating system on top of an existing architecture like, for example, a PDA, a mobile phone or another embedded system. In this way an open environment is provided where different applications are able to access or even share variables such as time, position and speed through application programming interfaces (API). Taking again the simplified technical view of a generic telematics IVE from above, the common platform would specify the system hardware and software, as highlighted in Figure 7.4.

There are many examples of already existing common platforms as understood in this context. Apple's iPhone is one of them. It is not about bringing the iPhone as a telematics computing platform into a vehicle, but rather about having a similar architecture principle.

All successful common platforms share some attributes: They have at least one "killer" application, an application users really crave for. For the private car market this could be a navigation application. Then, they make available a breadth of further useful applications, which are easily obtainable. With the advent of development tools like a Software Development Kit (SDK) and a defined API the fundamental functional behaviour of the computing platform could be extended. Similar to the convention of Apple's App Store, any developer could contribute, if the guidelines, which need to be defined by the

regulatory authority, are observed. Applications fulfilling all security and privacy directives advance into a pool of a Service Provider, from where the owner of the common platform can obtain or purchase it.

A Service Provider, who also acts as the institution authorised with the inspection and certification of new applications, has to proceed strictly according to the requirements and, and at the same time, has to ensure that no malicious software can be installed on the computing platform the Service Provider will provide. This is a really important matter of security.

The system software running on the computing platform must allow commercial applications to make use of hardware resources and system variables. It must further provide a secure environment to the mandatory applications along with a dependable priority distribution. Under no circumstances may it occur that applications become maleficent, for example, by allocating too much memory or an inadequate consumption of computing power. If this cannot be guaranteed, commercial and mandatory applications will not coexist on the same computing platform.

It is clear that with a common platform the main difficulties arise with security, reliability and privacy concerns. The question regarding the regulatory authority is also of a major challenge. The framework is intended to be as open as possible. But mandatory applications require a certain level of protection. This does not mean that an open computing platform can not provide this type of environment, but it is clearly given that such requirements are hard to achieve.

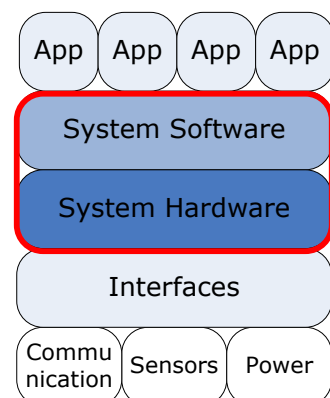


Figure 7.4: A Common Platform characterises the System Platform.

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First beginnings in developing a common telematics computing platform exist: AutoLinQ™ from Continental, for example, is an open end-to-end vehicle connectivity platform that intends to create an environment, where users can have interaction with vehicles from outside (via mobile devices or workstations). An SDK is expected to be available in 2010 consisting of API documentation, a vehicle simulator, a vehicle emulator and the HMI design guide.

7.1.4 Off-Board Approach

The off-board approach is more a business and less a technical concept. It depicts an architecture where the IVE acts as a data collector and forwarder only. The processing of the data by one or more applications is done on the system of a Service Provider. It is exactly specified, which data has to be collected (e.g. position, speed, time), how to protect it, when it needs to be transferred the latest and how it must to be stored. However, it is thoroughly left to the Service Provider how this data is collected and evaluated and how the IVE is design in detail. Figure 7.5 illustrates this layer of specification, which is located somewhere in between the vehicle and the provider. Neither technical regulations for the system hardware and software nor for the applications should be characterised when defining an off-board solution.

Service Providers need to meet reliability, financial, functional and technical standards defined by the regulatory authority in order to be certified. During this procedure all security-related system approaches and activities by the Service Provider must be verified. It is therefore in the responsibility of every Service Provider to implement a justifiable system respecting the guidelines as well as the European Directives.

The off-board approach is extremely prescriptive simply because the business architecture is given. Furthermore, it is only applicable for commercial vehicles. The private car will not see any benefit as value added services do not exist in the car itself and, as a consequence, are unobservable.

But the concept also has some advantages, especially for the commercial market. Transport companies are free to choose from a variety of Service Providers, concluding a contract with the one offering the most adequate applications for the best money. For the Service Provider there are almost no complicated governance issues. For example, the main problem, namely the implementation of mandatory applications, is simply neglected.

7.2 Options for Business Architectures

The business architecture for ITS applications is defined in the prospect of different stakeholder groups, each of which having different perspectives and demands regarding an optimal structure. Furthermore, the receivables depend strongly on mandatory and optional applications and, as a consequence, vary significantly for commercial and private vehicles. The development of appropriate business architectures will therefore be discussed separately in the upcoming chapters.



7.2.1 Business Architecture for Commercial Vehicles

For a common open in-vehicle platform to be defined (or agreed), a business architecture should be selected that serves the interests of key stakeholders for the full range of in-vehicle applications, while safeguarding the interests of other stakeholders and offering sufficient flexibility for the development and implementation of future in-vehicle applications.

In terms of commercial vehicles, particularly two applications are in the foreground: the Digital Tachograph and EFC. These two killer (because mandated) applications can substantially increase sales and the adoption of the computing platform on which they run. In this regard, the main stakeholders are the User, Toll Chargers and Authorities. For different applications other parties can be involved of course.

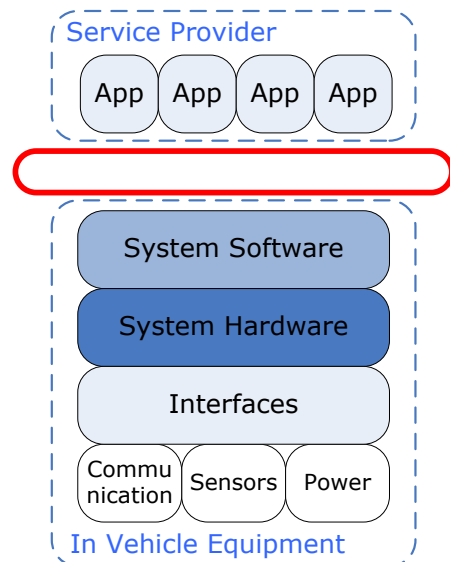


Figure 7.5: The Off-Board Approach defines the data transferred between vehicle and Service Provider.

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The User group is either represented by the vehicle’s operator, driver or owner, depending upon the nature of the service and the contract terms. This group can be seen as Direct Service Consumers. They use the services provided by applications running on their IVE. What is obvious for optional applications (such as navigation) does not necessarily apply to mandatory applications. Taking EFC as an example, a Toll Charger will probably have a higher profit margin from another application than EFC, running on the IVE. This is of course a matter of opinion, but that is the reason why this group is combined under the term Third Party Service Consumers. This includes all parties involved in the deployment of mandatory applications. All regulated applications provide some kind of service, be it for safety reasons or surveillance and governance responsibilities.

In the legal prospect, there is a direct relationship between the User and these Third Party Service Consumers, as depicted in Figure 7.6. For example, the Digital Tachograph underlies certain regulatory provisions, which exist between both parties. The same arises for EFC applications where the relationship between User and Toll Charger is the toll declaration

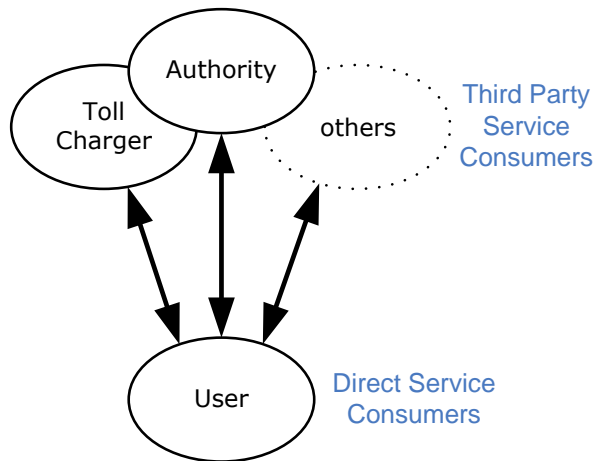


Figure 7.6: For mandatory applications there exist legal relationships between the User and various “partners”, such as Toll Chargers or Authorities.

In the course of the CESARE projects [6], a basic model was designed in order to give a general overview of the EETS. In this basic model, four roles were identified as being part of an interoperable EETS service. Within this model shown in Figure 7.7 two new stakeholders appear: The Service Provider who in this context is responsible for the provision of EETS and the Interoperability Management.

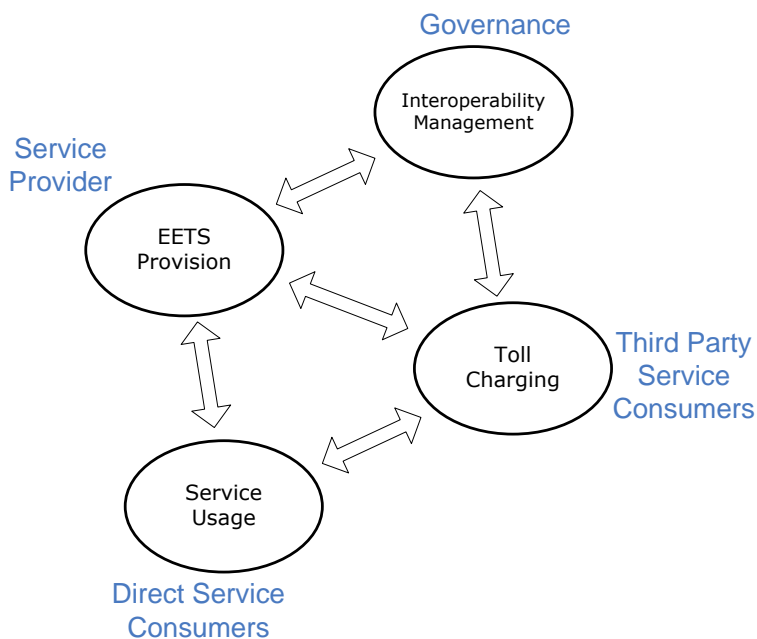


Figure 7.7: CESARE role model introduced for the interoperable European Electronic Toll Service (EETS). The terms in blue refer to a more general notation when applying the Role Model to other mandatory applications.

The Service Provider allocates equipment, contracts and payment means to those who want to use the EETS. This includes claiming money from the Users and guaranteeing payment for substantiated claims received from the Toll Charger. The primary contractual relationship exists only between the User and the Service Provider. In terms of business articulation there is no direct contractual relationship between the User and Toll Charger, because this is cumbersome and superfluous.

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The other party showing up in Figure 7.7 is the Interoperability Management as part of the Governance that represents the regulatory role of the EETS interoperability scheme. The Interoperability Management gathers the functionality that deals with overall management of interoperable EFC. It consists of European and national legal authorities and defines the directives for all involved parties. That covers for instance the certification procedure for IVEs or the agreement procedure for providers, as well as common specifications, guidelines for interoperability and so on. The Interoperability Management is an inherent part in the role model, especially because it is always present in the background and affecting the relationships between the parties as well as the scope of action of each one.

The role model developed in the series of CESARE projects seems to be appropriate for other mandatory applications as well. A Service Provider could always act as the main contact for the User and offer him all the necessary equipment and information required by the Third Party Service Consumers. Users are free to sign a contract with the provider of their choice.

The traditional bilateral relation between User and Third Party Service Consumers is reduced to a legal relationship and substituted by a multilateral, open, and market based arrangement between Service Provider and User. Another direct relationship exists between the Service Provider and the Third Party Service Consumers for the reason of compliance with requirements and regulations as well as the exchange of compulsory information. Taking EFC as an example, this would be the transfer of billing details.

As mentioned above, it is not the intention that Third Party Service Consumers provide mandatory applications, but rather define the general requirements. It is then in the responsibility of the Service Provider to implement a permitted solution. How this is done is not within the area of responsibility of Third Party Service Consumers.

The same applies for enabling a series of optional applications. In case no rules defined by Third Party Service Consumers are disobeyed, it is completely left to the Service Provider how to distribute further applications. As stated in Figure 7.8, there are several business models to be considered how software applications and additional services are made available to the User:

- **In-house** (orange line): In-house refers to the provision of additional services using the Service Providers own resources. This means that software applications and services are developed in-house. An EETS Provider for example can directly offer his computing platform to a user with his self made products running on top of it, as long as the general conditions in the EETS toll domain statement are met of course.
- **Direct** (red line): A direct relationship may exist between the User and an Application Provider in some specific instances, where the issues of IVE compatibility and compliance as well as separate contract terms can be satisfactorily addressed. For example, an internet based entertainment provider with e-commerce capability would possibly prefer such a business model. A User would have a computing platform from the provider of his choice, but would then obtain additional services and software applications from a separate Application Provider.
- **Hosting** (blue line): The Service Provider hosts all services from external Application Providers and provides information about available applications to the User. It is the Service Provider who is responsible to create a contract with the User in order to provide service content data and payment information. There are also contracts between Service Provider and Application Provider associated with payment and delivery. The hosting business model can be compared to the "App Store", with Apple being the Service Provider.
- **Branding** (green line): Application Providers deploy services to the Service Provider, who on his part hosts and provides all of them to the User. The Service Provider is responsible for provisioning of an application whenever a User subscribes for it. There are contracts between the Service Provider and both the Application Provider and the User. The GPS device manufacturer Garmin along with Navteq as electronic map provider serves as nice example for the branding business model. Users purchase devices from Garmin without considering how maps are distributed, while Garmin has its contract with Navteq to buy the required maps.

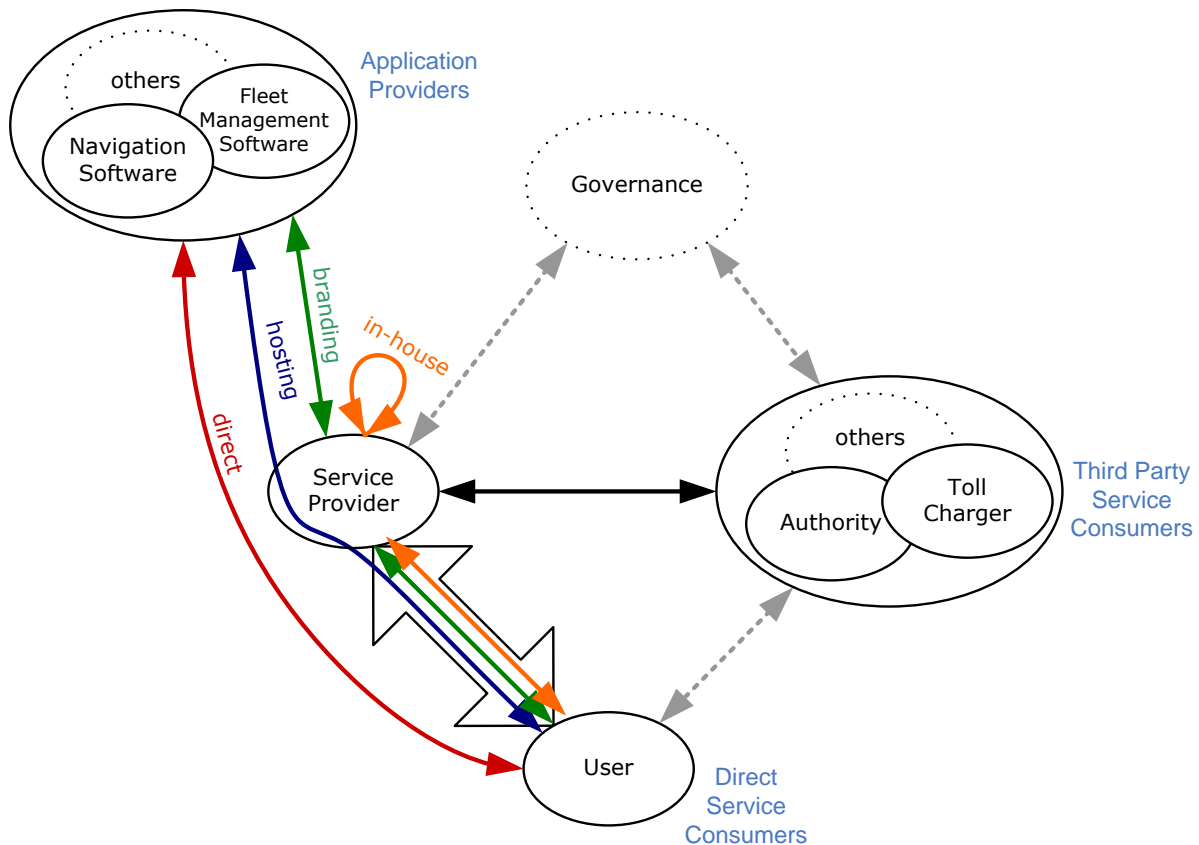


Figure 7.8: Options for Application Acquisition within the Business Architecture.

The presented role model finds its similarities in the GSC project [7], with the main difference that the Governance has been reintroduced in the background. As it was concluded in the GSC project, the responsibility of the Service Provider (in the GSC project it is referred to as Service Aggregator) is at least identical with the competence of an EETS Provider.

The operation of computing platform remains in the responsibility of the Service Provider, also to ensure compatibility between tolling and all other applications as well as managing overall performance and security policies. As a consequence, the direct relationship described above as a business model is not recommended, because of both increased complexity for the User and increased risk to the overall platform security, when different applications running on the same system are not managed by the same Service Provider. At least for computing platforms embedding regulatory applications, a direct provision of applications will not be feasible. Additional applications from Application Providers have to be approved by the Service Provider, which is only possible in case of the business models "hosting" and "branding" respectively.

Anyway it is quite unrealistic that a Service Provider will ever take full responsibility to provide both optional and regulatory applications on the same computing platform by reason of certification and accountability to the Third Party Service Consumers and the Governance. Looking at optional applications separately, the business model "direct" could come back into a discussion. But again it is unlikely that a Service Provider will offer an open computing platform, which Application Providers are able to use, without having any economic bearings.

7.2.2 Business Architecture for Private Vehicles



Analogous to the development for commercial vehicles, a business architecture for the private vehicles should be developed for the benefit of the main stakeholders. The focus is always directed towards the key beneficiaries and the killer applications. While for the commercial vehicles this applied to the Third Party Service Consumers and primarily the regulatory applications, it looks quite different for the private market. Here, the key stakeholder is the User (driver) whereas the killer applications are navigation and communication (e.g. mobile phones) and if mandated eCall.

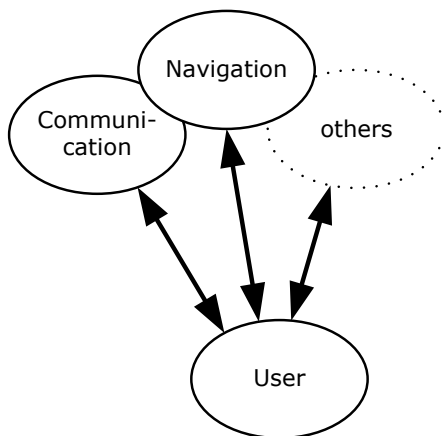


Figure 7.9: Current (direct) Relationship between User and different Application Provider.

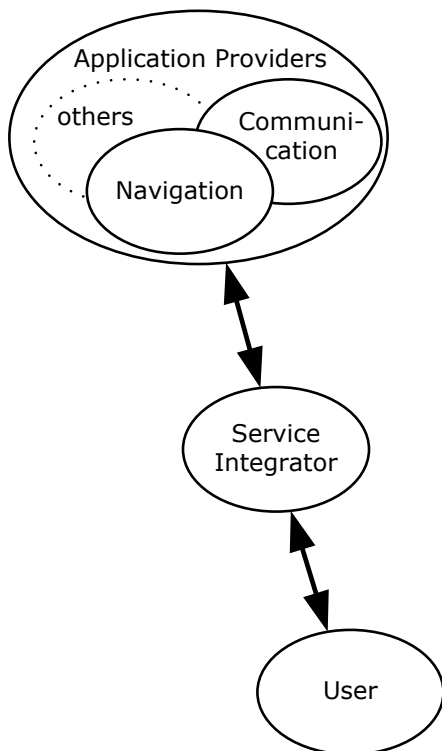


Figure 7.10: Role Model with a Service Integrator.

Considering the current situation, there is a direct correlation between the User and an application. For example, the User purchases a navigation device from one specific supplier, has a mobile phone contract with another provider while using an entertainment system of another vendor. Figure 7.9 illustrates this relationship. Note that all of these applications are optional. Adopting an in-vehicle platform architecture for the provision of several applications on a single computing platform requires certainly a different structure.

The administration and, even more important, the responsibility must be passed over to a single Service Integrator that manages the applications and deploys them at the front-end (Figure 7.10). This Service Integrator also implements the customer relationship management, thus, the relations between the User, the Application Providers and the Service Integrator himself. The idea of having a Service Integrator holds as a simpler model for the User, because he then has a clear contact for service or application requests, agreement of contract terms and payment transactions. The operation of the computing platform remains again completely within the responsibility of the Service Integrator to ensure compatibility between different applications, as well as managing the overall performance.

In case the model should be extended towards regulatory applications (e.g. EETS), further parties come into play. First of all, Third Party Service Consumers such as Toll Chargers or the Authority require a linkage towards the Service Integrator responsible for the computing platform. And secondly the Governance needs to be introduced again simply because mandatory applications are enforced by legislation. It is within their responsibility to accompany the processes of standardisation, certification and audit. This brings us back to the role model developed above in Figure 7.8 with the Service Integrator and the Service Provider merging together.

Please note that such a concept of a business architecture still leaves economic scope for a range of business strategies and models – not only for the distribution of applications, but also for the (inter)acting of all parties.

7.3 Level of Platform Specification

The so far presented architecture options focused on technical and business aspects. Apart from this, one has to think about how a platform in general is specified. To point this out again: It is not only the technical platform that has to be specified, it is much more. Of course there are hardware components, an operating system and executable applications. But there are also services, business structures and governance that form the overall platform.

Different functional perspectives on various levels exist, as depict in Figure 7.11. It is important to note that these levels of abstraction do not compete with the technical view of a generic telematics IVE introduced in the chapter above. This context is not about a technical division into hardware, software and so on. On the contrary, technical aspects are partially encapsulated in all levels.

This might be a bit confusing first, but the reader will see later on in the analysis that the introduction of these levels will be particularly helpful when trying to get an overview of the application demands regarding a platform. In the end it should be possible to choose for every

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application the platform arrangement, which it deems the most appropriate for providing a service. Or vice versa, it should be clear what kind of platform and on which level it needs to be defined in order to serve a range of applications. Five levels of abstraction are distinguished:

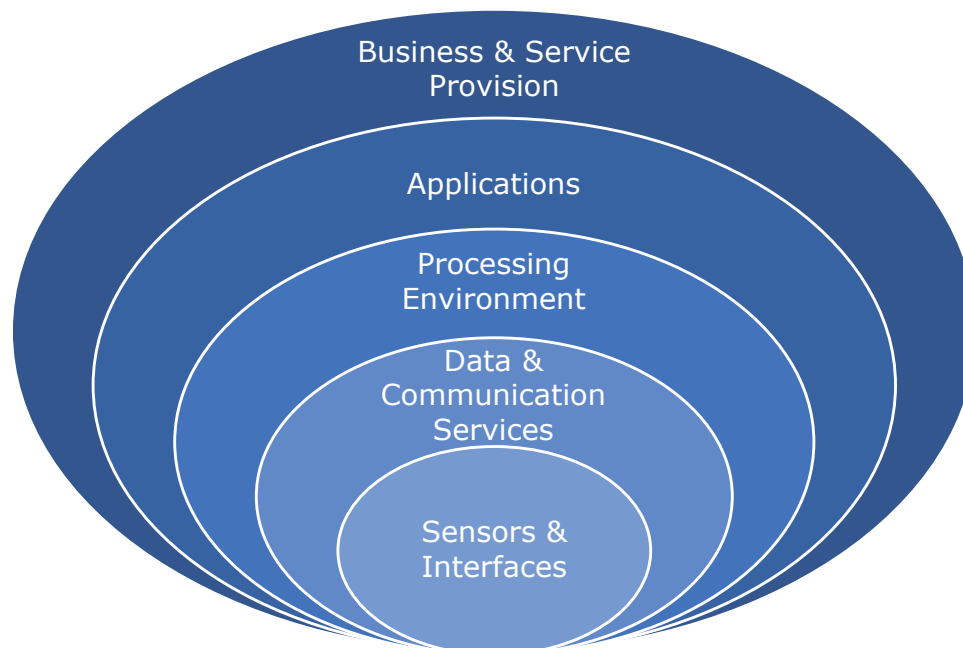


Figure 7.11: Levels of Platform Specification.

Sensors & Interfaces

The level referred to as sensors and interfaces defines physical specifications for devices. This includes for example choice of cables, connector layouts and voltage levels. In the same way the interaction of a sensor device with the medium needs to be standardised and data protocols need to be defined. Resources have to be shared, which leads to mechanisms for contention resolution and control of the data flow. There exist two types of sensors: the ones that are already in place in the vehicle (e.g. power) and others that have to be installed separately. For both of them standards should be in place in order to serve as a bottom level platform.

Data & Communication Services

The level of data and communication services is more concerned with the interaction of multiple devices. The services provided in the vehicle together with the quality and availability are specified. These kinds of services should not be confused with the services provided on the top level, which are discussed in a moment. The data and communication level focus on physical services (e.g. time, location, identity and other common on board services), whereas the business and service provision level address to functional services (e.g. navigation from A to B). As an example, not the GNSS module for the location is specified, but having the information of the vehicle position available in the car along with the knowledge how to use this data.

Processing Environment

The processing environment incorporates the hardware architecture, the software framework and the related user interface that form an OBU. This is what in computer science is typically referred to as computing platform or just platform. It is defined as the environment where to run the application software in order to process and produce information. Requirements regarding system design and access to system resources have to be specified. This includes processing performance parameters, memory

Applications

It is not about programming software applications and integrating them in a computing platform, but rather defining the functional aspects of applications such as behaviour, reliability, security, safety, latency and other performance parameters. When specifying at the level of applications, all these operational requirements must be defined in order to describe an application.

Business & Service Provision

The level of business and service provision describes the business structure together with the direct measurable or tangible benefits in terms of available services. The intention of this matter of specification is to define the framework and its value chain in which services are provided. EETS serves as a good example. Defined are the requirements for the Service Providers in order to offer contracts to Users, who in turn benefit from access to the EETS in the entire EU, and demands on the Toll Chargers, such as publishing toll domain statement outlining the general conditions for EETS providers to access their toll domains. Neither the processing environment nor specific sensors and interfaces are determined. The same specification could also be done for the Digital Tachograph, which is so far standardised at lower levels. For example, a truck needs to have a contract with a Service Provider that would guaranty to alarm the driver when he is over time and alarm the contact of authority when he is excessively over time. One does not have to care about how exactly it is done as long as certain requirements are met (e.g. access to the data, which will be stored over a long time for reasons of investigation).

As one can see, applications like the Digital Tachograph or Electronic Fee Collection can not only be specified on complete different levels, but (depending on the application demands) also on the exact same level or may even overlap. Each of those levels represents a different model of the same information and processes, but uses a system of expression involving a unique set of objects and compositions that apply only to a particular domain. Each relatively abstract "higher" level builds on a relatively concrete "lower" level, which tends to provide an increasingly "granular" representation. For example, communication builds on sensors, computing environment on data, application on the computing platform and services on the applications. Each level is embodied, but not determined, by the level beneath it.

The idea is therefore to think about the optimal level of specification for each application. In general, the higher you go on the level when specifying the better, because in the end the User will consume on the level of service provision and does not care about how exactly this service is implemented on lower levels.

7.4 Security Considerations

This chapter is not about giving security solutions for various platforms, because that would go beyond the scope of this report. The aim is to point out some security aspects. It is important to understand that the strength of a security solution depends on the platform architecture. The more complex a concept becomes, the less secure it tends to be. If more security mechanisms are required in a complex system, chances for attack increase dramatically. Complexity is therefore the worst opponent of security, which means that "keep it simple" is always a good security advice.

As mentioned above, a platform can be specified at different levels for which reason also security plays on different levels (the same is true for the Governance). On lower levels, security addresses more hardware and software aspects, whereas on higher levels it is about business requirements. To give an example: At the level of the sensors and interfaces, quality and integrity of the data as well as authentication of the information is of a major concern. The level of service provision deals with complete different security aspects. For instance it is about how a service can be certified or a provider can be audited to maintain client confidence and avoid privacy risks.

Not only vary these security considerations for different levels of platform specification but also one has to distinguish between different applications. Assuming that in future a single computing platform will provide a variety of telematics applications, such an IVE can host mandatory and optional applications side by side, using the same central processing unit, memory and other resources. The applications may have intended or accidental side effects and impacts on each other. These mutual influences give rise to security concerns because some applications require a higher level of integrity, while others may need a higher level of cryptography. It depends strongly on the particular type of application to be able to determine the extent to which security reaches.

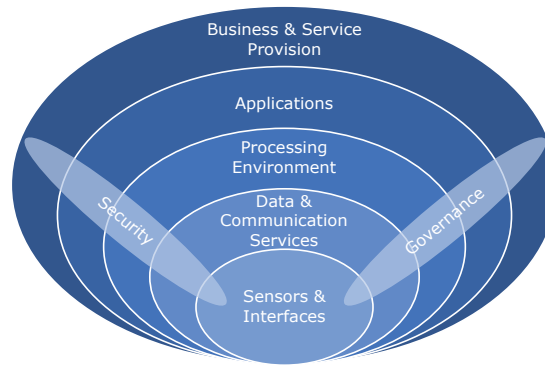


Figure 7.12: Security and governance aspects cover all levels of specification.

The technical architecture of the security system consists of technical components that protect the data from illegal changes, and detect and report attempts of unauthorised manipulation. In general, the transfer of personal data should be limited to what is necessary and sufficient to satisfy the conditions based on legal and contractual grounds. Encryption methods and participants authentication should be used to protect all communication processes from access by unauthorised parties.

Main component of the technical architecture of a security system might be a Public Key Infrastructure (PKI). This infrastructure is based on the widely used public key cryptography, where the key used to encrypt a message is not the same as the key used to decrypt it. The PKI allows protection of a message by creating a digital signature of it using the so-called private key, which can be verified using the so-called public key. It also allows protection of the confidentiality and integrity of a message by encrypting the message using the public key, which can only be decrypted using the private key. The private key is kept secret, whereas the public key may be widely distributed.

Generally, a so-called trusted third party is responsible for security key management. This means that the trusted third party will issue the secure tokens for the IVE and the public key certificates for each User containing unforgeable data like User identity, public key, validity conditions and possibly other attributes. Besides security key management, trusted third parties can also be used for other services, such as consulting, adjudication and mediation.

The IVE should support tamper evidence and provide mechanisms for data integrity and authentication. This requires a secure token inside the IVE. Such a secure token stores the private keys and certificates, and prevent them from duplication. A secure token can also contain cryptographic functions, such as signing and signature verification. Secure tokens are copy protected and access restricted storage and cryptographic computing devices, such as the secure chips used in smartcards.

Each IVE should have a unique identifier linked to only one vehicle for the duration of the corresponding account. An IVE with redundancy (e.g. using multiple sources to gather distance information) and/or fraud resistance features (e.g. fixed installation in the vehicle) further helps preventing fraud possibilities, and therefore can result in less compliance checking effort.

What could be done for a computing platform is the arrangement of a Secure Application Module (SAM). This IVE module could provide generic security services (e.g. cryptography, identification) to different applications and include countermeasures against threats related to security features, such as tamper-proof data storage and software, and data integrity and authentication mechanisms. In all cases, this security system must be a safety closed chain that prevents any manipulation of data.

It is of course not possible to harmonise all necessary security architecture approaches. But it is recommended to implement from the start a consistent and comprehensive security system that covers security requirements for all expected (regulatory) applications. Exploiting the available synergies is also essential for a cost-effective future-proof security system. Note that security requirements tend to limit commercial freedom, since security solutions always require some level of regulation, standardisation and prescription.

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The organisational architecture of the security system has to do with roles, responsibilities and procedures to protect the scheme against fraud and to ensure the required level of data quality. To reduce the risk of fraud and to prosecute violators, it is important to define the responsibilities of the different actors in the User role. The driver or the vehicle operator for commercial vehicles should be legally responsible for checking the operational status of the IVE, for correct vehicle registration and for payment. In all cases, any form of manipulation of the charging scheme (e.g. shield the antenna, disconnect the IVE from the power supply, develop or possess a tampering device) should be forbidden and prosecuted by law.

A certification process for the IVE and an auditing process for the Service Providers might be useful to guarantee the required level of data quality. This especially applies to Service Providers who compete on an open market and might benefit from manipulation to make their services more appealing to the User. In case the Service Provider is mandated, this reduces the security threats, because he does not directly benefit from any kind of manipulation.

Certification refers to the confirmation of certain characteristics of an object, person or organisation. In this context, certification applies to the IVE and the Service Providers for which requirements need to be formulated. These requirements should be described as tests to be passed. Each requirement should lead to a verdict (passed or failed) on which the certification is based. For example, consider the IP code that classifies the degrees of protection provided against water in electrical enclosures, which provides more detailed information than vague marketing terms such as „waterproof“. The requirements can be directly defined as test cases.

In terms of platform certification, this refers to processes intended to determine if the IVE meets minimum standards to assure the required quality, as well as the certification of Service Providers, where an organisation is certified as being able to competently complete the tasks to be fulfilled in the application scheme. Certification of Service Providers will include requirements for both the organisation and the processes. Note that such requirements should not be too narrow, as newcomers should not be excluded too easily. Other requirements, such as financial backing and business plan, are in this respect important as well. Process requirements refer to the IT system used in the collection, processing, storage and reporting of data, security, quality management procedures and so on.

Certification has a significant business impact. Based on the certification, it will be decided which companies will be included as Service Providers. Companies that were turned down during the certification process might go to court, so the certification process must be accurate, sound and court-proof.

Audits are then performed to ascertain, if the certification is still valid. The most useful approach is not a go/no go decision, but to think along with the Service Provider and help to further develop the business and thus the charging scheme. It goes without saying that the auditing process needs clear criteria related to potential damage to the charging scheme (e.g. loss of money).

Driver privacy is one of the most important questions in case of mandatory applications. In case GNSS is used to monitor vehicle movements, drivers tend to see this as violation of their privacy to have „big brother“ in their car. Of course, the gathered data will only be used for the purpose of delivering the service (e.g. toll charging billing details), but it needs a lot of communication and explanation to the parties concerned.

In case of commercial vehicles, privacy is probably less of an issue. The driver of a commercial vehicle drives for the company he works for. In that sense, the vehicle movements in first instance relates more to business behaviour and „business privacy“. Of course, business privacy must be protected as well (like respecting business privacy in case of tax declaration).

The perception of business privacy by drivers and companies depends strongly on the computing platform solution and primarily a task for the authority. It is important that the business information collected by a Service Provider (e.g. tracking data) is not accessible to unauthorised others. Securing such information is a challenge for the organisational structure and internal processes, which is again a matter of Governance.

8 Analysis of Commercial Vehicle Applications



8.1 Relevant Applications for Commercial Vehicles

Chapter 8 summarises the findings of the previous chapters on legislation, standardisation, the business, platform and technical architecture, security and governance for Commercial Vehicles. In order to do so, the relevant applications are identified first.

The telematics market of Commercial Vehicle applications covers applications described as “mandatory” and “optional” in chapter 5. The key drivers are mainly regulated and mandatory applications:

- Digital Tachograph
- EFC/EETS
- Hazardous Goods Tracking
- Livestock Transport Tracking
- Intelligent Truck Parking
- Co-operative Systems
- eCall⁵

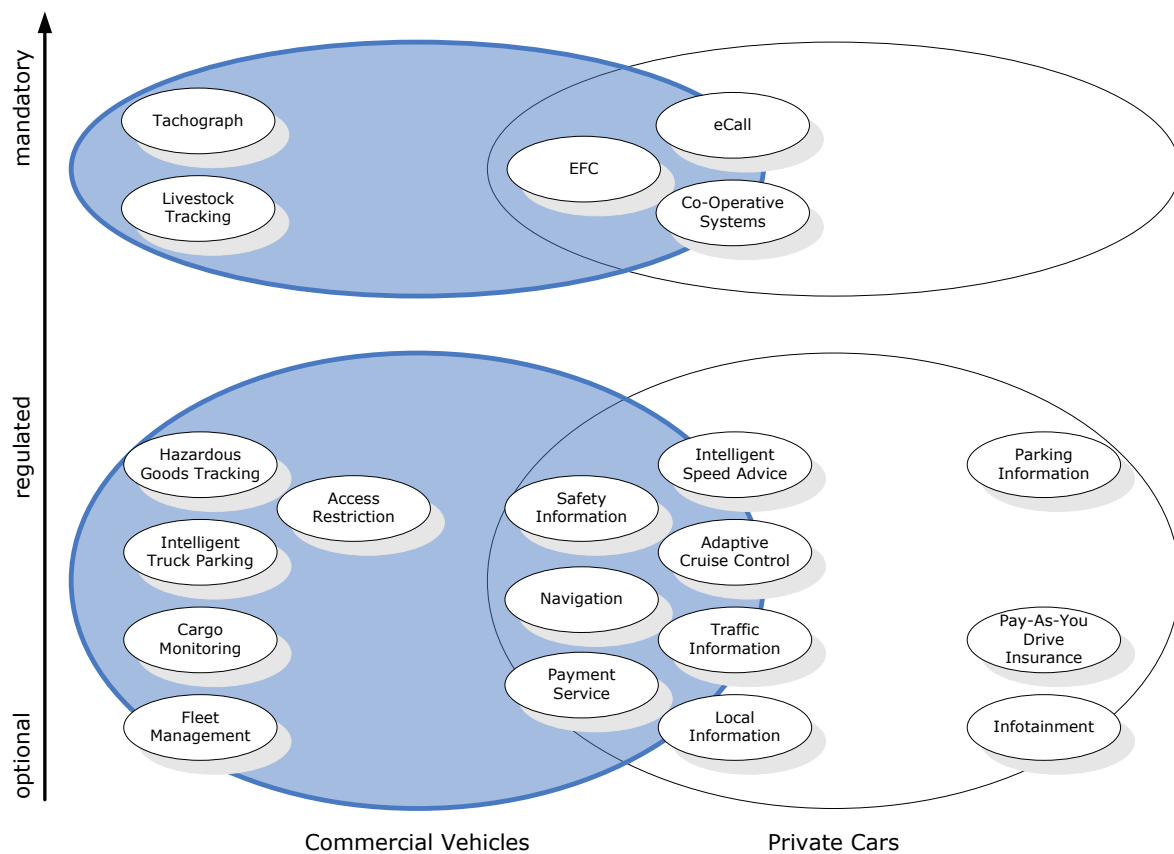


Figure 8.1: Relevant Applications for Commercial Vehicles.

The main objective of this analysis will be to identify the communalities between these applications on both a functional and business related level as well as to provide a concept for promising approaches towards an in-vehicle platform in a short synthesis at the end of the chapter. Recommendations and visions for the development of an open in-vehicle platform are then drawn in chapter 10 and 11 respectively.

⁵ eCall for trucks is a highly complex issue, which needs further detailed investigation

8.2 Communalities between Applications

8.2.1 Technical Aspects

In order to find out the communalities between applications a differentiation is made between technical and business related aspects, a somewhat coarser distinction within the level of specification introduced in chapter 7.3. Regarding the technical aspects it is analysed whether the technical requirements of enclosed applications overlap and create synergies.

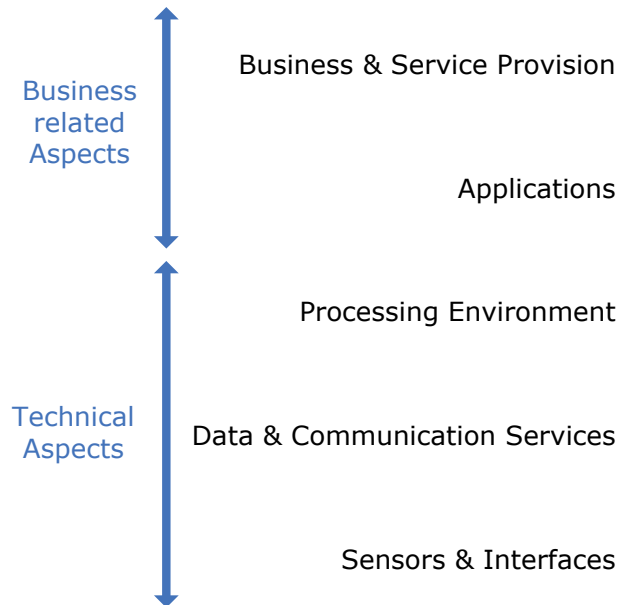


Figure 8.2: Technical and Business related Aspects.

To give an example, requirements for position, time and vehicle status concerning tracking applications such as Hazardous Goods or Livestock Transport are very similar to the requirements of a GNSS/CN based EFC application. So there are obvious communalities on the level of sensor and data services for the mentioned applications.

The listing in figure 8.3 summarises the necessary technical components and requirements regarding interfaces, sensors, data and communication per killer application based on the compilation in annex 2.

The technical components and requirements for these Commercial Vehicle applications are to some degree similar. Some sort of mobile data communication is considered to be indispensable in most of the cases. The same applies to a module for (secure) positioning. Then there is an overlap in demands concerning the vehicle identification.

Apart from the common requirements every applications has specific needs for sensory input and functionality (e.g. airbag deployment sensor). Driving critical applications will require specific sensory input and dedicated reliable ultra-fast processing power. For co-operative systems, distance sensors and short-range communication are presumed with a product life span similar to the vehicle. Therefore the processing environment of driving critical applications will likely not be the same as for other applications.

It does not mean that applications with specific needs have to be excluded in their entirety when thinking of a common platform. Even if applications differ to some extent on the levels of Processing Environment, Data & Communication and Sensor & Interfaces, they still share requirements and this should not be ignored. Chapter 8.3.2 will address exactly such a scenario and further elaborate, why the development of a generic in-vehicle services standard for the provision of reliable and up-to-date basic vehicle information (e.g. location, speed, date and time, etc.) is advised.

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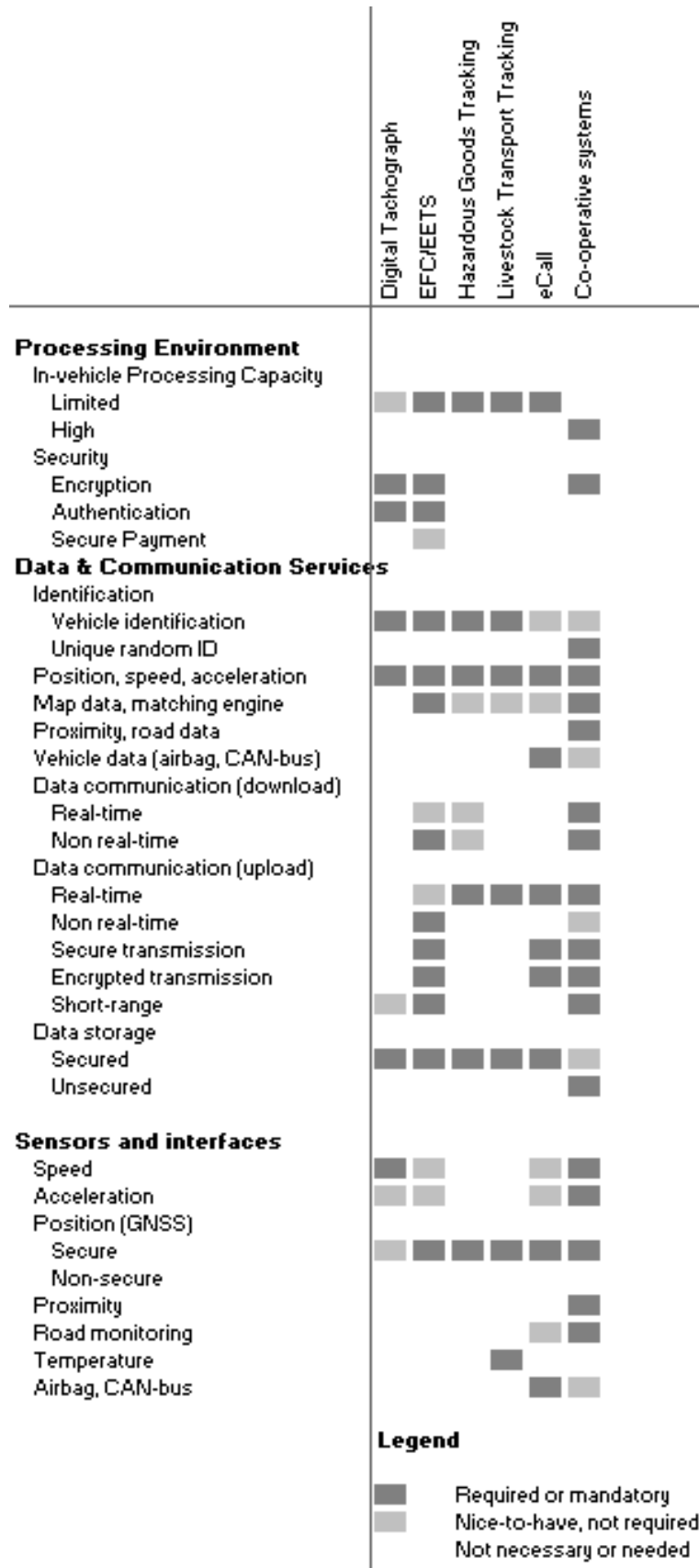


Figure 8.3: Requirements per Application.

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8.2.2 Business related Aspects

A successful platform for multiple services requires also a fit with application environment in terms of business aspects, such as a match in the arrangements regarding institutional setup, certification regime, legal environment and governance. Also equipment and service lifecycle considerations enter here.

As devised by the GSC role model, for example, EFC Service Providers will be eager to extend their scope of service delivery towards fleet management in order to become true Service Aggregators. General security provisions must ensure the coexistence with the EFC application in compliance with privacy and security aspects.

It is still a matter of fact that technicians from system manufacturers and suppliers have a very technical view when thinking of an in-vehicle platform. The business field is often forgotten. For sure one problem is that, so far, the customers were vehicle operators and not Service Providers. This can be changed and amended simply by shaping the existing market. It is well conceivable that the introduction of EETS, for example will promote the establishment of such a modified economic cycle.

To apply the service provision model to other applications than EFC solely, the different roles, functional processes as well as business and legal relationships have to be defined for each of the following stakeholder groups:

- Service Providers
- Application Providers (e.g. electronic navigable maps manufacturer)
- Direct Service Consumers (e.g. transport companies, Road Users)
- Third Party Service Consumers (e.g. Toll Chargers)
- Governance (e.g. Member States)

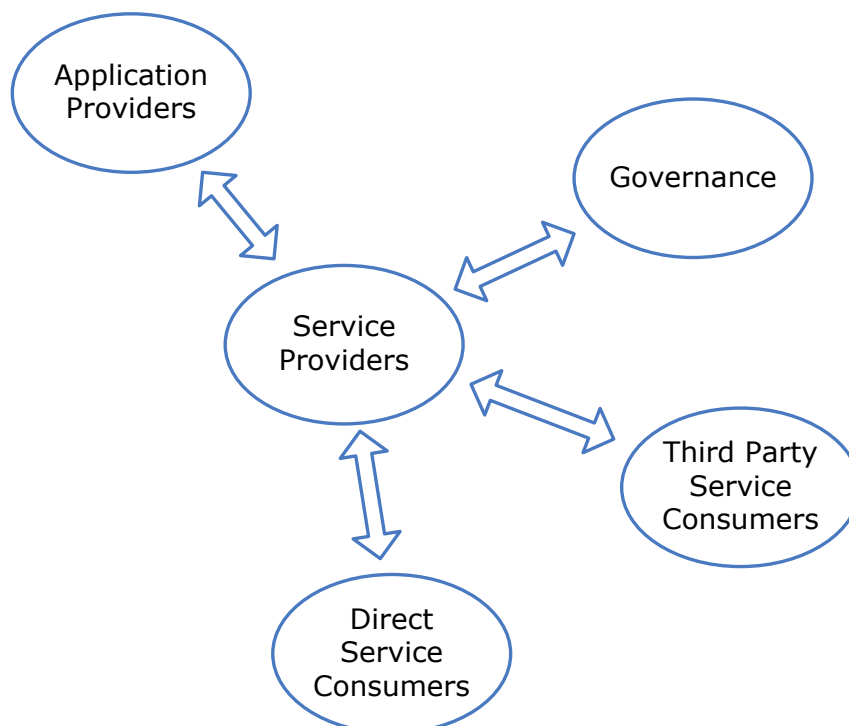


Figure 8.4: Business relationships between Service Providers and the other stakeholders (legal relationships are omitted to simplify matters).

Single business relationships between Service Providers and the other stakeholders imply a simple business model (especially for the Service Consumers) and a clear point of contact for service requests, agreement of contract terms and possible payment transactions. These individual aspects are combined together in some form of a Service Level Agreement (SLA).

Another aspect that should not be ignored is the fact that the traffic telematics market is of a very fragmented nature. Different sectors of the freight business have very different information

requirements. Vehicle tracking is important to some international long-haulage companies, geofenced recording of freight bay doors is of relevance to some others, frozen food transport require monitoring of bay temperature, some companies record speed, acceleration and gear settings in order to educate drivers for better fuel efficiency, and many companies need to connect freight and contract information to trips and delivery points in numerous ways. There appears to be a multitude of niche markets for value added services, where apparently no application has the required volume for successful mass delivery. Therefore it is difficult to come up with a customized solution to meet all needs. However, this should not be too much of concern to the European Commission. If the idea of providing services once is achieved and the right framework conditions are created, it is then being left to the Service Providers whether or not to meet the market demands.

8.3 Synthesis

Chapter 7.3 introduced the levels of specification to emphasise in particular that a platform should also be considered on higher levels than just the technical ingredients. In fact, almost every application can be specified on each of the levels in figure 8.5. But as became clear in several sections of this report, there are mainly two obvious approaches to follow up, in order to integrate a variety of applications and services under one common concept.

The first approach is what is called a Regulatory Framework in the following chapter. It is based on the service provision model and pursues the idea of a migration of regulatory applications to a service model. Rather than specifying the technical side (as it was done in the past), more attention should be given to business aspects, role definitions for parties involved and the alignment of governance.

Generic Services is the second notion and concerned with the technical aspects, such as providing basic vehicle information (e.g. location, speed, date and time, etc.) with a guaranteed quality to many different applications. The proposal also addresses the problem of data redundancy in the vehicle nowadays (e.g. a lot of nomadic devices have their own GPS receiver).

It is evident that both concepts can coexist, because they act on different levels.

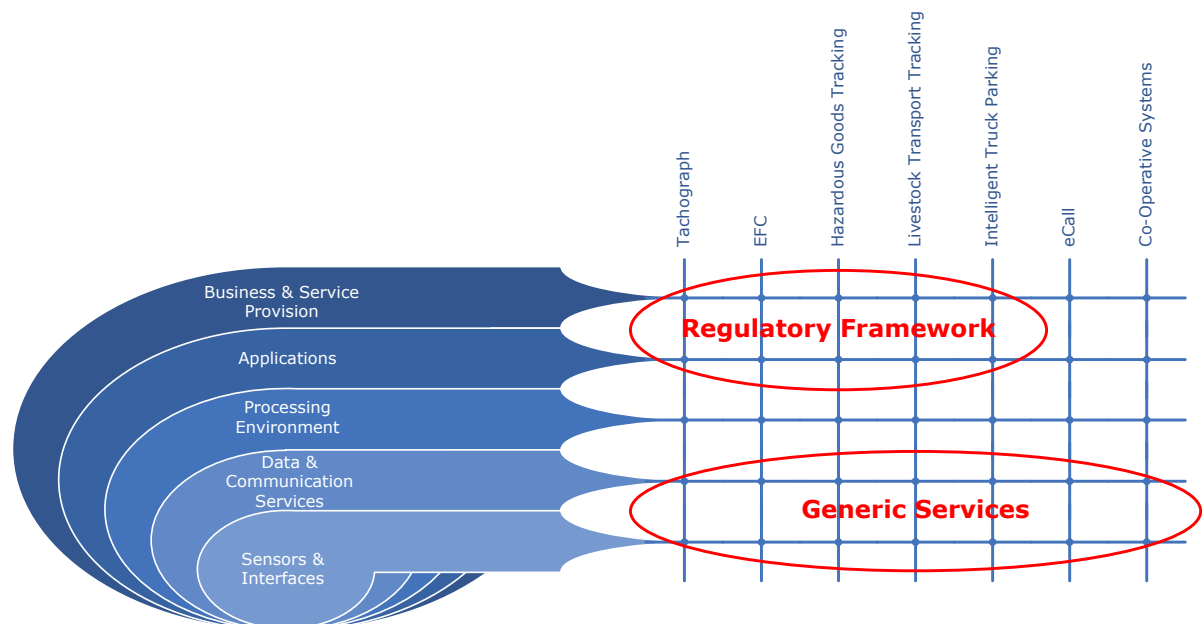


Figure 8.5: The level of specification model extended to the killer applications for the Commercial Vehicles; The marked areas "Regulatory Framework" and "Generic Services" are explained in the upcoming sections and try to show where promising approaches towards an in-vehicle platform are seen and how the development could be supported.

8.3.1 Regulatory Framework

The regulatory framework concept depicts basically the Service Provider model as it was brought up in the development of EETS. It is based on meritocracy, best practices and values of the open source culture and comprises the two business related specification levels business & service provision and applications.

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In terms of Commercial Vehicles, regulatory applications are the key drivers of the telematics market. Currently, they are not defined as a service that is delivered to Users. The EETS is the first European wide regulated application that fundamentally rests on a Service Provider model. It would be advisable in future revisions of regulations pertaining to the Tachograph, to Hazardous Goods Tracking, Livestock Transport Tracking, Intelligent Truck Parking and the like to allow for an equivalent model.

To come straight to the point: Although some sort of hardware is essential to collect the required data on the side of the vehicle, all those technical components should not be of a major concern for within this concept. If the type and quality of generally available data is defined it is then within the responsibility of a Service Provider to provide a corresponding system. The idea is therefore solely on characterising an economic framework providing services, which are mandatory to Commercial Vehicles.

This would result in a certain change in paradigm, though: Taking the Tachograph as an example, instead of the Authority chasing for non-compliant Users one could turn the situation around and asks users instead to positively demonstrate compliance. Users could even be given the choice: option (a): use the Tachograph as is, option (b) go for a private company that assists in managing your fatigue regime. The rules regarding the working and rest hours would be the same, but in option (a) the authority does the policing work and in (b) one allows the company to positively demonstrate compliance. Cost savings for authorities with option (b) are obvious, but also the transport trade benefits because it can receive a number of services, from EETS over track and trace, to fatigue management from a single provider.

Such an approach is currently being pursued in Australia. The Tachograph is not mandatory but companies willing to sign a contract with a Service Provider and equip their fleet with data collection boxes get benefits. Australia has a system with fixed driving hours and it is therefore not possible to get from Melbourne to Sidney without a longer resting phase in between for example. With the new system this becomes possible because the Service Provider is able to ensure that certain conditions are met (like for instance a longer rest before the trip).

Despite being voluntary, the Tachograph as a service becomes mandatory in terms of business simply because many companies are not competitive any longer without using it. This shows once again to make a service attractive, rather than regulate it. It is noteworthy that this concept is also the scope of an ISO work item.

Further benefits could stem from improvements to the regulatory environment by aligning governance of different regulatory measures. Nowadays, applications such as Tachograph, EETS and Livestock Transport Tracking follow very different rules for institutional arrangement, responsible actors, equipment certification, compliance checking and prosecution. If these frameworks could be closer aligned or even merged into one single framework, synergies would emerge on the side of the regulator, but also on side of the market because it would become easier to deploy these applications through a single delivery channel.

A regulatory framework would be necessary in order to have uniform rules for Service Providers as well as European interoperability. By means of appropriate measures, the Commission could further increase the competitiveness between providers and orientate their business activities towards the growth of market sectors.

8.3.2 Generic Services

It has been shown that different applications have common requirements, especially regarding interfaces, sensors, data and communication. The idea of the generic services platform concept is basically to specify those common requirements.

One approach for example would be to standardise vehicle networks, both internal and towards the outside. Developers would then now how to use available resources like wireless communication (DSRC, cellular networks), GNSS or sensor data within the vehicle to implement applications.

Standardisation bodies like CEN, ISO or ETSI are working on vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication standards. The goal should be to support the ongoing work while at the same time ensure interoperability between different work items.

The linking of the vehicle with the transport infrastructure – that is embedding the vehicle into the transport network – is also a priority area within the ITS Directive 2010/40/EU. Member States are responsible for their road infrastructure. The question remains how they should be obligated (or, even better, encouraged) to invest in new technologies or renew their existing infrastructure.

Another point related to generic services is the communication of different nomadic devices in the vehicle with each other, whereby the compatibility is of a major concern. Integration challenges occur when using incompatible standards and connecting multiple systems. Because there is a need for effective systems integration, demands for interoperability rise. Therefore, more progress in this area needs to be done. The long-term answer involves implementing open information technology architectures and working with the respective standardisation bodies to adopt widely used common or open standards, particularly in the field of data communication.

8.3.3 Thoughts on eCall and Co-Operative Systems

As can be seen from figure 8.5, the two applications eCall and Co-operative Systems are not included in the so-called Regulatory Framework. The reason for this is that both do not implement a straight Service Provider model. The public eCall builds on E112. A telecom operator transmits the location information through cellular networks to the emergency centre, which in turn will take the necessary precautions. Therefore the answering point is a local emergency agency and not a Service Provider.

For Co-operative Systems it looks a bit different. Taking the CVIS development project as a reference, the system for example includes a variety of applications: automatic driving, cooperative traffic control, eco driving, parking reservation and travel assistance (just to name a few). Some of them would certainly fit well into the Service Provider scheme. Though, not all of them are probably mandatory, which again would complicate the regulatory framework, because Service Providers should be free to decide what they offer besides the mandatory services. Other applications within the group of Co-operative Systems function on a very low level, i.e. enhanced driver awareness is based on information exchange between vehicles and does not imply business related aspects.

This does not mean that Co-operative Systems do not play a role on the levels of business aspects. To the contrary, it is important to start to think about infrastructural, legal and institutional issues to support the policy on Co-operative Systems and create a stable foundation for the industry to continue with the development.

On the technical side, Co-operative Systems are so to say cooperative in two ways: firstly in terms of direct two-way communication such as vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) or infrastructure-to-vehicle (I2V) and secondly in terms of the computing platform which allows for multiple applications and services to be implemented. However, critical applications like automated braking and non-critical applications such as traffic sign information have to be separated at least into two different runtime environments due to security reasons and to support the availability, confidentiality and integrity of applications as well as the integrity and confidentiality of data.

The same statement is made by a research project on a secure multi-application platform for vehicle telematics (see [9]). Critical or mandatory applications and data within a closed runtime environment should never be illegally affected by applications running on a more open platform. And yet data communication between the two runtimes is possible to allow applications on one runtime environment to make use of data and services on the other processing platform. Here in particular, data communication standards for in-vehicle and communication could encourage implementation. This issue is addressed by defining generic in-vehicle services.

A number of co-operative Systems could also fit into a regulatory framework. This would need being able to clearly distinguish between mandatory, regulatory and optional systems among the different classes of applications covered by this concept. The works of ISO/TC 204 WG16 & WG18 and ETSI lead to conclude that most applications are or should be "cooperative" to a smaller or larger extent. Technically, EFC and even eCall are candidates to fit inside secure multi-application platform, but business models and legislation may restrict how far this is actually possible.

9 Analysis of Private Vehicle Applications



9.1 Applications Overview

This chapter summarises the findings of the previous chapters for the private vehicle applications market, and provides a vision for the development of the open in-vehicle platform for this market.

The market of private vehicle applications covers applications described as 'mandatory' and 'optional applications for private vehicles' in chapter 5.

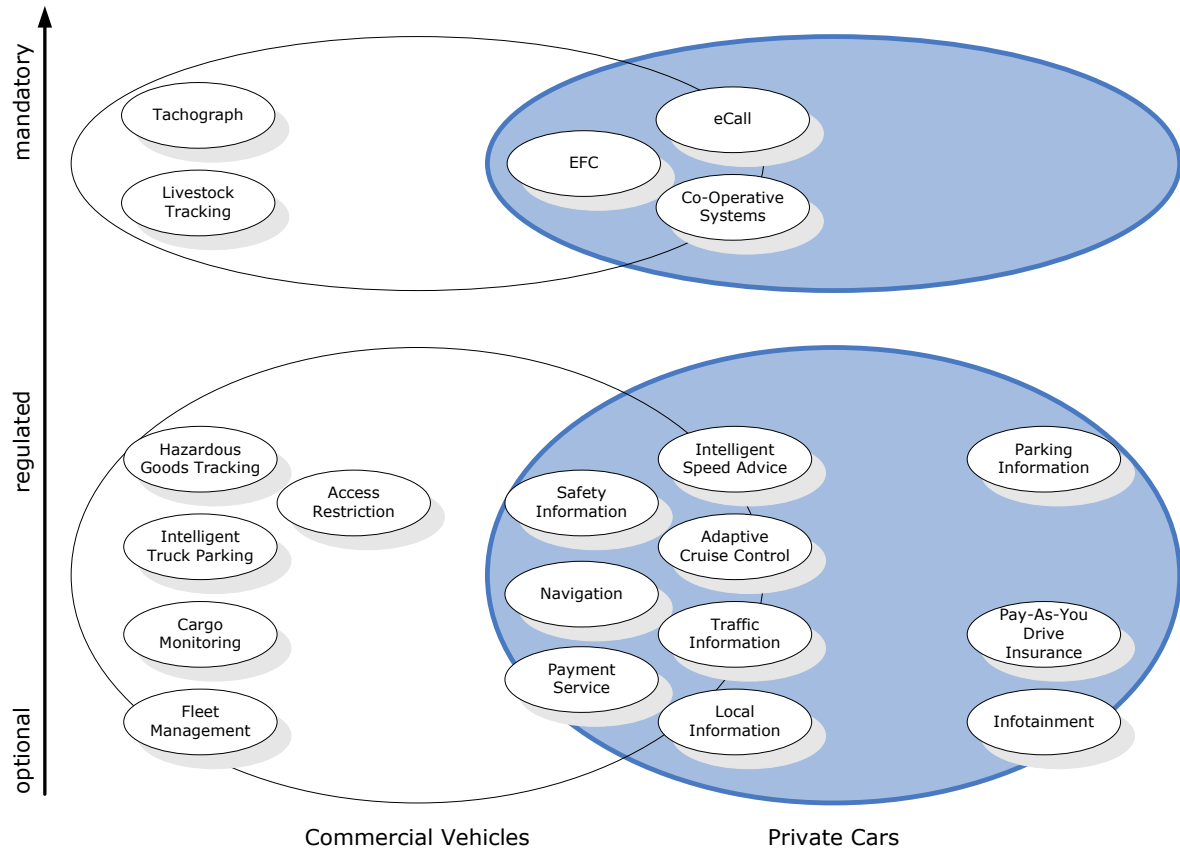


Figure 9.1: Relevant Applications for Private Cars.

These applications are:

- Adaptive cruise control
- Advanced driver assistance services
- Intelligent speed advice
- Co-operative systems
- EETS
- eCall
- Navigation
- Traffic information
- Safety info
- Local info
- Parking info
- Payment
- PAYD insurance
- Infotainment

Some of these applications are shared with commercial vehicles as described in chapter 8, but are presented here from the viewpoint of the market for in-vehicle applications for private vehicles.

This chapter starts by listing the key findings from previous chapters on legislation,

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standardisation, the business, platform and technical architecture, security and governance. Then a synthesis of the findings is provided.

9.2 Key Findings**9.2.1 Application Requirements**

Figure 9.1 presents an overview of the functional and technical requirements of the various private car applications. It demonstrates the substantial variation in requirements between applications. It also indicates that there are three different types of application groups in terms of functional and technical requirements: driving critical, regulatory and optional applications.

This functional and technical division largely matches the application grouping from chapter 5, and the market segments identified in chapter 6.

	Existing market segments	Regulatory grouping
Driving critical	Vehicle manufacturers / OEM	Optional
Regulatory	After market, regulated apps	Mandatory
Optional	After market, commercial apps Smart phone, commercial apps	Optional

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9.2.2 Legislation

Current private car applications are not subject to EU legislation. Although in some countries regulated EFC services are in place for private cars, the market for private car applications is mainly a free market where suppliers of services and devices vie for the consumer's interest.

The introduction of eCall and EETS could change this situation. Both applications are in the early stages of deployment and rooted in EU regulations. The deployment of eCall and EETS requires installation of in-vehicle equipment in large volumes of private cars, and therefore can provide impetus to the establishment of a common open in-vehicle platform in the EU.

Recent pilot projects have demonstrated that there are no technological impediments to the deployment of co-operative systems. Successful deployment of co-operative systems will require a concerted action by road operators, industry and motorists. New legislation will be required to enable implementation of co-operative systems throughout the EU.

9.2.3 Standardisation

To serve the needs of all its key stakeholders, a common open in-vehicle platform will have to connect different types of hardware, software and content that originated from different market segments dominated by different stakeholders. This complex operational environment requires the definition of clear interfaces between the various system components on all levels of specification.

R&D projects like SISTER, Coopers, CVIS and SAFESPOT, as well as industry initiatives such as AutoLinQ and AutoSAR have proven the technical feasibility of complex systems consisting of various vehicle-based and road-side equipment. A number of the key technologies required to define a common in-vehicle platform are in the process of being approved as standards or have achieved common market acceptance. Examples are: the CAN-bus, CALM, DSRC, GNSS and GSM protocols.

Relatively recently the consumer electronics market has attained a foothold in vehicles through the mass adoption of personal navigation devices and smartphones, jointly referred to as nomadic devices. These fast-moving consumer goods have proven to be cost-effective platforms for in-vehicle applications. Interface protocols that are currently being development, or that are in the process of approval as standards, do not cater for the integration of nomadic devices in the in-vehicle ITS environment. Development of new standards could enable sturdy mounting of these devices, and allow them to make use of in-vehicle sensors data, power supply, the audio system, etc.

Another example demonstrates that the automotive industry is willing to develop interfaces for PNDs and nomadic devices: In the recent release of iPhone OS 4.0 a new functionality called iPod Out was introduced. It is a new application that displays an interface for controlling music, with the menu system piped to the display of a car audio system, which could not only handle the iPhone's audio but support hands-free integration. Car manufacturers have the ability to send control commands through external controllers like steering wheel buttons and separate control wheels via a standard docking cable directly to the iPhone or iPod. BMW has already confirmed that the feature will be coming to future cars and other manufacturers will likely follow.

9.2.4 Business Architecture

The market of in-vehicle applications for private cars is complex, involving many different types of stakeholders, applying various different types of technologies. Recent developments have led to the establishment of different segments in in-vehicle equipment in the private car market.

Applications requiring factory-fitted devices, and regulatory applications both rely on equipment that requires long life cycles and high reliability. Key players in this under-the-bonnet segment are the car manufacturers, OEM suppliers and public regulators.

The segment of nomadic devices constitutes the on-the-dashboard segment and can be broadly split into the following 3 types; Navigation devices (PNDs), entertainments (video, iPod, MP3 Player, TV, Internet, etc.) and Smartphones (iPhone, Google phone, etc.). It has emerged relatively recently and is dominated by the consumer electronics industry and consumer demand. This segment of fast moving consumer goods is expected to experience continued rapid growth and short innovation cycles.

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In both segments different business models are in use. In particular in the market of in-vehicle applications for private cars, there appears to be a trend away from one-off and subscription models, towards sponsoring and advertising models for in-vehicle applications.

Although market developments are difficult to predict, it is certain that there will remain a clear separation between the under-the-bonnet and on-the-dashboard segments. The segmentation of the market does not stimulate the development of interoperability. Both segments would however benefit from increased interoperability.

The automotive industry has been working on the design of open in-vehicle solutions, for example AutoLinQ, AUTOSAR and NGTP. Nokia and CE4A have developed Terminal Mode, an open protocol for connecting a nomadic device to an in-dash device. The ability of industries to quickly design and implement such platforms should be considered positive. However, there is a risk that technology is monopolised, or that multiple solution will be adopted by industry.

The introduction of mandatory regulatory applications, such as EETS and eCall, could be used to achieve industry-wide acceptance of common interoperability standards, or to move to open-source proprietary solutions.

The emergence of ITS applications on nomadic devices, and initiatives from the automotive industry to establish open platforms, suggest that multiple processing units will be established in private vehicles in the future. As described in chapter 6 these devices emerge under very different market conditions. Each market segments provides specific benefits to consumers, which are difficult to combine (e.g. low costs versus high reliability, fast innovation versus long lifecycles).

The deployment of co-operative systems is expected to significantly contribute to road safety and a reduction of the environmental impact of traffic, by enabling co-operative driving. The technical feasibility has been proven by various EU projects but successful deployment will only be achieved if complexity is minimised and dependencies between stakeholders are limited through standardisation.

9.2.5 Technical Architecture

For the Commercial Vehicles market it is quite difficult to come up with the one and only technical architecture. To still be able to bring it down to a common denominator the focus must be strengthened on standardisation of communication interfaces and generic services, rather than the processing environment itself.

First, ITS applications make use of wireless communications:

- Communications between mobile ITS stations (vehicles), and between mobile ITS stations and fixed ITS stations (roadside installations)
- Access to public and private (local) networks including the global Internet.
- Infrastructure and satellite broadcast.

And secondly, ITS applications require sensor data and basic vehicle information (such as location referencing, identification, speed, time, etc.). These generic services should to be guaranteed and supported via an in-vehicle communication standard.

To achieve some sort of a common in-vehicle platform it is important to recap functional and technical requirements of applications. To share common functionality and to allow for the development future applications, it is clear that the common functionality needs to be made available in a generic way for all applications. The processing environment(s) itself will likely be conceptualised by the industry, but in order to accompany the ongoing development in the field of ITS telematics platforms, while at the same time ensuring interoperability and compatibility, the architecture of at least communications should be standardised.

The reference architecture from ETSI EN 302 665 is a good starting point and could be used as a tool-box for future telematics platforms. For generic services that should be available in the vehicle, standards have yet to come.

It is worth pointing out that due to the big efforts being made in the deployment of ITS services and applications, particular attention has to be paid to coordinate the actions – especially by inviting the standardisation organisations (ISO, CEN, ETSI) to create coherent sets of standards.

9.2.6 Security

Security requirements differ between driving critical, regulated and optional applications. For driving critical, it is essential that no outside interference is possible. This means that in general a closed box approach will be pursued. Optional applications prefer an open platform with cryptographic solutions for paid services. Projects such as EVITA are investigating security requirements for cooperative systems in particular focusing on the intra-vehicle communications

Regulated applications in general require storage and strict protection of personal and usage information. Past regulations often rely on a standardised box approach because data communication possibilities were either not available, provided insufficient coverage, or were too expensive. This is likely to change as regulated applications move towards a more service oriented architecture.

9.2.7 Governance

It is unlikely that the identified market segments will merge. Driving critical applications will remain in the factory fitted market segment, and as such their functionality will be determined directly by car manufacturers, and indirectly by their customers. Through legislation, public authorities can influence this market segment to some degree, although the rate of technological innovation will likely outpace the legislation process.

Navigation and informative applications will become a commodity feature of nomadic devices. Manufacturers of consumer electronics and their customers control this market. Product life cycles are short and the degree of innovation is high. The low costs have turned nomadic devices into an excellent platform for ITS applications.

Nomadic devices however have some clear drawbacks. The physical mounting of nomadic devices in general is cumbersome. Mounting solutions based on windshield suction cups are commonly used for personal navigation devices. These do not provide a reliable fix and can cause nomadic devices to fall off the dashboard whilst driving. This can lead to dangerous situations in the cabin. In addition, such devices are not currently governed by the European Statement of Principles for HMI within vehicles.

Mobile phones in general are in general not docked in the vehicle. No common docking interface is available for mobile phones. Poorly docked or loose nomadic devices become lethal flying objects in case of accidents and as such pose an inherent safety risk to the EU motorists.

For the power supply, personal navigation devices rely on the cigarette lighter socket, an archaic power source that does provides neither a proper connection to any plug, nor a continuous stable power current. Also, the position of the cigarette lighter socket in the dashboard is not fixed. This means long loose wires are used to connect the PNDs to the cigarette lighter socket, resulting in wires running across the dashboard. These wires pose a serious risk of entanglement to the driver and as such can lead to dangerous driving conditions.

The fast innovation and product life cycles of nomadic devices make regulation by public authorities difficult. However, public policy could facilitate the use of nomadic devices in vehicles by making a universal mounting and powering solution mandatory private vehicles. Such a measure could also be used to enforce interoperability and would certainly improve road safety.

9.3 Synthesis

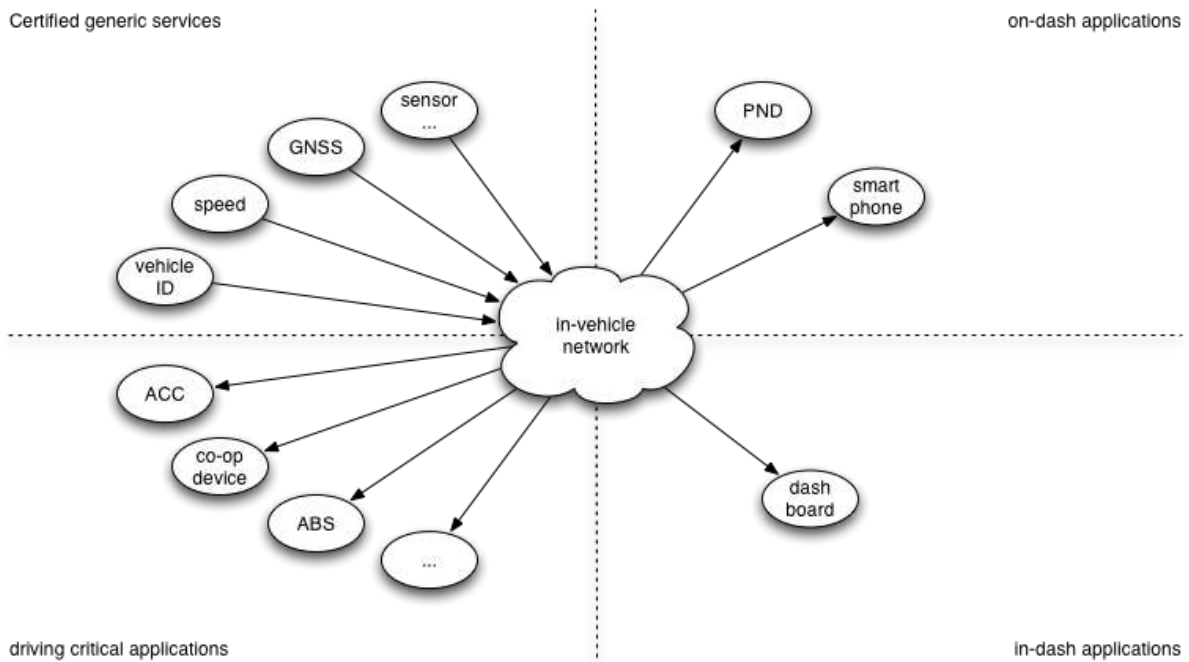
The current market of in-vehicle applications is clearly divided into different segments, being dominated by different stakeholders, and with different market drivers. These market segments will persist as new applications will be developed.

Technical architectures based on the 'standardised box' or 'common platform' model require the implementation of a common hardware device and operating system. Such an approach could therefore only be used for a limited set of applications. The 'off-board approach' is not suited because various applications require fast and reliable processing that can only be carried out in a distributed way. For these reasons these models are ill suited for the establishment of an open platform for in-vehicle applications for the private car market.

The future open platform will therefore be based on 'generic on-board services'. This approach is in line with the expected development of the Internet. IPv6 will enable the establishment of the 'Internet of things', a situation whereby an ever increasing number of objects possess the

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The diagram below presents a graphical presentation of the move towards an in-vehicle environment that connects various components through an open in-vehicle network.



The table below identifies components that will constitute the first deployment scenario for the described platform. These are components that will likely be required for regulatory applications, and components that are likely to evolve in the near future.

Name	Description	Functionality provided
Nomadic device	PND, smartphone or other nomadic device mounted on the vehicles dashboard	GNSS position data, motion sensor, mobile internet access, HMI, person ID
Regulatory components	Components hosting one or more regulatory applications.	Vehicle ID, GNSS position data (incl. accuracy and reliability), motion sensor
Driving critical components	Components hosting one or more driving critical applications	Access to data from various sensors. E.g. tyre pressure, airbag, light on/off, temperature, etc.

Nomadic devices need to be better integrated into in-vehicle ITS environment. The development of a universal dashboard docking interface, such as that being investigated by the Nomadic Device Forum, would not only allow for better usability of nomadic devices as part of the in-vehicle ITS platform. Also, loose nomadic devices pose a safety risk, as they potentially become lethal projectiles in case of an accident.

Regulatory applications can be implemented in dedicated components, but share non-personal information with other applications in the vehicle. The UOBV specifications could provide a basis for such a solution.

With the advent of mobile internet and reduction of data communication costs, vehicles will be online continuously. Future regulatory applications could therefore rely on continuous online reporting instead of a closed box as security measurement. This would allow implementation of regulatory services on open platform, provided reliable and secure identification, and sensory input services are available on the platform.

10 Conclusions and Recommendations

This chapter presents the conclusions and recommendations on the adoption of an open in-vehicle platform architecture for the provision of ITS services and applications, including standard interfaces.

Based on the main outcomes of this study, eight recommendations to the European Commission have been formulated. These recommendations are presented in the respective boxes below. They are connected to the five levels of platform specification as depicted in the following figure (see also chapter 7.3). The first three recommendations are related to technical aspects and refer to the bottom two levels. The other five recommendations are related to applications and business aspects as represented by the three top levels of platform specification, whereby recommendations 4 to 6 apply to heavy vehicles in particular.

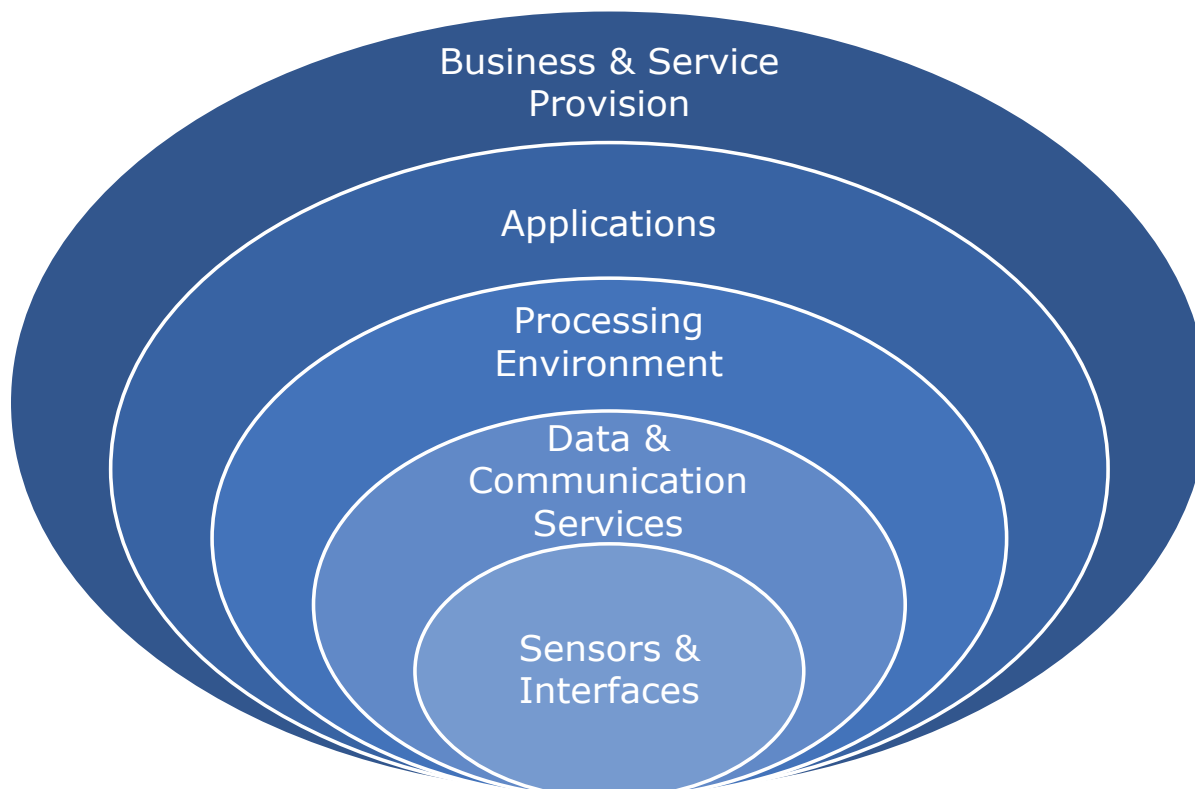
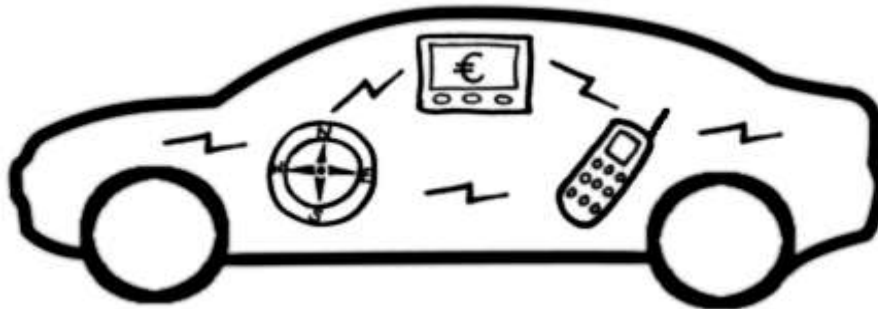


Figure 10.1: Levels of Platform Specification.

Recommendation 1: Common in-vehicle communications standards

The European Commission is recommended to align the industry initiatives and to encourage the development of standards on wired and wireless data communication between ITS components and devices within the vehicle.



Many industry initiatives take place (or have taken place) to come to standards. The most important standards are communications standards, as for establishing an open in-vehicle platform it is necessary that different components can communicate with each other.

Up to now, the focus has been on communication from the vehicle to the outside world, for example to other vehicles (V2V) or infrastructure (V2I). The communications standards for co-operative systems based on V2V or V2I communication are swiftly handled by ETSI.

In contrast to the efforts in the field of co-operative systems, there is currently no focus on the communication **within** the vehicle. However, the ITS Directive (Directive 2010/40/EU) calls for common standards on communication between components and devices within the vehicle.

As the respective communications standards will be strongly driven by the car industry and ETSI, the European Commission is recommended to align the industry initiatives and to encourage the car industry and ETSI to the development of common standards for both wired and wireless in-vehicle data communication. First drafts for an ITS communication architecture exist (e.g. [4]), including the common vehicle sub-system, but as long as the in-vehicle network is not precisely standardised the risk remains that manufacturer try to push their own approaches.

Without clear guidance, there might be a chance that multiple standards will emerge. That this is certainly not recommended can be illustrated by the following example related to the introduction of two standards for storing high definition video and audio: Blu-ray Disc and HD DVD.

These competing standards had significant differences that made each incompatible with the other. Despite negotiations to unify the standards, the resolution of the so-called format war was in favour of Blu-ray. Format wars have often proved destructive to both camps, because they delay market introduction and refrain consumers, afraid of committing to a losing standard, from purchasing either.

To avoid a tedious format war, it is essential for the European Commission to help creating one solution consisting of a single (set of) standard(s). Only in this way, all devices – whether OEM or nomadic – can be connected independently of vehicle type or car brand and use the standards on common in-vehicle communications for wired and wireless data communication, enabling the driver to switch devices or vehicle without any problem.

The introduction of the GSM standard in Europe is a good example to show that the market will benefit from the introduction of a single (set of) standard(s). The establishment of the GSM standard can be seen as one of Europe's success stories which has resulted in an enormous technical and commercial boost.

The ubiquity of implementation of the GSM standard has been an advantage to both consumers, who may benefit from the ability to roam and switch carriers without replacing phones, and also to network operators, who can choose equipment from many GSM equipment vendors. Its ubiquity also enables international roaming arrangements between mobile phone operators, providing subscribers the use of their phones in many parts of the world.

Hence, we recommend that the European Commission encourages the development of standards for wired and wireless data communication between ITS components and devices within the vehicle, presumably by giving a mandate to the respective standardisation bodies.

Recommendation 2: Powering and mounting standards

The European Commission is recommended to encourage the development of standards on powering and mounting of nomadic devices within the vehicle.



Since the last decade, the number and range of nomadic devices used in the vehicle have increased significantly. Consider, for example, a navigation system attached with a suction cup to the windshield, a mobile phone on a special holder attached with a suction cup to the dashboard, an mp3 player lying on the passenger seat connected to the in-car stereo, and a back-seat DVD player strapped to the front-seat headrest. The devices can use the cigarette lighter to power the GPS unit, to recharge the internal battery or to directly operate from the vehicle electrical system.

The above example illustrates the current dangerous situation of mounting and powering nomadic devices:

- Nomadic devices can easily become deadly projectiles in case of an accident.
- The mounting solutions are not sturdy; falling devices can easily lead to dangerous situations while driving.
- The cigarette lighter is bulky, has the disadvantage of voltage fluctuation and poor contact stability; hence, it is not a good power connector.
- The growing number of wires across the dashboard can easily lead to confusion or even entanglement by the driver.

As the current situation is unacceptable from a safety point of view, the European Commission is recommended to encourage the development of standards on:

- Physical mounting of nomadic devices
- Powering solution
- Wired and/or wireless data connection (giving access to generic services and other in-vehicle devices)
- Audio connection to in-car stereo

Such powering and mounting standards will in the first place improve safety, also because they are expected to contribute to the use of handsfree calling. However, these standards will also bring other benefits. As nomadic devices are low-cost devices with short life cycles and fast innovation paths, they have become ITS platforms offering a range of applications, such as navigation, traffic and travel information, black spot warning, etc. This means that standard interfaces will boost innovation in general and combine the benefits of automotive and nomadic device markets:

- Nomadic devices will become cheaper as they get access to generic services.
- New services will quickly develop based on generic services info.
- Other in-vehicle applications could use nomadic devices to identify the driver and use the HMI; this might lead to unforeseen, surprising applications.
- For the customer it would be an advantage that he no longer needs to buy new equipment (e.g. holder, cable, connector) in case he exchanges a device (e.g. new mobile phone).

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Ideally, the powering and mounting standards would encompass the electrical connectivity of nomadic devices in the vehicle as well as their physical mounting. In this respect, positive lessons could be learnt from the introduction of the so-called DIN-slot, a standard size for car audio head units. Originally established by the German standards body (DIN), this standard was adopted as an international standard in 1984 (ISO 7736).

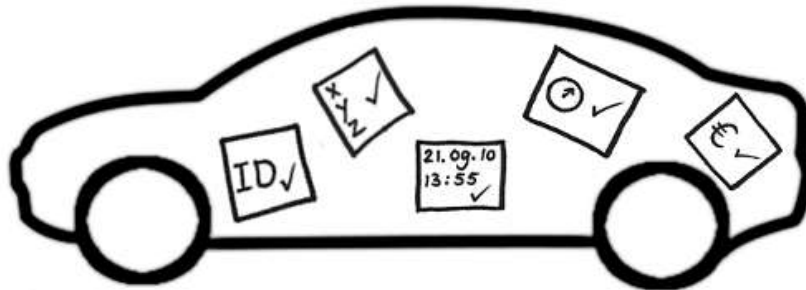
The DIN-slot allowed for the development of the in-car radio market and is not protruding in accidents. Nowadays, there exists a wide range of low-cost products for factory-fit and after market. Trucks sometimes have several DIN-slots for nomadic devices, such as the DIN-slot type of OBU offered in the German LKW-Maut system.

However, the proposed solution for the powering and mounting standards must be smaller and more intelligent than the DIN-slot. In that respect, it might be more similar to the current USB port. Although originally designed for personal computers, USB has become the standard connection method for many other devices, such as smartphones, PDAs and video game consoles.

Hence, we recommend the European Commission to encourage the development of standards on powering and mounting of nomadic devices within the vehicle, presumably by CEN.

Recommendation 3: Generic in-vehicle services standard

The European Commission is recommended to encourage the development of standards on generic in-vehicle services for the provision of reliable and up-to-date basic vehicle information (e.g. location, speed, date and time, etc.) by certified in-vehicle sensors and receivers.



Currently, many vehicles face the problem of data redundancy, as the CAN-bus, OEM (after market) devices and nomadic devices may capture the same data, such as vehicle ID or location. This also gives rise to the question of which data are genuine. In contrast to the overlap of data, there is also a lack of sharing information between the multiple components and devices.

It would be a benefit for the telematics field if generic in-vehicle services would be standard in such a way that basic vehicle information (e.g. location, speed, date and time, etc.) with a guaranteed quality is available in the vehicle. The ITS Directive (Directive 2010/40/EU) calls for standards on generic in-vehicle services, as these services can be used for several purposes and are relevant for many mandatory and optional applications for both private and commercial vehicles.

For this reason, the European Commission is recommended to encourage the development of standards on generic in-vehicle services that includes reliable and up-to-date basic vehicle information related to, among others:

- Location/GNSS
- Speed/accelerometer
- Date and time
- Vehicle ID
- DSRC Communication Service
- CALM Interface
- Payment

These standards on generic in-vehicle services should specify the content of data, but also aspects related to the quality and security of data to ensure protection of the data from unauthorised access, use, disclosure, disruption, modification or destruction. Access to the basic vehicle information should be assured through the development of standards on common in-vehicle communication (see recommendation 1).

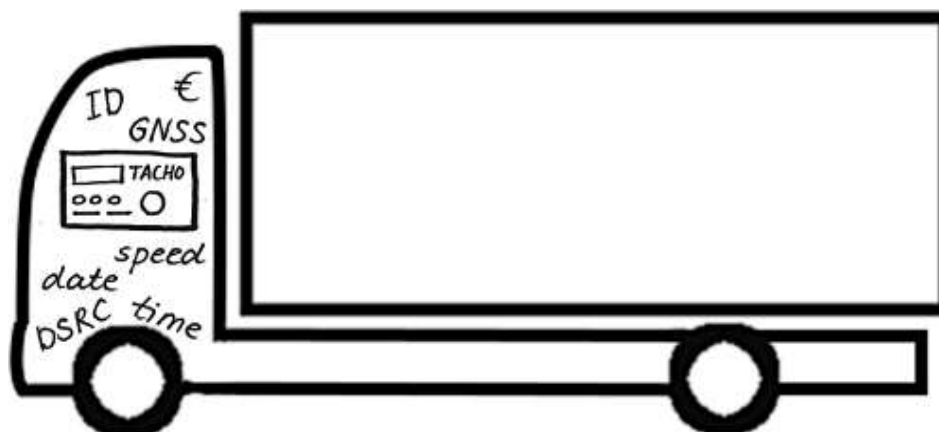
In particular authenticity is of utmost importance for the development of standards on generic in-vehicles services. This can be illustrated by the following example related to a GPS receiver. Although a vehicle nowadays might have more than one GPS receiver on-board, this does not necessarily mean that the collected data are genuine. Ideally, there should be one GPS receiver on-board that wirelessly sends out data messages to other in-vehicle devices to tell "I am a certified receiver, you can trust and use my data". These data messages should therefore include security elements with a digital signature to ensure a certain quality standard together with the usual location data, such as coordinates and number of satellites used.

Such standards might also play a catalytic role in establishing extended services. Consider, for example, the recent activities of a major map manufacturer and a major car manufacturer in the development of a detailed map-based location service. This service results in an enhanced knowledge of the location of a vehicle related to its current environment (e.g. position on the road, curvature and slope of the road, etc.). This knowledge can be used for several applications, such as adaptive head lights (for illuminating the road ahead regardless of the current steering wheel input), automatic gear box, hybrid vehicles (for optimising the switch between battery and petrol, e.g. empty battery on top of hill), driving information and speed adaptation.

Hence, we recommend the European Commission to encourage the development of standards on generic in-vehicle services, presumably by CEN and ETSI.

Recommendation 4: Digital tachograph as core for in-vehicle services

The European Commission is recommended to use the opportunity of the revision of the tachograph specification (Council Regulation (EEC) No 1360/2002) to define the digital tachograph as essential core telematics element in the ETSI ITS station of a (heavy) vehicle.



The purpose of Council Regulation (EEC) No 3821/85 is to regulate the recording equipment in trucks and buses needed to ensure compliance with the social legislation (i.e. drivers' working hours). This Regulation is considered in need of updating (Council Regulation (EEC) No 1360/2002), particularly in light of the advent of the digital tachograph.

The current situation faces a couple of disadvantages on the legal, implementation and compliance level, including:

- Legal level: The tachograph is now specified as a technical device in law (i.e. a physical box), which is a cumbersome approach as "debugging" a law is difficult and technology is moving faster than a law ever can.
- Implementation level: Prescribing the tachograph as a technical solution hinders competition and limits the freedom of the industry to come up with innovative solutions.
- Compliance level: The current tachograph is a mere recording device and not a compliance tool, which makes the compliance process cumbersome. Roadside checks are relatively inefficient, as stopping and interrogating passing vehicles is dangerous and time-consuming and not always based on real suspicion of non-compliance. Next to that, tachographs can be tampered with in various ways, such as placing a magnet near the Motion Sensor (MS) to interfere with correctly detecting electromagnetic variation induced by the gearbox in case of a digital tachograph.

The revision of the tachograph specification provides an opportunity for the European Commission to tackle the above disadvantages and to define the digital tachograph as the core telematics element in a (heavy) vehicle. This way, the European Commission could push the telematics field tremendously by using its freedom and power to establish the first open in-vehicle platform around the digital tachograph.

In order to do so, the European Commission is recommended to take into consideration the following adaptations in the revision process.

The tachograph would benefit from being specified as an ITS service rather than as a technical box. A more functional definition in terms of requirements regarding a telematics application or service would tackle the current disadvantages on the legal and implementation level. This more modern approach can be successfully demonstrated by the recent EU move towards interoperability of electronic fee collection. The European Electronic Toll Service (EETS) as mandated by Directive 2004/52/EC and described in detail in Decision 2009/750/EC is described as a service, not as a technical box. Something similar is currently being undertaken in Australia, where the fatigue and speed compliance regulations for heavy vehicles are being under revision and will most likely be formulated in a services language.

Furthermore, the tachograph would benefit significantly from including a short-range communication means (e.g. DSRC) and integrating a GNSS receiver to tackle the above disadvantages on the compliance level.

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With a suitable short-range communications means, compliance checking would become much more efficient and easier. A short-range radio interface (e.g. 5.8GHz DSRC technology like in electronic fee collection) would allow non-stop interrogation of passing vehicles in free-flow traffic without the need of stopping them. A road side station could read out their current status (e.g. driving time, speed, card presence, etc.) while leaving the interpretation of these data to the officer (and software) at the road side. Due to a much higher risk of being caught, this approach would improve the productivity of compliance checking tremendously.

Independent of the exact nature of the data, the effectiveness of the tachograph as a compliance tool could be improved vastly. It would allow pre-filtering in the sense that officers only need to stop suspect vehicles, and let non-suspect vehicles pass without being bothered. It would also allow comparing speed claimed by the tachograph with the actual speed as measured by a road side radar.

Integration of a GNSS receiver into the tachograph can be seen as a major step forward in making distance recording tamper proof as it will provide an extra sensor to double-check results and to detect fraud and hard- and software malfunctioning. Not only would GNSS integration allow for automatic recording of journey start and end, it would also provide an independent speed, time and distance sensor and thus make manipulation of the MS of the gearbox more difficult. Speed as measured via GNSS and via gear-box MS cannot be manipulated in the same way. This principle is successfully used in the Swiss Heavy Vehicles Fee since more than 10 years. The Swiss Heavy Vehicles Fee charges per distance driven, whereby this distance is taken both from the tachograph and from a GNSS receiver built into the charging on-board equipment. Fraud related to the distance recording and tachograph MS manipulations have not been seen since.

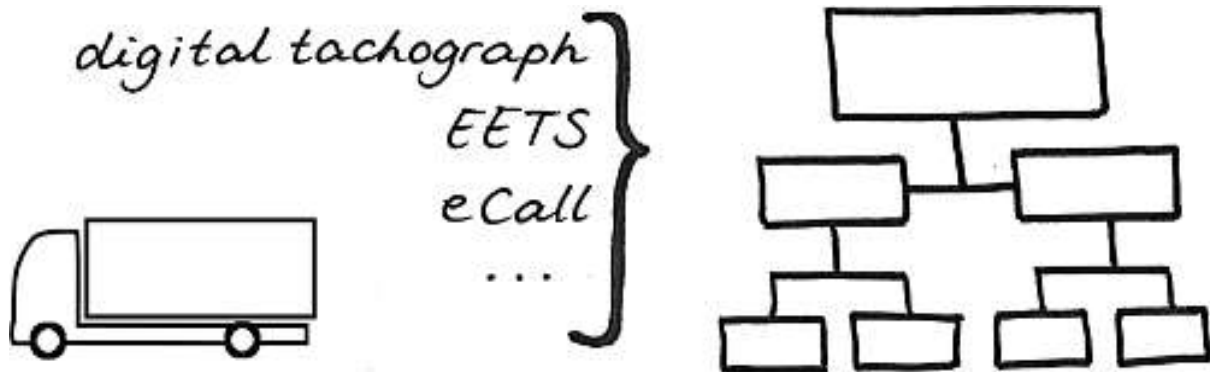
GNSS integration would also allow the tachograph to become a core component of an in-vehicle ITS platform. As a core element in the vehicle, the tachograph could provide reliable and up-to-date generic in-vehicle services, including basic vehicle information on location, speed, date and time, vehicle ID, etc. of a certified quality (see also recommendation 3). This would be an invaluable asset for all other telematics applications, be it mandated ones such as eCall and hazardous goods tracking, or commercial ones such as intelligent truck parking and fleet management. Moreover, this would justify the integration of a wide-area communication means (e.g. GSM) into the tachograph to transmit data from the vehicle to a back-office.

Once ubiquitous, such devices could provide enough data for the accurate determination of truck parking occupancy rates throughout the EU, solving one of the key issues identified in Action 3.5 of the ITS Action Plan.

Hence, we recommend the European Commission to push the telematics field tremendously by using its freedom and power to propose to the Parliament a revision of Council Regulation (EEC) No 3821/85 with the digital tachograph as the core telematics element in a (heavy) vehicle.

Recommendation 5: Alignment of governance

The European Commission is recommended to use the opportunity to streamline the regulatory framework and operational set-up in order to better align the governance across different (regulatory) telematics measures, such as the digital tachograph, EETS and eCall.



Currently, every telematics measure comes with its own governance including different roles and responsibilities for organisations and different regimes for certification and audits. This can be shown by the following examples.

The tachograph has its own special certification regime, which is centralised and top-down. This regime is performed by one dedicated organisation (i.e. JRC) that can issue interoperability certificates and type approval certificates for the recording equipment and the tachograph cards. In contrast, EETS will come with a different certification regime, which is decentralised and bottom-up. This regime is a more modern approach based on self-certification including CE-marking and "fit for use" certification by the respective toll systems. The governance of eCall will be based on CE type approval based on European standards, whereas the governance of Livestock Tracking is functionally defined and under the responsibility of the individual companies with a checking task for the animal welfare organisations.

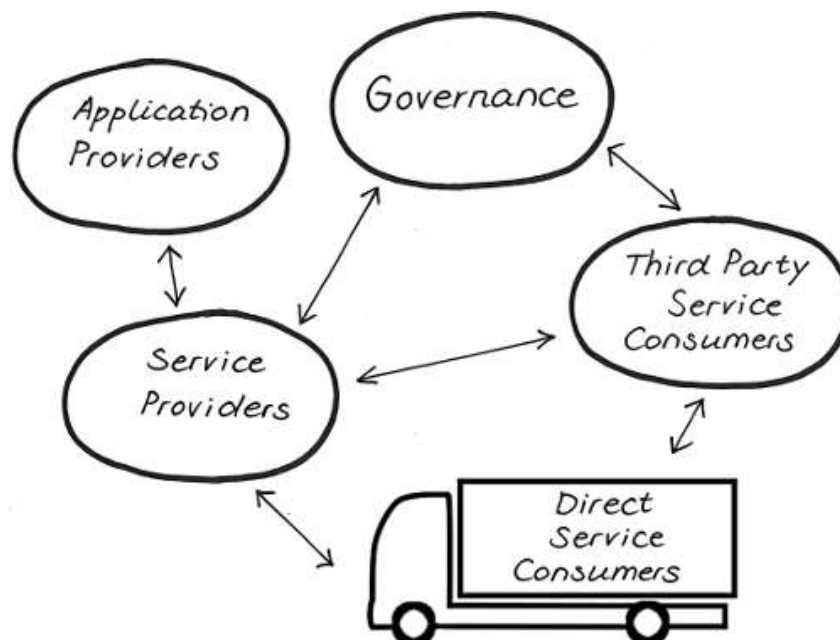
To reduce the complexity and overhead induced by the current governance situation, the European Commission is recommended to use the opportunity to streamline the regulatory framework and operational set-up in order to better align the governance across different (regulatory) telematics measures.

It would be a major improvement of efficiency when all telematics measures or ITS legislation and measures of the European Commission would be aligned to a certain extent and be based on the same institutional set-up. The ITS Directive provides an impetus to change this regulatory framework now. This would speed up implementation of measures, reduce overhead, reduce complexity to the user, stimulate convergence technology and business models, etc.

Hence, we recommend the European Commission to push the telematics field tremendously by using its freedom and power to streamline the regulatory framework and operational set-up in order to better align the governance across different (regulatory) telematics measures for (heavy) vehicles (in minimum: digital tachograph, EETS and eCall).

Recommendation 6: Migration of regulatory applications to services model

The European Commission is recommended to consider a services model for regulatory applications and investigate whether the (current) applications, such as digital tachograph, EETS and eCall, can be migrated to a services model.



The current regulatory applications are governed by different bodies (see also recommendation 5) and are specified on different levels. For example, the current version of the digital tachograph is described on a technical level (how does the device look like), whereas the EETS is described on a service level (what will the user receive). The latter approach can be considered a more modern and innovative approach with the great advantage of creating an open, competitive market and fostering higher performance through product innovation and customer service.

For regulatory applications to benefit from being specified as a service, the European Commission is recommended to investigate whether these applications can be defined on a service level and be migrated to a services model.

In essence, the regulatory applications require a company to operate within legal boundaries and to store relevant data to proof this. According to a services model, the company would engage an independent Service Provider and pay for his services: e.g. providing a device, monitoring the data, regularly reading-out and storing these data. In case of any suspicions, the Service Provider would alert the company and the authority. The Service Provider is free to offer a variety of services (e.g. EETS, eCall, Intelligent Truck Parking). To be compliant, the Service Provider would engage a certification body and pay for certification of the respective services.

In summary, the European Commission could achieve the following advantages from developing a services model for regulatory applications:

- A services model is good for competition and promotes the Service Provider market, which will result in cost-effective service provision for the user.
- Next to ensuring interoperability, a services model only needs to set out the performance requirements for the service provision of the regulatory applications. This means that only the content and quality of the required data must be specified. The Service Provider has the freedom to provide a cost-effective solution and determine how the required data will be delivered.
- A services model improves compliance, as the Service Provider has the duty to demonstrate compliance. He will apply for certification because of a huge interest in being compliant and delivering service and data of high quality.

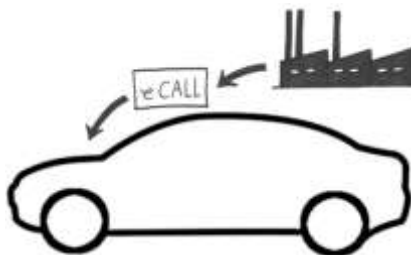
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- A service model carries itself: the user (i.e. company) has the freedom to choose a Service Provider and pay for the service provision, whereas the Service Provider will pay for certification in order to be compliant.

Hence, we recommend the European Commission to consider a services model for regulatory applications and investigate whether the applications for (heavy) vehicles can be migrated to a services model by, among others, clearly defining the roles and responsibilities for organisations on a EU level and for the Member States.

Recommendation 7: eCall implementation by the industry

The European Commission is recommended NOT to mandate eCall as an open platform for other applications due to its specific constraints, but leave eCall implementation to the industry.



eCall is a pan-European service that will operate in all EU Member States and states associated to the initiative. It will be available in all vehicles, irrespective of brand, country and actual geolocalisation of the vehicle. Based on this potential volume, eCall could be expected to be the “killer application” being the catalyst for an open in-vehicle platform. However, due to the following specific features and requirements, eCall is likely to be less suitable for the basis of an open in-vehicle platform:

- eCall is a safety-critical application entailing specific liabilities for the manufacturer: the liabilities of the manufacturer will be based on the specific eCall requirements; it is expected that the manufacturer will have no particular interest in building upon eCall as an open in-vehicle platform for other applications provided by third parties, if only for liabilities reason.
- eCall offers limited synergies with other applications: due to its safety-critical character, eCall needs to be highly reliable also in extreme conditions and must always have priority over other applications. The specific requirements for eCall (e.g. voice connection, crash resistance, panic button, etc.) are linked with potentially critical driving situations and are considered a barrier to other, optional applications.

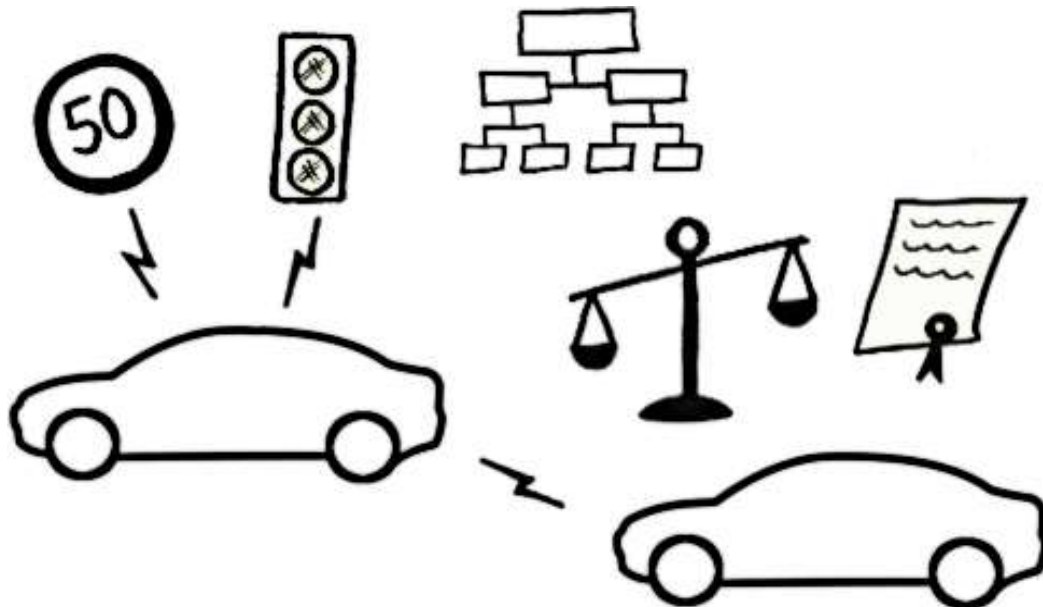
For the above reasons, the European Commission is recommended to rely on the industry for eCall deployment. There is no need for the European Commission to advance further standardisation in this direction.

Instead, the industry should be free to integrate eCall in vehicles by using or establishing the “normal” technical synergies with similar applications, such as co-operative systems (see also recommendation 8). Furthermore, eCall can benefit from the future generic in-vehicle services standard, for example for the provision of reliable and up-to-date GNSS localisation data (see also recommendation 3).

Hence, we recommend the European Commission to leave the eCall implementation and deployment to the industry and NOT to advance further standardisation aimed at eCall as the basis of an open in-vehicle platform for other applications, as eCall has strong specific constraints in this respect.

Recommendation 8: Supportive environment for co-operative systems

The European Commission is recommended to create a supportive environment without any infrastructural, legal or institutional obstacles for the industry that allows for a stepwise introduction of co-operative systems.



Co-operative systems are expected to show great promise for improving road safety, traffic efficiency and the environment in the future by reducing the human factor in car driving. Although the end point is not totally clear (automated driving?), the general trend is obvious and will be progressive. The technical development is on its way and several pilots have proven the technical feasibility of co-operative systems.

However, for the vehicle industry to continue the technical development and to really introduce co-operative systems in the near future, the European Commission is recommended to create a supportive environment consisting of the following infrastructural, legal and institutional aspects:

- **Infrastructural:** Encourage the vehicle industry and infrastructure providers to talk to each other so that developments are compatible and meet the same overall objectives and timing. Where the vehicle industry takes care of the vehicle-side of communication, the infrastructure owners must take care of the infrastructure-side of communication. Significant investments are needed (e.g. electronically readable lane marking, wirelessly talking road signage) to enable co-operative systems based on V2I and V2V communication. Also deployment plans are needed that provide a future-oriented framework and ensure planning reliability (e.g. road signage requires power supply and data communication means).
- **Legal:** When the vehicle takes over parts of driving from the human driver, new legal issues arise. For example, who is responsible or liable in case the wrong information is displayed on a talking road sign or in case the vehicle does not react properly on a brake-warning received by another vehicle? Such liability issues and their consequences for the insurance need to be sorted out.
- **Institutional:** To achieve wide deployment of co-operative systems, concerted action of many stakeholders is required. For this, a clear vision on the deployment of co-operative systems including a realistic road map is needed. A stepwise introduction seems most suitable, for example, starting with co-operative vehicles that benefit from passive infrastructure providing basic co-operative driving facilities (e.g. passive lane guidance and identification) while mingling with non-co-operative vehicles.

Although the technical development of co-operative systems could best be left to the vehicle industry, the European Commission should not leave the deployment of co-operative systems solely to the industry. Clearly, more investigation is needed in the above infrastructural, legal and institutional issues to support the policy on co-operative systems and create a stable foundation for the industry to continue with the development.

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Like eCall (see recommendation 7), the European Commission is recommended NOT to interfere with the technical development of co-operative systems. No actions from the European Commission are required on, for example, the integration of co-operative systems in the vehicle. Instead, the vehicle industry should have the freedom to integrate co-operative systems with similar applications and make use of technical synergies. An open in-vehicle platform is more suitable for consumer-facing applications than vehicle-facing applications, such as co-operative systems and eCall.

Hence, we recommend that the European Commission leaves the technical development of co-operative systems to the vehicle industry, but to create a supportive environment without any infrastructural, legal or institutional obstacles for the vehicle industry that allows for a stepwise introduction of co-operative systems.

11 Summary and Visions

This chapter presents a summary of the main findings of the study on the adoption of an open in-vehicle platform architecture for the provision of ITS services and applications, including standard interfaces. It describes a vision based on the eight recommendations discussed in the previous chapter. This vision represents what an in-vehicle platform architecture could look like when the recommendations are being fulfilled.

The car as telematics environment OR in-vehicle plug-and-play connectivity

It is expected that the development of standards will continue to move forward resulting in standardisation of common in-vehicle communications, powering and mounting of nomadic devices and generic in-vehicle services (among others). The respective in-vehicle platform will revolve around connectivity. In fact, this means that the car of the future will become the platform, being a telematics environment where in-vehicle devices can be easily and safely connected to the car and to each other.

The user will face the prospect of a future in which he can freely buy consumer-facing applications, such as Infotainment, Navigation and Payment Service, and connect these to any car regardless of vehicle type or car brand. These applications will seamlessly connect to the vehicle in an electronic and mechanical way. Moreover, this connectivity is oriented towards data exchange with the vehicle, meaning that each application has access to and makes use of reliable and up-to-date vehicle information on location, speed, payment, etc.

Regulatory service supporting transport productivity

Road transport is a key necessity for modern societies. For road transport to remain sustainable, regulatory efforts are needed continuously. For this reason, it is expected that the future will move towards more regulation. Also the respective in-vehicle platform will revolve around more regulation. In fact, this would mean that the platform covers a regulatory environment that rests on streamlining the institutional framework and where an increasing number of regulatory applications are delivered to the user of commercial vehicles through one dedicated channel.

The user will face the prospect of a future in which he can freely choose a certified Service Provider that will provide him with regulatory applications, such as the Digital Tachograph and EETS, support him with being compliant to the rules and achieve good quality and efficiency. Regulation is not longer seen by the user as complex and a nuisance, rather it will be experienced as a service that enhances the productivity factor within the allowed framework of routes, driving hours, etc. Australia illustrates that regulation can be beneficial for the trade and improve the efficiency of the freight chain [10].

Safety applications embedded in the vehicle

Safety applications like eCall and co-operative systems are expected to show great promise for improving road safety, traffic efficiency and the environment in the future by supporting the human driver. The respective in-vehicle platform will be embedded in the vehicle and make use of technical synergies with similar car-facing applications. This platform will not be suitable for consumer-facing applications; hence the user cannot access or connect to it.

The user will face the prospect of a future in which he will be assisted by his car and relieved from certain driving tasks resulting in a safer, cleaner and more comfortable way of travelling. The car will be aware of its surroundings: it will know the actual speed, where other cars are, whether there is a queue ahead, what the current speed limit is, etc. The car is able to communicate with other cars and with the infrastructure. In case of an accident, the driver is aided by eCall which notifies the accident, speeds up the emergency response and lowers the effects on the severity of injuries. Without any legal or institutional barriers, the user will stepwise experience new ways of being assisted by an increasing number of in-vehicle safety applications.

Annex 1: Relevant Projects

Co-Operative Vehicle-Infrastructure Systems (CVIS)

The CVIS project aimed to define a unified technical solution allowing all vehicle and infrastructure elements to communicate with each other to enable a wide range of potential cooperative systems. For this purpose it defined an open architecture and system concept for a number of cooperative system applications based on the set of CALM communication standards from ISO/TC 204 WG16.

Thus the CVIS architecture comprises not only a view on the in-vehicle architecture, but also other subsystems:

- Central Subsystem
- Handheld Subsystem
- Roadside Subsystem
- Vehicle Subsystem

They all are connected (transparently) via communication channels such as CALM, IPv6, GSM, G3, etc. Architecturally thus a CVIS network can be regarded as a peer-to-peer network of CVIS hosts, allowing communication at every location, at any time and also to everybody (ubiquitous communications). The overall CVIS architecture is further separated into a set of layers, with the communications infrastructure complexity "hidden" from the application layer by a middleware layer. For the in-vehicle architecture, the following example is given:

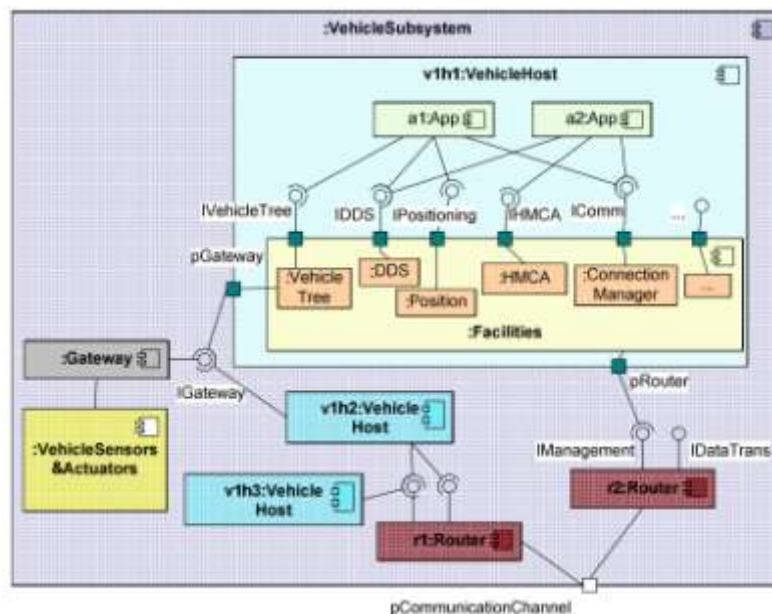


Figure 0.1: CVIS Vehicle.⁶

Conceptually the architecture is thus based on various gateways (can also be seen as different processing environments) connecting sensor units, hosts and routers via seamless communication channels, with "facilities" such as the Connection Manager, Position or HMCA providing functions to the actual applications on the top layer.

The host computer and communication router will essentially provide the backbone of the CVIS vehicle, roadside and central systems that will be connected via internet technology. Such a system architecture would then provide a framework – based on user requirements – for planning, defining and deploying Co-operative Systems

⁶ Source: Figure 9 from CVIS deliverable DEL_CVIS_3.3_Architecture_and_System_Specifications_v1.2

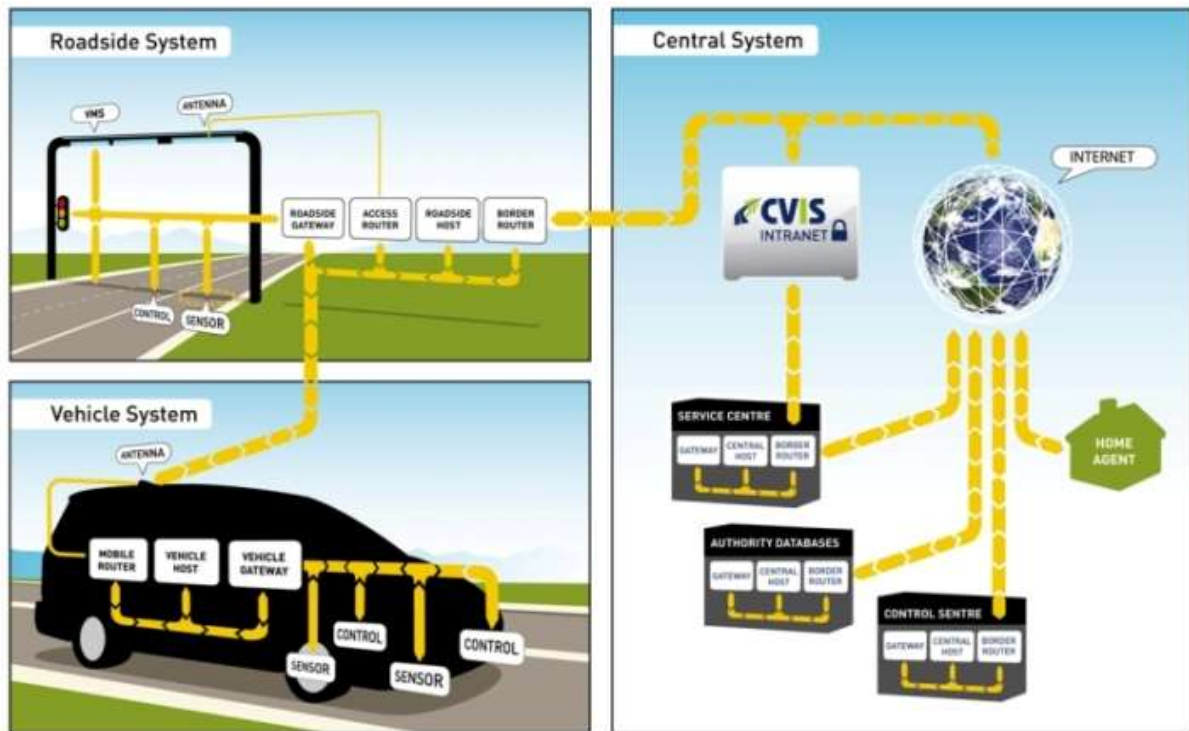


Figure 0.2: CVIS technical sub-systems.⁷

Further details can be found in the CVIS deliverable
"DEL_CVIS_3.3_Architecture_and_System_Specifications_v1.2".

⁷ Source: CVIS Handbook Final Version

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European Field Operational Test on Active Safety Systems (euroFOT)

The euroFOT is establishing a comprehensive, technical, and socio/economic assessment programme for evaluating the impact of intelligent vehicle systems on safety, the environment, driver efficiency. The project is assessing several technically mature systems using vehicles that include both passenger cars and trucks across Europe.

A variety of intelligent vehicle systems (IVS) are being tested on a large scale in real driving conditions. Some 1500 IVS-equipped vehicles will be driven over the course of one year, tested on roads across Europe.

The objectives of the testing are to:

- Assess various aspects of in-vehicle systems, such as their capabilities and performance, and the driver's behaviour and interactions with those systems;
- Gain a better understanding of the short- and long-term socio-economic impact of such systems on safety, efficiency and driver comfort;
- Provide early publicity of the systems to the consumer and create wider acceptance of them.

The results of euroFOT are expected to be a major contributor to the processes of deploying ICT systems for transport across Europe. The insights gained during the project will help policymakers decide on the right policy framework, and business leaders to make informed decisions on the best way to bring these technologies to the market.



The euroFOT field testing is focusing in particular on 8 distinct functions that assist the driver in detecting hazards and preventing accidents:

Assisting the driver in forward/rear directional safety - longitudinal control functions:

- Adaptive Cruise Control
- Forward Collision Warning
- Speed Control System

Assisting the driver to detect hazards at the sides of the car - lateral control functions:

- Blind Spot Information System
- Lane departure warning / Lane assist / Impairment warning

Advanced applications:

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- Curve Speed Warning
- Fuel Efficiency Adviser
- Safe Human / Machine Interface

The project follows three major steps:

PREPARING...

Specification and piloting: First, the fleets are being prepared for the trials. Specifying the functions, defining hypotheses for each of the functions, setting up data management procedures are only some of the steps required for the actual trials. The first phase of the project will also involve the recruitment, selection and training of the drivers.

DRIVING...

Execution: Subsequent steps involve the installation of data loggers and functionalities into the vehicles. In this way, users drive under normal, everyday conditions, and their actions and responses are logged.

ANALYSING...

Impact assessment: In the final phase, euroFOT analyses data collected from the vehicle monitoring devices and from the driver himself (the so-called objective and subjective data). This data describes the driver behaviour and adaptation, vehicle dynamics and system acceptance. The collected data is considered representative of ordinary driving conditions on EU roads, thus providing valuable data on the overall effectiveness and feasibility of intelligent vehicle systems.

Further details can be found in the euroFOT website
http://www.eurofot-ip.eu/en/welcome_to_eurofot.htm

Final Report Action 4.1**E-safety vehicle intrusion protected applications (EVITA)**

Future automotive safety applications based on vehicle-to-vehicle and vehicle-to-infrastructure communication have been identified as a means for decreasing the number of fatal traffic accidents. While various functionalities inspire a new era of traffic safety, new security requirements need to be considered in order to prevent attacks on these systems. Secure and trustworthy intra-vehicular communication is the basis for trustworthy communication among cars or between cars and the infrastructure.

The objective of the EVITA project is to design, verify, and prototype an architecture for automotive on-board networks where security-relevant components are protected against tampering and sensitive data are protected against compromise when transferred inside a vehicle.

By focusing on the protection of the intra-vehicle communication EVITA complements other e-safety related projects that focus on the protection of the vehicle-to-X communication.

The work plan follows five stages:

Security requirements analysis

Starting from relevant use cases and security threat scenarios, security requirements for on-board networks will be specified. Also legal requirements on privacy, data protection, and liability issues will be considered.

Secure on-board architecture design

A secure on-board architecture and secure on-board communications protocols will be designed based on the security requirements and the automotive constraints. The security functions will be partitioned between software and hardware. The root of trust will be placed in hardware security modules that may be realised as extensions to automotive controllers or as dedicated security controller chips.

Implementation

For prototyping, FPGA's will be used to extend standard automotive controllers with the functionality of cryptographic coprocessors. The low-level drivers for interacting with the hardware will be partially generated from UML models. For even faster prototyping, the security functionality will also be implemented purely in software.

Prototype-based demonstration

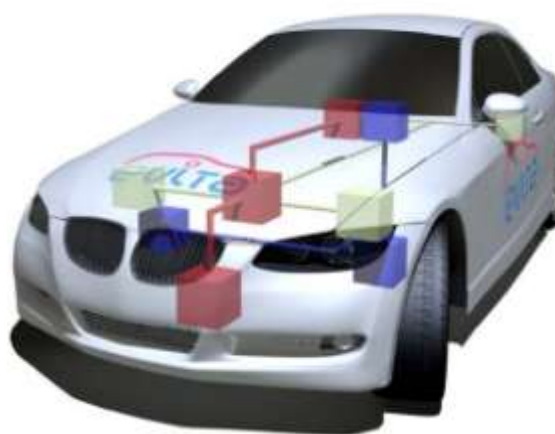
The secure on-board communication will be deployed inside a lab car demonstrating e-safety applications based on vehicle-to-X communication. Cryptographic methods will ensure the integrity and authenticity of information exchanged within the vehicle and will protect the electronic control units against theft, tampering, and unauthorised cloning.

Dissemination and external interfaces

Finally, the secure on-board architecture and communications protocol specifications will be published as open specifications.

The EVITA project partners will liaise with related initiatives in the fields of e-safety and embedded security to achieve multilateral synergies

Further details can be found in the EVITA website: <http://www.evita-project.org/index.html>



Final Report Action 4.1**GNSS Enabled Services Convergence Project (GSC)**

GNSS enabled Services Convergence is a European research project funded through the Galileo Supervisory Authority under the 7th Framework Programme. It has started in March 2009 and is scheduled to end in February 2011. The goal of GSC is to bring existing results of the following projects together in a single context in order to overcome the real world challenge of co-existence of multiple services:

- Road user charging: the CESARE and RCI projects;
- Telematics based services: the GST and CVIS projects.

The GSC project establishes conditions for an open and competitive mass market of GNSS-enabled road transport services. The project identifies the specifications and requirements for GNSS-enabled converged tolling and ITS VAS services that run on the same in vehicle equipment.

The GSC project goes beyond the demonstration of the technical feasibility of the 'multiple services platform' into an analysis and recommendations with respect to the feasibility of market deployment.

Role Model

The following main roles have been identified:

- Service Generator (VAS or Toll Charger)
- Service Aggregator (for VAS and ETSP)
- Service User

The (RCI) Toll Charger is the equivalent of the (GST) Service Provider. In order to prevent conflicts the more generic name Service Generator is used.

The (RCI) Toll Service Provider / EETS Provider is the equivalent of the (GST) Service Aggregator; both make services available for the driver by offering a payment method for this service. Therefore the more generic name Service Aggregator is used.

The (RCI) Service User is the equivalent of the (GST) Service User). In both cases the Service Users make use of a service. Only the payment in GST could differ with the payment methods of RCI; therefore the name Service User is kept.

Figure 3 shows the GSC role model. To make it more transparent, the EETS Provider is shown as part in the bubble "Service Aggregator". On the top of the figure, the service generators are placed, comprising commercial and public services (ITS services) and the Toll Charger. The Service User is the client, who wants to consume a service, public or commercial, or he wants to drive on a tolled infrastructure (tolling business). The Service Aggregator is the enabler of the services: public and commercial, as well as of the Toll Service.

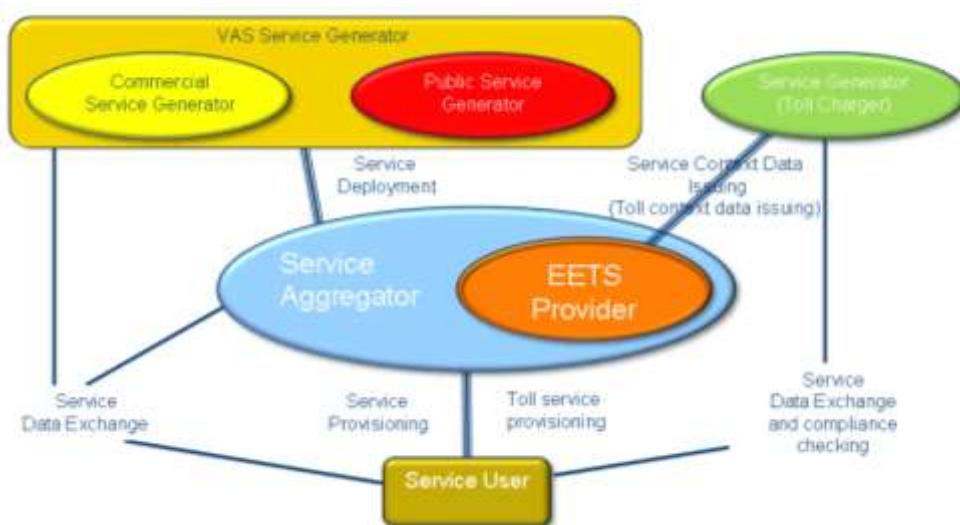


Figure 0.3: GSC Role Model.

As a result of the comparison of the RCI/CESARE and GST/CVIS projects it has been identified that all strong responsibilities are required by the EETS Provider of the CESARE /RCI or EETS world compared to the GST / CVIS where responsibilities are weak and not stringently defined.

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The main conclusion is that the responsibility of the Service Aggregator is at least identical with the responsibility of the EETS Provider (ETSP).

Business Model

For VAS the relations between Service Generator, Service Aggregator and Service User depend on the different business models which have to be considered. GSC will evaluate the following business models:

Business model 1 ("App Store" like): The Service Aggregator hosts all services and provides the Service User with information about available services. The Service Generator is responsible to create a contract with the Service User in order to provide service content data and payment information. There are contracts between Service Generator and Service Aggregator, Service Aggregator and Service User, Service Generator and Service User. "Multiple contracts, multiple invoice"

Business model 2 (EETS like): The Service Generator deploys a service to the Service Aggregator. The Service Aggregator hosts all services and provides the Service User with information about available services. The Service Aggregator is responsible for provisioning of a service whenever a Service User subscribes for a service. There are contracts between the Service Generator and the Service Aggregator, the Service Aggregator and the Service User. For the Service User point of view: "one contract, one invoice"

For more details see [7].

GST

GST’s vision is to create an open environment in which innovative telematics services can be developed and delivered cost-effectively. Thereby, the range of services that will become available to manufacturers and consumers will increase. Drivers and occupants will be able to rely on their on-board integrated telematics system to access a dynamic offer of on-line safety, efficiency- and comfort-enhancing services wherever they drive in Europe.

GST comprises of four technology-oriented sub-projects (Open Systems, Certification, Service Payment and Security) and three service-oriented sub-projects (Rescue, Enhanced Floating Car Data and Safety Channel). Each of those sub-projects has made investigations into architectural aspects that can be best summarised by the figure below:

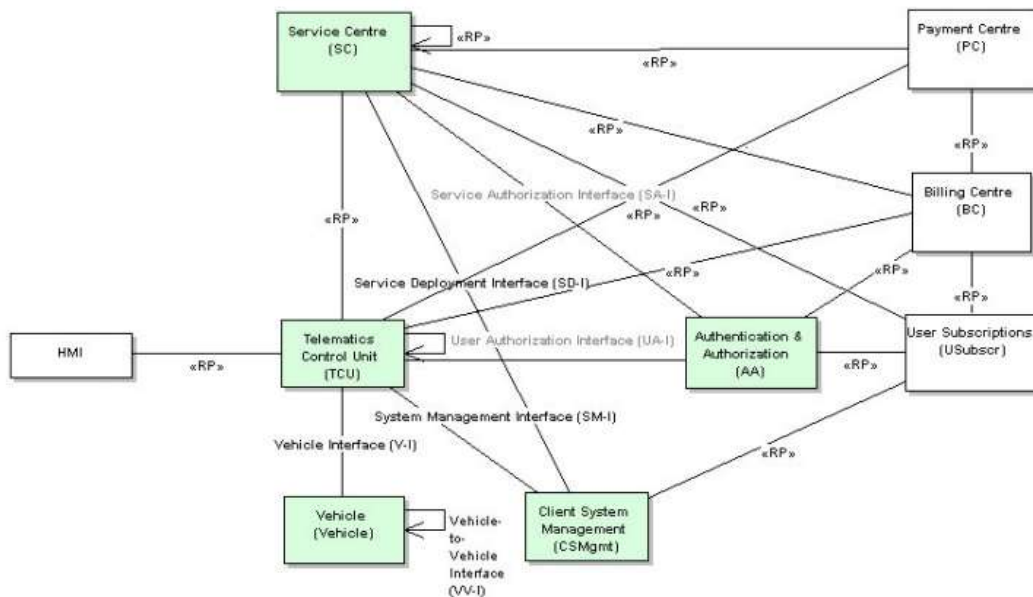


Figure 0.4: GST System Overview.⁸

In the context of GST a vehicle contains vehicle sensors and the Client System and is able to interact with the external world. Those interactions take place through communications based on a simplified OSI layer model (comprising of only physical, datalink and payload layers), using (for example, among others) IEEE 802.11p and IPv6.

As an example for where the GST client system would sit within a possible hardware architecture of a car, the following figure shows an OSGi platform as part of the MOST-bus environment:

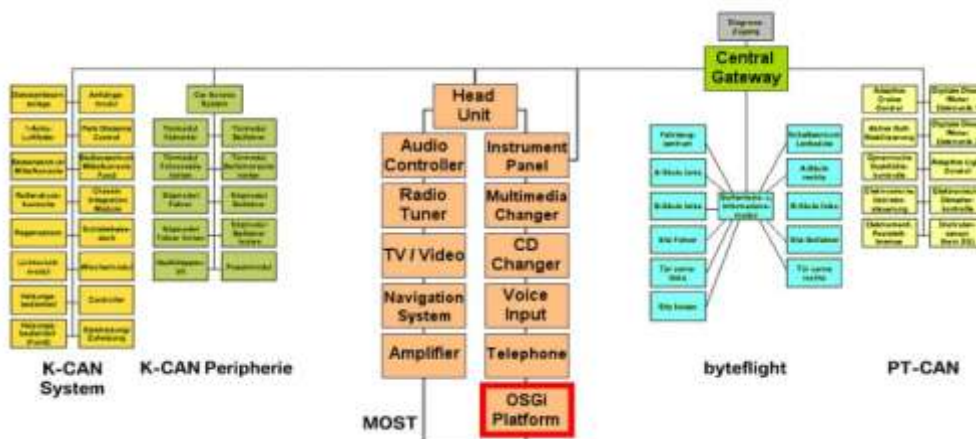


Figure 0.5: Example Vehicle Hardware System Architecture.⁹

In this example, the platform is only able to access CAN-bus related status information. This

⁸ Source: Figure 4 from GST deliverable DEL_OS_DEV_3_1_Architecture_and_interface_specifications_v1.1

⁹ Source: Figure 15 from GST deliverable DEL_OS_DEV_3_1_Architecture_and_interface_specifications_v1.1

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example illustrates the dependency on the vehicle configuration to access vehicle data; the Navigation System for instance may not be present in all vehicle makes and models, or may be a detachable plug-in device.

Further details can be found in GST deliverable

“DEL_OS_DEV_3_1_Architecture_and_interface_specifications_v1.1” and the equivalent other GST sub-projects deliverables.

GST Role Model

The GSC project analysed and summarised the GST roles as follows:

The *Service Provider* is the entity who constructs, deploys, and operates a Service Centre, which offers one or more ITS Value Added Services (VAS), which bring more value to Service Users. For certain services, the Service Provider needs content, which is delivered by his Content Providers. They belong to the business process of the service of the Service provider itself.

The *Service Aggregator* manages from its Control Centre multiple End-Users and their platforms. The Service Aggregator is responsible for registration of users (platforms), authentication, service provisioning, subscription and the subsequent download of service applications, service updates, remote administration and all other required management procedures on a platform.

A *Service User* is the person using the Services on a platform in the vehicle. The Service User pays a fee for the consumed service to the Service provider. The Service Aggregator is the enabler for this service.

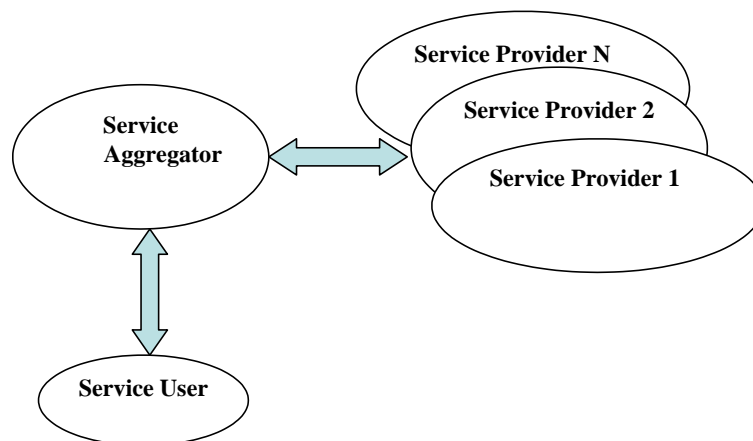


Figure 0.6: GST/CVIS High-Level Role Model.

Technical view

GST has the idea of an open market for servicing, constructed via four processes:

- Content delivery: the activity of providing the content by a Service Application;
- Service deployment: the activity of transferring the Service Application from Service Provider to Service Aggregator (Control Centre User), registering it in the Control Centre and its various administrative systems and publishing it for the End-User to select, and/or subscribe to and execute a Service;
- Service provisioning: the activities of providing End-Users with all necessary means to consume a Service. This usually involves registering users for the Service, issuing the appropriate authorization, making the necessary adjustments in the respective registries and control systems and application download Application download is the activity of downloading the Service Application from the Control Centre to the Client System or platform;
- Service execution.

See also the figure below for the GST roles and relations. For more details see the GST project and especially [GST Del. 1.3].

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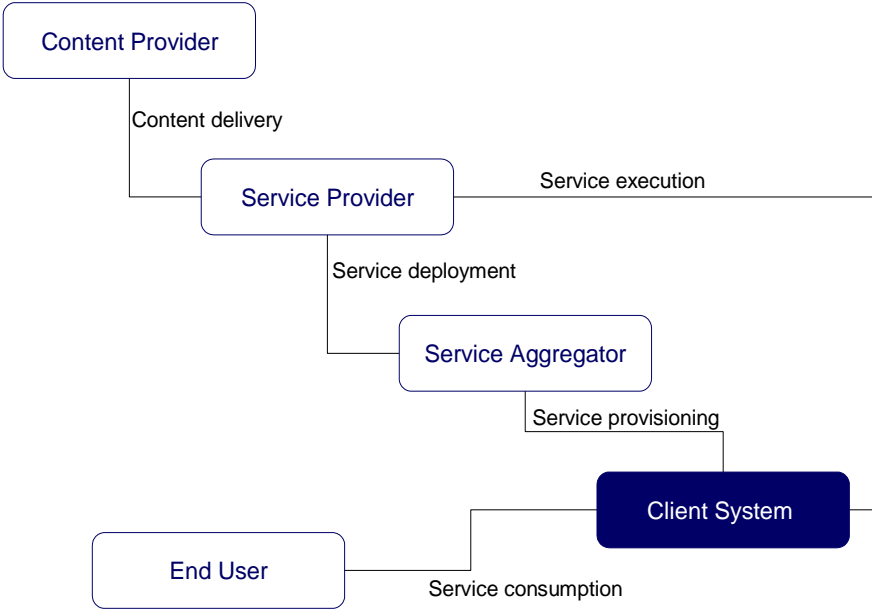


Figure 0.7: GST Roles and Relations.

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Monitoring of the Implementation of Digital Tachograph (MIDT)

The MIDT project aims to support concrete implementation measures for the introduction of the digital tachograph in all Member States of the European Union, the European Economic Area Countries and non EU-AETR Countries.

A digital tachograph is a control device for road transport which will give a major impulse to road safety by ensuring that professional drivers keep their driving and rest times. However the implementation of European Union legislation is extremely complex for all actors: Member States and their national authorities responsible for card issuing, enforcement, policy implementation, and also related stakeholders from industry such as tachograph, card and vehicle manufacturers, etc. Therefore, the MIDT Platform has been set up in order to:

- Inform on the use of the digital tachograph (for drivers & road transport operators, enforcement bodies, workshops) and
- Inform on the introduction of the digital tachograph (Member States authorities, including accession countries and AETR countries.)
- Support all stakeholders in their efforts to implement Regulation (EEC) n°: 3821/85 and the AETR as last amended.

The main activities that are provided under the MIDT Project are:

1. Providing a Helpdesk
2. Providing a Forum for National Authorities & Stakeholders
3. Training & Communication

Help Desk - Form to Submit a Question

Please fill in the following form prior to submit your question to the Help Desk. All data are treated confidentially so do not hesitate to also fill in the non mandatory fields that will, through aggregate statistics, provide us with a better understanding of visitors' backgrounds.

Questions are answered within 3 working days.

Personal Details First Name : <input type="text"/> Name : <input type="text"/> E-mail Address : <input type="text"/> Country of Residence : <input type="text" value="Austria"/> Nationality : <input type="text" value="Austria"/> Gender : <input type="text" value="Male"/> Age : <input type="text" value="<18"/>	Professional Category * <input checked="" type="checkbox"/> Driver Professional Driver Please specify: <input type="text"/> <input type="checkbox"/> Road Transport Company Transport of Goods Please specify: <input type="text"/> <input type="checkbox"/> Industry Automotive sector (Car Manufacturer) Please specify: <input type="text"/> <input type="checkbox"/> National Authorities Card Issuing Authority Please specify: <input type="text"/> <input type="checkbox"/> International Institutions European Commission Please specify: <input type="text"/>	Postal Address Street : <input type="text"/> Nr : <input type="text"/> Postcode : <input type="text"/> Town : <input type="text"/> Country : <input type="text" value="Austria"/>
About your question Subject * : <input type="text"/> Question * : <input type="text"/> <input type="button" value="Send"/>		

Figure 0.8: Interface of the Help Desk.

The Helpdesk provides full legal and technical information about the digital tachograph system to national authorities, drivers and road transport operators, tachograph, card or vehicle manufacturers, industrial partners, or to any other interested person.

The Forum meets at least once every 6 months. It ensures the follow-up for on-going discussions on card issuing, enforcement, workshop approval, activation & calibration of digital tachographs, security policy, risk assessment and TACHOnet users' group.

Further details can be found on the MIDT website: www.eu-digitaltachograph.org

Open vehicular secure platform (OVERSEE)

The overall goal of OVERSEE project is to contribute to the efficiency and safety of road transport by developing the OVERSEE platform, which will provide a secure, standardized and generic communication and application platform for vehicles.

The idea of OVERSEE can be split in three main parts:

1. The *open platform* for the execution of OEM and non OEM applications,
2. the *secure* single point of access to
3. internal and external *communication* channels.



Openness

OVERSEE is open in a way that the platform provides protected runtime environments for the simultaneous execution of multiple OEM and also non-OEM applications (like applications for mobile phones). This allows the development of platform and vehicle independent automotive applications (e.g., open source projects). Basis for these future applications will be an open and standardized Application Programming Interface (API).

Communication

This project acts as a single point of access to the vehicle network. Therefore, the OVERSEE platform will provide multiple communication interfaces that allow application providers to simply build connections to internal and external sources. On the other hand, OVERSEE will give the vehicle manufacturers and suppliers the freedom to specify the rules for these communications.

Security

OVERSEE is also secure in a way that the interfaces to vehicular internal and external networks are protected against passive and active attacks. Hence, the OVERSEE platform will be equipped with a firewall enforcing the compliance of communications with the configured security policies. The OVERSEE architecture design allows each vehicle manufacturer or supplier to define security policies that ensure privacy and restrict access to the networks, according their needs. In addition, OVERSEE offers a secure and dependable runtime environment and the capability for secure and non-deniable recording. Moreover, OVERSEE provides to the application developers Hardware Security Module-based security services over a standardized programming interface as well as validation support.

It is expected that OVERSEE will realise an open vehicular IT platform that provides a protected standardized in-vehicle runtime environment and on-board access and communication point. Therefore, the main objectives of the OVERSEE platform will be IT security and dependability that means enforcing a strong level of isolation between independent applications and ensuring that vehicle functionality and safety cannot be harmed by any OVERSEE application.

OVERSEE will first carry out a requirement analysis based on a security risk and dependability analysis. It will then specify the in-vehicle platform architecture based on the following key elements:

- Efficient resource virtualization that meets the stringent real-time and security requirements,
- Trusted access to security services protected by a vehicular hardware security module,
- Flexible trusted dynamic administration of application deployment, and
- Monitoring capabilities based on a trusted point of control and observations (PCO).

OVERSEE will also specify and develop the capabilities that are needed to validate future open platform implementations. This will involve assurance approach, validation tools, and run-time building blocks. Finally, OVERSEE will realize at least two novel ICT applications to proof the feasibility of the projected approach.

Further details can be found in the OVERSEE website: <https://www.oversee-project.com/index.php?id=2>

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Universal On-Board Unit (UOBU)

The UOBU project investigated a platform that “provides as a minimum location, time, vehicle identification, power and communications through a common in-vehicle interface. This will facilitate, support and accelerate the delivery of strategic pan European services such as EFC, eCall, Digital Tachograph and private sector services.”

For its architecture, the UOBU design embodied five principles:

- Open (built on open standards)
- Framework (allowing for later addition of systems and services in a structured way)
- Cooperative (UOBU comprising of discrete cooperating components; avoidance of single monolithic system)
- Simple (strongly bounded, discrete components)
- Secure

In hardware terms, the UOBU system is organised in five areas:

- Power
- Core UOBU
- Communications
- Vehicle data links
- Application links

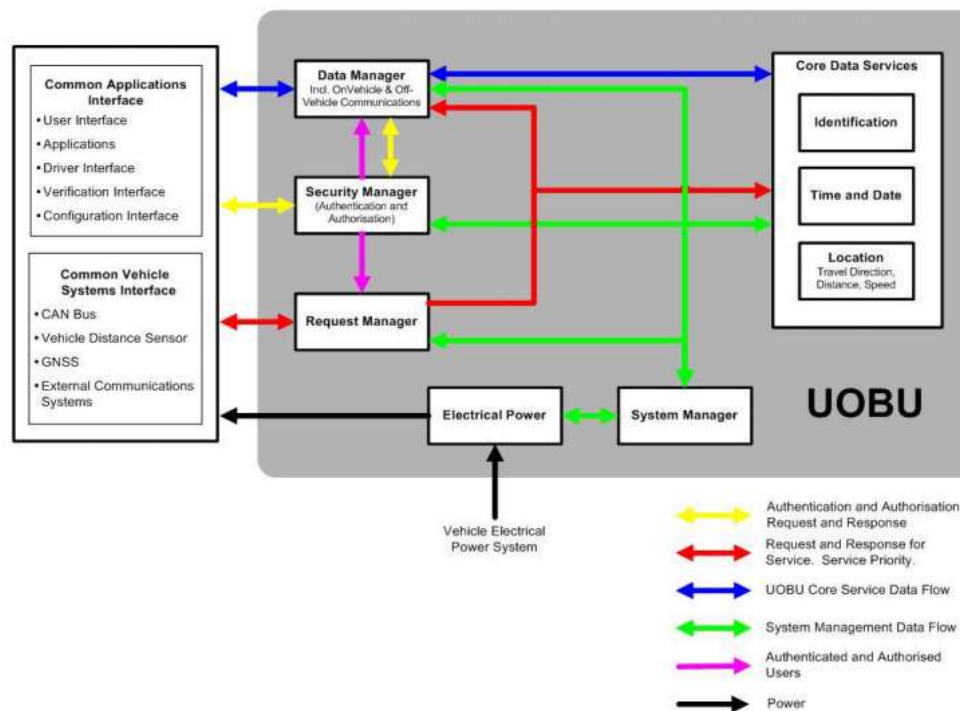


Figure 0.9: UOBU High Level Functional Groups and Associations.¹⁰

Conceptually this architecture is based on 5 principal functional groups:

- Data manager
- Security manager
- Request manager
- System manager
- Core Data Services

The Data Manager functional group is primarily concerned with communications and the receipt and sending of data. The Security Manager functional group enforces the security model of the UOBU and mediates with the Data Manager and Request Manager to ensure that only authenticated and authorised requests for a service are actioned. The System Manager is concerned with

¹⁰ Source : Figure 6-1 from UOBU report WP2-1-1 SEA-06-TR-4874 UOBU Architecture Options - Issue 1

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monitoring and updating the system. The Core Data Services functional group maintains and provides services in relation to data the UOBU provides.

Further details can be found in the UOBU report "WP2-1-1 SEA-06-TR-4874 UOBU Architecture Options - Issue 1".

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Co-Operative Systems for Intelligent Road Safety (COOPERS)

The COOPERS project’s mission is to define, develop and test new safety related services, equipment and applications using two-way communication between road infrastructure and vehicles from a traffic management perspective.

COOPERS developed a reference architecture (using FRAME) to analyse the data exchange along the value chain. It is built around four main nodes:

- COOPERS Service Centre
- Traffic Control Centre
- Roadside Unit
- In-vehicle sub-system

Those nodes can be connected via various communication channels (GPRS, DAB, WiMAX, CALM etc) to exchange data via defined COOPERS interfaces. As an example for the in-vehicle architecture and its communication links to a road side controller, the following diagram was provided to COOPERS by EFKON:

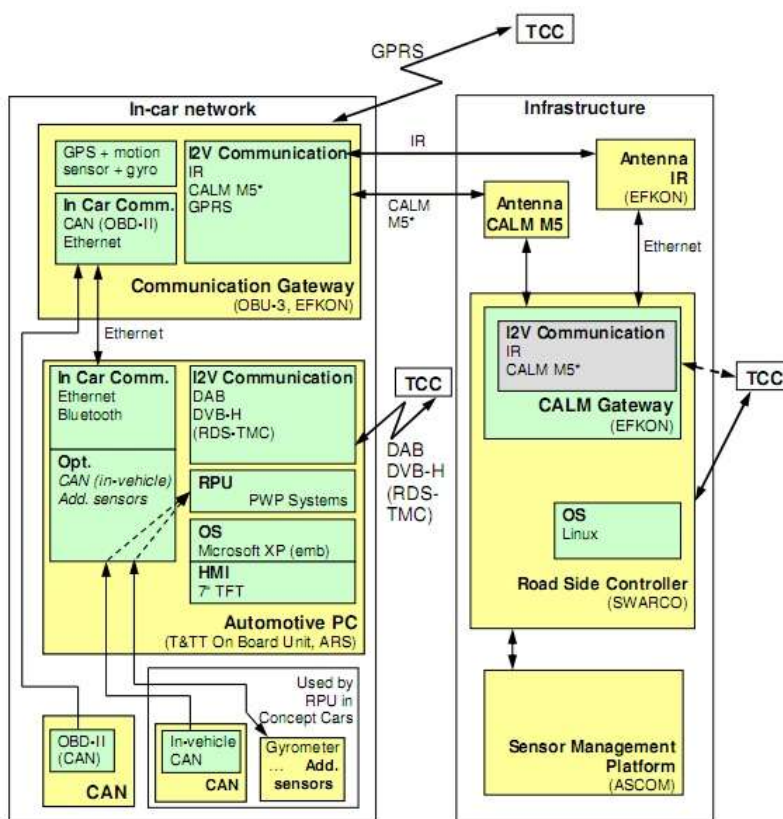


Figure 0.10: COOPERS In-Vehicle Communication Architecture.¹¹

It is based around existing components (such as the OBU-3 platform by EFKON), grouped into

- Vehicle sensors
- CAN-bus
- Automotive PC
- Communication Gateway

Since existing platforms were used, the design of the in-vehicle architecture was more focussed around what was available rather than a more detailed investigation into architectural options. Further details on the in-vehicle architecture and systems used for the tests in COOPERS can be found in the deliverable "D7-5300-5400_Testbench_vehicle_environment_DBV0.3".

¹¹ Source: Figure 52 from COOPERS deliverable D_3600_3700_COOPERS_services_and_value_chains_V04

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Extend FRAMEwork architecture for cooperative systems (E-FRAME)

E-FRAME is a Support Action project that will provide support for the creation of interoperable and scalable Cooperative Systems throughout the European Union. It will provide a centre of knowledge that is commercially and politically neutral, and which services everyone's long term interests.

The principal objectives of the E-FRAME project are:

- To extend the European ITS Framework (FRAME) Architecture to include Cooperative Systems.
- To show how the Extended FRAME Architecture can be used to develop and implement Cooperative Systems in member states, regions and projects.
- To provide advice on the capture of deployment and operational issues for a given ITS Architecture.
- To study the standardisation issues for Cooperative Systems highlighted by given ITS Architectures, and to create a set of recommendations for the appropriate organisations.
- To organise Working Groups, Seminars and Workshops for all stakeholders to study the business cases for, and how to apply the Extended FRAME Architecture.
- To provide advice and guidance on using the Extended FRAME Architecture.

Extending the FRAME Architecture

The system requirements for the COOPERS, CVIS and SAFESPOT integrated projects have already been collated into a set of combined requirements in the format of the FRAME User Needs.

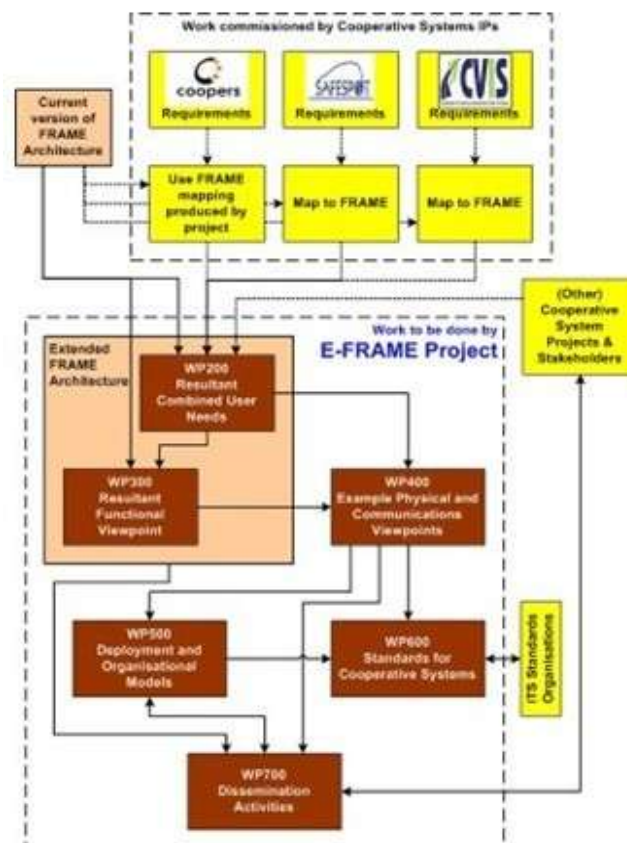


Figure 0.11: Relationship between the E-FRAME Project and other organisations

Once these combined requirements have been reviewed, the existing FRAME Architecture will be modified to create the Extended FRAME Architecture that includes the Cooperative System applications and services.

Deployment and Organisation Models

Starting from the above example, advice on the management of deployment and organisational

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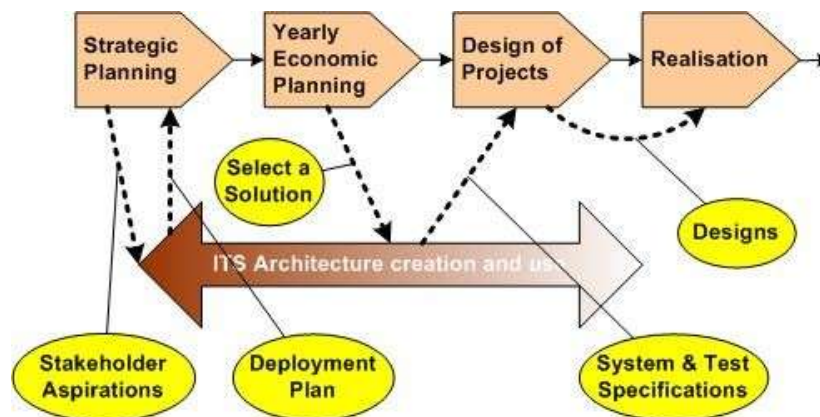
issues for Cooperative Systems will be created. The project will provide these in draft form for discussion at an E FRAME conference to which both public authorities and industry representatives will be invited. The resulting version will be reviewed by national experts and then published on the FRAME web-site.

❖ Standards

Standards are required to ensure compatibility between various Cooperative Systems components. Communication standards are not always sufficient to create fully functioning and interoperable systems; of equal importance are the data that they use and the behaviour of the components at the ends of the communication links. The project will use the above examples as the starting point for the identification of many of the standards that are needed, and make recommendations for their development.

Dissemination

❖ Support



Technical assistance in the use of the Extended FRAME Architecture is already available in the form of Seminars, targeted at decision makers, and Workshops for those who actually need to create their own architecture.

Throughout the duration of the project a number of publications will be added to the FRAME website to provide further guidance on issues related to the use of an ITS Architecture.

❖ Outreach

Discussions will be held with groups of Cooperative Systems stakeholders to identify their needs at the "application level", and to identify the required business cases. These discussions will normally be held in association with ITS conferences, or other events that they usually attend.

Further details can be found in the E-FRAME website
<http://www.frame-online.net/top-menu/e-frame-project.html>

eSafety Working Group on Service Oriented Architecture

Service-Oriented Architecture (SOA) is software architecture that puts together a complex topology of interfaces, interface implementations and interface calls. The application can also ensure relationship of services and service consumers through its software modules.

SOA concepts and related technologies are expected to play an important role to avoid any possible market fragmentation and to facilitate service interoperability and cooperation among stakeholders and specialised parties.

The eSafety SOA working group analyses the potential benefits of SOA in eSafety environment and applications and will focus on non-technical, business oriented aspects such as:

- Type of services that can be supported by SOA
- Identify the main obstacles in using SOA on mobile and safety relevant applications
- Identify the best approach to introduce the services SOA can offer to the eSafety

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EURIDICE

The basic concept of EURIDICE is to build an information services platform centred on the individual cargo item and on its interaction with the surrounding environment and the user.

Thus the EURIDICE project makes some abstractions regarding in-vehicle devices (or indeed any node within the overall system), as shown in the general architecture overview below:

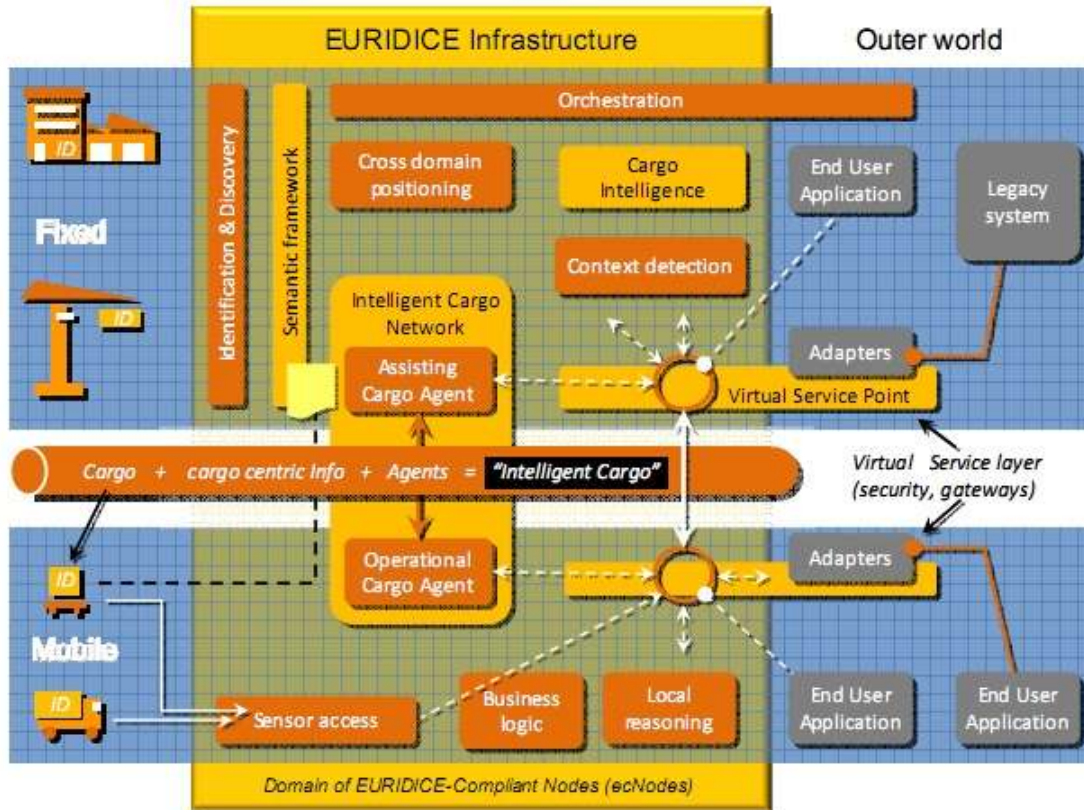


Figure 0.12: EURIDICE Architecture Overview.¹²

To reduce complexity all business objects (cargo, means of transportation, services and human-operated devices) are represented by the abstract concept of an EURIDICE Compliant Node (pronounced like "easy node"). An ecNode can be uniquely identified and has a reference to an Information provider where more information can be found when authorised. Global identification and discovery services are included in the architecture to find the applicable information based on the identification of an ecNode.

Communication services between ecNodes are based on a secure peer-to-peer network.

Since EURIDICE is cargo- and not vehicle-centred, little detail is available on in-vehicle architecture considerations. Further details on the EURIDICE architecture in general can be found in the deliverables "D11.1 High level architecture overview" and "D11.2 Detailed architecture specifications". Those two deliverables however are currently not available to the public through the EURIDICE website (www.euridice-project.eu).

¹² Source: EURIDICE White Paper – Nov 2009, page 15

Implementation of GNSS tracking & tracing Technologies for EU regulated domains (MENTORE)

MENTORE is a project co-funded by the European GNSS Supervisory Authority (GSA) with funds from the 6th Framework Programme of the European Commission. MENTORE began in July 2007 and ended in July 2009.

The key objective of MENTORE is to demonstrate the added value of EGNOS and GALILEO at the service of tracking and tracing applications, with a long term view to:

- supporting the application of National and EU regulations already in place;
- accelerating the set-up process of regulations presently under development in support of EU policies;
- triggering the development of a new EU regulatory framework that integrates national trends and strategies.

Capitalising on the results of previous EU initiatives and using existing tracking technologies, MENTORE will help achieving a shared understanding of the regulatory and technological enablers supporting the widespread usage of GNSS as a tool to monitor and control the position of objects for safety, efficiency and traceability purposes.



MENTORE specifically identified and implemented actions that:

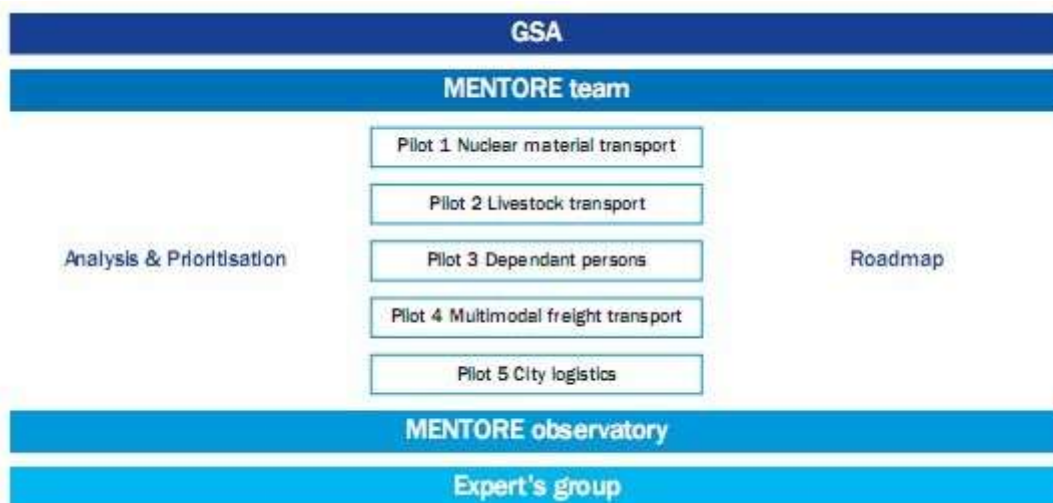
- target T&T regulated markets for which GNSS technologies are a tool to monitor and control the position/displacement of objects for safety, efficiency and traceability purposes
- analyse and develop services supporting the implementation of the corresponding National and EU regulations
- demonstrate and validate the relevant Service Provisioning scheme, along with the related business interest and market opportunities.

MENTORE has developed a two-year work plan to analyse the regulatory framework, identifying services that are or may be subject to regulation and investigate the main technology enablers, in terms of service architecture and its constituting elements.

Following a selection of the most promising T&T services, a subset of five pilot services have been analysed in greater detail and tested in real-life conditions. These pilots have demonstrated the social and commercial benefit of GNSS tracking and tracing solution that can in turn, develop into a new regulatory environment.

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The MENTORE Consortium is composed of 18 partners, from seven different EU Member States associating end-users, user associations, operators, competent authorities and institutions, regulatory bodies and relevant research entities.



Today, MENTORE’s results provide indications on how the EU GNSS can be integrated into National and EU regulations and policies currently being prepared. Recommendations and suggestions for actions to decision-makers are based on the solid knowledge of the project consortium and its external experts, with the active support of the GSA.

Further details can be found in the MENTORE website <http://www.gnsstracking.eu/>

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Preparation for Driving implementation and evaluation of C2X communication technology (PRE-DRIVE C2X)

PRE-DRIVE C2X develops an integrated simulation model for cooperative systems that enables a holistic approach for estimating the expected benefits in terms of safety, efficiency and environment. This includes all tools and methods necessary for functional verification and testing of cooperative systems in laboratory environment and on real roads in the framework of a field operational test.

The objectives of PRE-DRIVE C2X are:

- Establish a pan European architecture framework for cooperative systems ensuring interoperability of all different applications of vehicle to vehicle and to infrastructure communications for safety and mobility;
- Perform consistent a priori estimations of the impact on traffic safety and mobility of cooperative systems for road safety and traffic efficiency;
- Pave the road for the forthcoming field operational tests on cooperative systems;
- Identify the key enabling and disabling factors to plan the future market introduction of vehicular communication systems.

PRE-DRIVE C2X is part of the COMeSafety architecture task force and transposed the COMeSafety architecture description into a detailed specification.



At the end of PRE-DRIVE C2X, it is expected to achieve that:

- **System architecture** for a EU cooperative driving system developed together with COMeSafety on the basis of the COMeSafety architecture draft
- **Integrated simulation tool set** allowing to assess all aspects of vehicular communication
 - Technical aspects
 - Traffic and safety impact
 - Environmental effects
- **Robust prototype** hard- and software components suitable for use in field operational trials
- **Commonly agreed use cases** for vehicular communication systems with particular focus on implementation aspects and benefit/cost ratio
- Verified **methods and tools for field operational trials** with vehicular communication
- **Demonstration, functional verification** and **impact assessment** of C2X communication system based on PRE-DRIVE C2X/COMeSafety architecture
- Contribution to relevant **standardisation** activities
- **Public awareness** of benefits of vehicular communication technology

Further details can be found in the PRE-DRIVE C2X website <http://www.pre-drive-c2x.eu/>

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PREVENT

The Integrated Project PREVENT is designed to contribute to road safety by developing and demonstrating preventive safety applications and technologies. Preventive safety applications can help drivers to avoid or mitigate an accident through the use of in-vehicle systems which sense the nature and significance of the danger, while taking the driver's state into account.

Depending on the significance and timing of the threat, the active and preventive safety systems will:

- inform the driver as early as possible
- warn driver if there is no driver reaction to the information, and
- actively assist or ultimately intervene in order to avoid an accident or mitigate its consequences.

Preventive safety applications also help drivers to:

- maintain a safe speed
- keep a safe distance
- drive within the lane
- avoid overtaking in critical situations
- safely pass intersections
- avoid crashes with vulnerable road user
- reduce the severity of an accident if it still can not be prevented.

Preventive safety makes use of information, communications and positioning technologies to provide solutions for improving road safety. With such technology - which can operate either autonomously on-board the vehicle or co-operatively based on vehicle-to-vehicle or vehicle-to-infrastructure communication - the number of accidents and their severity can be reduced, leading to a decrease in the number of accidents.

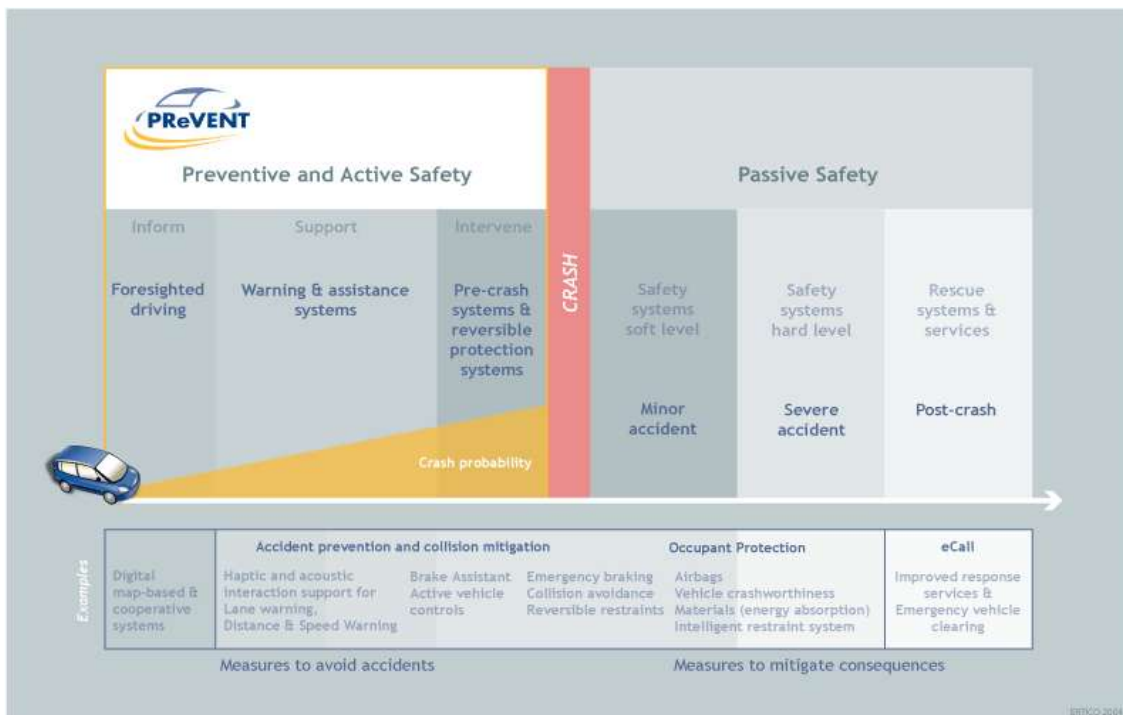


Figure 0.13: PREVENT's architecture.

The goal of Integrated Project PREVENT is to contribute to the:

- road safety goal of 50% fewer accidents by 2010 - as specified in the key action 2.3.1.10. eSafety for Road and Air Transport from the European Union.
- competitiveness of the EU automotive industry
- EU scientific knowledge community on road transport safety
- congregation and cooperation of EU and national organisations and their road transport safety

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initiatives

PREVENT envisions the early availability of advanced, next generation preventive and active safety applications and enabling technologies and an accelerated deployment on EU roads.

A range of technologies are used and integrated in safety applications:

- **Sensing technologies for environment perception** (infrared sensing, video and camera image perception, LIDAR / RADAR sensors, gyro sensors sensing vehicle motion and acceleration, inertial sensors such as tachometers and speedometers). Processing the sensor data through mathematical algorithms results in a virtual understanding of the vehicle environment - for example, the path and position of vulnerable road users from other vehicles and road infrastructure.
- **In-vehicle digital maps and positioning technologies** (GPS, GNSS and GALILEO) can be perceived as further sensing systems to accurately identify the vehicle position and interpret the environment to help the prediction of a vehicle's path, especially a vehicle ahead.
- **Wireless communication technologies** can send information from the vehicle to other vehicles or infrastructure, as well as enable high-value safety information to be received to further complement the real-time road information.

In addition, the human machine interface (HMI) ensures that the preventive and active safety applications operate according to the expectations and ergonomic restrictions of the driver and his/her physiology.

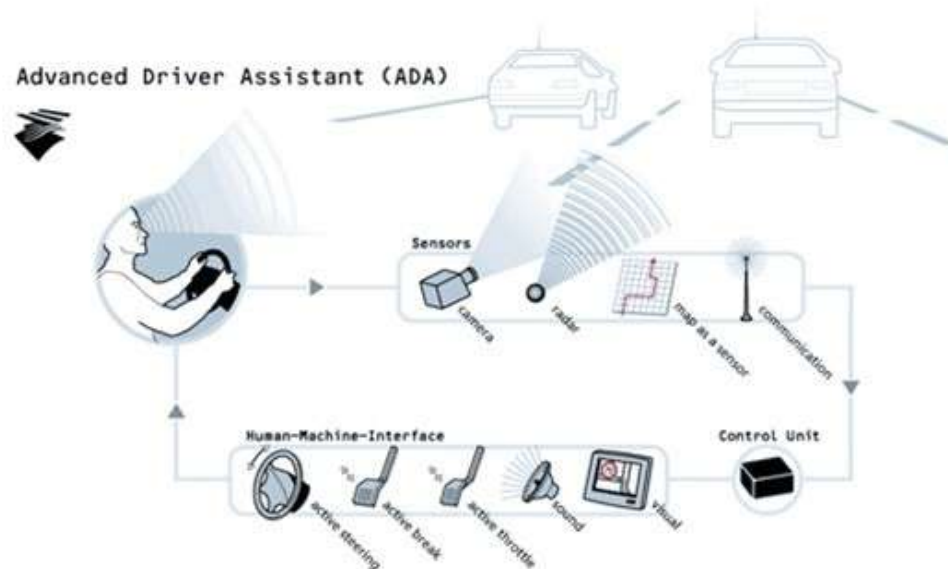


Figure 0.14: Advanced Driver Assistance applications in the preventive and active safety systems.

The above figure illustrates how information from the road environment, vehicle and driver is collected with different technologies (camera, radar, digital map, and vehicle communications) and processed to be interpreted and modelled. The vehicle safety application performs the risk assessment and decision making regarding sending warnings and assistance functions to the driver via the human machine interface. The driver, as a supervisor of safety systems, can be adequately warned of dangers to avoid or mitigate accidents and remain in the 'loop' of the application.

Further details can be found in the PREVENT website <http://www.prevent-ip.org/en/home.htm>

Final Report Action 4.1**SafeSpot**

The SafeSpot Integrated Project aims to understand how intelligent vehicles and intelligent roads can cooperate to produce a breakthrough for road safety. The aim is to prevent road accidents developing a "Safety Margin Assistant" that:

- detects in advance potentially dangerous situations,
- extends "in space and time" drivers' awareness of the surrounding environment.

The "Safety Margin Assistant" is an Intelligent Cooperative System based on Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communication. The communications within SafeSpot are based on the new IEEE 802.11p standard, based on ad-hoc generated peer-to-peer networks.

Since SafeSpot is based on CVIS, many similarities apply; below an example for the overall hardware architecture used gives an indication of the envisaged in-vehicle architecture:

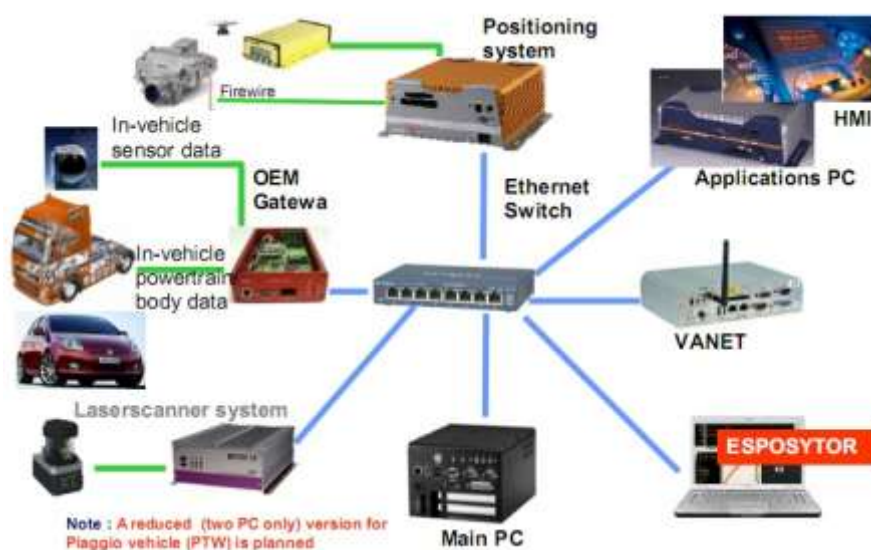


Figure 0.15: SafeSpot Hardware Architecture.¹³

The in-vehicle network in SafeSpot itself is an Ethernet based switched LAN, connecting

- Positioning system
- In-vehicle sensor gateway
- Laserscanner system
- Main PC
- ESPOSYTOR data probe (for test data collection)
- Applications PC
- and the VANET gateway.

For the software architecture model, the "Main PC" has the following functional components:

- LDM database server
- Data fusion / LDM data producer
- Message generation client
- Application client(s)
- VANET router

Since safety- and time critical applications are investigated in SafeSpot, the software framework has to support multi-threading in a soft real-time system. Further details can be found in the SafeSpot deliverable "D1.3.4_PublicHwSwSpec".

¹³ Source: Figure 7 from SafeSpot deliverable D1.3.4_PublicHwSwSpec

Final Report Action 4.1**SeCuring the EU GNSS adopTion in the dangeroUs Material transport (SCUTUM)**

SCUTUM is a European Research & Development project, aimed at a wide adoption of Satellite Navigation EGNOS/Galileo based technology and services for the safe hazardous goods transport management.



Based on the MENTORE experience, SCUTUM, started on February 2010, is aimed at an EU-wide use of EGNOS, by implementing the actions identified in MENTORE:

- EGNOS nation best cases extension on a cross-border basis, as a first step towards a wider adoption in Europe and in the freight transport market
- Large scale trials to support standardization and harmonization at EU level.

SCUTUM launches and pursues a concrete path for the use of EGNOS-based services for the dangerous goods transport market in Europe. The project implements an EGNOS best-practice programme: the ENI is a leading Italian oil company, presently using EGNOS to monitor its fleet transporting hydrocarbon in Italy. The ENI operational experience is extended to two neighbouring countries, France and Austria, as a first step, for further extensions to other Member States and other freight types.

SCUTUM plans to develop products and services ready for the commercial market, and to launch the relevant standardization.

The involvement of main stakeholders (institutions, Authorities, goods owners/producers, transport operators, service/application providers, equipment manufacturers) ensures to validate business feasibility and benefits (commercial and social).

By extending the ENI/Italian experience towards neighbourhood countries (France and Austria), SCUTUM provides active contribution to regulatory policy planning and standardization processes, with EGNOS and in view of Galileo introduction.

In 21 months, SCUTUM extends the ENI Italian system on a cross-border basis in neighbouring countries Austria and France, for further future extension to other Member States and other freight types. In parallel, SCUTUM enhances the ENI monitoring system to use EGNOS CS, and operates it in large scale trials involving 100 vehicles.

The outcomes of the SCUTUM trials support the launch of a technical standardization, and an institutional validation, concerning the use of GNSS for dangerous goods transports management. JRC and CEN involved in the project, guide the work on standardization; the authorities involved in the trials (Italy's and France's Ministry of Transport) validate EGNOS benefits and value while outlining guidelines for the evolution from a best practice programme to a wider adoption.

Further details can be found in the SCUTUM website <http://www.scutumgnss.eu/>

Traveller Information Services Association (TISA)

The Traveller Information Services Association (TISA) was established to ensure an international framework for market-driven, coordinated, proactive implementation of traffic and travel information services and products based on existing standards such as RDS-TMC and TPEG. It also works towards the development and deployment of future standards and services.

TISA has taken over all the activities undertaken by the previous TMC Forum, TPEG Forum and the German Mobile.Info project. It also supports standards that provide elements or framework for services and products covering traffic and travel information, including roads, public transport and related information needs such as points of interest, weather and environmental information.

Their activities in particular include:

The Traffic Message Channel (TMC)

TMC is a specific application of FM RDS used for broadcasting real-time traffic and weather information. Data messages are received silently and decoded by a TMC-equipped navigation system, and delivered to the driver, typically by offering dynamic route guidance - alerting the driver of a problem on the planned route and calculating an alternative route to avoid the incident.

TMC traffic information systems conform to a global standard that has been adopted by traffic data gatherers, information service providers, broadcasters and vehicle/receiver manufacturers. TMC information is received via the normal FM radio antenna.

All TMC receivers use the same list of event codes, while the location database (typically on the navigation system map CD-ROM or DVD) contains a country-specific set of location codes for the strategic EU road network.

The Transport Protocol Experts Group (TPEG)

TPEG technology has been designed to provide a 21st century multimodal TTI data protocol for delivering content to the end-user, regardless of location or client type in use. A common Location Referencing methodology has been developed to allow any client device to take advantage of content without necessarily having a location database installed.

TPEG technology is now specified in a suite of worldwide international Standards that have been adopted by CEN and ISO. TPEG specifications offer a method for transmitting traffic and travel information.

In contrast to TMC (a single defined application (event-based road traffic information) that is typically used to make GPS navigation for vehicles traffic-enabled or 'dynamic'), TPEG refers to a whole set or toolkit of specifications, for offering a wider range of services to a wider range of users and devices.

TISA addresses traffic and travel information via TMC and TPEG, and also the development of any other supporting technologies. The travel information 'service chain' involves data collection, analysis and prediction, location referencing, the use of broadcast or other 'bearer' technologies and new and innovative ways of presenting and interacting with travel information. All these technological aspects are inside the scope of TISA's technology work.

Further details can be found in the TISA website <http://www.tisa.org/en/welcome.htm>

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Vehicle-to-Vulnerable roAd user cooperaTive communication and sensing teCHnologies to imprOVE transpoRt safety (WATCH-OVER)

The WATCH-OVER project started in January 2006 and successfully ended in December 2008. It aims to avoid road accidents that involve vulnerable users such as pedestrians, cyclists and motorcyclists. This topic is in line with the ambitious goal to reduce road fatalities by 50%, as stated in the White Paper on European Transport Policy for 2010.

WATCH-OVER intends to examine the detection of vulnerable road users in the complexity of traffic scenarios in which pedestrians, cyclists and motorcyclists are walking or moving together with cars and other vehicles.

The project carries out Research and Development activities with the aim to design and develop a cooperative system for the prevention of accidents involving vulnerable road user in urban and extra-urban areas. System concept is based on interactions between an in-vehicle module and users' devices. It foresees the development of a cooperative system integrating low cost communication technologies, as an extension to autonomous sensor based systems, in combination, if feasible, with localisation technologies, to cover the most critical situations.



Projects main activities are:

- identification of user requirements and relevant use cases
- specification of system architecture, functions and applications
- selection and adaptation of the most promising short range communication technologies
- design and development of new generation automotive CMOS cameras
- implementation of software algorithms for real time detection of vulnerable road users
- design and development of the system customised for different users
- results dissemination and deployment

The WATCH-OVER project approach is focused on the cooperation between in-vehicle modules and devices inserted in wearable objects or integrated in motorcycles.



The candidate sensing technologies to support the detection of vulnerable users are summarised in the following categories:

- far and near infrared systems
- 2D, 3D vision sensing technology
- microwave radar
- laser radar

In the project Robert Bosch GmbH develops a second generation of automotive CMOS multi-purpose camera. The automotive CMOS cameras have anti-glare capabilities and high performance

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in the visual and near infrared range.



The candidate short range wireless communication technologies for the WATCH-OVER system development are:

- IEEE 802.15.4 standard works in the 868/915MHz or in the 2.4 GHz, with data rates of up to 250 kb/s
- RFID (Radio Frequency Identification) is a technology which unambiguously identifies an object by means of an RF wireless system
- UWB (Ultra Wide Band Radio) is a wireless technology based on the emission of a pulse train with low power and short duration.

Further details can be found in the WATCH-OVER website <http://www.watchover-eu.org/index.html>

Final Report Action 4.1**AutoLinQ™**

Continental introduced AutoLinQ™ in June 2009. AutoLinQ™ is an open, end-to-end vehicle connectivity platform that will enable vehicle owners to safely connect to what matters in their lives. AutoLinQ™ extends the vehicle ownership experience by creating an “always connected” environment where users can have meaningful interaction with their vehicles from home, from the office, or from their mobile devices.

AutoLinQ™ is based on the Android™ open source project, which offers an operating system as well as versatile software set for mobile devices. With this system, new applications can be easily integrated into the mobile environment.

AutoLinQ™’s architecture is comprised of 4 system elements called “Views”. These “Views” can be configured and combined to create a unique version of the AutoLinQ™ platform, to suit individual requirements of end customers and OEMs.



Figure 0.16: System Elements of AutoLinQ™’s Architecture.

CarView can include an in-vehicle display and computing platform, along with a pre-loaded Android™ application set. Core applications can include:

- Enhanced trip planning and navigation
- Social networking
- Communication / Telephony / E-Mail
- Global Media Access
- Safe Driving Apps
- Eco Driving Apps
- Customized OEM applications

The Mobile View functions include:

- Online vehicle status and information
- Context-sensitive vehicle security and control
- Natural language text entry
- Car finder

Functions supported in Home View include:

- Online vehicle status and information
- Vehicle security and control
- Driver-specific application selection and download to vehicle
- Driver-specific vehicle personalization
- Vehicle diagnostics and dealer access
- Online owner’s manuals
- Driver-specific vehicle restrictions and owner SMS notifications
- Enhanced trip planning and navigation
- Social networking
- Communication / Telephony / E-Mail

In terms of Partner View, AutoLinQ™ intend to freely distribute open source tools and APIs that

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simply extend existing Android™ frameworks and tools. By contributing additional API-tools to the Android™ developer's "toolbelt", AutoLinQ™ hope to foster a world of new applications that can take advantage of the vehicle's contextual awareness - pushing the boundaries of apps beyond what is possible in mobile phones and other portable devices.

For example, through AutoLinQ™ MobileView, vehicle owners can ask questions or send commands to their vehicle via their mobile phone, in a very familiar and intuitive way. This includes options like checking the location of a vehicle, locking doors, or receiving text message alerts if beginning drivers are speeding. With AutoLinQ™ HomeView, vehicle owners can access real-time vehicle status, diagnostic information, or vehicle settings from an account on their home PC. Or, while on the road, vehicle occupants will be able to access real-time location-based information and content that is relevant to the driving situation.

Continental recently announced the availability of the AutoLinQ™ Software Development Kit (referred to as the "AutoLinQ™ SDK") which includes the Emulator, Vehicle Simulator, Generic API, and AutoLinQ™ skins.

The AutoLinQ™ SDK is an add-on to the Android™ SDK and the Android™ Virtual Device ("AVD") Manager. It creates an Automotive AVD and allows the licensee to take advantage of Automotive API's to create Android™ applications which leverage vehicle information and systems. The Android™ SDK must be licensed and downloaded from Google. For more information about the Android™ SDK and AVDs see android.com.

The AutoLinQ™ SDK enables Android™ developers to write applications that leverage the state of the vehicle, such as the fuel level, or whether the doors are locked to create exciting and new applications.

The SDK consists of the following components:

- Automotive API – The API describes how to create an application that can access the vehicle's information and systems.
- AutoLinQ™ Emulator – The Emulator creates a virtual in-vehicle environment that allows applications to run as if in a real vehicle. It includes an AutoLinQ™ skin that emulates a Head unit and Android™ system image, which includes the new Automotive API.
- Vehicle Simulator – The simulator replicates the data coming from the vehicle. Developers can configure the dials and buttons within the vehicle simulator to replicate events and to trigger updates to the Vehicle Manager, and thus your application.
- HMI Design Guidelines - Describes best practices and common techniques for creating an effective user interface for use in the automotive environment.



Continental plans to create an application certification process to ensure application conformance to established safety standards, and conformance to OEM style guidelines. Certified applications will be available to download via an Application Store - a prototype of which is expected to be available in the second half of 2010.

Further details can be found on the AutoLinQ™ website: <http://autolinq.szygy.de/default.aspx>

Automotive open system architecture (AUTOSAR)

The AUTOSAR project aims to develop an open and standardised automotive software architecture through the cooperation of automobile manufacturers, suppliers and tool developers.

The AUTOSAR partnership is an alliance of OEM manufacturers and Tier 1 automotive suppliers working together to develop and establish a de-facto open industry standard for automotive ECU to ECU architecture which will serve as a basic infrastructure for the management of functions within both future applications and standard software modules

The core members of the project are:

- BMW Group
- Robert Bosch GmbH
- Continental AG
- Daimler AG
- Ford Motor Company
- General Motors Company
- Peugeot Citron Automobiles S.A
- Toyota Motor Corporation
- Volkswagen AG

The goals of developing a standard architecture in order to master the growing complexity of automotive electronic architectures are:

- Implementation and standardization of basic system functions as an OEM wide "Standard Core" solution
- Scalability to different vehicle and platform variants
- Transferability of functions throughout network
- Integration of functional modules from multiple suppliers
- Consideration of availability and safety requirements
- Redundancy activation
- Maintainability throughout the whole "Product Life Cycle"
- Increased use of "Commercial off the shelf hardware"
- Software updates and upgrades over vehicle lifetime

Standardization of functional interfaces across manufacturers and suppliers and standardization of the interfaces between the different SW-Layers is seen as a basis for achieving the technical goals of AUTOSAR.

The AUTOSAR Software Components encapsulate an application which runs on the AUTOSAR infrastructure.

The AUTOSAR Software Components have well-defined interfaces, which are described and standardized within AUTOSAR.

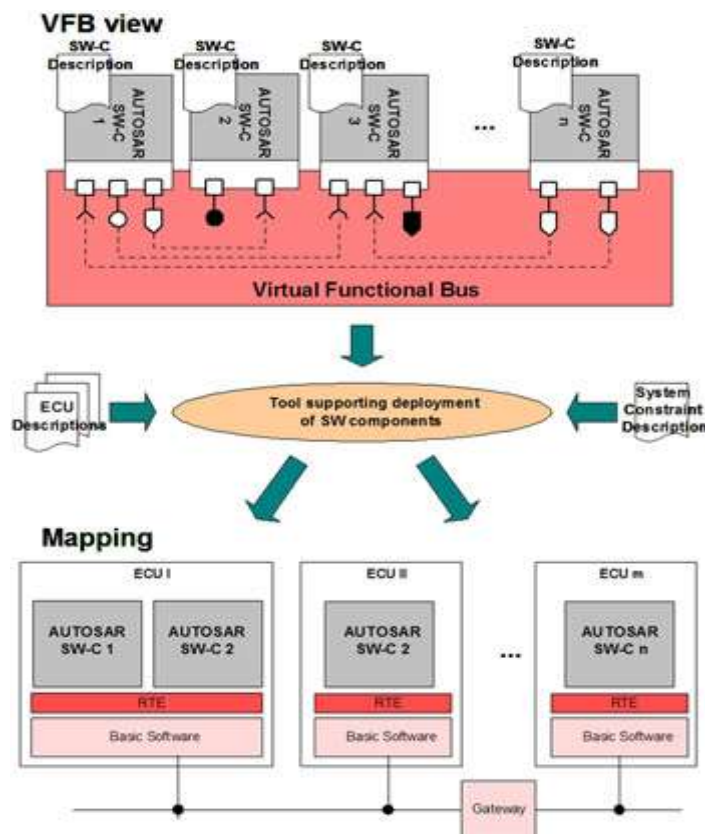


Figure 0.17: Condensed View of the AUTOSAR Approach.

The AUTOSAR scope includes all vehicle domains. Finally AUTOSAR is enabling multiple different functions as for example software modules to be hosted on the same ECU, independently from the supplier of either part. It based on standardised interfaces for the different layers.

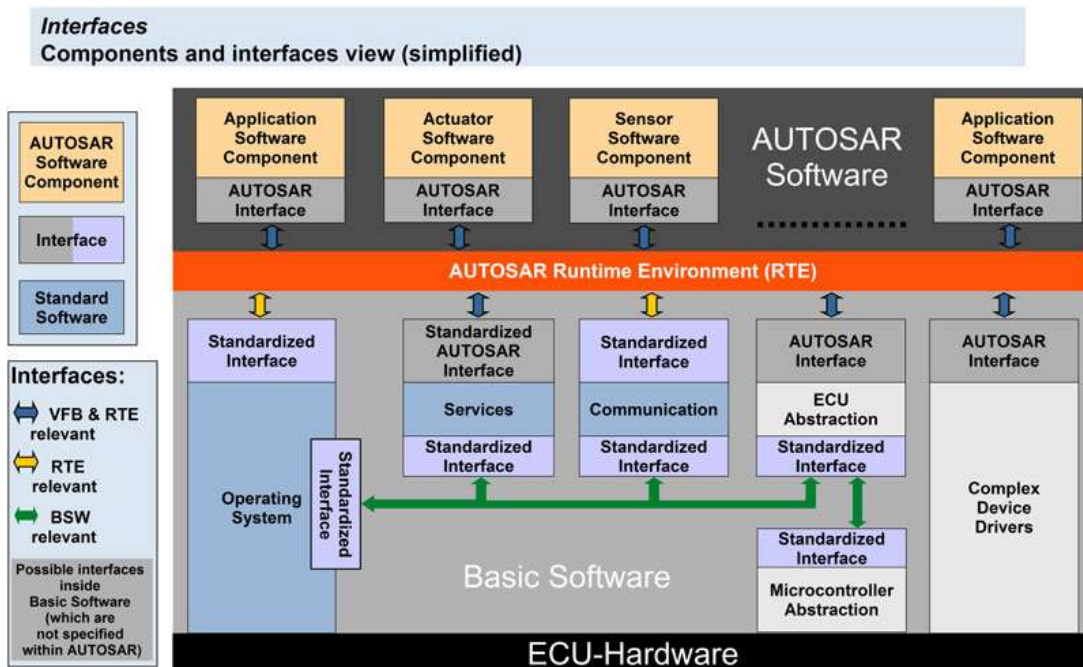


Figure 0.18: Structure of the Software for an ECU.

Further details can be found on the AUTOSAR website: <http://www.autosar.org/>

Final Report Action 4.1**Next Generation Telematics Protocol (NGTP)**

NGTP is a new approach for delivering telematics services to in-vehicle devices and hand sets alike, with the focus on open interfaces across the entire service delivery chain.

With the proliferation of new technologies (e.g., UMTS, WiFi, VoIP), it is likely that future in-vehicle devices will access services using multiple methods and technologies. BMW and its partners concluded that the telematics industry would greatly benefit from a technology-neutral protocol to expand the options for delivering services. Therefore, BMW, Connexis, and WirelessCar have brought their considerable experience together to develop a new protocol, NGTP, based on a standardized and highly flexible infrastructure.

NGTP's developers set the following six objectives:

- Provide a technology-neutral protocol and consistent user interface for telematics services;
- Reduce barriers to collaboration and implementation;
- Enable adoption of new technologies as they come online;
- Support legacy systems for connectivity throughout the service life of a vehicle;
- Gain wide acceptance and encourage innovation through an open approach;
- Increase the value proposition for vehicle manufacturers, service providers, content providers, and motorists.

The protocol has three main segments. The key component is a technology-neutral intermediary called the dispatcher, which connects the vehicle's telematics unit (TU) to telematics service providers (TSPs).

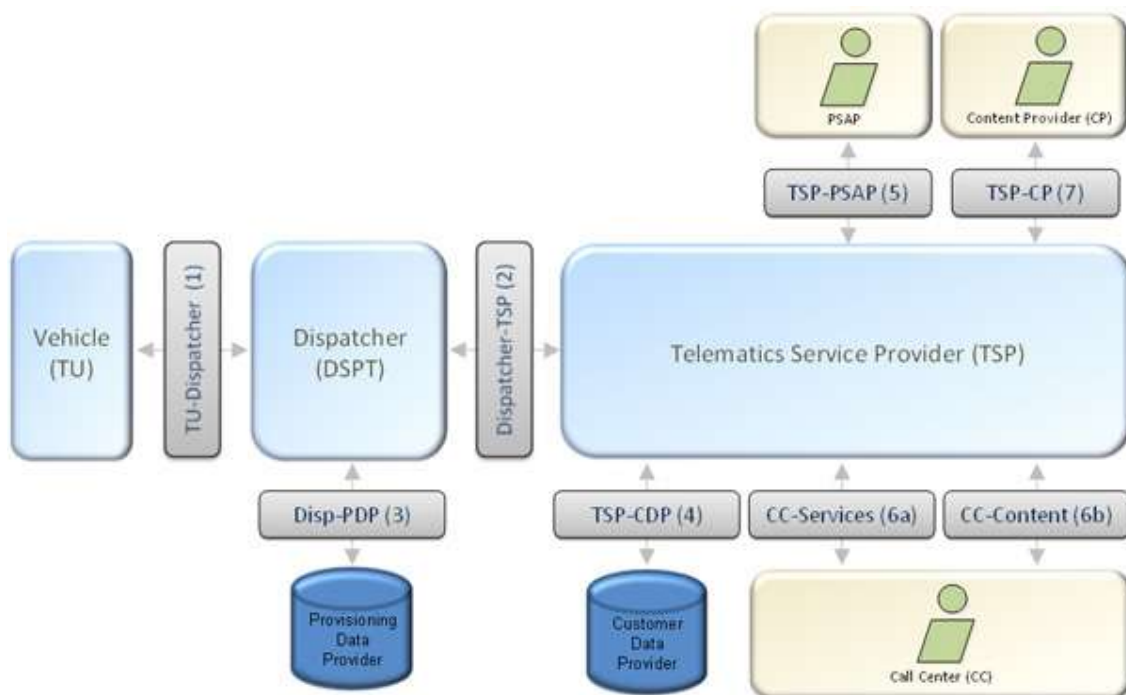


Figure 0.19: NGTP's Infrastructure.

NGTP's dispatcher provides vehicles with a seamless link to TSPs by performing the following functions:

- Receiving requests from the vehicle TU,
- Accessing the vehicle manufacturer's customer and configuration databases in order to route requests to the appropriate TSP, and
- Forwarding the TSP's voice and data traffic back to the vehicle.

The dispatcher provides the customer interface, allowing vehicle manufacturers to offer new services without reconfiguring the vehicle. Separate and open interfaces connect the TSP to call centres, content providers, and public safety answering points (PSAPs), allowing providers to be interchanged as the market demands. Proprietary customer data resides within the vehicle manufacturer's customer relationship management (CRM) system.

Further details can be found on the NGTP website: <http://www.ngtp.org/>

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Nomadic Devices Forum (NDF)

The use of "Nomadic Devices" or portable and aftermarket devices used in the vehicle by a driver for support, assistance, communication or entertainment, is increasingly common. However, the lack of standards for device "docking" in the vehicle, and for safe installation and use, imply added costs, inconvenience and perhaps risks for the user.

To address these challenges a Nomadic Device Forum (NDF) was established by the Adaptive Integrated Driver-vehicle InterfacE (AIDE) integrated project (6th Framework Programme, eSafety Strategic Objective, co-funded by European Commission) to bring together representatives of the key stakeholders involved.

The aim of the Nomadic Devices Forum is to constitute a cross-sector working group to deal with all aspects of safe, effective and user-friendly nomadic device integration and use in the vehicle. The aims of the Forum are as follows:

- act as European consensus platform to reach cross-sector agreement on issues relating to nomadic device safety, technical harmonisation, in-vehicle integration and deployment
- define the principles for managing nomadic device-vehicle information exchange via a "Smart Vehicle-Device Interface"
- address key issues for nomadic devices, including specifications for in-vehicle docking/integration and installation, standardisation of interfaces and guidelines for nomadic device HMI and safety
- identify requirements for new work items in the appropriate standardisation bodies
- act as a bridge between the eSafety research projects on nomadic device issues and also between Europe and the rest of the world
- provide advice to the EC and support AIDE and other projects' work on nomadic devices issues

To achieve these goals, Nomadic Devices Forum has organised working groups which are presently constituted illustrated below:

Working Group A: Smart Device-Car Gateway:

- compile and agree scenarios and use cases for nomadic device-vehicle cooperation (installation, interaction, integration)
- identify functional and system requirements
- define system architecture for a nomadic device-vehicle solution
- outline specifications for a "smart" vehicle-device gateway (including intermediate gateway for information management), including physical, data, functional and application interfaces

Working Group B: Nomadic Device Safety and HMI:

- for nomadic devices/applications in use, make expert assessment of likely risks related to driver use and device installation
- agree principles and propose harmonised guidance for safe use and installation of nomadic devices
- make recommendations for action by all responsible organisations to implement guidelines.

Working Group C: Commercial issues for vehicle-device integration:

- Car industry view of ND issues
- Positive business case options
- Pre-conditions for cross-sector collaboration
- Obstacles to a standardised gateway
- Possible steps forward

These working groups meet regularly; approximately every six months. In addition the groups work off line using web tools and other means of communication. Within AIDE every year a report (deliverable) is prepared describing the activities of the AIDE Nomadic Devices Forum. Additional Working Groups may be set up with the approval of the Organising Committee to address other issues as needed.

Further details can be found in the NDF website: http://www.aide-eu.org/for_nomadic.php

Final Report Action 4.1**ITS Communications Architecture**

ETSI and ISO have developed the ITS Communications Architecture in ISO 21217 and EN 302 665. These documents specify the architecture of communications in ITS (ITSC) supporting a variety of existing and new access technologies and ITS applications. The term ITSC denotes communications protocols, related management and additional functionality. The present document is arranged as a tool-box, i.e. conformance with the present document does not require to implement the whole functionality illustrated and partly specified in the present document.

Four different ITS sub-systems are distinguished:

- Personal ITS sub-system
- Vehicle ITS sub-system
- Central ITS sub-system
- Roadside ITS sub-system

Those sub-systems are connected via ITS peer-to-peer communication channels, mostly based on IPv6 or CALM FAST.

The vehicle sub-system's architecture is defined as shown below:

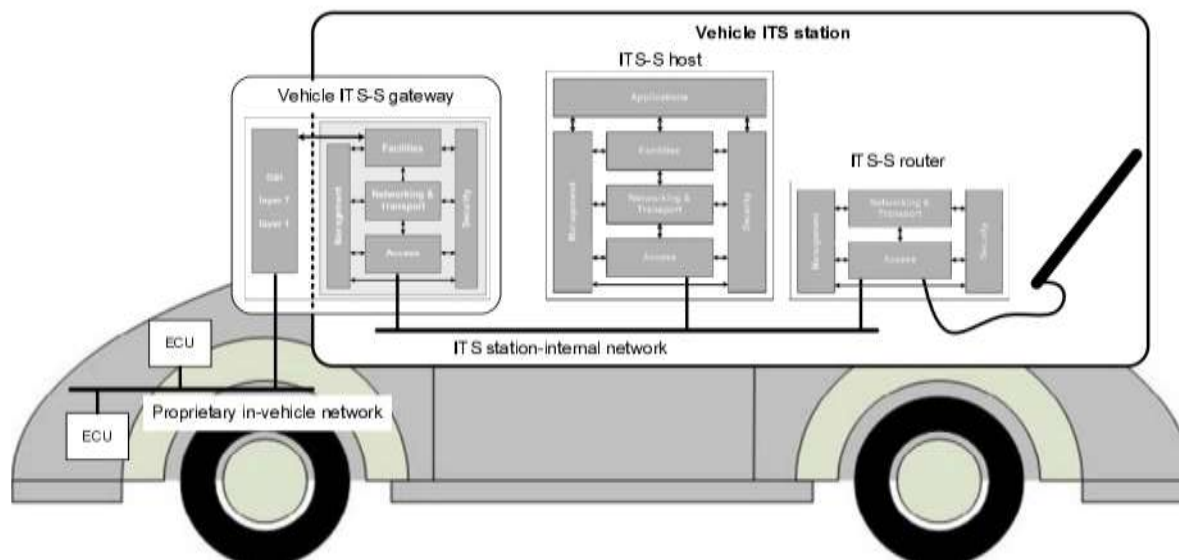


Figure 0.20: Vehicle ITS Station in a Vehicle Sub-System.¹⁴

The vehicle ITS-S gateway provides functionality to connect the components at the proprietary network, e.g. ECU, to the ITS station-internal network. The interface to the in-vehicle components such as ECU is outside the scope of the present ETSI document. Access to components (ECU) may be achieved also in an implementation specific way.

Further details can be found in [4] and [5].

¹⁴ Source: Figure 7 from Draft ETSI EN 302 665 V1.0.0 (2010-03)

Annex 2: Application Description

Tachograph

Application	Electronic system for recording driving and rest times for (co)drivers along with speed and distance travelled.
Legislation	<ul style="list-style-type: none"> • Council Regulation (EEC) No 3821/85 – recording equipment in road transport • Commission Regulation (EC) No 1266/2009 – recording equipment in road transport • Regulation (EC) No 561/2006 – harmonisation of certain social legislation relating to road transport
Application Requirements	The recording equipment shall record and store relevant data in its memory (internal or on tachograph card). Selective data shall be displayed on request.
Governance and Certification	Member states, EU Root Certification Authority (ERCA).
Stakeholders, Organisational Framework	Motorists, road authorities
Architecture Overview	Reports must be available to road authorities whenever requested to do so.
Modules and Functions	<ul style="list-style-type: none"> • motion, speed, and distance sensors • vehicle unit (VU) • driver, company, and workshop card
Sensor Requirements	Secure positioning, auxiliary movement detection.
Interface Requirements	<ul style="list-style-type: none"> • HMI for manual entry of activities • Interface between motion sensors and VU
Application Data Requirements	Vehicle identification (VIN, VRN, and registering member state) and vehicle characteristics (w, k, l, tyre size, speed limiting device setting, current UTS time, current odometer value).
Application Communication Requirements	The communication of electronic data between the source of vehicle movement and the motion sensor should be protected against tampering and corroborated by additional and independent internal and external sources.
Security Architecture	It is essential for the integrity and trustworthiness of the security of the digital tachograph system to ensure that tachograph cards issued to drivers are unique. In order to prevent drivers from applying for or possessing more than one valid card, an electronic exchange of data between Member States should exist.
Data Storage Requirements	<p>The recording equipment shall record and store in its data memory the following data relevant to the 255 most recent company locks:</p> <ul style="list-style-type: none"> • lock-in date and time, • lock-out date and time, • company card number and card issuing member states, • company name and address. <p>Data previously locked by a lock removed from memory due to the limit above shall be treated as not locked.</p>
In-Vehicle Processing Requirements	Basic processing power required.

Final Report Action 4.1**Livestock Transport Tracking**

Application	Tracking of vehicles carrying livestock.
Legislation	<ul style="list-style-type: none"> • Council Regulation (EC) 1/2005 – protection of animals during transport.
Application Requirements	The application registers and logs time-stamped positions of the vehicle and the temperature in the area where animals are located. It alerts the driver when the temperature reaches the maximum or the minimum limit.
Governance and Certification	Central authority of member states in charge of animal welfare.
Stakeholders, Organisational Framework	Drivers, vehicle operators, road authorities (all administrative levels), public authorities in charge of animal welfare.
Architecture Overview	In-vehicle equipment registers the data. An in-vehicle HMI communicates information to the driver. The data logs can be printed in the device or in the back office.
Modules and Functions	<ul style="list-style-type: none"> • Module for the continuous and secure monitoring of vehicle movement and cargo area temperature • Module for logging the data • Module for printing the data • HMI
Sensor Requirements	<ul style="list-style-type: none"> • Reliable registration of movement • Reliable registration of time • Reliable registration of temperature
Interface Requirements	Not applicable.
Application Data Requirements	Not applicable.
Application Communication Requirements	Offline reporting of data logs on request.
Security Architecture	Not applicable.
Data Storage Requirements	Data logs need to be retained for 3 years in some form or location. In general the IVE requires storage capacity for storing data logs of several trips.
In-Vehicle Processing Requirements	Limited processing power required.

Final Report Action 4.1**Hazardous Goods Tracking**

Application	Tracking of vehicles carrying goods that can potentially harm citizens.
Legislation	<ul style="list-style-type: none"> • Directive 98/91/EC – motor vehicles and their trailers intended for the transport of dangerous goods by road • Council Directive 95/50/EC – uniform procedures for checks on the transport of dangerous goods by road • Directive 2008/68/EC – inland transport of dangerous goods.
Application Requirements	Registration of vehicles carrying dangerous goods, continuous reporting and logging of vehicle position, detection of violation of area or road access restrictions for vehicles with hazardous goods.
Governance and Certification	Road authorities.
Stakeholders, Organisational Framework	Drivers, vehicle operators, emergency services, road authorities and public authorities in charge of public health and the environment (all administrative levels).
Architecture Overview	An IVE registers, logs and reports the position and nature of the cargo of the vehicle to a central system of public authorities.
Modules and Functions	<ul style="list-style-type: none"> • Module for the continuous and secure monitoring of vehicle position. • Module for configuration of vehicle and cargo characteristics. • Module for reporting the data.
Sensor Requirements	Secure positioning
Interface Requirements	Depending on regulation and governance this may be an Interface for reporting traces to road authorities, and an interface for receiving access restrictions from road authorities. This can be an interface to a back office system or a roadside (co-operative) system.
Application Data Requirements	None. Descriptions of access restrictions would allow instant warning of drivers when violating an access area.
Application Communication Requirements	Depending on regulation and governance this may be offline reporting to real-time data communication.
Security Architecture	Depending on regulation and governance. Road authorities may demand position and cargo are protected from becoming public.
Data Storage Requirements	Depending on regulation and governance. Road authorities may demand position and cargo data is stored in a log.
In-Vehicle Processing Requirements	Only basic processing power is required.

Final Report Action 4.1**Access Restrictions**

Application	Informs and alerts drivers on vehicle weight, height and length restrictions on the road network.
Legislation	No EU policy, many member states have legislation in place.
Application Requirements	Provides accurate, up-to-date and reliable information on access restrictions.
Governance and Certification	National road authorities.
Stakeholders, Organisational Framework	Motorists, road authorities (all administrative levels).
Architecture Overview	Road authorities publish information on road restrictions. The information can be used by a central system or IVEs to calculate routes taking into account access restrictions. An IVE can present the route or access restriction information to the driver, or warn the driver when an incursion is imminent.
Modules and Functions	<ul style="list-style-type: none"> • Module for receiving restriction data from road authorities. • Module for the continuous and secure monitoring of vehicle position. • Module for configuration of vehicle characteristics. • Module for detecting potential restrictions on route. • Module to warn the driver.
Sensor Requirements	Secure and reliable positioning.
Interface Requirements	Interface to receive access restrictions from road authorities.
Application Data Requirements	Accurate, reliable and up-to-date information on access restrictions.
Application Communication Requirements	Intermittent updates of access restriction information.
Security Architecture	Not applicable.
Data Storage Requirements	Limited but sufficient to store all relevant access restrictions.
In-Vehicle Processing Requirements	Limited processing power required.

Final Report Action 4.1**Intelligent Truck Parking**

Application	Application that provides commercial vehicle drivers with information on parking facilities.
Legislation	Not applicable.
Application Requirements	Inform commercial vehicle drivers on availability, costs and time restrictions for their vehicle (and cargo) of parking facilities parking. Advanced parking services allow for reservation of parking spaces.
Governance and Certification	Road authorities and private parties determine the costs and time restrictions of parking facilities. The parking services are operated by private parties, no public governance or certification is in place.
Stakeholders, Organisational Framework	Drivers and operators of commercial vehicles, road authorities (all administrative levels, mainly local), car park operators.
Architecture Overview	Information is provided by back office systems of car park operators, and presented in-vehicle.
Modules and Functions	<ul style="list-style-type: none"> • Module for storing static data • Data communication module for receiving dynamic data • HMI for presenting the information.
Sensor Requirements	Not applicable.
Interface Requirements	Standardised interface to back office systems.
Application Data Requirements	Static information on geographic location, parking fee scheme, time and vehicle restrictions, available payment methods, and car park facilities. And dynamic information on occupancy status and trend.
Application Communication Requirements	Data casting from back office to vehicles. For reservation services two-way data communication is required.
Security Architecture	Encryption of data to protect IPR on data. For reservation vehicle or user authentication, secure data communication, and a secure payment service is required.
Data Storage Requirements	Storage of static parking information. For reservations systems secure storage of ID and account details is required.
In-Vehicle Processing Requirements	Only limited processing power required.

Final Report Action 4.1**Cargo Monitoring**

Application	Application for the monitoring of specific cargo parameters to guarantee cargo quality.
Legislation	Not applicable.
Application Requirements	The application registers and logs information from cargo sensors, and reports the information to the driver, vehicle operator, cargo handler, supplier and/or receiver.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Driver, vehicle operator, cargo handler, supplier and/or receiver.
Architecture Overview	Sensor continuously record cargo parameters, an in-vehicle unit processes the parameters and presents information to the driver and/or reports the information to on-shore information systems.
Modules and Functions	<ul style="list-style-type: none"> • Module for the continuous and secure monitoring of cargo parameters. • Module for processing the data • HMI • Module for reporting the data to on-shore information systems
Sensor Requirements	Depending on the type of cargo; in general reliable registration of temperature, humidity, etc.
Interface Requirements	Optional interface to on-shore systems
Application Data Requirements	Not applicable.
Application Communication Requirements	Offline or online reporting of data.
Security Architecture	Not applicable.
Data Storage Requirements	Depends on requirements of cargo supplier, handler and receiver.
In-Vehicle Processing Requirements	Limited processing power required.

Final Report Action 4.1**Fleet Management**

Application	Enables the vehicle owner and/or operator to manage the movement of vehicle in their fleet, thus improving efficiency and reducing overall transportation costs.
Legislation	No legislation in place.
Application Requirements	The application provides the fleet operator with an overview of the position of the fleet vehicles. Based on this information the operator can dispatch vehicles to perform certain tasks.
Governance and Certification	Not applicable
Stakeholders, Organisational Framework	Vehicle driver, fleet operator, customers.
Architecture Overview	An in-vehicle device reads GNSS data and continuously sends the position data to a central system. The central system can send tasks to the individual vehicles.
Modules and Functions	<ul style="list-style-type: none"> • Module for determining the vehicles position • Module for the continuous reporting of the vehicle position to the central system. • Module for receiving and processing tasks from the central system. • Module for presenting tasks to the driver.
Sensor Requirements	Positioning device.
Interface Requirements	Interface to the central system.
Application Data Requirements	In general fleet management systems will use road network data to allow the IVE to plan routes.
Application Communication Requirements	Continuous connection between the vehicle and central system.
Security Architecture	Depending on the requirements of the fleet operator data communication and data storage might require encryption.
Data Storage Requirements	In case road network data needs to be stored in the vehicle, the data store needs to be substantially large to accommodate this.
In-Vehicle Processing Requirements	Limited in case the IVE is not used to plan routes, or to navigate the driver. Else required processing is high.

Final Report Action 4.1**eCall**

Application	Manual or automatic reporting of collision time, location and vehicle description to emergency services.
Legislation	<ul style="list-style-type: none"> • 4th eSafety Communication: 'eCall: Time for Deployment' (August 2009) • Commission Communication: Towards Europe-wide Safer, Cleaner and Efficient Mobility: The First Intelligent Car Report (September 2007) • 3rd eSafety Communication: Bringing eCall back on track (November 2006) • eCall Factsheet • 2nd eSafety Communication - Bringing eCall to Citizens • The introduction of a single EU emergency call number (91_396_EEC) • Universal Service Directive 2002-22-EC • Directive on Privacy and Electronic Communications 2002-58-EC • European Road safety Action Programme C(2003) 311 - Final • ICT for Safe and Intelligent Vehicles C(2003) 542 - Final • Location-enhanced Emergency Call C(2003) 2657 - Final <p>Working document on data protection and privacy implications in eCall initiative adopted on 26 September 2006.</p>
Application Requirements	Immediate reporting of airbag deployment or panic button push to 112, specifying at least time, location and vehicle description.
Governance and Certification	Governed by the Driving Group eCall of eSafety, standards mainly developed by 3GPP, no certification required.
Stakeholders, Organisational Framework	Motorists, emergency services, road authorities (all administrative levels).
Architecture Overview	In-vehicle "blackbox" reports to back office systems of emergency services.
Modules and Functions	<ul style="list-style-type: none"> • Positioning module • CAN Interface • Data communication module • HMI
Sensor Requirements	Airbag deployment (CAN-bus), secure positioning, panic button.
Interface Requirements	Standardised CAN-bus and reporting interface.
Application Data Requirements	No static data required.
Application Communication Requirements	Instant reporting of airbag deployment or panic button push.
Security Architecture	Not applicable.
Data Storage Requirements	Not applicable.
In-Vehicle Processing Requirements	Basic processing required, device needs to be shock proof.

Final Report Action 4.1**EETS**

Application	Interoperable electronic road toll application. Both heavy and light vehicle road users subscribe to a single contract with an EETS provider that will process all charges.
Legislation	<ul style="list-style-type: none"> • Directive 2004/52/EC – interoperability of electronic road toll systems in the community • Commission Decision 2009/750/EC – definition of the European Electronic Toll Service (EETS) and its technical elements • Directive 95/46/EC – protection of individuals with regard to the processing of personal data and on the free movement of such data • Directive 2002/58/EC – processing of personal data and the protection of privacy in the electronic communications sector
Application Requirements	<ul style="list-style-type: none"> • Reporting usage of taxable road segments • Storage and reporting of charging data.
Governance and Certification	EC, member states, local regulatory authorities.
Stakeholders, Organisational Framework	Motorists, service provider, road operators, road authorities (all administrative levels).
Architecture Overview	
Modules and Functions	
Sensor Requirements	Secure positioning, auxiliary movement detection.
Interface Requirements	Microwave technology (DSRC, based on both EN1 5509 and ETS ES 200674-1), and/or mobile communications (GSM-GPRS).
Application Data Requirements	Location, distance, identification
Application Communication Requirements	GSM/GPRS and/or DSRC.
Security Architecture	EETS protects users against fraud. Data stored, handled and transferred between stakeholders in the EETS environment shall be protected and secure.
Data Storage Requirements	
In-Vehicle Processing Requirements	

Final Report Action 4.1**Intelligent Speed Advice**

Application	
Legislation	Not applicable.
Application Requirements	Correct indication of, or adaptation to, the speed limit in force.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Motorists, map data suppliers, road authorities (all administrative levels).
Architecture Overview	The back office system of road authorities provides the speed enforcement data. The in-vehicle unit autonomously and continuously compares the vehicle speed with the speed limit and advises the driver or automatically adapts the vehicle speed.
Modules and Functions	<ul style="list-style-type: none"> • Module for the continuous and secure monitoring of the vehicle speed. • Module for determining the applicable speed limit. • Module for determining the appropriate action • HMI.
Sensor Requirements	Secure positioning and vehicle speed monitoring.
Interface Requirements	Standardised interface for receiving speed limit data from road authorities. This can be an interface to a back office system or a roadside (co-operative) system.
Application Data Requirements	Accurate map data for unambiguous determination of the exact vehicle position (carriageway) on the road network.
Application Communication Requirements	Intermittent road network updates, or continuous on roadside updates.
Security Architecture	Not applicable.
Data Storage Requirements	Permanent data storage for road network data.
In-Vehicle Processing Requirements	High-speed processing, limited footprint.

Final Report Action 4.1**Safety Information**

Application	Black spots, speed limits, sharp corners, road conditions.
Legislation	Not applicable.
Application Requirements	Warns motorists for unsafe driving conditions.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Motorists, road authorities.
Architecture Overview	Data is supplied by road authorities and meteorological organisations, and presented to the driver by the IVE.
Modules and Functions	Data communication module for receiving regular updates. HMI for presenting the information to the driver.
Sensor Requirements	Positioning.
Interface Requirements	Standardised interface to road authorities for receiving the data.
Application Data Requirements	Complete and accurate information, regularly updated.
Application Communication Requirements	Regular updates (off-/online) for static data, continuous updates for road conditions.
Security Architecture	Not applicable.
Data Storage Requirements	No specific requirements.
In-Vehicle Processing Requirements	Limited.

Final Report Action 4.1**Adaptive Cruise Control**

Application	Adaptive cruise control and eco-drive assistance.
Legislation	Not applicable.
Application Requirements	Reliable adaptation of vehicle speed based on forward proximity.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Motorists, car manufacturers.
Architecture Overview	Adaptive cruise control works autonomously.
Modules and Functions	<ul style="list-style-type: none"> • Module for the continuous and secure monitoring of the vehicle speed. • Module for the continuous and secure determination of the distance to the vehicle (or obstacle) in front of the vehicle. • Module for determining the appropriate action • HMI.
Sensor Requirements	Secure and continuous forward proximity and vehicle speed monitoring.
Interface Requirements	Not applicable.
Application Data Requirements	Not applicable.
Application Communication Requirements	Not applicable.
Security Architecture	Not applicable.
Data Storage Requirements	Not applicable.
In-Vehicle Processing Requirements	High-speed processing, limited footprint.

Final Report Action 4.1**Navigation**

Application	Application that allows driver to plan routes and then guides the driver to the destination.
Legislation	Not applicable.
Application Requirements	Reliable route planning and guidance.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Motorists, map data suppliers, navigation providers, road authorities (all administrative levels).
Architecture Overview	Based on the vehicles position, destination and map data the route is planned and guidance carried out. The map data and route planning software can either be stored in the device (on-board navigation) or in a back office system (off-board navigation).
Modules and Functions	<ul style="list-style-type: none"> • Module for the continuous monitoring of the vehicle's position and speed. • Module for route planning. • Data store for map data. • Module generating guidance instructions. • HMI.
Sensor Requirements	Continuous monitoring of position and speed.
Interface Requirements	Interface for updating map data.
Application Data Requirements	Accurate road network topology and attributes.
Application Communication Requirements	Not applicable.
Security Architecture	In case of on-board navigation map data encryption for IPR protection.
Data Storage Requirements	In case of on-board navigation high-volume data store providing fast read access.
In-Vehicle Processing Requirements	High-speed (graphic) processing.

Final Report Action 4.1**Traffic Information**

Application	Traffic incidents and status information (e.g. travel time (prediction)).
Legislation	Not applicable.
Application Requirements	Real-time representation of traffic information relevant to the driver.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Motorists, road authorities (all administrative levels).
Architecture Overview	Information is collected through various traffic monitoring systems and distributed to in-vehicles units through RDS-TMC, mobile internet or other channels.
Modules and Functions	<ul style="list-style-type: none"> • Module for the continuous monitoring of the vehicle's position. • Data store for map data. • HMI
Sensor Requirements	Continuous monitoring of position.
Interface Requirements	Standardised interface to back office system providing the traffic information with unambiguous location reference, e.g. RDS/TMC, TPEG.
Application Data Requirements	Accurate location reference data, or road network topology data for unambiguous location referencing.
Application Communication Requirements	Datacasting from back office to vehicles. Intermittent location data updates.
Security Architecture	Map data encryption for IPR protection. In case of paid services, authentication and payment services are required.
Data Storage Requirements	Data store providing fast read access.
In-Vehicle Processing Requirements	Depending on the HMI requirements.

Final Report Action 4.1**Payment Services**

Application	Services that allow driver to carry out financial transaction from their vehicle.
Legislation	<ul style="list-style-type: none"> • Regulation (EC) No 924/2009 – Cross-border payments in the Community • Decision 2009/72/EC – Payment Systems Market Expert Group (PSMEG) • Directive 2007/64/EC – Payment services in the internal market • Regulation (EC) No 1781/2006 – Information on the payer accompanying transfers of funds • Directive 2000/46/EC – Electronic money institutions • Directive 2000/28/EC – Credit institutions • Directive 98/26/EC – Settlement finality in payment and securities systems
Application Requirements	Secure financial transactions for the payment of in-vehicle services, toll, etc.
Governance and Certification	National banks of member states.
Stakeholders, Organisational Framework	Motorists, service providers, financial service providers (banks, credit card companies, etc.).
Architecture Overview	The system's architecture will depend on the nature of the transaction system (e.g. debit versus credit). In general an on-board unit will provide identification with which it can perform financial transaction with a financial service provider. The financial service provider will carry out authentication and will then authorise the service provider.
Modules and Functions	<ul style="list-style-type: none"> • Module for secure identification • Data communication module (off-/online) • HMI
Sensor Requirements	Not applicable.
Interface Requirements	Standardised interface between financial service provider and the on-board unit, and between the financial service provider and service providers.
Application Data Requirements	Not applicable.
Application Communication Requirements	Secure communication, online for mobile transactions.
Security Architecture	Secure and upgradable encryption of account data. Secure data communication.
Data Storage Requirements	Secure encrypted storage.
In-Vehicle Processing Requirements	Limited.

Final Report Action 4.1**Local Information**

Application	Information on retail and business nearby.
Legislation	Not applicable.
Application Requirements	Completeness of data.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Motorists, business and retail.
Architecture Overview	Private parties collect and distribute information.
Modules and Functions	Module for storing data, HMI.
Sensor Requirements	Positioning.
Interface Requirements	Not applicable.
Application Data Requirements	Complete set of locations, extensive set of attributes.
Application Communication Requirements	Intermittent updates, limited bandwidth.
Security Architecture	Encryption of data for IPR protection.
Data Storage Requirements	Permanent data storage.
In-Vehicle Processing Requirements	Limited.

Final Report Action 4.1**Co-Operative Systems and Services**

Application	Services that combine information from vehicles, road and traffic monitoring equipment to optimise safe traffic flow. These include in-vehicle signage, intersection management, lane change assistance and traffic light optional speed advice.
Legislation	No legislation is in place.
Application Requirements	Co-operative systems provide a framework for the implementation of a wide range of new applications, and the enhancement of existing applications. In general the applications should enhance safer driving and increased traffic flux.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Co-operative systems by nature involve many stakeholders, these include at least the motorists and road authorities (at all administrative levels) but in general will also include car manufacturers, suppliers of roadside systems, map data suppliers, navigation providers, and map data companies.
Architecture Overview	In co-operative systems information is exchanged from vehicle to vehicle, and between vehicles and roadside systems.
Modules and Functions	<p>Co-operative systems will allow for road operators to influence in-vehicle systems with traffic management directives and advices, and will enhance existing safety applications.</p> <p>Traffic management functions:</p> <ul style="list-style-type: none"> • Lane banning, auxiliary lane accessibility • Navigation recommendations • In-vehicle variable speed limit information • Speed adaptation <p>Safety enhancements:</p> <ul style="list-style-type: none"> • Lane keeping assistance • Improved accident/incident warning (Including wrong-way driver information) • Improved road condition warning (Ice Road Warning, Fog Warning) • Improved congestion warning <p>In vehicle modules required for co-operative systems:</p> <ul style="list-style-type: none"> • Modules processing sensor data • Module for processing data from other vehicles • Module for processing infrastructure data • Module for probabilistic/heuristic interpretation of (contradicting) data • Data communication module • HMI
Sensor Requirements	<ul style="list-style-type: none"> • Secure and high frequency position measurement, preferably augmented with high frequency speed or acceleration measurement and relative beacon positioning • Continuous proximity measurements • Continuous CAN data
Interface Requirements	Interface with nearby vehicles and road infrastructure systems.
Application Data Requirements	Road network topology, sensor data.
Application Communication Requirements	Continuous duplex data communication between vehicles and between vehicles and information systems on-shore.
Security Architecture	Secure but anonymous data communication.

Final Report Action 4.1

Data Storage Requirements	Network topology, advisory and regulatory measures.
In-Vehicle Processing Requirements	High-speed processing.

Final Report Action 4.1**Parking Information**

Application	Application that informs drivers on parking facilities.
Legislation	Not applicable.
Application Requirements	Inform motorists on availability, costs and time restrictions of parking facilities and on-street parking. Advanced parking services allow for reservation of parking spaces.
Governance and Certification	Road authorities and private parties determine the costs and time restrictions of parking facilities. The parking services are operated by private parties, no public governance or certification is in place.
Stakeholders, Organisational Framework	Motorists, road authorities (all administrative levels, mainly local), car park operators.
Architecture Overview	Information is provided by back office systems of car park operators and road authorities, and presented in-vehicle.
Modules and Functions	Module for storing static data, data communication module for receiving dynamic data, HMI for presenting the information.
Sensor Requirements	Not applicable.
Interface Requirements	Standardised interface to back office systems.
Application Data Requirements	Static information on geographic location, parking fee scheme, time and vehicle restrictions, available payment methods, and car park facilities. And dynamic information on occupancy status and trend.
Application Communication Requirements	Data casting from back office to vehicles. For reservation services two-way data communication is required.
Security Architecture	Encryption of data to protect IPR on data. For reservation vehicle or user authentication, secure data communication, and a secure payment service is required.
Data Storage Requirements	Storage of static parking information. For reservations systems secure storage of ID and account details is required.
In-Vehicle Processing Requirements	Only limited processing power required.

Final Report Action 4.1**Pay-as-You-Drive Insurance**

Application	Application that allows insurance companies to base the insurance fee on driving characteristics.
Legislation	Not applicable.
Application Requirements	Registers driving behaviour and reports traffic regulation incursions.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Motorists, insurance companies, road authorities.
Architecture Overview	Road authorities provide traffic regulations, the OBE reports incursions to the driver and insurance companies.
Modules and Functions	A data communication module for receiving the regulatory information, and reporting incursions. Module that determines incursions. HMI for presenting the information.
Sensor Requirements	Positioning, speed.
Interface Requirements	Standardised interface to road authorities and insurance companies.
Application Data Requirements	Accurate regulations data mapped to the road network.
Application Communication Requirements	Intermittent updates and reporting.
Security Architecture	Reports need to be encrypted and authenticated.
Data Storage Requirements	Secure data store for temporary logging of incursions.
In-Vehicle Processing Requirements	Limited.

Final Report Action 4.1**Infotainment**

Application	Application that provide information to drivers and/or passenger that is not mandatory or safety related.
Legislation	Not applicable.
Application Requirements	Depends on type of service.
Governance and Certification	Not applicable.
Stakeholders, Organisational Framework	Motorists, service providers
Architecture Overview	Depends on the type of service.
Modules and Functions	Depends on the type of service.
Sensor Requirements	Not applicable.
Interface Requirements	Depends on the type of service.
Application Data Requirements	Depends on the type of service.
Application Communication Requirements	Depends on the type of service.
Security Architecture	Data encryption for protecting IPR.
Data Storage Requirements	Depends on the type of service.
In-Vehicle Processing Requirements	Depends on the type of service.

Annex 3: Terms & Definitions

Commercial Vehicles / Private Vehicles

In the European Union the classifications for vehicle types are defined by:

- Commission Directive 2001/116/EC of 20 December 2001, adapting to technical progress Council Directive 70/156/EEC on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers
- Directive 2002/24/EC of the European Parliament and of the Council of 18 March 2002 relating to the type-approval of two or three-wheeled motor vehicles and repealing Council Directive 92/61/EEC

A Commercial Vehicle is defined as any motorised road vehicle which by its type of construction and equipment is designed for, and capable of, transporting, whether for payment or not:

1. more than nine persons, including the driver;
2. goods;

Platform

There exist ambiguous definitions for the term platform. A computing platform, for example, describes some sort of hardware architecture and software framework, where as the term platform in general describes more an organisational structure. In this report, the single term *platform* is used for the overall arrangement that, besides the technical components, also includes business architecture, governance, security, certification regime, specification and further aspects. In cases, where actually the technical framework is meant only, it is referred to as *computing platform*.

List of Abbreviations

API	Application Programming Interface
CALM	Communications Access for Land Mobiles
CEN	European Committee for Standardization
CESARE	Common Electronic Fee Collection System for a Road Tolling European Service
CI	Communications Interface
CN	Cellular Network
COOPERS	Cooperative Systems for Intelligent Road Safety
CVIS	Cooperative Vehicle Infrastructure Systems
DSRC	Dedicated Short Range Communication
EC	European Commission
eCall	Emergency Call
EETS	European Electronic Toll Service
EFC	Electronic Fee Collection
ETSI	European Telecommunications Standards Institute
EU	European Union
GNSS	Global Navigations Satellite System
GSC	GNSS-enabled Services Convergence
GST	Global System for Telematics
GPRS	General Packet Radio Service. A GSM data transmission technique that transmits and receives data in packets.
GPS	Global Positioning System
GSM	Global System for Mobile communication. A European digital standard for mobile or cellular telephony.
HMI	Human Machine Interface
IPv6	Internet Protocol version 6
ISO	International Organization for Standardisation
ITS	Intelligent Transport System
IVE	In-Vehicle Equipment
MSD	Minimum Set of Data
OBU	On-Board Unit
SP	Service Provider
TC	Toll Charger
VANET	Vehicular Ad-hoc Network
VAS	Value Added Services

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