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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Human Factors (HF).

Intended readers of the present document are:

- manufacturers of vehicles and their suppliers;
- manufacturers of after-market equipment intended for use in the vehicle;
- ITS service providers;
- mobile network operators;
- developers of equipment communicating with in-vehicle networks;
- suppliers of other services and devices that may be used in a vehicle;
- mobile communication device manufacturers;
- road administrations;
- road operators;
- insurance companies;
- European Research and Development projects.

Introduction

Whilst driving, the driver needs to focus on multiple tasks. This leads to varying levels of concentration and particularly a lower level of visual attention and ability. The present document highlights the potential dangers of driver distraction and the consequential impact that this can have on road safety. The present document also considers the use of ICT by passengers and of ICT jointly used by drivers and passengers.

The state of the art in the area has been studied, including the "European Statement of Principles on the Design of Human Machine Interaction, European Commission, 2006 (ESoP)" [i.21] which is currently being implemented by car manufacturers. Whereas the focus is on the users' needs and applications in this area, the present document identifies potential possibilities and any limitation(s) of technical solutions and, where appropriate, provides examples of the application of the ESoP and suggests future actions in order to open up new service opportunities.

1 Scope

The present document identifies the key aspects of use of ICT in cars and provides advice on safer and more effective use. Both the driver's and the passenger's requirements are examined. Factors relating to the safe use of ICT and to the personalization of the user experience are identified.

Issues with services and devices related to both the driver and passengers are addressed, including devices which are:

- mounted rigidly in the vehicle, either fitted during manufacture or later (e.g. for navigation, entertainment, games, emergency assistance services);
- communicating with the in-vehicle network e.g. for connecting phones, navigation equipment;
- portable equipment used in the vehicle.

Those aspects of ICT in cars with which the car user has no involvement are outside the scope of the present document. Also excluded from the scope are special functions designed exclusively for use in taxis or cars used as emergency service vehicles.

The approach taken in the present document is compatible with the European Statement of Principles on the Design of Human Machine Interaction [i.21].

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
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2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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[i.3] ETSI TS 102 747: "Human Factors (HF); Personalization and User Profile Management; Architectural Framework".

[i.4] ETSI EG 202 421: "Human Factors (HF); Multicultural and language aspects of multimedia communications".

[i.5] ETSI ES 202 076: "Human Factors (HF); User Interfaces; Generic spoken command vocabulary for ICT devices and services".

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[i.16] ISO/EN 15005: "Road vehicles - Ergonomic aspects of transport information and control systems - Dialogue management principles and compliance procedures".

[i.17] ISO/EN 15006: "Road vehicles - Ergonomic aspects of transport information and control systems - Specifications and compliance procedures for in-vehicle auditory presentation".

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[i.19] ISO 11429: "Ergonomics - System of auditory and visual danger and information signals".

[i.20] ISO 17287: "Road vehicles - Ergonomic aspects of transport information and control systems - Procedure for assessing suitability for use while driving".

[i.21] European Commission (2006): "European Statement of Principles on the Design of Human Machine Interaction".

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[i.24] Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications).

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3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

accessibility: ensuring that all sectors of the community have equal access to communications and online information

Advanced Driver Assistance System (ADAS): "interacting" with the driver with the main purpose of supporting the driving task on the tracking and regulating levels

car: vehicle with three or more (and most commonly four) wheels that has its own onboard means of propulsion (rather than being moved by another vehicle or animal) moving primarily on roads, that has seating for one to eight people and is constructed principally for the transport of people rather than goods

feedback: information presented to users that relates to an action that the user has requested

primary driving task: activities that the driver has to undertake while driving in navigating, manoeuvring and handling a vehicle including steering, braking and accelerating

profile: total set of user related information, preferences, rules and settings which affects the way in which a user experiences terminals, devices and services

NOTE: The use of the word profile in the present document implies user profile unless otherwise stated.

secondary task: all interaction tasks undertaken by the driver that are not primary tasks

usability: extent to which a product can be used by specific users to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use

user: person using ICT services

user profile: see profile

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ABS	Anti-lock Braking System
ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance System
AIDE	Adaptive Integrated Driver-vehicle InterfacE
ARV	Application Request Vector
AU	Application and Control Unit
CALM	Communications Access for Land Mobiles
CCAS	Car Collision Avoidance System
CCTV	Closed-Circuit Television
CCU	Communication and Control Unit
CSV	Channel Status Vector
DIM	Driver Impairment Monitoring
DVE	Driver-Vehicle-Environment
DVEM	Driver Vehicle Environment Monitoring
GPL	Liquefied Petroleum Gas
GPS	Global Positioning System
HMI	Human Machine Interaction
HUD	Head-Up Display
ICA	Interaction and Communication Assistant
ICE	In-Car Entertainment
ICT	Information and Communication Technology
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISA	Intelligent Speed Adaptation
ITS	Intelligent Transport Systems
IVIS	In-Vehicle Information and Communication System
MPH	Miles Per Hour
MSD	Minimum Set of Data
PDA	Personal Data Assistant
PM	Profile Management
PSAP	Public Safety Answering Point
RNV	Request No More Valid Vector
RV	Reply Vector
TICS	Transport Information and Control System
V2X	Vehicle to Vehicle or/and to road Infrastructure
VMS	Variable Message Signs

4 Background

4.1 What is "ICT in cars"?

"ICT in cars" can be simply and broadly defined as information and communication equipment and related services which are used within the car environment. The present document focuses on where ICT in cars interacts with the car occupants. This definition includes the impact of both Intelligent Transport Systems (ITS) and pure entertainment systems such as radio, music and video on the driver and passengers.

Those ITS services whose operation does not require a direct interaction with the driver or passengers will not be considered in the present document.

4.2 Previous work on ICT in cars

Significant research work that considers how ICT in cars impacts on the drivers and passenger has been carried out over a number of years in research projects and by in-house work from vehicle manufacturers and road transport testing laboratories. Much of this work has been undertaken in European research projects, see annex B. The European Commission has paid particular attention to ensuring that the best research findings were analysed and discussed, and the outcome of this programme has been incorporated into the "European Statement of Principles on the Design of Human Machine Interaction", which was first produced in 1999 [i.22] and significantly updated and enhanced in 2006 [i.21]. A detailed analysis has been made of existing ITS projects (National and European) and also of the work of Consortiums/Organizations/Institutes working in the ITS related area, and the high-level observations on what work may be relevant to the context of the present document are contained in annex B.

The present document fully reflects the importance of this Statement of Principles by making significant references to it in all those parts of the document where the fundamental best practice requirements for the Human Factors (HF) are discussed.

The ETSI Human Factors work on personalization [i.1] can be useful for meeting the specific needs and requirements of the individuals such as preferred language [i.4]. Further details on personalization are given in clause 10. The ETSI Human Factors work on voice commands [i.5] is relevant for use in secondary tasks, where spoken input will allow the visual focus of the driver to remain on the primary driving tasks. Further details on voice commands are given in clause 7.2.2.

In addition to the work referred to above, much work on ITS services has taken place in the standards bodies ISO and ETSI. Most of this work has not yet reached the marketplace and some of which have had little or no experimental trials of any kind. Although the focus of the ETSI work on ITS is on the communication system there was a need to define a set of applications [i.7] comprising, road safety use case, traffic efficiency, other applications (e.g. stolen vehicle, tourist information, parking) to assess the functional requirements for communications. A comprehensive history of the development of ITS services is contained in annex C.

4.3 Major achievements during the last ten years and identified problems

Major achievements during the last ten years:

- improved display technologies that allow a more flexible, dynamic and adaptable dashboard;
- haptic devices have become available, providing new channels to give feedback to the driver;
- speech input lowers driver's distraction when commanding the vehicle or its options (e.g. navigation devices, radios or mobile phones) compared to the usual control involving hand-eye co-ordination;
- better understanding of human factors (e.g. prioritising of tasks).

Major problems, now and in coming ten years:

- the availability of new services and devices (onboard and nomadic) are driving towards increased complexity of the driver's environment;
- despite the potential to bring safety benefits (e.g. from the use of navigation systems), nomadic devices could also increase safety risks (e.g. by masking important warnings from safety systems), unless integrated into the in-car human interaction environment.

5 Driver interactions

5.1 Introduction

Although at a conscious level drivers are frequently focussed on the very simple aim, to get to where they intend to go, there are a number of complex behavioural tasks taking place at varying levels of awareness as the journey takes place. This also shows that the driver has a number of potentially competing issues to deal with whilst driving, e.g.:

- issues related to the immediate task of controlling the car;
- awareness of the immediate environment (including other road users, road signs, etc.);
- issues related to the long-term goal of the journey.

Certainly in driving, the driver needs to be aware of and frequently needs to interact with many different things apart from the car itself. In fact the drivers' ability to maintain an appropriate level of awareness is a fundamental issue in relation to road safety.

5.2 Interaction with the car and passengers

In all cases the driver has to interact with the car controls and displays in order to perform the primary driving task. The ergonomics of car driving and the analysis of driver behaviour with regard to the tasks directly related to controlling the vehicle are well researched and industry has many sources of information to help them to optimise this environment for the driver.

The driver may also interact with passengers in the car which may make the journey more enjoyable, reduce drowsiness, but may also distract the driver from the driving task. In general, the interaction between multiple passengers in a car is another factor that may affect the driver. The nature of the interaction can have a significant effect on the performance of the driver. Pleasant conversation between passengers, that may or may not involve the driver, may slightly distract the driver from the driving task. However, arguments and shouting can easily stress the driver and this can quickly lead to a marked deterioration in the driver's performance.

Although all interaction with passengers will have a negative impact on visual attention, there is a general positive effect of the presence of passengers in a car as they influence the driver's behaviour towards more cautious and thus safer driving behaviour [i.47], but for younger drivers the risk of accidents increases especially as the number of passengers increases [i.48].

In some cases, such as when there are children in the car who may distract the driver very much, in-car entertainment services such as video, games, music may be useful to keep the children busy and thus allow the driver to concentrate better. It is necessary to design those entertainment services for passengers in a way that they do not interfere with the driving task or that the interference is kept to a minimum and avoided in critical situations.

In general, the interaction between humans in a car is outside the scope of ICT in cars, but there is an unresolved research issue related to whether driver assistance systems may require alternative support options when passengers are present.

5.3 Interaction with the immediate environment

Another important part of the driving task is awareness of the immediate local environment including awareness of other road users. Drivers need to develop strategies to ensure that the vehicle is driven safely in the context of the immediate environment.

The environment includes:

- traffic signs;
- road characteristics;
- traffic conditions including presence of vehicles, pedestrians and obstacles;

- weather conditions (e.g. fog affecting visibility, road friction due to snow and ice).

5.4 Interaction with the planned route

Arriving at a destination is usually the ultimate goal of a particular journey. Therefore following a suitable route to arrive at that destination is the plan to achieve that objective. What is suitable may depend on the time available and the preferences of the driver and passengers at any particular time. Frequently people may choose the fastest route to get to their destination but they may sometimes choose the shortest route (perhaps saving fuel costs) or instead chose a particularly beautiful route. Part of the task of following the planned route involves paying attention to the instructions from navigation systems and reading and responding to the directions shown on road signs.

6 Human performance issues

6.1 Fundamental issues

A most comprehensive and thorough analysis of research in the field of human performance in the in-car environment has been undertaken within Europe and the overall findings have been distilled into the European Statement of Principles on the Design of Human Machine Interaction [i.21], referred to as ESoP. Most fundamental are the overall design principles:

- Design goal I: The system supports the driver and does not give rise to potentially hazardous behaviour by the driver or other road users.
- Design goal II: The allocation of driver attention while interacting with system displays and controls remains compatible with the attentional demand of the driving situation.
- Design goal III: The system does not distract or visually entertain the driver.
- Design goal IV: The system does not present information to the driver which results in potentially hazardous behaviour by the driver or other road users.
- Design goal V: Interfaces and interface with systems intended to be used in combination by the driver while the vehicle is in motion are consistent and compatible.

The ESoP contains a set of 5 installation principles. These principles are being interpreted and turned into specific rules for how and where products are mounted in the car by motor manufacturers and the producers of all categories of device that may be expected to be mounted in cars, with activity being focussed within the work of the Nomadic Device Forum [i.26]. There are no additional insights into this highly specialized area that can be contributed from the present document.

The ESoP also provides recommendations on influencing use, many of which relate to the obligations of employers to their customers and employees. One recommendation on influencing use is number VIII which states that: "Vehicle hire companies should ensure that a copy of the manufacturer's instructions for use is available in every equipped vehicle". This is further addressed in clause 6.7.1 of the present document.

All the other principles of ESoP are addressed in clauses 6 and 7 of the present document. In the following clauses some significant aspects of human performance that are particularly relevant to the in-car environment are mentioned.

6.2 Vision

Most of what drivers see is memorized as the eye continuously samples important parts of the visual environment and updates this memorized total picture. In situations where there is a lot of visual input and where there is a need to quickly react to events this mismatch between what drivers think they see and what their eyes are actually viewing at a particular instant can be the cause of some failures to correctly assess the visual environment.

Despite the above, it is possible to effectively monitor multiple information sources in parallel in normal situations that do not compete too severely with the attention switching that actually takes place when drivers believe they are multi-tasking.

6.3 Hearing

What can be heard will be very dependent on the overall auditory environment. In noisy situations it may be difficult to detect new sounds or to correctly hear spoken output. Hearing is an essentially serial output channel, so that simultaneous presentation of information from two sources via the auditory channel may result in neither being correctly understood.

6.4 Physical performance

Many tasks performed in a car by the driver are well learned and can be performed with little or no conscious effort. Because these tasks are so well learned, they place very little cognitive load on the driver in most normal conditions, allowing the driver to concentrate on the other aspects of the driving task.

6.5 Hand-eye co-ordination

Hand-eye co-ordination is often utilised as a means to perform precise control tasks, where the results of manipulating a control device with the hand can be continuously monitored in real time by observing visual feedback of the results of the control actions. Control mechanisms requiring hand-eye co-ordination are very common on products not designed for in car usage. Such mechanisms are particularly suitable for tasks such as selecting items from long menus and lists. However, when considered in the context of in-car usage, selection mechanisms that heavily rely on hand-eye co-ordination can be argued to conflict with four of the ESoP interaction with displays and controls principles (II to V) that are listed in clause 7.1. Such tasks can also easily be argued to be "unsuitable for use when driving" when the standard criteria for judging this suitability [i.20] are applied i.e. such tasks require high levels of glance duration and frequency that are explicitly highlighted as key criteria for unsuitability in [i.20].

6.6 Attention and distraction

Driving a car requires a consistently high level of attention. At its least serious, inattention can cause the driver to miss critical points on the route and take a wrong direction. A very real and much more serious outcome of even very momentary inattention can be a serious and possibly fatal accident. So it is important that the fundamentals of human attention are taken into account in the design and assessment of ICT in cars.

Most people believe that they are very effective at multitasking and therefore feel confident in simultaneously writing a document whilst monitoring the status of their e-mail inbox. However, the functioning of the human attention system is such that, for activities that require explicit attention, multitasking is actually frequent switching between tasks, with each task capturing the attention when it is switched to. A well accepted model that describes the process of such task switching is Posner and Peterson's model [i.55] which proposes three networks in the brain that deal with the switching of attention, the:

- alerting or arousal network - which is operating at all times and is on the lookout for things that may require attention;
- orienting network - which is alerted by the alerting network and directs the person's spatial attention to the event detected by the alerting network;
- executive network - which is the conscious part of the process that assumes command and begins to direct active attention to the new focus of attention.

In the most basic switching of tasks, four steps occur. These are:

- when a new event occurs, the alerting network detects an event that may require attention;
- the alerted brain then has to disengage the attention that is allocated to the current ongoing task;
- the brain then has to switch focus to the new task and identify the relevant brain processes to deal with such a task;
- the rules that apply to processing the new task are activated.

Some of these steps are themselves two-part operations and the overall time to switch attention can easily take half a second. The actual time taken to switch will vary between individuals, and there is certainly a bias towards faster switching for young adults and increasingly slow switching with age in older people. This latter factor is very significant in determining which ITS and other ICT services may assist older drivers to drive more safely.

When a driver attempts to multitask, the brain is regularly switching attention between two or more tasks. Whilst switching tasks and whilst focussed on a new task, the attention devoted to the original task is removed. There will be frequent switches between the common driver interactions described in clause 5, and this too will decrease driver performance. So, when drivers switch attention to the screen of their navigation system, the disruption of attention to the driving task will be greater than might be assumed by the length of the glance at the navigation screen, as while processing the implications of what is on the screen, the driver will not be fully attentive to the primary driving task. Similarly, when highly focussed on a complex driving situation (e.g. traffic), the lack of attention to the focus on following the pre-planned route may cause the driver to chose the wrong route.

In addition to the lapses in attention caused by switching between the different driver interactions of clause 5, there will be further problems related to switching of attention onto other non-driving related activities such as talking on the telephone, and controlling music players. There has been much research done on the effect that talking on a mobile phone has on driving behaviour, with comparisons that relate the decrease in driving performance to that associated with driving whilst drunk. Although there appear to be conflicts in some of the research that tries to assess the severity of the effects of talking on mobile phones, and comparing it to the effects due to talking to passengers, the overall conclusion from assessing these is that a common factor that determines the severity of the effect is the need to direct serious attention to the task of talking or phoning. So, whereas casual conversation with a passenger may appear to have little impact on the driver's performance, a technically challenging or emotionally charged conversation may be as disturbing to driving performance as any call made on a mobile phone.

One of the effects of the distraction of attention that has been frequently reported is a lack of an awareness of objects and events in the direct field of vision of the driver. So that a driver talking on a hands-free mobile phone may have their eyes looking directly at the road ahead and still fail to notice a pedestrian about to cross the road.

Situational awareness is "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" [i.49]. Thus, there are three levels of situation awareness, each of them implying different mental processes.

- Level 1 situation awareness is where we look and perceive basic information.
- Level 2 situation awareness is where we think about and understand the meanings of that information.
- Level 3 situation awareness is where we use the meanings in order to anticipate what will happen ahead in time and space.

In an experiment, [i.50] fifteen subjects were asked to drive on a driving simulator for 25 km on a single carriageway rural road with traffic in front of and behind them and on-coming vehicles. They were told to observe the speed limits and expect some severe weather conditions. They were asked a series of questions on a hands-free phone during the drive, and their reaction times, braking profiles, lateral position, speed, and situational awareness were measured. Reaction times were significantly slower during the early part of the phone conversations, but improved as the phone call proceeded. However, when using a mobile phone the drivers took an average of 200 metres longer to respond to a change in the speed limit. The simulation was stopped at various points and the drivers were asked questions about the traffic conditions. Using the mobile phone resulted in a significant deterioration of the drivers' awareness, to such an extent that they had very little awareness of what was happening on the road around them.

If a new task is presented in a different modality to the ongoing task, the disruption may be less serious than if it was in the same modality, however there is evidence that the disruption can still be quite significant. As a lapse of attention of half a second could result in the driver braking too late to avoid an accident, even this reduced disruption may be too much.

Given the above, it is important when analysing ICT in cars to look for solutions that avoid the driver having to switch their attention to something of low importance when it is important that they fully concentrate on safely driving to avoid any upcoming hazards. Approaches to this issue are discussed in clause 10.

Therefore, the following issues were identified in the AIDE project which might need to be addressed in a context of driver workload and distraction assessment methods and tools [i.29]:

- successful use of a system;
- misuse of a system;
- learning curve for new systems;
- system understanding by the driver;
- effects of the system on traffic in general (safety, density, etc.) according to penetration degree (e.g. dynamic navigation: what happens to alternative routes if every car is redirected?);
- effects of the system on the individual driving behaviour;
- portability of the use experience between different IVIS/ADAS categories, system limitations and/or system failures.

Because of the vital importance of maintaining a high attention level whilst driving, methods are being considered for detecting states when that attention level has temporarily lapsed or when the drivers' overall state will severely affect their ability to appropriately attend to the driving task. These methods include:

- Facial monitoring for detection of drowsiness and distraction.
  For example, a series of warnings are initiated if the system detects that the driver is not looking ahead for a few seconds, drowsiness detection monitors the driver's rate of eye blinking and/or when a pattern of long duration eye-lid closures is detected. The driver will receive a warning such as his seat cushion will vibrate. In other system variants, if an obstacle is detected, the car may automatically take other actions to minimise the risk or severity of an accident.
- Recognition system to assess driver capability to drive (e.g. alcohol, drugs).
  It is known that driving under the influence of drugs and/or alcohol makes drivers' over-confident about their skill and accuracy whilst these factors are actually dramatically decreased. This makes any driver who is under the influence of drugs or alcohol a serious hazard to themselves and other road users. Systems able to prevent the car from being used if the level of drugs or alcohol is above a predefined threshold are currently being developed.

6.7 Cognitive overload

In the environment of a car there is an increasing trend for more systems and devices to be present in the car. This includes systems that are traditionally always built into cars (e.g. radios and CD players) as well as those that are traditionally brought into the car as part of the drivers normal portable equipment (e.g. a mobile phone and an MP3 player). This latter category of devices is usually referred to as "Nomadic Devices" in the automotive sector.

As well as the risks of the driver's attention being distracted by trying to control, watch, or listen to such devices, there is another risk that the driver may reach a level of cognitive overload from having to try to makes sense of (to process) the range of competing and un co-ordinated warnings and feedback messages that are being generated by such systems.

Unaided, drivers will rapidly reach a level where these competing demands from systems within the car will begin to adversely affect their ability to fully perform the primary driving task. Solutions to minimise such risks are discussed in clauses 8 and 10.

6.7.1 Learning and behavioural adaptations to new driver support systems

Ideally, services should be so easy and intuitive to use that manuals are not needed. However, manuals may sometimes be useful. EG 202 417 [i.6] provides guidelines for the development, presentation, and evaluation of user education such as paper-based user guides or digital help systems for mobile terminals and services.

6.8 Trust, reliability and accuracy

6.8.1 Sufficient reliance on support systems

If services or car systems are to fully deliver their intended benefits, it is important that they are trusted by the driver (and passengers). If a service or system is not trusted by drivers and passengers then they may either fail to use, ignore or not believe the service or system. Reliability and accuracy are the two major issues that are important in establishing trust in a service or system.

It is very important that all services or systems that support safe driving, or that provide the driver with information related to their driving task, are highly reliable. If any such service or system were to fail they could cause serious problems for the driver and passengers. Also, if there is a known risk of failure, the driver may fail to make use of (or rely on) the service or system even if it may be vital that they do so.

The trust in accuracy of services is important to their acceptance by drivers and will influence future behaviour of the driver - i.e. the driver may ignore information or warnings where the trust in the accuracy is too low. For example, if the user gets regular inaccurate warnings about oil making the road slippery, then the user will start ignoring the message, which could be potentially dangerous if after an accident there is new oil on the road.

6.8.2 Over-reliance on support systems

There is a potential danger that, for all driver support systems, drivers may rely too heavily on the support system and modify their behaviour in ways that are inappropriate. The trend to such reliance places even stronger emphasis on the need to ensure that the reliability of the systems is sufficiently robust to match the importance of the tasks that the system supports. So, for systems that support safe driving, it is important that reliability is extremely high, whereas a system that supports the tuning of a car radio can be subject to less stringent criteria.

There are risks that intelligent speed adaptation systems might lead drivers to become overly reliant on the system, and fail to adopt slower speeds when road conditions deteriorate [i.51]. There is evidence of drivers adapting their driving to the benefits of using ABS, thereby cancelling the benefits gained by the use of ABS. Taxi drivers with ABS have been shown to drive closer to other vehicles compared to taxis without ABS [i.52]. It is hoped that such adaptations are unlikely to occur for drivers who drive less intensively.

Similarly support systems may result in the amplification of potentially dangerous traits such as over-confidence. Automation can hide real complexity and make the driving task appear simpler than it really is. This can be a particular problem with younger drivers, where the vehicle automation may amplify the very common overconfidence in driving ability of young male drivers [i.53].

6.8.3 Trust and privacy

Information flowing from the car to external systems could reveal personal information about the car occupants. Car occupants will lose trust in the in-car systems if personal information is revealed to external entities (people or systems) against the wishes of the car occupants.

Because ICT services in cars may require management of data in remote systems, they are therefore subject to the provisions of the data protection and data privacy acts in Europe [i.23], [i.24], [i.25]. These acts place obligations on the receiver of the data to respect the privacy of the data subject and rely on a trust being established between the data users.

The ETSI personalization scheme described in clause 10 allows the user to be informed of the release of personal information to other entities and to limit to which entities or classes of entity, and under what circumstances, specific types of personal information may be released. Such a mechanism, that allows the user to control their personal information, is one level of protection against the undermining of trust that the unwanted release of personal information represents.

7 User interaction and information management

7.1 Fundamental principles

This clause covers the general features of the interface between the driver (and passengers) and the ITS systems. It looks at current interfaces and known or expected future interfaces.

Most of the core issues related to user interaction in a car have been captured at a high level in the European Statement of Principles on the Design of Human Machine Interaction (ESoP) [i.21].

ESoP's information presentation principles are:

- Information presentation principle I:
  Visually displayed information presented at any one time by the system should be designed such that the driver is able to assimilate the relevant information with a few glances which are brief enough not to adversely affect driving.

- Information presentation principle II:
  Internationally and/or nationally agreed standards relating to legibility, audibility, icons, symbols, words, acronyms and/or abbreviations should be used.

- Information presentation principle III:
  Information relevant to the driving task should be accurate and provided in a timely manner.

- Information presentation principle IV:
  Information with higher safety relevance should be given higher priority.

- Information presentation principle V:
  System generated sounds, with sound levels that cannot be controlled by the driver, should not mask audible warnings from within the vehicle or the outside.

The ESoP's interaction with displays and controls principles are:

- Interaction with displays and controls principle I:
  The driver should always be able to keep at least one hand on the steering wheel while interacting with the system.

- Interaction with displays and controls principle II:
  The system should not require long and uninterruptible sequences of manual-visual interfaces. If the sequence is short, it may be uninterruptible.

- Interaction with displays and controls principle III:
  The driver should be able to resume an interrupted sequence of interfaces with the system at the point of interruption or at another logical point.

- Interaction with displays and controls principle IV:
  The driver should be able to control the pace of interface with the system. In particular the system should not require the driver to make time-critical responses when providing inputs to the system.

- Interaction with displays and controls principle V:
  System controls should be designed such that they can be operated without adverse impact on the primary driving controls.

- Interaction with displays and controls principle VI:
  The driver should have control of the loudness of auditory information where there is likelihood of distraction.

- Interaction with displays and controls principle VII:
  The system's response (e.g. feedback, confirmation) following driver input should be timely and clearly perceptible.

- Interaction with displays and controls principle VIII:
  Systems providing non-safety related dynamic visual information should be capable of being switched into a mode where that information is not provided to the driver.

Details and explanations of all of the above are contained in the European Statement of Principles on the Design of Human Machine Interaction [i.21]. Some of these principles will reappear where issues and potential solutions are explained in later parts of the present document. Additional information related to specific user interface issues and modalities follows.

7.2 Input methods

7.2.1 Alternative input methods

While driving, users interact with the integrated car systems and nomadic devices through various input methods, some of which are listed in table 1.

Table 1: Car occupant input methods

Modality	Type	Typical applicability
visual	Camera facing car occupants (usually the driver)	face recognition, sleep detection from looking at eyes, etc.
auditory	speech	spoken commands, speech recognition, speaker identification, etc.
Tactile	Physical controls - buttons, switches, knobs, "Soft" controls - touch screen, etc.	Single function and multi-function selection of features and services. Physical controls can be located in order to be operated without direct visual gaze. Single function and multi-function selection of features and services. The range of functions and services offered can be context dependently configured. Individual controls cannot be located by touch and hence they need to be located close to the drivers normal gaze direction.
NOTE: The term "soft" controls refers to either control functions that are displayed on a screen or physical controls that are context dependently labelled by software.		

Each of the above input methods may be particularly suitable for certain input tasks and less so for others. For example, visual input is well suited for the detection of driver alertness whereas gaze detection may be a particularly unsuitable control method as it would be likely to interfere with the need for full flexibility of gaze direction whilst driving. However, the provision of alternative ways of performing the same input function can frequently provide greater flexibility in being able to perform an input task. This could be beneficial in situations where the driver needs to perform several simultaneous input tasks but is unable to do so because in that context the driver is unable to use the provided input mechanism (e.g. if a driver is steering the car and changing gear they will not be able to operate a tactile control such as a switch but they might be able to issue a voice command if the required function could also be controlled by a voice interface).

There are many important sources available for determining what types of input methods may be used and how they should be used. Principle among these are the ESoP "interaction with displays and controls principles" [i.21] listed in clause 7.1 and the following important ISO standards that are widely used by car manufacturers [i.9], [i.10], [i.11] and [i.12].

7.2.2 Speech recognition and spoken commands

In order to keep visual concentration on the traffic situation, spoken input can be of great advantage. However the accuracy of speech recognition can be limited by different factors. The characteristics of a person's voice can change significantly under high stress conditions and this can greatly decrease the chance of recognition. The presence of external sounds in a car environment (e.g. engine noise, road noise, sounds from infotainment systems) may also have an adverse effect on speech recognition performance even after corrective methods to minimize the effects of such noises have been taken. Limitations in correctly recognizing the spoken input/commands may be due to other factors such as the driver's pronunciation capabilities when using a system which cannot be configured to the native language of the user (e.g. depending on language abilities and speech impairments).

Limited vocabulary systems can potentially achieve high recognition rates, but cannot be guaranteed to be 100 % accurate. Speaker independent full speech recognition systems will not achieve such high recognition performance as the limited vocabulary systems. When, the recognition fails, the speaker may be asked by the system to choose between a set of options. These results may be spoken to the user or displayed on a visual display. The need for this confirmation dialogue would have a negative effect if used for time critical input.

Due to the risk of the system misinterpreting the driver intentions, speech input is most suitable for secondary tasks such as for interaction with a navigation system, entertainment system and climate control. Speech based systems are already implemented in cars and nomadic devices by some manufacturers, but it is expected that it may be possible to have a wider use of speech input in the future. ETSI has produced a standard on generic spoken command vocabulary for ICT devices and services. The standard is not focused for use in cars although it may also be applicable for in car devices [i.5]. Some suggestions for future ways in which the use of speech based systems could be enhanced are proposed in clause 14.

7.3 Output methods

Car and nomadic device systems interact with the user through various output methods, some of which are listed in table 2.

Table 2: Output methods

Modality	Type	Typical applicability
Visual	Fixed - format display panel Configurable display panel Head-Up displays (HUD) Lamps	Used for displaying information that may be needed at any time and will always be visible Used for situations where there are many alternative sets of information that may need to be viewed Used to display information (on a transparent surface such as a windscreen) that may need to be continuously monitored (e.g. vehicle speed) Used to display simple information (e.g. on/off) that may need to be visible at any time
Auditory	Artificial speech Sounds informative warnings	text to speech buzzer in-vehicle speakers (e.g. voice instructions, audible warning signals)
Haptic	Steering wheel vibrations Force feedback steering wheel torque switch vibrations switch resistance Seat vibrations	haptic steering wheel haptic switch (barrel keys) haptic seat (other techniques such as vibrating seats to indicate potential hazards such as unintended lane changes - ABS vibration through brake pedal?, etc.)

Auditory and haptic output are generally (but not always) preferable since they reduce driver distraction by respecting the main principle of "eyes on the road and hands on the steering wheel".

There are many important sources available for determining what types of output methods may be used and how they should be used. Principle among these are the ESoP "information and presentation principles" [i.21] listed in clause 7.1 and the following important ISO standards that are widely used by car manufacturers [i.17], [i.18], [i.19] and [i.12].

7.4 Alerting the driver

There are two main categories of alerting that are provided to the driver: auditory and visual. Other types of alerting may also be used, but at present these are less common e.g. driver's seat vibrations.

For these two categories of alerting, a metric can be defined, based on the complexity of the alerting signal (grade of attention required). The complexity of the alerting signal is closely related to its potential to convey richer informational content. The types of alerting signal can be graded into a number of basic categories as shown in table 3.

Table 3: Categories of alerting signal

Complexity	Auditory	Visual
Basic	Buzzer	Spot (e.g. steady or flashing warning light)
Simple	Multi-tone buzzer	Icon
Structured	Music	Images
Complex	Synthesised voice	Animated images/video

So, for example, a basic alerting signal can only convey that something has happened and also the category of event if the driver has learnt to associate the specific sound or light with a particular event. In contrast, a complex sound can convey precise and detailed information about many aspects of the related event. The grades defined in the table can be identified.

It can be asserted, in general, that the more complex the alerting signal (or the interaction in general), the more the related service requires the driver's attention, and can interfere with or be disturbed by other services acting at the same time. This may be not true in some special cases where, for example, navigation information superimposed on the windscreen may not require additional attention, rather, it may complement the visual information without disturbing the driver, but these can be considered as exceptions to the general rule.

7.5 Multimodality

Input to and output from the system should be multimodal, when relevant. Using additional modalities when a situation becomes more serious/urgent can be highly beneficial.

EXAMPLE 1: The system asks whether Maria wants to have a message read to her. However, she feels that it can wait until later and answers "no" by a slightly shaking her head [i.31].

EXAMPLE 2: The system "alerts Maria of the potential danger using a flashing light combined with a slight seat vibration" [i.31].

7.6 Implementation of the user interaction methods

The user interaction methods (see clause 7.2 on input methods and clause 7.3 on output methods) may be implemented using controls and displays that are built into the car, fitted to the car after manufacture, or that are provided on a nomadic device. ISO/EN 15005 [i.16] provides a very comprehensive analysis and guidance on the user interaction dialogue principles that apply for use within a car. Although it refers to "transport information and control systems (TICS)" the principles appear to be equally applicable, if not more so, to those functions of nomadic devices that were never initially targeted at in-car use. Once in the vehicle, it is desirable that all systems that the user may attempt to use will not have a negative impact on the primary driving task.

It is expected that OEMs will pay great attention to HMI aspects in respect of positioning and functioning of displays and controls for ITS systems. HMI safety and efficiency ought to take priority over dashboard design, and this will prove particularly challenging for ITS systems implemented to upgrade existing models. It is expected that the controls and displays built into the car will be well positioned to support usage when driving i.e. within easy reach of the driver's hands when driving and very close to the driver's line of sight whilst driving.

Post manufacture, it is expected that both aftermarket devices and nomadic devices may provide ITS systems, and in both cases, there is likely to be a high level of HMI. However the concepts are functionally different and have different HMI impact.

Safely mounting nomadic devices so that their controls and displays are optimally positioned for use when driving may frequently prove to be very difficult because:

- the optimum position for placing controls may be different to that required for displays, yet it is not usually possible to separate the controls and the displays associated with a nomadic device;
- the optimum positions for placing controls and displays are usually already used by the controls and displays built into the car.

Aftermarket systems, that is systems designed to be imported either permanently or temporarily into vehicles to be used specifically to provide ITS services, will be devices that are designed to work solely in-vehicle. Vehicle based navigation systems are a good example. As these systems are enhanced to include other ITS services, such as dynamic route guidance, on-board VMS, emergency call etc, such devices will be specifically designed for use in vehicles, so it may be expected that the HMI aspects, including mounting position, switches, buttons, and touch-screen interactions, will be designed to be focussed around the driving task, and issues of driver distraction etc. need to be at a high level of priority in equipment and system design. Indeed such design considerations need to be addressed before such equipment is permitted to be used in vehicles.

Nomadic devices, such as mobile phones and infotainment systems, present an even greater issue, as these devices are not specifically designed to be used in vehicles, nor as part of the driving task. Where they are to be used in-vehicle, it is critical to ensure that HMI aspects, and in particular, potential driver distraction, are addressed and resolved without jeopardising the security and safety of the occupants of the vehicle. Specific interfaces, such as docking stations, need to be used wherever possible, and designed with the driving task priorities and requirements in mind.

The integration of nomadic devices into the car in ways that allow the device to be controlled using the user interaction facilities of the car (for example using a docking station) represent one solution to addressing the difficulties in positioning nomadic devices so that they can be safely used within the car. Facilities such as "Hands-Free" spoken command and control provide another example of enabling the control of a nomadic device to be achieved in a way that is independent of where the nomadic device is mounted (for the same reason spoken command may also be very useful for aftermarket systems). Even then, certain tasks that require lengthy hand-eye co-ordination tasks, such as manual scrolling through very long lists, will always be inherently unsuitable for use whilst driving however they are implemented, according to the criteria defined in [i.20].

Understanding user needs has always been the key to designing and building user services. This is especially true when the user is a driver who is driving while using the service. Users need clear, simple and understandable information without risks of misunderstanding. Spurious information or demands for user actions need to be minimised.

Consideration of user needs are fundamental in order to present information to, and demand responses from, the user, in order to optimise modality (or modalities) that is/are appropriate, taking into account the total context, safety, representing user expectations, and respecting user privacy. When appropriate, the method of presentation should take into account individual user needs and preferences (for example to provide visual and haptic feedback to a person with hearing impairment). Drivers may wish to have such preferences stored in their own user profile (see clause 10.3).

8 Ways of identifying a car occupant

8.1 Driver recognition

One way in which the car can know from which profile to request personalization data is by recognizing the driver. A Driver Recognition feature covers 3 main needs:

1) Vehicle Security: prevent usage of the vehicle by unauthorized drivers.

2) Vehicle Safety: help the driver in critical driving situation.

3) Vehicle Personalization: set preferences (e.g. driver and passenger preferences and driving attitudes).

One way of performing the recognition is by "indirect driver recognition", which is achieved by recognising something that is possessed by, associated with or known by the driver. All of these techniques cannot absolutely guarantee that the driver is correctly identified as the thing that is being recognised (or entered) could be stolen by or loaned to another person.

Direct driver recognition is only possible if biometric measures are used. Further developments are looking to biometrics identification of the driver among which the most promising are based on finger tip and face recognition [i.40].

The most commonly used technologies in implementing Driver Recognition feature are:

1) RFID Systems

2) Access codes

3) Biometric sensors.

An RFID system recognises a transponder (which may hold information about an individual, or individuals or other specific data) (indirect), an access code system recognises a code (indirect), whereas a biometric system directly recognises an individual (direct).

RFID Systems: RFID refers to the use of Radio Frequency signals to identify items through the use of tags attached to the items. RFID can be "active" (using a battery - range up to 100 meters) or "passive" (no battery - ranges up to maximum 3,5 meters, but more commonly limited to a few centimetres).

RFID Systems are used for different car related purposes such as, e.g. toll collection, vehicle registration, vehicle access control and driver recognition. As far as the driver recognition aspect is concerned, the data held in the memory of an RFID transponder can be programmed into the memory of the vehicle, together with the allowed days, and the time of usage (for example, to prevent use of a vehicle outside of working hours). Use of the vehicle is forbidden to unrecognized drivers.

Biometric sensors: able to detect physiological or behavioural characteristics of a human being.

1) The physiological characteristics are relatively stable. Some examples: fingerprints, facial feature, iris and retina recognition, hand geometry, vein pattern recognition.

2) The behavioural characteristics are affected by mental status. Some examples: voiceprints, hand-written signature, keystroke dynamics.

Typical biometrics in-car applications are:

1) Speaker recognition system: identifies characteristics of the voice of a specific person.

2) Fingerprint or hand-written signature to authorize the driving and to adjust vehicle preferences such as seat and mirrors positions, etc.

3) Very interesting studies are done on the pressure a driver applies on the accelerator and/or brake pedal and on steering control mode recognition. The result of these studies indicates uniqueness in driving behaviour among individuals ([i.56] and [i.57]). This behavioural information can be used to assist safer driving.

EXAMPLE: Upon recognition of the driver by the system, their behaviour can be compared to a stored profile of their normal behaviour. Any deviation of the driver behaviour from the normal driving (e.g. due to drowsiness, alcohol, drugs) can then be identified and necessary actions can be taken accordingly.

Biometrics offers an interesting research area in finding new in-car applications, new related features may be expected to be proposed in the near future. Where safety and security is concerned, driver recognition systems need to guarantee reliability close to 100 %. However, many current technologies do not yet achieve reliable performance.

User acceptance plays a critical role in biometric identification. Invasive techniques such as iris recognition are generally not well appreciated. Non-invasive techniques such as fingerprint and speaker recognition obtain a better success. There are already many devices today that offer biometric identification.

There is a safety issue if safety critical systems are using wrong information, which can be the result of the wrong assumption on the identity of the driver. Therefore, where safety and security is concerned, a combination of various driver recognition technologies is recommended to meet the required degree of accuracy and robustness.

Best practice in driver recognition is generally accepted to be achieved by adopting at least the following three guidelines:

- Driver recognition should be performed accurately.
- When weak methods of recognizing the driver are used, some additional procedures may be needed in critical situations such as providing health related information in emergency situations.
- Where safety and security is concerned, a combination of various driver recognition technologies is recommended to meet the required degree of accuracy and robustness.

9 ICT Services

9.1 Introduction

This clause contains a short description of the main ICT services in cars and assesses the relevance of Human Factors to them. Definitions of a basic set of ITS services are contained in [i.7] and in annex C.

As stated in clause 4.1, ICT services in cars include ITS and entertainment systems. There are many ways of classifying ICT services. The classification adopted in this clause emphasizes the human factors aspects. Classifications of ITS services can be found in annex C.

9.2 Safety related HMI

In the context of the present document safety related services are those that encourage safe driving or assist the driver to avoid or mitigate the consequences of hazardous situations. A common characteristic of all such services is that they need to be capable of achieving a high priority compared to other classes of services, although the required level of priority may vary according to the immediate situation. The present document considers the prioritization of interaction with the driver, in contrast to other prioritization schemes such as those applied at the communication level to or from the car. The topic of adaptive assistive systems is discussed in detail in clause 10.4.7.

9.3 Avoiding conflicts between concurrent actions

It is necessary to avoid a cognitive overload and therefore crucial to present messages at the right moment. Thus, it is important to avoid conflicts between concurrent actions. Information with higher safety relevance should be given higher priority (see clauses 4.3.3.4 and 4.3.3.5 of [i.21]). In order to decide how to deal with conflicting situations, these conflict situations need to be identified and classified [i.29], as well as actions and priority of output messages. There are two major methods to deal with output messages in demanding driving situations and conflict situations; one is to combine messages in a suitable way, and the other is to reschedule less important messages to a later time when the driving situation is less demanding. ISO standard ISO/EN 16951 [i.15] provides a procedure for determining priority of messages presented to the driver. Also the AIDE project [i.29] identified the following three action classes:

1) Class 1: Warnings, which present very urgent information to the driver and which comes mainly from driving assistance systems like lane departure warning systems or collision avoidance systems. Such information is of highest priority for the driver and has to be presented in any case.

2) Class 2: Dialogs should be answered or followed by the system immediately, because they are directly desired and initiated by the driver. Nevertheless the first "warning" class is of higher priority and might even allow an interruption of a dialog.

3) Class 3: Other output messages which comprises all output information not belonging to class 1 and 2. Output messages are mainly issued by information systems, but assistance systems can also issue important messages. The output message class is further divided into three subclasses in order of importance:

   - output subclass 1: time critical, mandatory real-time or preferred actions;

   - output subclass 2: transient actions relevant to the driving task;

- output subclass 3: sustained information for or about the primary task, not requiring an action in the near future. Also, messages or information related to secondary tasks.

The AIDE project has done further work on action classes [i.29]. While there will be message prioritisation schemes at the communications level and other prioritisation decisions at the HMI level (see the example about approaching e in clause 10.4.7), there will be occasions when there is contention between two alerts. The normal HMI prioritisation for such messages would be for the system to note that both messages carry the same communications priority, then prioritise the "nearer" alert and allocate a higher priority to it in respect of notification to the driver. However if the location of the alert is at the same place, there is contention.

For example, in some meteorological situations ice and fog often occur together. In this circumstance the vehicle may receive two warnings in rapid sequence, one about ice ahead at location x, and one about fog ahead at location y. Both may be allocated the same prioritisation level of importance at the communications level. In the case that both are present in the same location it is important to manage the contention. In some systems the driver may have been able to prioritise between messages of similar communications priority as part of pre-trip system set-up. However the default should be that, where no user priority has been pre-set, the message received first is allocated the higher priority or both messages are combined into a single message.

The HUMANIST network of excellence stated in [i.40] that "Due to the fact that human information processing resources are limited, the design and implementation phases shall consider the in-vehicle information management and prioritization as a critical matter. Issues concerning information management are only marginally covered by standardization activities".

9.4 Route related

The task of following a route is frequently considered as of very high priority by the driver of a car as it enables them to complete the ultimate goal of most journeys - reaching the destination. However, this task is of secondary importance to the overall safe and secure completion of the journey, which means that it needs to assume a lower priority when compared to safety related services.

Typical services that fall into this category are navigation and dynamic map systems. The category also includes a variety of parking related, and commuting related services.

9.5 Advanced Driving Assistance Systems (ADAS)

9.5.1 Overview

Services that help reduce the driving workload are often based on Advanced Driving Assistance Systems (ADAS). ADAS systems may range from simple tasks such as automatic cruise control to extremely complex tasks, such as taking the full control of the driving actions. Levels of control that are shared between the human and the ADAS service(s) can be preset, or dynamically reconfigurable according to the driver's needs and status, and the context.

The "Highly Automated VEhicles for Intelligent Transport" (HAVE-IT) project shows that ADAS systems can be tailored according to user needs, while the "System for effective Assessment of driver state and Vehicle control in Emergency situations" (SAVE) project recommends interaction with Driver Impairment Monitoring (DIM) systems that monitor the driver's status. Hence, it seems clear that ADAS systems need interaction with the driver, either explicit as in the HAVE-IT case, or implicit via automatic recognition/monitoring systems, as in the SAVE case, to be flexible and ultimately useful.

In general, ADAS systems are isolated from each other, i.e. their environment is limited to one vehicle. New developments tend to exploit co-operation among different ADAS systems communicating in a vehicle-to-vehicle or vehicle-to-infrastructure manner. It has been shown, for example, that Adaptive Cruise Control systems can be improved in terms of efficiency by allowing them to co-operate with each other or with the road infrastructure. However, an AIDA result [i.34] shows that particular situations can occur (e.g. excessive automatically generated platooning), where overall system efficiency is decreased.

The findings of the research projects quoted above have led to a consensus around the following broad rules about ADAS systems:

- Advice and warnings to the driver, associated with route related services should be prioritized at a lower level than those associated with Class1 and Class 2 (see clause 10.3 on action classes) safety related services.

- Advice and warnings to the driver associated with route related services should be able to be prioritized at a level higher than those of all non-safety related services.
- Within the range of priorities assigned to route related advice and warnings, drivers should be able to choose a level that meets their individual needs.
- ADAS services should provide a flexible level of interaction with the driver according to explicitly or implicitly recognised driver needs.
- Accurate modelling of each and every aspect that can impact on a traffic flow is needed to avoid choosing solutions that could cause more harm than effective gain.

9.5.2 Navigation systems linked to ITS services

If navigation systems are linked to in-car and ITS services, it is capable of provide intelligent information, direction indications, warnings, and/or automatic action such as:

- advising the desired route;
- reaching the speed limit;
- approaching a location with a low safe speed, such as a sharp bend or intersection;
- the way ahead is unsafe;
- imminent risk of a collision arising.

The information provided to the driver could be based on many sensors and devices such as front anti-collision radar, focus area side radar, road recognition sensors (video based sensors), up-graded navigation map (an alternative solution could be based on beacon but imply a strong infrastructure based environment) and navigation devices based on GPS positioning.

Navigation systems could also provide information about environmental and road surface conditions based on input from the following:

- Intelligent Speed Adaptation (ISA);
- Adaptive Cruise Control (ACC);
- Car Collision Avoidance System (CCAS);
- vehicle dynamics and position of the vehicle in relation to other vehicles;
- environmental information with knowledge of road geometry (from map database or beacon input) and vehicle;
- position (GPS);
- automatic SOS when crashing.

9.6 Services not part of the primary driving task

There may be many systems and services in a car that are unrelated to both safety and route related support. These can be generally classed as information and entertainment services. Examples include nomadic devices, GSM phone, radio, climate control, other information and entertainment (for passengers).

Although much publicity has been centred on the use of mobile phones in cars, the use of other ICT not related to the driving task is recognised by drivers as being as or more distracting. In a 2009 survey of car drivers [i.54], the radio/CD/DVD controls were the biggest in-car distraction for 57 % of all motorists (rising to 72 % for young drivers). This finding emphasises that it is not necessarily the most recent additions to cars that are the biggest distracters. Other products that can enhance safety when in correct use, such as navigation systems, can also be distracting to two in five of the surveyed users. Again the more mundane features such as air conditioning distract almost a third of motorists in this survey.

Most of the above systems are unlikely to distract drivers when in their ideal operating state. Examples of ideal operating states are:

- the air conditioning/climate control is set to the driver's preferred temperature;
- the CD player is playing music that makes the driver feel relaxed yet alert;
- the navigation system is helping the driver to safely negotiate complex junctions without having to look at road signs and decide which of several obscure route options to take.

However, it is possible that:

- the driver has selected a temperature that makes them feel very uncomfortable;
- the CD has finished and the drive wants to hear more music;
- an unexpected event has occurred and the driver needs to completely change route.

In all these cases, the driver will wish to correct these situations. Ideally, these corrections should be done with the vehicle stationary, but all too frequently these corrections are attempted whilst driving. At this point, a device or service that had a beneficial safety effect will be used in a way that adversely affects safe driving.

A common feature of all of the above examples is where the behaviour of the device or service does not meet the current preferences of the driver. One area in which solutions to such problems can be found is that of personalization. This is explored in more detail in clause 9.

9.7 Commercial and security services

The market offers a large range of commercial and security services. Some of them require subscription and are managed directly by the Services Providers that offer them.

The most popular services in this category are:

- Insurance related services:
  - PPU = Pay Per Use. A box records the travelled kilometers, the times of travelling, the route type and periodically transmits the data to the Insurance Control Center that may charge the user according to the travelled kilometers, the time and the type of route (for example: the headway is more expensive than a countryside road, travelling during night hours is more expensive then travelling during day hours, etc).
  - PAYD = Pay As You Drive. A box connected to the cars system may detect the behavior of the driver, the speed, the acceleration the fuel consumption and transmit the data to the Insurance Control Center. For example: user may be charged based on the fuel consumption. This kind of service may help the driver to adopt a more correct driving behavior.
- Theft related services:
  - Different technologies are used. Normally a box connected to the car systems is able to transmit location data to the Service Provider Control Center authorized to forward them to the Police in order to recover the stolen vehicle. Correlates services are:
    - Allow users to monitor their car through a web or a mobile application.
    - Possibility to lock/unlock the engine by remote (in Europe it is allowed only when the car is stopped).
    - Possibility to active blinkers and/or horn by remote through a web or a mobile application (example: to be used during an attempted car theft).
- Travel Control:
  - Possibility, on a trip-by-trip basis, to select the trip type (business, home, commuting trip) to be undertaken and, later to produce (using a web application) a tax declaration that can be used to reclaim tax in some European countries.

9.8 Services related to emergency situations

9.8.1 Introduction

These services are intended to benefit the driver and passengers in emergency related situations. Sensors can be used to detect that an accident has occurred and how many, occupants are in the vehicle. In addition sensors could also be used to detect the number of live occupants of the car (e.g. by detecting heartbeats).

In emergency situations, drivers are likely to be very highly stressed. This requires that HMI related to the emergency situations should be immediate, intuitive, easily accessible and easy to use.

9.8.2 eCall service

eCall is an emergency call either generated manually by car occupants or automatically via activation of in-car sensors when an accident occurs. When activated, the in-car eCall system establishes a 112-voice connection directly with the relevant PSAP (Public Safety Answering Point), which is a public authority or a private eCall centre that operates under the regulation and/or authorisation of a public body. At the same time, a Minimum Set of Data (MSD) - including key information about the accident such as time, location and vehicle description - is sent to the PSAP operator receiving the voice call.

The use of in-car emergency call (eCall) to deploy emergency assistance will save lives and reduce the social burden of road accidents by improving the notification of such accidents, speeding up the emergency service response and lowering the subsequent effects on fatalities, severity of injuries and traffic flows. A scenario describing the eCall use is addressed later in clause 13.2.

In order to provide information about the car occupants and allow for personalization it is necessary to consider the use of eSafety services (see clause 10.4.5).

9.8.3 Extended eSafety services

An example of an extended eSafety service is an extension of the basic capabilities of eCall. These usually rely on a contract between the service provider and the customer (e.g. driver) that permits the service provider to supply information about the driver and passengers to the PSAP. Making this additional information available to the PSAP allows the emergency services to respond in ways that take account of the personal needs of the car occupants.

An eSafety related example is given in clause 13.2.

9.9 Nomadic device integration

Nomadic devices (e.g. mobile phones, navigation systems) are increasingly used by the driver for support, assistance, communication or entertainment. Increasingly, portable devices are offered as original equipment or after-market options by car manufacturers and by traditional navigation system suppliers. At present there is a limited range of very proprietary ways of integrating nomadic devices into the other systems within the car. These current solutions are almost exclusively limited to controlling the interactions of the nomadic device with the In-Car Entertainment (ICE) systems. Typical examples of such integration include:

- allowing the controls of a specific make of portable music player to be controlled using the car's own ICE controls;
- silencing the audio being played on an ICE system to allow a hands-free telephone call to be made or received;
- combining the audio output of a nomadic navigation device with the audio output of the ICE system in a way that suits the driver's preferences (e.g. switchable override of normal ICE output).

Currently when nomadic devices are used in cars there are three major installation options. The nomadic device can be either:

- used with a general purpose car mounting cradle positioned where the driver chooses to mount it;

- used with a mounting cradle that has been designed for attachment to a specific mounting point in a specific car;
- used with a mounting cradle that is designed for mounting the specific device in a specific car (usually as a result of a bilateral agreement between the device and car manufacturers).

With the exception of the third option above, there is a high risk that the mounting of the nomadic device could be unsafe in terms of obstruction of the driver's view, mechanical solidity of the mounting and the safety of using the user interface of the device.

The Nomadic Device Forum [i.26] has proposed a standardized way of mounting nomadic devices in cars (NaviFix). This proposal is based on the idea that the car manufacturer can provide suitable safe mounting positions for a NaviFix based electro-mechanical interface and that nomadic device providers can make their devices compatible with the electro-mechanical interface. Standardization activities in this field should help car makers and nomadic device manufacturers to normalize the incoming services from the point of view of position, colour, symbol and shape (another example: car makers would supply an integrated cradle able to support nomadic devices. On the other side, nomadic devices manufacturer would have to equip their product with a standardized interface able to fit in the in-car standardized cradle).

The work of the Nomadic Device Forum [i.26] has been heavily focussed on those nomadic devices primarily expected to be used in cars, in particular navigation devices. However much of the output from the Nomadic Device Forum, such as the ideas behind the NaviFix mounting proposals, could be applied to any type of nomadic device. However, it is very difficult to see how their proposals for certification of the HMI could be effectively applied to classes of nomadic devices such as mobile phones, where the very diverse range of functionality within the device and the rapid model replacement cycle would make any third-party certification completely impractical.

Today's limited solutions provide little or no ability to control the priority of the user input/output demands of the nomadic device with the sometimes safety-critical user interactions with the ICT services that are accessed through the core car infrastructure.

Some of the issues related to how a driver may interact with a nomadic device when brought into a car are described in clause 7.6 about "Implementation of the user interaction methods".

Requirements and potential outline solutions that meet these broader demands are described in clause 11 "Service and device integration".

9.10 Green ICT

"Green ICT" can contribute to providing green solutions to car usage by means such as:

- parking information: that minimizes the need to drive in circles while searching for a parking place;
- traffic management: that helps prevent traffic jams and helps drivers to avoid them;
- economic routes: that provide the best compromise between the fastest (sometimes long) and shortest (sometimes slow and time-consuming) route in order to reduce CO_2 and other emissions;
- in-car ICT that assists the driver in adopting more economical driving techniques (e.g. better braking strategies, gentler acceleration, early anticipation of speed correction situations).

These measures can be seen as additional approaches to promoting greater usage of "green-car" technologies (e.g. cars that have low CO_2 and other emissions, electric cars, the use of fuels such as methane, GPL and hydrogen).

The AIDA project recommends using modelling techniques to estimate the impact of the introduction of co-operative vehicle-infrastructure systems on air pollution. This helps, for example, in assessing the cost/benefit analysis when a new system is to be designed and deployed [i.35].

10 Personalization

10.1 Current situation

Currently, personalization in cars is generally used for setting the position of seat and mirrors, to suit the requirements of the people who are pre-programmed into the car. Drivers will have to manually configure most other features of the car to suit their needs (e.g. setting the language of a navigation system). This can be a major issue for all cars that are shared by several drivers (e.g. rental cars, car sharing schemes).

10.2 Ideal situation

Ideally, users will have a range of services and devices (e.g. laptop, mobile phone and ICT in cars) that are automatically configured according to their needs. To achieve this, it will be necessary for the preferences to be stored in a user profile. Services and devices will access the user profile in order to get the preferences that are appropriate for the particular service/device. Some preferences such as preferred language will be useful for a wide range of services, whereas other preferences can be service or device specific. One advantage of a user profile is that the user can enter a preference only once, and use it many times - in many services and devices.

As people have individual needs, the ideal situation is if the car can adapt to each driver's needs. Some preferences, such as preferred language and those related to the driver's abilities and disabilities are common to many ICT devices independent of where they are used. Other preferences may be very specific for use in cars.

10.3 User profiles for personalization

ETSI Human Factors has produced an ETSI Guide on user profile management [i.1], that describes a personalization and user profile concept and establishes a set of guidelines relevant to users and their need to manage their user profiles to personalize their services and devices. It is necessary that different services and devices understand users' preferences and offer an expected user experience and ETSI HF has therefore developed an ETSI Standard on "User Profile Preferences and Information" [i.2]. In addition, an architectural framework is provided in a Technical Specification [i.3].

The fundamental perspective of the ETSI approach is that the user chooses what information is in their user profile and who or what is allowed to use that information. A setting configured by a user profile may be overridden by the driver at any time. The user profile concept provides users with a means to define their preferences in a flexible way that meets their requirements in a range of situations and roles, and depending on whether the driver is alone or have passengers.

10.4 Service personalization examples

10.4.1 Travel planning and navigation systems

Travel planning systems are used to plan an entire journey, possibly including different means of travelling such as aeroplane, train, bus car. Navigation systems guide the user to the required destination. Travel planning and navigation systems may be combined into one system or interoperate with each other.

Personalization of travel planning and navigation systems may be useful when more than one person is using the same system (e.g. when renting a car with a navigation system). Travel planning and navigation systems can be personalized to suit the user's needs by getting users' preferences on ICT in general, and way-finding and navigation preferences which can be stored in the user profile, see [i.2].

The following preferences are examples of what may be stored in a user profile:

- map visualisation (satellite-view, 2-d map, 3-d map, hybrid) [i.2];
- route preferences (shortest, quickest, most beautiful, cheapest (e.g. avoiding road tolls and/or less fuel consumption), least environmental impact (e.g. with better traffic flow), same route as last time (e.g. preferred to the default from navigation system);

- sharing position (e.g. the user's current location may be shared with a friend to facilitate meeting a convenient location or may be hidden (default)) [i.2];
- voice guide (whether spoken guidance is required or not) [i.2].

In addition to preferences, information such as routes previously used (e.g. in order to take the same route another time) may be stored in a user profile.

A scenario related to a person rushing to catch a plane/train/bus rather than miss it is given in clause 13.1.

10.4.2 Information from the external environment

Information about the current environment (e.g. advice and warnings about the road and parking) can be addressed to an individual driver in the preferred language that is stored in their user profile and not just in the local language(s) (see the scenario on targeted parking in clause 12.3).

10.4.3 Parking assistance

Clause 13.3 on "Parking in cities" explains how the driver can be assisted in finding an available parking place. In addition, the service can be enhanced by personalisation. A user profile could for example bring benefits to a driver who wishes to be guided to a disabled parking space that will allow the driver or passenger to exit and enter the car with a wheelchair.

10.4.4 Comfort and entertainment

Examples of preferences which may be useful for the wellbeing of the driver:

- temperature in the car;
- fan speed and direction (e.g. towards windscreen or feet);
- preferred radio channel, playlist and volume;
- seat and mirror position.

10.4.5 eSafety services

eSafety services can provide a link to the user profile containing important information about the user, in particular eHealth related information such as data in the personal health record (PHR) including contact information to the medical doctor and relatives and information on diseases and medication.

An eSafety related example is given in clause 13.2.

10.4.6 Maintenance and reminders

The driver can specify preferences related to maintenance and alerts such as preferred reminders when oil needs to be changed, check-up at a garage, preferred garage, insurance related preferences (e.g. related to pay as you drive schemes).

10.4.7 Adaptive assistance systems

The basic design of safety related systems will give warnings based upon the expectation of the correct time to warn a driver to allow them to respond appropriately. As drivers have differing abilities (e.g. reaction times) and driving styles it will be desirable to be able to adapt the advice and warnings to the driver to match their specific needs.

For example, where a driver consistently brakes a long way before a hazard, safety warnings may be given earlier than for drivers who consistently brake later. Successful adaptation would normally depend on monitoring of driver behaviour to establish their "normal" driving style.

Systems need to be able to prioritize the delivery of advice and warnings to the driver according to the relative imminence of the hazard/threat/danger. This would typically involve the system monitoring the current driving situation (e.g. speed, weather, other traffic).

EXAMPLE: At the communication level if a warning is received that there is ice at a particular location ahead of the vehicle this would carry a high priority categorization. However, at the HMI level, display of this information would only assume a high priority when approaching the location. Further, if the driver has options to change route between the location of the vehicle and the location of the ice, then the system would need to find an appropriate level of prioritization which will be considerably lower. If the navigation system identifies that the driver will be turning before the ice, then advice to the driver may be very low priority or delayed until after the predicted diversion from the location of the ice.

An interesting work on the adaptive learning system is currently under progress with the Smart-Vei European project [i.43]. The AIDE project [i.33] has described how to integrate adaptive personalization into an HMI architecture.

10.4.8 Green ICT

Drivers may have preferences related to driving style (e.g. performance or economical) and hence whether they get guidance on how to achieve a more ecological style (e.g. less CO_2 emissions and less fuel consumption). It might also be possible to provide preferences for agreement with other drivers to travel together in the same car.

10.4.9 Information acquisition

In order to offer personalized services and devices, information on the user needs to be gathered. Profiles are usually composed and managed prior to use a device or service and/or during the use of a services and devices. This information may be acquired by asking the driver to provide information, or by tracking the driver's actions and choices when using services or devices. The key to a successful profile implementation is to gather a driver's personal information in ways that are acceptable to users. There are three methods for information acquisition. Which of the following methods is appropriate is dependent on satisfying the requirement that the driver should not be distracted from the primary driving task:

- explicit methods: The driver actively defines the settings of the service. They may be asked to actively provide information by filling in questionnaires and online forms and will also be able to choose relevant templates providing default values. These default values can be changed by the driver when it is safe to do so.
- implicit methods , also called adaptive personalization: Implicit methods, also referred to as adaptive personalization, are mechanisms that more or less continuously adapt profile data to match the driver's requirements that have been inferred as a result of continuously monitoring driver behaviour. Adaptive profile agents can relieve users of the burden of personalizing their profiles and so may overcome the limitations of explicit methods of customization. Whether adaptive personalization is seen as a pure benefit to a driver or a violation of their freedom and privacy will depend largely on why the driver's behaviour is being monitored, and what control the driver has over what is done as a result of the behaviour monitoring.
- combination of implicit and explicit methods: Combining explicit and implicit methods can be highly beneficial for drivers. The profile tool, or another application that communicates with the profile tool, will continually search for patterns in the driver's behaviour. When a pattern is detected, the user would be asked an explicit question to check the assumptions made about the driver. Alternatively, the profile tool may initially ask drivers to provide information (explicit method), and then update this information based on patterns in the driver's subsequent behaviour (implicit method). The profile system should avoid asking drivers' questions which might cause a cognitive overload while driving.

Further details and guidelines on information acquisition are available in EG 202 325 [i.1].

11 Service and device integration

11.1 Introduction

An increasing number of services and devices are (being) developed to support the driving task as well as providing information and entertainment to the driver as well as the passengers. However, various services and devices interacting with the driver should not be implemented independently as conflicting information from different systems may distract, overload, confuse and annoy the driver, with a risk of causing problems and potentially serious risks for accidents that did not exist for the systems in isolation. The potential for conflict is greatly exacerbated by the desire of many drivers to use devices that are separate from the in-car infrastructure (nomadic devices).

When more than a single service or device is active at the same time, the problem of interfering interactions arises.

It is not sufficient to make simple absolute statements such as "an acoustic service may coexist at the same time with a visual service" as their coexistence depends on the overall grade of interaction. Clause 6.6 expands on the basic fact that information presented in different modalities is less likely to create cognitive overload, but that within this simple rule there are sufficient examples of where information presented in two modalities can still cause significant problems for a driver.

The safest way of minimising the problems of information and instructions from multiple services interacting in ways that cause problems for the driver is to consider one of the following two approaches:

1) By assuming that a "controller" is available in the vehicle that effectively manages all the in-car ICT services, and decides when and how a service is able to interact with the driver.

2) By assuming that each device and service is able to communicate with all other devices and services, and derive an interaction policy by using the knowledge inferred from that communication.

While the latter alternative is the trend in ICT services, it seems that the former one is the more viable although the diversity and rapid developments in the ITS and after-market nomadic device marketplaces makes it hard to envisage a practical approach that could be adopted to support such complex inter-service interaction that is closely linked with driver safety. This would have major implications on the way cars are made and, particularly, on the protocols and ICT interfaces offered by the car manufacturers, ITS services and nomadic device manufacturers and their standardization.

Thus there is a strong case for a unified in-car human machine interface that integrates the different systems, resolves conflicts between different functions and takes into account combined effects from interaction with a range of systems. This requires a common architecture and one or more accepted methodologies for the development and deployment of ITS services.

The AIDE project produced a very comprehensive demonstration of a system for handling the integration of nomadic devices and multiple services. This project has examined many of the issues that arise when trying to integrate nomadic devices and multiple services into a car environment and developed a system architecture, data flow protocol definitions and design specifications [i.33].

ETSI TC ITS developed a technical specification [i.8] for the ITS communication architecture. This work is based on the results of an architecture task force with participants from the most important ITS projects of the 6th and 7th Framework Program of the European Commission, Safespot, CVIS, COOPERS, FRAME and PRE-DRIVE C2X, and additional stakeholders like the Car-to-Car Communication Consortium, which includes most of the European OEMs and several suppliers. For completeness it should be mentioned, that in particular via the projects CVIS and COOPERS also the architectural concept of the CALM standardisation (Communications Access for Land Mobiles, see clause C.1) in ISO TC204 WG16 was considered. The task force was coordinated by the project COMeSafety, which provided the result as publically available project deliverables [i.28].

The architectural approach provide the framework for the integration of almost all access technologies, which are available for vehicular communications from 5,9 GHz short range communications, infrared technology, 2G/3G mobile systems to broadcast systems like DAB or DVB and others. Although emphasis of the work in ETSI TC ITS is on the communication system, the architecture allows also the coordination of different communication systems and includes a facility and application layer providing services, which are most relevant for the architectural considerations of the present document.

Clause 11.2 provides an overview of the ITS communication architecture of ETSI TC ITS and the COMeSafety Task Force Architecture.

11.2 ITS vehicle station communication architecture

ETSI TC ITS distinguishes between four main ITS components, ITS Vehicle Station, ITS Personal Station, ITS Roadside Station and ITS Central Station. All these components contain an ITS Station, which basically consists of one or more Communication and Control Units (CCUs) and one or more Application Units (AUs) connected by an internal network as shown in figure 1. It may be considered to have separate CCUs, e.g. for safety and non-safety related communication, but also an implementation of a CCU and an AU in a single node could be possible. In order to provide environment specific functions the ITS Station may be interconnected to additional components via a gateway interface.

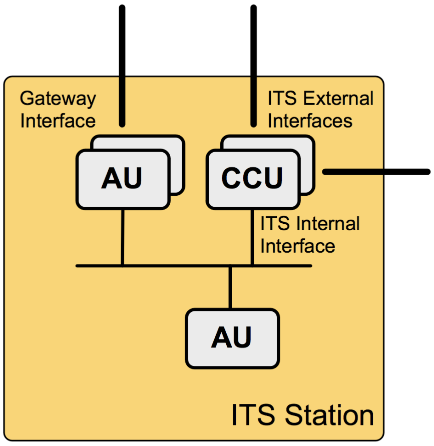


Figure 1: Components of an ITS (from [i.28])

The ITS Vehicle Station is mounted within or fixed to a vehicle and enables the vehicle to participate in ITS applications. With respect to ITS communications it is irrelevant whether the ITS Vehicle Station is fully integrated into the vehicle or whether a separate mobile component is connected to the vehicle. A vehicle CCU is in charge of communication with other vehicles or roadside units and may also provide access to the Internet domain, e.g. by integrated UMTS communication hardware. The AUs are responsible for ITS applications. In order to provide vehicle specific ITS applications, the ITS Vehicle Station requires access to vehicle data, e.g. data from the electronic control units (ECUs) or sensors which are interconnected by a vehicle-specific network like the CAN-bus. The link to the vehicle-specific network is provided by the vehicle gateway, which in the reverse direction may also provide data to vehicle controllers or to presentation devices integrated in the vehicle.

The ITS Station reference architecture in figure 2 presents the protocol stack of the ITS Station, which basically follows the ISO/OSI reference model with four horizontal layers and two vertical layers flanking the horizontal protocol stack. The following paragraphs provide a brief description of each layer but more details for those layers with are stronger related to the focus of the present document.

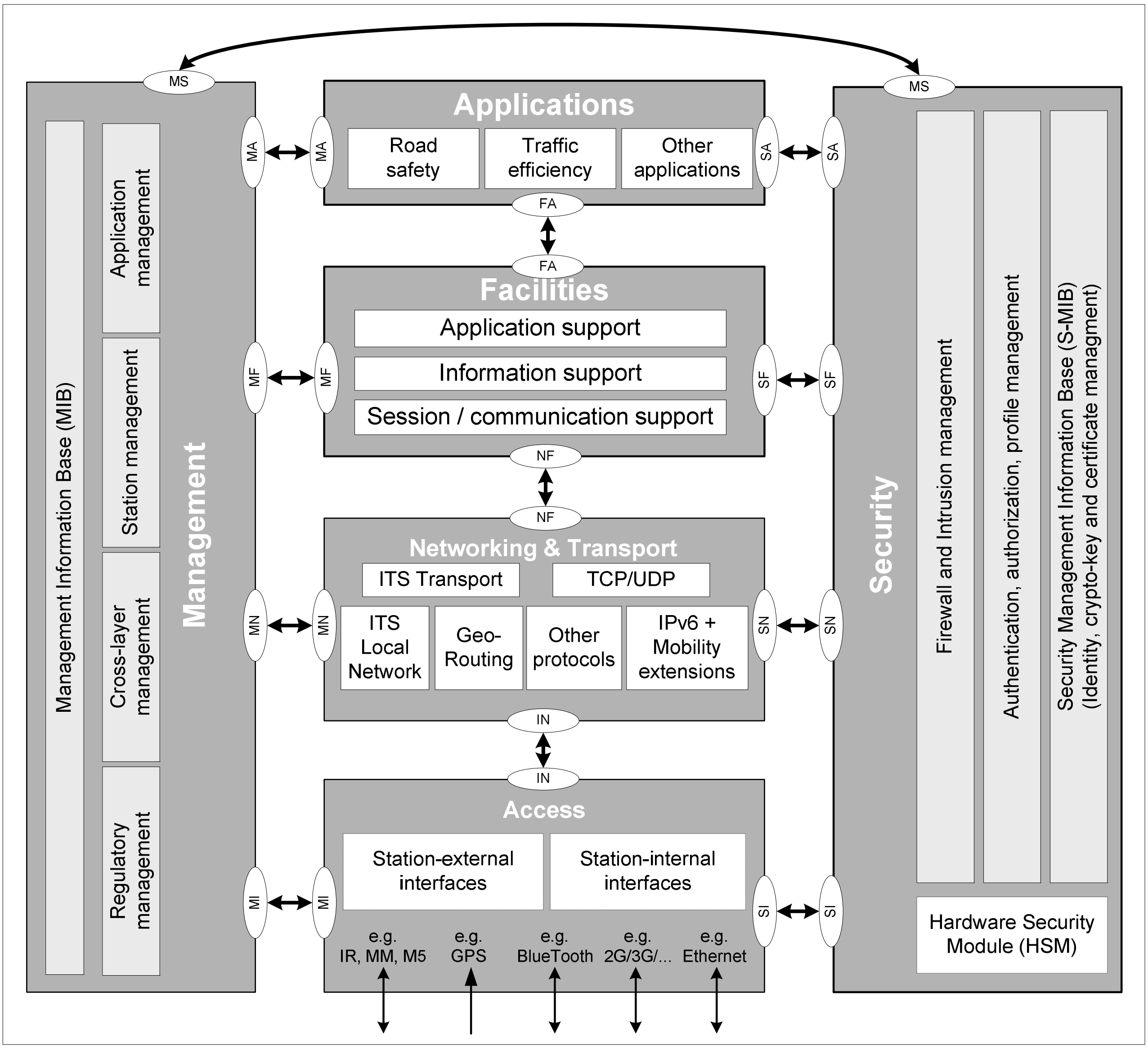


Figure 2: ITS Station Reference Architecture (from [i.8])

The lowest layer, **ITS Access Technologies**, includes various communication media and related protocols for the physical and data link layers. The access technologies are used for both the communication inside of an ITS Station among the internal components (e.g. via Ethernet, CAN), which could be in special case the interconnection with a mobile device in the vehicle (e.g. via Bluetooth), and the external communication for example to other ITS Stations. For external communication some of the ITS access technologies represent complete, non-ITS specific communication systems such as GPRS, UMTS or WiMAX.

The **ITS Network and Transport** layer comprises protocols for data delivery among ITS Stations and to other network nodes like the Internet.

The **ITS Management** layer is responsible for the configuration of an ITS Station and for cross-layer information exchange among the different layers.

The **ITS Security** includes security and privacy services, which do not prevent the other layers to contribute to the overall security and privacy concepts.

The **ITS Facilities** are a collection of facilities or functions to support applications for various tasks, in particular for those tasks, which are common for several applications.

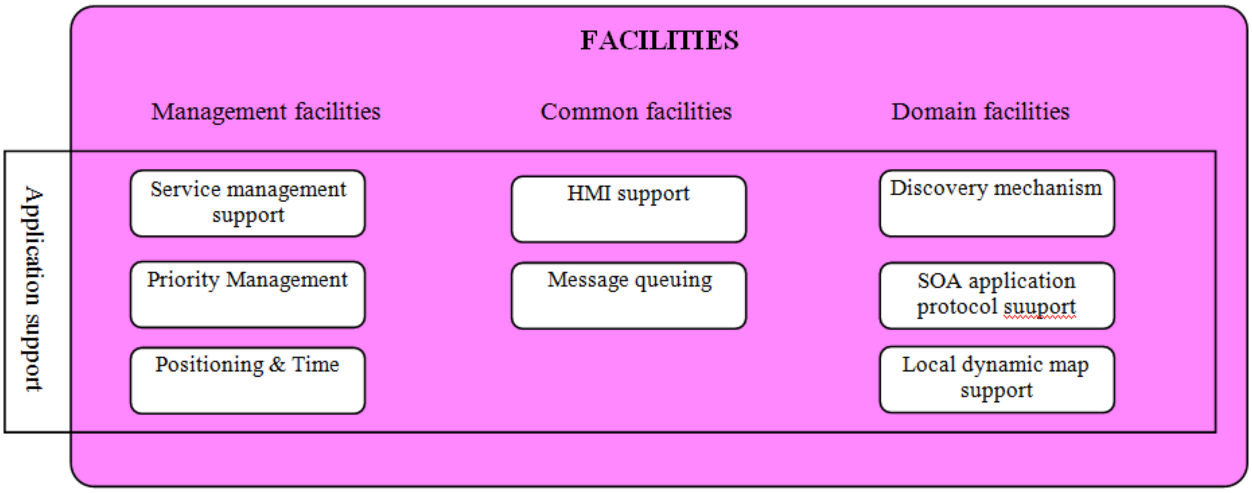


Figure 3: Application support facilities (from [i.28])

The facilities listed in figure 3 represent only a selection which is far from being complete. The most important facility in the context of the present report is the HMI Support Facility. In the definition of COMeSafety, this facility provides a bidirectional, programming language independent information exchange between vehicle applications and in-vehicle HMIs based on well defined XML files. This mechanism was chosen to decouple the application logic from any OEM-specific HMI properties and moreover allows OEMs for optimizing the user interface with respect to their display or other output device capabilities (e.g. display resolution, colour depth) and input modalities. Additional requirements for the HMI Support Facilities arise from the HMI architectural considerations presented in clause 11.3.

The **ITS Applications Layer** refers to one or many different applications in combination with various use cases. In order to avoid duplication, functions that are used commonly by applications are grouped in the ITS Facility Layer as described above. Usually it is distinguished between road safety and traffic efficiency, and other non safety related applications, including commercial applications. Each application consists of several building blocks, for example, as shown in figure 4 for car-to-car communications related application.

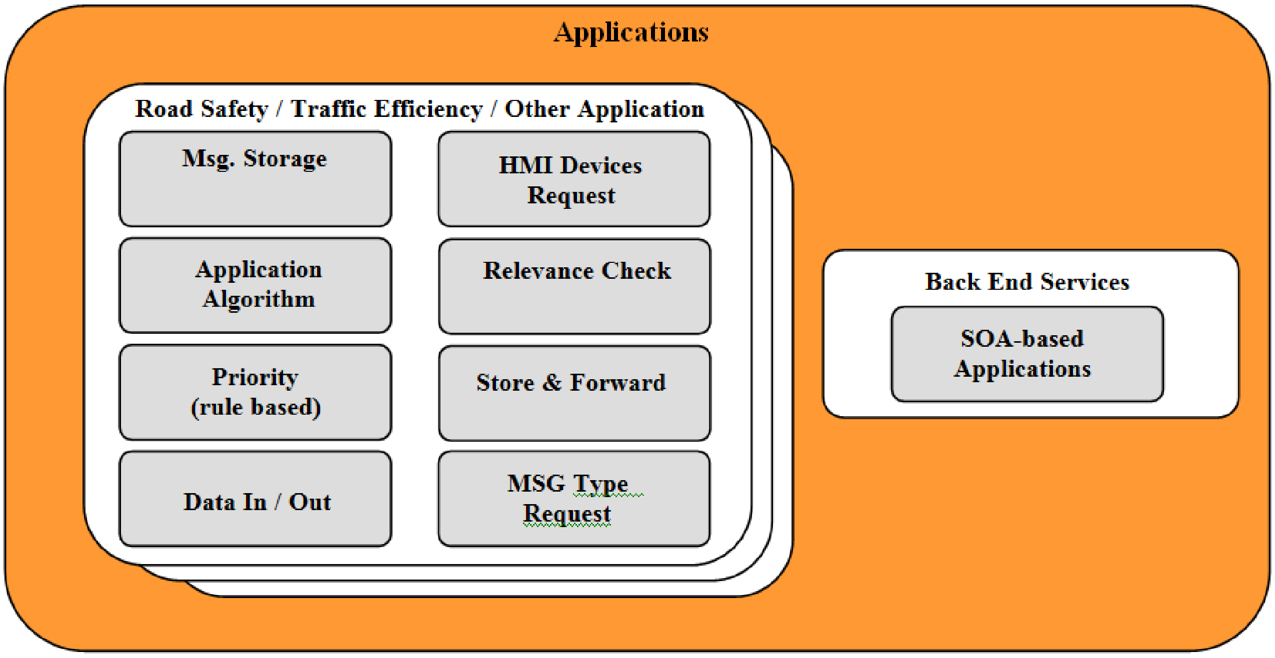


Figure 4: Building blocks for applications (from [i.28])

The **Message Storage** stores the received V2X messages data for application controlled store and forward of messages and application controlled relevance check. The heart of an application is the **Application Algorithm** defining the functionality including HMI, e.g. location relevant warning or information output, event detection, initiation of event message transmissions, message storage control etc. The **Data In/Out** interface provides for sending and receiving of messages. The **Priority** is rule based, depending on the vehicle location, type of application and relevance of messages. It is used for transmission of messages and user output as well. The **HMI Device Request** is an application specific call for access to the HMI devices as needed for the applications user interface. HMI devices are not considered to be part of the communication architecture. They can be integrated into the vehicle or as well be part of a linked mobile device. The **Store&Forward Request** initiates the re-sending of a stored message to other ITS station, vehicle or roadside unit. The **Relevance Check Request** will make use of the Relevance Checker of the facilities layer and finally the Message Type Request will communicate the application specific message type, in which the subjacent layers of the ITS stack will format the transmitted event message.

11.3 Architectural considerations for the HMI

11.3.1 Introduction

The ITS Vehicle Station Communication Architecture presented in the previous clause provides a framework for both the integration of several communication media and devices and the integration of multiple safety related ITS applications and as well non safety related ITS applications. Due to the focus on ITS applications, this architecture does not cover the integration of other ICT services, e.g. speech communication or SMS.

The concept of the facility layer allows optimising the coordination of the information provided by several applications. Facilities like the HMI support enable the coordination of several output requests and together with facilities like Priority Management, Positioning&Time and the Local Dynamic Map the optimisation of the output regarding mode, timing and fading of output in other HMI devices. The HMI support facility could be the appropriate instance for a centralized output control for ITS applications and clause 10.2 provides some advice for the future development of this facility. An additional facility is needed to decide whether the received information should be provided via HMI or used only by vehicle control units.

Addressing the coordination of independent devices used in a car, further architectural considerations are required, such as:

- availability of common interaction facilities for all services;
- design of services that take account of a common architectural framework;
- an architectural framework which controls the usage of interactions among different services on the same human interfaces.

While it is not in the scope of the present document to define any architecture for ICT services for vehicles, yet it is worth mentioning some results gained from a number of European research projects.

11.3.2 Availability of common interaction interfaces

Many projects have shown the necessity of an in-car services architecture that allows for the integration of current and future ITS services. For example, one result from the GST project [i.38] has shown that emergency services should be integrated with other ITS services (e.g. route guidance services) in order to work in a more efficient way. The EASIS project [i.36] has demonstrated that integrated safety systems can be managed by an architecture build in a cost effective manner and able to provide common services upon which future applications can be built.

Also, the availability of an open in-car architecture allows for the sharing of basic functions (such as presentation or communication) for all ITS services. The AIDE system architecture [i.33] focuses on the logical structure of the software components and their communication. In addition to this the individual components are specified in terms of their tasks, responsibilities and dependencies which are necessary to provide adaptive functionalities for an integrated, in-vehicle HMI system.

11.3.3 Human-centred design

In terms of system architecture, the human machine interface is often seen as the last unit in a chain of components. But to the driver it is the only perceivable one, therefore it is perhaps the most critical in the design of information and communication systems for driver assistance. For this reason, a user-centred design approach is the only approach that will ensure that the driver's needs are adequately addressed.

This has been recognised by a number of projects, and:

- the approach of the human-centred design was applied to design the human machine interaction (the sum of threat assessment, warning strategy and human machine interface) of the EUCLIDE system (see annex B);
- the simplification of the human interaction with multiple IVIS and ADAS function (including nomadic devices) is the base of the requirements, design, development and validation of three prototypes in AIDE subproject3 [i.32]. The AIDE project has developed a system architecture, data flow protocol definition and design specifications for an integrated, in-vehicle HMI system [i.33]. In addition, AIDE did develop a "cookbook" for Human-Machine Interface (HMI) testing in the automotive industry [i.30];
- the identification of user needs in relation to ITS and the impact analysis of ITS on driving behaviour are recognised by HUMANIST, Im@gine, INVENT and Prosper projects (see annex B);
- the HUMANIST network of excellence stated in [i.39] that "Due to the fact that human information processing resources are limited, the design and implementation phases shall consider the in-vehicle information management and prioritization as a critical matter. Issues concerning information management are only marginally covered by standardization activities";
- the impact of road surface, road geometry, road signalling design and location on driver behaviour is studied in RANKERS project (see annex B);
- support safety while driving, by understanding the driver's behaviour and needs and by providing personalised services to the different classes of users is recognized by Smart-Vei project (annex B and [i.43]).

The usage of a service often implies manual actions for both nomadic and in-car devices. Manual actions, as outlined throughout the present document, imply some degree of driver distraction which risks putting the driver in a dangerous situation. The greater the unfamiliarity with the correct manual actions that are required to use the service the greater is the potential distraction and risk. Minimising the complexity and enhancing the familiarity of the human interface presented to the driver are factors that will reduce the risk of potentially dangerous distraction.

11.4 AIDE architecture for an integrated in-vehicle HMI system

11.4.1 Centralized control

The AIDE (Adaptive Integrated Driver-vehicle InterfacE) architecture [i.33] focuses on the logical structure of the software components and their communication. AIDE focussed on the design and development of an adaptive integrated driver-vehicle interface, with the main aim to improve driver system interaction in terms of distraction and usability to increase driving safety and improve user comfort. In brief, the following output meta-functions will be relevant depending on the situation:

- change modality during running output or terminate output;
- interrupt and resume the output;
- postpone the output;
- enhanced output;
- extended output;
- simplified output.

In order to reach this goal, the AIDE system explicitly considers the effects of HMI interdependences, i.e. for example preventing interference between different events presented at the same time to the driver. Moreover, to take into consideration factors such as personalization (preferences in profiles), and the possible seamless inclusion of nomadic devices in the vehicle's environment, a central intelligence controlling the interaction between driver and system is needed. In AIDE, this intelligence is called the Interaction and Communication Assistant (ICA) and ensures that information is given to the driver at the right time and in the right way and that only functions that are relevant in the present driving context are active. The communication flow between ICA and an application is simple and uses only four different messages:

- The Application Request Vector (ARV) asks for permission to perform an output.
- The Reply Vector (RV) informs the application about if and how to perform the output.
- The Channel Status Vector (CSV) informs the ICA when devices are freed again.
- The Request No More Valid Vector (RNV) informs the ICA when a postponed output is not any more valid.

In addition, there is a Driver Vehicle Environment Monitoring (DVEM) Vector and one Profile Management (PM) Vector to provide condition information and driver preferences which are used by ICA for all general valid adaptive functions and by applications for the application specific functions.

Figure 5 is a schematic view of the key functional components that will be required to realise such an integrated driver-vehicle interface, but does not imply any preference for a specific technical solution or sequence of operations.

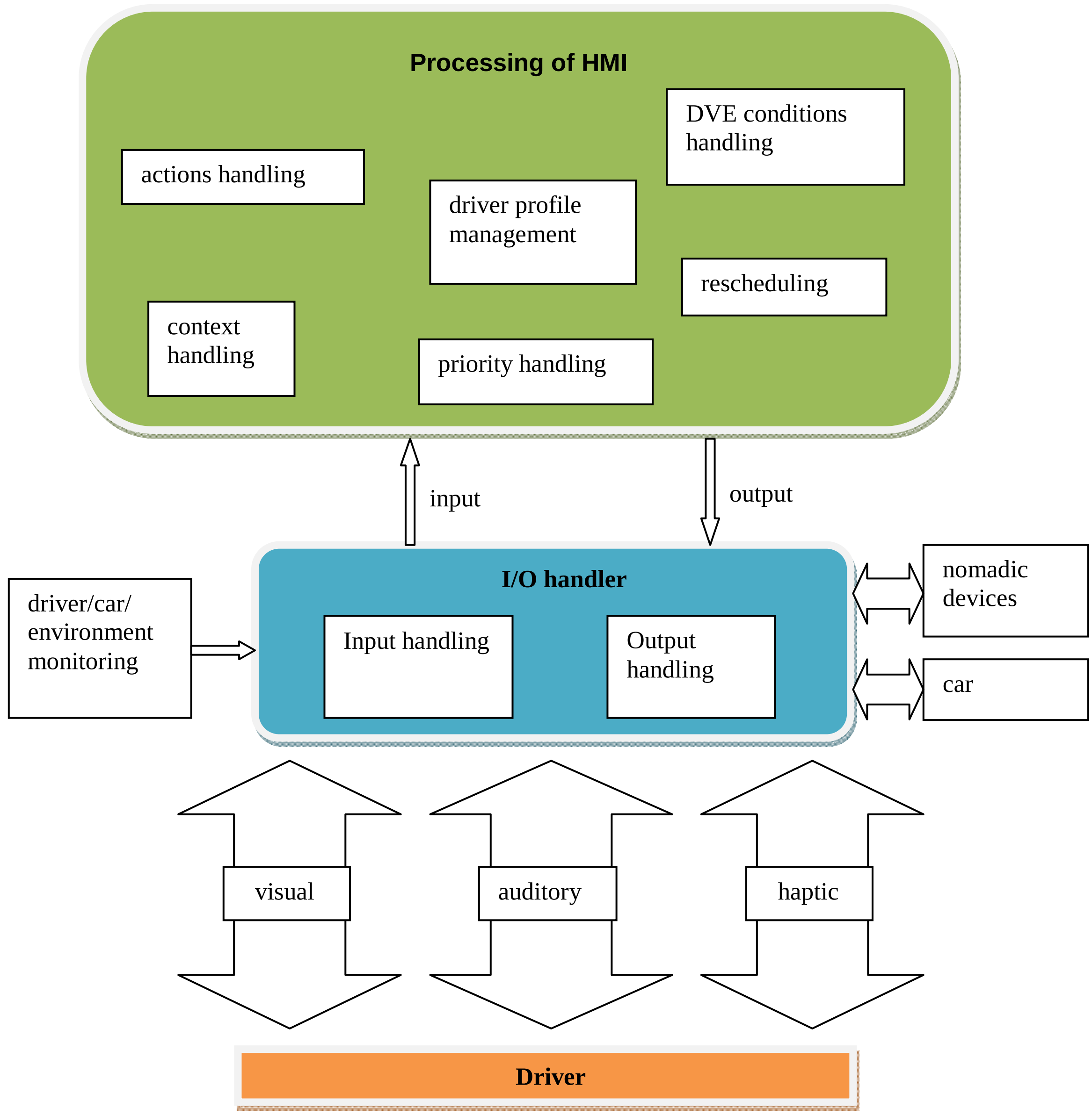


Figure 5: Schematic view of the major functional components of an adaptive integrated driver-vehicle interface

11.4.2 Driver vehicle environment

The driver vehicle environment (DVE) component intermediates between the AIDE sensors and the AIDE central intelligence. The DVE detected conditions have been grouped into the following broad categories [i.33]:

- **primary task demand detection:** which reflects the driver's "level of availability" to receive and process information according to the requirements of the current driving task At this level, the aim is to identify the current driving activity phase and the goal followed by the driver in order to automatically assess the strain for the driver at this precise time.
- **secondary task demand:** which reflects the driver's "level of availability" to receive and process information according to the requirements of the non-driving tasks in terms of cognitive and visual distraction.
- **driver intention for lateral manoeuvre:** which reflects the interference of the intent of the driver to perform a manoeuvre with the current cognitive workload of the driver, isolating the source of distraction during the perceptually demanding task of performing a manoeuvre.

- **driver impairment:** which reflects the decrease of attention allocation to the current driving task in terms of driver's physical state (due to drowsiness, substance use, or a low level of arousal).
- **environment/traffic risk:** which gives an estimation of the potential risk determined by the driving environment and traffic situation.
- **Driver profile parameters:** able to specify driving attitude (e.g. aggressive driving), driver's preferences (e.g. graphical layout of visual messages) and trip context (e.g. driver is a commuter or tourist)

11.4.3 AIDE in other projects

AIDE has collaborated with, and provided input to other projects (further details on these projects in annex B) in the eSafety area, such as:

- PReVENT: The AIDE HMI architecture will be integrated into the general architecture of PReVENT. All PReVENT sub-projects will integrate the AIDE architecture into their SW architecture.
- GST: The general objective of the GST project is to develop an open and standardized architectural framework for end-to-end telematics services. A key issue for AIDE is thus to ensure that the AIDE and GST architectures [i.39] are compatible or, more specifically, how telematics services could interface to the AIDE integrated HMI in a flexible way.
- EASIS: The general objective of the EASIS project [i.36] is to develop a modular, scalable electronics architecture for active, passive and integrated safety systems. An enabling electronics architecture is one of the most important pre-requisites for an AIDE-type integrated HMI to enter the market.

11.5 Benefits of an architecture with centralised control

An architecture such as the one described above (or similar) can bring benefits such as:

- the in-car service architecture can support the addition of new services in a seamless and controlled manner;
- several applications can share the same output devices;
- several applications can share the same input devices;
- individual applications can be controlled by several alternative input devices;
- individual applications can use several alternative output devices;
- nomadic devices can be integrated into the vehicle human machine interface;
- techniques for prioritization and queuing of messages can be used to avoid driver overload;
- techniques for rescheduling of messages can be used when the driver workload is high (demanding traffic situation, high traffic risk);
- presentation of messages can be adapted to driver state and preferences;
- techniques for intensification or earlier presentation of important messages can be used to make sure an inattentive (distracted or drowsy) driver does not miss them or get them too late;
- when messages need to be presented even though the driver workload is high (demanding traffic situation, high traffic risk), then the messages can be presented in a simplified form.

12 The human in the design loop

12.1 Meeting the user's needs

Understanding user needs has always been the key to designing appropriate services. This is especially true when applied to the user while driving. Users need clear, simple and understandable information without risks of misunderstanding.

In-depth studies of users' needs are fundamental in order to present information to the user in a modality (or modalities) that is/are appropriate, taking into account the total context and respecting user expectations When appropriate, the method of presentation should take into account users' needs and preferences (e.g. rather visual and haptic information to a person with hearing impairments). These needs may be stored in the user profile (see clause 10).

12.2 A process

The following clauses describe a process for developing safety related services that is based upon the findings of a number of research projects. However, many parts of this process are already adopted within industry to ensure that systems put into modern vehicles achieve the high levels of safety that they were expected to deliver.

The detail of the process described below is not being explicitly recommended for use. However, it is illustrative of a way of ensuring that the most fundamental principle of human factors is incorporated - that the ultimate guarantee that a system designed according to the best possible principles will deliver the expected behaviours is to test it with real people in realistic operating conditions.

12.3 Analysis

Before starting designing new safety related services, a preventive analysis on the effectiveness of the new services should be performed. TRACE, in its deliverable D4.1.3 "A-priori evaluation of safety functions effectiveness - Methodologies" [i.44], defines tools to be used for such analysis. TRACE results also show that different methodologies should be used to evaluate the effectiveness of services belonging in different areas, and that, for some sets of services, using more than one methodology leads to better results.

12.4 Development

The following methodological steps for building ITS services are suggested in [i.42], subproject Driver Behaviour and Human-Machine Interaction FVM:

1) Construct searchable database for driver behaviour literature relevant to assistance systems.
2) Derive operational model of learning behaviour and performance.
3) Derive method for assessment of learning progress and system comprehension.
4) Develop evaluation procedure for traffic safety of driving assistance and information systems.
5) Develop procedure for long-term assessment of assistance systems tested using a system prototype.
6) Provide evaluated prototypes for the learning and comprehension improvement.
7) Provide driver behaviour data for specification and design of the assistance system applications.
8) Identify and compile guidelines and norms relevant to the HMI.
9) Provide guidelines for design of self-explanatory, comprehensible, and safe assistance systems.
10) Support implementation of guidelines for application design.

This represents the development of the background resources that will be required during the development of individual services. Such background resources should be made available in the form of databases and standards that could be used during the development of specific services.

The most significant result of the PReVENT project from the Human Factors point of view is the Code of Practice for the development of new ITS services, which has been summarized in figure 6.

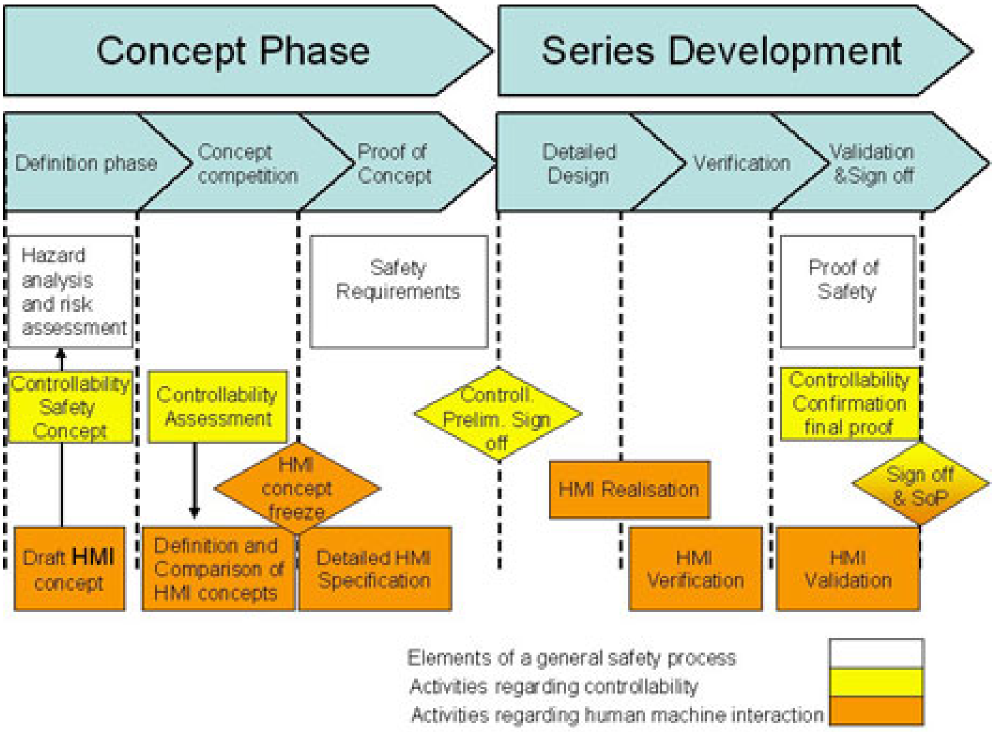


Figure 6: Code of Practice development methodology

Figure 6 shows a methodology in which Human Factors is considered in each development step. Such a methodology is appropriate to the development of services that meet the real user needs.

12.5 Test

Active safety systems need assessment criteria and evaluation methods to be deployed, which include driver-in the-loop testing, meaning that the driver takes an active part in the iterative development process, as recommended by the eValue project (cfr. "Testing and Evaluation Methods for ICT-based Safety Systems", eValue Deliverable D1) [i.37].

13 Scenarios

This clause contains scenarios that illustrate the user related issues of a range of different types of deployment of ICT in cars. They illustrate the human experience of how solutions discussed elsewhere in the document can be used to enhance the user experience. The scenarios illustrate the effect of multiple services in a real-world situation and also more complex services that may be difficult to capture as complete service descriptions.

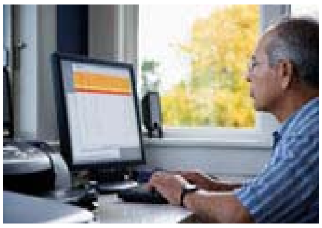
13.1 Travelling to catch a train

This scenario illustrates the following issues:

- Pre-journey planning services (clause 10.4.1).
- Navigation systems (clause 10.4.1).

- Integration of nomadic devices (clause 9.9).
- The application of the ESoP Design goal IV that warns of systems that encourage dangerous behaviour (clause 6.1).
- How personal preferences in a user profile can influence the recommendations that ICT systems give to the driver (clause 10).

The following scenario has been based upon some of the ideas from the IM@GINE IT project [i.41].



1) Using the integrated travel planning environment, Martin plans a journey by train to a hotel in Madrid whilst sitting at home using his PC. The system calculates all elements of the journey for Martin.

2) Martin loads his travel plan into his PDA. The plan covers all elements of route including earlier/later trains and booking conditions (e.g. whether his booking allows him to take an earlier or later train). The PDA also has links to relevant travel sites to allow it to re-plan if necessary.

3) On arriving at his car the PDA connects to the car infrastructure which allows his car navigation system to work with the PDA to guide Martin on his journey.

4) During the journey his car navigation system assists Martin to reach the railway station in the normal way.

5) As Martin approaches the station the car informs him of the next train time - as he has a flexible ticket.

6) In the above step, the planning systems calculated the predicted remaining car journey time plus the predicted time to park and walk to the railway platform and determined that Martin would just miss a train. So it did not tell him about this train, as to do so would have encouraged Martin to drive dangerously to reach the station at an excessively fast speed. Instead, the system told Martin about the time of the following train.

7) However, Martin was very lucky in getting quickly through traffic and finding a parking space. The system has now calculated that Martin can make the earlier train so, as soon as Martin turns off the ignition it informs him that he can catch the earlier train if he hurries. Martin had previously indicated in his personal user profile (see clause 10) that he was willing to rush to catch a plane/train/bus rather than miss it.

8) Martin removes his PDA from the car (which he can then use to help him on later stages of his journey when he reaches Madrid) and rushes to catch the train.

9) He successfully catches the train and is safely on his way!

13.2 eSafety services

This scenario illustrates the following issues:

- Pan European eCall.
- Third Party support for eCall and additional third party services.

The following scenario has been based upon some of the ideas from the draft deliverables of CEN TC278 WG15 and from discussions regarding eSafety and, in particular, eCall.

1) Knut lives in Trondheim in Norway. Maria lives in Vilnius in Lithuania, but is on holiday in Norway. Knut has a car that is equipped with pan-European eCall. Maria has a car that is equipped with a private, so called "third party", eCall.

2) The weather is not good. It is snowing. Unknown to each other, both cars are heading towards each other on different sides of a hill. Just they are nearly cresting the top of the hill an elk walks out into the road, completely ignoring/unaware of the two cars rapidly approaching. Both cars sound their horns and take evasive action, but in manoeuvring to avoid the elk, and, being on opposite sides of the crest of the hill, not seeing each other, the cars collide on the crest of the hill. Both sets of air bags inflate, and in Maria's car additional crash sensors are activated.

3) When the air bags in Knut's car are inflated, his Pan European eCall system is activated. Using GSM/3G, this notifies and provides the emergency services that his car has been in an accident. It provides a "minimum set of data" (MSD) providing information about the type of vehicle, provides the VIN, energy type, position, direction of travel, and number of fastened seatbelts. The emergency services spring into action and the in-car eCall system attempts to establish a voice link between the emergency services assistance provider and the occupants of the vehicle.

4) When the air bags in Maria's car are inflated, other sensors in the vehicle also identify and confirm that there has been a crash and provide additional data. The eCall system in this case provides the crash notification and MSD to a commercial service provider, together with additional information about the damage to the vehicle, whether it has rolled over, has caught fire, is leaking fuel, the local outside temperature, whether the engine is still functioning, etc. The third party support service consults Maria's record and collates information on her age, blood group, and any particular medical issues that have been recorded. This is especially important information for Maria as she has a very rare blood group. The third party service provider contacts the relevant local emergency services and is able to provide the same information as was provided by Knut's car, but also provides the additional medical information, and as Maria cannot speak either Norwegian or English, offers the Norwegian emergency services translation services. This enables Maria to say that she is bleeding very seriously. As with Knut's car, but using the communication routing of third party service provider in this case, a direct link between the emergency services and the occupants of the vehicle is established, but in this case, with the third party service provider joining the conversation to provide translation services.

5) The location information from both cars is critical as these are mountain roads. They are some distance from the nearest town, and it is snowing. Without knowledge of the location of the vehicles, it could literally take days to find the vehicles. With this information, the nearest emergency service vehicles are soon onsite, and as Maria's car sensors have identified that her car has rolled onto its roof, heavy lifting gear is immediately sent out. Also, the ambulance has a supply of Maria's rare blood group in case this may be urgently needed. The location recorded for Knut's car identifies that when it came to rest it was some distance from the road, so a crane is sent out as the location identifies that it may have fallen some way down a cliff.

6) Notable Human Factors issues:
Both emergency calls were triggered and sent automatically, without any input from the driver or occupants of the vehicle. In both cases an "eCall" button is present in the car to enable a manual generation of an eCall for assistance. In Maria's case there are two assistance buttons, one for eCall and one for other roadside assistance. The emergency services talk to both Knut and Maria while the emergency services are on their way to the crash site, advising them that help is on its way, thus relieving stress of the injured parties, and enabling any basic first aid procedures that can be guided via the phone call to be done.

7) Without the eCalls, the rescue operation would have taken several hours longer. Possibly if the occupants were too injured to make a call to the emergency services, they may have lain in their vehicles for days before they were discovered, because this is a remote area. Getting the vehicle occupants to hospital within the first hour (the "golden hour") has greatly improved the chances of survival of the occupants, and significantly reduced the probability of long term injury/disfigurement.

8) Maria's car has also provided her insurance company with the core details of the crash, officially registering the claim, and leaving her to identify additional details, such as damage and details from Knut's insurance.

13.3 Parking in cities

This scenario illustrates the following issues:

a) Intelligent car parking guidance.

b) Intelligent targeted car parking.

c) Parking assistance.

13.3.1 Background

The following scenario has been based upon some of the projects from CEN TC278 and ISO TC204, but particularly from products and research projects of Siemens, Mercedes, Toyota/Lexus, BMW, Volkswagen, and projects such as CVIS and VII.

Traffic in cities and congested areas are constantly growing. An important task of transport planning consists in integrating traffic of parking search as smoothly as possible into the traffic situation.

It has been estimated that every third driver in our cities is not going from A to B, but is searching for a parking lot. Often, this is not because there is no parking space available, but the information as to where to find free parking lots is missing.

Intelligent car park guidance systems can, and in many cities already do already, provide real -time information to drivers, not just about the location of the car parks, but the number of spaces available in each car park. At the moment, however this is available only by large Variable Message Signs (VMS).

While these signs are very useful and a significant improvement, road sign clutter can add to the cognitive overload of all drivers, both those looking for parking, and those simply driving from A to B, and has been identified as a cause of accidents.

Bringing this information into the car means that it will only be seen by those who are looking for parking, thus reducing the potential for cognitive overload and clutter on the streets. Dynamic parking guidance systems guide drivers to a free parking lot or the next car park.

However, once having arrived at a car park, often it is nearly full, and the drivers may have to drive around several times, wasting time and causing pollution, until they find a vacant parking space.

13.3.1.1 Targeted parking scenario

In the "intelligent" car park, sensors above or below every parking space detect reliably whether the parking space is occupied or not. This information is transmitted to the central parking space management system. As soon as Bob passes through the car park entrance, the guidance system directs Bob reliably along the shortest route, "targeting" him to the next available unoccupied parking space.

13.3.1.2 Assisted parking

Once at the vacant car parking space, Bob then has to manipulate his car into a restricted space. It is estimated that at least one in three drivers experience difficulty parking a vehicle, and a considerably greater number find it a stressful process, particularly in car parks. Equipment now exists to automate this task, and automotive companies such as Mercedes, Toyota/Lexus, Volkswagen, BMW, and General Motors have already introduced "Parking Assist" options into their vehicle ranges.

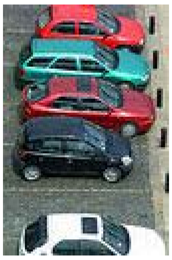
13.3.2 The parking in cities use case

Dieter has arrived in a busy city that he does not know well for a meeting. He has programmed his navigation system to his destination, and instructs the system (fixed or aftermarket) to find the nearest car park with available spaces. His navigation system provides him with directions.

He arrives at the car park

In some systems his car space will already be reserved for him, in others it will be dynamically allocated on his arrival. He follows the personalised direction signs to his car space. The language used in these signs is in English as Dieter has stored his preferred language in his user profile (see clause 10 on personalization and user profiles).

When he arrives at the allotted space.



He presses the button to activate his parking assist system, and selects whether parking is to be "car park" or "parallel".

Once a suitable parking space has been found between two cars, an arrow appears in the display to inform Dieter on which side of the road the parking space is located. He engages reverse gear, and acknowledges the display message. Active parking assist takes over the steering and automatically manoeuvres the car into the parking space.

Dieter only needs to cover the brake. Dieter's active parking assist uses ten ultrasonic sensors and an electronic control unit which processes the sensor signals and calculates the best possible entry path into the parking space.

This information is fed to the electromechanical power steering, whose electric motor performs the necessary steering movements of its own accord. The car is steered gently into its parking space, and the car informs Dieter that the parking is completed, and he applies the handbrake and switches the system off.

Having driven efficiently to the car park, been guided to his allotted parking space, and with the car neatly parked by the assisted parking system, Dieter now proceeds to his meeting, on time and stress free.

13.3.3 Human factors issues

Guidance to a suitable car park with vacant spaces reduces stress on the driver, generally reduces cognitive overload, and reduces the probability of accidents. However, additional signage on the roadside can lead to additional cognitive overload and increase probability of accidents. Bringing this information into the car means that only those who seek parking receive it.

Guidance to a specific parking place also reduces stress and cognitive overload when car parks are busy, and should reduce the probability of accidents if well planned.

Parking assist, although sometimes slower than manual parking, generally reduces stress and reduces the probability of minor accidents.

Further amendment to this service can be obtained if personalization and user profiles are used see clause 10.

14 Discussions and further work

14.1 The application of personalization

Clause 9.6 "Services not part of the primary driving task" gives some examples of services that can be perceived as very beneficial from the point of view of safe driving in terms of the way that they make the driver feel comfortable, confident and relaxed (e.g. air conditioning, an in-car entertainment system, and a navigation system). However a large driver survey [i.54] highlighted these as being identified as a major source of driver distraction. Clause 9.6 highlights that it is when these devices and services need to be adjusted in some way that they become a distraction.

It is therefore very important to identify ways in which the need to adjust these devices and services can be minimized as, despite safety warnings and even perhaps laws, drivers will attempt to adjust these devices. It is certainly the case that drivers even attempt to take CDs out of their cases and remove and replace the CD in the player whilst driving.

The increased fitting of multi-CD players and, more recently, hard disk players by car manufacturers should help to reduce the dangers that occur when drivers attempt to manually change CDs whilst driving. However not all of the problems can be alleviated by changing the hardware used in the car, and even when this is done the problem of CD removal may be replaced with another challenge - making the music selection task of a large music collection a safe and easy task for the driver. This latter problem is of the type referred to in clause 14.2.

Hardware upgrades may make incremental improvements to the potential safety hazard of mid-driving adjustment of devices and services. However, the most effective way to alleviate the problem is to remove the need to have to make such changes. To do this, it will be necessary to identify the driver's actual current needs and then to meet them automatically without the driver having to make a number of manual selections. This is a class of problems for which personalization is the most effective solution.

The key to an effective personalization environment is access to the broadest possible range of context information about the driver that enables their precise current situation to be determined. These sources can include:

- the drivers explicitly identified preferences (e.g. what language they want information to be presented in);
- the driver's location (taken from GPS devices or from proximity sensors at key locations);
- information about the drivers planned future intentions (taken from their schedule, or from predictive inference from past behaviour);
- the current time;
- the presence of others near the driver;
- etc.

Examples of problems that can be addressed by the adoption of a comprehensive personalization solution, as described in clause 10.4 and in [i.1], include:

- allowing the user to select a favourite playlist of music that is loaded on their own hard disk music player;
- automatically adjusting the speed readout of their own portable navigations system to that of the country in which they are driving (e.g. from km/h to MPH) if the driver prefers to use localized settings in order to make it easier to identify how close to a speed limit the car is travelling;
- automatically program in the destination of the trip into the navigation system based on knowledge of the driver's destination (obtained from their online scheduling application);
- music choice based upon the joint interests of the driver and passengers;
- delivering a user's manual for a hire car to the drivers PDA in the driver's own language (making use of back-end dynamic documentation delivery service similar to that used by at least one major car manufacturer in Europe to deliver maintenance manuals customized to an individual vehicle to the mechanic in any garage in Europe);
- having the temperature of a hire car's climate control system adjusted to the driver's personal preferences (rather than the preferences of the last person to hire it);
- etc.

All of the above will deliver an environment for the driver that is comfortable and that help to avoid safety threatening situations (particularly to the drivers of hire cars visiting a foreign country).

14.2 Alternate user interaction styles for in-car usage

If future car developments move towards an architecture similar in concept to that described in clause 11.3, one aspect that can make Nomadic Devices a potential safety risk will be reduced as it will be expected that the device can be controlled by in-car integrated optimised control elements and displays. For example, the control of an mp3-player could be done with the buttons on the steering-wheel and the play list could be presented on the display used for the integrated head unit (including navigation, radio and CD-player). Even an in-car integrated speech recognition system could be used to control a connected nomadic device, if a standardized interface exists. Bluetooth is a common current implementation for linking nomadic devices to the vehicle. If the display of the nomadic device should be still used by the driver, the device needs to safely fixed and positioned with regard to the driver's field of view and comfortable reach.

However, as indicated in clause 6.5 "Hand-eye co-ordination" and clause 7.6 "Implementation of the user interaction methods", those products that have been optimized for hand-held use with the assumption that close and long-duration hand-eye co-ordination will be possible may not be able to be effectively used just by transferring the control function to the car integrated control components. The problem in this case is that the underlying tasks upon which the control mechanisms have been built are not easily compatible with safe in-car use as defined in [i.20]. The task of selecting one item from a list of many hundreds (if not thousands) is not one that can be done successfully as a single task without close visual attention over an extended period (and voice output of such a long list of items would not be a practical solution on many levels). However many portable music players offer such a selection mechanism as their primary way of selecting music.

So if a product that has been designed with the primary aim of being used as a portable handheld device, there may be many aspects of the logical interaction model that will need to be rethought if the device is going to be safe and successful when used in an in-car situation by the driver.

Manufacturers of devices, and services, are aware of the need to provide physical and electrical interconnectivity plus device user interface element mappings for their devices and services if they expect that these devices or services could be used as part of an in-car architecture similar to that described in clause 11.3. However it is suggested that these device and service suppliers consider the implications of what may be needed to support different forms of interaction logic when the product is used in the car to that used for portable handheld usage. ISO/EN 15005 [i.16] states that functions not intended to be used by the driver while driving "shall be inaccessible for, or inoperable by, the driver, or both, when he vehicle is in motion. Otherwise, the driver shall be provided with the intended scope of the TICS use, together with suitable warnings". Although this is aimed at transport information and control system (TICS) functions, the argument for applying similar criteria to functions that may be used in a car but that are not "suitable" for use whilst driving as defined by [i.20] is at least as strong as for functions that are not inherently related to transport.

14.3 Need for additional actions

It is proposed that device and service suppliers consider:

- the implications of being able to exploit a comprehensive personalization environment to delight and protect their customers when using their product in a car;
- the implications of needing to support an in-car mode as well as the existing handheld mode of usage that could radically alter the way that the device behaves when controlled by users. Such a dual mode may be a necessity rather than an option if safe and effective use of the product is to be achievable in a car;
- where device and service suppliers are not able to provide an alternate in-car mode that meets the suitability requirements of [i.20], it would be desirable if those suppliers were able to identify such functions in such a way that a standardized device mounting scheme or an in-car HMI architecture could make those functions "inaccessible", "inoperable" or both as stated in [i.16]. To achieve such an objective, there would need to be a form of joint agreement between car manufacturers and device and service suppliers, as represented at ETSI, to develop standards that would support such functionality.

If there is a common agreement that such developments would be either desirable as a commercial opportunity or required as a way to ensure that their products are used in a safe manner, or both, then standards should be developed to support both of these objectives in a consistent way across the broad ICT and automotive sectors. It is hoped that such standards would complement the initiatives that have already been taken with regard to Nomadic Devices by the Nomadic Device Forum [i.26] (see clause 9.9).

It is expected that the personalization standards already developed by ETSI would form a very broad and appropriate basis for the personalization part of the above requirements.

As already addressed in clause 7.2.2, spoken input can be of great advantage while driving a car. In order to raise the recognition probability, a solution is to establish a limited set of standardized spoken commands, which should be available in a range of languages. The ETSI Human Factors standard on voice commands [i.5] is relevant to the development of speech systems used in cars where spoken input will allow the visual focus of the driver to remain on the primary driving tasks (e.g. in terms of basic control functions and for the methodology for expanding the spoken command vocabulary).

Ideally, a spoken command vocabulary should be intuitive, easy to learn, memorable, natural, and unambiguous. A well designed speech interface should [i.5]:

- have a shallow learning curve;
- execute most common tasks;
- the ability to handle the vagaries of speech recognizers in a reliable and predictable way, maximizing the user experience.

Adequate feedback should be provided to users indicating, where applicable, that a command cannot be executed when requested. Three examples are:

- When a function is not supported.
- When the function is currently not available.
- When the command is not understood.

Another important factor is to address phonetic discriminability. It is important to ensure that two (or more) commands are not to similar which might cause a risk of high degree of confusability in the speech recognizer. Thus, it would be important to co-ordinate the development of the vocabulary with the existing standard for spoken commands [i.5], in order to avoid conflicting commands or very similar commands that could be confusing for the driver and which could also result in a misinterpretation by the speech system.

There is a need to avoid conflict between in-car voice systems and those supported by nomadic devices. (in terms of vocabulary or in activating/deactivating listening in the devices). A solution for determining which device or service is being controlled needs to be developed for the case where there are multiple devices and services that each separately support spoken commands and for the case where a single in-car voice system is controlling multiple devices and services.

Annex A: Detailed ICT service analysis

A.1 Safety related service examples

NOTE: The following tables represent some services that were examined to look for the core issues related to both specific services and also to categories of services. The major implications that relate to categories of services have been extracted and described in more detail in the main part of the present document.

Table A.1: Collision Avoidance (includes Emergency Brake Assist, Lane Keeping, etc.)

Collision Avoidance (includes Emergency Brake Assist, Lane Keeping, etc.)	
Circumstances where service is designed to react:	Collision predicted
Current driver activity:	Unknown
Stages of service action	a) Warning
	b) System takes control (see note 2)
Specific service actions	
Notification/alerts	Either
Vehicle control	System modifies car speed/position to avoid crash where possible/feasible
Where to notify	Audible
Service notifications	
Immediacy	Immediate / real time
Accuracy of prediction	Vital
Intrusiveness (distraction)	High
Required driver actions	Users cannot override the collision avoidance action nor can they silence the audible alarm
NOTE 1: This is a broad class of services and some are very future oriented. NOTE 2: Service specific decision on whether the service is notification only, system controlled avoidance only, or notification followed by system controlled avoidance if the driver fails to take adequate avoidance action.	

Table A.2: Electronic Stability Control (ESC)

Electronic Stability Control (ESC)	
Circumstances where service is designed to react:	When the vehicle detects a loss of steering control
Current driver activity:	Driving beyond the limits of the road conditions
Stages of service action	Braking action is applied to the individual wheels - engine power may be temporarily reduced until the control is regained
Specific service actions	
Notification/alerts	Non-intrusive visual indications may encourage more responsible driving
Vehicle control	Braking action is applied to the individual wheels - engine power may be temporarily reduced until the control is regained
Where to notify	Visual in the forward vision (if appropriate) - threshold level for warnings could be subject to user preferences
Service notifications	
Immediacy	
Accuracy of prediction	
Intrusiveness (distraction)	
Required driver actions	User may be able to de-activate the system

Table A.3: Blind Spot

Blind Spot	
Circumstances where service is designed to react:	Driving in traffic
Current driver activity:	Looking ahead and in mirrors - concentrating on traffic
Stages of service action	a) General notification
	b) When the driver tries to move into the path of the vehicle in the blind spot
	c) When driver ignores warning
Specific service actions	
Notification/alerts	a) An indication that a car is in the blind spot - maybe a visible but non-intrusive light
	b&c) An intrusive alert e.g. loud sound, short command, vibration
Vehicle control	Optional c) Automatic avoidance action taken
Where to notify	a, b, c) Rear view mirrors
Service notifications	
Immediacy	Immediate
Accuracy of prediction	100 % accurate
Intrusiveness (distraction)	a) No b, c) Yes
Required driver actions	Avoid colliding with vehicle in blind spot

Table A.4: Ice on Road Ahead

Ice on Road Ahead	
Circumstances where service is designed to react:	Ice somewhere ahead (e.g. notified by road infrastructure or by car-to-car signalling)
Current driver activity:	Unknown
Stages of service action	a) Ice > 0,5 km
	b) Ice < 0,5 km
Specific service actions	
Notification/alerts	Limited repeating (with escalation on approach)
Vehicle control	
Where to notify	Audible warning and possible text warning. Also shown on SatNav (see notes 1 to 4)
Service notifications	
Immediacy	As soon as possible.
Accuracy of prediction	The likely accuracy should be notified to the driver. Low OK
Intrusiveness (distraction)	a) Quite low
	b) Quite high
Required driver actions	User may silence the alarms
NOTE 1: User may silence the alarms. NOTE 2: SatNav can show the extent and severity of the ice. NOTE 3: Details of ice in voice and text alerts will need to be carefully phrased. NOTE 4: The user will need to be able to replay any voice alerts and redisplay any text alerts given.	

Table A.5: Emergency vehicle prioritisation pre-emption and warning

Emergency vehicle prioritisation pre-emption and warning	
Circumstances where service is designed to react:	When emergency vehicle approaching
Current driver activity:	Driving normally
Stages of service action	a) In advance of emergency vehicle approach the service will prioritize traffic signals and warn other vehicles
	b) Advising drivers and pedestrians. This summary is focussed on (b)
Specific service actions	
Notification/alerts	Minimum: High priority alert that vehicle is approaching Preferred: Also information on the direction of approach and an indication of distance
Vehicle control	
Where to notify	Audible alarm to alert driver + Visual indication in line of view of direction of approaching vehicle (e.g. in a screen near the line of sight, in a HUD and mirrors)
Service notifications	
Immediacy	Immediate
Accuracy of prediction	Important - but not critical (direction most important to be correct)
Intrusiveness (distraction)	High
Required driver actions	Move out of the path of the approaching vehicle and allow other vehicles to also do so

Table A.6: Pedestrian Crossing Control

Pedestrian Crossing Control	
Circumstances where service is designed to react:	If the pedestrian crossing is in active use
Current driver activity:	Driving normally
Stages of service action	Vehicle is brought safely to a halt before the crossing
Specific service actions	
Notification/alerts	Audio/visual alert
Vehicle control	Vehicle is brought safely to a halt before the crossing
Where to notify	In line sight and audio
Service notifications	
Immediacy	Quite soon
Accuracy of prediction	High
Intrusiveness (distraction)	Medium
Required driver actions	No additional actions

Table A.7: eCall

eCall	
Circumstances where service is designed to react:	In an emergency i.e. is triggered by sensors in the vehicle or by pressing the emergency button
Current driver activity:	Potentially injured
Stages of service action	a) Call automatically generated by sensors or button
	b) Automatically sends minimum set of data to PSAP
	c) Establishes voice channel between PSAP and vehicle occupants
	d) PSAP operator speaks to occupants and possible dialogue ensues
Specific service actions	
Notification/alerts	Voice of PSAP operator
Vehicle control	
Where to notify	Car speakers
Service notifications	
Immediacy	Data sent within approx. 4 seconds of establishing call
Accuracy of prediction	System operation > 99 % (assuming communications link available)
Intrusiveness (distraction)	None - driver not driving - post traffic incident
Required driver actions	Occupant(s) should speak through microphone if possible

A.2 Other services

Table A.8: Parking assist

Parking assist	
Circumstances where service is designed to react:	Driver wishes to find a parking space and park
Current driver activity:	Driver approaching journey destination
Stages of service action	a) Driver initiates service (presses button)
	b) System finds suitable parking space
	c) Driver confirms
	d) System parks vehicle without driver intervention
Specific service actions	
Notification/alerts	a) System activated
	b) Space identified
	c) Service completion
Vehicle control	c) Car automatically parked
Where to notify	a, b, c) Screen and audio message
Service notifications	
Immediacy	Immediately on request when vehicle travelling at slow speed
Accuracy of prediction	High
Intrusiveness (distraction)	Driver needs to remain aware of other traffic and pedestrian movements (although system deactivates if obstacle detected)
Required driver actions	On system activation (either automatic or manual, the vehicle contacts and advises the returns depot of vehicle ID, current odometer reading, fuel tank status. System matches with record and produces sign off sheet/charge for service assistant to deliver to driver for agreement
	b) Driver confirms parking space suitable
	c) Driver takes control at end of manoeuvre
NOTE: Systems vary slightly from manufacturer to manufacturer (this example based on Lexus system). No standardisation so there is a danger that different system behaviour does not cause accidents/ mis-operation if control instructions and behaviour different.	

Table A.9: Rental car processing

Rental car processing	
Circumstances where service is designed to react:	Driver returns vehicle to rental car depot
Current driver activity:	Driver approaching rental car depot to return the car
Stages of service action	a) Driver instigates system by pressing button, calling up on screen and activating, or vehicle automatically activates on entrance to car returns
	b) Present result
Specific service actions	
Notification/alerts	a) Parking return action has commenced
	b) Return processing complete
Vehicle control	
Where to notify	a) Automatically activation notified on screen and via audio message
	b) Contract completion information on in-car screen. Also in paper or electronic version that the driver can agree with the parking depot assistant
Service notifications	
Immediacy	Not immediate but within a few seconds
Accuracy of prediction	High
Intrusiveness (distraction)	Should not be too intrusive while vehicle still in motion
Required driver actions	User either initiates system, or responds to location based request from vehicle
NOTE 1: On system activation (either automatic or manual, the vehicle contacts and advises the returns depot of vehicle ID, current odometer reading, fuel tank status. System matches with record and produces sign off sheet/charge for service assistant to deliver to driver for agreement. NOTE 2: Service description from Intelligent Transport Systems Standards. No known service in operation at present. Service variants could be significant - certain processes can be automated - still requires human intervention. Feedback to user is important to ensure that driver and the rental company are agreed on what has happened and what the charge is.	

Table A.10: On trip route guidance

On trip route guidance	
Circumstances where service is designed to react:	Driver/Vehicle occupant identifies destination and requests route guidance
Current driver activity:	Driving to a pre-specified location
Stages of service action	a) Request service
	b) Enter destination information
	c) Activate system
	d) System plots route and provides step-by-step instructions
	e) System monitors traffic information data and proposes route revisions as appropriate
Specific service actions	
Notification/alerts	Step-by-step directions, route changes, TOA data
Vehicle control	None
Where to notify	Screen and audio
Service notifications	
Immediacy	In time for the driver to take appropriate action. But delayed or suppressed if an important and urgent safety related message needs to be displayed or spoken
Accuracy of prediction	Needs to be accurate and timely
Intrusiveness (distraction)	Screen information, screen clutter, spurious messages, small images can all detract from the driving task. Navigation instructions could prevent the driver from hearing or seeing important safety related messages from other ICT service in the car
Required driver actions	The drive (or passenger) activates the system and inputs destination information
NOTE: There are many products already on the market that perform most or all of this functionality. This description includes on trip rerouting, which is currently available on only a few systems. Operating procedures and display information vary from model to model. Most current in-car systems and all nomadic systems will fail to delay or suppress navigation instructions if there is a need to convey an urgent and important safety warning.	

Table A.11: Vision enhancement systems (VESs)

Vision enhancement systems (VESs)	
Circumstances where service is designed to react:	Night driving and limited visibility (fog, mist, spray)
Current driver activity:	Driving and concentrating hard to see the road ahead
Stages of service action	When activated, VES provides enhanced contrast to drivers, detection and recognition of targets while performing speed monitoring and navigation tasks
Specific service actions	
Notification/alerts	Normally none in envisaged products
Vehicle control	
Where to notify	On light indication
Service notifications	
Immediacy	Immediate
Accuracy of prediction	Enhances contrast, therefore visibility
Intrusiveness (distraction)	In trials, VES enhancements were not always detected by drivers because of the visual, scanning and cognitive demands of the driving tasks. Also, older drivers were less willing to rely on the system
Required driver actions	VES provides target contrast at longer preview distances than low-beam headlights alone. VES increases curve detection

Table A.12: Transport related electronic financial transactions (e.g. road tolls)

Transport related electronic financial transactions (e.g. road tolls)	
Circumstances where service is designed to react:	When a car passes a toll point/toll plaza
Current driver activity:	Driving towards a toll point/toll plaza
Stages of service action	Payment by electronic means (usually transponder) linked to pre-pay or post-pay accounting system. System may be open (single toll point) or closed (entry and exit noted). System may be lane dependent, or free flow, depending on technology
Specific service actions	
Notification/alerts	Audible/visible warning at point or on entry/exit. Barriers lift when required
Vehicle control	
Where to notify	No specific location
Service notifications	
Immediacy	In a timely fashion
Accuracy of prediction	High (monetary transaction)
Intrusiveness (distraction)	Is usually low
Required driver actions	None (automatic)

Table A.13: Disadvantaged pedestrian assistance

Disadvantaged pedestrian assistance	
Circumstances where service is designed to react:	When a disadvantaged pedestrian (e.g. physically disabled, blind) wishes to cross a traffic signal controlled road crossing
Current driver activity:	Approaching a pedestrian crossing
Stages of service action	a) The traffic system detects a disadvantaged pedestrian
	b) The traffic signal system informs the in-vehicle units of a traffic signal change and presence of a pedestrian who may move too slowly to cross the road using the normal signal change duration
Specific service actions	
Notification/alerts	a) Disadvantaged pedestrian alerts road signals
	b) The signal from the crossing is used to ensure that the driver is alerted
Vehicle control	
Where to notify	The driver is given an audio (and possibly visual) warning to alert them to be careful of slow moving pedestrians on a crossing
Service notifications	
Immediacy	In a timely manner
Accuracy of prediction	Needs to be accurate
Intrusiveness (distraction)	Intended to be intrusive to warn drivers
Required driver actions	Modify driving behaviour as a result of the awareness of slow moving pedestrians
NOTE: Alternative solutions such as systems that adjust the crossing time when a person with disabilities is automatically detected may also be used.	

Annex B: Summary of existing work

B.1 Analysis of existing work

A detailed analysis has been made of existing ITS projects (National and European) and also of the work of Consortium/Organizations/Institutes working in the ITS related area.

Those addressing Human Factors aspects are listed in the tables below.

Name	AIDA - Applications of Integrated Driver Assistance
Type/Dates	National Institute - NL/2003 - Continuous
Aims in short	The knowledge centre Applications of Integrated Driver Assistance (AIDA) is realised by TNO and the University of Twente. Its aim is to carry out innovative research and to educate students working in the field of driver support systems, a field in which the integration and coordination of subsystems and services is an issue. Projects: 1. Modelling of driving behaviour and behavioural adaptation to advanced driver assistance systems (ADAS) when driving on urban intersections. 2. Environmental traffic management through integrated vehicle-road systems. 3. Evaluation of the effects of a speed surveillance system in delivery vans.
References	http://www.aida.utwente.nl/ http://www.aida.utwente.nl/organisation/AIDA-brochure-2008.pdf
Human Factors Issues that are relevant	The first project addresses Human Factors aspects. The driving task is a hierarchical task with three interacting levels. This interaction becomes most clear on urban intersections, where all levels are equally important. A behaviour simulation model of intersection driving will be developed, based on this hierarchical structure of the driving task. With this driver model, behavioural adaptation to ADAS on urban intersections can be studied. Scientific and Societal Relevance. The behaviour simulation model will give new insight into driving behaviour and the driving task. It can also be implemented into the driver module of simulation software (e.g. driving simulator software and microscopic traffic simulation models) to improve its performance. New knowledge about behavioural adaptation to intersection ADAS can be used for further development of new ADAS systems. Background and problem definition.
Human Factors topics	- Driver behaviour
Human Factors evaluation	Medium Importance

Name	AIDE - Adaptive Integrated Driver-vehicle InterfacE
Type/Dates	European Project/March 2004-February 2008
Aims in short	General principles The objectives of AIDE are to: • maximise the efficiency, and hence the safety benefits, of advanced driver assistance systems; • minimise the level of workload and distraction imposed by in-vehicle information systems and nomadic devices; and • enable the potential benefits of new in-vehicle technologies and nomadic devices in terms of mobility and comfort. The following principles regarding HMI integration has been identified by AIDE: 1. Several applications sharing the same output devices. 2. Prioritization and queuing of messages to avoid driver overload. 3. Several applications sharing the same input devices. 4. Individual applications being controlled by several alternative input devices. 5. Integration of nomadic devices into the vehicle HMI. AIDE Architecture AIDE provides a flexible and modular architecture. The situation today, IVIS (In-Vehicle Information Systems) and ADAS (Adaptive Driver Assistance Systems) individually interact with the driver. With the AIDE architecture, the Communication between driver and in-vehicle systems is managed by a central I/O Management based on the Driver-Vehicle-Environment.
References	http://www.aide-eu.org/
Human Factors Issues that are relevant	The AIDE project addresses the following HMI adaptivity issues: 1. Rescheduling of messages due to high driver workload (demanding traffic situation, high traffic risk). 2. Adaptation of message presentation to driver state. 3. Intensification or earlier presentation of important messages to make sure an inattentive (distracted or drowsy) driver does not miss them or get them too late. 4. When messages need to be presented even though the driver workload is high (demanding traffic situation, high traffic risk), presentation of messages in a simplified form.
Human Factors topics	- Driver workload - Driver distraction - HMI design
Human Factors evaluation	High Importance

Name	CALM - Communications Access for Land Mobiles
Type/Dates	ISO Standardization Project (ISO TC204 WG16) / Continuous
Aims in short	The concept of CALM, and the architecture and standards that embody it, is predicated on the principle of making "best" use of the resources available. The resources are the various communications media available, and "best" is defined by the objectives to be achieved and their relative cost. Flexibility, adaptability, and extensibility are the keys to its success. The CALM concept is therefore developed to provide a layered solution that enables continuous or quasi continuous communications between vehicles and the infrastructure, or between vehicles, using such (multiple) wireless telecommunications media that are available in any particular location, and have the ability to migrate to a different available media where required. Media selection is at the discretion of user determined parameters. The concept is being embodied in more than 20 International Standards, and there is close co-operation between ISO, ETSI and IEEE on these developments. CALM Benefits CALM combines several communication media in an open manner in accordance with International Standards that provide: - Openness, since the standards are available to everybody - Stability, since there is a formal body responsible - Visibility and credibility of the specifications - An open way to influence the next phases of standards - Extensibility Wherever possible, CALM is based on IPv6 (Internet Protocol Version 6) which means that it is fully compatible with Internet services, while at the same time not being restricted by the addressing shortcomings of the current IPv4 protocols. For time critical safety services, where processing or radio protocols are not rapid enough to support IPv6 protocols, there is a "CALM-FAST" mode of operation which enables very rapid transmission of short messages. CALM is based on an architecture that is capable to utilise any communications media (but does not expect many of them to be present at any time).With CALM Management Standards that manage the prioritisation and use of particular media for particular purposes.
References	www.calmforum.com www.calm.hu www.iso.org www.etsi.org In standards, particularly: ISO 21217 [i.58]
Human Factors Issues that are relevant	Human factors are recognised as an important factor, as is the integration of nomadic/mobile devices, but focus to date has been on developing standards for basic communications aspects and human factors is seen as future work once applications become more specific.
Human Factors topics	- Information prioritization
Human Factors evaluation	Low importance

Name	COVER
Type/Dates	European Project/March 2006-February 2009
Aims in short	Development of applications such as intelligent speed adaptation, and cooperative early information that are shared in real time among vehicles and infrastructures. The COVER project fosters the creation of next generation, intelligent, cooperative systems that will make road transport more efficient, safer and more environmentally friendly. By integrating semantic technologies, intelligent agents, in-car and infrastructure sensor data, multi-channel communication technologies and context-aware and multimodal (voice/graphics) interfaces, COVER will provide interoperable semantic-driven cooperative systems that are user-friendly, cost-effective and able to achieve unprecedented road transport efficiency as well as implement advanced eSafety applications.
References	http://www.loquendo.com/en/brochure/Cover-project.pdf
Human Factors Issues that are relevant	By improving communication channels between vehicles and the existing road network infrastructure, far more in-depth information will be passed on to the driver, such as fully up-to-date info on road/traffic conditions, road works and weather conditions. Further, by employing and sharing "context knowledge", vehicles will have far more sophisticated recognition systems, directing drivers' attention to road hazard signs, to sharp bends and to accident hotspots, allowing appropriate action to be taken well in advance.
Human Factors topics	- HMI design
Human Factors evaluation	Low importance

Name	EASIS - Electronic Architecture and System Engineering for Integrated Safety Systems
Type/Dates	European Project/2004-October 2007
Aims in short	The targets to road safety set by European commission transport policy can only be reached by an integrated approach for vehicle safety systems, i.e. the combination of active and passive safety systems over vehicle domains or networks. EASIS Approach: - Develop a standardized in-vehicle electronic architecture and a standardized system engineering approach for integrated safety systems - Provide an enabling technology for the introduction of integrated safety systems Objectives and expected outcomes: - A modular scalable E/E-architecture for active, passive and integrated safety systems - Standardized signal and functional interfaces to environment detection systems, telematics, power train, chassis, and HMI - Embedded system safety analysis - Prototype implementation and validators - Means to handle high system complexity in the development process - Provision of a migration path into existing automotive system architectures - Provision of a high availability and safety even in case of single component failures - Preparation for standardization
References	http://www.ist-world.org/ProjectDetails.aspx?ProjectId=d50a12df488f420d841cc8bc0af81351
Human Factors Issues that are relevant	Even if HMI is not the main goal of this project, the human factors aspects are addressed in its developing a standardized architecture for integrated safety systems.
Human Factors topics	- Unique architecture for integrated safety systems - HMI design
Human Factors evaluation	Low Importance

Name	EUCLIDE- Enhanced human machine interface for on vehicle integrated driving support systems
Type/Dates	European Project/March 2001-May 2004
Aims in short	EUCLIDE will develop a new reliable integrated driver assistance support system, which will monitor the area ahead of the driver and will provide an effective support especially in cases of night and adverse weather conditions. This system will integrate the functionalities of a radar and a far infrared sensors resulting to a highly reliable and efficient system. At the same time a new enhanced multifunction HMI, based on the state of the art at EU level, will be developed. The proposed system is expected to the market stepwise within the next 5 years.
References	http://www.google.co.uk/search?hl=fr&q=euclide+european+project http://www.ist-world.org/ProjectDetails.aspx?ProjectId=5aac345aae9b44f8a37870c7fc87784e&SourceDatabaseId=9cd97ac2e51045e39c2ad6b86dce1ac2
Human Factors Issues that are relevant	The main aim of the project is to address the strong societal needs of reducing the total number of accidents. So the proposed project will strongly address Human Factors issues. The following principles regarding HMI integration has been identified by EUCLIDE: 1. "User cantered" design process: the system development started up with the analysis of end-user requirements. 2. Definition of human machine interaction based on expert evaluations and subsequent simulator trials. Optical information presented to driver in two areas: a) permanent, detailed information outside the primary field of view b) simple, time restricted information cantered in front of the driver
Human Factors topics	- HMI design
Human Factors evaluation	Medium Importance

Name	eVALUE (FP7)
Type/Dates	European Project/January 2008-December 2010
Aims in short	To develop testing and evaluation methods for ICT-based safety systems. To increase public perception and customer acceptance of ICT-based Safety systems. To support development of ICT-based safety systems at vehicle OEMs and suppliers.
References	http://www.evalue-project.eu/ http://www.evalue-project.eu/pdf/evalue-080402-d11-v14-final.pdf
Human Factors Issues that are relevant	Analysis of the existing and future ICT-based safety systems. HMI design details are included in. Besides eValue studies the customer acceptance of these systems and one of the acceptance criteria is HMI.
Human Factors topics	- HMI design - Driver acceptance
Human Factors evaluation	Medium Importance

Name	GST - Global System for Telematics
Type/Dates	European Project/March 2004-April 2007
Aims in short	GST is a so-called "Integrated Project" or programme of interdependent activities, aiming to structure European research in the field of telematics. This was a European funded Integrated Project (IP) in the 6th framework. The main GST objectives are the development of an overall system architecture for end-to-end telematics, including the use of the car itself as a floating traffic sensor where vehicles monitor and report the road network status situation in their vicinity. GST goals also include the development and validation of cost-effective broadcast mechanisms to communicate safety-relevant information to drivers, and ensuring a fast, reliable and safe pan-European response to vehicle incidents (based on eCall).
References	http://www.gstforum.org/
Human Factors Issues that are relevant	Among the 7 Subprojects, the following 2 projects address Human Factors aspects: Safety Channel (SAF-CHAN) This sub-project aims to develop and validate the "Safety Channel" concept for priority, real-time communication and warnings relevant to traffic, road and weather conditions. Safety Channel will support the generation, management and delivery of safety-related information to drivers such as variable speed limits, hazard warnings, weather alerts and dynamic traffic information that will lead to improved road safety and mobility. RESCUE (RSQ) RESCUE ensures that information about the incident will be available in the emergency vehicles and that they are able to quickly and safely reach the incident scene. To ensure this, the sub-project will complete the in-vehicle emergency call chain, provide guidance to the emergency service to the scene of the incident by accurate locations, trial blue corridors and coning systems (vehicle-to-vehicle communication) thus warning other road users of the approach of the emergency services. In addition, the emergency response can greatly benefit from an exchange of information between the rescue units and control rooms (police, hospitals, etc.).
Human Factors topics	- Information prioritization - HMI design
Human Factors evaluation	Medium Importance

Name	HAVE-IT - Highly Automated VEhicles for Intelligent Transport
Type/Dates	European Project/February 2008-July 2011
Aims in short	HAVE-IT proposes to develop, validate and demonstrate 6 cutting edge, automated driving applications for both passenger cars and trucks, which will contribute to the long-term vision of highly automated driving. Some of this development builds on an earlier IP, SPARC. HAVE-IT is an FP7 project.
References	http://ec.europa.eu/information_society/activities/esafety/doc/rtd_projects/fact_sheets_fp7/have_it.pdf http://www.haveit-eu.org/displayITM1.asp?ITMID=10&LANG=EN
Human Factors Issues that are relevant	The improvement of road safety, energy efficiency and comfort will be reached with the development of a virtual co-pilot, which will be able to support the driver in optimizing the vehicle control. To achieve this goal, HAVE-IT will investigate the level of adequate and internally synchronized support. Driver monitoring will be used to estimate the driver's performance.
Human Factors topics	- Driver behaviour
Human Factors evaluation	Medium Importance

Name	Highway
Type/Dates	European Project/April 2004-December 2006
Aims in short	Safety and location-based value added services where interactions between the person in control, the vehicle and the information infrastructure are addressed in an integrated way through intelligent maps
References	http://www.ist-world.org/ProjectDetails.aspx?ProjectId=1acfda9f6a954d688c0e2b1a85b4dd96 http://ec.europa.eu/information_society/activities/esafety/doc/rtd_projects/fact_sheets_fp6/highway.pdf
Human Factors Issues that are relevant	HIGHWAY maps will help drivers facing critical driving situation resulting from road topography, e.g. by delaying incoming phone calls or triggering safety mechanisms based on map information like the radius of the curve ahead or speed limits or data like an accident ahead. In addition to decreasing the probability for accidents and minimising potential damage to drivers and property, HIGHWAY services will be more cost-effective, efficient (saving time to customers) and informative.
Human Factors topics	- HMI design
Human Factors evaluation	Low Importance

Name	Humanist - Human centered design for Information Society Technologies
Type/Dates	European Project/March 2004-February 2008
Aims in short	Create and maintain a network of excellence coordinating research about user/system interactions and their applications on in-vehicle information systems / advanced driver assistance systems
References	www.noehumanist.org
Human Factors Issues that are relevant	Particularly relevant - Task Force A: Identification of the driver needs in relation to ITS. - Task Force B: Evaluation of ITS potential benefits. - Task Force D: Impact analysis of ITS on driving behaviour. The following principles regarding HMI integration has been identified by HUMANIST: 1. Identification of user needs in relation to ITS. 2. Impact analysis of ITS on driving behaviour.
Human Factors topics	- Driver behaviour - Driver needs
Human Factors evaluation	High Importance

Name	Im@gine IT
Type/Dates	European Project/January 2004-June 2006
Aims in short	Develop a unique access point, through which the end user can obtain location-based, intermodal transport information (static and dynamic), mapping and routing, navigation and other related services everywhere in Europe, anytime, taking into account personal preferences of the user.
References	http://ec.europa.eu/information_society/activities/esafety/doc/esafety_library/projects_fact_sheets/imagine_it.pdf
Human Factors Issues that are relevant	The following principles regarding HMI integration has been identified by Im@gine IT: 1. Design of a user preference and context of use. 2. Issue of guidelines towards on-board compatible and off-board user interfaces. 3. Provide service through different devices (mobile phone, mobile PC, PDA, in-car device). 4. Develop a Multi-Agent System that recognizes and learns user preferences and guides the system's interaction with its ambient intelligence.
Human Factors topics	- Driver workload - Driver profile and preferences - HMI design
Human Factors evaluation	High Importance

Name	INFONEBBIA - Fog Monitoring System
Typology/Dates	National Project - IT/2003-ongoing
Aims in short	Infonebbia is a common research project between FIAT Research Center and ANAS (Italian road Authority). The aim of this project is to develop and test an integrated system to support the driver in low visibility scenario (with major accent on Fog). Key points of the research are the integration between the drivers (in his car) and the infrastructure, and the global approach to the problem supported by a monitoring system that centrally controls all the involved parameters (weather sensors, car sensors, traffic sensors, safety cars, …) and decide the actuation of one or more support strategies (using variable message signs, on board unit, optical systems, etc.).
References	http://www.cvisproject.org/en/links/infonebbia.htm
Human Factors Issues that are relevant	One of the results is to select the best way to transmit the information to the driver.
Human Factors topics	- HMI design
Human Factors evaluation	Medium Importance

ISP: also include a table on the ISP project: "The EU project within the Integrated Safety Program (ISP) has been under way since 2004 and encompasses five projects, of which Volvo participated in four and was responsible for the Adaptive Integrated Driver-vehicle InterfacE (AIDE)".

Name	IN-SAFETY
Type/Dates	European Project/February 2005-February 2008
Aims in short	IN-SAFETY project aims to use intelligent, intuitive and cost-efficient combinations of new technologies and traditional infrastructure best practice applications, in order to enhance the forgiving and self-explanatory nature of roads.
References	http://www.insafety-eu.org/
Human Factors Issues that are relevant	Two of its goals are: - Assessing the potential and cost-effectiveness of combined use of such new technologies (ADAS, IVIS) and innovative HMI concepts. - Harmonising / optimising vertical and horizontal signing and personalising their information to the specific needs and wants of each user.
Human Factors topics	- HMI design - Driver needs - Driver profile and preferences
Human Factors evaluation	Medium Importance

Name	INVENT - Intelligenter Verkehr und Nutzergerechte Technik = intelligent traffic and user-friendly technology
Type/Dates	National Project - DE/September 2001-April 2005
Aims in short	One of the greatest challenges in sustaining mobility is to improve traffic safety and keep traffic flowing in the face of growing demands on our roadway networks. Avoiding accidents and reducing congestion by making traffic itself intelligent: these are the goals of the research initiative INVENT). Within the German federal program "Mobility and Transport", the INVENT consortium unites the talents of 23 partners, including automobile and electronics manufacturers, information technology and software companies, and research institutes, to achieve the goal of INVENT. With a budget of over 76 million Euros, the INVENT consortium will develop new driver assistance systems and sophisticated information services based on advanced intelligent technologies in the coming four years. Funding from the Federal Ministry for Research and Education (BMBF) will cover 45 % of the costs.
References	http://www.invent-online.de/ www.invent-online.de/downloads/INVENT_Pressrelease_01-09-18.pdf
Human Factors Issues that are relevant	Driver behaviour and HMI requirements were carefully investigated in INVENT project. Interesting aspects were about how drivers learn to operate new systems, what kinds of warnings could be perceived and interpreted most rapidly, as well as what input could irritate the driver and even provoke errors.
Human Factors topics	- HMI design - Driver behaviour
Human Factors evaluation	High Importance

Name	I-WAY - Intelligent co-operative system in cars for road safety
Type/Dates	European Project/February 2006-December 2009
Aims in short	The i-way project is strongly committed to achieve the two strategic objectives of i) increasing road safety and ii) bettering transport efficiency. The goal of I-WAY is to develop a multi-sensorial system that can ubiquitously monitor and recognize the psychological condition of driver as well as special conditions prevailing in the road environment.
References	http://www.iway-project.eu/index.aspx
Human Factors Issues that are relevant	The following Human Factors aspects are addressed: - Increase safety in road transport by empowering the information exchange among vehicles and between vehicles and the surveillance control system and by providing vehicles with active sensors that recognise driver fatigue and act on it. - Improve traffic management control by providing vehicles with on-car sensors recognising weather conditions, distances to various types of obstacles on the road including automobiles, road shape and driver fatigue. - Make transport more efficient and effective by supporting drivers with warnings and suggestions (i.e. traffic and accident alert, distance alert from objects, warning of lane deviations, warning for driver sleepiness) thanks to an intelligent decision support system and an intelligent driving control system that monitors, collects and manages information and communication to the driver. - Make voyages more friendly and comfortable for drivers and passengers that endowed with a large amount of information about weather conditions and road traffic have the chance to vary their route as well as their destination for better trip.
Human Factors topics	- Driver workload - Driver behaviour
Human Factors evaluation	Medium Importance

Name	PReVENT
Type/Dates	European project/February 2004-March 2008
Aims in short	The Integrated Project (IP) PReVENT is a European automotive industry activity co-funded by the European Commission to contribute to road safety by developing and demonstrating preventive and active safety applications and technologies. Preventive safety applications 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. Among the long list of in PReVENT integrated subprojects, the ones following are relevant for the present document: - APALACI: this is developing a system for advanced pre-crash and collision mitigation, including innovative sensor fusion techniques. The APALACI application is based on the detection of a collision event some instances before it occurs to improve the intervention of on-board systems and enhance the protection of car occupants, thus mitigating the severity of unavoidable crashes. - INSAFES: concentrated on monitoring the area around the vehicle, developing and/or improving a wide range of functions: from pre-crash and collision mitigation, all-around collision warning to safe speed and safe distance functions. The general goal of INSAFES was to improve the functionality and reliability of applications developed within IP PReVENT, and to advance from stand-alone safety applications targeting one specific function to an integrated system covering a vast range of applications. This priority of INSAFES focused on monitoring the complete area around the vehicle, in order to warn the driver, intervene or mitigate the effects of an accident. INSAFES refers to results from the AIDE project. - LATERAL SAFE: introduced a cluster of safety applications which contribute to the prevention of lateral/rear-related accidents and assist the driver in adverse or low visibility conditions and blind spot areas. Drivers should be warned about an imminent risk of accident, particularly during lane change manoeuvres. - PReVAL: deal with a evaluation framework for PReVENT. A methodology was defined to be used for the impact assessment of various applications. - RESPONSE 3: elaborated a European Code of Practice (CoP) for the development and testing of Advanced Driver Assistance Systems (ADAS) by the industry. - SASPENSE: developed and evaluated an innovative system able to perform a reliable and comfortable Safe Speed and Safe Distance concept, which helps the driver, avoid dangerous situations related to excessive speed or too little headway.
References	http://www.prevent-ip.org/
Human Factors Issues that are relevant	- APALACI: Human Factors issues relevant only in the context of the considered application. - INSAFES: as above. - LATERAL SAFE: as above. - PReVAL: HMI results were evaluated with respect to user acceptance, preferences and behaviour. - RESPONSE 3: The European Code of Practice should help manufacturers to "safely" introduce new safety applications through an integrated perspective on human, system and legal aspects. - SASPENSE: The system should co-operate seamlessly with the driver through the most suitable HMI channels, and suggest the proper velocity and headway for the given driving conditions.
Human Factors topics	- HMI design - Driver acceptance
Human Factors evaluation	Medium Importance

Name	Prosper
Type/Dates	European Project/December 2002-September 2012
Aims in short	Assess user reactions to different types of road speed management methods, and evaluate implementation strategies for different types of speed management methods
References	Final results of the trial on Intelligent Speed Adaptation (ISA) in Belgium: http://www.ist-world.org/ProjectDetails.aspx?ProjectId=4c76de4c3a064253b0c07388b0b076a5
Human Factors Issues that are relevant	In the PROSPER-project different countries participated regarding ISA-research, the term acceptance was related to research on opinions, perceptions and attitudes of the test drivers.
Human Factors topics	- Driver behaviour
Human Factors evaluation	High Importance

Name	RANKERS - Ranking for European road safety (V2I)
Type/Dates	European Project/February 2005-January 2008
Aims in short	The overall objective of RANKERS is to develop scientifically researched guidelines on road infrastructure safety enabling optimal decision-making by road authorities in their efforts to promote safer roads and eradicate dangerous road sections.
References	http://www.rankers-project.com/ http://www.rankers-project.com/en/reports/
Human Factors Issues that are relevant	RANKERS is highly innovative in its scope and objectives. The safety analysis will address all types of existing roads (dual-carriageways, motorways, rural and urban roads), integrate human behaviour and vehicle technology considerations and consider both accident prevention and mitigation. Ultimately, RANKERS will help answer the following questions: - How does the road surface (e.g. rough roads) and road geometry (e.g. monotonous roads) affect drivers' state (e.g. fatigue)? - How are road signalling design and location influencing signals recognition? - How do the position and features of the various road elements affect driver situation awareness?
Human Factors topics	- Driver behaviour
Human Factors evaluation	High Importance

Name	SAVE - SYSTEM FOR EFFECTIVE ASSESSMENT OF DRIVER STATE AND VEHICLE CONTROL IN EMERGENCY SITUATIONS
Type/Dates	European Project/January 1996-December 1998
Aims in short	Develop an integrated system capable of detecting driver status problems, inform the driver and the surrounding traffic. If the driver is incapable of safely controlling the vehicle, the SAVE system will manoeuvre the vehicle to the roadside.
References	http://www.esafetysupport.org/en/esafety_activities/related_projects/research_and_development/save.htm
Human Factors Issues that are relevant	The following principles regarding HMI integration has been identified by SAVE: 1. Integration of detection systems into an Integrated Monitoring Unit (IMU), to be managed by a Hierarchical Manager with a harmonized HMI. 2. If an Emergency is detected, a Pre-Emergency Warning System will inform the driver and the surrounding traffic.
Human Factors topics	- HMI design
Human Factors evaluation	Medium Importance

Name	Smart-Vei
Type/Dates	European Project/March 2008-February 2011
Aims in short	The main objective of the Smart-Vei project is to support safety while driving, by understanding the driver's behaviour and needs and by providing personalised services to the different classes of users. To this end, a new generation Advanced Driver Assistance System will be designed and developed. It will adapt car performance and increase driver's attention to warnings, being able to recognise and predict the driver's behaviour which is used for the estimation of hazardous situations. The Consortium is spread between Europe (14 partners) and the Middle East (1partner).
References	http://www.ist-world.org/ProjectDetails.aspx?ProjectId=09b74206bf304d2aaf0ad1b9087930c9&SourceDatabaseId=9900e74f1158484985c6bf0d2aa3cc2a
Human Factors Issues that are relevant	Smart-Vei project aims to design, develop a portable "predictive-adaptive" learning system through in-car portable devices able to detect and report characteristics and attitudes related to the driver's profile. The system will be a learning system as it will build the user profile by storing, monitoring and analysing the user's behaviour while driving. The Smart-Vei will provide innovative control strategies based on the best input and cues (or other classes of services) to be provided to the specific user. The decision support system of the Smart-Vei will merge information from the users (real time state and behaviour track record) together with the information from the road environment and the vehicle itself, so as to improve driver-warning strategies and hazardous situations prevention.
Human Factors topics	- Driver behaviour - Driver profile and preferences - Information prioritization
Human Factors evaluation	High Importance

Name	TRACE TRaffic Accident Causation in Europe
Type/Dates	European Project/January 2006-June 2008
Aims in short	TRACE focuses on the following objectives: - The identification and the assessment (in terms of saved lives and avoided accidents), among possible technology based safety functions, of the most promising solutions that can assist the driver or any other road users in a normal road situation or in an emergency situation or, as a last resort, mitigate the violence of crashes and protect the vehicle occupants, the pedestrians, and the two wheelers in case of a crash or a rollover. - The determination and the continuous updating of the aetiology, i.e. causes, of road accidents (as well as the causes of injuries) and the assessment of how the existing technologies or the technologies under current development address the needs of the road users inferred from the accident and driver behaviour analyses.
References	http://www.trace-project.org/
Human Factors Issues that are relevant	Improve the multidisciplinary methodologies in analyzing the influence of human factors and also the statistical methodologies used in risk analysis and evaluation.
Human Factors topics	- Driver behaviour
Human Factors evaluation	Medium Importance

Name	WATCH-OVER
Type/Dates	European Project/January 2006-December 2008
Aims in short	WATCH-OVER is a specific targeted project co-funded by the European Commission with the goal to design and develop a cooperative system for the prevention of accidents involving vulnerable road users in urban and extra-urban areas. The system is based on short range communication and vision sensors.
References	http://www.watchover-eu.org/index.html
Human Factors Issues that are relevant	One objective is design and development of the system customised for different users.
Human Factors topics	- HMI design - Driver profile and preferences
Human Factors evaluation	Low Importance

B.2 Other projects, standards activities and initiatives analysed

The following projects, standards activities and initiatives were analysed and considered to have no (or no significant) areas related to human factors issues:

GeoNet (FP7), SMartfreight (FP7), ISSTE, FNIR (FP7), ADOSE (FP7), SAFERIDER (FP7), SCVP (FP7), FESTA (FP7), ROSATTE (FP7), SAFETY-TECHNOPRO, PSC Europe, MISS - Monitor Integrated Safety System, Car2Car, SpeedAlert Forum, EU-India, TRACKSS, REPOSIT - RElative POSitioning for collision avoidance systems, MORYNE - Public Transport, GOOD ROUTE Goods transportation.

Annex C: ITS

C.1 History of ITS

Intelligent Transport Systems (ITS) are not just future technology. ITS has been a feature of transportation for many years. The capabilities of traffic management systems have been developing for more than half a century. Equipment to assist drivers has been developed ever since the car was invented.

Many of these developments do not, of course, involve "intelligence", and car safety belts are a good example of this. However, the introduction of a warning that you have not put your safety belt on - usually a flashing sign and an audible signal - requires intelligence to know that you are sitting on a seat and are not connected. ITS has therefore evolved, rather than being a disruptive change. Traffic Management, road tolling, access control, traffic and traveller information, public transport, commercial transport management, recovery of stolen vehicles, driver advisory systems, and eSafety systems have all evolved as areas where "ITS" has already made an impact, and is making an increasing impact, and will make even greater impact in the future.

Initially these developments were all proprietary innovations, but there has been an ever increasing realisation of the need for and benefits of co-ordination, and standardization has been seen as being at the core of this. Around the turn of 1990 a group of experts were commissioned by the European Commission to study where these developments that were then described as "Road Transport and Traffic Telematics" were going and what co-ordination was needed. The so called "TET" report resulted in the creation of CEN TC278 - a European Standards development technical committee, still going strong and still called "Road Transport and Traffic Telematics". Within two years, the wider global community reached the same conclusions and formed ISO TC204, originally called "In Vehicle and Highway Systems", but subsequently renamed "Intelligent Transport Systems". ETSI became involved in ITS Standardisation and support to regulators, firstly through its ERM Technical Group 37, subsequently and continuingly in respect of radio matters, ERM Technical Group 37, and now principally through its recently formed Technical Committee - ITS.

More than one hundred deliverables have been published by CEN TC278 and more than 50 work items are under development or in a renewal phase. ISO TC204 has published more than 70 deliverables and has more than 80 more in development. ETSI entering the field only around 2000, has published far fewer, but has been responsible for the creation of a suitable regulatory environment for ITS communications in Europe and the associated standards as its priority and is only now moving beyond these aspects. ITU also has a working party providing recommendations for ITS, and, importantly has a committee (ITU-T APSC Telemov) to coordinate the efforts of all of the involved standards development organization. IEEE and SAE International also have committees making standards for ITS. IEEE has recently signed a co-operation agreement with ISO.

Most of these technical committees work in close liaison with each other, helped by the co-ordination activities of TELEMOV, and there are joint work items shared between the CEN and ISO committees.

C.2 What is ITS?

The scope of "ITS" is therefore a range of services provided within a number of application areas that can be loosely grouped together under the title "Intelligent Transport Systems".

Intelligent Transport Systems are those systems where vehicles interact with the environment, and with each other, to provide an enhanced driving or travelling experience, and where intelligent infrastructure involving ICT improves the safety and capacity of road systems.

Intelligent Transport Systems do not have to be only about vehicles and roads. Air transport, marine transport, and rail transport systems can, and frequently are, increasingly "intelligent". Indeed, air and rail transport systems have used advanced system and electronics design as part of their operation and infrastructure for decades. Marine navigation systems for all but small vessels have also used electronics and radio for location finding, obstacle avoidance and collision avoidance, for a long time.

However, the scope of the present document is limited to "ICT in Cars". In this context a "car" can be loosely described as a vehicle with three or more (and most commonly four) wheels that has its own on board means of propulsion (rather than being moved by another vehicle or animal) moving primarily on roads, that has seating for one to eight people and is constructed principally for the transport of people rather than goods. The closest formal description is a category M1 vehicle [i.27]. Generic ITS features that may be used by and useful for commercial vehicles (vans, lorries, buses, etc.) or motor cycles are included, but ITS systems designed specifically for commercial vehicles or motor cycles are outside the scope of the present document.

ITS services are about enhancing the driving and/or travelling experience. This may provide some services to ease the task of driving or to help pass the time of passengers in a vehicle. It may provide some connectivity en-route or some infotainment services. It may extract money from the occupants to pay road tolls, or may provide information about the next leg of the journey. However, the most important focus of ITS service provision are safety and environmental aspects (minimising pollution and minimising emissions, is becoming increasingly important). Safety of the driver, passengers, and other road users is considered the single most important justification for ITS service provision. The present document primarily focuses on safety, and the other services described above.

[i.45] estimates that global road deaths were between 750 000 and 880 000 for the year 1999. Later estimates have put this figure at closer to 1,25 million deaths per year, and the toll is increasing. The study also estimates that global road injuries (of whatever severity) amounted to between 23 and 34 million road accident injuries per annum in the late 1990's. Later estimates [i.46] have estimated 1,25 million deaths per year and other estimates calculate over 30 million injuries per year in addition to the death rate.

If Intelligent Transport Systems can help to mitigate this carnage, then on this count alone they are justified, however, as summarised above, they are also about enhancing the driving experience, not just for the driver, but also his passengers. But with such a diverse mix of systems, it is not immediately obvious how they can be categorised in a consistent manner.

ISO 14813-1 [i.13] provides a definition of the primary services and application areas that can be provided to Intelligent Transport System (ITS) Users. Those with a common purpose can be collected together in ITS service domains, and within these there can be a number of ITS service groups for particular parts of the domain.

C.3 How can ITS be categorised?

ISO 14813-1 [i.13] identifies 11 service domains, within which numerous groups are then defined. Within this framework, there are varying levels of detail related to definition of different services. These details differ from nation to nation, depending on whether the specific national architecture building blocks are based directly upon services or on groups of functions. Thus, the intent is to address groups of services and the respective domains within which they fit. As these domains and service groups evolve over time, it is intended that this International Standard is revised to include them.

ISO 14813-1 [i.13] is aimed at those developing International Standards and services for the ITS sector and associated sectors whose boundaries cross into the ITS sector (such as some aspects of urban light railways, intermodal freight and fleet). It is designed to provide information and explanation to those developing ITS International Standards and to those developing specifications, implementations and deployments for ITS.

ISO 14813-1 [i.13] is designed to assist the integration of services into a cohesive reference architecture, assist interoperability and common data definition. Specifically, services defined within the service groups will be the basis for definition of use cases and the resultant reference architecture functionality, along with definition of applicable data within data dictionaries, as well as applicable communications and data exchange standards.

The previous version of this standard was a published Technical Report, and described "Fundamental Services". The new version, "ITS service domains, service groups and services" [i.14] reflects the evolution of technology-oriented transportation practices and applications.

The International Standard ISO 14813-1 [i.13] recognizes that ITS activities will interface with more generalized activities and environments outside the transport sector. For example, road pricing and revenue systems activities may interface with electronic commerce, or eCommerce activities, and may thus utilize standards and principles associated with the banking industry along with generally accepted accounting principles. The addressing of national security and coordination issues also requires addressing specific national standards related to civil defence, emergency communications, and other procedures. These interfaces, while largely outside the scope of this study, are nevertheless critical external influences on the functionality of the various services supported by "ITS service domains, service groups and services".

Figure 1 of ISO 14813-1 [i.13] is reproduced as figure C.1 of the present document. It shows a hierarchy upon which the domains and services are grouped.

C.4 ITS Service Domains, Service Groups and Service Types

"ITS service domains and groups" is a common descriptive framework, based upon existing U.S., European Union, Japanese and other international and national classification systems.

The national architectures are based on national overviews of what the ITS sector comprises in their countries, and of course there are national differences. However they are all developed from the perspective of national implementation and management and focus on the types of services that ITS can and will provide.

ISO 14813-1 [i.13] identifies the following "Service Domains":

- Traveller information
- Traffic management and operations
- Vehicle services
- Freight transport
- Public transport
- Emergency
- Transport-related electronic payment
- Road transport related personal safety
- Weather and environmental conditions monitoring
- Disaster response management and coordination
- National security
- Data Management

The International Standard ISO 14813-1 [i.13] makes it clear that categorization of the services into 12 domains does not imply that all ITS Architectures should be required to follow this construction. The construction that they use should be that which is best suited to their ultimate use and should be independent of the services that they support. It should also be made clear that the ISO 14813-1 [i.13] is focused on ITS Services, and not on supporting enabling technologies (for example media provision, etc.).

ISO 14813-1 [i.13] notes that services are often interdependent on, or providers to, other services within a service group, or are key enablers for the provision of services in other service groups. And it observes that in architecture elaborations based on these services it is important that the proposed classification schema identify WHO is responsible for the provision of the service.

For each service domain, ISO 14813-1 [i.13] goes on to elaborate the "Service Groups" within the domain and in some cases identifies specific services that comprise the groups. - A summary description and identification of the service groups are provided in the following pages. Further detail can be obtained by reading ISO 14813-1 [i.13].

C.4.1 Traveller Information

The International Standard ISO 14813-1 [i.13] describes this domain as "Provision of both static and dynamic information about the transport network to users, including modal options and transfers".

Traveller information domain includes the service groups:

- Pre-trip information
- On-trip information
- Route guidance and navigation-pre trip
- Route guidance and navigation-on trip
- Trip planning support
- Travel services information

Clearly, these services involve interaction with humans and so "Human Factors" are an important consideration. Those aspects that occur in-vehicle are considered in the present document.

C.4.2 Traffic Management and Operations

ISO 14813-1 [i.13] describes this domain as "The management of the movement of vehicles, travellers and pedestrians throughout the road transport network".

Traffic management and Operations domain includes the service groups:

- Traffic management and control
- Transport related incident management
- Demand management
- Transport infrastructure maintenance management
- Policing/enforcing traffic regulations

Clearly, these services involve interaction with humans and so "Human Factors" are an important consideration. But many of these humans are outside the car (e.g. in traffic management centres) and are therefore outside the scope of the present document. In general these services do not occur in the vehicle, and as such they are not considered further in the present document. However, where the provision of such services is taken into the vehicle, and provided to the driver, it is dealt with in the appropriate clause below.

C.4.3 Vehicle Services

ISO 14813-1 [i.13] describes this domain as "Enhancement of safety, security and efficiency in vehicle operations, by warnings and assistances to users or control vehicle operations".

Vehicle Services includes the service groups:

- Transport-related vision enhancement
- Automated vehicle operation
- Collision avoidance
- Safety readiness
- Pre-crash restraint deployment

Clearly, these services involve interaction with humans and so "Human Factors" are an important consideration. Those aspects that occur in-vehicle are considered in the present document.

C.4.4 Freight Transport and Logistics

ISO 14813-1 [i.13] describes this domain as "The management of commercial vehicle operations; freight and fleet management; activities that expedite the authorization process for cargo at national and jurisdictional boundaries and expedite cross-modal transfers for authorized cargo".

Freight Transport includes the service groups:

- Administrative functions
  - Commercial vehicle pre-clearance
  - Commercial vehicle administrative processes
  - Automated roadside safety inspection
  - Commercial vehicle on-board safety monitoring
- Commercial functions
  - Freight transport fleet management
  - Intermodal information management
  - Management and control of intermodal centres
  - Management of dangerous freight

Many of these services involve interaction with humans and so "Human Factors" may be an important consideration, however although drivers benefit from these services, they do not occur in the vehicle, and so are not considered further in the present document.

C.4.5 Public Transport

ISO 14813-1 [i.13] describes this domain as "Operation of public transport services and the provision of operational information to the operator and user, including multimodal aspects".

Public Transport domain includes the service groups:

- Public transport management
- Demand responsive and shared transport

Clearly, these services involve interaction with humans and so "Human Factors" are an important consideration, however although drivers benefit from these services, they do not occur in the vehicle, and so are not considered further in the present document.

C.4.6 Emergency

ISO 14813-1 [i.13] describes this domain as "Services delivered in response to incidents that are categorized as emergencies".

Emergency domain includes the service groups:

- Transport related emergency notification and personal security
- After theft vehicle recovery
- Emergency vehicle management

- Emergency vehicle pre-emption
- Emergency vehicle data
- Hazardous materials and incident notification

These services involve interaction with the driver and so "Human Factors" are a consideration, however only those aspects relating to the interface to the driver in the vehicle are considered in the present document.

C.4.7 Transport-related Electronic Payment

ISO 14813-1 [i.13] describes this domain as "Transactions and reservations for transport related services".

Transport-related Electronic Payment domain includes the service groups:

- Transport related electronic financial transactions
- Integration of transport related electronic payment services

These services involve interaction with the driver and so "Human Factors" are a consideration, however only those aspects relating to the interface to the driver in the vehicle are considered in the present document.

C.4.8 Road Transport Related Personal Safety

ISO 14813-1 [i.13] describes this domain as "Protection of transport users including pedestrians and vulnerable users".

Road Transport Related Personal Safety includes the service groups:

- Public travel security
- Safety enhancements for vulnerable road users
- Safety enhancements for disabled road users
- Safety provisions for pedestrians using intelligent junctions and links

Clearly, these services involve interaction with humans and so "Human Factors" are an important consideration, however, only those factors that impact with the occupants of the vehicle are considered in the present document.

C.4.9 Weather and environmental conditions monitoring

ISO 14813-1 [i.13] describes this domain as "Activities that monitor and notify weather and environmental conditions".

Weather and Environmental Conditions Monitoring domain includes the service groups:

- Environmental conditions monitoring

This area only impacts on the human factors associated with ICT in cars by the provision of information to vehicle occupants and only these aspects are considered in the present document.

C.4.10 Disaster response management and coordination

ISO 14813-1 [i.13] describes this domain as "Road transport based activities in response to natural disasters, civil disturbances, or terror attacks".

Disaster Response Management and Coordination includes the service groups:

- Disaster data management
- Disaster response management

- Coordination with emergency agencies

This area only impacts on the human factors associated with ICT in cars by the provision of information to vehicle occupants and only these aspects are considered in the present document.

C.4.11 National security

ISO 14813-1 [i.13] describes this domain as "Activities that directly protect or mitigate physical or operational harm to persons and facilities due to natural disasters, civil disturbances, or terror attacks".

National Security domain includes the service groups:

- Monitoring and control of suspicious vehicles
- Utility or pipeline monitoring

This area is largely outside of the scope of the present document.

C.4.12 ITS Data Management

ISO 14813-1 [i.13] describes this domain as "The collation, management, and supply of ITS data to legitimate interested parties".

ITS Data Management domain includes the service groups:

- Data registries
- Data dictionaries
- Emergency messages
- Control centre data
- Enforcement
- Traffic management data

This area only impacts on the human factors associated with ICT in cars by the provision of information to vehicle occupants and only these aspects are considered in the present document.

C.5 Other Views of ITS Services

C.5.1 Services to Drivers

In addition to the analysis of services into "Service Domains", as analyzed in ISO 14813-1 [i.13], there are other "views" that are needed to be considered in order to fully understand ITS. Each of these views considers an aspect of ITS that can be used by interested parties to group some of the services in different ways. These are complementary, not competitive means of analysis, and when considering Standards that support ITS can provide a very useful "view".

A closer analysis of the list of domains, and the services which comprise these domains, shows that many of the services are provided to drivers. Services to drivers can be categorized into five types:

a) Driver/User Information Services

b) Driver Assistance Services

c) Collaborative Driver Assistance Services

d) Collaborative Driving Services

e) Background Services

An understanding of the generic characteristics of these services to drivers can further assist the understanding of some aspects of ITS services. In almost all of these areas "Human Factors" are a most important consideration.

C.5.1.1 Driver/User Information Services

Driver/User Information Services provide relevant information to the driver/user. They may comprise, for example, navigation information (excluding route guidance), congestion and incident information, etc.

The characterising nature of this group of services is that they are passive or semi-passive in respect of driving or vehicle control. Passive in that they provide general information but no specific parameters are entered and no direct driving assistance is offered or suggested.

Often loosely incorporated in this group are indirect services made possible by an ITS link into the vehicle, such as in-vehicle internet for passengers, and the ability of passengers to directly, or via the internet, book restaurants and hotels, etc.

Add text related to messages that are received that are designed for reading when not driving. We can say that this needs to be of high quality and make reference to the use of existing best practice Human Factors guidelines (with specific references).

C.5.1.2 Driver Assistance Services

The next group of services are those that provide direct driving support and assistance to drivers that propose modification of driving behaviour, but do not enact such behaviour. These systems are further characterised in being "stand-alone". That is they do not require the communication or cooperation of other vehicles.

An example of this type of service is a lane departure warning system, where the driver receives an audible, visual, or sensory (usually vibration) warning when he is about to stray from the lane. Forward and backward obstacle warning systems, where drivers are alerted that they are getting close to an obstacle; round blind corner assistance systems, which provide a CCTV image from the front of the vehicle, provide other examples.

Route guidance, where the driver programmes in his destination and the system advises him of route directions, also fall into this group.

Here the information to the driver is driving specific, and advices drivers to modify their behaviour.

Many of the early instances of ITS - that are already appearing in production models - provide services of this nature as they are significantly easier to design and install and, with the exception of congestion sensitive route guidance systems, do not need a communication link to third parties outside of the vehicle.

C.5.1.3 Collaborative Driver Assistance Services

Collaborative driving services also provide driver assistance services, but require a communication link to other vehicles and/or the infrastructure to provide the service.

Early examples of these services were electronic road toll collection and vehicle access control systems. However the characterisation of these systems more typically requires information from others in order to provide the service.

Collision warning advice systems, where a vehicle collects location, movement and danger information from other vehicles around are more typical examples of where this type of service is headed.

An example would be where a vehicle detects ice, or slippery surface, and sends that information to other vehicles nearby, advising them of the danger. Once received, the driver receives advice of the distance location and nature of the warning. When he is approaching the dangerous area, he receives a second warning.

The characteristic being that this type of service can only be performed where there is quasi-continuous communication with other vehicles and/or the infrastructure.

C.5.1.4 Collaborative Driving Services

Collaborative driving services are of a similar communications nature to collaborative driver assistance services, except that the systems directly affect control, rather than advise the driver.

Examples of these systems are collision avoidance systems, grade (level crossing) collision avoidance systems, platooning, etc.

By their nature, they require that most, if not all, vehicles are equipped, and can therefore be considered as "future systems", that may not appear for another decade or more. However, in order for them to be possible, the communications architectures at least have to start to be implemented in vehicles in the near term.

C.5.1.5 Background services

Background services also require a communications link to the vehicle, but do not directly affect driver action. Such systems should not give real-time advice to the driver that the service has run as such messages would add an unnecessary additional cognitive load for the driver e.g. "Your route has been recalculated and it has not been changed" is an unnecessary notification of an update process that does not affect the driver.

Automatic software updates to engine or system management software in the vehicle provides one good example of these types of services. They can be implemented on a much shorter timescale than Collaborative Driving Services, or Collaborative Driver Assistance Services, but require a communications link to the vehicle.

These background services do not involve consideration of "Human Factors" and so will not be considered further within the present document.

C.5.2 Other categorization options

Alternative way of classifying systems will be examined in the present document. One option could be looking at whether the operation of a service is related to:

- **permissions:** The service allows or assists drivers to achieve something that they were not previously able to do as effectively e.g. parking assist systems;
- **obligations:** The service requires drivers to do something e.g. road toll payment systems;
- **prohibitions:** The service prevents drivers from doing something or warns them against doing something e.g. lane departure warning systems.

These dimensions may have relevance when issues related to the need for user agreement to the operation of a service are being considered.

Alternatively services could be categorized according to whether they:

- inform the user;
- instruct the user;
- take control from the user.

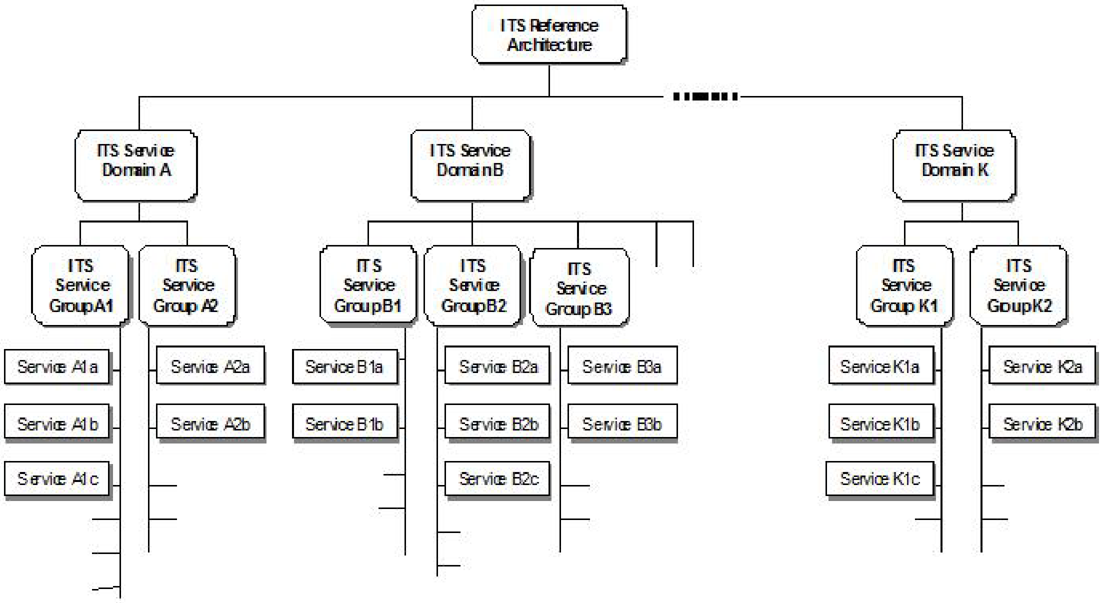


Figure C.1: ITS services - Hierarchy of definitions for "ITS reference architecture"

C.6 ITS Users

Who are the users of ITS Services? ISO 14813-1 [i.13] defines an ITS user as

- "one who directly receives and can act on ITS data or control products. An ITS user is one who receives, directly or indirectly, or provides to, the transaction of an ITS service; these users of ITS services may be human, systems or environment monitoring".

At the end of the chain, the final user is the driver and/or other occupants of a vehicle, a pedestrian, or user of public transportation, public transportation operator, commercial vehicle operator, emergency assistance provider, or road operator, and "Human Factors" play an important role for this group.

However, behind these end users, are those that enable the transport to function. The road manager, control centre, road maintenance provider, etc. These too are users of ITS services. But at the same time, in many cases they are also providers of components of ITS to other ITS service providers.

And to complicate matters further, when used as a provider of probe data or enquiry response data, ad-hoc network link, the "end user" may also be a provider of data components to ITS service providers.

In general, however, it can broadly be said that services are provided to groups known as "drivers", "vehicle occupants", "public transportation users", "public transportation service providers", "commercial vehicle operators", "emergency services", "pedestrians", "road managers", and "regulators and enforcers".

But it is not possible to distinguish TS services by user group because different user groups will often use the same or similar ITS service. ISO 14813-1 [i.13] therefore divides ITS services into service "Types".

History

Document history		
V1.1.1	April 2010	Publication