Development Platform for Safe and Efficient Drive

HMI Needs Analysis and Specifications

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ABBREVIATION	DESCRIPTION
ADAS	Advanced Driver Assistance Systems
ADTF	Automotive Data and Time triggered Framework
API	Application Programming Interface
ASM	Automotive Simulation Model
AUTOSAR	AUTomotive Open System Architecture
CAN	Controller Area Network
DAS	Driver Assistance System
DVE	Driver's vision enhancement
ECU	Electronic Control Unit
ESP	Electronic Stability Program
GPS	Global Positioning System
GUI	Graphical User Interface
HIL	Hardware-In-the-Loop
HMI	Human Machine Interface
HW	Hardware
ICA	Interaction and Communication Assistant
ICT	Information and Communication Technology
IWI	Information, warning and intervention
ISO	International Organization for Standardization

OEM	Original Equipment Manufacturer
PC	Personal Computer
PTW	Powered Two Wheelers
SDK	Software Development Kit
UCD	User centered Design
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle

0. EXECUTIVE SUMMARY

The main objective of WP3.3 is the definition and the analysis of HMI needs in order to define a general integrated HMI solution to be integrated within the DESERVE platform. The Deliverable presents the results of the activities performed in Tasks T3.3.1. and T3.3.2 of the DESERVE project. It provides an overview of the DESERVE platform with a specific focus on its HMI features. It presents first of all the DESERVE platform from the HMI perspective, including a review of previous projects representing an input for DESERVE.

Subsequently, it illustrates in broad terms the HMI needs for basic driver assistant applications identified in the subproject WP11- Application needs.

Additionally, it illustrates the HMI needs for DESERVE target applications, i.e. the Demonstrators, in the broad context of the user centered design methodology. Finally, the deliverable introduces the HMI software architecture and requirements.
This deliverable is strictly related to Deliverable 33.2 Definition of a general integrated HMI solution, and D34.1 HMI solution design which are the logical follow up of this report.

While this deliverable presents the HMI user needs collected so far, D33.2 will present an analysis of main HMI solutions available on the market for DAS and design guidelines for the final DESERVE HMI solutions.
Further updates during the course of the project and in particular of the demonstrator development activities may happen as appropriate and useful. This might have a significant impact on the HMI needs and requirements of the demonstrators.
These updates will be reported in Deliverable 34.1 HMI solution design which will present the DESERVE HMI solution.

1. INTRODUCTION

1.1 Objectives and scope of the document

The deliverable presents the results of the activities performed in Tasks T3.3.1. and T3.3.2 of the DESERVE project.

In particular in task *T3.3.1* a wide analysis of the HMI needs has been performed by applying a User Centered Design (UCD) methodology (whereas the main users are the DESERVE project partners in charge of setting up demonstrators). In the context of prototype development, the UCD methodology places the end user as well as the main stakeholders at the fulcrum of the design and testing process. Since in the DESERVE project the main stakeholders are not only the end user the HMI is intended for, but also the industrial partners that will exploit the DESERVE platform for the development of innovative integrated HMI, all of them will be involved in the analysis of the HMI needs.

Moreover, the project encompasses a wide range of embedded systems in terms of context of use (commercial vehicles, passenger cars, other types of vehicles) and classes of software and hardware application. Thus, it is probable that a single existing UCD methodology may not be able to cover them all. Various relevant methodologies will be applied to collect the information for the analysis that will focus on the driver's HMI needs in different vehicles, especially in terms of safety.

In Task 3.3.2. HMI Requirements and specifications definition the general requirements for an innovative integrated HMI solution have been defined, as well as the specification for the development of all possible hardware and software modules it may be composed of.

This task aims at defining the overall specification for a general HMI that will be integrated in the DESERVE platform. It will also include specification for the arbitration of the information to be provided to the driver, the modalities of representation of the information (visual, audio, haptics, etc.) and the sharing of the resources (among several displays in the vehicle, use of the audio speakers for the radio, phone calls and the audio messages from the vehicle, etc.).

Along these lines, this deliverable provides an overview of the DESERVE platform with a specific focus on its HMI features. It presents first of all the DESERVE platform from the HMI perspective, including a review of previous projects representing an input for DESERVE. It then illustrates in broad terms the HMI needs for basic driver assistance applications identified in the subproject WP11 - Application needs.

It then illustrates the HMI needs for DESERVE target applications, i.e. the Demonstrators, in the broad context of the User Centered Design methodology.

It finally introduces the HMI software architecture and requirements.

This deliverable is strictly related to Deliverable 33.2 Definition of a general integrated HMI solution, which is the logical follow up of this report.

Further updates during the course of the project and in particular of the demonstrator development activities may happen as appropriate and useful. This might have a significant impact on the HMI needs and requirements of the demonstrators. Moreover, the list of HMI needs and requirements for the DESERVE demonstrators is not yet complete at the time of the elaboration of this deliverable.

2. THE DESERVE PLATFORM FROM THE HMI PERSPECTIVE

In order to enhance ADAS market penetration, users and suppliers acceptance, reduce costs and broaden the scope and effectiveness of ADAS in the medium and long term, there is a need of managing the level of complexity of the different ADAS functions in an integrated way, allowing them to co-exist and co-operate.

Nonetheless the integration of ADAS functions poses several challenges, bearing significant implications e.g. in terms of drivers safety: each individual function should be designed, integrated and deeply validated against user needs and high level objectives before its acceptance as a standard product. Consolidated methodologies (such as the V-model) exist to guide the development process and the validation of new safety systems).

And yet, in order to address the above mentioned challenges, there is a need to step beyond the traditional V-Model-based system engineering for ADAS functions integration. An innovative design and development validation environment has to be established where new components can be embedded and functions can be developed and tested.

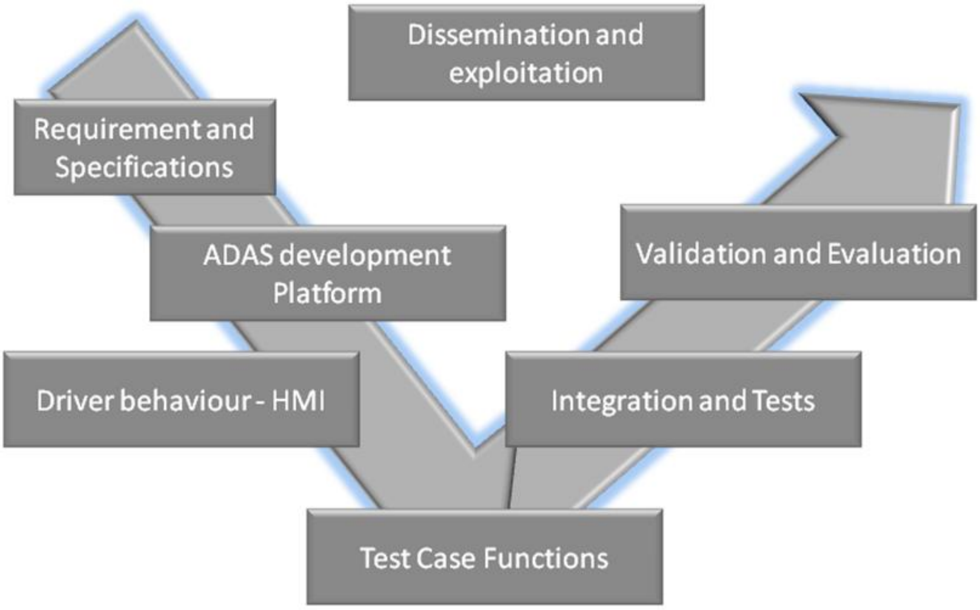

Figure 1: The V-Model development process

Therefore the overall objective of the DESERVE project will be to build an innovative platform for compositional development of ADAS systems contributing to safe and highly efficient driving and designed to be economically viable in the low volume vehicle market, going beyond traditional design-development-validation patterns.

The DESERVE project will therefore provide a low cost, highly reliable, standardised tool platform, that can seamlessly integrate different functions, sensors, actuators and HMI to enable the development of a new generation of ADAS applications.

In particular, advancements compared to the state of the art are foreseen in relation to the sensor fusion modules, the HMI systems and for the adopted vehicle and driver models. Figure 2 compares the traditional approach with the DESERVE approach, highlighting the advancements of DESERVE platform compared to state of the art.

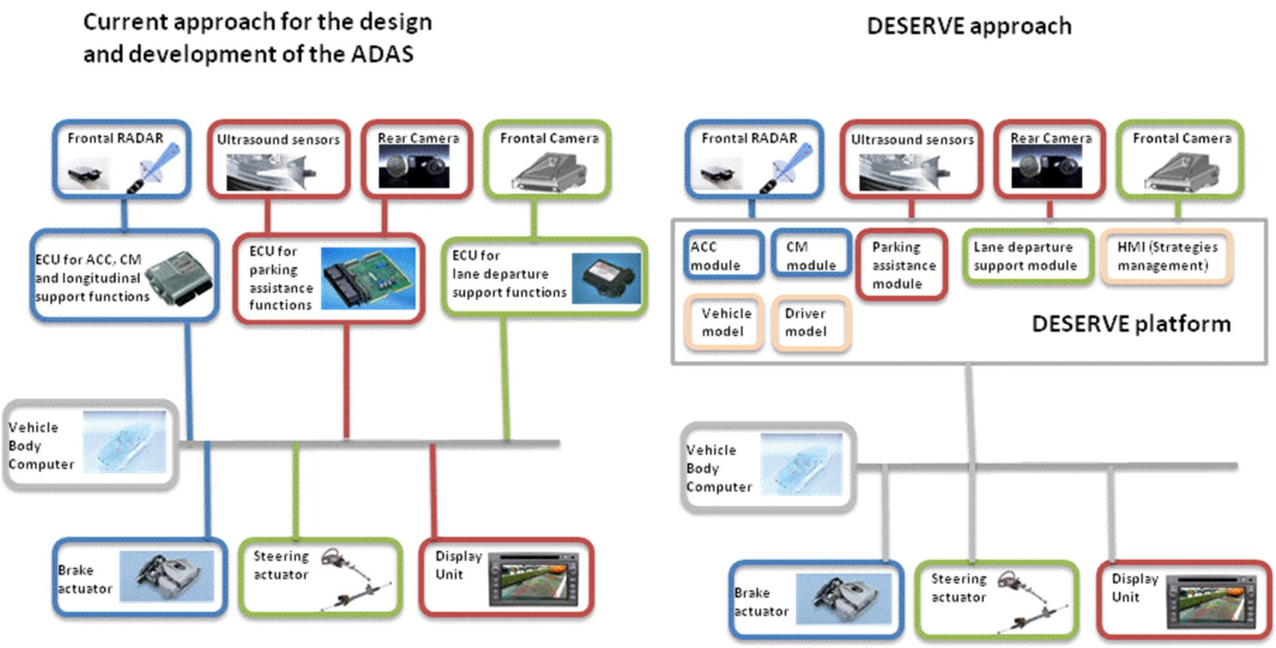

Figure 2 - DESERVE platform compared with traditional approach

The main innovation related to HMI in DESERVE is the following: Human Machine Interface of ADAS functions will be unified in order to implement an integrated, safe and harmonized interaction with the driver; the architecture should be flexible and modular, to easily allow addition of new (software) components, modules and functions based on the same set of vehicle sensors, actuators and HMI.

The DESERVE platform will be validated on emerging risk-prone use cases for next generation vehicles, including full electric ones and hybrids, as well as in relation to the integration of existing safety functions. Furthermore, it will be consistent with future introduction of cooperative solutions, based on Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication.

The benefits of the tool platform will be demonstrated to the stakeholders by developing different types of prototypes: urban vehicles (passenger and freight), passenger car, motorcycle and long distance freight transport vehicle.

These demonstrators will implement next generation ADAS such as low speed maneuvering assistance, urban driving support, pedestrian detection and avoidance, collision mitigation, adaptive cruise control and lane keeping integration, driver monitoring, eco driving and cooperative applications.

The development of the DESERVE HMI solution will take into consideration and utilize results of several previous R&D projects. A brief description of these projects and their relevance in the framework of DESERVE is presented below.

The D3COS-Designing, Dynamic, Distributed, Cooperative Human-Machine Systems project[1] is an on-going R&D initiative funded by the ARTEMIS Joint Undertaking. This project aims to develop methods, techniques and tools (MTTs) for system engineers and to embed them in industrial system development processes to support affordable development of highly innovative cooperative human-machine systems.
D3COS results related to human-machine cooperation are a fundamental input for DESERVE under several respects. In this domain D3Cos is developing a generic cross-domain applicable framework for cooperative systems which connects to existing tools for embedded system design. Moreover D3Cos is also expected to deliver modeling and simulation of cooperative systems including human modeling and simulation, and reference designs as well as design patterns for intelligent multi-modal human-machine interfaces.

SAFESPOT[2] was an integrated research project co-funded by the European Commission Information Society Technologies among the initiatives of the 6th Framework Programme. The SAFESPOT co-operative system was composed by the following communicating elements:

- Intelligent vehicles equipped with on board co-operative systems
- Intelligent infrastructure including road side units
- Safety centre(s) and/or Traffic centre(s) able to centralize or forward safety information coming from the intelligent vehicle and/or the intelligent infrastructure.

This project created a cooperative system composed of intelligent vehicles equipped with on board cooperative systems, intelligent infrastructure, safety centre and traffic centre able to centralize information from intelligent vehicles and infrastructures. This project developed a sustainable deployment strategy for cooperative systems for road safety evaluating also related liability, regulations and standardization aspects. SAFESPOT used infrastructures and vehicles as sources and destinations of safety related information and developed and flexible architecture and communication platform.

[1] http://www.d3cos.eu

[2] http://www.safespot-eu.org

CVIS-Cooperative Vehicle-Infrastructure Systems project[3], funded under the 6th Framework programme, created an integrated platform with pluggable communication interfaces, IPv6 mobile routing capability, supporting cooperative applications and easily implemented by open design and introduced into commercial products. This platform, called 'reference execution platform', represented a unified technical solution allowing all vehicles and infrastructure elements to communicate with each other in a continuous and transparent way using a variety of media and with enhanced localization. CVIS validated an open architecture and system concept for a number of cooperative system applications to support cooperation models in real-life applications and services for drives, operators, industry and other key stakeholders.

CVIS project created a multi-channel terminal capable of maintaining a continuous internet connection over a wide range of carriers, including cellular, mobile Wi-Fi networks, infra-red or short-range microwave channels, ensuring full interoperability in the communication between different makes of vehicle and of traffic management systems, that can be easily updated and scaled up to allow implementation for various client and back-end server technologies. The project created an urban network management, cooperative area destination-based control, cooperative acceleration/deceleration and dynamic bus lanes.

The results of SAFESPOT, CVIS and particularly the HMI concepts underlying the cooperative systems developed in these two projects are a valuable input for DESERVE.

PReVENT-Preventive Safety Applications[4] has been funded under the 6th Framework programme. It developed and validated a variety of preventive safety applications and assessed the road safety benefits of the technologies to accelerate the introduction of preventive and active safety in Europe.
Examples of preventive safety applications developed were:

- MAPS&ADAS - Reduction of costs and complexity of map-based ADAS safety applications by providing a standardised interface to access map and positioning data from various vehicle applications
- SASPENCE - Development and evaluation of an innovative system able to perform the Safe Speed and Safe Distance concept

[3] http://www.cvisproject.org

[4] http://www.esafetysupport.org/en/esafety_activities/related_projects/research_and_development/prevent.htm

- Wireless Local Danger Warning - Development of a system for on-board hazard detection, in-car warning management and decentralised warning distribution by communication between moving vehicles on a road network as well as lateral support
- SAFELANE - Development of a lane keeping support system that operates safely and reliably in a wide range of even difficult road and driving situations.
- LATERAL SAFE - Lateral support and driver diagnostics and development of a driver assistance for coping with safety critical lateral situations based on a multi-sensor platform
- InterSafe - Improvement of safety in intersections based on sensor systems and communications. Development of an intersection safety system by use of two full-scale dynamic driving simulators.
- APALACI - Advanced Pre-crash And LongitudinAl Collision Mitigation: Development of advanced pre-crash and collision mitigation applications including the development of systems with pedestrian classification ability
- COMPOSE - Collision Mitigation and Protection of Road Users: Development and evaluation of collision mitigation and vulnerable road user protection systems for trucks and cars
- UseRCams - Use of Active Range Cameras: Specification, application, evaluation and customisation of an active 3D range camera for obstacle recognition, localisation and classification.

Not only the HMI solution of the preventive safety applications developed but also the methodology used in the project is a relevant input for DESERVE, and particularly the user centered design approach. Chapter 3 of this deliverable explains how this approach is taken into account in DESERVE. Prevent also represented an important milestone for the Interactive project, described below.

The Cybercars project[5], funded under the 5th Framework programme, aimed to accelerate the development and the diffusion of fully automated road vehicles driving capabilities by improving the performances and lowering the cost. This was achieved by bringing together all European actors of this field, in order to test and exchange best practices, share some of the development work and make faster progress in the experiments. Several cities throughout Europe have collaborated with the partners in the project, studying the potentiality to run such systems, providing their specific constraints and accepting to do some preliminary tests of technologies and demonstrations. A major part of the work involved the improvement and testing of key technologies for better guidance, collision

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[5] http://www.cybercars.org

avoidance, energy utilisation and fleet management and the development of simple, standard user interfaces.

The project was able to improve significantly the performances of these technical systems or to lower their cost. A good example is the development of a guidance technology based on navigation and recalibration on magnets in the ground. All these improvements will now help the companies providing these transportation systems by lowering their costs while improving the performances and in particular the safety. The initial targets of 30% have been exceeded in several cases.

Another significant outcome of the project is the detailed implementation guidelines which can help the manufacturers and the operator to achieve the highest safety for their system. These guidelines have been put to test successfully in the installation of several systems.

The results of CyberCars project and particularly the HMI solution developed in relation to the autonomous drive function represent an important input in view of the definition of the DESERVE HMI solution.

The HAVEit[6] project, funded under the 7th Framework Programme, developed, validated and demonstrated important intermediate steps towards highly automated driving for passenger cars, busses and trucks, thereby strongly promoting safe and intelligent mobility of both people and goods.
In particular, HAVEit aimed at significant improvement in terms of traffic safety and efficiency by three measures:

- Development and validation of the next generation of ADAS with an optimised task repartition between the driver and the highly automated vehicle, with higher level of automation compared to the current state of the art.
- Optimum system joining and interaction between the driver and the co-system, by defining different degrees of automated driving, which will be selected according to the needs of the driving task.
- Development and validation of a scalable and safe vehicle architecture that includes advanced redundancy management, in order to suit the needs of highly automated vehicle applications.

[6] http://www.haveit-eu.org

The human machine interface of the HAVEit platform for shared control between driver and vehicle is a meaningful result to be considered in relation to the definition of the DESERVE HMI solution.

CESAR[7], funded by the ARTEMIS Joint Undertaking aimed to design and develop embedded safety-critical systems in four different domains: Avionics&Space, Automotive, Rail and Automation. The domains are reflected in the Domain-Subproject's which are SP5 (Automotive), SP6 (Avionics), and SP7 (Automation & Rail). The Domain-Sub-Projects provided information about their gaps and needs in safety-critical development to the Innovation-SP's. The Innovation-SP's turn solutions over to the Domain-SP's who evaluating them in applied pilot applications.

CESAR has brought significant and conclusive innovations in the two most improvable systems engineering disciplines:

- Requirements engineering in particular through formalization of multi viewpoint, multi criteria and multi-level requirements,
- Component based engineering applied to design space exploration comprising multi-view, multi-criteria and multi-level architecture trade-offs.

The results of Cesar project, and particularly the specifications related to the HMI of the Functional Safety Platform are particularly meaningful in the framework of DESERVE.

The AIDE-Adaptive Integrated Driver-vehicle InterfacE project[8] has been funded in the Sixth Framework Programme (FP6). It aimed at generating the knowledge and developing methodologies and human-machine interface technologies required for safe and efficient integration of ADAS, IVIS and nomadic devices into the driving environment.

The objectives of the project were:

- to maximize the efficiency, to enhance the safety benefits of advanced driver assistance systems;
- to minimise the level of workload and distraction imposed by in-vehicle information systems and nomad devices;
- to enable the potential benefits of new in-vehicle technologies and nomad devices in terms of mobility and comfort.

[7] http://www.cesarproject.eu

[8] http://www.aide-eu.org

The results of AIDE project related to the HMI have been considered in DESERVE. In particular, the HMI concept of the ICA (Interaction and Communication Assistant) are a valuable input. The ICA, developed as the central intelligence of the AIDE system, was responsible for managing all the interaction and communication between the driver and the vehicle, and has been based on the assessment of the driver-vehicle-environment state situation provided by the DVE (Driver's Vision Enhancement) monitoring modules. The ICA implements sets of rules defined in order to optimize driver's interaction with the incoming information, through the various human sensorial channels distracting the driver from the driving task.

ICA is composed by four modules: priority manager, filter, modality selector and channel selector. Each of them actuates a different set of rules, taking into account the current DVE outputs and the number and type of incoming messages. It introduces a concept that allows the creation of adaptive, integrated, multimodal automotive HMIs, to be able to cope with multiple systems and information sources in a safe, efficient and personalized way. Its flexibility allows the customization of the main system to different needs and strategies. So, the goal of AIDE was to let in-vehicle communication to adapt to the characteristics of the driver, the vehicle and the surrounding environment in a way that guarantees driver's and vehicle's safety.

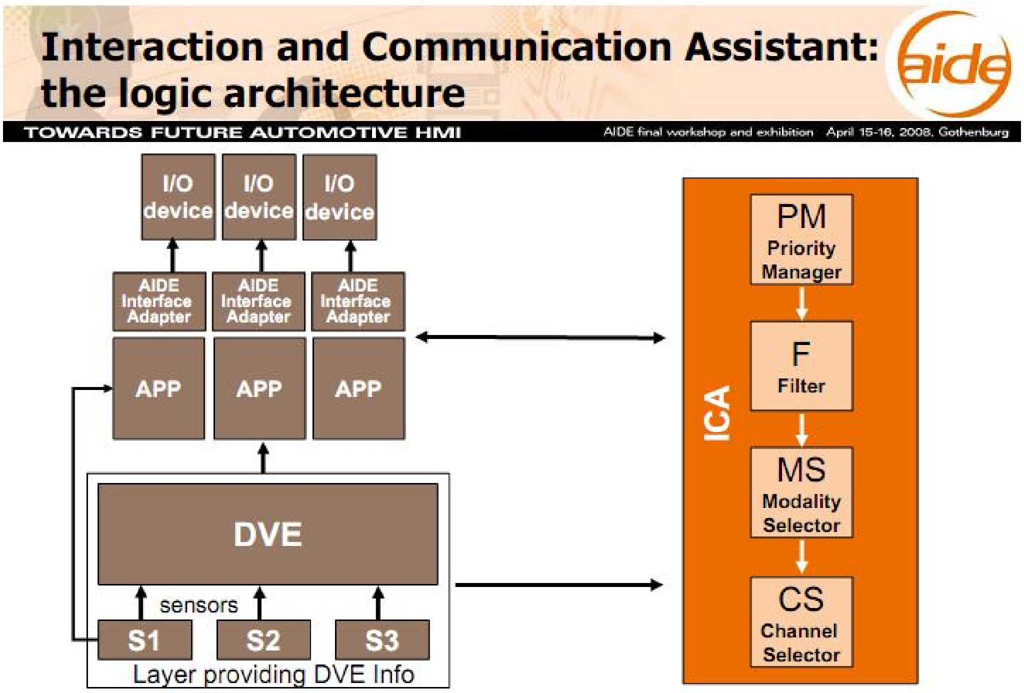


Figure 3 - Architecture of AIDE Interaction and Communication Assistant

The InteractIVe-Accident avoidance by active intervention for Intelligent Vehicles project[9] develops safety systems supporting the driver when dangerous situations occur and help to mitigate the impact of collisions in accidents that cannot be avoided.

The scientific objectives of interactIVe focused on the design, development, and evaluation of integrated ADAS applications. Five major scientific objectives have been defined. All of them serve the purpose to cover more scenarios, to enhance system intelligence, and to avoid full collision:

- Extend the range of possible scenarios and the usability of ADAS. The focus is on joint steering and braking actuations. Two specific areas are being investigated: continuous driving support and emergency interventions. Collision avoidance will thus become more effective.
- Improve decision strategies for active safety and driver-vehicle-interaction.
- Develop solutions for collision mitigation with market potential for lower automobile segments
- Create an innovative platform for enhancing the perception of the driving situation, integrating the environment sensing information as a part of the perception layer, including the inertial sensors, digital maps, and vehicle-to-vehicle as well as vehicle-to-infrastructure communication.
- Advance the application of standard methodologies for the evaluation of ADAS.

Several outputs of interactIVe represent a valuable input for the DESERVE project and the HMI task within DESERVE.
In particular the most innovative autonomous ADAS functions such as the dynamic prediction of a safe trajectory ahead, the sensor platform recognising the driving situation, and issues information, the warning and intervention (IWI) strategies that are based on driver's needs, advanced human machine interface (HMI) concepts integrated into the primary driving controls so to foster the usability of ADAS, the innovative platform for enhancing the perception of the driving situation represent a starting point for DESERVE.

Actually the DESERVE project is planning to use and extend the functionalities of the interactIVe platform, as displayed in Figure 4.

[9] http://www.interactive-ip.eu

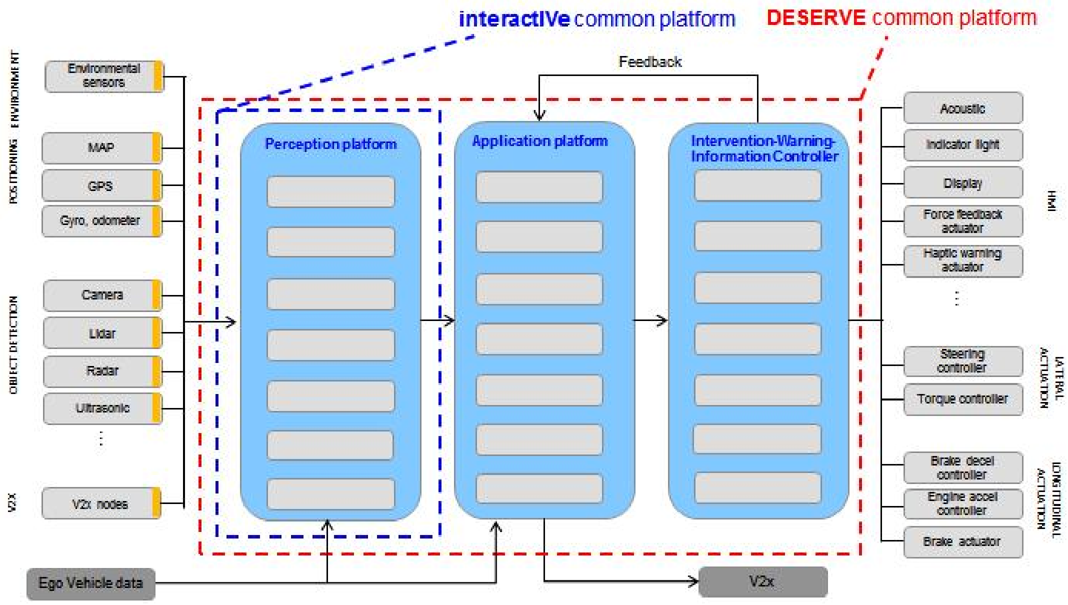


Figure 4 – Overview of the Deserve platform

The DESERVE project will progress beyond the state-of-the-art in the ADAS domain as pointed out in the definition of project objectives and the concept description. In particular it will provide a low cost, highly reliable, standardised platform, for compositional development, sharing sensors, actuators and HMI, enabling the low cost development of complex driver assistance systems and applications.

3. HMI NEEDS AND USER CENTRED DESIGN METHODOLOGY

One of the basic tenets behind the DESERVE approach is the necessity to involve users throughout the project from the earliest stages of development in order to obtain an understanding of user and task requirements. Before outlining the methodology for user participation that will be adopted, it is important to be clear about the basic terminology. The following taxonomy will be used (adopted from Karlsson, 1996 and Janhager, 2002)

- *Primary users / end-users / target users,* are individuals that directly interact with the product for its primary purpose. For example, truck and bus drivers are primary users of a vehicle, but also the passengers in a bus can be regarded as primary users even though they are not actually operating the vehicle.

- *Secondary users* are individuals that interact with the product, but not for its primary purpose, e.g. service and repair personnel.

- *Side users* who are indirectly affected by the product, but do not interact with the product, e.g. people living near a motorway.

- *Co-users* who co-operate with primary or secondary users in a common system, e.g. drivers in other cars are co-users in a traffic system.

- *Customer* is the person who purchases the product. This may, but does not have to, be the user.

User involvement will be of fundamental importance for the DESERVE design, development and experimental work. To this end, the ISO Human-Centred Design methodology (ISO 13407:1999) will be adopted. This standard describes characteristics and activities for a human-centred design. The basic principles of this methodology are illustrated in Figure 5.

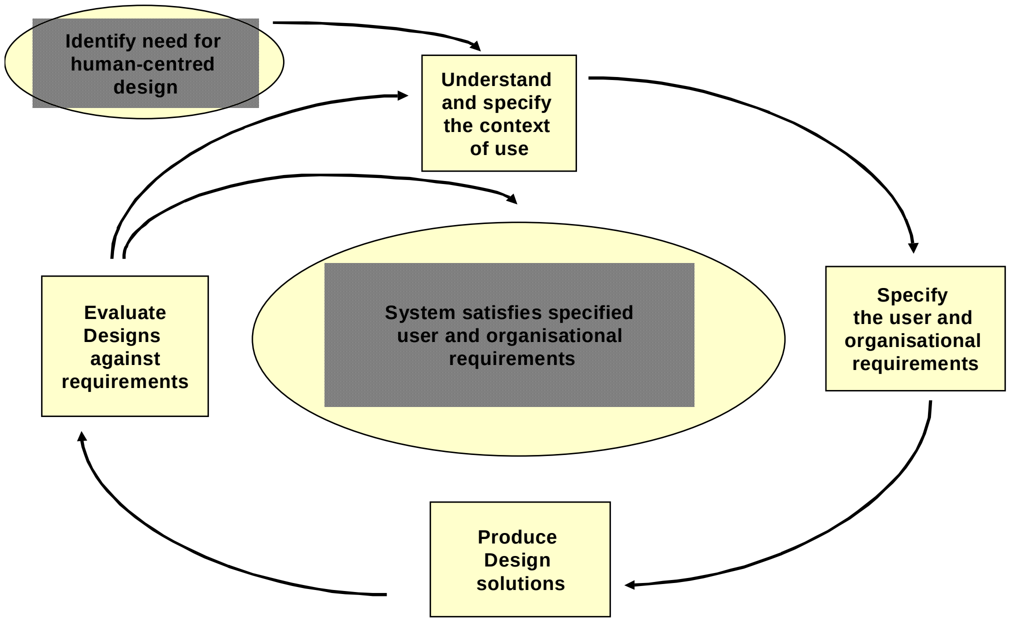


Figure 5 The basic principles of the ISO UCD methodology

As illustrated in the Figure 6, the UCD methodology entails an iterative procedure of formative design and evaluation with respect to user requirements. Figure 6 provides a further illustration of the User Centered Design methodology.

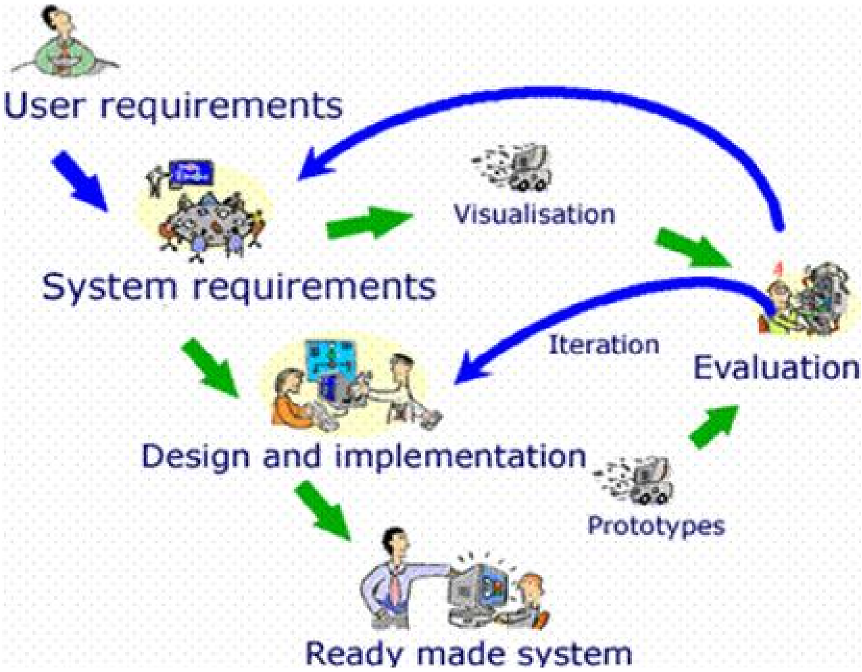


Figure 6 User-centered design involving iterative prototyping and evaluation of design solutions, where users are involved in each step

Following the UCD methodology, end users and/or customers will be involved in all phases of the DESERVE system development, i.e. the specification, the development and the validation phase. Moreover, users will participate as subjects in the experimental work.

The specific methods to be applied at different stages for user involvement are listed in Table 1.

Table 1 - Methods for user/customer involvement in the AIDE system development

General Activity	Main relevant work packages	Purpose of user involvement	Examples of methods for user/customer involvement
Specification	WP33	Gather user requirements	User/customer clinics, work place analysis, interviews
Development	WP34	Identify usability problems in order to improve design and user	Rapid (virtual) prototyping Heuristic evaluation Checklists (Video) observation

		acceptance	
Validation	WP62	Verify that the system meets the user requirements	Field trials with realistic prototype system implemented in the test vehicle. Questionnaires, structured interviews, behavioural data analysis etc.

In the human factors evaluation of the DESERVE prototypes, it is of key importance to take into account different characteristics of the target user groups, and to compose the subject groups accordingly. The detailed definition of the most relevant user-related factors is part of the experimental design, to be performed in the project. However, some general factors of interest may be distinguished:

- Driving experience
- Driving attitude
- Experience with technological devices
- Age
- Gender
- Professional versus private drivers
- Socio-economic groups – e.g. target customers of the different prototype vehicles (city car, luxury car).
- Nationality
- Functional disabilities.

The experiments will be designed so that user groups of particular interest (e.g. young inexperienced and elderly drivers) may be compared to “typical” users. It should be noted that all factors mentioned above are not necessarily considered in each test. The detailed experimental design is obviously determined by the hypotheses to be tested.

4. HMI NEEDS FOR BASIC DRIVER ASSISTANCE APPLICATIONS

In the subproject WP11 - Application needs, an application database was created, that identified 10 groups of DAS (Driver Assistant Applications) with 33 applications that are currently available or will be soon introduced in the automotive market. This elaborated DAS database will serve as a basis for the DAS applications addressed, investigated and finally selected for further work within the DESERVE development framework. It should be noted that not all of the DAS applications could be dealt with in the same manner and working depth throughout the project and a selection to a few demo cases, that will be examined and developed in more detail in WP4, is therefore needed. The DESERVE consortium assumes that this is not limiting the general approach and concept of an universal platform approach for DAS function development to any extend.
The database content is divided into 10 main DAS groups:

- Lane change assistance system
- Pedestrian safety systems
- Forward/Rearward looking system (distant range)
- Adaptive light control
- Park assistant
- Night vision system
- Cruise control system
- Traffic sign and traffic light recognition
- Map supported systems (Note: only DAS scope, no driver information)
- Vehicle interior observation

The following table presents an initial list of HMI features (i.e. type of message for users) which will be tested in relation of the main DAS groups.

Table 2 - Initial list of HMI features which will be tested in relation of main DAS groups

	HMI interfaces					
Driver Assistance Application Groups	HMI warnings	Acoustic	Visual	Haptic	On/Off commands	Other
Lane change assistance system	x	x	x	x		
Pedestrian safety systems	x	x	x	x		
Forward/Rearward looking system (distant range)	x	x	x	x		
Adaptive light control			x		x	
Park assistant	x	x	x			
Night vision system	x		x			
Cruise control system	x	x	x		x	
Traffic sign and traffic light recognition	x		x		x	
Map supported systems (Note: only DAS scope, no driver information)	x				x	
Vehicle interior observation	x					

More detail on each DAS group will be provided in D33.2. The next paragraph will explain which ADAS functions will be tested in the DESERVE demonstrators and the HMI implications.

5. HMI NEEDS FOR DESERVE TARGET APPLICATIONS

The following paragraph focuses on the vehicle demonstrators and on the ADAS systems to be developed. For each of them the HMI needs are briefly outlined. Within the DESERVE project the following functions will be demonstrated:

DAS-function	Demonstrator from
Driver impairment warning system for cars	CRF
End-Of-Tail-Congestion warning for motorcycles	Ramboll
Blind-Spot-Detection for motorcycles	Ramboll
Motorcycle occupant detection and classification system	Ramboll
Emergency braking ahead for Powered Two Wheeler (PTW)	Ramboll
Rider drowsiness for PTW	Ramboll
Electronic brake signal (brakelight) for PTW	Ramboll
Collision warning	Technolution and NXP
Inter Urban Light Assist for passenger car	Daimler
Adaptive cruise control for heavy trucks	Volvo

The following paragraph illustrates the HMI needs for each demonstrator, presented according to a common template. The template foresaw first of all to describe the type of function (information - warning – intervention), the HMI needs related to the type of message (acoustic, visual, haptic), the presence of On/Off commands, the timing between different functions (e.g. contemporary or sequential), the possibility that the driver overrides the warning, information, intervention function, levels of response associated to a function (e.g. binary, or based on different degrees of response), case dependencies (e.g. function dependent on day/night, road type…), the possibility that a message / function is repeated (e.g. in case a warning message is ignored) the possibility that different degrees of risks exist in relation to each function. Finally, it has been requested to specify whether a need to acknowledge the drivers exist in relation to a function.

Information has been requested to project partners and at the time of finalizing this report HMI needs are not yet defined nor complete. Below is the information received.

4.1 Driver impairment warning System for cars (CRF)

The HMI needs for each function tested in this demonstrator are described in the following tables.

Table 3 - HMI needs for Driver impairment warning System for cars

Function	Type (Information - warning - intervention)	Acoustic		Visual		Haptic		On/Off commands		Timing (e.g. contemporary w/other functions, before/after)
		(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	
AEB pedestrian	IWI	Y		Y		?		N		?
Low speed collision mitigation	WI	Y		Y		Y		N		?
Diver monitoring (distraction detection)	IW	N		Y		N		Y		?
Drowsiness monitoring	Information & warning	Y	information about drowsiness status proportional with drowsiness level	Y	information about drowsiness status proportional with drowsiness level	N		N		
Visual distraction monitoring	Warning	Y	information about distraction only if driving fault is detected or critical driving situation is detected	Y	Could be combined with ADAS feedback on head up display	Y	Could be combined with ADAS feedback on head up display for example for lateral control haptic steering wheel, for longitudinal control haptic gas pedal	N		Yes, time concordance between driving fault or critical situation (from ADAS) and assessment of visual distraction

Function	Override permitted?		Levels of response?		Describe case dependencies (e.g. day/night, road type, interaction w/other ADAS)	Repetition of message / function?		Are there different degrees of risk?		Need of an acknowledge from driver?	
	(y/n)	remarks	n° of levels	remarks		(y/n)	Description (same, different degrees, etc.)	(y/n)	Remarks	(y/n)	Remarks
AEB pedestrian	N		?		?	Y	SAME	?		N	
Low speed collision mitigation	N		?		?	Y	SAME	?		N	
Diver monitoring (distraction detection)	Y		?		DAY/NIGHT	Y	SAME	?		Y	
Drowsiness monitoring	Y	This is the decision of the driver to stop to take a rest	4	Alert, slightly drowsy, drowsy, sleepy	Need information about driving behaviour to improve drowsiness diagnostic (lateral position, ...). Information about driving time, duration is also useful. Not really concerned with urban scenarios	Y	Degrees can be increased depending of the observed driver state evolution. For acceptability by the driver alarm recurrence should not be to frequent	Y	Depending on the observed drowsiness level		Y
Visual distraction monitoring	N	to be discussed	Binary		The visual distraction as standalone system won't be accepted by users. They must be combined with information about the driving situation provided by ADAS (i.e. performance of lateral or longitudinal control, obstacles...)	Y	Repetition is acceptable but for acceptance the frequency should be quite low and also depending on the scenarii	Y	Depends of the criticality of the driving situation provided by ADAS	Y	time concordance between driving fault or critical situation (from ADAS) and assessment of visual distraction

4.2 End-Of-Tail-Congestion warning for motorcycles (RAMBOLL)

Table 4 - HMI needs for End-Of-Tail-Congestion warning for motorcycles

Type (Information - warning - intervention)	Acoustic		Visual		Haptic		On/Off commands		Timing (e.g. contemporary w/other functions, before/after)
	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	
Information	Yes	During day-time, when the visibility of a single light on the dashboard is low, an audio signal inside helmet can be used. A single "Bling" could do since more information can be read on the screen on the dashboard. During darkness the effect of the light is emphasized.	Yes	A signal light on the dashboard. Effect by blinking. Text e.g. "Queue ahead!".	No		No		Several warning/information icons may be shown on the screen, but only one sound signal may be presented at a time. Cognitive overload disturbs the rider. An urgent warning signal is of a higher priority than an information signal.

Override permitted?	Describe case dependencies (e.g. day/night, road type, interaction w/other ADAS)	Repetition of message / function?		Are there different degrees of risk?		Need of an acknowledge from driver?		Other
(Y/N)		(y/n)	Description (same, different degrees, etc.)	(y/n)	Remarks	(y/n)	Remarks	
	Red light suits best both the nature of the function and the human-ability to see in low-light environment.	Yes		Yes	Two levels of risk. 1) Initial information 2) Second warning	Yes	A second warning is given if speed or lane is not adjusted in time.	Events and special occasions such as track days or training events may give rise to very exceptional traffic arrangements which may fool the system, so the ability to turn off all these applications is also appropriate.

4.3 Blind-Spot-Detection for motorcycles (RAMBOLL)

Table 5 - Blind-Spot-Detection for motorcycles

Type (Information - warning - intervention)	Acoustic		Visual		Haptic		On/Off commands		Timing (e.g. contemporary w/other functions, before/after)
	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	
Information	No		Yes	Blinking light warning at side mirror. Light flashes always when the respectful turn signal is on and an obstacle is detected in the blindspot. Audio warning only when lane change attempt is detected and a collision is probable.	No		Yes		Several warning/information icons may be shown on the screen, but only one sound signal may be presented at a time. Cognitive overload disturbs the rider. An urgent warning signal is of a higher priority than an information signal.
Warning	Yes	A sound warning when lane change attempt is detected and a collision is probable.	Yes	Blinking light warning at side mirror. Light starts blinking always when an obstacle is detected in the blind spot. Audio warning only when lane change attempt is detected and a collision is probable.	No		Yes		Several warning/information icons may be shown on the screen, but only one sound signal may be presented at a time. Cognitive overload disturbs the rider. An urgent warning signal is of a higher priority than an information signal.

Override permitted ?	Describe case dependencies (e.g. day/night, road type, interaction w/other ADAS)	Repetition of message / function?		Are there different degrees of risk?		Need of an acknowledge from driver?		Other
(Y/N)		(y/n)	Description	(y/n)	Remarks	(y/n)	Remarks	
No		No	Once	No		No		Events and special occasions such as track days or training events may give rise to very exceptional traffic arrangements which may fool the system, so the ability to turn off all these applications is also appropriate.
		No	Once	No		No		

4.4 Occupant detection and classification Systems for PTW (Ramboll)

Table 6 - Occupant detection and classification Systems for PTW

Type (Information - warning - intervention)	Acoustic		Visual		Haptic		On/Off commands		Timing (e.g. contemporary w/other functions, before/after)
	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	
Warning	Yes	A warning sound, a buzzer or similar alerting sound.	Yes	A blinking red light on the dashboard. On a screen a three-four frame animation of a collision from the rear.	No		Yes		Several warning/information icons may be shown on the screen, but only one sound signal may be presented at a time. Cognitive overload disturbs the rider. An urgent warning signal is of a higher priority than an information signal.

Override permitted?	Describe case dependencies (e.g. day/night, road type, interaction w/other ADAS)	Repetition of message / function?		Are there different degrees of risk?		Need of an acknowledge from driver?		Other
(Y/N)		(y/n)	Description (same, different degrees, etc.)	(y/n)	Remarks	(y/n)	Remarks	
		No				No		Events and special occasions such as track days or training events may give rise to very exceptional traffic arrangements which may fool the system, so the ability to turn off all these applications is also appropriate.

4.5 Emergency Braking Ahead for PTW (Ramboll)

Table 7 - Emergency Braking Ahead for PTW

Type (Information - warning - intervention)	Acoustic		Visual		Haptic		On/Off commands		Timing (e.g. contemporary w/other functions, before/after)
	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	
Warning	Yes	A warning sound, a buzzer or similar alerting sound.	Yes	A blinking red light on the dashboard. On a screen a three-four frame animation of a collision from ahead.	No		Yes		Several warning/information icons may be shown on the screen, but only one sound signal may be presented at a time. Cognitive overload disturbs the rider. An urgent warning signal is of a higher priority than an information signal.

Override permitted?	Describe case dependencies (e.g. day/night, road type, interaction w/other ADAS)	Repetition of message / function?		Are there different degrees of risk?		Need of an acknowledge from driver?		Other
(Y/N)		(y/n)	Description (same, different degrees, etc.)	(y/n)	Remarks	(y/n)	Remarks	
		No		No		No		Events and special occasions such as track days or training events may give rise to very exceptional traffic arrangements which may fool the system, so the ability to turn off all these applications is also appropriate.

4.6 Rider Drowsiness for PTW (Ramboll)

Table 8 - Rider Drowsiness for PTW

Type (Information - warning - intervention)	Acoustic		Visual		Haptic		On/Off commands		Timing (e.g. contemporary w/other functions, before/after)
	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	
Warning	Yes	A "bling", for instance. The warning sound grows in aggressiveness as the rider continues to discard the warning.	Yes	Information icon on a screen notifying about decreased level of alertness.	Yes	A vibration device on the handlebars, as more aggressive signal is required due to rider indifference.	Yes		Several warning/information icons may be shown on the screen, but only one sound signal may be presented at a time. Cognitive overload disturbs the rider. An urgent warning signal is of a higher priority than an information signal.

Override permitted?	Describe case dependencies (e.g. day/night, road type, interaction w/other ADAS)	Repetition of message / function?		Are there different degrees of risk?		Need of an acknowledge from driver?		Other
(Y/N)		(y/n)	Description (same, different degrees, etc.)	(y/n)	Remarks	(y/n)	Remarks	
		Yes	Growing aggressiveness of warning message.	Yes	Three degrees. 1) A single warning signal (audio and haptic) and an icon on the screen. 2) A more powerful warning signal (audio and haptic) and an icon on the screen. 3) A long lasting (three seconds) warning signal (audio and haptic) and an icon on the screen. Each warning has to be acknowledged in order to make it stop repeating itself. The system can be "rebooted" by stopping the PTW and turning off the engine for 1 minute, the power may be left on.	Yes	The signal keeps repeating until the rider acknowledges the warning, much like an alarm clock function on a smartphone	Events and special occasions such as track days or training events may give rise to very exceptional traffic arrangements which may fool the system, so the ability to turn off all these applications is also appropriate.

4.7 Electronic Brake Signal (Brakelight) for PTW (Ramboll)

Table 9 - Electronic Brake Signal (Brakelight) for PTW

Type (Information - warning - intervention)	Acoustic		Visual		Haptic		On/Off commands		Timing (e.g. contemporary w/other functions, before/after)
	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	
Warning	No		No		No		No		Several warning/information icons may be shown on the screen, but only one sound signal may be presented at a time. Cognitive overload disturbs the rider. An urgent warning signal is of a higher priority than an information signal.

Override permitted?	Describe case dependencies (e.g. day/night, road type, interaction w/other ADAS)	Repetition of message / function?		Are there different degrees of risk?		Need of an acknowledge from driver?		Other
(Y/N)		(y/n)	Description (same, different degrees, etc.)	(y/n)	Remarks	(y/n)	Remarks	
Yes		No		No		No		Events and special occasions such as track days or training events may give rise to very exceptional traffic arrangements which may fool the system, so the ability to turn off all these applications is also appropriate.

4.8 Collision warning (Technolution and NXP)

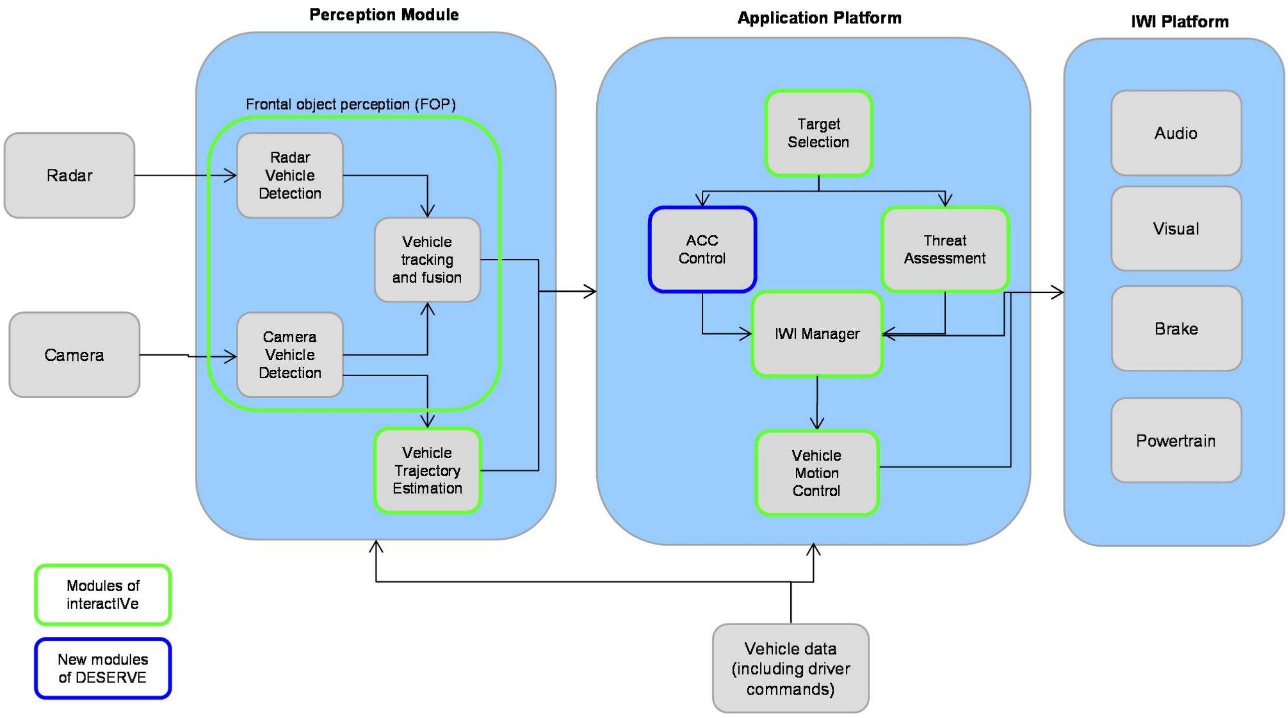
Table 10 - Collision warning

Function	Type (Information - warning - intervention)	Acoustic		Visual		Haptic		On/Off commands		Timing (e.g. contemporary w/other functions, before/after)
		(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	(y/n)	Needs description	
collision warning	warning	y	simple beep	y	icon + motivation	n		y		
traffic flow drop warning	warning	y	simple beep	y	icon + motivation	n		y		
traffic jam tail warning	warning	y	simple beep	y	icon + motivation	n		y		

Override permitted?		Levels of response?		Describe case dependencies (e.g. day/night, road type, interaction w/other ADAS)	Repetition of message / function?		Are there different degrees of risk?		Need of an acknowledge from driver?		Other
(Y/N)	remarks	n° of levels (e.g. 2 if yes/no only)	remarks		(y/n)	Description (same, different degrees, etc.)	(y/n)	Remarks	(y/n)	Remarks	
n.a.		n.a.		day/night	y		y	distance based	n		
n.a.		n.a.		day/night	y		y	distance based	n		
n.a.		n.a.		day/night	y		y	distance based	n		

4.9 Adaptive cruise control for heavy trucks (Volvo)

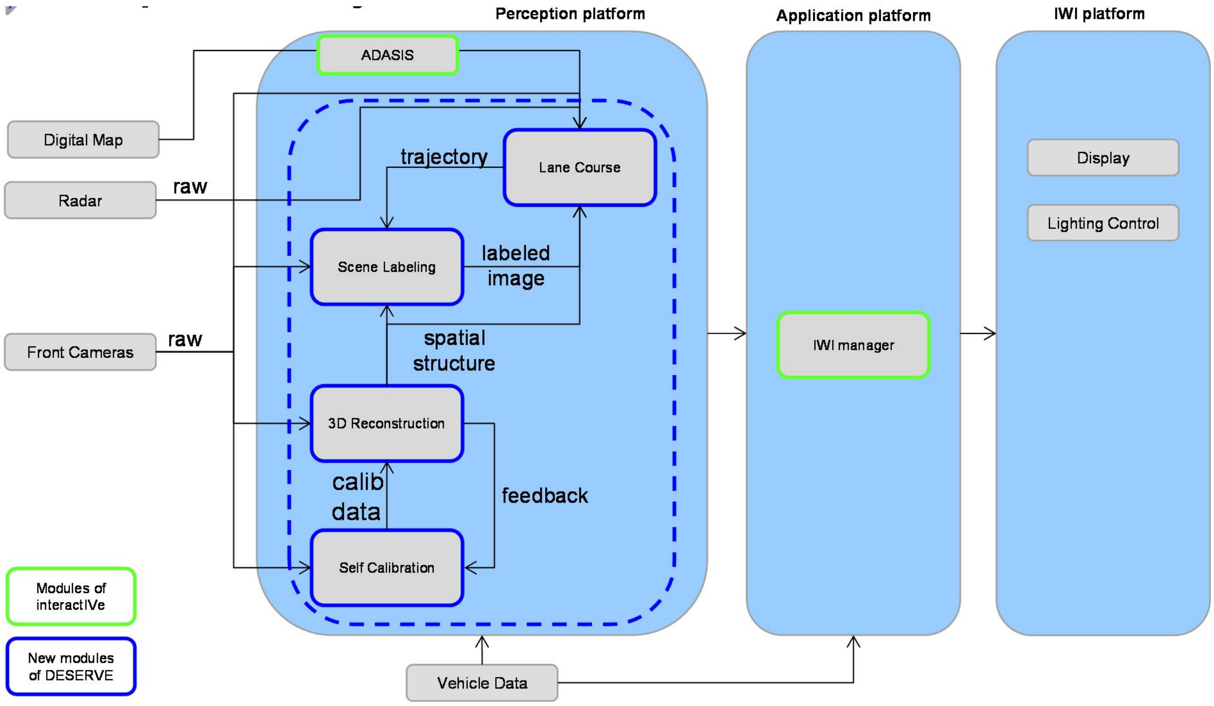
Complete information is not yet available since HMI needs of this demonstrator are still to be defined at the time of compiling this deliverable. The components layout is reported below.



The HMI needs of this demonstrator are related to acoustic and visual messages to drivers.

4.10 Inter Urban Light Assist for passenger car (Daimler)

Complete information is not yet available since HMI needs of this demonstrator are still to be defined at the time of compiling this deliverable. The components layout is reported below.



The HMI needs of this demonstrator are related to visual messages to drivers.

5. HMI SOFTWARE ARCHITECTURE AND REQUIREMENTS

5.1 General architecture requirements

Within DESERVE the communication between driver and in-vehicle system is managed by a central intelligence to avoid critical effects of interdependences. This intelligence lies in the DESERVE IWI module. It 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 IWI module of the DESERVE platform is responsible for managing all the interaction and communication between the driver and the vehicle. This includes the selection of modality for presentation, the message prioritisation and scheduling and the general adaptivity of the driver-vehicle interface (e.g. display configuration and function allocation).

Furthermore such a fully integrated common in-vehicle HMI allows the exploitation of synergies and reduces HW costs and enhances system performance.

5.2 HMI architecture and requirements

In this paragraph a scheme concerning the classification of the IWI modules is presented in Figure 7.

Figure 7 - DESERVE IWI Platform

As reported in D1.2.1 and in accordance with the information on HMI needs collected, the main HMI requirements of the IWI modules that indicate the HMI used to alert the driver in case of danger, are presented and shortly described in the following table.

Table 11 - Description of HMI requirements for IWI platform modules related to HMI

IWI platform modules related to HMI	Description	ID	Requirement short description
Acoustic	Provides information and warnings to the driver (verbal messages and acoustic signals) upon request from the applications. In some demonstrators (as presented above) the use of the acoustic signal provides information and warnings without distracting the driver visually.	HMI-IWI-1.1	Sound pressure level within acceptable range for human ears
		1.2	Frequency range within acceptable range for human ears
		1.3	When designing a warning, map acoustic sources to the location of the risk in space.
		1.4	User the loudness level of each sound in the acoustic display needs to be calibrated so that a proper level of urgency is achieved without creating annoyance
		1.5	Allows for cross-modal matching with other display types such as visual and haptic displays.
Displays	Provides information and warnings to the driver (icons and text) upon request from the applications.	2.1	ISO standards design requirements (brightness/intensity, visual acuity/spatial contrast sensitivity, colour specification, resolution and field of view)
		2.2	Visual elements should be organised according to a recognizable hierarchy (i.e.: more relevant and critical information must be more salient). Figure-ground organisation, grouping principles (proximity, similarity, continuity, closure, common elements with common dynamics tend to be grouped together).
		2.3	Any piece of information presented through the visual channel should minimise distraction from the road scene ahead.
Telltales	Provides information and warnings to the driver	3.1	Compliance with ISO 2575 Road vehicles – Symbols for controls, indicators and tell-tales. In general the

IWI platform modules related to HMI	Description	ID	Requirement short description
	(different kinds of visual signals) upon request from the applications.		red colour is used if a danger is present; the yellow/amber colour invites to get caution; the green indicates a normal operating condition.
Physical feedback: through steering Wheel	Provides feedback to the driver in form of steering torque or steering vibration	4.1	User acceptance: the signal should be clearly perceivable without being intrusive or disruptive and well accepted by the user. Redundancy on other channels (e.g.: telltales) is recommended in order to avoid ambiguity.
		4.2	The signal should combine an oscillation/vibration with directional information or torque lead
Physical feedback through throttle	Provides haptic feedback to the driver by the accelerator pedal. Haptic accelerator pedal signals are most often applied for longitudinal support systems, mainly in Forward Collision Warning scenarios, Curve Speed Warning, Speed Limit Warning or Adaptive Speed Control.	5.1	The warning accelerator pedal module gives a feedback on the acceleration pedal. Semantics can be associated to different physical patterns (e.g.: vibration, knocking or pressure).
		5.2	The parameters for vibrations and torques have to be individually adapted to pedal type and position in combination with the seating position of the driver in the vehicle.
Physical feedback through safety belt	Provides feedback to the driver by tensioning the safety belt or generating a vibration through a vibrating pad in case of warning condition, gives a feedback to the driver through a vibration or a tightening on the seat belt. This kind of feedback is used for frontal dangerous conditions.	6.1	The parameters for vibrations have to be adapted to the seating position of the driver in the vehicle.

6. CONCLUSIONS

The present report has listed the HMI needs of the DESERVE development platform with specific regards to DESERVE demonstrators, in the context of the so-called user centered design methodology.

It then presented a list of requirements related to HMI related IWI platform modules. This deliverable is strictly related to Deliverable 33.2 Definition of a general integrated HMI solution, which is the logical follow up of this report.

Further updates during the course of the project and in particular of the demonstrator development activities may happen as appropriate and useful. This might have a significant impact on the HMI needs and requirements of the demonstrators. Moreover, the list of HMI needs and requirements for the DESERVE demonstrators is not yet complete at the time of the elaboration of this deliverable. Nevertheless this deliverable, alongside with D33.2, paves the way to the definition of the DESERVE HMI solution, to be presented in D34.1 – HMI Solution Design.
While this deliverable presents the HMI user needs collected so far, D33.2 will present an analysis of main HMI solutions available on the market for DAS and design guidelines for the final DESERVE HMI solutions.
These two reports will support the detailed definition of HMI specifications and architecture, which will be reported in Deliverable 34.1 HMI solution design.

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