INFORMATION SOCIETY TECHNOLOGIES (IST) PROGRAMME

AIDE

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AIDE Final Activity Report

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Executive summary

This is the Final Activity report of the EU 6th Framework Programme Integrated Project AIDE (Adaptive Integrated Driver-vehicle interfacE). AIDE was a 50 month project, running from March 2004 to April 2008, with 31 partners from European automotive industry and academia, and with a total budget of 12.4 M€, of which 7.3 M€ were European Community research funding.

The project addressed a number of present and future challenges within the area of driver-vehicle interfaces, regarding maximisation of safety benefits of advanced driving assistance systems (ADAS), minimisation of the workload and distraction imposed by in-vehicle information systems (IVIS) and nomadic devices (portable consumer electronic devices which drivers use while driving), as well as issues related to the currently rapid growth in numbers of such systems within vehicles, both in terms of associated integration difficulties in the development phase and in terms of increased risks of driver information overload.

These challenges were addressed by both basic research and development of methodologies and technologies, with the overall goal being to design, develop and validate a generic driver-vehicle interface that is *integrated*, in the sense that all system input and output is coordinated and handled via shared in-vehicle controls (displays, buttons, speech input, speech output, and so on), and *adaptive*, in the sense that the amount and format of information given to the driver is varied depending on the situation at hand.

The project, being an Integrated Project, was divided into four Sub-projects, each addressing a slightly different aspect of the overall goal.

Sub-project 1 researched the behavioural effects of use of IVIS and ADAS while driving. Short and long term studies were conducted to assess behavioural adaptation of drivers to ADAS, and a number of relevant findings were made, e.g. showing that without careful integration, the beneficial effects of individual ADAS may disappear when the ADAS are installed together in a vehicle. Other key findings were that simultaneous learning of multiple ADAS at the same time increased the duration of learning significantly, and that adaptation of ADAS to driving style (e,g. careful versus aggressive driving style) improved acceptance considerably.

Further, Sub-project 1 developed a theoretical model of the driver, the vehicle and the environment, (a *DVE model*) and the interactions between these during driving. This theoretical model was then implemented in computer simulation in a software tool, SSDrive, and it could be shown that the behaviour of this simulation was comparable to human driving in some respects. The long-term purpose of SSDrive is to be a tool that can be used for cost-efficient simulated assessment of the effects of IVIS and ADAS on driving, e.g. within system development within automotive industry, and a first step towards this goal has been achieved within AIDE.

Sub-project 2 researched and developed methodologies for evaluation and assessment of in-vehicle systems and their human-machine interfaces (HMI). A large number of tools and methods were developed, improved and/or validated, measuring effects of in-vehicle system use both subjectively (e.g. by means of questionnaires) and objectively (e.g. by means of reaction time tasks, eye movement analysis tools, and metrics quantifying vehicle control performance).

Further, based on these developments and validations, Sub-project 2 defined a generic *AIDE evaluation methodology*, prescribing use of the tools and methods that had been found preferable. This generic methodology was delivered in the form of a “cook book” for system evaluation, listing a full set of steps to follow, ranging from defining the aims of the evaluation up to doing the final analyses of obtained data. One part of this methodology is the application of a procedure for assessment of aggregated traffic risk, also developed in AIDE Sub-project 2. This procedure is an attempt at bridging the gap between observed driver behaviour and actual traffic risk, and although future work and verification remain before this ambitious endeavour is completed, AIDE has also in this case provided a relevant step forward.

Finally, Sub-project 2 applied the AIDE evaluation methodology to the three AIDE demonstrator vehicles developed in Sub-project 3, and was able to demonstrate positive effects of the AIDE driver-vehicle interface solutions in terms of increased attention of drivers to the forward roadway, use of multiple in-vehicle systems without associated increases in workload, as well as a subjective preference among drivers for the AIDE-enabled driver environment compared to a non-AIDE case.

Sub-project 3 designed and developed the actual adaptive and integrated driver-vehicle interface. After defining basic system requirements and use cases, a generic functional and logical architecture for adaptive and integrated HMI was developed, defining involved modules, their responsibilities and the protocols for communication between them. This architecture is highly modular and is designed to permit cost-efficient addition of new systems and functions into existing vehicle platforms.

The core module of the AIDE architecture is the *Interaction and Communication Assistant* (ICA), responsible for the central coordination of input and output for all in-vehicle systems, i.e. thus implementing HMI *integration*, and the selection of suitable timing and format of information presentation depending on the current driving situation, thus implementing HMI *adaptivity*. Sub-project 3 defined the ICA logic needed for both these features.

In order to provide the ICA with an understanding of the driving situation, a set of five *Driver-Vehicle-Environment (DVE) monitoring modules* were developed, using sensors inside and outside of the vehicle to estimate in real time a number of DVE parameters quantifying driver drowsiness, distraction and driving style, the demand imposed by the traffic situation, as well as any current traffic or environment related risks.

In order to extend the ICA's integration and adaptivity capabilities also towards nomadic devices, a *nomadic device gateway* was developed, allowing, by means of BlueTooth communication, the driver to access a range of nomadic device functions via in-vehicle displays and controls. The work on nomadic device integration was supported by the *Nomadic Device Forum*, a pan-European multi-sector working group set up by AIDE to facilitate European consensus building on nomadic device related issues where consensus could be beneficial for traffic safety and for business.

The AIDE HMI components listed above were integrated in three demonstrator vehicles – one city car, one luxury car, and one heavy truck. The prototype HMIs in these demonstrators feature state-of-the-art input/output devices such as speech input and haptic controls, and show that the AIDE solutions are flexible enough to allow implementation of a wide range of different in-vehicle HMIs. Further, tests were carried out on a dedicated implementation of AIDE modules in a product vehicle architecture, showing that overheads, in terms of bus loads and delays, induced by the central AIDE HMI coordination were within acceptable limits.

Sub-project 4, finally, dealt with the technical and administrative coordination of the Integrated Project, and other horizontal issues such as dissemination and exploitation of AIDE results, as well as development of recommendations for standards and guidelines based on AIDE results.

This final activity report provides further details on the matters introduced above, and also provides, on both Sub-project and Integrated Project level, suggestions for suitable future work within the field of automotive human-machine interfaces, as well as assessments of project results versus project objectives and against the state of the art in the field. The overall conclusion is that the AIDE Integrated Project has advanced the state of the art considerably in a large number of areas, and that, in general, the project objectives have been very well met.

Further, on an Integrated Project level, this report also provides summary listings of key exploitable results of AIDE, the main dissemination efforts of AIDE, as well as a listing all of the AIDE deliverables, in terms of reports and prototypes.

Revision chart

Version	Date	Reason
0	2008-03-07	Template by VTEC distributed to SP and WP leaders.
0.1	2008-04-07	Draft version prepared for AIDE Final Review, providing overall structure but not all envisioned content. Submitted to EC.
0.2	2008-05-16	Updates to SP2 and dissemination overview sections. Suggested modifications and comments from VTEC.
1	2008-06-30	Executive summary, background, introduction, missing SP4 sections, IP level discussion, conclusions and references added by VTEC. First full version for Core Group review.
2	2008-10-08	Modifications after Core Group feedback. Version submitted to EC.

Abbreviations

ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance Systems
AIDE	Adaptive Integrated Driver-vehicle InterfacE
ARV	Application Request Vector
CAA	Cockpit Activity Assessment
CAN	Controller Area Network
DAE	Driver Availability Estimation
DC	Driver Characteristic
DSD	Driver State Degradation
DVE	Driver-Vehicle-Environment
DVEM	Driver Vehicle Environment Monitor
EASIS	Electronic Architecture and System Engineering for Integrated Safety Systems
EC	European Commission
ESoP	European Statement of Principles
FCW	Frontal Collision Warning
GPS	Global Positioning System
GST	Global System for Telematics
GUI	Graphical User Interface
HBK	Haptic Barrel Key
HMI	Human-Machine Interface
ICA	Interaction and Communication Assistant
I/O	Input/Output
IP	Integrated Project
ISA	Intelligent Speed Adaptation
IVIS	In-Vehicle Information Systems
LDW	Lane Departure Warning
MP3	Moving Picture Expert Group 1.0 Layer 3, here MP3 player
ND	Nomadic Device
OEM	Original Equipment Manufacturer
PDA	Personal Digital Assistant
PDT	Peripheral Detection Task
PND	Personal Navigation Device
PReVENT	PReVENTive and Active Safety Applications
SP	Sub-project
TERA	Traffic and Environmental Risk Assessment
WP	Work package

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1 Introduction

This is the Final Activity report of the EU 6th Framework Programme Integrated Project AIDE (Adaptive Integrated Driver-vehicle interfacE). In contents and format it follows the guidelines set out in the European Commission (EC) document "Project reporting in FP6".

The purpose of this final activity report is to describe the initial objectives of the project, how work towards these objectives was organised and carried out during the project, and what results were obtained. Also, it is a purpose of the final activity report to assess the project's results against the project objectives and against the state of the art in the field, as well as to outline suitable areas for future research within the area.

The document is organised as follows:

First, a background to the work carried out in the AIDE project is given, quoted from the original Description of Work. Then follows the stated objectives of the IP, also quoted from the Description of Work. Next, a general, Integrated Project-level description of the work carried out is given, listing project partners, sub-project and work package structure, time plans and internal and external interactions. Then, three summary sections follow, providing summary listings of the key exploitable results of AIDE, the main dissemination efforts and results of AIDE, and the deliverables (reports and prototypes) generated by AIDE.

Next, a report per each of the four AIDE sub-projects follow. Each such sub-project report is structured as follows:

First some overall facts about the sub-project, including its objectives, are listed, and a sub-project level overview of the work carried out is given. Then, each work package of the sub-project is reported on in turn, explaining work package objectives, work carried out and results obtained. For each work package, results are assessed against work package objectives and against the state of the art in the field. After the work package reports an assessment of overall sub-project achievements against objectives and state of the art is made, and suggestions for suitable future work are listed.

After the four sub-project reports, this final activity report is concluded by an overall IP level assessment of results against objectives and state of the art, a summary of suggested future work is given, and final conclusions are made.

2 Background

The following is a quote from the Description of Work (Annex I to the project contract):

Every year, about 45 000 people die and 1.5 millions people are injured in traffic accidents in Europe. These figures imply that one person out of every 200 European citizens is injured in a traffic accident each year and that around one out 80 European citizens die 40 years short of their expected lifetime. It is known that the great majority of road accidents (about 90-95%) are caused by human error (Treat, et al., 1979). More recent data has identified inattention (including distraction, "looked but did not see" and falling asleep at the wheel) as the primary cause of accidents, accounting for at least 25% of the crashes (Wang et al., 1996). […]

HMI design for maximising the safety benefits of new Advanced Driver Assistance Systems (ADAS)

Today, a wide range of *Advanced Driver Assistance Systems (ADAS)* are being developed for enhancing the driver's perception of the hazards, and/or partly automating the driving task. These include speed alert, lane support/blind spot detection, automated safe following, pedestrian detection, vision enhancement and driver impairment monitoring. These systems have great potential for reducing accidents, in particular the great portion related to human error (European Commission, 2002). The safety impact of these systems depends will to a great extent be determined by their interaction with the driver. For example, in order to efficiently support the driver in avoiding crashing into a front obstacle, it is crucial that the warning/feedback given by the system intuitively generates the appropriate response (e.g. an avoidance manoeuvre). New technologies, exploiting new concepts for driver-vehicle interaction in multiple sensory modalities (e.g. visual, tactile and auditory), offer great potential for maximising the potential safety benefits of ADAS. […]

Moreover, it is well known that the introduction of new safety functions may induce longer-term changes in driver behaviour. This type of behavioural change, often referred to as *behavioural adaptation*, may significantly affect the actual (as compared to the expected) safety benefits of a safety measure, both in positive and negative directions (OECD, 1990). Behavioural effects demonstrated for ADAS include system over-reliance on in-vehicle safety technologies resulting diversion of attention from the driving task and safety margin compensation (e.g. increasing speed in response to enhanced visibility in adverse conditions; e.g. Fosser, Saetermo and Sagberg, 1997; Nilsson, 1995 and Brown, 2000; see Smiley, 2000, for a review). […]

Finally, the potential safety impact of an ADAS ultimately depends on its market penetration rate and whether it is actually used by drivers. Here, the human-machine interface is of crucial importance; annoying system behaviour (e.g. nuisance warnings) will lead to drivers simply abandoning the system, which hence obviously looses its potential safety benefit.

HMI design for minimising workload and distraction imposed by In-vehicle Information Systems (IVIS)

In addition to Advanced Driver Assistance Systems, a growing number of *In-vehicle Information Systems (IVIS)* are being introduced in modern vehicles. By contrast to ADAS, these systems provide services not directly relevant for the primary driving task and thus impose a *secondary tasks* on the driver. Moreover, the in-vehicle use of portable computing devices e.g. hand-held mobile phones and portable digital assistants (PDAs), often referred to as *Nomad devices,* is increasing rapidly.

These systems have great potential for increasing mobility and comfort. For example fleet management systems enhance the efficiency of work in the freight industry and road-and traffic information systems potentially facilitate the quality of life for the commuter. However, information systems in vehicles may also compete with the primary driving task for the driver's attention and

hence induce dangerous levels of distraction and workload. The safety risks of IVIS are well known, in particular the case of mobile phones. Results from an epidemiological study conducted by Redelmeier & Tibshirani (1997), mobile phone use increases the accident risk by a factor 4 compared to normal driving. Given this critical safety impact of mobile phones alone, the introduction of additional information functions such as email, internet access, navigation aids, road and traffic information raises obvious safety concerns. In particular, nomad devices are not designed for use while driving and thus major potential future in-vehicle distractors

The design of the human-machine interface of IVIS and nomad devices is of key importance for minimising the workload and distraction that they impose on the driver. Methods and criteria are needed to validate these systems with respect to their potential negative safety effects.

Towards a unified HMI solution for integrating ADAS and IVIS

In addition to the safety issues associated with the *individual* systems described above, the proliferation of complex in-vehicle functions itself poses a further challenge for the design of the driver-vehicle interface. Figure 1 below illustrates the situation facing vehicle system HMI designers in the near future.

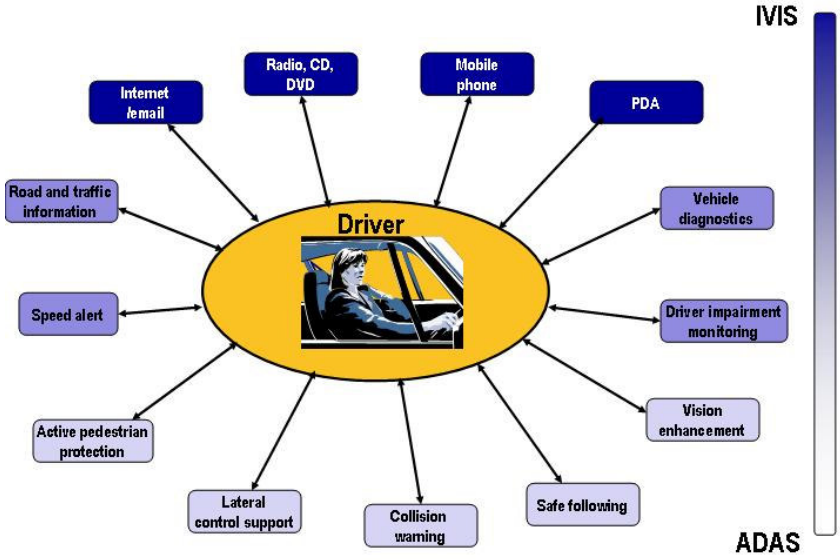


Figure 1. Examples of various ADAS and IVIS interacting with the driver in a future vehicle[1]

It is clear from Figure 1 that the various systems interacting with the driver cannot be implemented independently. The most obvious reason for this is that such a large number of separate HMI devices would simply not fit into the vehicle cockpit. Moreover, conflicting information from different systems may distract, overload, confuse and annoy the driver, thus causing problems that did not exist for the systems in isolation. Moreover, behavioural changes in response to a combination of systems may be very different from responses to the systems in isolation. Thus there is a strong need for a unified human machine that integrates the different systems into functioning whole, resolving conflicts between different functions and taking into account their aggregate effects. Some key features of such an integrated HMI would include:

[1] The distinction between ADAS and IVIS is not always clear-cut. "Typical" ADAS are placed at the bottom of the Figure and "typical" IVIS at the top.

1. Multimodal HMI devices shared by different systems (e.g. head-up displays, speech input/output, seats vibrators, haptic input devices, directional sound output)
2. Centralised intelligence for resolving conflicts between systems (e.g. by means of information prioritisation and scheduling).
3. Seamless integration of nomad devices into the on-board driver-vehicle interface.
4. Adaptivity of the integrated HMI to the current driver state/driving context

3 IP objectives

The following is a quote from the Description of Work (Annex I to the project contract):

The general objective of the AIDE IP is to generate the knowledge and develop the methodologies and human machine interface technologies required for safe and efficient integration of multiple driver assistance and information functions into the driving environment.

Specifically, the goal of the IP is **to design, develop and validate a generic Adaptive Integrated Driver-vehicle InterfacE (AIDE) that...**

- ...maximises the efficiency of individual and combined advanced driver assistance systems by means of innovative, integrated and adaptive, human-machine interface concepts that prevent negative behavioural effects (e.g. under-load, over-reliance and safety margin compensation) and maximises positive effects (e.g. enhanced situational awareness), thereby enhancing the safety benefits of these systems. **AIDE should demonstrate significantly enhanced safety benefits compared to existing solutions.**
- ..reduces the level of workload and distraction related to the interaction with individual and combined in-vehicle information and nomad devices, thereby reducing the number of road accidents. **AIDE should demonstrate a significant reduction in the imposed workload and distraction compared to existing solutions.**
- ...enables the potential benefits of new in-vehicle technologies and nomad devices in terms of mobility and comfort, without compromising safety. **AIDE should demonstrate that the benefits of new in-vehicle technologies could be enjoyed without increased accidents risk.**

Moreover, the concepts and technologies developed should have high product-feasibility in order to penetrate the market and contribute significantly towards the EC goal of 50% reduction of fatalities by 2010.

In order to reach these objectives, three sub-goals have been defined:

1. Development of a model for prediction of behavioural effects of driver assistance and information systems. This model will be the basis for the design of the adaptive integrated driver-vehicle interface.

2. Development of a generic, industrially applicable, methodology for the evaluation of road vehicle human-machine interfaces with respect to safety. This methodology will be used for verifying the quantified goals stated above.

3. Design, development and evaluation of an adaptive integrated driver-vehicle interface which will be implemented into three prototype vehicles, one city car, one luxury car and one heavy truck..

4 IP-level description of work performed

4.1 Project partners

In Table 1 below, the partners of the AIDE IP are listed, together with the corresponding short names used to reference these partners in the remainder of this document, the countries in which these project partners are based, and the time interval in which they were active in the project. In some cases partner names have changed during the course of the project, and in these cases only the most recent name is listed.

Table 1. AIDE Integrated Project partners.

Participant name	Participant short name	Country	Date enter project	Date exit project
Volvo Technology Corporation	VTEC	Sweden	Month 1	Month 50
BMW Group Forschung und Technik GmbH	BMW	Germany	Month 1	Month 50
Daimler AG	DAIMLER	Germany	Month 1	Month 50
Ford-Werke GMbH	FORD	Germany	Month 1	Month 50
Adam Opel GMbH	OPEL	Germany	Month 1	Month 50
Peugeot Citroën Automobiles	PSA	France	Month 1	Month 50
Renault Recherche Innvation	REGIENOV	France	Month 1	Month 50
Centro Richerche de Fiat Societá Consortie per Azioni	CRF	Italy	Month 1	Month 50
Seat Centro Técnico	SEAT	Spain	Month 1	Month 50
Robert Bosch GmbH	BOSCH	Germany	Month 1	Month 50
Johnson Controls GmbH	JCI	Germany	Month 1	Month 13
Siemens VDO Automotive SAS	SV	France	Month 1	Month 50
European Commission Joint Research Centre	JRC	Italy	Month 1	Month 43
Institut National de Recherche sur les Transports et leur Sécurité	INRETS	France	Month 1	Month 50
Netherlands Organisation for Applied Scientific Research (TNO)	TNO	The Netherlands	Month 1	Month 50
Institute of Communications and Computer Systems	ICCS	Greece	Month 1	Month 50
Federal Highway Institute	BAST	Germany	Month 1	Month 50

Participant name	Participant short name	Country	Date enter project	Date exit project
Centre for Automotive Research and Development	CIDAUT	Spain	Month 1	Month 50
University of Stuttgart	USTUTT	Germany	Month 1	Month 50
Swedish National Road and Transport Research Institute	VTI	Sweden	Month 1	Month 50
VTT Technical Research Centre of Finland	VTT	Finland	Month 1	Month 50
Centre for Research and Technology – Hellas	CERTH/HIT	Greece	Month 1	Month 50
University of Leeds	UNIVLEEDS	UK	Month 1	Month 50
Linköping University	LIU	Sweden	Month 1	Month 50
Univerità degli Studi di Genova – Dipartimento di Ingegneria Biofisica ed Elletronica	DIBE	Italy	Month 1	Month 50
European Road Transport Telematics Implementation Co-ordination Organisation S.C.R.L	ERTICO	Belgium	Month 1	Month 50
Motorola Limited	MOTOROLA	UK	Month 1	Month 50
KITE Solutions	KITE	Italy	Month 1	Month 50
Nuance Telecommunications International BVBA	NUANCE	Belgium	Month 13	Month 50
Telenostra A/S	TELENOSTRA	Norway	Month 13	Month 50
Fundación para la Promoción de la Innovación; Investigación y Desarollo Technológico en la Industria de la Automoción de Galicia	CTAG	Spain	Month 19	Month 50
Universitá degli Studi di Modena e Reggio Emilia	UNIMORE	Italy	Month 33	Month 50

4.2 Organisation of work

To address the three sub-goals identified in the IP-level statement of objectives (see above), three R&D-focused *sub-projects* (SPs)were defined:

- Sub-project 1 (SP1), on behavioural effects and driver-vehicle-environment (DVE) modelling.
- Sub-project 2 (SP2), on evaluation and assessment methods.
- Sub-project 3 (SP3), on design and development of an adaptive integrated driver-vehicle interface.

In addition, a fourth sub-project was defined, gathering horizontal activities, and servicing sub-projects 1-3 on common issues such as IP-level technical coordination, review and quality management, result dissemination and exploitation and standards/guidelines. Each of the sub-projects 1-3 were jointly led by one academic partner and one industrial vice-leader. VTEC, as project coordinator, was leader of SP4.

Further, each sub-project was divided into a number of *work packages* (WPs), each with its own specific objectives, defined so as to contribute to the overall objectives of the SP. Most work packages were then also divided further into tasks.

The sub-project and work package structure of AIDE IP is illustrated in Figure 2.

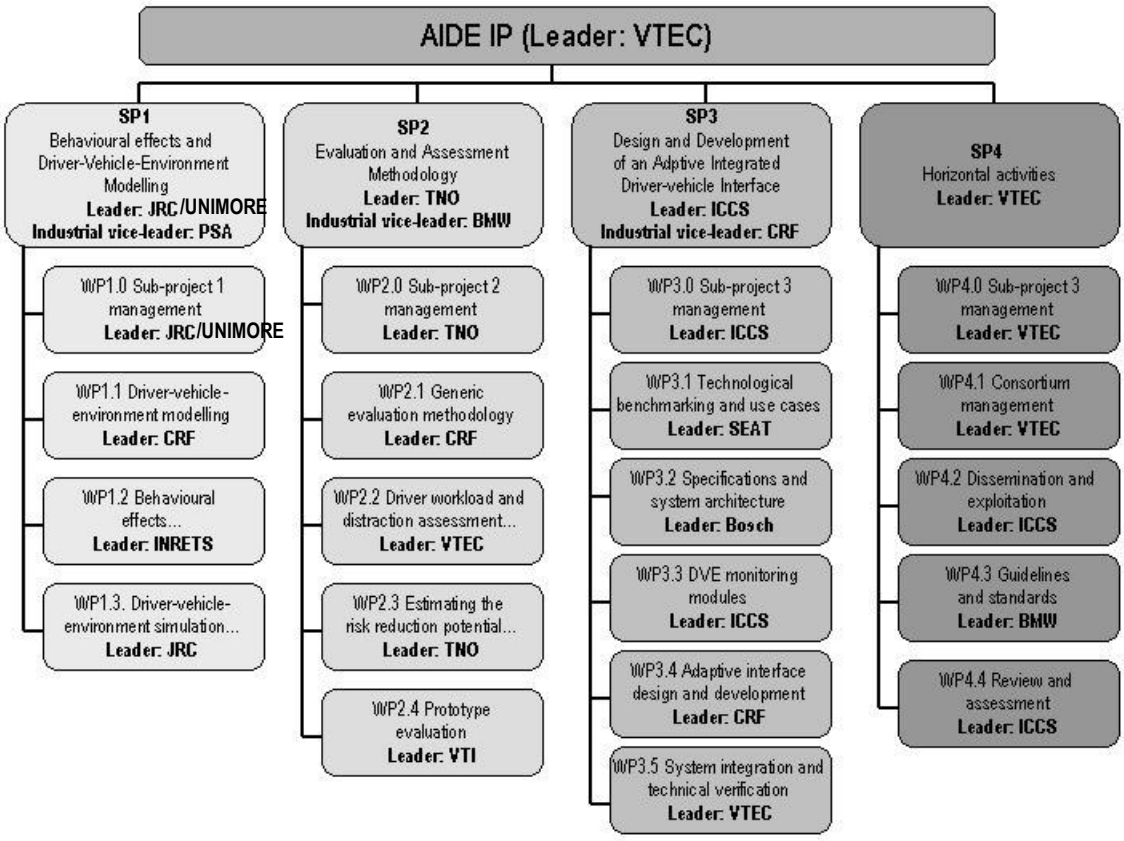


Figure 2. Sub-project and work package structure of the AIDE IP.

The work in the IP was roughly divided into three main phases:

1. The *specification phase*, in which preparatory investigations were made and use cases, requirements and first specifications for envisioned AIDE developments were defined.
2. The *development and experiment phase*, in which the various components of the AIDE solutions (e.g. DVE model, evaluation tools, HMI components and SW modules) were developed, and empirical work was carried out to support these developments (e.g. short and long term behavioural experiments).
3. The *integration, validation and demonstration phase*, in which developed components were integrated into the final AIDE deliveries (DVE simulation, evaluation methodology, demonstrator vehicles), which were then evaluated. AIDE results were disseminated and demonstrated throughout the entire project, but with a special emphasis in this last project phase.

Figure 3 shows the overall IP work plan, and its division into the abovementioned three phases.

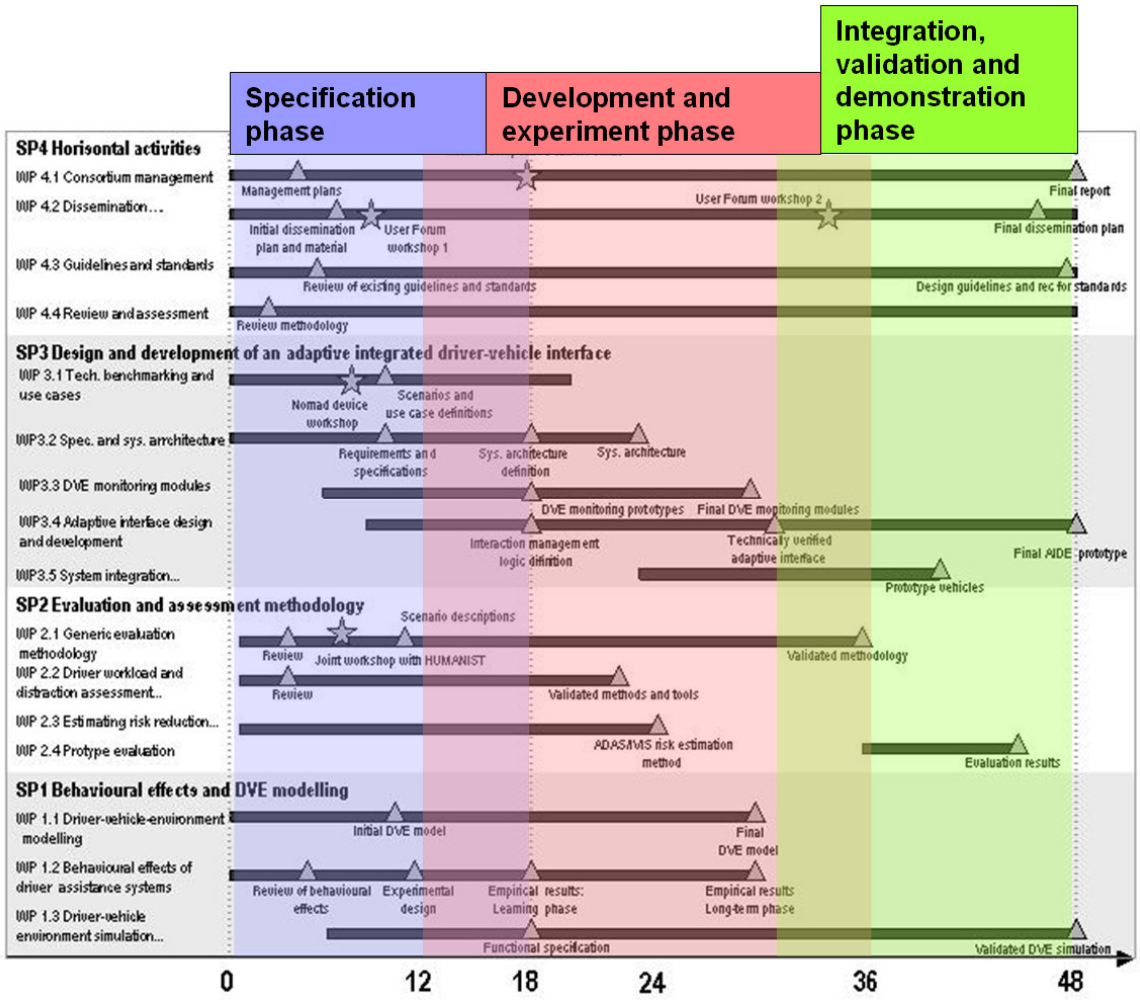


Figure 3. Schematic illustration of the AIDE IP work plan, with its three main phases.

The AIDE IP opened March 1, 2004, and closed April 30, 2008 after a two month extension of the originally envisioned 48 month duration, into 50 months. When "project months" are referenced elsewhere in this document, month 1 refers to March 2004, month 2 refers to April 2004, and so on.

The overall budget for AIDE IP was 12.4 M€, of which 7.3 M€ were EC funding.

4.3 Internal interactions

To ensure that work in the four AIDE SPs stayed in line with overall IP objectives, and that results from one part of the IP could be put to use elsewhere in the IP, it was identified already from the start of the project that good internal interactions between SPs and WPs was a crucial point, and much effort went into setting up and maintaining such interactions.

Figure 4 illustrates the main interactions between AIDE SPs and WPs. The bold arrows represent the main logical flow in the project, from a basic understanding of the DVE interaction (SP1), via AIDE design and development (SP3) and development of a generic evaluation methodology (SP2), up to delivery of the final validated AIDE prototypes vehicles. The thin arrows represent interactions within each SP supporting the main development flow.

The technical coordination work package WP4.0 was responsible for both internal and external interactions; see section 8.4.2.1 of this document for more information on this work.

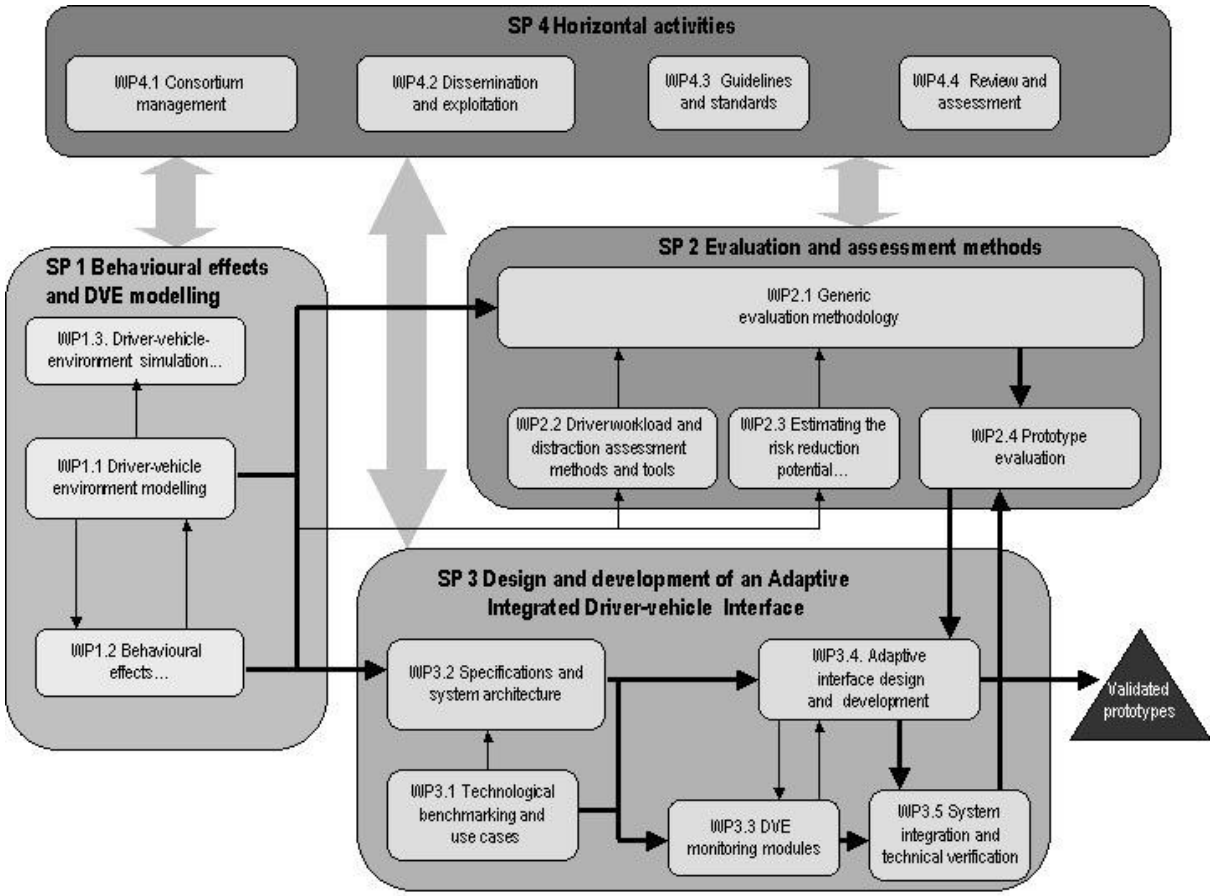


Figure 4. Main interactions between AIDE SPs and WPs.

4.4 External interactions

Also interaction with outside research activities and efforts was an important aspect of the work performed. External interactions served both to ensure compatibility of AIDE solutions with a wide range of applications and functions, and also as part of the dissemination/exploitation strategy, promoting the uptake of AIDE results in other research projects et cetera.

Main external cooperation partners were the projects in the EUCAR Integrated Safety Program (ISP; mainly PReVENT, GST and EASIS) and HUMANIST Network of Excellence.

The technical coordination work package WP4.0 was responsible for both internal and external interactions; see section 8.4.2.1 of this document for more information on this work.

5 Summary of key exploitable results

In Table 2, the key exploitable results, as identified in the final exploitation plan (AIDE deliverable D4.2.6), are listed. In the exploitation plan more information is given on each individual result, its planned or potential exploitations, and contact details are also given for suitable contact persons within the AIDE consortium.

Table 2. Key exploitable results of AIDE IP, as identified in D4.2.6.

SP	Self-descriptive title of the result	Type of Result
1	Parameters and indicators of behavioural adaptation to ADAS/IVIS for inclusion in DVE model for preliminary design of AIDE system	Scientific
1	Final DVE model structure	Scientific
1	Literature review of behavioural effects	Scientific
1	Measurement of the long-term effects of ADAS	Scientific
1	Investigation of learning and appropriation phase of ADAS and adaptive ADAS	Demo Trials
1	Computer simulation of Driver-Vehicle-Environment – SSDRIVE	Software
2	The Visual Demand Measurement Tool	Method
2	Development and validation of existing subjective tools and methods for the evaluation of driver mental workload	Scientific, Method
2	Taxonomy of IVIS/ADAS applications	Database
2	Modular subjective instrument to evaluate usability and other aspects of ADAS and/or IVIS systems	Method
2	Development and Refinement of Evaluation Tools and Methods: Tactile Detection Task and Peripheral Detection Task	Scientific, Method
2	Development and Refinement of Evaluation Tools and Methods: Enhanced Occlusion Test	Scientific, Method
2	Development and Refinement of Evaluation Tools and Methods: Lane Change Test in Driving Simulation	Scientific, Method
2	Review of existing techniques and metrics for IVIS and ADAS assessment	Scientific
2	Quantitative relationships for accident risk effects estimates	Scientific
2	Trade-off between driver state and behaviour with respect to effects on accident risk	Scientific
2	AIDE evaluation methodology (‘AIDE Cookbook’)	Method
2	Experimental results (evaluations)	Scientific, Demo Trials

SP	Self-descriptive title of the result	Type of Result
3	Drivers characteristics module	Demonstr
3	AIDE system logical and functional architecture	Other
3	ICA Module	SW code
3	HMI virtual prototypes	Lab Protot., Demonstr
3	DVE modules on Real Time in Vehicle Platform	SW code
3	Traffic and Environment Risk Assessment module	SW code
3	S/W Prototype of a Driver Availability Module	SW code
3	Speech I/O Software Device for in-car operation of phone or media player	SW code
3	Architecture and data flow for integrated HMI system implementation	Method, Tech drwg
3	Adaptation and Warning strategies	Scientific
3	Proof of Concept: Implementation of AIDE system in prototype vehicles	Protoype Demo
3	Cockpit Activity Assessment module	Protoype Demo
3	Nomadic Device Gateway and applications	SW code
3	A European Nomadic Devices Forum exploring a number of issues related to Nomadic Devices use by drivers	Other
4	Review of existing HMI design guidelines and standards.	Guideline
4	Recommendation for HMI Guidelines and Standards	Guideline

6 Summary of dissemination efforts

During the AIDE duration a sum of *5 publications to journals and book chapters* were achieved, presenting the work of the project. In addition a total of *36 technical papers were presented to 23 scientific conferences, workshops and congresses* and were included to the respective proceedings. These publications emanating from the AIDE research activities greatly enhanced the efficiency of the dissemination task by reaching the expert target group of key stakeholders in industries, research and national or international authorities. Specifically, Table 1 lists the publications realised emanating from AIDE project and the respective first author and company.

Table 3. AIDE publications.

AIDE Publications to Books and Journals	
Springer-Verlag, London, UK, 2007 Cacciabue P.C., (Ed.)	*"Modelling Driver Behaviour in Automotive Environments: Critical Issues in Driver Interactions with Intelligent Transport Systems"*
Journal of Automobile Engineering - Part D Spring 2006 ,Vol. 220 of 2006, Editor: Professional Engineering Publishing, United Kingdom	*"Cockpit Activity Estimation with Detecting Cognitive Distraction"* Matti Kutila (VTT) et al.
Special Issue of the International Journal of Cognition Technology and Work (IJ-CTW) "Human-Centred Design in Automotive Systems"	*"Some critical issues when studying Behavioural Adaptations to new driver support systems"* by F. Saad (INRETS), specially referring to SP 1 activities "*Communication and interaction strategies in automotive adaptive interfaces"* by A. Amditis, A. Polychronopoulos (ICCS), L. Andreone (CRF), E. Bekiaris (CERTHO referring to AIDE in general *"Shaping the drivers' interaction: how the new vehicle systems match the technological requirements and the human needs"* by F. Tango (CRF) and R. Montanari (UNIMORE), specially referring to SP 1 activities
AIDE Publications to Conference Proceedings	
3rd Conference on Active Safety through Driver Assistance, 7-8 April 2008, Munich Germany	*The AIDE Project on in-vehicle HMI – Results and Next Steps.* G. Markkula (VTEC) et al
DSC 2008 Europe, Driving simulation conference, Monaco, January 31st-February 1st 2008	*"Analysis of integrated warning strategies for ADAS systems through high performance driving simulator",* Ana Paul Tomillo (SEAT) et al
20th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Lyon, France, June 18-21, 2007	*To be available or not? That is the question: A pragmatic approach to avoid drivers overload and manage In-Vehicle Information,* Bellet T (INRETS) et al
IEEE International Conference on Image Processing (ICIP 2007). 16-19 Sep. 2007. U.S.A., Texas, San Antonio.	*"Driver Distraction Detection with a Camera Vision System",* Kutila, M. (VTT) et al.
Transport Research Arena - TRA conference, Gothenburg, Sweden, 12 - 15 June 2006	*"AIDE – Adaptive Integrated Driver-vehicle InterfacE",* J. Engström (VTEC) et al
Joint HUMANIST/AIDE workshop, Munich, Germany, 13 September 2006	*Project presentation,* Baumann (TUC) et al
IEEE Intelligent Vehicle Symposium Tokyo, Japan, June 13-15, 2006	"*System architecture for integrated adaptive HMI solutions" ,* Angelos Amditis (ICCS) et al
AIDE presentation to TRA	*Project presentation,* Johan Engström (VTEC) et al.

"Transport Research Arena 2006" conference Göteborg, Sweden, June 12th - 15th 2006	
Ninth International Symposium of the ISSA Research Section Design process and human factors integration: Optimizing company performance, 1-3 March 2006 - Nice, France.	*Dealing with Behavioural Adaptations to new driver support systems A modelling perspective,* P. C. Cacciabue (JRC) et al.
AAMA 2006 - Advanced Microsystems for Automotive Applications, Berlin, Germany, 25 - 27 April 2006	*"Towards the automotive HMI of the future: Mid-term results from the AIDE project"* , Johan Engström (VTEC) et al.
HFES Conference, San Francisco, 16-20 October 2006	*"Adapting a frontal collision warning system to distraction: Who is adapted?",* Rino F.T. Brouwer (TNO) et al.
VDI/VW-Gemeinschaftstagung "Integrated Safety and Driver Assistance Systems", /13.Oct 2006 in Wolfsburg, Germany	"*Enhancement on occlusion technique for driver visual distraction assessment: Results of the experiments performed in the AIDE project*", Roland Schindhelm (BAST) et al.
IFAC 16th World Congress, Prague, Czech Republic, July 4th - 8th 2005	*Design and Development of an Adaptive Integrated Driver-Vehicle Interface: Overview of the AIDE Project*", Angelos Amditis (ICCS) et al. *"From Driver Modelling to Human Machine Interface Personalization"* , Evangelos Bekiaris (CERTH) et al. *"Beyond Context-Awareness: Driver-Vehicle-Environment adaptivity. From the COMUNICAR project to the AIDE concept",* Luisa Andreone (CRF) et al *"Real Time Environmental and Traffic Supervision for Adaptive Interfaces in Intelligent Vehicles"* , Aris Polychronopoulos (ICCS) et al. *"AIDE and Nomadic Devices",* Patrick Robertson (MOTOROLA) et al *"Development of a Driver Situation Assessment Module in the Aide Project",* Héléne Tattegrain Veste (INRETS) et al.
International Truck and Bus Safety and Security Symposium, 14-16 Nov 2005, Alexandria, Virginia, USA.	*"Online Detection of Driver Distraction - Preliminary Results from the AIDE Project",* Markkula, G. (VTEC) et al.
UAHCI 2005, Las Vegas, Nevada, USA, July 22nd-27th 2005	*"An Adaptive HMI for integrated ADAS/IVICS presentation to the driver-The AIDE approach",* Angelos Amditis (ICCS) et al. *"Human Vehicle Context-Aware Communication multidisciplinary approach needs and requirements",* Sergio Damiani (CRF) et al.
EAM2005 conference, Athens, Greece, October 17th-19th 2005	*"Driver-vehicle-environment monitoring for an adaptive automotive HMI: the AIDE approach",* Anastasia Bolovinou (ICCS) et al.
International Workshop on Adaptive Driver Assistance Research, Washington DC, USA, May 13th 2004	*"Perspectives on human factor research on adaptive interface technologies for automobiles",* Wiel Janssen (TNO) et al.
IEEE SMC 2004, International Conference on Systems, Man and Cybernetics, Hague, Netherlands, October 10th -13th 2004	*"Communication and interaction strategies in automotive adaptive interfaces",* Angelos Amditis (ICCS) et al. *"A function-centred approach to joint driver-vehicle system design",* Eric Hollnagel (Linkoping) et al. *"Behavioural adaptations to new driver support systems - Some critical issues",* Farida Saad (INRETS) et al.
14th World Congress and Exhibition on ITS, Beijing, China, 5-9 October	*"A Real Time platform for estimating the Driver - Vehicle - Environment state in AIDE Integrated Project",* Angelos

2007	Amditis (ICCS) et al.
ITS World Congress, London 8-10 October 2006	*"In-vehicle integration of nomadic devices",* K. Kauvo (INRETS) et al *"A steering wheel reversal rate metric for assessing effects of visual and cognitive secondary task load"* , Gustav Markkula (VTEC) *"Integrating nomadic devices in vehicles"* , Erwin Vermassen (ERTICO) *"The AIDE adaptive and integrated HMI design: the concept of the Interaction Communication Assistant",* Luisa Andreone (CRF) *"Software architecture for an adaptive integrated automotive HMI",* Holger Kussmann (BOSCH)
ITS World Conference, San Francisco, USA, November 6th-12th 2005	*"Stochastic reconstruction of the traffic scenario and applications for situation adaptive interfaces",* Aris Polychronopoulos (ICCS) et al.
ITS at the Crossroads of Human Transport (ITS in Europe). Hannover 1-3 June 2005.	*"Technical and Human Factors Challenges for the Development of Adaptive Integrated Driver-vehicle Interfaces",* Johan Engström (VTEC) et al.
ITS Congress, Budapest, May 24, 2004	*"Meeting The Challenges of Future Automotive HMI Design: An Overview of the AIDE Integrated Project",* Johan Engström (VTEC) et al. *"Design and Development of an Adaptive Integrated Driver-Vehicle Interface" "Meeting the challenges of future automotive design",* Angelos Amditis (ICCS) et al. *"Overview of the AIDE Integrated Project",* Johan Engström (VTEC) et al.

AIDE also was presented to a vast number of various events and appeared to special broadcasts of European channels, press releases of various organisations and companies and to informative websites. In addition, one *Doctoral dissertation* and one *Master of Science Thesis* emanated from AIDE work.

Events including major demonstrations and presentations of AIDE results

- AIDE Final Workshop and Exhibition, Gothenburg, Sweden, 15-16 April 2008
- AIDE 1st User Forum, Cologne, Germany, 15-16 March 2005
- AIDE participation to the PReVENT IP Final Exhibition, Versailles, France, 18-22 September 2007
- ITS World Congress, London 8-10 October 2006

Other important dissemination events and meetings

- AIDE Nomadic Device Forum meetings (nine in total)
- AIDE participation to EUCAR annual conferences
- AIDE special sessions at:
  - ITS European Congress, Geneva, June 2008
  - ITS World Congress, London 8-10 October 2006
  - ITS World Conference, San Francisco, USA, November 6th-12th 2005
  - ITS World Congress Nagoya, Japan, October 2004

To support the dissemination work, a range of dissemination material was developed during the project, including posters, two sets of leaflets (initial and final), the project website (www.aide-eu.org), a number of newsletters, and an AIDE video.

More information on AIDE dissemination activities can be found in deliverable D4.2.7 "Final Dissemination Report".

7 Summary of project deliverables

Table 4 below lists all deliverables generated by AIDE IP, their dissemination level, the corresponding lead contractor, and the project month at which the delivery was made.

Dissemination level codes are to be interpreted as follows:

- PU = Public
- PP = Restricted to other 6th Framework Programme participants (including the Commission Services)
- CO = Confidential, only for members of the consortium (including the Commission Services)

Public deliverables, as well as public summaries of non-public ones, can be downloaded from the AIDE web site www.aide-eu.org.

Table 4. AIDE deliverables.

No.	Title	Dissemi-nation level	Lead contractor	Delivery month
D1.1.1a	Synthesis of models for Joint Driver-Vehicle interaction design.	PU	LIU	9
D1.1.1b	Requirements for HMI design and driver modelling	CO	JRC	9
D1.1.2	Preliminary model application to existing ADAS and IVIS and guidelines for implementation in design process	PP	JRC	20
D1.1.3	Parameters and indicators of behavioural adaptation to ADAS/IVIS for inclusion in DVE model for preliminary design of AIDE system	PP	CRF	20
D1.1.4	Final DVE Model Structure	PU	KITE	33
D1.1.5	Application of existing ADAS and IVIS Functions to final DVE Model	PP	CRF	41
D1.2.1	Behavioural effects of driver assistance systems and road situations	PU	INRETS	8
D1.2.2	General Experimental Plan for long term behavioural assessment	PP	INRETS	12
D1.2.3	Learning and Appropriation phase test and results	PU	INRETS	21
D1.2.4	Long-term phase test and results	PU	INRETS	30
D1.3.1	DVE Simulation architecture and preliminary guidelines for model software implementation	CO	KITE	18
D1.3.2	Driving Simulator Tests and Data Analysis for DVE model validation	PP	KITE	38
D1.3.3	DVE Model – Results of validation of model predictions vs Driving Simulator tests	PP	KITE	42
D1.3.4	Final software release and user manual	PP	KITE	46
D1.3.5	Driving Simulator Tests and Data Analysis for DVE model tuning	PP	CRF	48

No.	Title	Dissemi-nation level	Lead contractor	Delivery month
D2.1.1	Review of existing Tools and Methods	PU	CRF	6
D2.1.2	Review and Taxonomy of IVIS/ADAS applications	PP	CRF	6
D2.1.3	Considerations on Test Scenarios	PU	CRF	21
D2.1.4	Specification of AIDE methodology	PP	BMW	50
D2.2.1	Review of existing Techniques	PU	VTEC	8
D2.2.2_1 (a)	Visual Demand Measurement tool development – *restricted report*	CO	VTEC	18
D2.2.2_1 (b)	Visual Demand Measurement tool development – *public summary*	PU	VTEC	18
D2.2.2_1 (c)	Prototype version of VDM Tool	CO	VTEC	18
D2.2.2_2	Driver visual distraction assessment by Enhanced Occlusion Technique (EOT)	CO	BASt	18
D2.2.3	Development of advanced secondary task methodology	PU	UNIV-LEEDS	22
D2.2.5	Driving performance assessment methods and metrics	PU	VTI	22
D2.2.6	Subjective assessment methods for workload	PU	INRETS	22
D2.2.7	Empirical comparison of methods for off-line workload measurement	PP	DAIMLER	34
D2.3.1	Obtaining the functions describing the relations between behaviour and risk	PU	UnivLeeds	28
D2.3.2	Risk trade-offs between driving behaviour and driver state	PU	TNO	28
D2.3.3	Combining workload and behavioural effects into overall risk reduction estimate	PU	HIT	34
D2.4.1	Evaluation of the AIDE Demonstrators	PP	VTI	51
D3.0.1	AIDE Nomadic Forum activities report	PU	ERTICO	36
D3.0.2	AIDE Nomadic Forum activities report	PU	ICCS	42
D3.1.1	Workshop on Nomadic Devices minutes	PU	ERTICO	12
D3.1.2	AIDE scenarios and use cases definition	PP	ICCS	12
D3.2.1	Requirements for AIDE HMI and safety functions	PP	BOSCH	15
D3.2.2	System Architecture, data flow protocol definition and design and AIDE specifications	CO	BOSCH	21
D3.2.3	Report on AIDE Nomadic Forum activities	PU	ERTICO	24
D3.3.1	DVE monitoring modules design and development – first release	CO	SV	22
D3.3.2	Final and verified DVE monitoring modules	CO	ICCS	32
D3.4.1	Driver-vehicle interaction and communication management	CO	CRF	25

No.	Title	Dissemi-nation level	Lead contractor	Delivery month
D3.4.2	HMI components (displays, HUDs, speech I/O, sound etc)	CO	VTEC	31
D3.4.3	Integration of Nomadic Devices: The AIDE Case	PU	MOT	42
D3.4.4	Final AIDE HMI (description of the overall AIDE HMI both HW and SW)	CO	CRF	43
D3.5.1	Common Verification Plan	CO	SEAT	33
D3.5.2	Description of Final Demonstrators	CO	VTEC	49
D4.0.1	Interaction Plan, M13-30	PU	VTEC	17
D4.1.1	Financial Management Plan	PU	VTEC	3
D4.1.2	Quality Management Plan	PU	HIT	3
D4.1.3	Gender Equality Plan	PU	VTEC	3
D4.1.4-1;2;3;4	Year 1-4 Management and Activity Reports	CO	VTEC	Annually
D4.1.6	Final Management and Activity Report	CO (mgmt) and PU (activity)	VTEC	52
D4.2.1	Report on results of First User Forum	PU	ICCS	12
D4.2.2	Dissemination materials including web site	PU		12
D4.2.3	Initial exploitation plan: Public part and Confidential part	PU / CO	BMW	12
D4.2.4	Updated Dissemination Plan	PU	ICCS	25
D4.2.5	Updated Exploitation Plan	PU	BMW	26
D4.2.6 a / b	Final exploitation: public part / confidential part	PU / CO	BMW	50
D4.2.7	Final Dissemination Report	PU	ICCS	51
D4.2.8	Report on results from Second User Forum	PU	ICCS	56
D4.3.1	Report on the review of the available guidelines and standards	PU	BASt	8
D4.3.2	Recommendation for HMI Guidelines and Standards	PU	BASt	48
D4.4.1	AIDE Assessment and Evaluation Report	CO	ICCS	Every six months

8 Report per Sub-project

8.1 Sub-project 1: Behavioural Effects and Driver-Vehicle-Environment Modelling

Sub-project no.	SP1
Sub-project name	Behavioural Effects and Driver-Vehicle-Environment Modelling
Objectives (from Description of Work)	The general objective of this sub-project is to develop a basic understanding of the DVE interaction and the behavioural effects of IVIS and ADAS and develop this into a model and computer simulation for predicting these effects. The sub-project will also develop the general conceptual framework to be used throughout the project, including the definition of taxonomies for IVIS/ADAS functions and their behavioural effects.
Sub-project leader	JRC months 1-43; UNIMORE months 44-50
Other contractors involved	INRETS,PSA,REGIENOV,CRF,CIDAUT,ICCS,CERTH/HIT,TNO,LIU, UNIVLEEDS,VTI,KITE

8.1.1 SP-level description of work performed

The Sub Project 1 has been conceived with the aim to create a model for Driver, Vehicle and Environment and to integrate it into a simulation system. On the base of studies and experiments, a theoretical model has been built up to predict dynamic Driver-Vehicle-Environment (DVE) interactions (*DVE framework*), implemented in a computerised numerical simulation (*SSDrive*).

These results derive from work package activities organized as follows:

WP1.0 Sub-project 1 Management (Leader: JRC) leading the sub-project, co-ordinating the work of the different work packages, liaising and interfacing the sub-project to the other sub-projects and the IP management.

WP1.1 Driver-Vehicle-Environment Modelling (Leader: CRF) focusing on the release of the final theoretical DVE model. In particular: a) the definition of the basic modelling characteristics that enable the description of the DVE components, as normative performance and b) the identification of a number of crucial parameters for the definition of adaptive behaviour, errors and effects of attitudes.

WP1.2 Behavioural Effects of Driver Assistance Systems (Leader: INRETS), running a set of short and long term on-road experiments with purpose of a) indicating critical parameters and variables that may contribute to model driver's behaviour in a context of interaction with environment and vehicle, b) defininga set of safety critical parameters that describe Short and Long-term behavioural effects when using ADAS and IVIS systems such as AIDE.

WP1.3 Driver-Vehicle-Environment Simulation and Validation (Leader: KITE), focusing on the implementation of the Driver-Vehicle-Environment (DVE) model and Behavioural Effect parameters into a simulation software to perform predictive analyses of Human Machine Interaction. Then, a validation of the Driver Behaviour Model was carried out; finally, the Driver Behaviour model was tuned according to driver simulator test.

8.1.2 Report per work package

8.1.2.1 WP1.0 Sub-project 1 Technical Coordination

Work package no.	WP1.0
Work package name	Sub-project 1 Technical Coordination
Objectives (from Description of Work)	Technical coordination for the sub-project.
Work package leader	JRC months 1-43; UNIMORE months 44-50
Other contractors involved	PSA

8.1.2.1.1 Work performed and key results obtained

The sub-project management (SPM) is responsible for all contacts and progress reporting to the IP management. The main activities carried out have been: coordination of research work within SP1; provision and preparation of the periodical reporting of SP1, in quarterly and annual reports; promotion of information exchange and collaboration with other sub-projects; coordination and management of decisions taken at IP management level.

The sub-project controlling consists in detecting any deviations from the project plan and initiating prompt corrective action to guarantee its continuity and consistency and to adequately allocate its resources. Furthermore, this WP is responsible for the contents, schedule and budgets of the individual sub-project work packages.

8.1.2.1.2 Discussion and self assessment: results versus objectives and state-of-the-art

WP1.0 succeeded in keeping partners' efforts in line with IP, SP and WP objectives, thus assisting in finalizing SP's achievements to give a significant contribution to the progress of the State of the Art.

Main results are described in the deliverables related to managerial issues (technical, financial, quality) submitted at IP level within the work plan of WP4.1 together with the quarterly and annual progress reports, financial reports and information required from the IP technical coordination.

8.1.2.2 WP1.1 Driver-Vehicle-Environment Modelling

Work package no.	WP1.1				
Work package name	Driver-Vehicle-Environment Modelling				
Objectives (from Description of Work)	The main objective of WP1.1 is to develop a modelling architecture that is suitable for representing the DVE interaction in modern vehicles equipped with multiple IVIS and ADAS. A further goal is to identify the requirements for the use of such models in an industrial design and development process.				
Work package leader	CRF				
Other contractors involved	JRC, UNILEEDS, LIU, ICCS, CERTH / HIT, CIDAUT, VTI				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery date
	D1.1.1a	Synthesis of models for Joint Driver-Vehicle interaction design.	PU	LIU	9
	D1.1.1b	Requirements for HMI design and driver modelling	CO	JRC	9
	D1.1.2	Preliminary model application to existing ADAS and IVIS and guidelines for implementation in design process	PP	JRC	20
	D1.1.3	Parameters and indicators of behavioural adaptation to ADAS/IVIS for inclusion in DVE model for preliminary design of AIDE system	PP	CRF	20
	D1.1.4	Final DVE Model Structure	PU	KITE	33
	D1.1.5	Application of existing ADAS and IVIS Functions to final DVE Model	PP	CRF	41

8.1.2.2.1 Work performed and key results obtained

Two main tasks were envisaged for this WP, listed below:

- T1.1.1: Review and synthesis of models for Joint Driver-vehicle Interaction Design
- T1.1.2: Identification and validation of a Reference model of Driver-Vehicle-Environment

The developed model is based on the concept of joint cognitive system, in which the harmonic interaction between Driver, Vehicle and Environment (DVE) is represented. The key-point was to highlight the essential correlations among variables and parameters characterising these three

aspects of the framework, including specifically the driver's behaviour prediction in dynamic and rapidly changing conditions.

Starting from the review of the state of the art, a selection of the most suitable candidate DVE models had been performed (among 21 candidates), based on the requirements defined for the AIDE model DVE.

In this context, together with WP1.2, WP1.1 contributed towards the AIDE objectives by developing a basic framework for understanding of the driver-vehicle-interaction and predicting behavioural effects of new in-vehicle technologies and nomadic systems. In particular, the models (or at least some parts of them) had been used by WP1.3 to implement and develop the simulation environment called SSDRIVE.

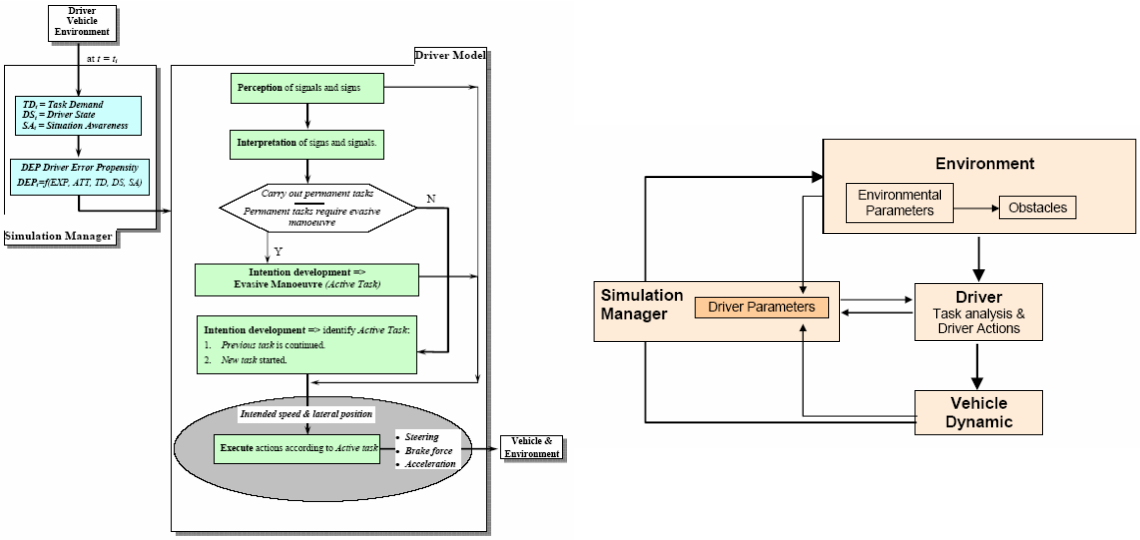


Figure 5: Scheme describing the passage from DVE to SSDRIVE tools.

Two types of DVE have been developed, for different goals:

- **G_DVE (Global DVE):** will support designers to predict the behaviour of the joint DVE system. It represents the theoretical generalization of the DVE model.
- **E_DVE (Embedded DVE)**: it will be part of the computerized numerical simulation of the DVE (the SSDrive system).

From the literature, the selected joint models for Global and Embedded DVE were:

- **COCOM/ECOM (Contextual Control Model / Extended Control Model)**: a qualitative model for Driver-in-Control (DiC) based on the principles of cognitive systems engineering.
- **IVIS DEMAND**: In-Vehicle Information System Design Evaluation and Model of Attentional Demand.

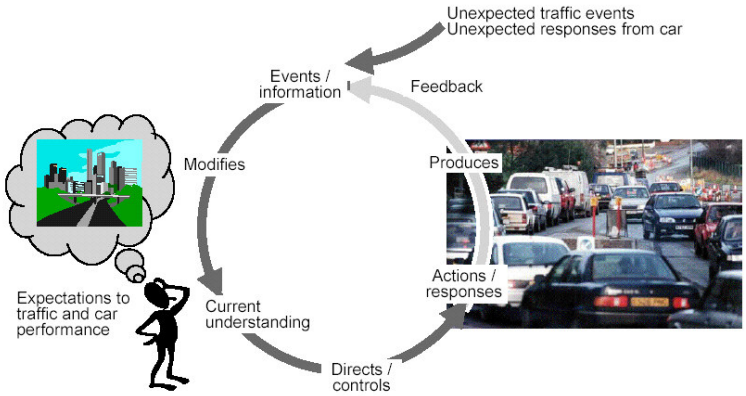


Figure 6: COCOM/ECOM (Contextual Control Model / Extended Control Model)

Three sub-models constitute the DVE framework: the Driver Model, the Environment Model and the Vehicle Model. All in all, each one is characterised by some features, as illustrated below.

Driver Model

- Tasks
- Parameters and fuzzy correlations
- Simple Model of Joint Cognitive System

Environment

- Road characteristics
- Presence of other vehicles
- Other vehicle, pedestrians, etc.

Vehicle

- Simple model
- ADAS and IVIS simple description

The Driver Model, used in AIDE-SP1, is based on the well known and "classical" Information Processing System (IPS) paradigm, according to which, driver's behaviour can be classified in normative[2] and descriptive[3]. Since the first condition does not reflect realistic behaviour, we focused on the second one, which reflects more the actual driver's behaviour. The most suitable approach for representing driver behaviour during the performance of normative and descriptive activities is to apply a simple "Task Analysis". The detail of accuracy of the analysis and description of the tasks, that are performed by the driver, defines also the *granularity* of the model and thus of the simulation.

8.1.2.2.2 Discussion and self assessment: results versus objectives and state-of-the-art

All in all, it is possible to say that the main objectives of the WP1.1 have been fully addressed. The division of the DVE model in G_DVE and E_DVE has allowed on one side to constitute a more general framework with respect to the "state of the art", and on the other side to provide a usable framework for the work carried out in WP1.3 about the DVE simulation. In particular, the most relevant results concern the five main parameters describing the Driver Model:

- **Experience:** accumulation of knowledge or skills that result from direct participation in the driving activity.

[2] "Normative behavior" can be represented by a model where no motivational or adaptive behavior is taken into account

[3] "Descriptive behavior" is modeled when motivational and adaptive issues are applied

- **Attitude:** a complex mental state involving beliefs and feelings and values and dispositions to act in certain ways.
- **Task Demand (TD):** parameter describing drivers' cognitive effort spent during the driving task.
- **Driver State (DS):** driver physical and mental ability to drive.
- **Situation Awareness/Alertness (SA):** 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.

Moreover, some of these parameters have been assessed and evaluated in the tuning and validation activity carried out again in WP1.3 (see below for details). This validation has shown that the approach was basically correct, especially for the Distraction parameter (linked to Situation Awareness/ Alertness).

8.1.2.3 WP1.2 Behavioural Effects of Driver Assistance Systems

Work package no.	WP1.2				
Work package name	Behavioural Effects of Driver Assistance Systems				
Objectives (from Description of Work)	The general objective of WP1.2 is to identify the key variables and parameters required for describing and explaining behavioural effects of individual and combined ADAS and IVIS. The work will address both learning- and long-term behavioural effects.				
Work package leader	INRETS				
Other contractors involved	JRC,PSA,REGIENOV,CRF,CIDAUT,ICCS,CERTH/HIT,TNO, LIU,UNIVLEEDS,VTI				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery date
	1.2.1	Behavioural effects of driver assistance systems and road situations	PU	INRETS	8
	1.2.2	General Experimental Plan for long term behavioural assessment	PP	INRETS	12
	1.2.3	Learning and Appropriation phase test and results	PU	INRETS	21
	1.2.4	Long-term phase test and results	PU	INRETS	30

8.1.2.3.1 Work performed and key results obtained

In more detail, the objectives of the work package have been:

- to indicate critical parameters and variables that may contribute to model driver's behaviour in a context of interaction with environment and vehicle;
- to define a set of safety critical parameters that describe Short and Long-Term behavioural effects when using ADAS and IVIS systems such as AIDE, for their inclusion in the design process of the system and its interface;
- to carry out experiments on Long term behavioural changes either on simulators or in the real world.

At first, a literature review was conducted of the most relevant studies on behavioural adaptation and the experimental results on learning and Short Term effects of ADAS and IVIS.

Then, the main activity carried out in WP 1.2 has been the planning and performance of experiments concerning "*learning and appropriation*" phase of drivers using ADAS systems. The figure below provides an overview of the six experiments conducted by AIDE partners.

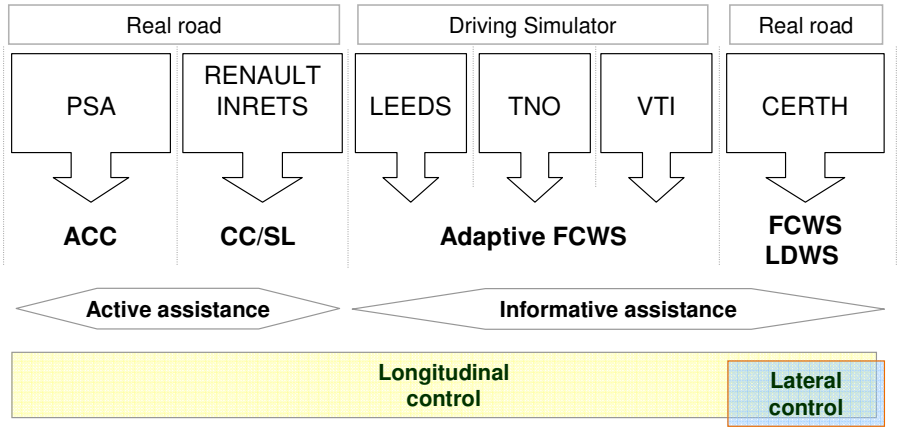


Figure 7: overview of the learning phase experiments in WP1.2

Objectives of these experiments were to indicate the critical parameters that contribute to model architectures, to define a set of safety critical parameters that describe Short-term and Long term behavioural effects when using ADAS and IVIS systems such as AIDE, for their inclusion in the design process of the system and its interface.

Different types of ADAS have been investigated: longitudinal control assistance systems (conventional cruise control/adaptive cruise control, speed limiter, intelligent speed adaptation, frontal collision warning) and lateral control assistance systems (lane departure warning). Some systems were adaptive to environment (local traffic, road coating, local speed limitations) or to driver (driver distraction, driving style). Some dual exclusive systems were integrated: either in time (simultaneous warnings) or in HMI (shared HMI, controls and display).

The research first focused on the learning and familiarisation phase at the beginning of driving with driver assistance system (system's representation, confidence, usage and short-term behavioural effects); and then on appropriation and long-term phase after a certain period of use (behavioural adaptation, user acceptance).

In summary, the results showed that ADAS can change driver behaviour, but adaptation depends on the context of use (road and traffic conditions), driver attitudes (e.g. social representation of the assistance), driver characteristics (e.g. driving style, sensation seeking). The results demonstrated that adaptive and integrated HMI can contribute to ensure higher acceptance and lower intrusiveness of ADAS.

8.1.2.3.2 Discussion and self assessment: results versus objectives and state-of-the-art

The experiments carried out on Long Term effects of specific driver assistance systems showed the following results:

- Long-Term behavioural effects of Citroen LDWS (Lane Departure Warning System), speed limiter/conventional cruise control and Intelligent Speed Adaptation;
- Specific methods to carry out the evaluation were developed.

Results on Long-Term behavioural effects of Citroen LDWS (Lane Departure Warning System), speed limiter/conventional cruise control and Intelligent Speed Adaptation were taken into account to optimize the development of the next version of LDWS, speed limiter and cruise control (functionality, HMI, user manual) to favour efficient and safe learning and use and avoid any misuse/abuse of ADAS.

Such results have important consequences and applications: the different methods developed for the evaluation of Long-Term effects of ADAS will be used in the internal procedure of HMI evaluation.

Achievements of such experiments could be an important help in the design and development of safer ADAS to be implemented on board vehicle.

In particular, regarding the learning and appropriation phase tests**,** results will be taken into account in the design and the development of future ACC and to define relevant information in the user manual to favour efficient and safe use, to optimize the development of the next version of speed limiter and cruise control (functionality, HMI, user manual) to favour efficient and safe learning and use.

Results will be taken into account in the design of ADAS (e.g. warnings) adapting to different drivers' driving style (sport like or family-like drivers).

At a final glance, it is important to underline how not just such results meet the objectives of the project, but even how some of the experimental results achieved in the project went significantly beyond the State of the Art in the project's field of activity, so providing knowledge that was not available before, as well as offering a new path to go through, in order to find new possibilities to develop driver/systems interaction, significantly improving safety and driving performances.

In this sense, in particular scientific results can be considered as an important, unique and coherent framework for future studies, not available before. In particular, it has to be pointed out that such results, managing to identify the key variables and parameters required for describing and explaining behavioural effects of individual and combined ADAS and IVIS (which were the target of the project), gave a significant contribution to individuate those conditions in which a more effective use of such systems can be done, so reaching a safer and more comfortable driving.

8.1.2.4 WP1.3 Driver-Vehicle-Environment Simulation and Validation

Work package no.	WP1.3				
Work package name	Driver-Vehicle-Environment Simulation and Validation				
Objectives (from Description of Work)	The general objective of WP1.3 is to implement a computer simulation of the driver-vehicle-environment for performing predictive analyses of the effects of IVIS and ADAS, based on the results from WP1.1 and 1.2.				
Work package leader	KITE				
Other contractors involved	JRC,INRETS, CRF,CIDAUT, ICCS, CERTH/HIT, UNIVLEEDS,VTI,UNIMORE				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	1.3.1	DVE Simulation architecture and preliminary guidelines for model software implementation	CO	KITE	18
	1.3.2	Driving Simulator Tests and Data Analysis for DVE model validation	PP	KITE	38
	1.3.3	DVE Model – Results of validation of model predictions vs Driving Simulator tests	PP	KITE	42
	1.3.4	Final software release and user manual	PP	KITE	46
	1.3.5	Driving Simulator Tests and Data Analysis for DVE model tuning	PP	CRF	48

8.1.2.4.1 Work performed and key results obtained

Within WP 1.3 two main activities have been performed: a) the development of the computational simulation tool based on DVE framework and b) the evaluation of the parameters of the DVE model defined in WP 1.1.

The requirements and specifications for simulation implementation have been applied in the development of a first simulation environment based on Matlab Simulink.

The DVE software implementation has followed three main lines of development: the Vehicle, the Environment and the Driver.

- As for the software implementation of the Vehicle, a specific set of equations have been implemented according to specifications derived from Deliverables D1.1.4, and D1.1.5;

- The software implementation of the Environment model continued with the aim to reproduce the environment of the simulator of VTI on which the experimental validation of the SSDRIVE tool was carried out.
- The simulation of the Driver was completed with the definition of the "fuzzy" functions and membership functions that characterise "descriptive" behaviour.

The simulation package has been called SSDRIVE for Simple Simulation of Driver interaction.

After the analysis of the data collected in the VTI simulator for the so called "validation process" of the model, the final release of SSDrive was developed.

SSDrive simulator is a tool that allows the study of a model of driver integrated with the environment and vehicles, defining the scenarios and driving contexts of their interactions. The overall aim of the simulation is to enable predictive representations of DVE interactions under different driver's characteristics and dynamic changes of several conditions, including human, traffic and environment situations.

The main purpose of this software is not to reproduce and simulate the perfect execution of driving performance, but rather to provide a powerful and flexible instrument to study patterns of behaviour, without necessarily having to produce different software applications every time different human, traffic and/or vehicle conditions have to be analysed.

The simulator has been developed using Delta3D (http://www.delta3d.org) as a platform for simulation and Lua (http://www.lua.org) (LUA) as a scripting language.

In the last phase of the WP, an evaluation of the parameters of the DVE model was provided, by means of comparison of model output to human driving data obtained in simulator experiments. Two parameters were selected: Task Demand and Distraction.

The evaluation consisted of the tuning and validation of these Driver Model parameters used to describe the driver's behaviour in different conditions, including the effects of IVIS interactions on driving task.

In order to pursue these validation and tuning goals, some machine learning techniques were applied, to guess a model for the variables, characterising Task Demand (TD) and Distraction (DIS) parameters, and their relationships. An interesting and positive result has been achieved for DIS parameter, where predicted data fits well the real data used for testing.

This can be considered as a relevant achievement, since DIS is mainly related to driver's distraction caused by IVIS, which is the main topic of AIDE-IP investigation. Moreover, DIS is strictly related to Situation Awareness, whose low levels can lead to high probability of error risk.

Figure 8: SSdrive simulation running

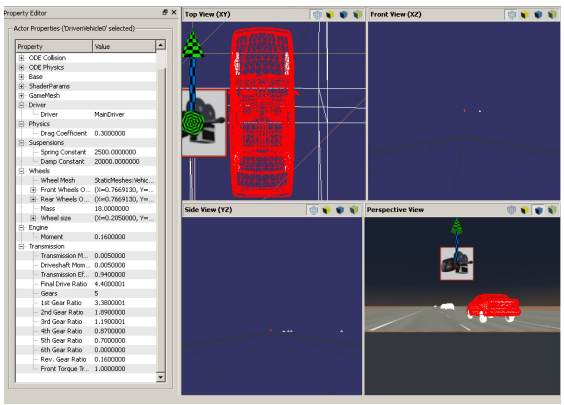


Figure 9: SSDrive Driver, Vehicle and Environment configuration panel

According to these results, and based on the model here developed, it is possible to estimate and assess DIS via parameters that are readily available from the on-board vehicle CAN bus architecture, establishing a strong link with the work done in SP3 as mentioned among the IP objectives.

8.1.2.4.2 Discussion and self assessment: results versus objectives and state-of-the-art

The objectives of this WP were to develop a simulation tool that will enable to: 1) predict behaviour of drivers of different characteristics, attitudes etc. while operating in 2) different traffic conditions and scenarios, 3) utilise advanced IVIS and ADAS tools; 4) the possibility to account for errors was also part of the goals of this WP.

The last objective was the tuning and validation of specific DVE parameters (Task Demand – TD – and Distraction – DIS), aiming at improving the Driver model in the prediction of driver's status.

The first two goals have been fulfilled. With SSDRIVE a non IT-skilled user can easily carry out simulations runs and study different driver behaviours. More IT-experienced users are able to develop complex correlations of driver attitudes, behaviours and can carry out studies of a wider scope.

The third goal has only partly been achieved, as the availability of models of IVIS and ADAS for software implementation has been fairly difficult to obtain from manufacturers and therefore to implement. However, the use of Opendrive and Lua scripts enables the user to develop more complex ad-hoc correlations and vehicle models that contain such characteristics.

The error model has been fully discussed and described in theory within WP 1.1. However, its implementation in the SSDRIVE simulation has only been developed in a "deterministic" form. This means that in the present version of the SSDRIVE the error making is: 1) always associated with an inappropriate manoeuvre, and 2) either occurs or not during a simulation, depending on the speed, traffic road conditions etc. The possibility to couple the error event with a risk based model that enables to study the outcome of different error making of different nature (observation, interpretation and planning as well as action) in association with a probabilistic approach has been devoted to future studies.

In addition to what was originally planned in AIDE, a specific support tool capable of displaying how the TD and DIS parameters work, has been implemented on the basis of the SSDrive simulator framework. This represents a good step towards providing a design tool for the stakeholders of this sector, to predictively evaluate the impact of IVIS in different driving scenarios and to evaluate the effort spent by the driver.

The advancement of the state of the art of the research in this domain provided by WP1.3, and the quality of the results. are proven by the success of the dissemination process of the model development. In particular, the publishing of a monograph dedicated to driver modelling by Springer and the acceptance of a special issue on the whole set of findings of SP 1 by Applied Ergonomics demonstrate the interest and attention that the scientific world dedicates to this activity and to its original and innovative results.

8.1.3 SP-level discussion and self-assessment: results versus objectives and state-of-the-art

The creation of the theoretical framework (DVE) and its implementation into the computerised numerical simulation (SSDrive) required studies and activities carried out during the full four years of AIDE-SP1 (see D1.1.4 for details), which converged into the work done for the tuning and validation of some parameters and variables aiming at modelling driver's behaviour, in particular during the interaction between driving task and use of IVIS devices, within a Driver-Vehicle-Environment (DVE) framework. A special attention has been focused on two of these parameters, Task Demand (TD), Distraction (DIS).

As initially proposed, activities and studies aiming at identifying the parameters of the DVE model were carried out, such as:

- experimental tests to know how Driver's behaviour changes when driving in different scenarios, as traffic, road and weather conditions change;
- an analysis of Driver's response to Advanced Driver Assistant Systems (ADAS) conducted by providing assistance to Vehicle control (lateral and longitudinal) during learning, appropriation and long-term phase;
- advanced modelling techniques to identify Driver's Task Demand, Distraction due to In-Vehicle Information System (IVIS) activation and Driver's propensity to incur in a safety critical condition. Specific numerical simulation approaches have been selected in order to tune and validate these parameters according to data collected during tests run on a driving simulator,

Objectives of these experiments were to indicate the critical parameters that contribute to model architectures, to define a set of safety critical parameters that describe Short-term and Long term behavioural effects when using ADAS and IVIS systems such as AIDE, for their inclusion in the design process of the system and its interface.

These achievements allowed reaching two fundamental objectives:

- The definition of the basic modelling characteristics that enable the description of the DVE components, as normative performance.
- The identification of a number of crucial parameters for the definition of adaptive behaviour, errors, and effects of attitudes.

In a second moment, thus, due to unexpected achievements and to not fully satisfying results, a deeper investigation has been carried on, in particular about the relationships among those variables characterising the chosen parameters for the description of driver's behaviour.

This activity of validation and tuning involved in particular two Driver Model parameters, i.e. Task Demand (TD) and Distraction (DIS). Such activity has been carried out by using a "Machine Learning" (ML) approach, namely, making some hypothesis of modelling, by machine learning techniques.

Data sets for tuning and validation have been derived by appropriate driving tests involving "real" human subjects. The machine learning approach showed very good results when DIS parameter is used for validation: in this sense, DIS could be considered as a good predictor of driver's Distraction.

In sum, it is possible to affirm that SP1's work on defining the DVE model has been completed, doing further steps towards the implementation of this model in a computer simulation (SSDrive). At the same time, in particular during the third year, an experimental work on long-term behavioural effects of ADAS has been finalised, producing highly relevant results.

With reference to the theoretical model, DVE represents a framework for all the most significant studies to describe a unique driver's behaviour model and a tool to predict driving behaviour influenced by IVIS and ADAS active on board, so reaching the scientific objectives of the project.

Concerning the DVE simulation, SSDrive could be considered as a flexible tool, allowing researchers to reproduce different vehicle, environment and driver's status conditions. Some of them are already available for simulation, while more specific ones can be shaped to user needs. SSDrive and its future developments have the potential of helping OEMs in predicting - at an early stage design - which effects the use of an information/driving assistance system active on board will have on the driver's performance.

8.1.4 Recommendations on future work

The developed computational simulation of DVE (SSDrive) will allow Automotive manufactures and suppliers to analyze drivers' and vehicles' behaviour in different driving environments, observing how the presence of one or more IVIS (here configured as a distraction source) can have an impact on the driving task, especially in some particularly critical scenarios.

SSDrive can also be a test-bed for developing innovative functions which allow an adequate tuning of all the ADAS systems active on the vehicle, adapting them to driving.

Moreover the results on Long-Term and Short Term behavioural effects suggested to optimize the development of the next version of advanced driver assistance systems (e.g. speed limiter and cruise control) and to improve learning and use of these devices.

Future work may involve the tuning and validation of other meaningful parameters characterising driver's behaviour. All these parameters could readily be integrated in the existing SSDrive implementation. Based on this, for instance, a link between the DEP parameter (which is related to driver's error making) and the DIS parameter, related to explore and predict the driver's intention (manoeuvre), could be established and promoted for further researchers' initiatives.

SP1's achievements and ongoing improvements of the *SSDrive-Driver, Vehicle and Environment model* provide an important starting point to have a future total control and integration of devices and systems active on board vehicle, contributing to making driving a more comfortable and safe experience.

8.2 Sub-project 2: Evaluation and Assessment Methodology

Sub-project no.	SP2
Sub-project name	Evaluation and Assessment Methodology
Objectives (from Description of Work)	While SP1 will identify and model the behavioural effects of IVIS and ADAS functions, the objective of SP2 is to develop a cost efficient and industrially applicable methodology for quantifying these effects and their relation to road safety. An important goal is to extend existing approaches in order to account for new adaptive integrated interface solutions, new ADAS and nomad devices. Moreover, the methods and tools developed will be linked to design guidelines and standards (in particular the European Statement of Principles). A further objective of SP2 is to perform the final evaluation of the AIDE prototypes developed in SP3, employing the methodology developed in the sub-project.
Sub-project leader	TNO
Other contractors involved	BMW, VTEC, CRF, VTI, BASt, Bosch, Cidaut, USTUTT, ICCS, INRETS, CERTH/HIT, REGIENOV, DAIMLER, KITE, PSA, UnivLeeds, LIU, SEAT

8.2.1 SP-level description of work performed

The logic of the SP's structure was as follows (see also Figure 10):

- The central WP was WP 2.1 'Generic Evaluation Methodology' that should deliver the evaluation methodology proper.
- Feeding into this was WP 2.2 'Workload and Distraction Assessment Methods and Tools' that should focus on specific methods and tools for workload and distraction measurement in order to incorporate those into the general methodology which then would be used for evaluating the three demonstrators developed in SP3.
- WP 2.3 'Estimating the Risk Reduction Potential of Integrated Adaptive HMI' should specify the way in which driver behaviour and driver state parameters can be 'translated' into accident risk estimates, i.e., into the expected accident risk reductions when driving with a support system. These specifications would also have to feed into the generic evaluation methodology of WP 2.1.
- Finally, the Generic Evaluation Methodology itself would have to find its first application in the evaluation of the (prototype) systems to be developed within the AIDE project itself, i.e., in SP 3. WP 2.4 (Prototype Evaluation) was created to do this work.

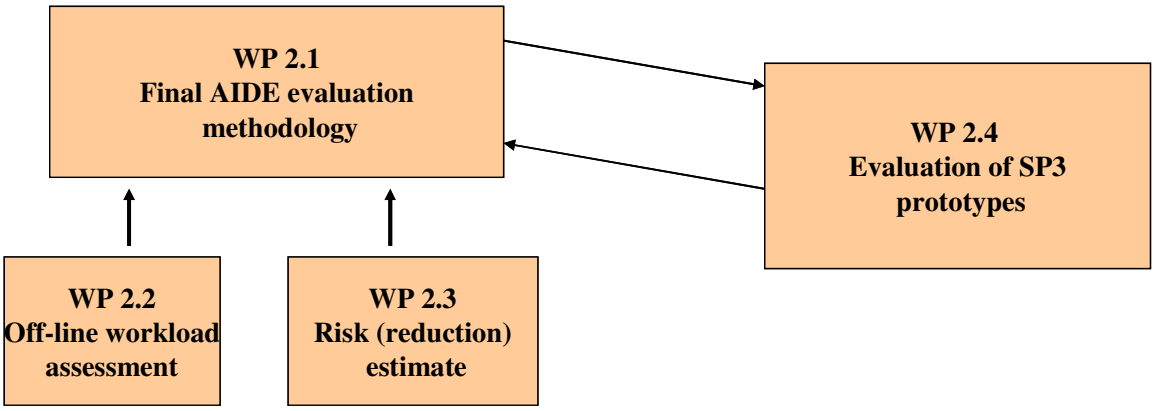


Figure 10 – Graphical illustration of the relation between the different work packages of SP2

8.2.2 Report per work package

8.2.2.1 WP2.0 Sub-project 2 Technical Coordination

Work package no.	WP2.0
Work package name	Sub-project 2 Technical Coordination
Objectives (from Description of Work)	Technical coordination for the sub-project.
Work package leader	TNO
Other contractors involved	BMW

8.2.2.1.1 Work performed and key results obtained

This involved the everyday leadership and coordination of the SP activities. Furthermore in this WP we liaise and interface the sub-project to the other sub-projects, other IP's, NoE Humanist, and the IP management.

8.2.2.1.2 Discussion and self assessment: results versus objectives and state-of-the-art

Quite some effort was directed to interaction on final evaluation (interaction) and involvement in dissemination support (SP4). In general given the prevailing level of professionalism among the partners participating in the SP these activities went mostly smoothly.

8.2.2.2 WP2.1 Generic Evaluation Methodology

Work package no.	WP2.1				
Work package name	Generic Evaluation Methodology				
Objectives (from Description of Work)	The general objective of this WP is to develop a generic and cost efficient methodology for industrial human factors safety evaluation of integrated IVIS and ADAS. A particular goal is to link this methodology to the design goals formulated in the European Statement of Principles (ESoP).				
Work package leader	CRF				
Other contractors involved	BASt, BMW, Bosch, Cidaut, USTUTT, ICCS, INRETS, CERTH/HIT, REGIENOV, VTEC				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D2.1.1	Review of existing Tools and Methods	PU	CRF	6
	D2.1.2	Review and Taxonomy of IVIS/ADAS applications	PP	CRF	6
	D2.1.3	Considerations on Test Scenarios	PU	CRF	21
	D2.1.4	Specification of AIDE methodology	PP	BMW	50

8.2.2.2.1 Work performed and key results obtained

This WP set out to specify the generic evaluation methodology proper. For a part, this relied on results from two WPs (2.2, 2.3) that dealt with two separate, major chunks that should form part of any methodology. Within the WP itself, activities first focused on the definition of IVIS/ADAS taxonomy and the resulting definition of the scenarios to be applied in evaluation studies. This was then bundled with the WP 2.2 and 2.3 results, delivering a set of reasonable candidate methodologies. A coordinated set of empirical studies comparing candidate evaluation methodologies was then performed so as to study the sensitivity and validity of these for AIDE conditions. On the basis of the conclusions from these studies the final methodology was then specified and reported in D 2.1.4.

The methodology comprises the following steps:

1. Define aims
2. Describe system
3. Define scenario
4. Define sample
5. Define parameters and instruments
6. Define study design

7. Develop instructions
8. Finalize set-up
9. Carry out
10. Analyze
11. Apply risk estimation procedure

The purpose of steps 1 and 2 are to highlight the importance of clearly defining *what* is to be evaluated, and *why*. Step 3 is supported by the guideline table below.

	Road type & conditions, visibility							Traffic type and actors					Tas	
Possible Scenarios	Type of road: city roads	Type of road: highways	Type of road: motorways	Type of road: rural	Road conditions	Visibility conditions	Weather conditions	Traffic in the same direction	Oncoming traffic	Crossing traffic	Pedestrians	Platoon driving	Car following	Lane Change Task (LCT)
IVIS:														
Navigation Systems	1,5	2	2,5	2,5	2	3	3	3	3	3	2	3	3	3
Travelling/Traffic Related Information Systems	2	2	2	2	2	2,5	2,5	2	2	2,5	2	2	2	2
Vehicle Communication Systems	1	2	3	1	2	2	2	2,5	2	2,5	2	3	2	2
Driver Convenience Systems	1	1	1	1	2	2	2	2	2,5	2	2	2	2	2
ADAS:														
Lateral Control	2	1	1	1	1	2	2	3	2	3	3	2	1	1
Lane Keeping and warning	2	1	1	1	1,5	2	2,5	2	2	2	2	2,5	1,5	2
Blind spot monitoring	2	2	2	2	3	1,5	2	1,5	2	1,5	2	3	1,5	1
Lane change and merge collision avoidance	2	1	2	1	2	2	2	2	2	1	2,5	2,5	2,5	1,5
Longitudinal Control	2,5	2	2	2	3	2	2	1	2	2	2	3	1,5	2
Intelligent Speed Adaptation	1	1	2	1	2	1	2,5	2	3	1,5	1	2,5	3	2
Road Low Friction Warning Systems	1	2	1	1	2	2,5	2	3	2	2,5	1	2	1	2
Reversing/Parking Aid	1	3	3	3	3	1	3	3	3	3	2	3	3	3
Vision Enhancement	3	2	2	1	2	1	1	2	2	2	1	3	2	3
Driver Monitoring	3	1	1	1	3	2	3	2	2	3	3	2	2	3
Pre-Crash Systems	2	1	1	1	2	1	1	1	1	1	1	2	1	3
Vulnerable Road Users Protection Systems	1	2	3	1	3	1	1	2	2	2	1	3	3	3

Figure 11 – Table for scenario development.

Figure 11 shows how applicable scenarios can be derived on the basis of the properties of the IVIS/ADAS system to be evaluated, constituting a major help to would-be evaluators (green cells: highly applicable condition to be included in evaluation scenario).

Steps 4-6 of the methodology specify the study design proper, in which attention should be paid to statistical considerations (sample size and power, experimental design), as well as to the definition of parameters to be measured. The latter is contained in a separate chapter of the evaluation D, known as the 'Cookbook'.

Steps 7-10 of the methodology prescribe the practicalities of performing an evaluation study per se, including analysis of obtained data.

Step 11 is the algorithm that extrapolates from the empirical data (on driver behaviour and driver state) to expected accident risk (reductions), on the basis of a comparison between data 'with' and 'without' the system. This works by through-multiplication of a total of seven underlying functions relating a behaviour (or state) parameter to risk, yielding an overall multiplier for the final overall estimate. (See also section on WP2.3 further below.)

8.2.2.2.2 Discussion and self assessment: results versus objectives and state-of-the-art

This SP was enormously ambitious. It tackled, and aimed to solve, a number of issues that have been around in the field for ages. WP 2.1 brought these efforts together, and it produced a generic evaluation methodology. As such, it met its objectives.

Looking into what was achieved, compared to what is going on elsewhere, it is probably fair to say that the results are state-of-the-art because they give an integrated approach covering all the aspects that should be dealt with in an evaluation. As apparent from the previous paragraph, it extends all

the way from scenario specification to estimating the expected risk effects of the system under consideration. The cookbook is available for stakeholders mentioned in ESoP.

But we're not quite there yet. There are number of things that still needs to be dealt with / clarified:

- **Magic number of participants?**
  It is important to remember that based on power calculations the cookbook suggests a number of participants. However when performing an experiment things will go wrong resulting in a loss of data for a number of participants. So the magical numbers refer to complete sets of data; with respect to a within subjects design one would need 18 complete sets of data. When resources are lacking to do this then one needs to apply a good method for substituting missing data points.
- **Analyses and pre-processing**
  After the experiment but before the statistical analyses the obtain raw data need to be pre-processed. This is especially of importance in on the road-studies. For example one need to select only those sections that need to be analysed and where there were no strange things occurred during the experiment (like a strong deceleration a other vehicle)
- **Different task lengths**
  When comparing tasks between AIDE and Non-AIDE it was clear that certain tasks took more time in one of the conditions. Certain measurements are sensitive to task length and would require similar task lengths to be comparable. How to deal with different task lengths is still an open question.
- **How to incorporate experience?**
  Although the cookbook describes important steps it is difficult to incorporate the experience of people who are used to designing experiments.
- **Repeat scenarios or use only different scenarios**

8.2.2.3 WP2.2 Workload and Distraction Assessment Methods and Tools

Work package no.	WP2.2				
Work package name	Workload and Distraction Assessment Methods and Tools				
Objectives (from Description of Work)	While WP2.1 will focus on the development of a general evaluation and assessment methodology, WP2.2 will focus on specific methods and tools for workload and distraction measurement, to be incorporated into the general methodology.				
Work package leader	VTEC				
Other contractors involved	BASt, BMW, CRF, DAIMLER, INRETS, KITE, PSA, REGIENOV, TNO, VTI, UnivLeeds,				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D2.2.1	Review of existing Techniques	PU	VTEC	8
	D2.2.2_1 (a)	Visual Demand Measurement tool development – *restricted report*	CO	VTEC	18
	D2.2.2_1 (b)	Visual Demand Measurement tool development – *public summary*	PU	VTEC	18
	D2.2.2_1 (c)	Prototype version of VDM Tool	CO	VTEC	18
	D2.2.2_2	Driver visual distraction assessment by Enhanced Occlusion Technique (EOT)	CO	BASt	18
	D2.2.3	Development of advanced secondary task methodology	PU	UNIV-LEEDS	22
	D2.2.5	Driving performance assessment methods and metrics	PU	VTI	22
	D2.2.6	Subjective assessment methods for workload	PU	INRETS	22
	D2.2.7	Empirical comparison of methods for off-line workload measurement	PP	DAIMLER	34

8.2.2.3.1 Work performed and key results obtained

The objectives for Workpackage 2.2 were to investigate a set of specific workload and distraction measurements methods and tools and to make sure that these would be incorporated into the general methodology. The methods focused on off-line measurement in contrast to the on-line workload estimation done in SP3.

The first task performed was to look into the existing methods and metrics available at the start of the AIDE project. A thorough State of the Art report was created covering driving and visual performance methods, metrics and tools, the Occlusion technique, physiological measures, secondary task methods (such as the Peripheral Detection Task), subjective assessment methods and finally situation awareness measures.

A visual demand measurement tool (VDM tool) was developed in task 2.2.2 in order to allow for an improved way of speeding up the analysis of eye movement data (see below for an example view of the tool). The main ideas were to have interchangeable eye trackers and with a graphical user interface that would allow for an easy analysis with non-professional users compared to the tedious traditional way of doing this kind of analysis with manual video transcription.

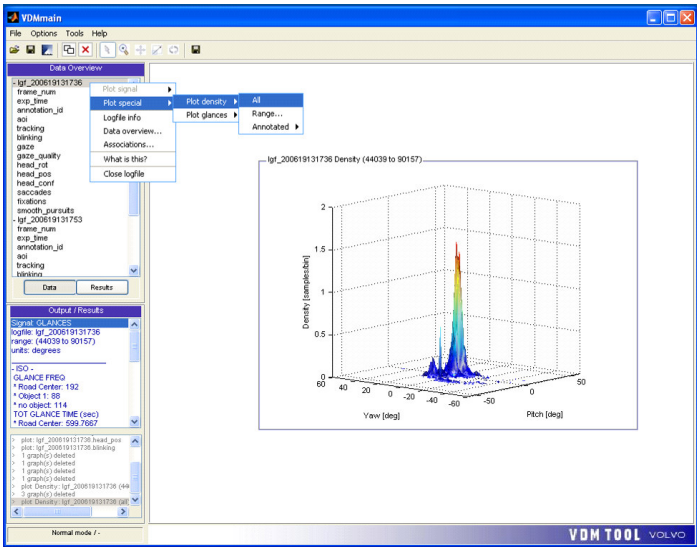


Figure 12 – Example view of the VDM tool

In task 2.2.2 the Occlusion technique was also refined. The development of the so called Enhanced Occlusion Technique (EOT) was based on the original occlusion technique using occlusion goggles. Both the original occlusion technique and EOT can be used for the evaluation of in-vehicle information tasks in early stages of HMI development. In comparison with the original occlusion technique, EOT presents a better simulation of real driving task and driver workload. A continuous sensorimotor tracking task, which the subjects performed additionally to the IVIS task under occlusion conditions, was developed within AIDE.

Furthermore, the peripheral detection task was investigated and modified in order to provide the best detection task method for the AIDE evaluation methodology. In AIDE two main research questions were tested: (i) is sensitivity to demand depending on stimuli eccentricity and (ii) is sensitivity to demand depending on stimuli modality? In order to test these questions several modifications of the stimulus devices were made where the traditional peripherally placed stimuli was compared to tactile stimuli given on arm wrist, neck and in seat as well as comparison with audio stimuli. See picture below for an example from the study performed by University of Leeds.

The work in task 2.2.5 constituted a thorough investigation of a selection of driving performance and Lane Change Test (LCT) based metrics. As a result a set of control metrics were chosen and specified in terms of definition, description of use, interpretation, guidelines and limits. Primarily,

two metrics are proposed: modified lateral position variation and steering reversal rate. New metrics for the Lane Change Test were evaluated, as well some amendments to the LCT-method. The outcome was a user's guide to a set of vehicle control metrics.

The objective of task 2.2.6 was to recommend the most suitable subjective driver workload method for the final test methodology. Three methods were chosen and further evaluated and developed: the BMBMW (behavioral markers of driver mental workload), DALI (Driving Activity Load Index) and PSA-TLX (Task Load Index).

Finally the methods and metrics mentioned here were collected and experimentally compared.

Figure 13 – Tactile stimuli given on the neck.

8.2.2.3.2 Discussion and self assessment: results versus objectives and state-of-the-art

This WP uncovered a number of new ways in which to assess driver workload as it may result from having to deal with a support system, particularly when this is of a mainly informative nature. These findings were then 'internally' compared, and – after that – handed over to WP2.1 for inclusion in the methodology. As such, this WP met its objectives.

This was a very fruitful WP. It found new, and better, ways to measure driver workload, and by doing so significantly contributed to scientific developments in an area that is being researched heavily in many places around the world.

8.2.2.4 WP2.3 Estimating the Risk Reduction Potential of Integrated Adaptive HMI

Work package no.	WP2.3				
Work package name	Estimating the Risk Reduction Potential of Integrated Adaptive HMI				
Objectives (from Description of Work)	The objective of this WP is to develop methods for extrapolating from behavioural effects of IVIS and ADAS (e.g. the workload and distraction metrics developed in WP2.2), to actual road safety.				
Work package leader	TNO				
Other contractors involved	CERTH/HIT, LIU, VTI, UnivLeeds				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D2.3.1	Obtaining the functions describing the relations between behaviour and risk	PU	UnivLeeds	28
	D2.3.2	Risk trade-offs between driving behaviour and driver state	PU	TNO	28
	D2.3.3	Combining workload and behavioural effects into overall risk reduction estimate	PU	HIT	34

8.2.2.4.1 Work performed and key results obtained

This WP tackled two (related) issues that have been bothering this area of research for some time now:

- How are driver behaviour and driver state parameters related to accident risk?
- Can driver behaviour and driver state effects be exchanged for each other, i.e., are they compensatory? (This is a derived issue from the previous one).

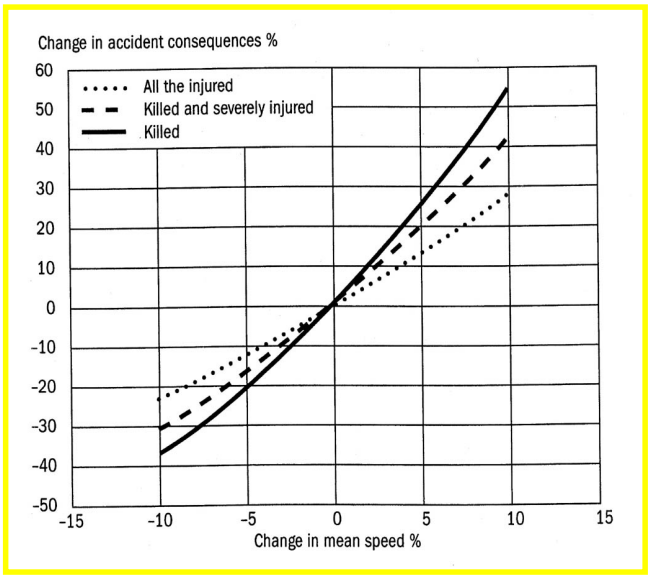
The WP's organization reflected these issues. First, the available evidence on the functions relating specific parameters, like average speed or speed variability, was collected. Second, the available evidence relating specific driver state parameters (like workload and distraction) to accident risk was collected. Third, the separate relationships were brought together in an algorithm that permits accident risk estimates to be made from a limited set (n = 7) of observed empirical data.

The seven parameters in this algorithm are:

(1) Average speed
(2) Speed variability
(3) Lane keeping performance
(4) Headway
(5) Workload
(6) Visual distraction

(7) Alertness level

An example for one of the behavioural parameters is shown below



Function relating average speed to accident risk (from Nilsson)

An example of a driver state parameter is parameter nr. 6, driver visual distraction. In order to apply this, one needs to measure driver eye glance durations away from the forward roadway. Eye glances away from the forward roadway that last longer than 2s are critical. In fact, research has shown that the factor by which accident risk increases for those glances (the multiplier for this parameter) happens to be 2.19. Therefore, the change in accident risk associated with this parameter is 2.19 times the change in the measured proportion of glances away from the forward roadway that last longer than 2s.

8.2.2.4.2 Discussion and self assessment: results versus objectives and state-of-the-art

As stated before, this WP tackled some long-standing issues in the area. These have been resolved in the sense that we have come up with a procedure that permits us to make the step form empirical data on driver behaviour/driver state to the expected accident risk effects of the system if used on the road. In that sense, the objective of this WP has been met.

It is crucial to go from driving behaviour to risk. The algorithm developed within WP2.3 is, however, a first step on a difficult road. The material on which the proposal is based is uneven. That is, some is material from outside that we could have collected in a different way, and some of it is pragmatic extrapolation from mainly theoretical insights. The model needs, therefore, further input (e.g., from FOT, naturalistic driving studies). This first step, however, is of importance since it may trigger a discussion among researchers on how to get from driving behaviour to risk. And this is a very relevant discussion.

8.2.2.5 WP2.4 Prototype Evaluation

Work package no.	WP2.4				
Work package name	Prototype Evaluation				
Objectives (from Description of Work)	The objective of this WP is to perform the final evaluation of the three AIDE prototype vehicles developed in SP3. The main objective is to assess the AIDE concept with respect to the IP objectives, most importantly with respect to its potential safety-enhancing effects (compared to non-integrated, non-adaptive IVIS and ADAS and driving with no IVIS/ADAS at all). The evaluation will also address the issues of mobility, comfort and user acceptance.				
Work package leader	VTI				
Other contractors involved	VTEC, TNO, CRF, CIDAUT, KITE				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D2.4.1	Evaluation of the AIDE Demonstrators	PP	VTI	51

8.2.2.5.1 Work performed and key results obtained

The WP2.4 work started with a joint (SP2 – 3) project meeting in Barcelona September 2006. The purpose was to provide specification for vehicle sensors needed for the W2.4 evaluation. A document was compiled with, among other things, a specification in terms of resolution, accuracy, sampling rate for, for example, steering wheel angle. However, the actual work started in December 2006 with a meeting in Linköping. Several joint meetings were held with WP3.5, the WP in which the demonstrators were implemented.

As shown in Figure 14 the work plan in WP2.4 depended to a large extent on WP3.5 and WP2.1. In order to plan a harmonized evaluation approach and to facilitate the communication between partners and other WPs we developed and used a planning tool called “scenario building tool” (see Figure 15). This tool was used to specify which use cases (UC; tasks drivers had to perform, e.g., find a certain radio station. While doing so a message was triggered) were in principle possible to actually evaluate with each of the demonstrators. The input came from the demonstrator developers in WP3.5. In the scenario building tool triggering of UC, specification of start and end of UC and relevant metrics were also specified per UC.

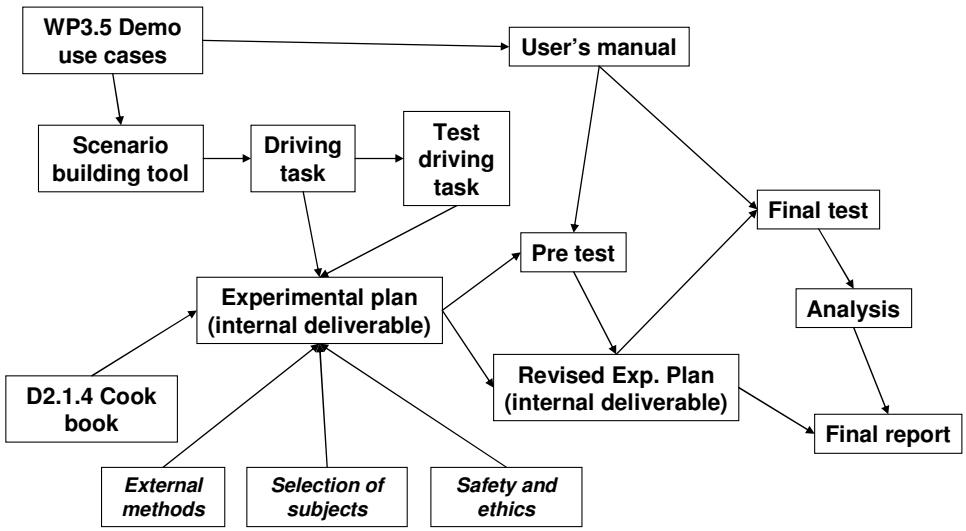


Figure 14 – WP2.4 work plan

Driving scenario - actual driving				Triggering of Use Case			Use case start and e	
Demonstrator use case (only from meta functions so far)	Use case details	Notes for route selection	Aide/ nonAide	Triggering of Use Case	GPS	Manually	Start	End
WARN_ADAPT_SAFELANE_INTENT	The driver is asked to make a lane change when possible. Warning is supressed, since DVE state identifies lane change as intended	Must permit lane changes	Aide	no specific trigging. Will occur anyway.			any automatic process for ident this in data?	any automati process f ident this data?
ND_INT_PHONE_IN	Incoming call on nomadic device, transferred to SID	Low risk of blocking call due to DVE state driver availability	Aide			y	ring start	phone hur up
ND_INT_PHONE_OUT	SPEECH-inititated phone call.		Aide			y	when speech is manually activated by driver	phone hur up
ND_INT_MP3	Start an mp3-song (should be rather short song) via barrel key and SID		Aide			y	First keypress in menu	When out menu
	Check tire pressure, fuel consumption etc info in CIC and new order message is						First	

Figure 15 – Excerpt from the scenario building tool used in WP2.4

Furthermore, each pilot responsible partner was requested to write an experimental plan according to a template. This document should later on be used as a starting point for the final evaluation report which should go in to the final test report (D2.4.1). The pre-tests were planned for June 2007 but it was only the Truck that was available at that time. After the review in spring 2007 we were asked to submit an intermediate deliverable on the methodology for WP2.4. A deliverable called "WP2.4 Overall Evaluation Plan" was written and submitted to the project officer. The general evaluation approach is described in this document together with specifications of measures to be included in each evaluation (see Table 5).

Table 5 – Overview of Cookbook recommendations for objective measures to be included in WP2.4 evaluations

Evaluation aspect	Objective measures		Subjective measures	
	Mandatory	Optional	Mandatory	Optional
Driving behaviour	Speed Speed variability Time headway MSDLP SWRR LANEX	None	Perceived driving behaviour (CRF quiz)	None
Workload	Modified SDLP SWRR	Eye Gaze Tactile Detection Task (TDT)	DALI (abridged) RSME	None

Acceptance	None	None	CRF questionnaire	None
Usability	Errors Time of completion	None	CRF questionnaire	

The first evaluation to be launched was the evaluation of the Truck in Gothenburg which was conducted in October 2007 after ethical approval by the local ethical committee. This was done as a joint effort between VTI and VTEC. Twenty-one professional truck drivers participated in the test and drove a pre-defined route three times. During two of these drives they performed a set of UC based tasks. A lot of data was collected and in the pre-processing phase considerable time was devoted to the extraction of data segment for analysis. Thus, a critical issue for the analysis of objective data is to determine the relevant data lengths. This was the topic of several discussions in WP2.4. See Figure 16. The VDM tool (see WP2.2) was used analyse eye gaze behaviour.

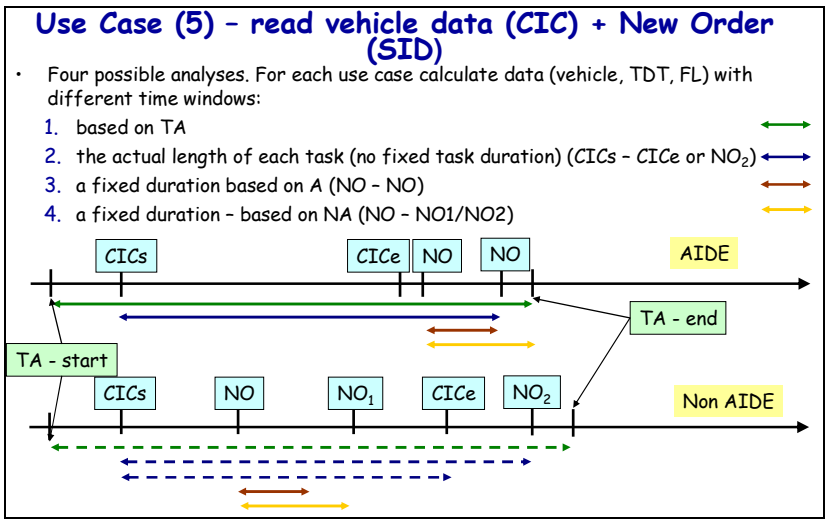


Figure 16 – An example of different task lengths and possible analyses sections

Based on this discussion relevant data for the statistical analysis was calculated using Matlab. Figure 17 shows plots of several vehicle metrics. Data was manually checked before being accepted for the analysis.

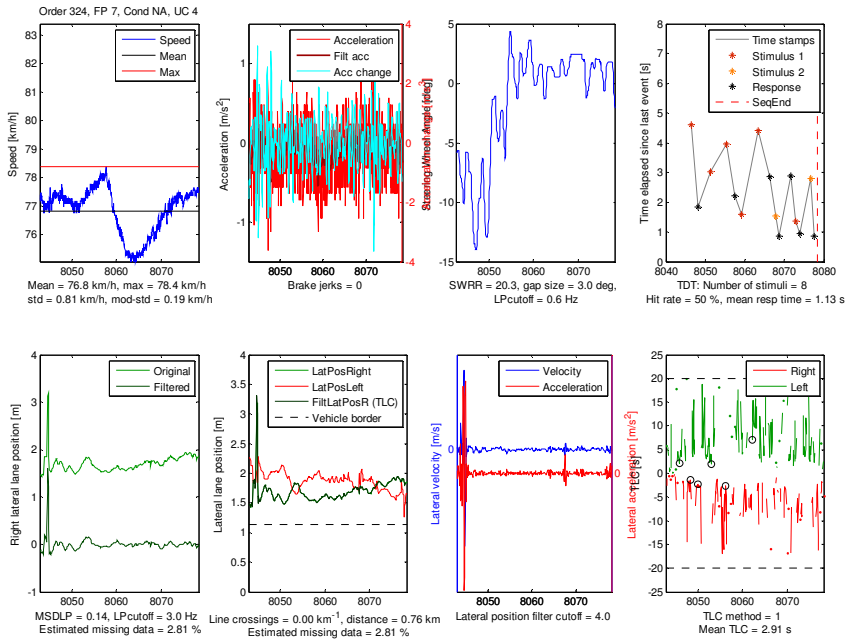


Figure 17 – Plots of vehicle metrics

The VDM tool (see WP2.2) was used analyse eye gaze behaviour. In December 2007 was the evaluation of the City car demonstrator was concluded by CIDAUT. Eighteen subjects participated in this evaluation which was carried out in Valladolid (see figures below).

Figure 18 – Route and information panel of City car demonstrator

The evaluation of the luxury car demonstrator was done in Turin with the luxury car demonstrator. This evaluation was led by TNO. The evaluation itself was carried out by Kite in collaboration with CRF. Eighteen drivers participated also in this test. The actual test was finalised in January 2008. A final WP meeting was held in Linköping in February 2008 with the objective to finalise a common methodology for the evaluation and presentation of the work. Since then the work has continued in order to present the results of the demonstrator evaluation for the final AIDE event in Gothenburg in April 2008.

In a very short summary the evaluations of the three demonstrators showed that the AIDE system helped drivers to keep their eyes more on the road than in a non integrated and a non-adaptive solution (non-AIDE system), the AIDE system moderated workload and ensured that although all messages were perceived in case of simultaneous presented messages (due to adaptation) this did not always result in increased workload. Moreover, most participants preferred the AIDE solution compared to a non-AIDE solution.

The abovementioned results were significant, but in general it was difficult to obtain significant results, the reason for this most probably being that the evaluations were performed on the road with potential users and therefore the system could not be pushed to the extreme situations (e.g., real dangerous situations in which the benefit of adaptation becomes clearer, very high workload situations) in which it is easier to find benefits of integration and adaptation.

The evaluations of the demonstrators were interesting and the partners have exchanged a lot of useful ideas for the evaluation. The collaboration with WP3.5 was good. These were complex evaluations which were performed under strict and rather small time and resource constraints. In that sense there is room for improvement. Nevertheless, we have successfully applied the cookbook and provided recommendations, such as

- How to select use cases (use a structured process)
- Specification of relevant scenarios (more detail in cookbook is recommended)
- Relation between type of use case and metrics could be clarified
- How to deal with differences in task lengths
- System status logging needed for detailed analysis
- The cookbook could provide guidance on how to implement a sufficiently accurate data collection function.

The tools and metrics developed were useful, but

- (Workload) questionnaires can be further clarified/improved
- Recommendations for number of subjects is based on complete sets of data
- SDT is strongly recommended
- Gaze metrics highly recommended
- Useful metrics for crossings/roundabouts need to be developed

Despite a lot of effort in SP3 due to technical problems it was not possible for all evaluations to measure the required vehicle metrics (e.g., because the radar didn't function properly which meant time that headway information was not available). Feedback (drivers' and test leaders' comments) has been provided to the developers. So with respect to the User Centred Design we have closed the loop. Among the feedback were the following comments

- DVE modules work - further development should focus fine tuning (trade-off between sensitivity and efficiency)
- Enhance transparency for the user of AIDE for some use cases
- Specific design solutions need improvement (e.g., PTT-button should be on the steering wheel; move displays further up)
- Interaction between developers and evaluators turned out to be essential and should be extended (message to both developer and evaluators)

8.2.2.5.2 Discussion and self assessment: results versus objectives and state-of-the-art

The prototypes developed in SP3 were quite complex which almost automatically also increases the complexity of the evaluation and increases the need for extensive interaction with the developers. Especially the latter part was underestimated and has to be taken into account in similar ambitious projects. Also the complexity of the evaluations itself was underestimated especially with respect to the preparation of the evaluation and the pre-processing of the data. Nevertheless the evaluations were successfully performed and the results were indicated a benefit of integrating and adapting information to the driver. This under rather difficult circumstances, meaning that due to the fact that

on the road studies were performed we could not drive in extreme situations (dangerous traffic situations or very high workload) in which case it would most likely have been easier to demonstrate further significant positive effects of the AIDE system. We successfully evaluated the three prototypes and the developed methodology. Furthermore based on the evaluations feedback was provided to the developers in SP3 and the developers of the methodology. In this sense WP 2.4 fulfilled its objectives.

There are not many (if any) studies on integrated and adaptive systems that have gone as far as AIDE. The three evaluations have contributed to the state-of-the art, or better: constitute the state-of-the-art in this area.

8.2.3 SP-level discussion and self-assessment: results versus objectives and state-of-the-art

Overall we did pretty well and closed the loop of user centered design. We developed relevant new evaluation methods and tools, and delivered new knowledge on the actual behavioural effects of adaptive and integrated driver-vehicle interfaces. We also entered into international discussions on these topics. All in all we thus consider that SP2 successfully met its objectives, and managed to advance the state of the art considerably in a number of areas.

However, one needs to remember that the greater the achievements in SP3 the bigger the complexity of the final evaluation done by SP2. In other words there is a direct relation between the complexity of system(s) to be evaluated and the complexity evaluation itself. Thus, since SP3 managed to deliver a very advanced set of prototype vehicles, in retrospect a longer time frame for the evaluations and a higher budget should have been allocated. Especially the work needed for interaction between developers and evaluators in this type of effort should not be underestimated.

8.2.4 Recommendations on future work

- Tasks performed and messages presented during the evaluation where quite short. Consequently there is only a very short period in which the effect of these messages/tasks on driving behaviour or on workload can be demonstrated. To detect these short effects on workload and driving behaviour it is of importance to develop measurements that are sensitive to very short changes in driving behaviour and workload. Because the evaluations were performed on the road dangerous situations had to be avoided. Nevertheless to investigate the adaptation of the system a number of use cases were performed near crossings or roundabouts. Metrics suitable for analysing driving in such environments are also lacking.

- There are big individual differences between drivers with respect to behaviour and preferences. Some drivers want information to be delayed, others do not. Some drivers react differently to increased workload than others. In the end systems should be tailored to these individual differences. Real-time online modelling in which a drivers profile is created that is applicable to, for example, different road categories and driving situations is an important step to tune systems to individual drivers.

- Similar tasks resulted in different task lengths in AIDE and Non-AIDE. However certain variables are sensitive to differences in task lengths. This means that for these variables the task lengths need to be similar. However when choosing a fixed task length based on, for example, AIDE and using this task length also to select the section that needs to be analysed in Non-AIDE it may result in analysing an incorrect or uninformative section. In AIDE we addressed these issues to a certain extent but they need to be developed further in order to perform similar evaluations. Moreover, this problem also clearly indicates the importance of logging any interaction with or activity of the system under investigation. Without this logging it is impossible to know what happened when and thus impossible to know when a message is presented to the driver by the system and what the reaction to a message was.

- The current risk procedure to get from driving behaviour to risk level is a first and very important step. In the end it is of crucial importance to be able to translate obtained effects to reliably assessing the risk reduction of such a system. The current proposal needs to be further developed for truly being able to estimate the impact of ADAS/IVIS.

- The current AIDE methodology recommends using a certain number of participants. However one should realise that what is meant by this is that one needs to have this certain number of *complete* sets of data. Due to, for example, sensor or logging failures it can be that data is not stored which results in missing data. Since it is sometimes too costly to continue experimenting until there is enough data a common understanding should be reached on how to deal with missing data.

8.3 Sub-project 3: Design and Development of an Adaptive Integrated Driver-vehicle Interface

Sub-project no.	SP3
Sub-project name	Design and Development of an Adaptive Integrated Driver-vehicle Interface
Objectives (from Description of Work)	The main objective of SP3 is to design, develop and validate an adaptive integrated driver-vehicle interface for road vehicles (including both cars and heavy trucks) for the safe integration of multiple IVIS and ADAS functions, including nomad devices.
Sub-project leader	ICCS
Other contractors involved	CRF, BMW, FORD, OPEL, PSA, REGIENOV, SEAT, VTEC, BOSCH, MOTOROLA, NUANCE, SV, TELENOSTRA, CTAG, CERTH/HIT, DIBE, ERTICO, INRETS, JCI, KITE, TNO, USTUTT, VTT

8.3.1 SP-level description of work performed

The objective of SP3 has been to design, develop and validate an adaptive integrated driver-vehicle interface for road vehicles (including both cars and heavy trucks) for the safe integration of multiple IVIS and ADAS functions, including nomad devices. The design and development of the HMI was partly based on the achievements of previous European funded projects but the ambition has been to develop a wide range of innovative HMI features which will drive the development of the future automotive environment. This subproject carried out the responsibility of the actual design and development of the AIDE system taking into account the outputs of the other SPs and implementing a user-centred design and development approach. The developed AIDE system was implemented, evaluated and demonstrated in three demonstrator vehicles (VTEC, CRF and SEAT). The AIDE SP3 work plan was divided into 5 Work packages (plus WP3.0 devoted to the technical coordination of SP3). These are described below.

8.3.2 Report per work package

8.3.2.1 WP3.0 Sub-project 3 Technical Coordination

Work package no.	WP3.0				
Work package name	Sub-project 3 Technical Coordination				
Objectives (from Description of Work)	Technical coordination for the sub-project.				
Work package leader	ICCS				
Other contractors involved	CRF				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D3.0.1	AIDE Nomadic Forum activities report	PU	ERTICO	M36
	D3.0.2	AIDE Nomadic Forum activities report	PU	ICCS	M42

8.3.2.1.1 Work performed and key results obtained

This WP led the sub-project, co-ordinated the work of the different work packages and liaised and interfaced the sub-project to the other AIDE sub-projects and the IP management.

ICCS performed the technical coordination of the SP, with the support of CRF (Industrial Vice Leader). ICCS and CRF represented the SP at the IP meetings and workshops and at the meetings with other SPs and eSafety projects. Synergies both internal and external were followed up. Moreover, a number of Plenary Meetings were performed during the SP life. All plenary meetings were coordinated by ICCS which prepared also the relevant minutes.

The work plan of SP3 was followed closely and the SP leaders coordinated the WP leaders making sure that deliverables and milestones were achieved on time. Where problems were identified solutions were proposed and followed and mitigation strategies and back up plans were created.

The use of “Nomadic Devices” (or NDs), or portable and aftermarket devices used in the vehicle by a driver for support, assistance, communication or entertainment, is increasingly common. As in-car use of mobile phones, handheld computers, portable navigators and personal music players grows rapidly, there are concerns that this may lead to driver distraction and increased safety risk. To address these challenges a Nomadic Device Forum (NDF) was established by the AIDE integrated project to bring together representatives of the key stakeholders involved (automotive OEMs, nomadic device manufacturers, automotive suppliers, telecom operators, public authorities etc). During the AIDE life, the Forum has organized a number of workshops and meetings to discuss important issues around nomadic devices and their use within the vehicle, addressing the most important use cases. Issues discussed in this forum have been the following:

- HMI and safety aspects of in-vehicle nomadic device use, including discussions on the possibility of setting up a Memorandum of Understanding between involved stakeholders

on the European Statement of Principles on HMI (updated 2006 version). First drafts of such an MoU have been generated by the Forum.

- The potential benefits of a gateway (possibly standardized) for integration of nomadic device functions into the vehicle have been discussed. A first draft for a set of use cases and requirements for such a gateway has been generated.
- Business case and business model aspects of in-vehicle use of nomadic devices have also been discussed.

8.3.2.1.2 Discussion and self assessment: results versus objectives and state-of-the-art

Within the framework of this WP the technical leadership of the SP took place. Taking into account the complexity of the involved tasks, the large consortium and the technical challenges the management of the SP can be considered as successful as all deliverables of the SP were delivered and all problems appeared during the life time of the project were addressed in a satisfactory way making sure that the overall objectives of the SP were not affected. During these four years the consortium worked in a very good spirit and in a cooperative way and this can be considered also as a success.

The challenge of the introduction of Nomadic Devices within the vehicle interior is now widely acknowledged by all stakeholders. AIDE was one of the pioneer projects in this area and through its Nomadic Devices Forum achieved to bring together all stakeholders and to open the discussion on a number of important issues including the introduction of a common Gateway, the issues related to HMI and safety and also the related business cases. Setting up the ND Forum has been an ambitious challenge, and bringing such a wide range of stakeholders together at one table has not always been an easy task. Nevertheless we conclude that AIDE has succeeded in establishing a Forum that is well known among these stakeholders and that has a potential of generating some highly relevant results in the area of in-vehicle use of Nomadic Devices.

8.3.2.2 WP3.1 Technological Benchmarking and Use Cases

Work package no.	WP3.1				
Work package name	Technological Benchmarking and Use Cases				
Objectives (from Description of Work)	The objective of this WP is to perform the initial "pre-study" activities that will provide the basis for the development work in SP3. The focus will be on performing (1) benchmarking and assessment of AIDE related technologies, (2) analyzing the user needs and (3) identifying scenarios and use cases.				
Work package leader	SEAT				
Other contractors involved	CRF, CERTH/HIT, BOSCH, ICCS, MOT, OPEL, JCI, ERTICO				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D3.1.1	Workshop on Nomadic Devices minutes	PU	ERTICO	M12
	D3.1.2	AIDE scenarios and use cases definition	PP	ICCS	M12

8.3.2.2.1 Work performed and key results obtained

In order to proceed with the appropriate development steps for optimised HMI solutions, the gaps of the existing systems were identified. For this reason, a review and analysis of HMI assessment results was carried out within AIDE WP3.1. The results of the HMI of ADAS/IVIS systems from 8 European projects that have been evaluated in the past, regarding user acceptance of the system, are analysed and categorized, based on a template that was prepared and distributed by HIT. A list of extracted guidelines for AIDE per system reviewed and best practices on how to develop multi-ADAS HMI was produced based on the survey results. Key contributors to this investigation were ICCS and SEAT, assisted by the contributions of CRF, MOTOROLA, ERTICO, JCI, DIBE, VTEC and HIT. The report produced, was fed to WP4.2 as input to T4.2.4 "Innovation Observatory".

In parallel, the WP (i) performed a review on user needs with respect to different human-machine interface (HMI) functions based on feedback by both drivers and experts and ii) described the general AIDE system functionality through the derivation of AIDE design scenarios and use cases. This work forms the basis for the work on designing and developing the adaptive integrated HMI in WP3.4 as well as the requirements and architecture work in WP3.2. It also provides input to SP1 and SP2.

The user needs analysis was based both on results from previous projects regarding the end-users needs and preferences but also in the analysis of the results of a questionnaire-based survey of relevant needs and preferences of experts mainly form the industrial partners of AIDE. This work was used for the definition of the AIDE design scenarios, needed for the design work of AIDE.

The AIDE meta-functions that reflect the system's intended functional scope in a general level together with the AIDE Design Scenarios, led to the definition of concrete Use Cases to be used both for the design and development work of SP3 but also for the creation of evaluation scenarios for SP2. The AIDE Design scenarios are taking into account all situations where possible conflicts between ADAS and IVIS warning and information messages can occur and which can lead to problems for the driver, taking into account always the Driver, Environment and Vehicle status.

A key objective of the AIDE system is to resolve HMI-related conflict situations. This includes conflicts between different systems interacting with the driver as well as conflicts between this interaction and the driving situation. A major difficulty in describing these conflicts is that there are infinitely many possible combinations of interactions and driving situations. A key innovative aspect of AIDE WP3.1 work is the development of a methodology for describing the relevant conflict scenarios that the AIDE system should address in a generalized way. These generalized *AIDE design scenarios* define the scope of the AIDE system and were used to derive the general AIDE functional requirements (in WP3.2).

The driver-system interaction is represented in terms of (driver/vehicle initiated) *actions* and the driving context defined in terms of *Driver-Vehicle-Environment (DVE-) conditions*. The generalized scenario descriptions were achieved based on parameterization and categorization of the actions and DVE conditions. Moreover, a set of general AIDE "meta-functions" for solving the conflict scenarios are derived from the scenarios.

Finally, a set of AIDE use cases not directly related to conflict situations are defined. These are mainly related to integration of nomad systems and adaptation to driver characteristics.

Special attention was given also to the creation of specific use cases related to Nomadic devices and their use within the vehicle environment and the personalisation of the AIDE HMI.

The most relevant user needs results for AIDE purposes, together with the AIDE design scenarios and Use cases were reported in D3.1.2. The results of WP3.1 are a key input to several different activities in the project, in particular:

- The derivation of AIDE functional requirements in WP3.2
- The definition of the basic principles of the AIDE architecture (WP3.2)
- The definition of the semantics of the data flow protocols between applications and the ICA (WP3.2 and WP3.4)
- The needed DVE state parameters (WP3.3)
- The design of the ICA logic (WP3.4)
- Demonstrator vehicle use cases (WP3.5)
- The derivation of the evaluation scenarios (SP2)
- The identification of requirements on the general AIDE evaluation methodology (SP2)
- The definition of DVE modelling scenarios (SP1)

8.3.2.2.2 Discussion and self assessment: results versus objectives and state-of-the-art

Apart from the benchmarking and assessment of AIDE related results, the results of the work of WP3.1 can be divided into two main areas: The user needs and preferences and the development of AIDE Design Scenarios.

The User needs form the basis for deriving requirements and constrains for the AIDE HMI work performed at WP3.2 and for design guidelines defined in WP3.4. They were also used for the creation of the AIDE design scenarios. The user needs analysis was based both on the analysis of material from previous projects (mainly for the end users needs and preferences) and on the analysis of the results of the experts questionnaire filled in by consortium experts. This is a common approach for the definition of the use cases and requirements, providing efficient results.

The second objective of this WP was to define the general AIDE functionality through definition of the scenarios and use cases that the system should address. Partly based on a user needs analysis, the generalized AIDE design scenarios were defined by means of an innovative methodology for parameterising and categorising the driver/system actions and DVE conditions. Based on this scheme, a set of general AIDE meta-functions were defined. In addition, a number of "normal" use cases for AIDE were identified. However the description of the nomad device and personalisation scenarios follows a standard system development process format, because the variety of those cases is limited and therefore do not require a generalised description.

The AIDE design scenarios on principle represent a comprehensive and general valid description of the functional extent of an integrated and adaptive in-vehicle HMI. The description format prevents from listing all cases of interaction conflicts and adaptations being a huge and therefore not manageable amount of use cases. The used categorization approach offers the possibility to create scenarios without defining fixed system behaviour. That is a crucial point, since the different vehicle manufacturers have different HMI strategies which fits best to their individual vehicle philosophy. The given approach using a generalised description offers a high amount of flexibility during the development of an integrated HMI and thus it do justice to that individuality.

Overall the WP offered the basis for the AIDE design and development work. The WP is considered to end successfully.

8.3.2.3 WP3.2 Specifications and System Architecture

Work package no.	WP3.2				
Work package name	Specifications and System Architecture				
Objectives (from Description of Work)	The objective of this WP is to specify the technical functional requirements for the different components and functions of the AIDE system. This includes technical specifications for sensors, I/O devices, computing hardware and software, data exchange protocol and system architecture, but also the basic functional specifications for the adaptive interface functions to be developed in WP3.4 and the driver-vehicle-environment monitoring modules developed in WP3.3.				
Work package leader	BOSCH				
Other contractors involved	CRF, BOSCH, ICCS, USTUTT, REGIENOV, MOTOROLA, INRETS, SEAT, DIBE, BMW, OPEL, VTEC, JCI, SV, PSA				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D3.2.1	Requirements for AIDE HMI and safety functions	PP	BOSCH	M15
	D3.2.2	System Architecture, data flow protocol definition and design and AIDE specifications	CO	BOSCH	M21
	D3.2.3	Report on AIDE Nomadic Forum activities	PU	ERTICO	M24

8.3.2.3.1 Work performed and key results obtained

Based on the scenario descriptions of WP3.1 all AIDE functional and non-functional requirements were defined in WP3.2. The main requirement for an AIDE HMI is to improve driver system interaction in terms of distraction and usability to increase driving safety and improve user comfort.

There exists no “best in-vehicle HMI”, thus, the most crucial requirements are derived from the fact that the HMI is strongly competitive and OEM specific. So, the AIDE system needs to be flexible and scalable concerning the detailed system behaviour, the extent of applications and the used I/O device constellation. That leads to the requirements of modularity and independence between individual components. Those and all other system requirements are listed and described in D3.2.1, in order to provide an easy access on the important requirements for the development (WP3.3, WP3.4 and WP3.5) and also for the evaluation (SP2) of the AIDE system.

The architecture design concentrates on the principal logical structure of the AIDE software system. This work was based on one hand on the deliverables D3.1.2 and D3.2.1 and on the other hand on the User Forum discussions and a joined meeting between AIDE and GST regarding the concepts for the overall architecture and the integration of nomad devices. In addition to that those meetings and workshops were used to agree on the principal architecture of AIDE system.

AIDE D3.2.2, reports the functional reference architecture of AIDE. This AIDE reference architecture is presented in the following figure. Since HMI strategies, I/O devices, and applications differ between different vehicle manufacturers and between different car segments, modularity and flexibility are most important requirements. This strongly affects the principle design decisions, the specification of the interfaces and the communication flow. Therefore, the AIDE architecture

describes a functional structure and semantic communication independent from a concrete implementation, because the implementation varies widely between the OEM's.

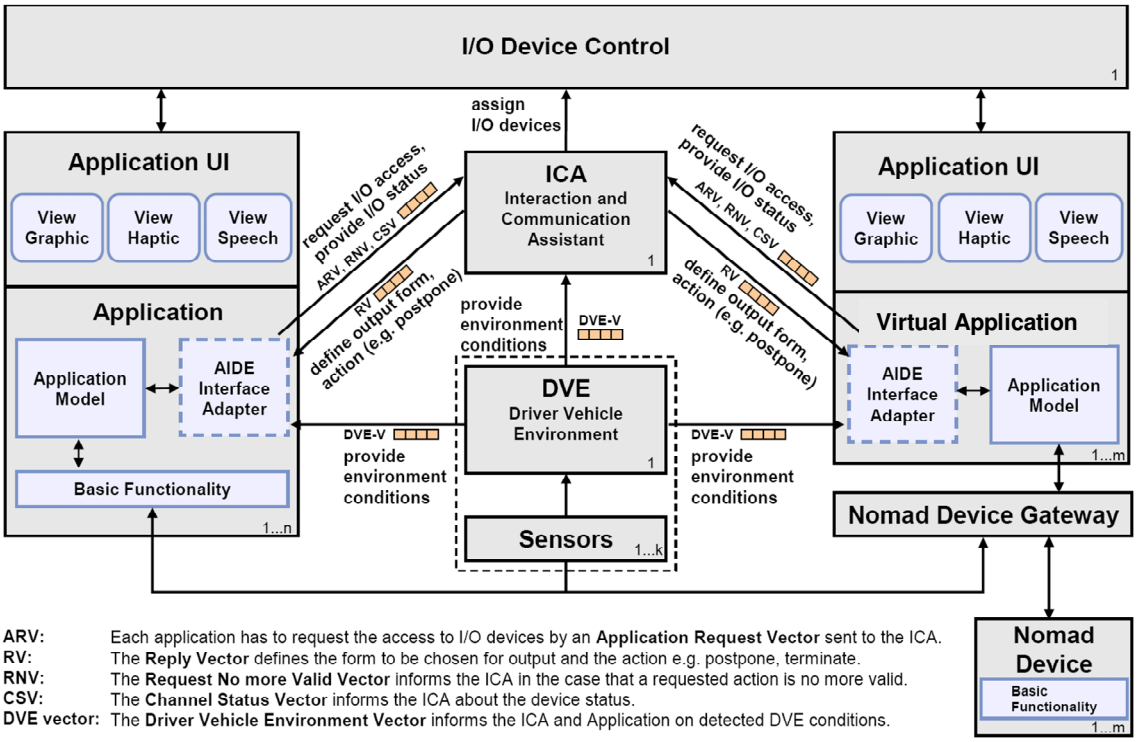


Figure 19: AIDE Functional Reference Architecture.

The AIDE architecture focuses on the functional structure of the AIDE software components and their communication. The individual components are specified in terms of their tasks, responsibilities and dependencies that are necessary to provide adaptive functionalities for an integrated, in-vehicle HMI system. In order to realize the I/O management of interfering output events and adapt the driver system interaction to the driver status and preferences and as well to the driving situation, the following main components were identified:

- *Applications:* These are components offering a specific functionality to the user such as navigation, phone, lane departure warning, music player, radio, etc. The application should be as independent as possible and should, in principle, work independently of the HMI management functions. The application is designed with a model-view-control pattern and includes an AIDE interface adapter offering the AIDE specific functions such as communicating to the ICA and the DVE and performing a priority mechanism.
- *I/O Device Control:* This includes the specific I/O devices such as LCD displays, head-up displays (HUD), haptic input/outputs, loudspeakers or buzzers. It also includes pre- or post processing units such as speech recognition system and TTS-engine.
- *Interaction and Communication Assistant (ICA):* An intelligent assistant that performs the management and adaptation functionality. It contains the rules governing the system behaviour or HMI strategy that is perceived by the user.
- *Driver Vehicle Environment (DVE) Module:* A module that monitors the driver and the driving situation and derives condition information about the driver, the vehicle and the environment that is used by ICA to adapt the driver-system-interaction. It is also used by the applications to adapt application-specific functionalities such as changing priorities and adapting warning strategies.
- *Nomadic Device Gateway:* The integration of nomad devices uses a Nomad Device Gateway to connect to the in-vehicle system. Thus the functionality of the nomad device in

terms of data, applications and I/O devices can be used by the in-vehicle system and vice-versa. The in-vehicle system contains a virtual application software connected to the nomad device functionality via a gateway that provides the user interface software (views) that accesses the I/O devices.

All interfaces between the above mentioned components are specified using generalised content to guarantee the modularity. For example, the ICA has to assign priorities to each output request from the applications. This is done using informing parameters sent by the application to the ICA. These parameters objectively characterize the output message which has to be done in terms of their importance for the driver like “driving relevance”, “safety criticality”, etc. All parameters are defined unambiguously and do not include application specific aspects. Thus, the communication flow between the ICA and application components remains simple and uses the following four messages:

- The Application Request Vector (ARV) to ask for permission to perform an output;
- The Reply Vector (RV) to inform the application about if and how to perform the output;
- The Channel Status Vector (CSV) to inform ICA when devices are freed again;
- The Request No More Valid Vector (RNV) to inform ICA when a postponed output is no longer valid.

Moreover, the DVE Vector and the PM Vector provide condition information and driver preferences that are used by ICA for all general valid adaptive functions and by applications for the application specific functions.

8.3.2.3.2 Discussion and self assessment: results versus objectives and state-of-the-art

AIDE WP3.2 integrated the work of WP3.1, as well as the results of the Nomadic Forum workshops, and the discussions between AIDE and GST (for nomadic Device integration), for the definition of the technical and functional requirements for the different components and functions of the AIDE system.

AIDE WP3.2 defined a flexible and modular architecture which should be able to match to arbitrary implementations. The design principles are chosen such that ordinary components like applications or I/O devices do not have to be changed principally but only extended by encapsulated AIDE specific functionalities. Great effort was spent to develop generalized interfaces, especially between ICA and application. It helps to easily exchange the set of rules implemented in ICA and representing the HMI strategies, because only the ICA has to be changed and no other component.

The results of WP3.2 form the mandatory frame for the development work of WP3.3, WP3.4 and WP3.5; the demonstrators apply an implementation instance of the architecture defined in WP3.2 by implementing the architecture principles, the interfaces and the communication flow defined.

In terms of nomadic device integration the considered forms of integration were documented and the architectural approach was finalised using an extended Bluetooth profile defined by MOT.

The AIDE HMI architecture developed within this WP can be considered as a general and modular HMI architecture that can be used and is already used (e.g. PREVENT IP) beyond the project limits. The AIDE logical architecture has also been mapped onto the electronics HW/SW architecture developed in the parallel EASIS project (this work was mainly conducted by EASIS but supported by AIDE). So this WP had a clear and measurable contribution to the SoA.

The target of the work was a high-level, logical, architecture which is largely independent of the underlying electronics HW and SW architecture (e.g. bus systems, gateways, middleware etc.), which can be adopted by different car segments and has been followed by a large number of automotive manufacturers. This type of architecture constitutes advancement to the current SoA. The main logical components of the AIDE system, their roles and mutual relations have been defined. Overall, the objectives of the WP are considered achieved.

8.3.2.4 WP3.3 Driver-Vehicle-Environment (DVE) Monitoring Modules

Work package no.	WP3.3				
Work package name	Driver-Vehicle-Environment (DVE) Monitoring Modules				
Objectives (from Description of Work)	The objective of this activity is to develop techniques for real-time monitoring of the driver-vehicle-environment state, in order to enable real-time adaptation of the driver vehicle interface.				
Work package leader	ICCS				
Other contractors involved	CRF, CERTH/HIT, ICCS, INRETS, VTEC, SV, KITE, VTT				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D3.3.1	DVE monitoring modules design and development – first release	CO	SV	M22
	D3.3.2	Final and verified DVE monitoring modules	CO	ICCS	M32

8.3.2.4.1 Work performed and key results obtained

Within the AIDE concept, the perception of the current driving scenario and its impact on the driver is considered to be represented through the following triptych: the Driver-Vehicle-Environment (DVE) state. WP3.3 developed a set of modules, called "DVE modules". These modules have been defined with the purpose of computing in real time a set of parameters needed for enabling the AIDE adaptive interface functions according to the AIDE design scenarios descriptions and the relevant criteria for HMI adaptation to certain driving conditions.

The work involved setting the requirements for the various sensors to be integrated in the three demonstrator vehicles (luxury car, city car, truck), and in some cases the actual sensors to use were also chosen as a part of WP3.3 work. The different sensors (i.e. active and passive sensor systems that perceive the surroundings or the cockpit activities, typical messages available in the bus and a positioning system) provide the necessary information to the different AIDE DVE monitoring modules. The sensor requirement specification and selection was done after investigation of existing solutions for real time DVE monitoring in the market.

The DVE monitoring and personalisation modules have been released as first prototypes and tested in partners' labs and test vehicles. The DVE modules perceive the driver the vehicle and the environment by the common DVE sensor set in order to give the AIDE system a description regarding the driver's ability and availability to drive the vehicle. Each module addresses a different dimension of the Driver Vehicle Environment state:

- The Traffic and Environment Risk Assessment Module (**TERA**) which estimates in real time the total level of risk related to traffic and environmental parameters.
- The Driver Characteristic module (**DC**) which includes the definition and estimation of the driver typical profiles.
- The Driver Availability Estimator (**DAE**) focusing on the analysis of the primary task activities.
- The Driver State Degradation (**DSD**) module which is monitoring the driver's fatigue and hypo-vigilance.

- The Cockpit Activity Assessment (**CAA**) module is considering the availability effects of a secondary task.

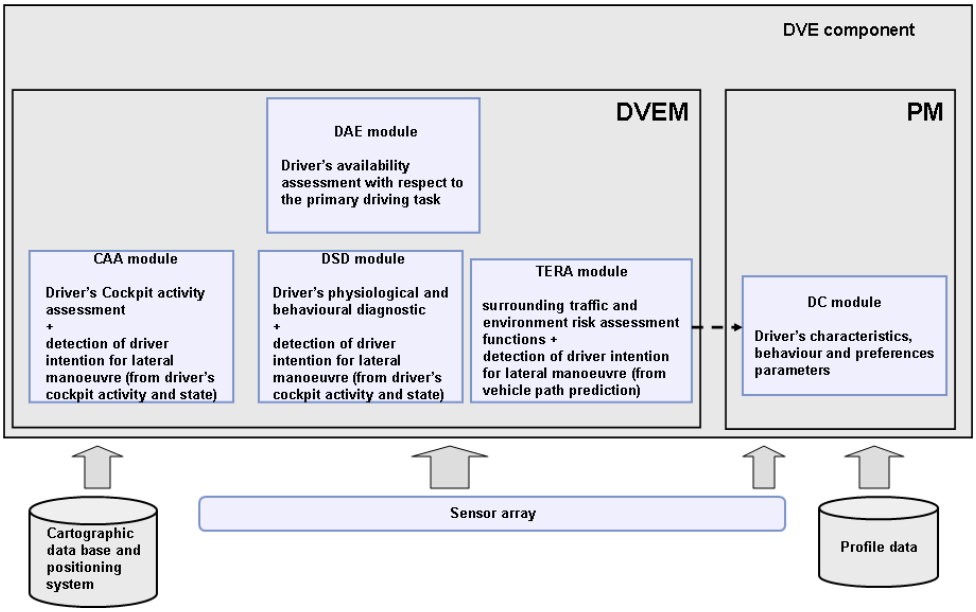


Figure 20: DVE modules architecture overview.

DVE modules' developers (ICCS/TERA module, HIT/DC module, INRETS/DAE module, VTEC-VTT/CAA module, SV/DSD module) worked on the definition and design of the needed software algorithms to allow interfacing the sensors with the integrated HMI on the base of DVE-dependent scenarios reported in D3.2.1. The results of the development work is reported in details in D3.3.1, which describes the design of the DVE component, the definition of each DVE module internal structure and its association with the other AIDE components.

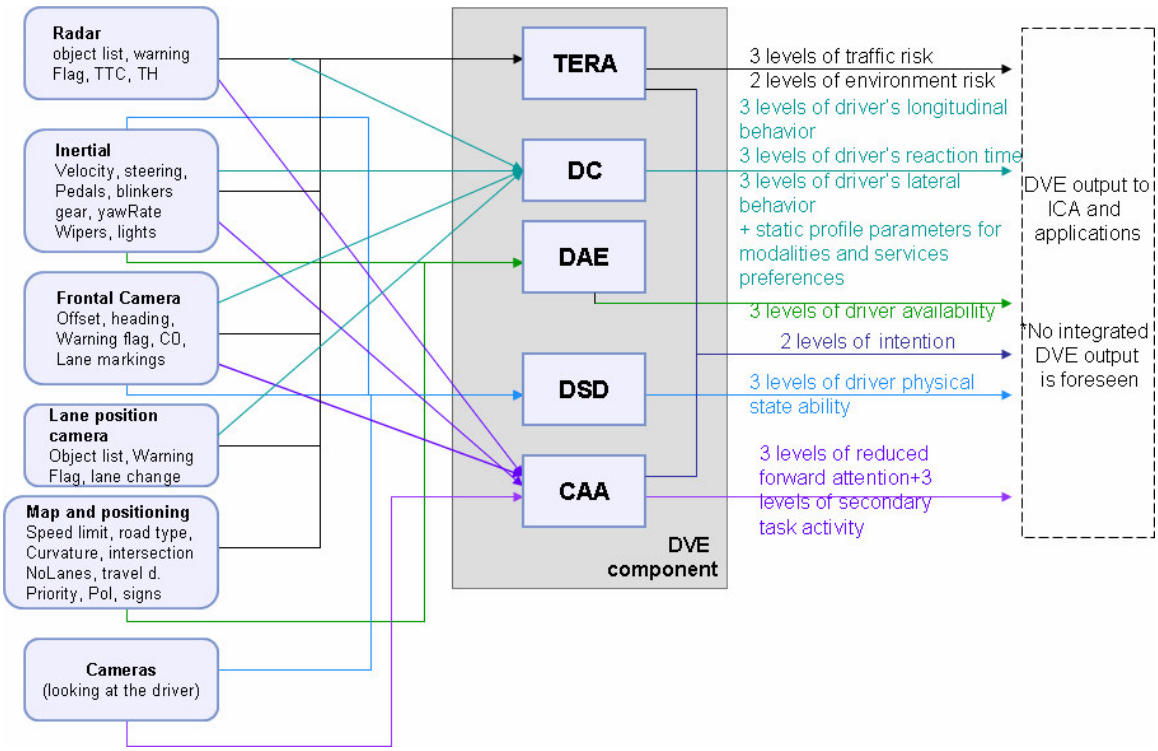


Figure 21: Internal functional architecture of DVE modules.

WP3.3 finally delivered the prototype Driver-Vehicle-Environment (DVE) modules to WP3.5 for in-vehicle integration. Each module is a prototype Software component and is based on sensors and processing units that monitor the driver, the vehicle and the environment. All modules were tested and verified both in lab (partners' facilities – e.g. test cars, simulators) and with the real AIDE system and sensing devices (data collection sessions from the AIDE demonstrators) before delivery.

8.3.2.4.2 Discussion and self assessment: results versus objectives and state-of-the-art

A pre selection of functions and scenarios that AIDE should address has been performed in WP3.1. These non-exhaustive scenarios and uses cases have been selected to demonstrate how AIDE functionalities meet the expectations of an adaptive HMI. This information has been used in WP3.2 to design a real time DVE monitoring system and the AIDE adaptive HMI. From WP3.2, all the requirements and specifications have been set for all modules and hardware components, while the in-vehicle integration constraints have been investigated taking care of the experimental vehicle specificities. The design and development of the DVE modules has followed the SP1 driver model parameters definition, the functional requirements and the design scenarios of the adaptive HMI defined in WP3.1 as well as the architectural aspects from WP3.2.

The five DVE modules have been considered in AIDE describe the driver availability and ability to drive the vehicle, according to the functional requirements and scenarios for the adaptive HMI defined in work package 3.1 as well as the architectural specification from work package 3.2. Each module addresses a dimension of the DVE state. The dimensions include primary (driving) task demand, secondary task demand, and driver state of degradation (e.g. fatigue), driver characteristics and the environment/traffic scenario. Previous work in this area (e.g. in the GIDS, CEMVOCAS and COMUNICAR projects) has generally been limited to a relatively simple, uni-dimensional, estimation of driver workload. However, this has not been considered sufficient to fully exploit the possibilities of HMI adaptivity (for both ADAS and IVIS). The AIDE project has taken a step forward by introducing a set of five different DVE monitoring modules, each responsible for a specific aspect of the DVE state.

The outputs of the DVE modules are associated and evaluated by the ICA module (WP3.4) in terms of an overall scenario assessment regarding driver's availability and ability in specific traffic and environmental conditions for a specific driver. The DVE modules were delivered (as Software prototype components) to the demonstrators for in-vehicle integration and testing, in the respective platforms in CRF, SEAT and VTEC. All modules achieved their goals and overall address the for DVE real time monitoring needed for the adaptivity features in an AIDE HMI, and specifically so in the AIDE demonstrator vehicles. Thus, it can be considered that WP3.3 has reached its objectives.

8.3.2.5 WP3.4 Adaptive Interface Design and Development

Work package no.	WP3.4				
Work package name	Adaptive Interface Design and Development				
Objectives (from Description of Work)	The objective of WP3.4 is to design, develop and technically verify the adaptive integrated driver-vehicle interface components and functions.				
Work package leader	CRF				
Other contractors involved	ICCS, USTUTT, MOTOROLA, FORD, TNO, DIBE, BMW, OPEL, VTEC, JCI, SV, VTT, NUANCE, TELENOSTRA, CTAG				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D3.4.1	Driver-vehicle interaction and communication management	CO	CRF	M25
	D3.4.2	HMI components (displays, HUDs, speech I/O, sound etc)	CO	VTEC	M31
	D3.4.3	Integration of Nomadic Devices: The AIDE Case	PU	MOT	M42
	D3.4.4	Final AIDE HMI (description of the overall AIDE HMI both HW and SW)	CO	CRF	M43

8.3.2.5.1 Work performed and key results obtained

WP3.4 was assigned with the tasks of the design, development and technical verification of the adaptive integrated driver-vehicle interface components and functions. The work includes the following activities.

HMI design and Virtual prototyping

The initial graphical design of the HMI was based on the general AIDE requirements of WP3.1, was followed by the development of virtual prototypes in combination with real HMI components, allowing the validation of the HMI prototypes, testing the logical designs of the ICA (see T3.4.5) and the selection the appropriate warning strategies for the HMI design and the HMI mock-ups. This activity led the development in the sequential tasks of WP3.4 and included the following undertaking tasks:

- *Definition of the logic for the Interaction and Communication Assistant*.
- *Rapid prototyping of the ICA logic and components* in order to perform expert evaluation tests on the ICA logic functioning.
- *Design of the speech, haptic and visual input/output devices*.
- *HMI design* (per demonstrator, including I/O devices)
- *Virtual prototype and test with users on virtual prototypes* (per demonstrator, including I/O devices).
- *Expert evaluation on HMI design* in order to evaluate the HMI solutions implemented in the virtual prototypes.

The results of this activity were used directly from the other tasks of WP3.4 towards the final design and the development of the AIDE HMI.

Development of user interface layout

In parallel the UI of each demonstrator were developed, taking into account the results of the aforementioned activity. The development of the UI layout of the AIDE prototype vehicles included the following activities:

- *Integration and synchronisation of the speech dialog with the visual outputs* which included the definition of the HMI specification of the speech dialogue system and led the development of the demonstrator vehicles (adaptation to the respective HMI solutions).
- *Definition of the HMI "look and feel"* for the three AIDE vehicle prototype vehicles.
- *Development of the interface layout* according to the defined solutions.

Development of I/O devices

In AIDE, the approach regarding the constellation of the I/O devices was to consider the same input and output devices for the same functions as much as possible in all prototype work and even in the demonstrators, and using the same principles of choosing and combining interface modalities. These reflected the integration and adaptation strategies being developed in the AIDE project as one and the same in all the prototypes and demonstrators. At the same time, each prototype and eventual demonstrator vehicle would retain its distinctiveness from the other, owing to the nature of the vehicle types themselves (i.e. city car vs. luxury car vs. truck) and the brand each vehicle carried. The results were three versions of combining HMI components based on the same integration and adaptation strategies being developed in the AIDE project.
A set of I/O devices were developed and integrated in the vehicle prototypes, including speech device (NUANCE), and multifunctional barrel key (TELENOSTRA). The exact set of I/O devices per demonstrator is detailed in D3.4.2, which was fed to WP3.5 for the I/O integration work.

Figure 22: A Haptic Barrel Key integrated to the SEAT Leon steering wheel.

Figure 23: Two Haptic Barrel Keys integrated to the VOLVO FH12 steering wheel.

Figure 24: A Haptic Barrel Key integrated to the FIAT Croma steering wheel.

Prototype Nomadic Device Integration and Validation tests

In the AIDE architecture, an application running on nomadic devices are treated as any other application by the ICA. The design and development of the AIDE Nomadic Devices gateway, which enables this type of generic modularity, and implements the communication of the nomadic device with the vehicle, included the following activities:

- *Safety assessment of NOMAD devices use within the vehicles* in order to acquire the relevant framework.
- *Specification of the NOMAD interface/gateway from OEM/ICA point of view.*
- *Design and development of nomad devices interfaces/gateway.*

The Nomadic Device Gateway (NDG) interface is designed to allow nomadic devices (ND) to interface with a vehicle running the Adaptive Integrated Driver Vehicle Interface (AIDE) system. The gateway allows such a nomadic device to be introduced into the vehicle, the control of the nomadic device can be passed to the vehicle's HMI system and functionality of the device can be altered depending on the driving state.

The AIDE solution for the in-vehicle integration of Nomadic Devices, is reported in D3.4.3, which is available for download from the AIDE website.

Figure 25: Sample of the device-to-vehicle communication – displaying and controlling play-lists from a portable music device on the vehicle's HMI.

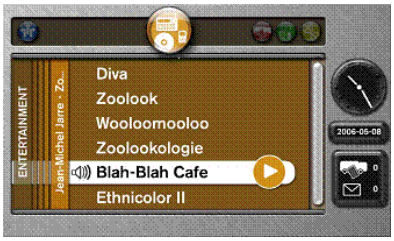


Figure 26:Sample of the vehicle-to device communication for the weight distribution function of the trucking application.

Interaction and Communication Assistant (ICA)

ICA is considered as the central intelligence of the AIDE system, and it is responsible for managing all the interactions and communications between the driver and the vehicle, based on the assessment of the driver-vehicle-environment state/situation provided by the DVE monitoring modules. This includes the selection of the modality for presentation, the message prioritisation and scheduling and the general adaptability of the driver-vehicle interface (e.g. display configuration and function allocation). The ICA implements sets of rules that define ad-hoc modalities of selecting the information provided to the driver. These rules shall be defined in order to optimise driver's interaction with the incoming information, through the various human sensorial channels and without overloading or distracting the driver from the driving task.

The ICA is composed by four modules: **Priority manager**, **Filter**, **Modality selector**, **Channel selector** and each of them actuates a different set of rules, taking into account the current DVE outputs and the number and type of incoming messages/warnings. See Figure 27 for an illustration.

When receiving an application's request for permission to provide information or warnings to the driver, ICA applies (on the basis of the parameters describing the specific action and the current DVE outputs), in sequence, all the sets of rules of its modules and decides if when and how the specific information/warning has to be provided to the driver.

If the answer to the application is negative, it means that the specific action should be delayed. So it will be queued. If the answer is positive, the ICA will indicate to the application the selected modality AND the selected channel (output device or display area) where to display the information. The applications feed their I/O content data directly to the I/O device and each application has to inform the ICA about the occupation/release of the output channels, as the ICA has always to keep track of the availability status of each output device. The logic of the ICA is detailed in D3.4.1 "Driver-vehicle interaction and communication management" and was used as input both for the ICA development work in WP3.4 and for the integration work of WP3.5.

8.3.2.5.2 Discussion and self assessment: results versus objectives and state-of-the-art

The growing demand for new in-vehicle support and services and the drivers' expectation to be connected to their own personal information systems (i.e. mobile phone, PDA, etc.) is increasing the amount of interactions of the driver with the systems inside the vehicle thus, raising the potential risk of driver's distraction and fatigue which are among the main causes of road accidents.

Today, more and more IVIS (in-vehicle information systems) and ADAS (advanced driver assistance systems) are integrated in vehicles, which individually interact with the driver and which

sometimes use dedicated I/O devices. Consequently, the systems and the communication between the driver and the individual systems are designed independent from each other. Frequently, the design process of each individual system takes into account human factor aspects and the HMI is optimised in terms of distraction and usability, but much too less effort is spent on the interdependence of the individual systems and the corresponding influence on the driver. Thus the higher is the amount of applications the more interdependences between I/O events from different systems occur. This dramatically effects driver's distraction and leads to driving safety risks.

In addition to that, although there is already a trend to exploit hardware synergies in using common I/O devices, the applications still interact independently with the driver and the HMI of IVIS applications is strictly separated from the ADAS one.

To guarantee that driver's workload is kept low enough to allow a safe driving, there is the need to design and develop an on-vehicle multimedia HMI, able to harmonize the huge volume of messages oncoming from the new and traditional functions for the driving support. At the same time the HMI should be able to control and manage all the different input and output devices of the vehicle in order to provide an optimised interaction between the driver and the vehicle. The final goal is to let the in-vehicle communication to adapt to the characteristics of the driver, the vehicle and the surrounding environment in a way that guarantees drivers' and vehicles' safety.

Towards that end, WP3.4 successfully designed, developed and technically verified the adaptive integrated driver-vehicle interface components and functions, thus meeting the WP's stated objectives. The work involved (i) HMI design and virtual prototyping, (ii) development of the User Interface (UI) layout, (iii) development of Input/Output (I/O) devices, (iv) prototype Nomadic Devices integration and (v) design and development of the Interaction and Communication Assistant (ICA).

The AIDE HMI ICA logic, was developed throughout the analysis of the AIDE Global Architecture, which involves the description of the applications, the I/O device control, the interaction with the communication assistant (ICA), the driver vehicle environment (DVE) and the nomad devices integration. ICA introduces a concept that allows the creation of adaptive, integrated, multimodal automotive HMIs, able to cope with multiple systems (and thus messages) and information sources in a safe, efficient and personalised way. Its modularity and flexibility allows the customisation of the main system to different needs and strategies.

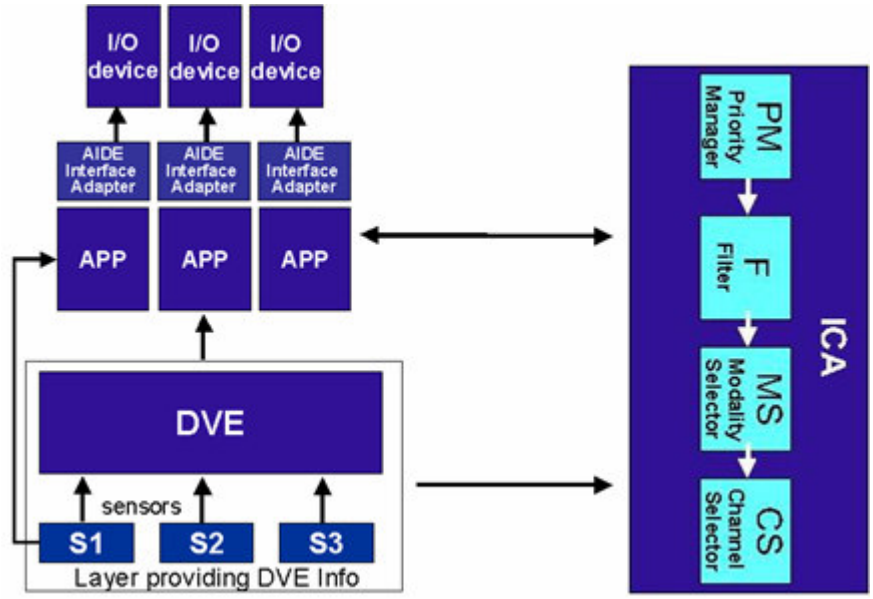


Figure 27: ICA information flow.

8.3.2.6 WP3.5 System Integration and Technical Verification

Work package no.	WP3.5				
Work package name	System Integration and Technical Verification				
Objectives (from Description of Work)	The objective of WP 3.5 is to integrate the system architecture (WP3.2), the DVE monitoring modules (WP3.3) and the adaptive integrated interface components (WP3.4) into three prototype vehicles, one city car, one luxury car and one truck. These vehicle types have been chosen in order to take into account the various requirements for different market segments and use cases (e.g. private vs. professional use).				
Work package leader	VTEC				
Other contractors involved	CRF, SEAT, PSA, CERTH/HIT, ICCS, MOTOROLA, INRETS, DIBE, NUANCE, SV, VTT, TELENOSTRA				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D3.5.1	Common Verification Plan	CO	SEAT	M33
	D3.5.2	Description of Final Demonstrators	CO	VTEC	M49

8.3.2.6.1 Work performed and key results obtained

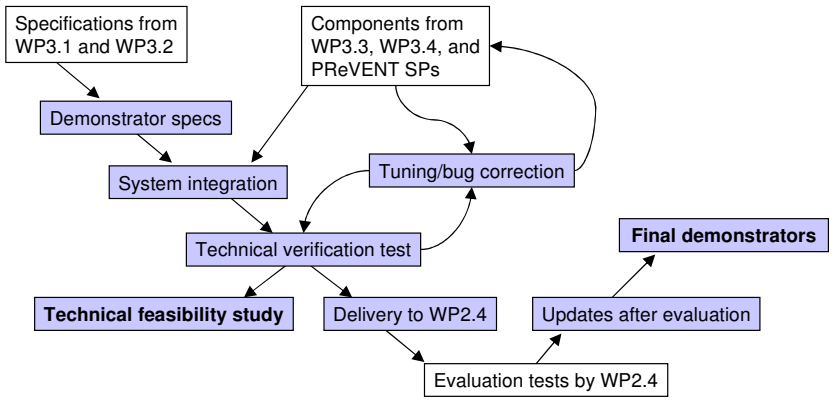


Figure 28. Organisation of work in AIDE WP3.5.

Figure 28 illustrates how work in WP3.5 has been carried out, within the WP and in interaction with other AIDE WPs as well as with PReVENT IP. Main contributors have been VTEC, SEAT and CRF, each developing their own demonstrator vehicle (truck, city car and luxury car, respectively), and PSA, developing the AIDE "test car" for use in technical feasibility experiments. Besides developing the city car, SEAT also made an important contribution by developing the common technical verification plan used for all three demonstrator vehicles (D3.5.1). WP3.3 and WP3.4 partners supported with iterative updates to their components during the tuning/bug correction work, and in the case of the truck demonstrator, integrating a number of PReVENT active safety systems, such support has also been given by PReVENT researchers.

All prototype vehicles were delivered successfully, although with delays. The original plan for demonstrator delivery was (end of) M40 (June 2007), but the first demonstrator was delivered in M42 and the last one not until early M46. These delays have been problematic, since they have caused chain delays to WP2.4, in consequence creating a need for an extension of the entire project.

The main reason for the delays in WP3.5 has been the high complexity of the demonstrators, integrating a remarkably high number of innovative components completely or to a substantial degree developed within AIDE (more than ten such components in each demonstrator). This high degree of innovation has been good in the sense that it has made it possible to tailor the AIDE prototypes to very effectively demonstrate the AIDE concepts, but the downside has been a number of specific integration problems occurring with some of the components. More time for the integration work should probably have been foreseen.

Nonetheless, the work in WP3.5 has generated a number of very relevant results:

- The most tangible of these are the three demonstrator vehicles themselves. They serve as important platforms for demonstration and evaluation of the AIDE HMI integration and adaptivity concepts.
- The successful implementation of most of (see next section) the envisioned AIDE integration and adaptivity use cases (specified in WP3.1) show that these are feasible with the technology available today (including the new advances of the state of the art made in WP3.3 and WP3.4), and this in itself is an important result.
- More specifically, the prototype vehicles show that the highly modular and therefore potentially development time and cost saving AIDE logical architecture (WP3.2), can be used to implement the AIDE HMI concepts.
- Further, the successful implementation of three considerably different vehicle HMIs (four if counting the PSA test car) using the same basic system architecture, shows that this architecture, and its most fundamental component ICA (Interaction and Communication Assistant; WP3.4) are flexible enough to be used for a wide range of vehicle types and models, which is a requirement for the modularity of the AIDE solution to really be worth while.
- Further, the experiments on the PSA test car have shown that the AIDE architecture and ICA module do not add unacceptable overheads, compared to non-modular solutions, in terms of bus loads or HMI response times.
- Finally, in the integration work some specific ideas for further developments to the ICA module have been identified.

These results have been reported on in more detail in deliverable D3.5.2.

8.3.2.6.2 Discussion and self assessment: results versus objectives and state-of-the-art

AIDE WP3.5 has integrated all WP3.3 DVE modules and WP3.4 HMI components into the demonstrator vehicles, using the logical architecture of WP3.2. WP3.1, specifying the AIDE design scenarios and use cases, is not mentioned in the Technical Annex objectives, but we anyway wish to report that almost all design scenarios and use cases have been covered by the three demonstrator vehicles. The only exceptions are:

1. A design scenario dealing with context specific resolution of conflicts between concurrent driving support system time and safety critical warnings. In AIDE WP3.2 it was identified that this could not be implemented using only the generic and modular AIDE logical architecture. Instead, a “joint warning application” is needed, with specific knowledge of the involved warning applications. The AIDE solution is compatible with this type of joint warning application, but since the development of such an application requires a deep insight into the specific warning application implementations themselves there was no such development within AIDE. An AIDE-compatible joint warning application was however developed in PReVENT sub-project INSAFES.
2. A nomadic device use case on integration of portable navigation devices. This was due to the decision to base the nomadic device integration on existing BlueTooth profiles, combined with the lack of a BlueTooth profile for navigation functions. Developing a BlueTooth profile for portable navigation integration did not fit within the AIDE scope.

Further, it could be noted that some of the DVE monitoring module output parameters (drowsiness, individual driver reaction times) were not practical to include in the set of demonstrator use cases evaluated in the WP2.4 experiments, since controlled evaluation of these aspects would not fit within the evaluation scope. Consequently, due to the time constraints in WP3.5, the tuning and final verification of the corresponding DVE modules in the vehicles has not been as extensive as for the other DVE modules. All DVE modules were however technically verified before delivery to WP3.5, and these developments are to be considered valid and valuable even though they weren't included in the human factors evaluations.

Comparing the AIDE demonstrators to the state of the art on the market and in research, the AIDE prototypes do provide some advances. In general, since HMI is a highly competitive issue within the automotive industry, in collaborative projects such as AIDE it is in some areas, such as I/O devices, often difficult to even *reach* the state of the art in the first place. In these problematic areas the AIDE prototypes nevertheless do reach on-market state of the art (haptic input controls, touch screens, HUDs etc) and then go further by adding novel aspects in terms of the AIDE adaptivity and integration features, which are not paralleled by on-market vehicles. Similar features existed on market before AIDE, and new ones have appeared during the project, but AIDE definitely goes beyond these existing solutions in terms of completeness of integration, as well as in terms of the richness of DVE monitoring and the adaptivity features thus enabled.

In summary, if accepting the abovementioned limitations in terms of the two envisioned specific functionalities that were not implemented, and the difficulty of performing extensive validation and tuning of all DVE modules in the demonstrators, it is our opinion that AIDE WP3.5 clearly succeeded in reaching its objectives, although with some delays.

Figure 29. The truck demonstrator at ITS World Congress 2006, the city car HMI and driver monitoring cameras, and the FIAT CROMA with its integrated components.

7.3.3 SP-level discussion and self-assessment: results versus objectives and state-of-the-art

The overall objective of AIDE IP has been "to generate the knowledge and develop the methodologies and human machine interface technologies required for safe and efficient integration of multiple driver assistance and information functions into the driving environment." Specifically, it has been envisioned that this entails a unified human-machine interface that resolves conflicts and exploits synergies between different in-vehicle functions. The key features of the AIDE HMI concept, further illustrated in Figure 30, are:

- *Multimodal HMI I/O devices* shared by different ADAS and IVIS (e.g. head-up displays, speech input/output, seats vibrators, haptic input devices, directional sound output)
- *A centralised intelligence* for resolving conflicts between systems (e.g. by means of information prioritisation and scheduling).
- *Seamless integration of nomadic devices* into the on-board driver-vehicle interface.
- *Adaptivity of the integrated HMI* to the current driver state/driving context. The adaptive interface should also be re-configurable for the different drivers' characteristics, needs and preferences. This requires techniques for real-time monitoring of the state of the driver-vehicle-interface system.

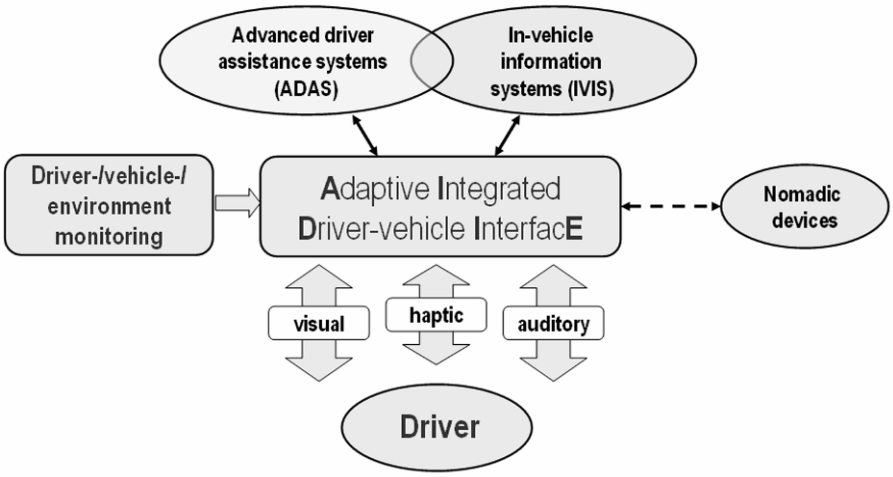


Figure 30. Illustration of the AIDE Concept.

The actual design and development of the AIDE HMI system took place in the AIDE sub-project 3 (SP3), led by ICCS and CRF. **The main objective of AIDE SP3 was to design, develop and validate an adaptive integrated driver-vehicle interface for road vehicles (including both cars and heavy trucks) for the safe integration of multiple IVIS and ADAS functions, including nomad devices.**

The work of AIDE SP3 has been successfully completed As discussed in the previous sections, the results of AIDE SP3 include the specification of use cases and requirements that the AIDE system should address according to the project's objectives, the definition of the AIDE software architecture, a centralised HMI management unit, a set of real-time modules monitoring the driver-vehicle-environment state, a set of HMI I/O devices (where the focus has been on the development of speech interfaces and multifunctional haptic inputs), and a gateway for nomadic device integration. These components have been implemented in the first step in a set of so-called virtual prototypes, which represent first versions of the AIDE system; these virtual prototypes were used in a first round of user tests. In the next step, the AIDE system was transferred from the virtual prototypes to a set of real demonstrator vehicles, including two passenger cars (by CRF and SEAT)

and one heavy truck (developed by Volvo). Finally, these vehicle prototypes went through human factor evaluation in real conditions and were optimized according to the tests' results.

The three prototype vehicles implement the envisioned AIDE system including I/O devices, Nomadic device gateway, Driver Vehicle Environment (DVE) modules and the ICA. Existing in-vehicle functions as well as some simulated or real additional functions are integrated in the AIDE system solution as well. The three prototype vehicles:

- Achieve a good coverage of the AIDE design scenarios and use cases.
- Successfully implement the AIDE logical system architecture.
- Integrate, in a satisfactory level, a rich DVE vector featuring a large number of DVE state parameters, which allows a flexible and transparent process of defining adaptive HMI function.
- Integrate the ICA software module (showing that it is possible to base quite different vehicle HMIs on this one same central HMI logic component).
- Integrate a large number of I/O devices (e.g. head-up displays, speech input/output, multifunctional haptic input devices, etc.), and a nomadic device.

It is valuable to note that the final demonstrator vehicles of AIDE successfully integrate a large number of HMI components, of which more than ten are completely or to a substantial level developed within the project itself (ICA, ND gateway, speech system, HBK, DAE, CAA, DSD, TERA, DC, DVE platform, and at least one HMI GUI software module per vehicle). The demonstrator setups reflect the level of complexity of HMI implementations in modern vehicles, with the added dimension of also implementing AIDE type adaptivity and integration features.

AIDE SP3 has implemented these complex prototype setups in order to prove the feasibility of the AIDE HMI concepts and of the AIDE logical architecture, and in this sense the work is clearly a success. We conclude that the AIDE system solution and logical architecture provide a means of implementing the AIDE's envisioned HMI concepts in a flexible manner, allowing OEM/vehicle specific design choices, and that it does so without adding unacceptable extra overhead in terms of timing or bus loads.

In summary, we can conclude that AIDE SP3 clearly succeeded in reaching its objectives, by designing, developing and validating an Adaptive Integrated Driver-vehicle interfacE concept for road vehicles, as envisioned.

7.3.4 Recommendations on future work

In terms of physical system architecture, the demonstrators are definitely not production grade implementations. Rather, to allow rapid iterative prototype development, processing units and communication networks have been chosen for their flexibility and ease of use rather than for their robustness. This is normal procedure for this type of prototyping work, but for industrial exploitation further iterations will be needed to tailor the AIDE system to production vehicle physical architectures. However, as mentioned above, preliminary tests within AIDE indicate that this adaptation should indeed be possible without introducing unacceptable overheads.

The handling of context specific resolution of conflicts between concurrent driving support system time and safety critical warnings clearly needs further research investigation, as dictated by the results of AIDE SP3. Research is needed towards the definition of a joint warning system, despite the system specific implementations defined in other research initiatives. One should add to the above the primary task HMI requirements. Although the HMI requirements related to the secondary tasks have been investigated, at least up to a significant point, further research is needed for the primary task HMI requirements. This is a normal conclusion for the future work needed, as this topic is clearly beyond the AIDE objectives.

Finally, Nomadic Devices and in general Commercial electronics systems impose an additional research challenge in terms of integration of such devices in the vehicular environment. HMI issues are of paramount importance in this area in order to make sure that such devices are integrated in a driver friendly and safe way.

8.4 Sub-project 4: Horizontal Activities

Sub-project no.	SP4
Sub-project name	Horizontal Activities
Objectives (from Description of Work)	No objectives on SP level. The Description of Work gives the following description: "Sub-project 4 gathers a set of horizontal activities that are common to the other sub-projects. This includes the Consortium Management, innovation-related activities (dissemination, exploitation etc.), the development of general HMI design standards and guidelines and review and assessment of the general work in AIDE. These activities are rather heterogeneous and have been gathered together for organisational rather than technical reasons and, thus, each has its own specific objectives."
Sub-project leader	VTEC
Other contractors involved	ICCS, BMW, CRF, JRC, PSA, CERTH/HIT, BOSCH, TNO, UNIMORE, ERTICO, USTUTT, SV, NUANCE, BASt, REGIENOV, OPEL,

8.4.1 SP-level description of work performed

Sub-project 4 of AIDE gathered a number of horizontal activities of a fairly heterogeneous nature:

- WP4.0, technical coordination, focusing on IP technical coordination in terms of interactions between SPs and interactions with external activities, as well as in terms of monitoring SP work to ensure alignment with IP objectives.
- WP4.1, providing the administrative coordination and quality control of the IP, and the management of the consortium.
- WP4.2, taking care of dissemination of AIDE results beyond the project consortium, as well as overseeing the project partners' work on planning their exploitation of AIDE results.
- WP4.3, dealing with standards and guidelines, both in terms of making sure AIDE work was based on existing standards and guidelines, and in terms of generating recommendations from AIDE to future standards and guidelines.
- WP4.4, providing a continuous review and assessment of AIDE work, as a further support to the IP management in ensuring the quality and timeliness of AIDE deliveries.

All of these WPs were active more or less during the entire IP duration, with some natural evolutions in work focus and intensity. E.g. standards and guidelines work began by identifying existing documents, and concluded by providing AIDE recommendations, and dissemination work was more intense towards the end of the project.

8.4.2 Report per work package

8.4.2.1 WP4.0 Sub-project 4 Technical Coordination

Work package no.	WP4.0				
Work package name	Sub-project 4 Technical Coordination				
Objectives (from Description of Work)	Technical coordination for the sub-project.				
Work package leader	VTEC				
Other contractors involved	-				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D4.0.1	Interaction Plan, M13-30	PU	VTEC	M17

8.4.2.1.1 Work performed and key results obtained

Since the WPs in SP4 are quite heterogeneous, the need for technical coordination of the SP has not been as great as for SP1-3. Rather, the main focus of WP4.0 has been the technical coordination of the entire IP, including its interactions with external initiatives.

The work progress of the SPs and the IP as a whole has been monitored by WP4.0 by means of attendance to relevant meetings on all levels of the project (IP Core Group, SP plenary meetings, WP meetings, task meetings) and by means of gathering quarterly and annual activity reports. Work progress has been compared to the work plan set out in the project contract Technical Annex, and to the annually revised Implementation Plans, every year updating the Technical Annex with more details on the work to be carried out during the next 18 project months. When deviations have been identified, appropriate actions have been agreed upon with concerned partners (most often in direct discussion with SP leaders only). One example of such corrective action is the two month IP extension to allow proper completion of activities.

Early on it was identified that while each SP should work towards SP objectives without detailed IP management involvement as far as possible, a main responsibility of WP4.0 should be to manage and ensure the interactions between SPs, and between AIDE IP and external initiatives. Therefore, an Interaction Plan was defined, initially covering project months 13-30, and then updated in subsequent Implementation Plans. Figure 31 gives an overview of the main internal and external implemented interactions, and roughly when they occurred.

Simplifying somewhat, the main internal interactions have been:

- Use in SP2 and SP3 of the conceptual framework and DVE state parameterization developed in SP1.
- Use in SP1 and SP3 of evaluation tools and methods developed in SP2, e.g. for driver behaviour analysis and during virtual prototyping of AIDE HMI.
- Use of AIDE system requirements and specifications from SP3 (with continuous updates throughout the project), in SP1 and SP2, to ensure applicability of SP1 and SP2 results.
- Cooperation between SP2 and SP3 on the final evaluation of the AIDE prototype vehicles, followed by final updates to the prototypes based on evaluation results.

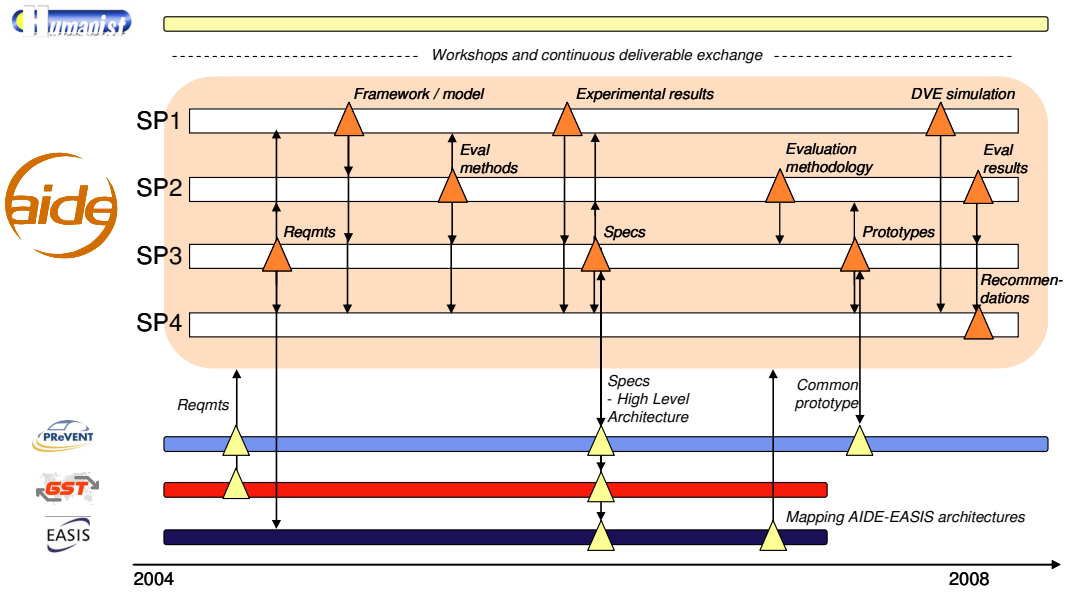


Figure 31. Overview of interactions between AIDE SPs and between AIDE IP and external initiatives.

In terms of external interactions, in addition to a large number of presentations of the AIDE project and its results to conferences and such, WP4.0 has ensured close interaction with relevant outside projects and activities mainly via 1) the EUCAR Integrated Safety Program (ISP), 2) cooperation with HUMANIST Network of Excellence, and 3) participation to EC Concertation Meetings.

The EUCAR ISP groups European safety related research projects (during AIDE's lifetime: GST, PReVENT, EASIS, AIDE, APROSYS, CVIS, SAFESPOT) with a strong connection to industry and EUCAR. The projects within the ISP focus on a wide variety of aspects of vehicle and traffic safety, and a main focus of the ISP activities during AIDE's lifetime has been to clarify the high-level picture of how these different aspects are interrelated, and how they should work together. To this end a common use case story and a High-Level Architecture (HLA), defining the main building blocks of integrated safety were developed. Figure 32 shows this HLA, and how the main components of an AIDE system map onto it.

Besides generating this high-level perspective, the most important contribution of the ISP has been to establish proper working level interactions, to ensure proper uptake of results between ISP projects. Coordination of common dissemination efforts at various events has been another work item.

Below, the main interactions with individual ISP projects are listed:

- PReVENT (preventive and active safety): Use of PReVENT function specifications to guide AIDE requirement specification work; Use of AIDE HMI system architecture in PReVENT specifications and demonstrators; Use of AIDE HMI evaluation methods in evaluations of PReVENT systems; The common VTEC truck demonstrator, with PReVENT systems integrated in an AIDE HMI
- GST (global system for telematics): Use of GST function specifications to guide AIDE requirement specification work; Use of AIDE HMI system architecture in GST specifications; The common VTEC truck demonstrator, with GST systems partially integrated in an AIDE HMI
- EASIS (electronic architecture and system engineering for active safety systems): Use of AIDE system specifications to guide EASIS requirement specification work; Mapping of the AIDE architecture onto the EASIS electronic architecture

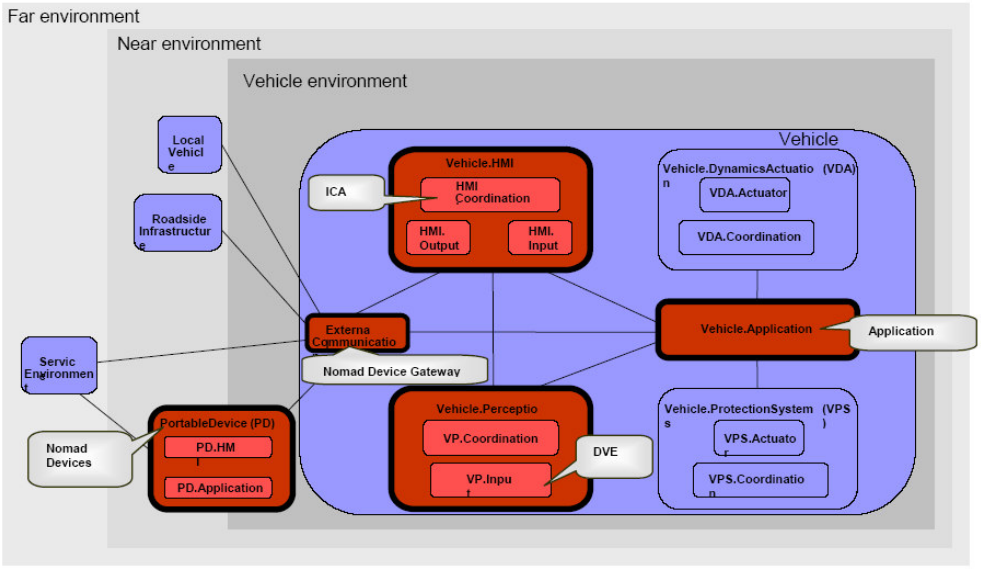


Figure 32. The EUCAR Integrated Safety Program High-Level Architecture, and a mapping of the main AIDE components onto it.

Further, the HUMANIST NoE, active during roughly the same time as AIDE, gathered a large number of research institutes in Europe on the general topic of HMI issues in intelligent transportation systems, thus with a strong overlap with AIDE in terms of general focus. Most academic partners in AIDE were also HUMANIST partners, facilitating cooperation. Main areas of common interest were driver modelling and evaluation methods, and a number of common workshops were organised on these topics and others, and related deliverables were shared between the projects.

Through EUCAR ISP and HUMANIST, AIDE managed to interact with the most immediately related European research initiatives. As a further complement, EC Concertation Meetings, gathering the entire set of ICT for Transport projects for common discussions, provided occasions to establish communication with an even wider circle of projects. During AIDE, three such Concertation Meetings were organised.

8.4.2.1.2 Discussion and self assessment: results versus objectives

Coordinating the technical work of a research project of AIDE's size is a non-trivial effort, and a considerable amount of work has been put into facilitating the smooth hand-over of results between interacting work groups inside and outside the project. In one perspective, the two month extension of the IP can be considered a failure in terms of not being able to keep to the original project time plan, but from another perspective the extension can be regarded a success since it permitted proper completion of contractually agreed work.

Overall, we conclude that WP4.0 successfully managed to coordinate the IP level planning, performance and follow-up of AIDE work. All the major interactions between SPs were established as planned, and in the work on external interactions a very wide coverage of relevant related research initiatives was achieved. The interactions with external initiatives increase the impact of AIDE results, both by ensuring the compatibility of the AIDE system with related systems, e.g. for active safety, telematics et cetera, and by increasing the awareness of AIDE results among researchers and developers of related systems.

8.4.2.2 WP4.1 Consortium Management

Work package no.	WP4.1				
Work package name	Consortium Management				
Objectives (from Description of Work)	To perform the management for the project and the consortium.				
Work package leader	VTEC				
Other contractors involved	BMW, CRF, PSA, ICCS, JRC, UNIMORE, TNO, BOSCH, HIT				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D4.1.1	Financial Management Plan	PU	VTEC	M3
	D4.1.2	Quality Management Plan	PU	HIT	M3
	D4.1.3	Gender Equality Plan	PU	VTEC	M3
	D4.1.4-1;2;3;4	Year 1-4 Management and Activity Reports	CO	VTEC	Annually
	D4.1.6	Final Management and Activity Report	CO (mgmt) and PU (activity)	VTEC	M52

8.4.2.2.1 Work performed and key results obtained

Aspects of IP coordination and management not covered by the technical coordination of WP4.0, have been handled by WP4.1. Involved partners have been VTEC, as coordinator, and the AIDE Core Group, consisting of VTEC, BMW, CRF, PSA, ICCS, TNO, BOSCH, and JRC, replaced by UNIMORE in Y4 after JRC's withdrawal from the project.

VTEC activities as coordinator have included, in addition to the WP4.0 technical coordination activities, to act as the speaking partner of the consortium towards EC, coordinate AIDE participation to the annual EC project reviews, arrange Core Group meetings (roughly quarterly) and IP General Assemblies (annually), distribute funding payments from EC to partners, be responsible for the overall IP budget and any corrective actions affecting it, and to implement amendments to the EC contract and the consortium agreement when needed. Amendments to EC contract and consortium agreement have been carried out to handle modifications such as partners leaving or entering the consortium and budget redistributions between partners.

Apart from managing the IP budget and updating it when needed, financial monitoring and follow-up, as defined in D4.1.1, the Financial Management Plan, has been a major work item for WP4.1. In parallel to the quarterly and annual activity reports generated in WP4.0, WP4.1 has generated corresponding quarterly and annual management reports (and in practice both the activity and management reports are regarded as WP4.1 deliverables, see the deliverable list above).

The management reports have been used both for status reporting towards the EC, in practice being the formal basis for EC funding payments, and as a means for the consortium management to identify financial problems in terms of overspending or underspending. Already at the beginning of the project it was clear that budget was scarce in some areas, and during the project other weak points were identified as well. Budget deficits were solved in many cases by transfer of budget

between partners, but in some cases AIDE partners also had to secure additional budget in other ways, typically from within the own organisations, in order to complete their contractually agreed work obligations.

Another important part of the consortium management work has been the project quality management, for which HIT has been the main responsible partner. At the beginning of the project, a Quality Management Plan was generated, defining project work processes, document templates et cetera. During the project WP4.1 has served the entire IP with peer reviews of project deliverables, to ensure high quality of deliverables before submission to EC and/or publication.

Also within WP4.1, at the beginning of the project a Gender Equality Plan for AIDE IP was defined. The basis for this was a questionnaire investigating the gender balance within the group of researchers involved in AIDE. It was found that gender balance within AIDE was unusually good, and no further gender equality actions were therefore considered needed.

8.4.2.2.2 Discussion and self assessment: results versus objectives

The consortium management team (coordinator and Core Group) has successfully managed the AIDE project consortium, ensuring the involvement of all partners in the decision process through General Assembly meetings and other means of interaction, ensuring quality of project deliveries, identifying early on any problems with IP finances or work progress, and applying appropriate corrective actions, delivering expected reports to EC, and distributing EC funding to partners.

This work package is one where the allocated budget was found to be too small, and involved partners have needed to secure additional budget from other sources (e.g. from within the own organisations, national funding) to carry out the needed work.

8.4.2.3 WP4.2 Dissemination and Exploitation

Work package no.	WP4.2				
Work package name	Dissemination and Exploitation				
Objectives (from Description of Work)	This WP has two main objectives: (1) To develop efficient dissemination methods and instruments and use them for spread the AIDE results to a wider audience outside the consortium, and (2), to develop instruments and plans for the market exploitation of the AIDE methodologies and technologies.				
Work package leader	ICCS				
Other contractors involved	All AIDE partners				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D4.2.1	Report on results of First User Forum	PU	ICCS	12
	D4.2.2	Dissemination materials including web site	PU		12
	D4.2.3	Initial exploitation plan: Public part and Confidential part	PU / CO	BMW	12
	D4.2.4	Updated Dissemination Plan	PU	ICCS	25
	D4.2.5	Updated Exploitation Plan	PU	BMW	26
	D4.2.6 a / b	Final exploitation: public part / confidential part	PU / CO	BMW	50
	D4.2.7	Final Dissemination Report	PU	ICCS	51
	D4.2.8	Report on results from Second User Forum	PU	ICCS	56

8.4.2.3.1 Work performed and key results obtained

Objective 1: To develop efficient dissemination methods and instruments and use them for spread the AIDE results to a wider audience outside the consortium

Dissemination activities were always considered of primary importance for the AIDE consortium since only if the achieved project's results are widely communicated to the public the impact of the project can be meaningful.

Since the early stages of the project, a concise *dissemination plan* was designed in order to assist the effective use of resources allocated to the dissemination task. To this plan the target groups were defined and the relevant communication channels for each target group were specified.

The target groups for the dissemination activities are divided to two equally important categories; the experts and key stakeholders in the area of Human-Machine Interaction, and to the end users and general public, interested in the traffic safety and comfort in using vehicles. The dissemination activities are evenly directed towards both categories, implementing in every individual case various dissemination means and channels as defined to the 1st AIDE Dissemination Plan included into deliverable D4.2.2 and later revised by the deliverable D4.2.4 "Updated Dissemination plan".

During the first two years of the project the dissemination activities focused on spreading the concepts and ideas behind the project's research activities. The AIDE consortium was keen on presenting papers and publications to various national and international events as described in detail in this report. The added value of each event was under careful examination, making sure each time that the maximum amount of audience belonging to the target groups already specified was reached. This was achieved through project presentations not only to European events but also to Asian or American conferences and congresses at international level.

During the later two years of the AIDE activities the dissemination task focused on the spreading of the AIDE achievements through specific technical papers to conferences and journal publications and results' demonstrations to various events. The interaction with other similar projects, such as the HUMANIST NoE through common workshops and the PReVENT and GST IPs through common demonstrators helped the exchange of valuable feedback and the better understanding on the part of the public of the AIDE contribution to road safety.

During the AIDE duration a sum of *5 publications to journals and book chapters* were achieved, presenting the work of the project. In addition a total of *37 technical papers were presented to scientific conferences, workshops and congresses* and were included to the respective proceedings. These publications emanating from the AIDE research activities greatly enhanced the efficiency of the dissemination task by reaching the expert target group of key stakeholders in industries, research and national or international authorities.

Specific AIDE related events were organised, namely the *1st AIDE User Forum* which was held at the end of the 1st year of the project and the *Final AIDE Workshop and Exhibition* which took place in April 2008 combined with the official closure of the project's activities.

AIDE participated and demonstrated its innovative results to a number of related exhibitions, such as the *PReVENT IP Final Event*, at which AIDE organised a dedicated stand and demonstration of two of the prototype vehicles, and the major ITS congresses such as the *ITS London World Congress* at which the results demonstration was also combined with special session participation. AIDE also participated through special sessions and technical papers to all *ITS congresses* (European or World wide ones) that were realised within the project's duration.

AIDE also was presented at a vast number of various events and appeared in special broadcasts of European channels, press releases of various organisations and companies and on informative websites. In addition, one *Doctoral dissertation* and one *Master of Science Thesis* emanated from AIDE work.

To enhance further the dissemination impact, the AIDE project specifically designed dissemination material informing on the project's concept and achievements. The *AIDE logo* was designed to be

included in all dissemination material relating to the project. In addition *two sets of AIDE leaflets*, one introductory at the beginning of the project and one consolidating the project's achievements at the end of the project were printed and disseminated to project's events. The *AIDE poster* decorated the project's public activities while the three *Newsletters* kept the project's User Forum informed and updated on the project's activities. Finally, the *project video* was produced for displaying the project's concept and results in a visual way e.g. at the AIDE final event.

Objective 2: to develop instruments and plans for the market exploitation of the AIDE methodologies and technologies.

To meet this objective the exploitation plan for the AIDE project was drafted. An initial version divided in one public and one confidential part was issued at the 1st year of the project, while these plans were refined for the final exploitation plans deliverable (D4.2.6), submitted at the end of the project's duration. The final exploitation plan was also divided in one public and one confidential part.

The purpose of the project's exploitation plan is to describe how the main results of the AIDE project will or can be exploited, by project partners or others. By defining this exploitation plan, the project wishes to show clearly that the work carried out in AIDE has generated substantial contributions with a great potential for beneficial socio-economic impact on national, European or world wide arenas. Also, it is a purpose of the document to facilitate exploitation of AIDE results, and encourage further exploitation, by providing a description of and a contact person for each exploitable result.

The procedure adopted to define the final exploitation plan was both bottom-up and top-down. Results were collected and synchronized by SP-leaders and Workpackage leaders, and content, description and detailed information were delivered by task leaders and partners in a bottom-up fashion. Also, the AIDE Core Group has acted as a continuous reviewer of the list of exploitable results, giving top-down recommendations on inclusion of missing items, etc.

The final exploitation plan document is organised as follows: In a first overview section, a brief background and motivation for the AIDE project is given, as well as an overview of the project and its main results, to indicate in what domains and to what ends AIDE results are expected to be exploitable. Then follows one section per AIDE Sub-Project. In these sections, exploitable results from each SP are listed, and summary discussions on corresponding overall exploitation plans are made. Finally, an IP-level summary is given, and conclusions are made. Detailed descriptions of all exploitable results and envisioned exploitation plans, including contact details of main contact persons for each result, are given as an annex to the report, grouped by subproject.

8.4.2.3.2 Discussion and self assessment: results versus objectives and state-of-the-art

The AIDE dissemination activities helped the project concept and results to reach an audience of more than 1000 experts participating to national and international events. This draft number, calculated by the attendance numbers of both the project's events and the events to which AIDE was presented, indicates an efficient dissemination plan and a great effort on the part of the project's consortium to disseminate as broadly as possible their research activities and results.

The impact of the project to the society and to the improvement of the road safety depends on both the dissemination effort success and the exploitation plans' accuracy and potential of market deployment. This impact remains to be assessed after the project's end, but the vast number of publications, project's events and demonstrations facilitates the understanding of the benefits of the project's results, while the exploitation plans facilitate and encourage their market integration and the later road safety improvement

8.4.2.4 WP4.3 Guidelines and Standards

Work package no.	WP4.3				
Work package name	Guidelines and Standards				
Objectives (from Description of Work)	The objective of this WP is to review and update/develop general design guidelines and standards for IVIS and ADAS interface design, based on the results from the sub-projects 1-3.				
Work package leader	BMW				
Other contractors involved	BASt; ERTICO; CERTH/HIT; ICCS; INRETS; JCI OPEL; REGIENOV; USTUTT; VTEC				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D4.3.1	Report on the review of the available guidelines and standards	PU	BASt	8
	D4.3.2	Recommendation for HMI Guidelines and Standards	PU	BASt	48

8.4.2.4.1 Work performed and key results obtained

Based on the experience gathered in the subprojects AIDE partners prepared recommendations on different fields of standardization and discussed them with experts.

The recommendations are based on the experience that was built during experiments or implementation in the AIDE working program and reflected using D4.3.1 (i.e. the review on existing standards and guidelines)

Platforms for these discussions were an international meeting with ISO WG8, working groups and forums on the European Statement of Principles.

8.4.2.4.2 Discussion and self assessment: results versus objectives and state-of-the-art

The results could be met completely as each SP could deliver a relevant contribution to its specific standardization interface. The input was prepared in a very structured way that enables the user of the deliverable to incorporate it into standardization activities.

D4.3.2 is considered to be a useful and valuable deliverable, for different “end users” (standardization WGs, researchers, MOU WGs). The two main reasonsfor the value are::

- The wide spectrum of items that are covered by the deliverable
- The depth of preparation and backup with empirical data delivered by AIDE experiments

8.4.2.5 WP4.4 Review and Asessement

Work package no.	WP4.4				
Work package name	Review and Asessement				
Objectives (from Description of Work)	To review and assess the progress of AIDE workplan towards the defined goals and objectives. To measure this progress in an as much as possible quantitative way and to give feedback to AIDE's management in order to react accordingly.				
Work package leader	ICCS				
Other contractors involved	SP leaders				
Deliverables generated	No.	Title	Dissemi-nation level	Lead contractor	Delivery month
	D4.4.1	AIDE Assessment and Evaluation Report	CO	ICCS	Every six months

8.4.2.5.1 Work performed and key results obtained

The methodology used for the Assessment task was described in detail in the internal document "AIDE Assessment and Evaluation methodology" (Doc. ID: AIDE_ICCS_WP4_R1_v5_Assessment Plan.doc).

Through the designed assessment methodology the evaluation framework to constantly monitor and assess the progress of the work of AIDE project and the level of quality of its associated achievements was specified. The proposed methodology has been originally developed for the 5th FW European Funded project COMUNICAR [IST 11595] to specify an evaluation framework to constantly monitor and assess the progress of the work of a research project and the level of its associated achievements. Moreover, the Consortium took into consideration the relevant evaluation criteria, weighting factors and thresholds used by both the 5th FW and the 6th FW programme of EU to evaluate the R&D project proposals; with which also AIDE had been evaluated. These parameters are critically reviewed and adapted to the particular AIDE issues, following a number of principles (principle of correlation, clarity, relevance, interoperability and flexibility).

The Project Assessment was carried out periodically, every 6 months, at Subproject and at IP level and its aim was twofold: on one hand to evaluate the progress of the AIDE project and on the other hand to identify possible deviations from the original workplan while the project was still in progress.

All needed input for the preparation of the assessment reports originated from the relevant SP leaders, who were responsible for the critical review of their subproject. Therefore, the assignment of the most representative mark for each criterion was set by the Sub-project leaders respectively. This was a critical task for the timely identification of possible deviations from the project's schedule and it helped raise the alarms when critical deviations were noted and focus the attention of the management team of the project on the definition of appropriate compensating measures.

8.4.2.5.2 Discussion and self assessment: results versus objectives and state-of-the-art

The task made an important contribution to the IP, with the submission of 7 assessment reports which identified the critical issues regarding the project's progress and enhanced the efficiency of the management task

8.4.3 SP-level discussion and self-assessment: results versus objectives and state-of-the-art

AIDE SP4 work packages have contributed in a number of relevant ways to the success of the overall AIDE IP. In terms of concrete results, the reports on exploitation plans and recommendations for standards/guidelines should be mentioned, and both these deliverables 1) clearly show that AIDE results overall have advanced the state-of-the-art, and 2) help maximizing the impact of AIDE results by allowing outside parties an insight into the results and into how these could be put to use. This impact-raising effect by increased external awareness has also been achieved by the high number of strong interactions with external research initiatives during the lifetime of the project, as well as by the very successful dissemination efforts. Finally, the management and coordination work packages have contributed by providing the necessary organisation, administration, monitoring and follow-up needed to ensure quality and timeliness of AIDE deliveries.

Overall, we conclude that AIDE SP4 successfully reached its objectives.

8.4.4 Recommendations on future work

It may be noted that the costs for technical and administrative coordination surpassed the allotted budget. In retrospect, it is clear that especially the need for work on internal interactions in a project of the size and complexity of AIDE is not to be underestimated, and this could be taken into account in coming EC funded research activities.

9 IP-level discussion and self-assessment: results versus objectives and state-of-the-art

To assess the results of the AIDE IP against its objectives and the state of the art, we return to the three main goals of the IP as formulated in the Description of Work (and already quoted in section 2 above):

"[…]the goal of the IP is ***to design, develop and validate a generic Adaptive Integrated Driver-vehicle InterfacE (AIDE) that...***

- *...maximises the efficiency of individual and combined advanced driver assistance systems by means of innovative, integrated and adaptive, human-machine interface concepts that prevent negative behavioural effects (e.g. under-load, over-reliance and safety margin compensation) and maximises positive effects (e.g. enhanced situational awareness), thereby enhancing the safety benefits of these systems.* ***AIDE should demonstrate significantly enhanced safety benefits compared to existing solutions."***

Relating to this goal, AIDE IP has delivered:

- Results on behavioural adaptation of drivers to ADAS systems, including recommendations on how to maximize driver acceptance in order to increase actual driver use of systems.
- Novel HMI designs, technical solutions, and actual implementations of integration of several ADAS (advanced driver assistance systems) into one in-vehicle HMI, both in virtual prototypes and in demonstrator vehicles.
- Novel HMI designs, technical solutions, and actual implementations of adaptivity of ADAS to DVE state, e.g. driver state and characteristics, both in virtual prototypes and in demonstrator vehicles.
- A rich set of DVE monitoring modules, allowing ADAS adaptivity to a wide range of different DVE state parameters.
- A clear specification of how to include ADAS in an overall architecture for and AIDE adaptive and integrated HMI.
- A significant interaction with PReVENT IP on active safety function development, resulting in AIDE and PReVENT solutions being compatible, and in a shared demonstrator vehicle (the VTEC truck).
- Empirical indications of beneficial effects on safety and acceptance of AIDE solutions for ADAS adaptivity and integration (WP1.2, WP2.1, WP3.4).

In conclusion, we would like to state that AIDE has delivered solutions that do enhance the potential safety benefits of ADAS. For a discussion on *actual* safety benefits, please see the final paragraph of this section.

- *"..reduces the level of workload and distraction related to the interaction with individual and combined in-vehicle information and nomad devices, thereby reducing the number of road accidents.* ***AIDE should demonstrate a significant reduction in the imposed workload and distraction compared to existing solutions."***

Relating to this goal, AIDE IP has delivered:

- Novel HMI designs, technical solutions, and actual implementations of strategies for resolution of HMI conflicts, both between multiple application messages and between application messages and DVE states, both in virtual prototypes and demonstrator vehicles, by means of a modular architecture and logic, and the DVE monitoring modules.
- A nomadic device gateway integrated in the functional architecture and in demonstrator vehicle implementations.
- The Nomadic Device Forum.

- Demonstrator vehicle evaluation results, indicating that the AIDE solutions for IVIS (in-vehicle information system) integration and adaptivity decrease driver distraction and allow functional growth with lower associated increases in workload.
- Also other experimental results (WP2.1 and WP3.4) indicating lower workload levels for AIDE solutions.
- The HMI evaluation results allowing the abovementioned experimental results to be obtained.

In conclusion, we would like to state that AIDE has delivered solutions that allow functional growth of in-vehicle information systems and nomadic devices, with less associated driver distraction and workload.

- *"...enables the potential benefits of new in-vehicle technologies and nomad devices in terms of mobility and comfort, without compromising safety.* ***AIDE should demonstrate that the benefits of new in-vehicle technologies could be enjoyed without increased accidents risk."***

This goal is similar to the second one, why the AIDE deliveries listed in relation to the second goal may be referenced also here. The difference is that this third goal addresses safety benefits rather than workload and distraction. Relating to the goal of demonstrating actual safety benefits, the main AIDE delivery is the WP2.3 risk assessment procedure, which has been partially applied in the demonstrator vehicle evaluation to provide some support for the hypothesis the AIDE solutions for ADAS and IVIS integration and adaptivity provided a less risky driving. However, the exact relation between distraction/workload/acceptance and traffic risk still needs further exploration. We would like to conclude that AIDE has taken one step further in this ongoing endeavour, and that AIDE has delivered solutions for which there is some indirect support for actual safety benefits, but that more work is needed to resolve this important issue.

The IP objectives text in the Description of Work continues as follows:

"Moreover, the concepts and technologies developed should have high product-feasibility in order to penetrate the market and contribute significantly towards the EC goal of 50% reduction of fatalities by 2010."

Relating to this statement, AIDE IP has delivered:

- A generic and modular AIDE system architecture, allowing quicker and lower cost development of new in-vehicle systems and HMI.
- Positive results of product feasibility benchmarking of the AIDE system architecture.
- Methods and tools for HMI evaluation, including to some extent the DVE simulation, for early and efficient evaluation of in-vehicle systems during development.

In conclusion, we would like to conclude that AIDE has delivered solutions that are product-feasible, and methods with potential for improving product development efficiency.

Finally, in addition to what has been mentioned above, it may be stated that AIDE, through various dissemination activities, has contributed to raising the general public awareness of HMI issues and their relation to safety, thus supporting the i2010 IntelligentCar Initiative's "awareness raising pillar". Awareness and common understanding of these issues have also been raised by continuous and extensive interactions with a wide range of related industrial (automotive and consumer electronics), academic (universities and research institutes) and policy making (government and standardisation bodies) stakeholders, as well as a number of related research projects on national, European and global levels. Increased awareness and common understanding are important factors in maximising the long-term take up, exploitation and impact of AIDE results. In terms of exploitation by AIDE partners, partner companies report planned AIDE HMI concepts and/or basic AIDE system solutions in product vehicles, use of AIDE methodologies in product development processes, and commercialisation of AIDE results e.g. in spin-off companies.

10 Summary of recommendations on future work

Summarising what has been said in previous sections of this document on suitable continuations to what has been studied and achieved in AIDE, some main items for future work are listed below:

- Improvement of ADAS (system and instructions to drivers) in accordance with recommendations from SP1 behavioural adaptation studies.
- Further tuning and validation of the DVE model and simulation.
- Widening the set of parameters covered by the DVE model and simulation.
- Further work on making the DVE simulation a tool that can be included in system and HMI development and evaluation processes within industry and academia.
- In the context of measuring objective indicators of workload and distraction, further clarifications on how to deal with short tasks, and how to compare tasks of different durations.
- Development of a common understanding on how to handle missing data (e.g. due to sensor limitations) in HMI evaluation experimental data analysis.
- Further work on how to measure actual safety effects of IVIS and ADAS. The AIDE risk assessment procedure provides a step forward and some tentative indications, but future studies, including e.g. large scale field trials (e.g. field operational tests) will be needed.
- Further work on how systems and their HMI should be adapted to individual drivers, as recommended e.g. from SP1 behavioural adaptation studies.
- HMI integration and adaptivity strategies and solutions for primary task systems, i.e. ADAS and automation systems deserve further attention in addition to what has been achieved in e.g. AIDE and PReVENT.
- In terms of secondary task systems, a main area for future efforts should be integration nomadic devices and other third party systems. Preferable HMI strategies for integration of third party systems are not yet well known, although AIDE has provided some example solutions. Corresponding technological developments for interfacing is also an important focus, in current product development as well as in research looking beyond current integration solutions.
- Exploitation of AIDE results by AIDE partners and others. See section 5 and D4.2.6, the AIDE “exploitation plan”, for more details.

11 Conclusions

In this final activity report of the AIDE Integrated Project, we have described the objectives of the project, and described how work towards these objectives was organised. We have also given an overview of the main results, and how they relate to the state of the art. Further condensing what has been said above, the following is a list of the main contributions of the AIDE Integrated Project:

- Experimental results on behavioural effects of ADAS
- Theoretical DVE model
- DVE simulation
- Tools and methods for evaluation of HMI
- AIDE methodology for evaluation of HMI
- AIDE HMI architecture and logic
- Nomadic device integration gateway
- The Nomadic Device Forum
- DVE monitoring modules
- Prototype vehicles and HMI
- Prototype evaluation results
- Recommendations for standards and guidelines on adaptive and integrated HMI

We have also discussed these results in terms of their impact on traffic safety and European economy, and would like to conclude that the generated AIDE results assist in making the currently ongoing in-vehicle functional growth manageable, by improving the in-vehicle HMI to cause less workload and distraction, provide increased driver comfort and system acceptance, and doing so with reduced development cost and time for industry. Also, awareness and understanding of HMI and safety issues has been raised among policy making bodies, assisting these bodies in the creation of appropriate policies, guidelines and standards. Further, AIDE has, through its dissemination activities been contributed to raising understanding and awareness of HMI and safety issues also among the general public, and this taken together with the system and HMI improvements made possible by AIDE in terms of decreased driver workload and distraction, and increased acceptance of systems (leading to increased driver use of e.g. safety systems) has a great potential for leading to driver behaviour which is actually safer.

Overall, we consider that the AIDE Integrated Project has been able to successfully reach its objectives, although some further work remains within some of the areas the project set out to explore. These have also been listed in this report. One area for future work where AIDE did not get as far as hoped for is the challenge of how to translate observed driver behaviour to actual traffic safety.

In final conclusion, we note that the AIDE Integrated Project has been able to generate knowledge and develop solutions that have considerably advanced the state of the art in the field. This knowledge and these solutions have good potential for contributing to improved competitiveness of European vehicle industry, improved mobility and productivity, and improved road traffic safety.

12 References

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See section 7 of this report for a complete listing of AIDE reports and other AIDE deliverables.