# Sub-Project 3: Design and Development of an Adaptive Integrated Driver-Vehicle Interface

Angelos Amditis, ICCS

Luisa Andreone, CRF

# Sub-Project 3 Overview



**General Objective**:

***Design, develop and demonstrate an adaptive integrated driver-vehicle interface.***

**Key activities**:

- **Technological benchmarking** and definition of **scenarios and use cases.**
- **Requirements and specifications.**
- **System architecture** definition.
- **Design** of the adaptive integrated interface.
  - Multimodal HMI and integration of nomadic systems.
  - Intelligence for Interaction Management (Interaction and Communication Assistant).
- Development of **driver-vehicle-environment state (DVE) monitoring modules** (to enable adaptivity).
- **Prototype vehicles** development.

# Sub-Project 3 Partners



**SUBPROJECT 3: DESIGN AND DEVELOPMENT OF AN ADAPTIVE AND INTEGRATED DRIVER – VEHICLE INTERFACE**

| Leader: | Industrial Vice Leader: |
|---|---|
| Institute of Communications and Computer Systems (ICCS) | Centro Ricerche FIAT (CRF) |

| | | |
|---|---|---|
| BMW | BOSCH | ICCS |
| CRF | MOTOROLA | INRETS |
| FORD | NUANCE | KITE |
| OPEL | SV | TNO |
| PSA | TELENOSTRA | USTUTT |
| REGIENOV | CTAG | VTT |
| SEAT | CERTH/HIT | ERTICO |
| VTEC | DIBE | |

**23 Partners!**

- 8 OEMs
- 5 Suppliers
- 7 Institutes
- 2 SMEs

# AIDE SP3 Innovation

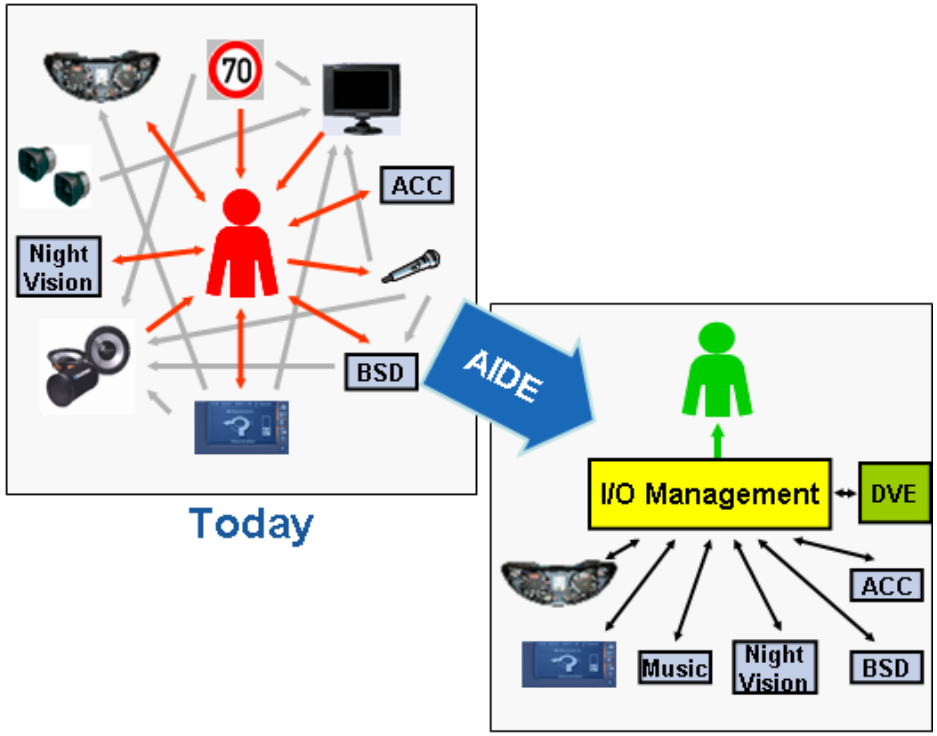


- Integrated management of all messages and input/output devices within the car interior.
- Dynamic information management.
- Adaptive User Interface (UI).
- Personalisation.
- Real-time monitoring driver/vehicle/environment.
- All traffic scenarios functionality.
- Common architecture.
- New input/output devices.
- Nomadic devices integration.

# The AIDE SP3 approach

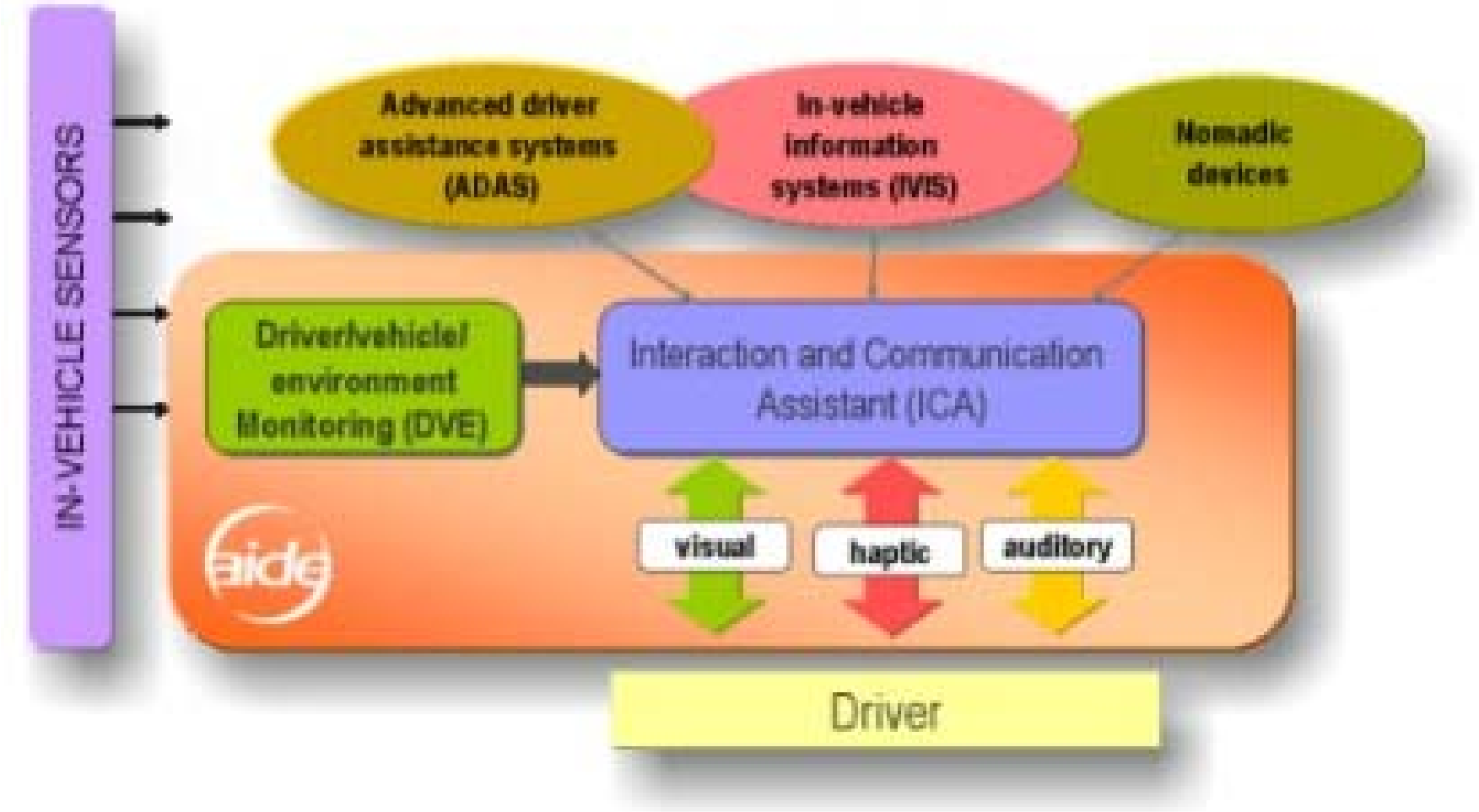
**Key issues:**

- Prevent interference between I/O events.
- Adaptation to the driver state and /or the driving situation (DVE).
- Integration of nomadic devices.
- Exploit synergies (reduce HW costs, enhance performance).



# The AIDE System



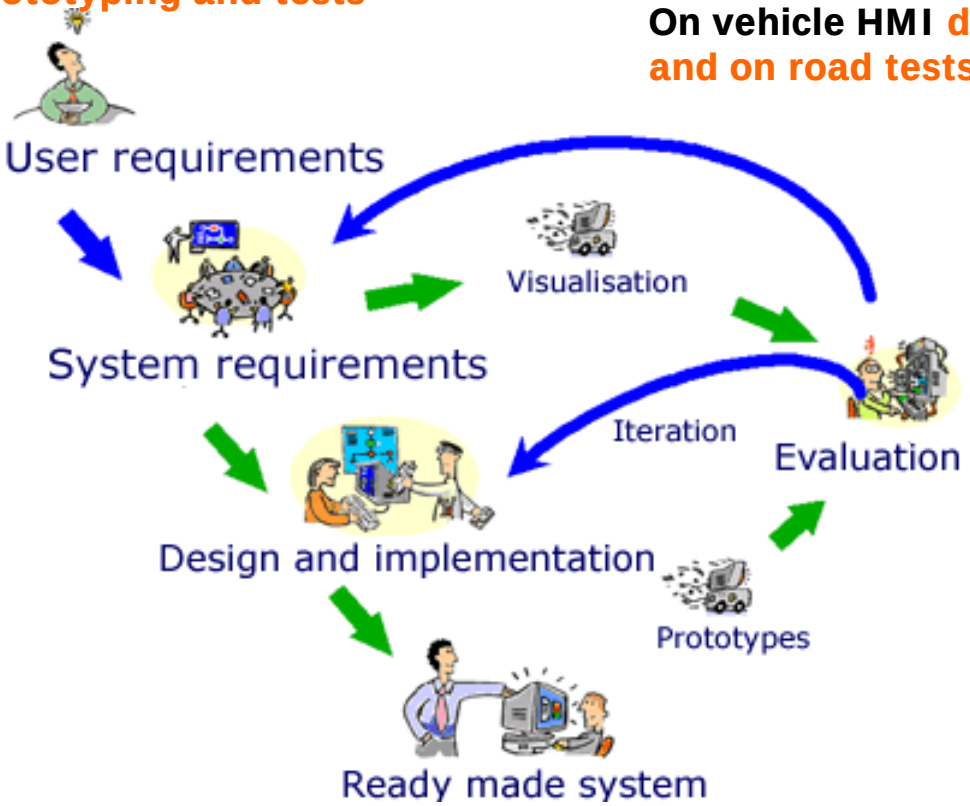


# User centered design (UCD) approach



**HMI virtual prototyping and tests**

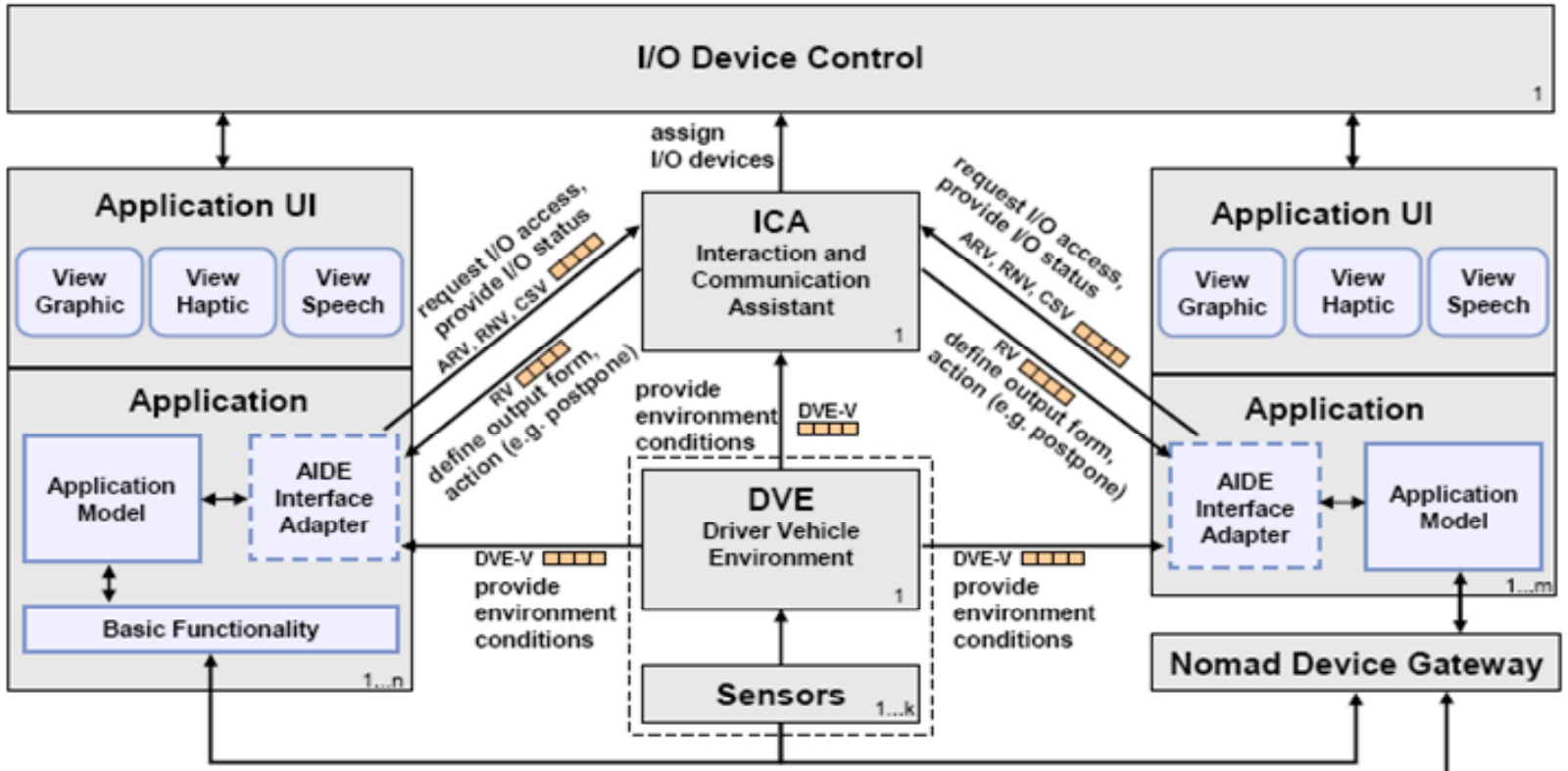
**On vehicle HMI design, implementation and on road tests (real scenario, test track)**




**HMI mockups tests on dynamic and static driving simulators**

# AIDE Functional Architecture






**ARV:** Each application has to request the access to I/O devices by an **Application Request Vector** sent to the ICA.

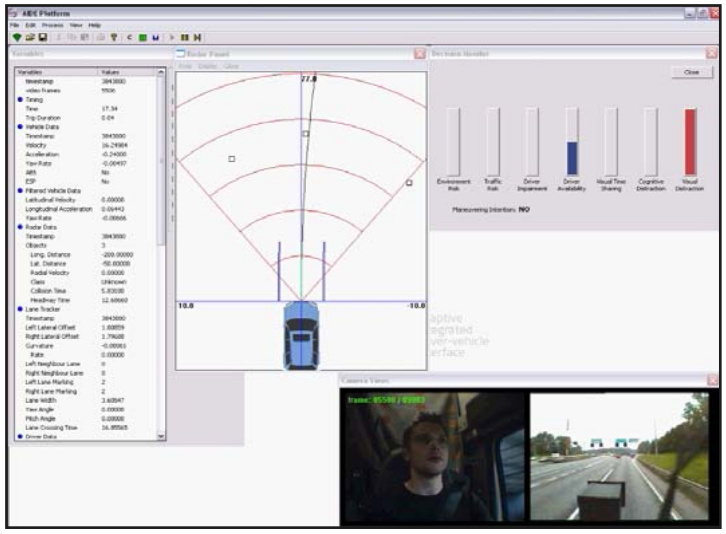
**RV:** The **Reply Vector** defines the form to be chosen for output and the action e.g. postpone, terminate.

**RNV:** The **Request No more valid Vector** informs the ICA about the device status.

**DVE Vector:** The **Driver Vehicle Environment Vector** informs the ICA and the application on the Detected DVE conditions.

# The Driver – Vehicle – Environment (DVE) modules





**Objectives**:

***Design and development of innovative adaptive interface functions and driver-vehicle-environment monitoring techniques for enabling real-time interface adaptivity.***

Five modules have been developed and integrated to the AIDE system, in order to assess the *Driver-Vehicle-Environment (DVE)* status:

- Traffic and Environment Risk Assessment Module (**TERA**): estimates in real time the total level of risk related to traffic and environmental parameters.
- Driver Characteristic module (**DC**): defines and estimates the driver typical profiles.
- Driver Availability Estimator (**DAE**): analyses the primary task activities.
- Driver State Degradation (**DSD**): monitors the driver's fatigue and hypo-vigilance.
- Cockpit Activity Assessment (**CAA**): assesses the availability effects of a secondary task.

# Interaction and Communication Assistant (ICA)

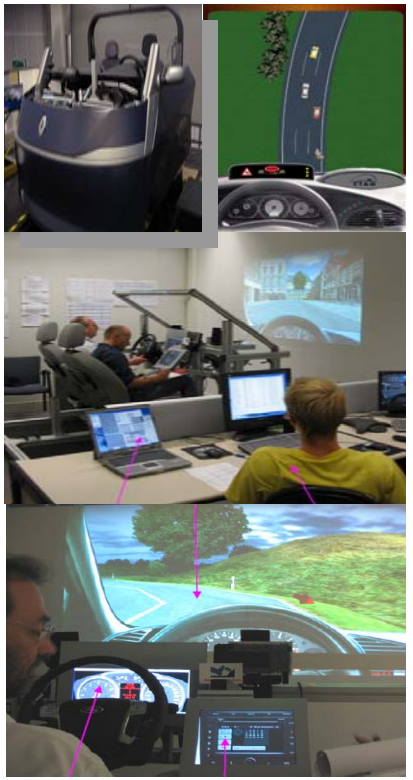


***Manages all interactions between the driver and the various in-vehicle systems in order to:***

- ***avoid the negative impact of the information sources on the driving task (e.g. distraction and information overload);***
- ***avoid interference between different pieces of information.***

The management functions include:

- Definition of what type of information should be delivered, when and how.
- Adaptation to the driver and to the environment.
- Personalisation of the adaptive HMI to the individual driver.

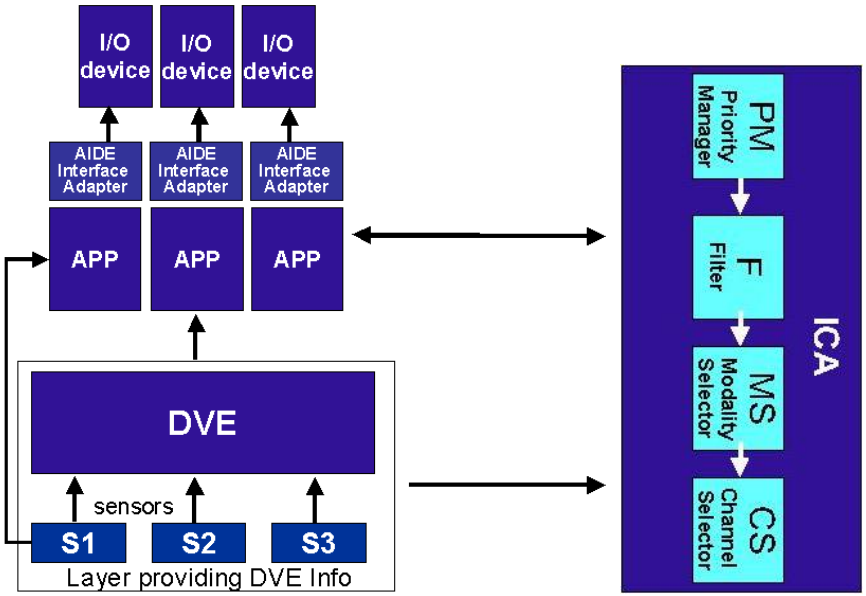


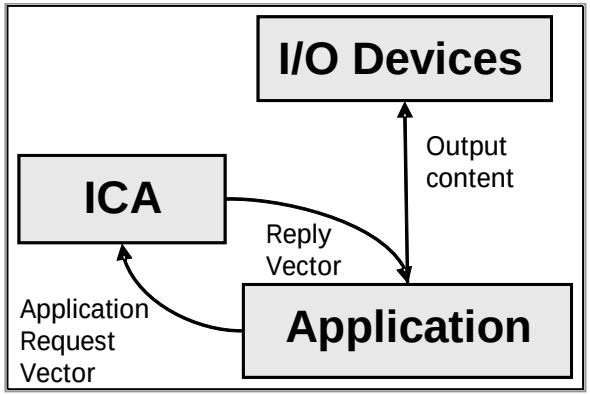
# Interaction and Communication Assistant (ICA) – The logic



An “application request vector” is sent by an application to the ICA each time an information has to be dispatched

- **Priority Manager:** assigns a priority level to all the messages to be displayed according to the parameters describing each action generated by the applications;
- **Filter:** filters the incoming information according to the DVE conditions and decides if and when it will be provided to the driver (display now/delay);
- **Modality Selector:** applies the adaptation strategy to select the best modality to provide the information to the driver according to the DVE conditions;
- **Channel Selector:** manages the allocation of the I/O channels according to the action’s priority (in case of concurrent actions) and the status of the availability of the I/O devices.



# Input/Output Devices

***I/O Device Controls in the AIDE system:***

- LCD displays.
- Head-up displays (HUD).
- Haptic input/outputs.
- Loudspeakers or buzzers.
- Speech recognition system and TTS-engine.

# Nomadic Devices

AIDE explored a number of issues related to Nomadic devices use by drivers:

- Safety issues raised by the introduction of the Nomadic Devices in the vehicle.
- Integration of Nomadic Devices and definition of a gateway concept.
- Functional and Technical requirements both from OEMs but also from device manufacturers point of view.

→ **The AIDE Nomadic Forum:** a success story!

# Integration of Nomadic Devices in the AIDE system



***Nomadic Device Gateway:***

- The integration of nomadic devices uses the AIDE Nomadic Device Gateway to connect to the in-vehicle system.
- The functionality of the nomadic 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 nomadic device functionality via the AIDE gateway that provides access to the I/O devices.

# AIDE Vehicle Prototypes

FIAT Croma

SEAT León

VOLVO FH12

# AIDE Vehicle Prototypes



- Prove the technical feasibility of the AIDE system design.
- Use the flexibility of the AIDE system to prove that different individual solutions can be obtained within the AIDE system solution.
- Demonstrate the AIDE functionality.
- Provide test vehicles for the AIDE system evaluation.

*The three demonstrators have implemented the entire AIDE system including:*

- Adaptive HMI.
- I/O devices.
- Driver Vehicle Environment (DVE) modules.
- Interaction and Communication Assistant (ICA).
- Nomadic device gateway.

→ Existing in-vehicle functions as well as some real or simulated additional functions have been integrated in the AIDE system solution.

# Conclusions

- AIDE **improves driver - vehicle interaction in terms of distraction and usability**.
- AIDE reduces negative **effects of HMI interdependences** preventing interference among different messages.
- AIDE assesses **driving situation** and **driver state to adapt the HMI**.
- AIDE integrates **nomadic devices** in the in-vehicle HMI.
- AIDE solutions allow **OEM / vehicle specific design choices**.
- AIDE prototype vehicles **integrate a number of HMI components** that are also deployable separately.
- AIDE prototype vehicles' setups **implement AIDE type adaptivity and integration features**.

# Experience our results...



***Demonstrators:***

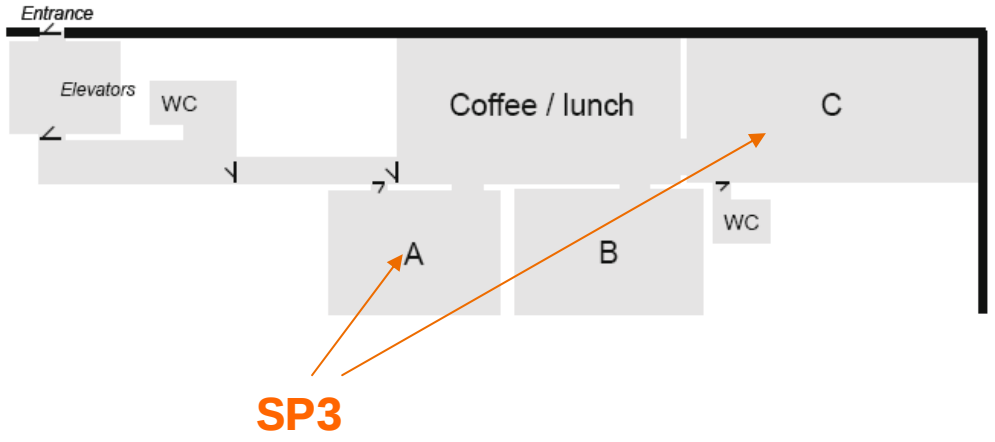
- Volvo truck demonstrator.
- FIAT demonstrator.
- SEAT demonstrator.

***Demos:***

- Truck simulator showing AIDE/PReVENT integration.
- DVE platform.
- Nomadic Device Gateway.
- Speech I/O Device.
- ICA Strategies Evaluation.
- Driver State Degradation module.
- Driver's Availability Estimator.
- HMI Virtual Prototype.

***Posters:***

- AIDE Architecture.
- Traffic and Environment Risk Assessment module.
- Cockpit Activity Assessment module.
- Driver Characteristics module.
- Interaction and Communication Assistant.
- Haptic Barrel Key.
- Haptic Seat.



# Thank you for your attention!


***Angelos Amditis***

**email: a.amditis@iccs.gr**
**phone: +30 210 772 2398**
**fax: +30 210 772 3557**

***Luisa Andreone***

**email: luisa.andreone@crf.it**
**phone: +390119083071**
**fax: +39 011 9083083**


**AIDE Integrated Project web site: www.aide-eu.org**

# Sub-Project 3
# Work-Packages



- WP 3.0 Subproject management (ICCS)
- WP3.1 Technological Benchmarking and Use Cases (SEAT)
- WP3.2 Specifications and System Architecture (BOSCH)
- WP3.3 Driver-Vehicle-Environment (DVE) Monitoring Modules (ICCS)
- WP3.4 Adaptive Interface Design and Development (CRF)
- WP3.5 System Integration and Technical Verification (VTEC)

# Sub-Project 3 Work-Packages

- **WP 3.0 Subproject management (ICCS)**

**Objectives**

- *To lead the sub-project, co-ordinate the work of the different work packages*
- *To liaise and interface the sub-project to the other sub-projects and the IP management*

- WP3.1 Technological Benchmarking and Use Cases (SEAT)
- WP3.2 Specifications and System Architecture (BOSCH)
- WP3.3 Driver-Vehicle-Environment (DVE) Monitoring Modules (ICCS)
- WP3.4 Adaptive Interface Design and Development (CRF)
- WP3.5 System Integration and Technical Verification (VTEC)

# Sub-Project 3 Work-Packages

- WP 3.0 Subproject management (ICCS)

- **WP3.1 Technological Benchmarking and Use Cases (SEAT)**

**Objective**

- *To perform the initial "pre-study" activities that provide the basis for the development work in SP3, focusing on performing (1) benchmarking of AIDE related technologies and (2) identifying scenarios*

***Tasks***

- *T3.1.1 Technological Benchmarking and User Expectations*
- *T3.1.2 Scenarios and use cases*

**Main results**

- *Technical benchmarking results*
- *Nomad devices workshop minutes*
- *Scenarios and use cases definition*

- WP3.2 Specifications and System Architecture (BOSCH)
- WP3.3 Driver-Vehicle-Environment (DVE) Monitoring Modules (ICCS)
- WP3.4 Adaptive Interface Design and Development (CRF)
- WP3.5 System Integration and Technical Verification (VTEC)

# Sub-Project 3 Work-Packages

- WP 3.0 Subproject management (ICCS)
- WP3.1 Technological Benchmarking and Use Cases (SEAT)

- **WP3.2 Specifications and System Architecture (BOSCH)**

**Objective**

- *Specify the technical functional requirements for the different components and functions of the AIDE system, including 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*

**Tasks**

- T3.2.1 Requirements and specifications
- T3.2.2 In-vehicle integration requirements
- T3.2.3 System architecture

**Main results**

- *Requirements and specifications for HMI and safety functions*
- *Data flow protocol and system architecture definition and design*
- *System architecture*

- WP3.3 Driver-Vehicle-Environment (DVE) Monitoring Modules (ICCS)
- WP3.4 Adaptive Interface Design and Development (CRF)
- WP3.5 System Integration and Technical Verification (VTEC)

# Sub-Project 3
# Work-Packages



- WP 3.0 Subproject management (ICCS)
- WP3.1 Technological Benchmarking and Use Cases (SEAT)
- WP3.2 Specifications and System Architecture (BOSCH)

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

**Objective**

- *Develop techniques for real-time monitoring of the driver-vehicle-environment state, in order to enable real-time adaptation of the driver vehicle interface.*

**Tasks**

- *T3.3.1 Real-time sensor set definition and development*
- *T3.3.2 Traffic and environment risk assessment module*
- *T3.3.3 Driver characteristics module*
- *T3.3.4 Driver availability estimator and driver state degradation module*
- *T3.3.5 Cockpit activity assessment module*
- *T3.3.6 Definition and development of DVE monitoring outputs*
- *T3.3.7 DVE monitoring modules verification and functionality tests*

**Main results**

- *Prototype versions of DVE monitoring modules*
- *Verified DVE monitoring modules*

- WP3.4 Adaptive Interface Design and Development (CRF)
- WP3.5 System Integration and Technical Verification (VTEC)

# Sub-Project 3
# Work-Packages



- WP 3.0 Subproject management (ICCS)
- WP3.1 Technological Benchmarking and Use Cases (SEAT)
- WP3.2 Specifications and System Architecture (BOSCH)
- WP3.3 Driver-Vehicle-Environment (DVE) Monitoring Modules (ICCS)

- **WP3.4 Adaptive Interface Design and Development (CRF)**

**Objective**

- *Design, develop and technically verify the adaptive integrated driver-vehicle interface components and functions.*

**Tasks**

- *T3.4.1 HMI design and virtual prototyping,*
- *T3.4.2 Development of user interface layout*
- *T3.4.3 Development of I/O devices,*
- *T3.4.4 Prototype nomadic device integration and validation tests*
- *T3.4.5 Interaction and Communication Assistant*
- *T3.4.6 HMI technical and functional verification*

**Main results**

- *Interaction, communication and harmonisation plan*
- *HMI components (displays, HUDs, speech I/O, sound etc,)*
- *Guidelines for safe Integration of NOMAD devices within the vehicle environment*
- *Technically verified adaptive integrated driver-vehicle interface in simulator*
- *Validated adaptive integrated driver-vehicle interface*

- WP3.5 System Integration and Technical Verification (VTEC)

# Sub-Project 3
# Work-Packages



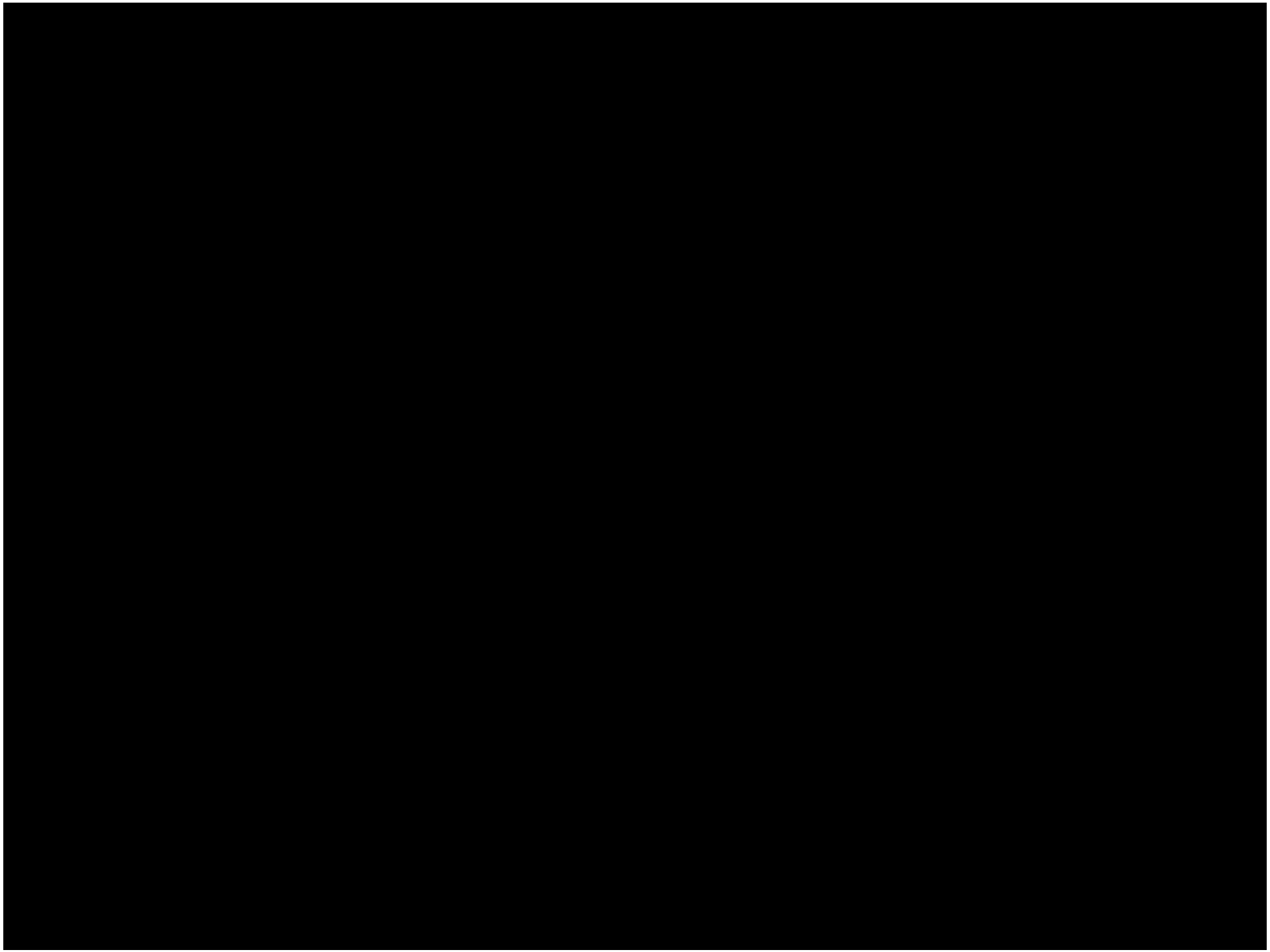
- WP 3.0 Subproject management (ICCS)
- WP3.1 Technological Benchmarking and Use Cases (SEAT)
- WP3.2 Specifications and System Architecture (BOSCH)
- WP3.3 Driver-Vehicle-Environment (DVE) Monitoring Modules (ICCS)
- WP3.4 Adaptive Interface Design and Development (CRF)
- **WP3.5 System Integration and Technical Verification (VTEC)**

**Objective**

- *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.*

**Tasks**

- *T3.5.1 System integration*
- *T3.5.2 Technical verification*
- *T3.5.3 Optimisation and support of AIDE system*

**Main results**

- *Three technically verified prototype vehicles*