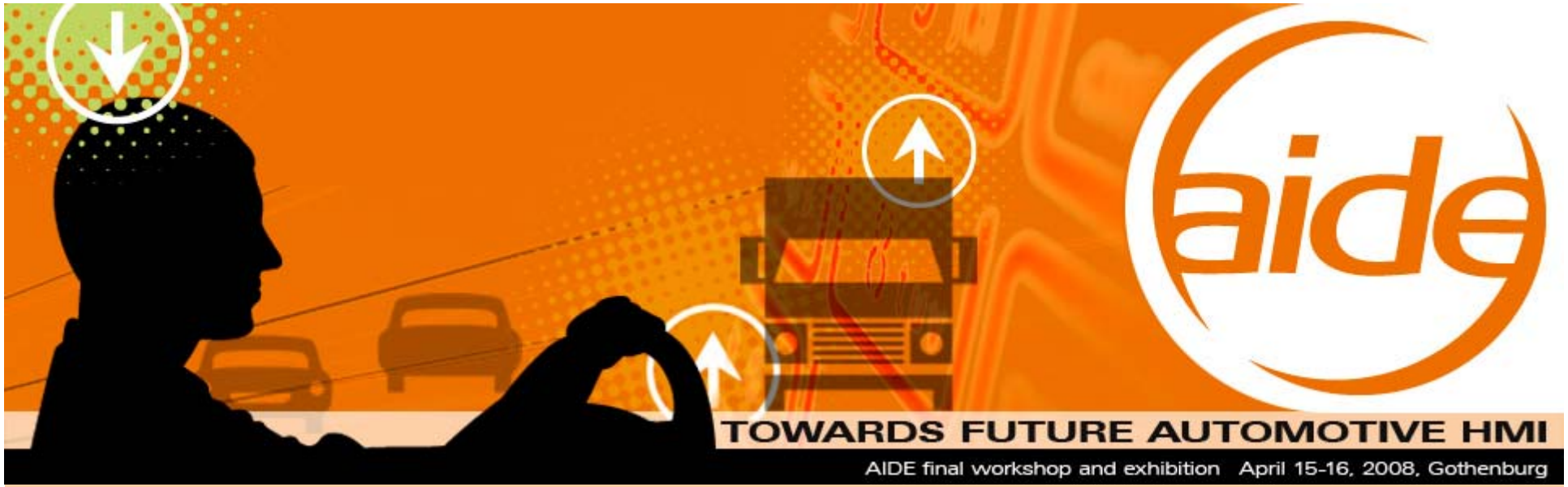

Sub-project 1

Behavioural Effects and

Driver-Vehicle-Environment Modeling

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

Objectives:

- to create a model for **Driver, Vehicle and Environment** (DVE) aimed at predicting Drivers' behavior according to different driver, vehicle and environment conditions;
- to experimentally study **short term and long term behavioral effects** when using various driver support systems, for inclusion in the design process of the system and its interfaces;
- to implement and validate a **software numerical simulation** of the DVE (SSDrive)

Key activities:

- **Empirical studies** on behavioral effects of ADAS/IVIS (learning, behavioral adaptation etc.)
- **Modeling and simulation** of the DVE system

SP1 partners

PSA PEUGEOT CITROËN

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SP1 Work Packages

WP1.1

DVE Model

Modelling Algorithms :
- Task Analysis;
- Independent Variables
- Parameters
- Error Generation

WP1.2

Field Experiments on Behavioural Adaptation

Effects of adaptation :
- Short vs. Long term;
- Parameters affected by adaptation
- Specific affects of ADAS and IVIS

WP1.3

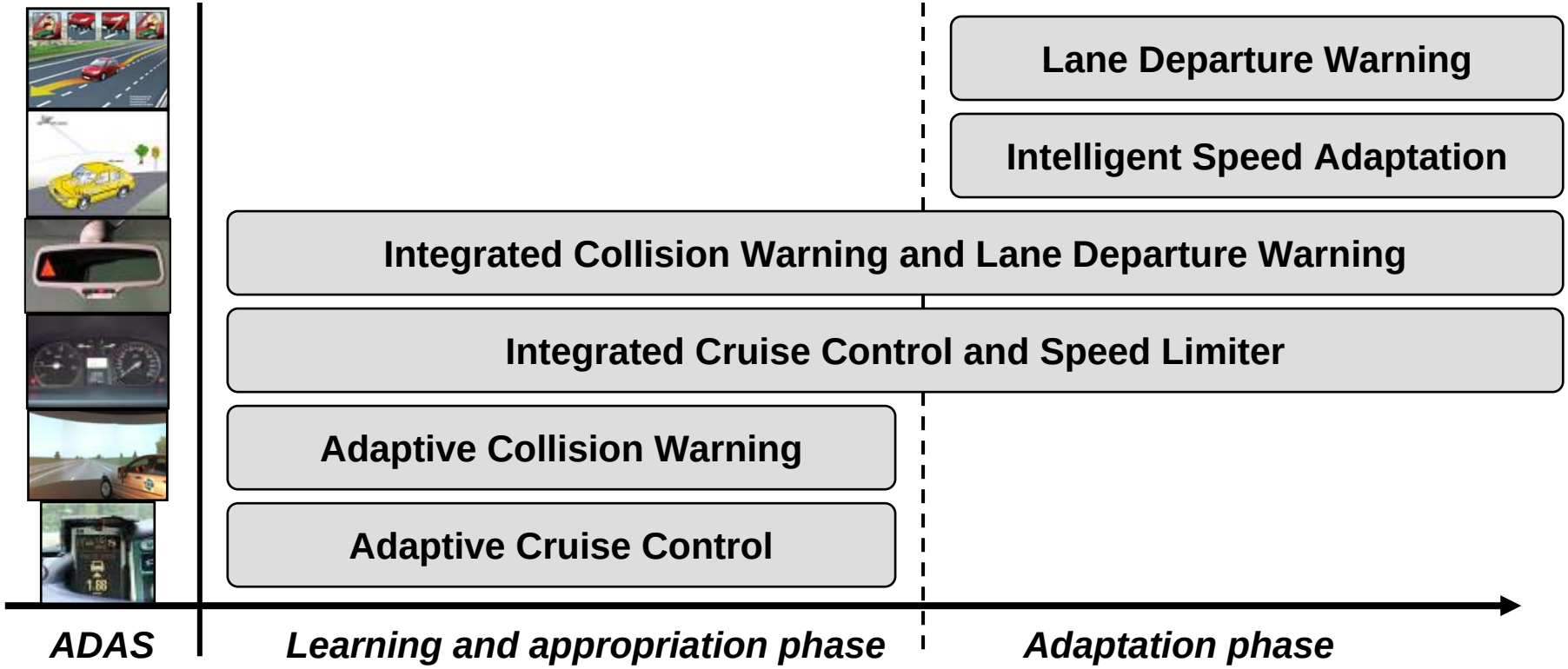
DVE Simulation

Simulation characteristics :
- Software Language;
- DVE implementation (Agents, BB, etc.)
- Special correlations (Control Theory, Fuzzy, Neural networks, etc.)

Overall– DVE – Predicting Model/Simulation

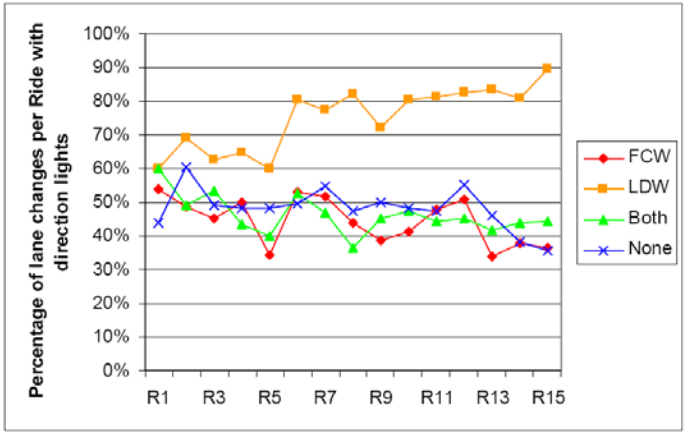
Behavioral effects of Driver Assistance Systems

- Short term and long term behavioral effects when using various driver support systems, for inclusion in the design process of the system and its interface.



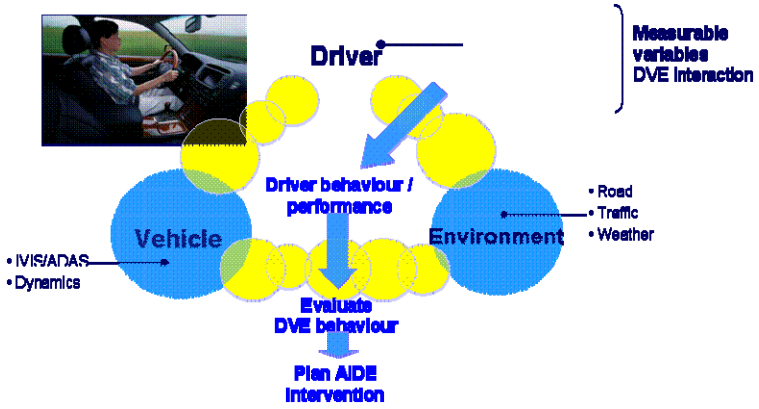
Behavioral effects of Driver Assistance Systems: some results

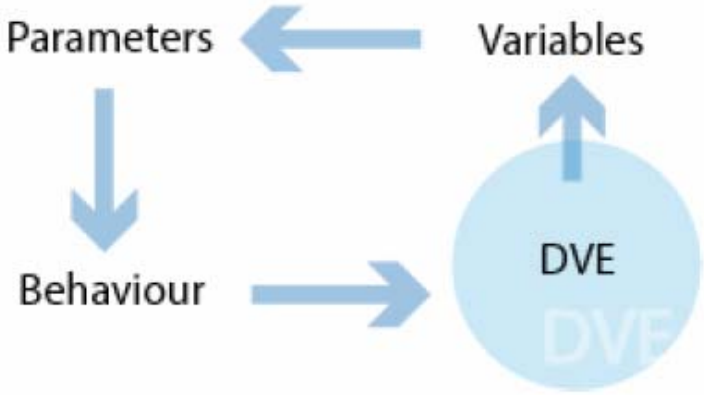
- **Frontal collision Warning**
  - Decreased the time spent in short headway (learning effect)
- **Lane Departure Warning (LDW)**
  - Less variation of lateral position
  - More attention in lane position
  - More use of indicators
- **Frontal Collision & Lane Departure Warning (FCW & LDW)**
  - Increased time spent in short headway
  - Warnings should be integrated and prioritized



DVE framework

- Theoretical model for predicting dynamic Driver-Vehicle-Environment (DVE) interactions

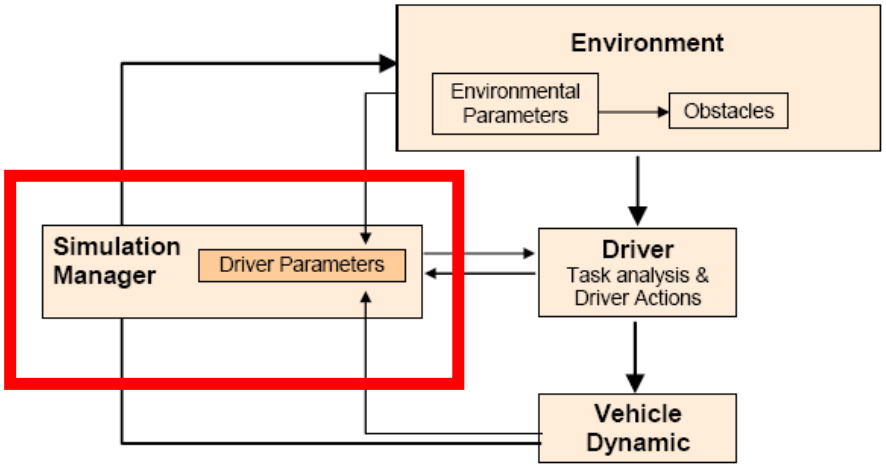


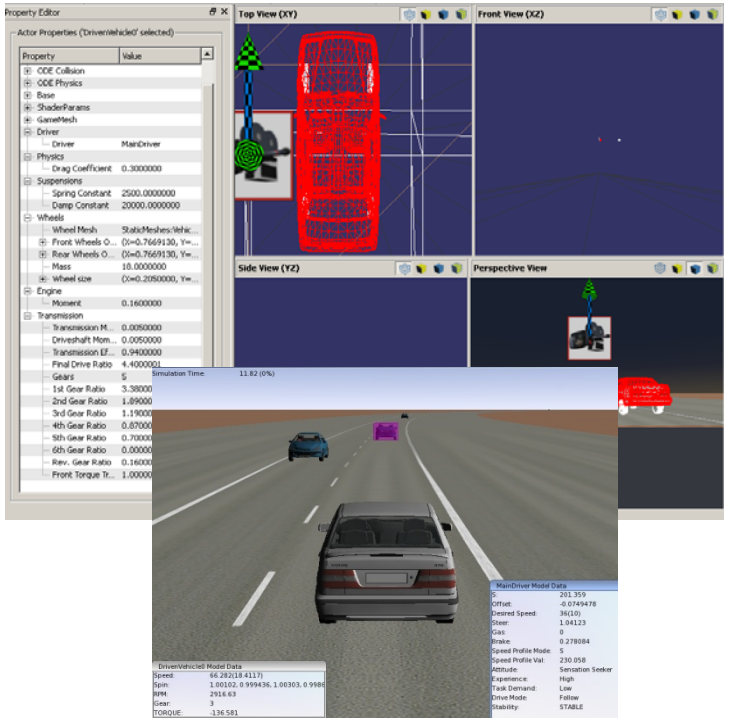


- Driver modeling is based on five main parameters: attitude, experience, task demand, situation awareness, driver state
- Driver modeling is interacting with Vehicle and Environment models

From the DVE model to the SSDrive tool

- The Driver Vehicle Environment system has been implemented in a software numerical simulation named **SSDrive** (Simple Simulation of Driver).



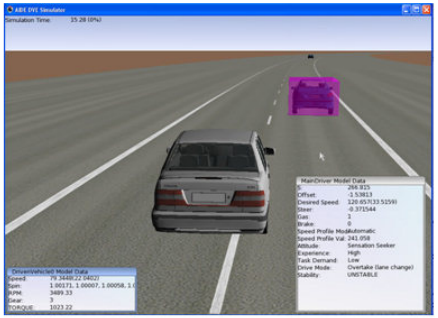


Example of use case implemented in SSDrive

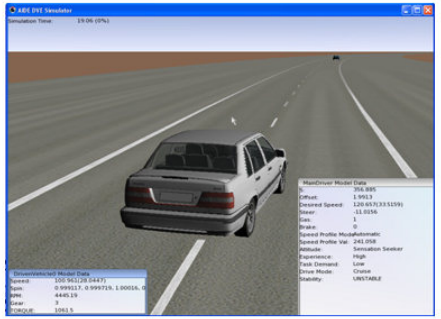
- **SSDRIVE: Driver behaviour set, namely: Attitude = Prudent, Task Demand = Medium, Experience = High**

a. Simulation at time 9,84 s.

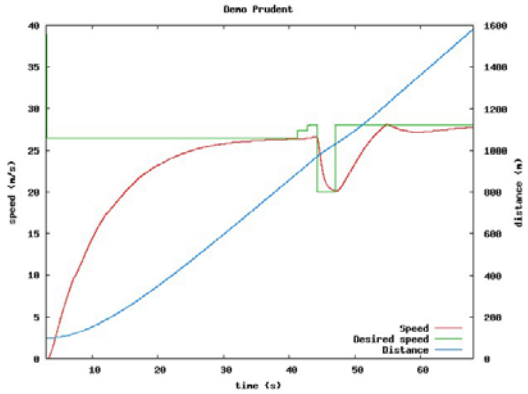
b. Simulation at time 11,82 s.

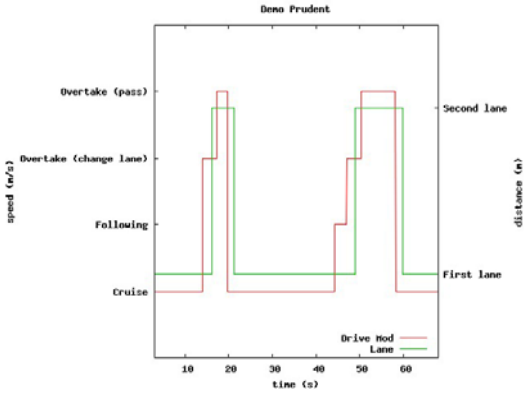


c. Simulation at time 15,28 s.



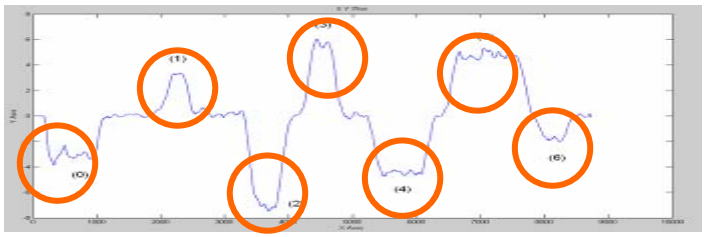
d. Simulation at time 19,06 s.



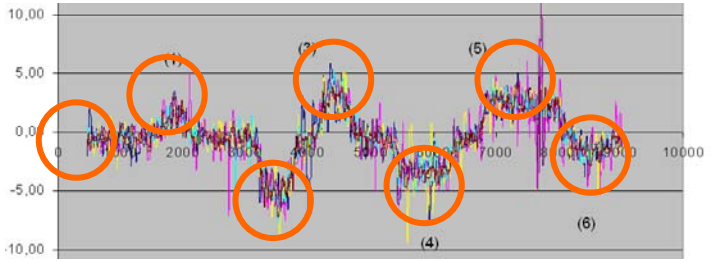


VTI data for SSDrive validation

- To validate SSDrive parameters VTI simulator tests have been carried out
- Observed data have been compared with SSDRIVE predictive simulation and good match had been found



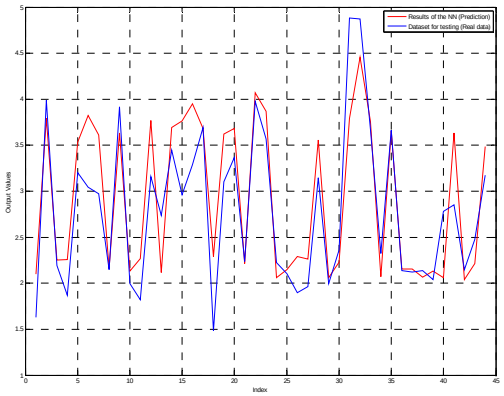
Predicted *steering angle (deg) vs driven distance (m)*



Observed *steering angle (deg) vs driven distance (m)*

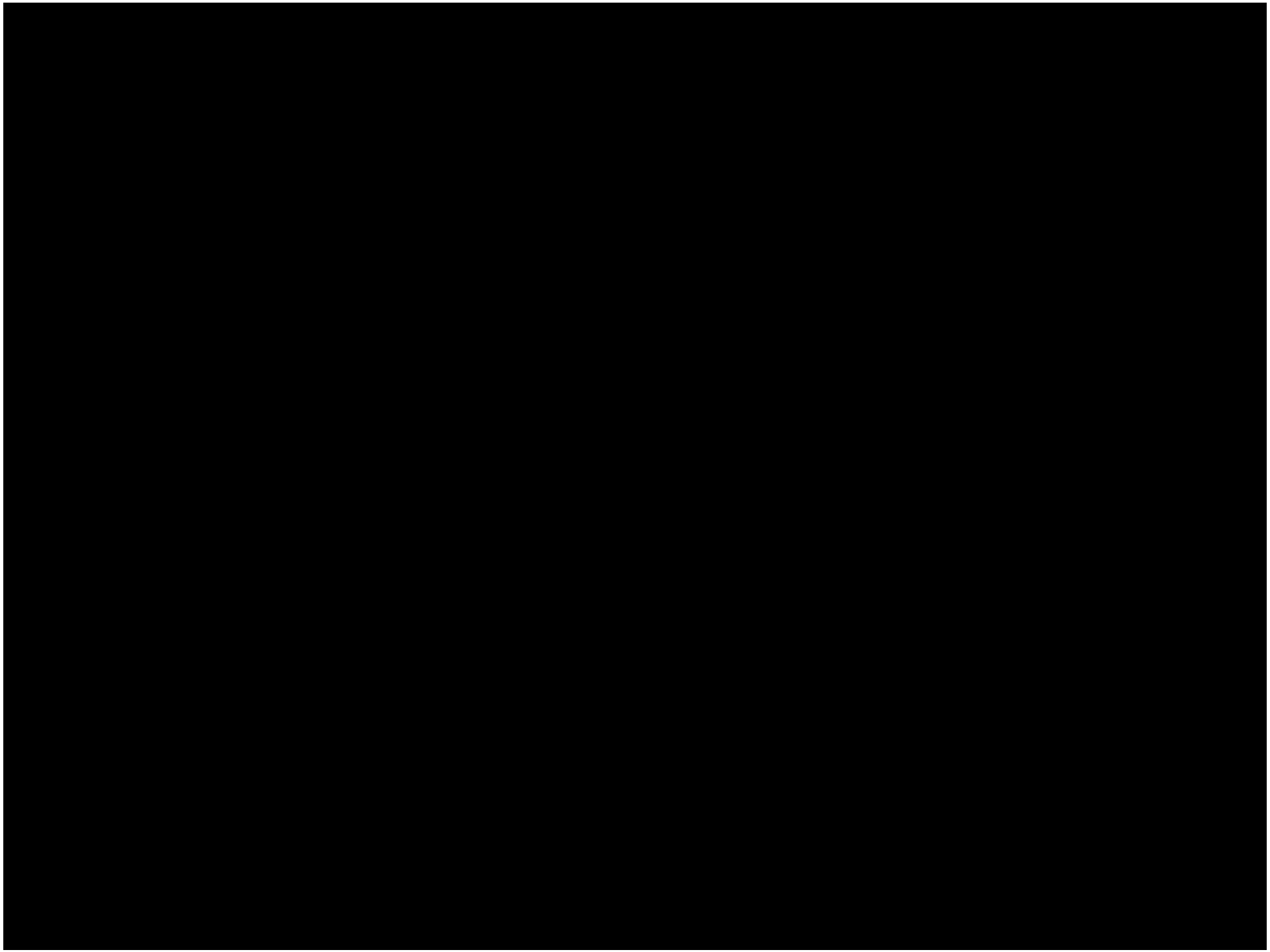
Task Demand and Distraction tuning and validation

- Task Demand and Distraction drivers' parameters have been modeled following a machine learning approach
- An experiment on UNIMORE driving simulator has been conducted to have real data and to validate these parameters
- A good matching has been found between models' prediction and real data and the models can be considered as validated



Task Demand and Distraction viewer

- Task Demand and Distraction viewer has been developed

Conclusions

- A theoretical model for Driver, Vehicle and Environment (DVE) has been developed
- A wide set of experimental studies on short term and long term behavioral effects when using various driver support systems has been carried out, results have been included in the modeling process and they also represent a relevant background for the design of these systems
- A software numerical simulation (SSDrive) has been developed and validated, including peculiar drivers' behavior parameters as task demand and distraction
- DVE model and its implementation in SSDrive system could allows OEM and suppliers to analyze drivers' behaviour in different driving environments, and to observe how the secondary task (e.g. in interaction with on-board systems) can have an impact on the driving. More rapid tests and analysis could therefore possible.