Key data

- **Integrated project:** ICT 2007.6.1, project no. 212154
- **Start:** 01 February 2008
- **End:** 31 July 2011
- **Budget / funding:** 28 M€ / 17 M€
- **Consortium:**
Improvement of safety and environment by

Highly automated vehicle applications supporting the driver in overload and underload situations built on

- The joint system driver – co-system selecting the appropriate degree of automation depending on driving situation and driver state and
- The safe vehicle architecture with migration concept supporting also by-wire-applications
Motivation: Driving is a strategic task

- **Goal:** Driving from A to B

- **Strategy:**
  Select optimal route
  - Duration, start time
  - Fuel consumption
  - Topology, weather
  - Road costs
  - etc.

- **Tactics/execution:**
  Take appropriate action
  - Obey rules
  - Avoid/minimize risks
  - “Local” solution or start strategy process

Take into account
  - Experience
  - Digitized Map
  - Traffic information
Highly automated driving is the key

- Both extreme positions in the automation spectrum are not desired
  - Pure information providing functions will increase accident probability by distracting the driver
  - Fully autonomous systems require a second, independent road network

- Selective automated driving is the key to enhance road safety
  - Keeping the driver appropriately in the loop (enhancing system acceptance)
  - Handing over command to driver if system can not deal with the situation
  - Assist the driver or even take control if driver can not handle the situation

- Automated Driving is a “dual use” technology
  - It will also serve environmental protection
  - Less traffic jams by steady flow, no disturbance injection
  - In future even lighter vehicles, virtual safety zone will make energy absorbing elements obsolete
Mission and technical objectives

Make driving more convenient and enjoyable by a driver centric, context sensitive automation (both in monotonous and tedious driving situations and in complex driving environment like roadworks), thereby increasing traffic safety.

Technical objectives

• Provide technologies for situation awareness (driving scene, vehicle state, driver state)
• Develop effective and efficient algorithms to define maneuvers and trajectories
• Decide on the optimum automation level (task repartition driver – automation)
• Develop suitable HMI concept
• Elaborate safe vehicle architecture
• Show new capabilities and functions in seven demonstrator vehicles (passenger cars, trucks and bus)
Demonstration vehicles

- Safety and functional architecture applications
  - Joint system demonstrator (DLR German Aerospace Center)
  - Brake-by-wire truck (Haldex / Volvo Technology)
  - Architecture migration demonstrator (Continental Automotive)

- Highly automated functions for use on public roads
  - Automated assistance in roadworks and congestion (Continental Teves)
  - Automated queue assistance (Volvo Technology)
  - Temporary auto-pilot (Volkswagen)
  - Active green driving (Volvo Technology)
The four HAVEit Layers

C1: Perception layer for real-time scene recognition
C2: Command layer to define maneuver, trajectory and automation level and to generate the motion control vector
C3: Execution layer to perform the motion control vector
C4: HMI layer to assess the driver state and to integrate the driver in the automation loop
Optimized task repartition

- Driver performance degrades in underload and overload situations: That can lead to a higher risk of accidents
- Direct and indirect measures to assess the driver state are implemented in the HAVEit joint system
- The mode selection and arbitration unit of the joint system organizes a dynamic task repartition to support the driver with the optimal level of assistance and automation
Mode selection and arbitration unit (MSU), automation levels

- **Driver assisted:**
  - Combination of "driver only" and "assisted"
  - State of the art, e.g. LDW
- **Semi-automated:**
  - Driver assisted plus longitudinal control
  - State of the art, e.g. ACC, Stop & Go, Collision Mitigation
- **Highly automated:** Integrated longitudinal and lateral control
- **Fully automated:** Substitution of the driver, not in the scope of HAVEit
- **Key parameters to determine the optimum automation mode:**
  - Real-time scene recognition
  - Driver wish and driver state (drowsiness, distraction)
  - Vehicle state
Direct driver state assessment

Driver state

- alertness
  - Fatigue/drowsiness
  - Driver monitoring: direct, indirect

- attention
  - distraction
  - Driver monitoring: direct, indirect

Reconstruction of driver’s state

Drowsiness:
- Sleepy
- Drowsy
- Slightly drowsy
- Alert

Distraction:
- Inattentive
- Attentive
**Indirect driver state assessment**

- Driver’s activity and driving performance correlate with increasing drowsiness and distraction
- Plot shows result achieved over a 5 hours drive in a driving simulator study

**Fusion of direct and indirect driver state assessment**

- Fusion is based on state and confidence parameters
Interaction design

- Design approach:
  - Design sessions in the theater system of DLR

- Main design questions:
  - Behavior of automation for different use cases
  - Visual, acoustic and haptic feedback within an automation level
  - Interaction design for transitions (changes between automation levels, e.g. activation and deactivation)
  - Documentation of the interaction design in sequence diagrams for each use case
Human Machine Interface (HMI)

Discussion with vehicle owners to prepare the transfer of generic developments to vertical sub-projects (HAVEit applications):

- Interaction design for the joint system
- HMI elements, display and cockpit design
Joint system demonstrator (DLR)

Demonstration vehicle for HAVEit technology
- System architecture allows rapid prototyping
- Development of safe interactions between driver and co-system
- Test vehicle for data fusion and copilot technology
- Transitions between different levels of automation regarding the driver in the loop assessment

Steer-by-wire functionality
- Mechanically decoupled steering column allows fully independent driver interaction and steering
- In case of failure: Graceful degradation to mechanical backup
- Fail-safe communication using FlexRay and redundant ECU
Safety and functional architecture application demonstrators

Brake-by-wire truck (Volvo Technology, Haldex)

Demonstration
• Improved braking performance (15% stopping distance reduction)
• EMB on public roads
• Pre-homologation of EMB system
Architecture migration demonstrator (Continental Automotive)

Demonstration

- Migration concept to transfer HAVEit technologies to future serial vehicles
- Transfer of essential joint system modules to near-serial automotive ECUs
- Basic automation functionalities
- Fail-silent ECUs using AUTOSAR standard
Automated assistance in roadworks and congestion (Continental Teves)

Key features

- Permanent lane keeping in roadworks and heavy traffic
  - Lane detection by lane marks and guardrail objects
  - Nearly 360° environment monitoring by six radar sensors and a mono front camera
- Automated ACC adaptation by speed limit sign recognition
- Recognition of non-moving obstacles and emergency braking function
- Detection of driver distraction and adaption of warning and control strategies
Automated queue assistance (Volvo Technology)

Key features

• Main purpose of automated queue assistance is to relieve the driver from the monotonous tasks associated with driving a truck at low speeds and in congested traffic situations

• It is intended to improve traffic safety via supporting the driver when their workload is very low

• Steering, acceleration and braking will be controlled using a variety of external vehicle environment sensors
  – Front sensing by lidar, radar and camera
  – Side sensing by radar
  – Infrared vehicle-to-vehicle communication
Temporary auto-pilot (Volkswagen)

Key features
- Support the driver in monotonous traffic situations like traffic jams or long distance driving
- Longitudinal and lateral support on motorways and similar roads with different levels of automation at speeds between 0 and 130 km/h
- Highly-automated (Pilot): hands-off driving, automated longitudinal and lateral control
- Semi-automated (ACC): hands-on driving, automated longitudinal control (ACC)
- Assisted driving (LKS): hands-on driving, assisted lateral control (LKS)
- Intervening safety functions: driver initiated emergency braking
Active green driving (Volvo Technology)

Key features

• In active green driving applications the fuel consumption and efficiency can be improved by using environmental information such as e-Horizon, forward looking sensors and dynamic traffic information

• With this information the power split between the combustion engine (ICE) and the electric motor can be adapted to use the energy storage in the most efficient way

• The function is intended to reduce the environmental impact of buses (and heavy duty vehicles)
More information:  http://www.HAVEit-eu.org

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