Highly and fully automated driving: How can the driver spend the time?

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The Road to Automated Drive

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Institute of Transportation Systems

Residence: Braunschweig and Berlin  
Since: March 2001  
Director: Prof. Dr.-Ing. Karsten Lemmer  
Employees: Presently about 150 employees from various scientific disciplines

Range of tasks
- Basic research  
- Creating concepts and strategies  
- Prototype development

Fields of Research
- Automotive  
- Railway Systems  
- Traffic Management  
- Intermodal and Public Transport

Quality Management
- DIN EN ISO 9001  
  VDA 6.2  
- RailSiTe ISO 17025
Agenda

- Levels of automation: Roles of driver and automation
- Transitions between levels

- Integration of mobile devices into the vehicle
- Usage of mobile devices in different levels of automation

- Summary
Levels of assistance and automation

- Even in automated vehicles there will be a driver on board (and/or other drivers around)
- Driver needs to build up a correct mental model of the automation
- Grouping of single ADAS functions into automation levels
- Selection of clearly distinguishable levels of automation
Different levels of automation in one vehicle
Different levels of automation in one vehicle

**BASl Definition:** Human driver executes manual driving task
Different levels of automation in one vehicle

**BASt Definition:** The driver permanently controls either longitudinal or lateral control. The other task can be automated to a certain extent by the assistance system.
Different levels of automation in one vehicle

**BASst Definition:** The system takes over longitudinal and lateral control, the driver shall permanently monitor the system and shall be prepared to take over at any time.
Different levels of automation in one vehicle

**BASst Definition:** The system takes over longitudinal and lateral control; the driver must no longer permanently monitor the system. In case of a take-over request, the driver must take-over control with a certain time buffer.
Different levels of automation in one vehicle

**BASSt Definition:** The system takes over longitudinal and lateral control completely and permanently. In case a take-over request that is not carried out, the system will return to a minimal risk condition by itself.
Different levels of automation in one vehicle
Transitions between different levels of automation

- Definition of transitions between levels of automation
- Driver initiated transitions vs. Automation initiated transitions
- Normal transitions vs. transitions at system limits
Transitions and the risk of mode confusion
Transition design: Interlocked Transitions

- Explicit transition design for transition to higher and lower levels of automation
- Hand-over of control only after confirmation by the other partner („Interlocked Transition“, „Handshake“)
Transition design: Concept for take-over requests


Driver does not react

Minimum Risk Manoeuvre
Mode Selection & Arbitration Unit in HAVEit
Agenda

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Other tasks than driving?

- "What would you like to do while driving highly automated?"

Write emails  Surf in the internet
Make phone calls  Watch TV
Look out of the window  Listen to music
Read something  Eat something

HAVEit Usability Assessment, 2009
8 participants, multiple answers were possible
Introduction

- Nomadic Devices can be used for entertainment, work, news etc.

- People already use nomadic devices illegally while driving
  (450,000 recorded violations in Germany, 2011)
Vehicle Prototype
Vehicle Prototype

Tablet Retainer
Vehicle Prototype

Buttons for the supported automation modes
Nomadic Device Integration – Concept

- While driving highly automated, the driver can use the nomadic device as usual
- Attention of the driver may completely shift to the nomadic device
- Mirror warnings, alerts and take-over requests on the device
- The automation decides which content is accessible depending on current driving-mode and situation
Nomadic Device Integration – Technology

- Loose coupling of nomadic device and vehicle

- Only data unveiled from the automation is accessible via a gateway

- Gateway to the automation is read-only (security against trojan horses, viruses and malicious data)

- Bluetooth based communication
Scenario

- Driving highly automated on a two-lane highway scenario
- Roadwork ahead, that the assistance system cannot handle
- Driver has to take over control to guide the vehicle through the roadwork
Highly automated driving activated

www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10008/
Scenario
Warning - Roadworks ahead!

Take over vehicle control soon
Scenario

Highly automated driving ends in 1100m (approx. 40s)
Scenario

Highly automated driving ends in 600m (approx. 27s)

Alert

Take over vehicle control now!
Highly automated driving ends in 600m (approx. 27s)

Alert

Take over vehicle control now!
Summary

- Several levels of automation in vehicle
- Transitions between levels are critical

- Highly automated driving requires no constant supervision and freedom for driver, but predictable takeover by driver

- Safe usage of nomadic devices in highly automated vehicles seems possible if device is linked with vehicle automation

- Vehicle automation maintains communication channel to driver
Thank you very much!

[Email Address]
Institute of Transportation Systems - Toolchain

**Empirical Research**
- Trends in politics / economics and society / requirements in mobility / requirements in ecology / accident analysis / simulator and driving studies / technologies / raw materials …

**Knowledge Management**
- Domain knowledge / standards / Models / Requirements / Data / Meta-Data …

**Detailed studies in research vehicles, simulations, AIM and by using models**
- ViewCar®
- VR-Lab
- Test Beds / AIM
- Models

**Finalization of prototypes and evaluation in AIM**
- FASCar® (I+II)
- Test Beds / AIM

**Development of prototypes and their evaluation in simulators and by using models**
- MoSAIC (Modular and Scalable Application Platform for ITS Components)
- VR-Lab
- IDeE-Lab
- HMI-Lab
- Dyn. Driving Sim.
- Mod. MockUp
- Models
Nomadic Device Integration – Concept

Conceptual design of a take-over request, presented on a tablet as an overlay.