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Adapt:/Ve

Automated Driving Applications and Technologies for Intelligent Vehicles

Key Results

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Aachen
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// 28 partners


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// Motivation for automated driving functions

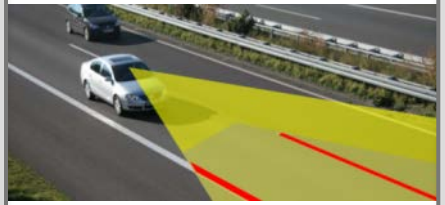
Zero emission	Reduction of fuel consumption & CO_2 emission Optimization of traffic flow	
Demo-graphic change	Support unconfident drivers Enhance mobility for elderly people	
Vision zero	Potential for more driver support by avoiding human driving errors	

// Examples of driver assistance systems

Longitudinal control

City Break Assist
ACC & Front Assist

Lateral control

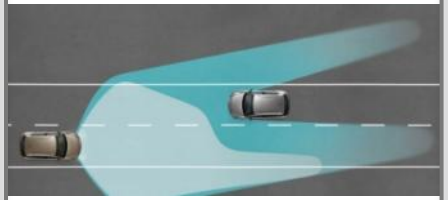


Side Assist
Lane Assist

Park assist systems

Park Assist Park Pilot
Rear Assist

Light



Light Assist

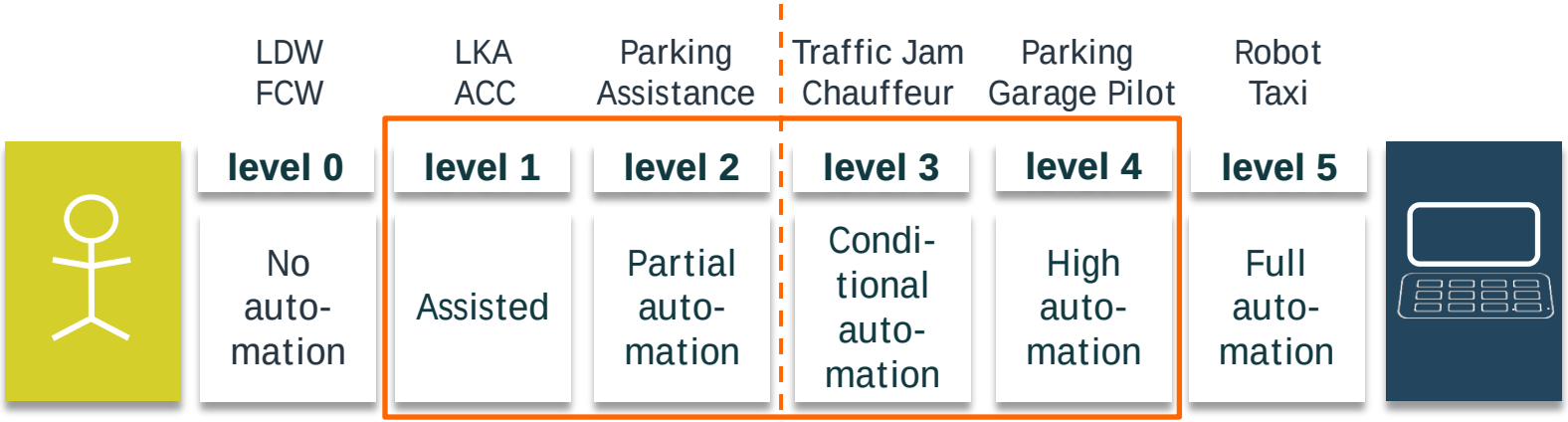
Recommendation

Pause
Recommendation

Driver information

Sign Assist

// Levels of driving automation acc. to SAE and VDA



Driver in the loop

- No significant change with respect to existing driver assistance systems

Driver out of the loop

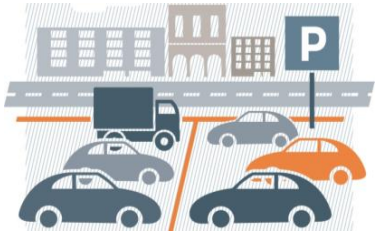
- Not in accordance with regulatory law (Vienna Convention of 1968, national road law)
- Shared responsibility for control between driver and system

➔ need for action

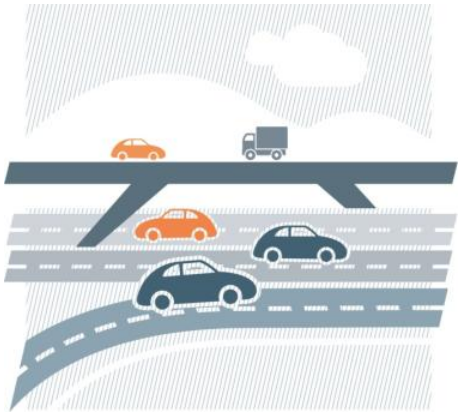
Source: SAE document J3016, "Taxonomy and Definitions for Terms Related to On-Road Automated Motor Vehicles", issued 2016-09-30, see also http://standards.sae.org/j3016_201609/

// Challenges and project objectives

Widespread application of automated driving to improve traffic safety, efficiency and comfort



// Automation scenarios



< 30

< 70

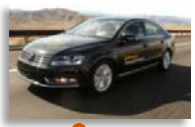
< 130

// Demonstrators

Close distance

Urban

Highway



Legal aspects - Response 4

// Research tasks

Group **categories** of automated driving functions

Define **steps towards** a safe **introduction** of highly automated driving functions into the market

Legal difficulties for market introduction of automated driving functions:

- New risks for the manufacturer resulting from product liability
- Usage and protection of data collected by automated driving functions
- Protection against corruption and fraud of vehicle data and V2X data

// System classification and safety validation

"System classification and glossary" (D2.1)

- systematic approach on the description of automated driving
- collection and priorisation of relevant parameters for AD classification
- extensive glossary for technical AD terms and functions
- Establishment of unified community-wide common understanding of AD system classification
- dissemination of SAE J3016 in Europe and beyond.

"Challenges for the development of automated driving functions due to system limitations and validation" (D2.2) and the additional report "Technical System Limits" (as part of D2.2)

- Assessment of existing safety standards and methodologies from automotive and other industries, such as the ADAS Code of Practice
- Analysis of existing sensor technologies considering their technical system limits including and overview of what can be expected from the sensor development in the upcoming years.
- A framework for further research on methodological approaches has been developed while deriving requirements for an AD Code of Practice

// Legal aspects

"Legal aspects on automated driving" (D2.3)

- **Creation of a set of scenarios to discuss possible cases of liability to make abstract considerations more "tangible".** The goal was to cover a wide range of different situations from technical malfunction to misuse.
- **Analysis of road traffic law of five EU member states: Italy, Great Britain, France, Germany and Sweden.** A focus was placed on international treaties, such as the Vienna Convention on road traffic, and the compatibility of the current version with automated traffic.
- **Comparison of liability law in five EU member states**: Not all questions of liability in case of a crash with automated vehicles can be clarified conclusively until further legislative activities. Due to EU Directives, liability law in the assessed countries is largely comparable. In principal, under product liability law the injured person has to prove the damage, the defect and the causal relationship between defect and damage. Whether an automated driving system could be solely responsible, and whether the burden of proof (who caused an accident) will lie with the manufacturer remains to be seen.
- **Analysis of general data privacy framework**: Emphasis was put on Event Data Recording, systems embedded in order to record data linked to the vehicle or the driving. Those EDR might help to prove, for example, who was driving at a decisive moment, yet, they also present problems in terms of data protection law.

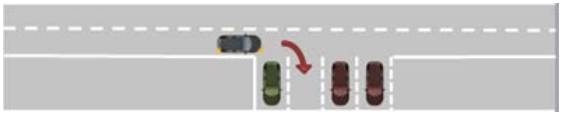
// Human-vehicle integration

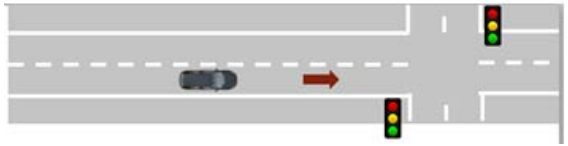
Collaborative automation

// Human-vehicle integration

Use Cases

- The Use case catalogue has in total of 23 situations covering manoeuvres for automation in close-distance scenarios, in urban scenarios and in highway scenarios
- The Use cases describe specific sequences of interactions between the users and the technical systems to achieve a specific goal.
- The Use cases serve as means to:
  - Develop detailed requirements regarding technical and human-factors aspects
  - Enhance the communication among team members
  - Reveal process alternatives, exceptions, undefined terms, and outstanding issues





// Experiments

- A total of 17 experiments were conducted
  - Surveys
  - Simulator studies
  - Field studies

- Over 490 car and truck drivers
- One survey with 2743 respondents

- Basis for the human factors recommendations

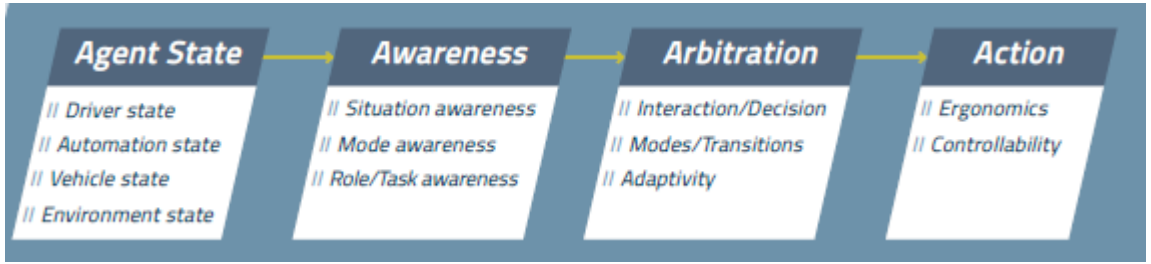






// Human-vehicle integration

- Human Factors Recommendations
  - 27 functional Human Factors recommendations gathered in a catalogue providing guidelines to developers and designers of automated human-vehicle systems.



ID	Name
FR1A_FBS	"Fallback strategy"

Related SAE Levels:

SAE0	SAE1	SAE2	SAE3	SAE4
	x	x	x	

Related to 4A subcategories: AGENT STATE

Automation State	Vehicle State	Environment state	Driver State
			x

Related to the following applications

Highway	Urban	Close-Distance
x	x	x

Human Factors challenge

The driver does not react to a take-over request.

Human Factors recommendation

Automation should provide an adequate fallback strategy.

NFR1A_FBS.1: Info/warning to drivers should escalate to make driver to take back control

NFR1A_FBS.2: If the driver does not react to take-over request, the automation should perform a Minimum Risk Manoeuvre (MRM)

NFR1A_FBS.3: The reason for activating the MRM should be clearly communicated to the driver

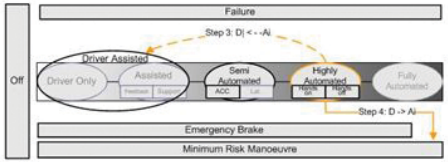
NFR1A_FBS.4: At higher speed, as long as lane detection is possible, the vehicle should reduce speed slowly to avoid risk exposure due to a sudden stand-still

NFR1A_FBS.5: When a MRM was performed, an E-call could be initiated if the driver does not resume in manual driving

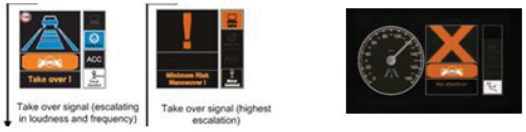
Already existing approaches and examples

FR1A_FBS.E1: Driver became unconscious

Transition HA→MRS (HAVEit)



FR1A_FBS.E2: Display Solutions for a Take-over request followed by a MRM (HAVEit)



References

HAVEit D33.2; Dambock, Weißgerber, Kienle & Bengler (2013); Bucchianico & Stanton (2014); International Harmonized Research Activities (IHRA) (2010); Moreillon (2017)

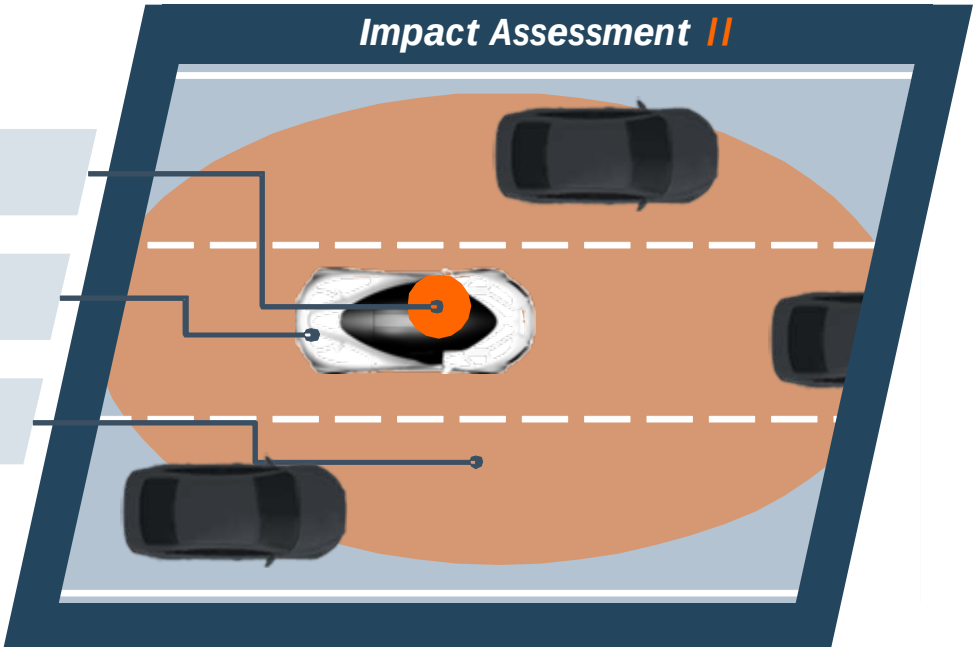
// Result of Experiments (sample)

- Drivers' understanding of, and ability to safely control an automated system adapts quickly when they are repeatedly exposed to the same type of event
- Drivers prefer to let the system maintain control of an overtaking task rather than having to re-take control themselves
  - They took longer to change lanes in Level 2 than in manual driving or Level 3. It is assumed that this extra-time was needed to establish situation awareness
  - 60% of drivers preferred using Level 3 over Level 2
- The current interior cab design is unsuitable for non-driving related secondary tasks. The interior cab design for automated trucks should ensure that non-driving related secondary tasks can be performed safely and with good ergonomics
- Where drivers look in the seconds after re-taking control is important
- Eye-tracking can help understand driver attention
- Continuous information is more helpful, but causes higher visual workload as compared to event-based situation announcements
- Remote as well as valet parking aids were evaluated as useful
- No major cultural differences (across 12 countries) regarding usefulness of parking HMI

// Evaluation

Evaluation framework

// Evaluation of AdaptIVe functions



// Real-traffic

// Test track

// Simulations

// Evaluation of AdaptIVe functions

// Technical assessment:

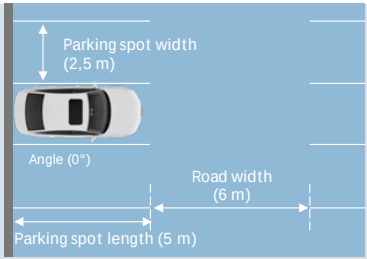
„Considering human driver behaviour as a baseline, the AdaptIVe automated driving functions are showing a more uniform driver behaviour.”

// User-related assessment:

„Test persons noted that automated driving functions affected driving positively in several ways, e.g. fewer dangerous lane changes”

// Impact Assessment:

„Automated parking functions can lead to a possible increase of parking space by 17 %.”



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Thank you.

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