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AdaptIVe

Automated Driving Applications and Technologies for Intelligent Vehicles

Automated Driving Applications and Technologies for Intelligent Vehicles - AdaptIVe

23rd Aachen Colloquium

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Aachen
October 7th, 2014

// Content

- AdaptIVe
- Automated Driving Functions
- Legal Aspects - Response 4
- Evaluation of automated driving functions

//AdaptIVe
Facts

Budget:	EUR 25 Million
European Commission:	EUR 14,3 Million
Duration:	42 months (January 2014 – June 2017)
Coordinator:	Aria Etemad, Volkswagen Group Research
8 Countries:	France, Germany, Greece, Italy, Spain, Sweden, The Netherlands, United Kingdom

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Project Overview

Widespread application of automated driving to improve road safety and address inefficiency in traffic flow whilst mitigating the environmental impact of road traffic //

Legal issues, terminology

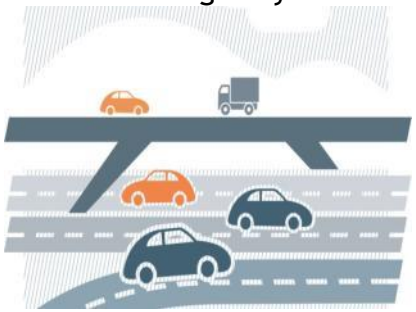
Strategies for human-vehicle integration

New evaluation methods, impact assessment

Automated driving close distance manoeuvring

Automated driving in urban environment

Automated driving on highway



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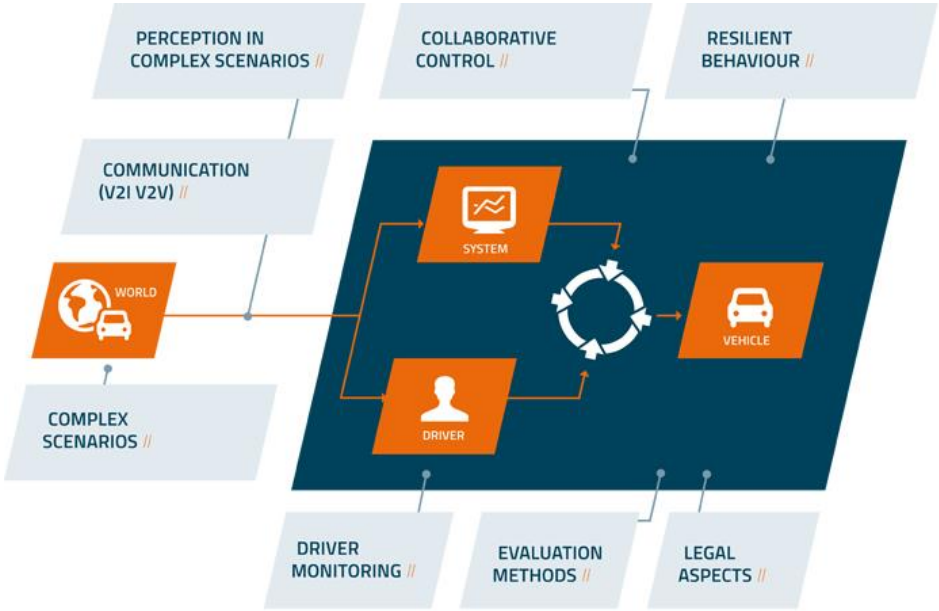
Motivation for automated driving functions

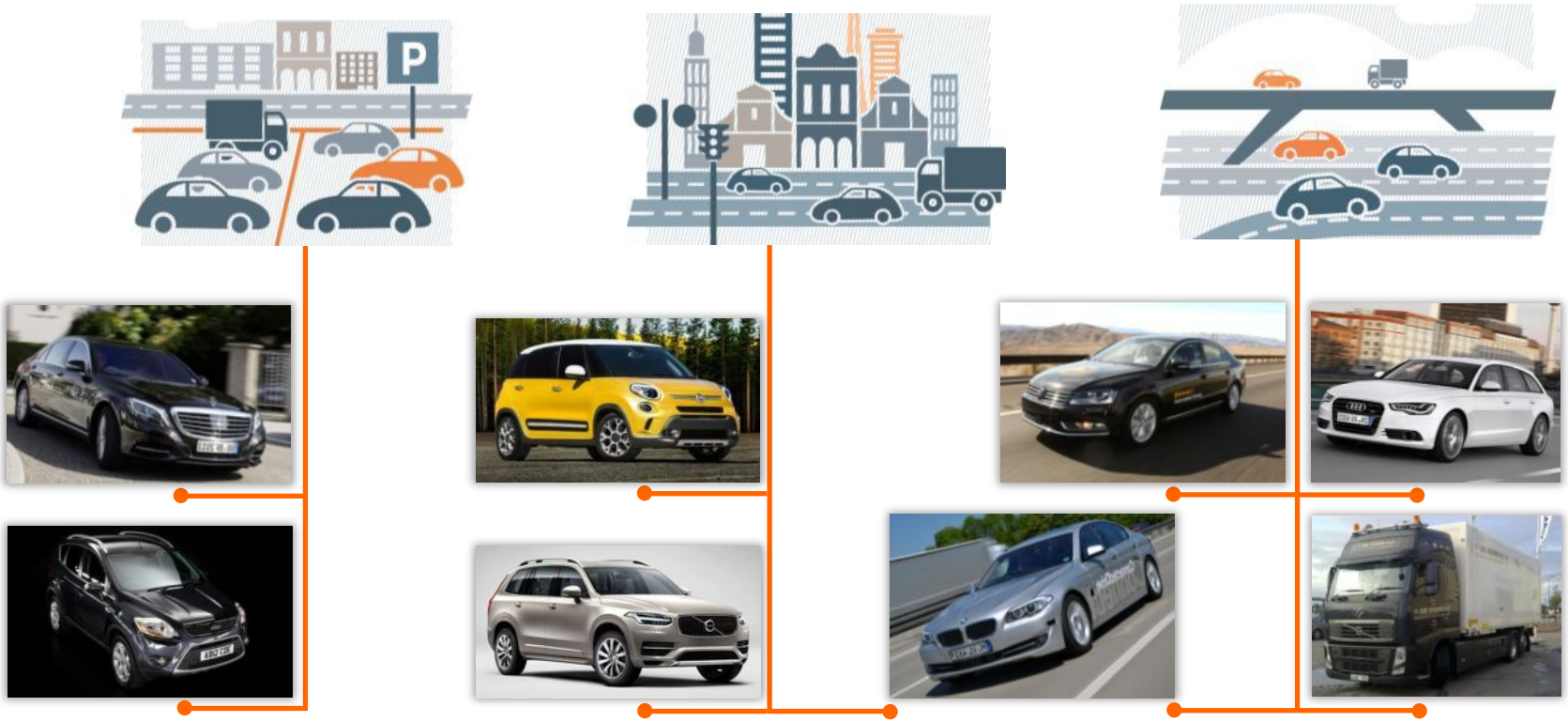
Zero emission	Reduction of fuel consumption & CO_2 emission Optimization of traffic flow	
Demographic change	Support unconfident drivers Enhance mobility for elderly people	
Vision zero	Potential for more driver support by avoiding human driving errors	

Targets for Research and Development

- Demonstrate automated driving in complex traffic environments. Test applications in scenarios considering the full range of automation levels.
- Enhance the perception performance by using advanced sensors supported by cooperative and communication technologies.
- Provide guidelines for the implementation of collaborative controls involving both drivers and automation.
- Define and validate specific evaluation methodologies and assess the impact of automated driving.
- Evaluate the legal framework with regards to existing implementation barriers.



// Demonstrators

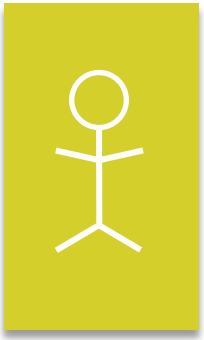


Standard actuators, ultrasonic sensors, radar, cameras	Actuators for vehicle control, laser scanner sensors, radar, cameras	Actuators, ECUs, on-board sensors, radar, map-based electronic horizon, V2X

//Response 4

Legal issues - Response 4

// Levels of driving automation acc. to SAE

	LDW FCW	LKA ACC	Parking Assistance	Traffic Jam Chauffeur	Parking Garage Pilot	Robot Taxi	
	**level 0**	**level 1**	**level 2**	**level 3**	**level 4**	**level 5**	
	No auto-mation	Assisted	Partial auto-mation	Condi-tional auto-mation	High auto-mation	Full auto-mation	

Driver in the loop

- No significant change with respect to existing driver assistance systems

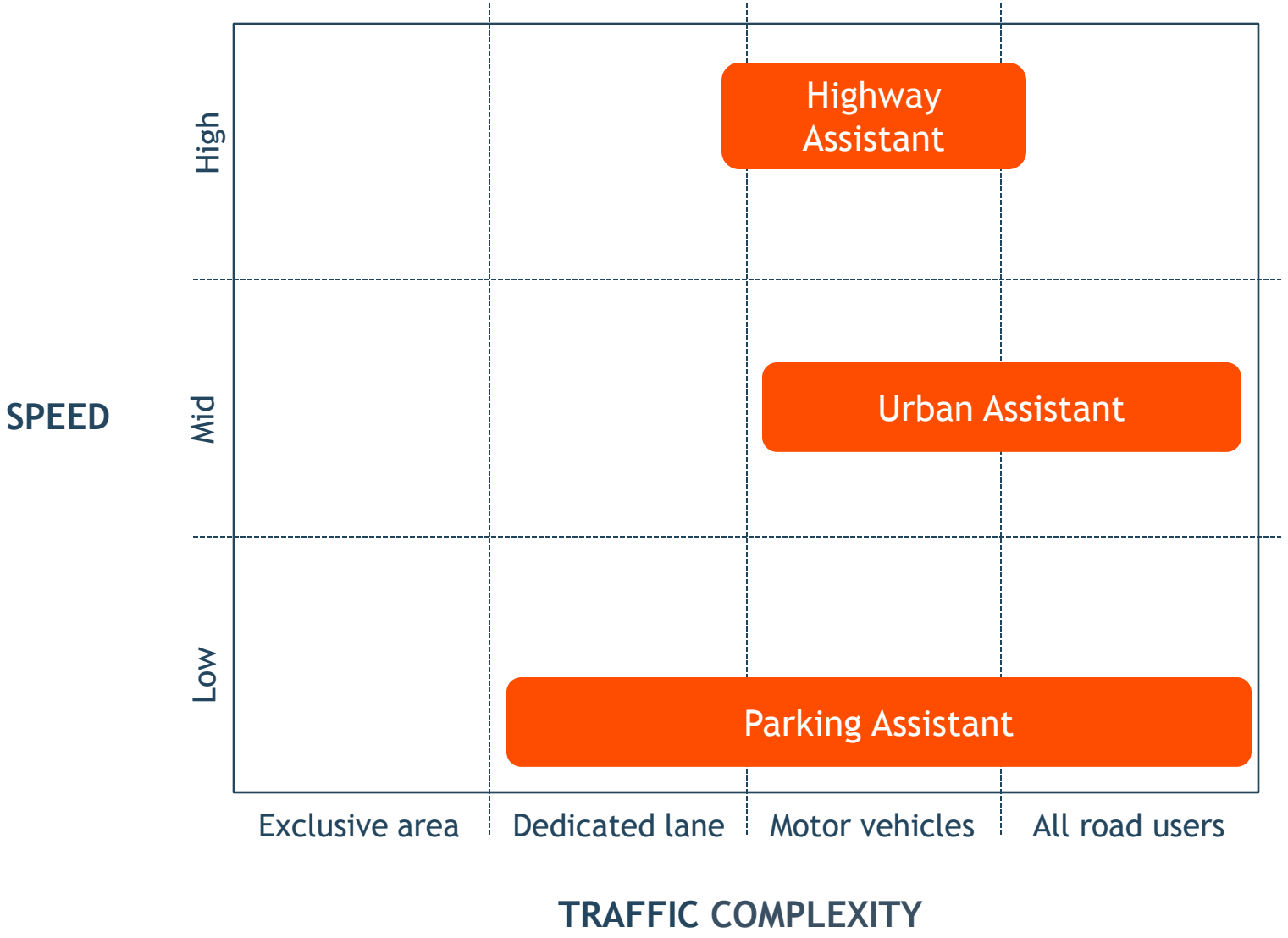
Driver out of the loop

- Not in accordance with regulatory law (Vienna Convention, 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 2014-01-16, see also http://standards.sae.org/j3016_201401/

// Application domains



// Challenges
Towards a code of practice

Unambiguous and easy to use classification of automated driving functions

Group **categories** of automated driving functions.

Customers expect safe and easy to use functions.

Assess technological limits of sensor systems.

Responsibility to supervise the driving task shifts from driver to system.

New approach to validate safety of functions needed.

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

// Legal topics

Determine need for action: allow introduction with acceptable risk

- Current legal situation does not allow automated driving on public roads.
- Conformity of automated driving functions to national law has to be assessed on a country by country basis.
- New risks for the manufacturer resulting from product liability
- Protection against corruption and fraud of vehicle data and V2X data
- Usage and protection of data collected by automated driving functions

Evaluation framework

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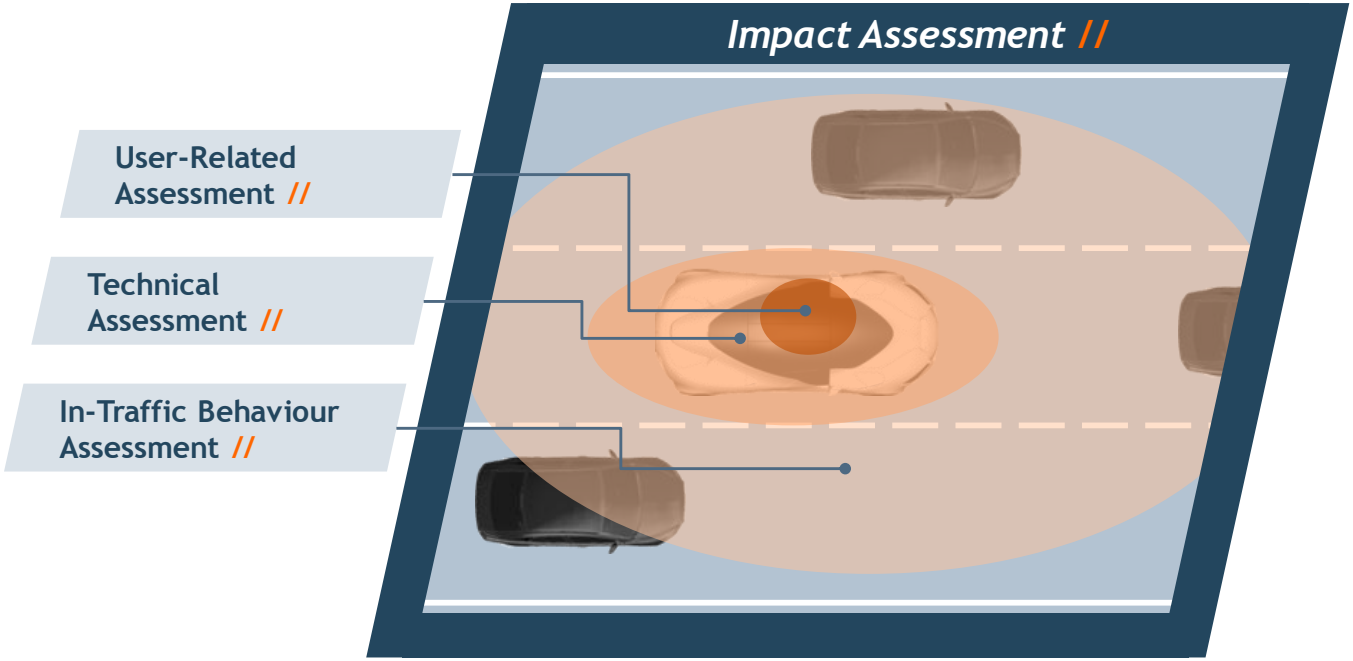
SP „Evaluation“

- Main objectives:
  - **Development of an evaluation framework for automate driving functions**
  - **Methodology for impact analysis of automated driving applications**
- Partners:
  - **ika, BMW, CRF, BASt, TNO, CTAG, Lund**



// AdaptIVe - Evaluation Approach

Function / System //

Classification //

- Operation time
- Level of automation

Focus of Evaluation //

(depending on classification)

- Research Questions
- Hypotheses
- Indicators

Test Methods //

(depending on classification)

- Test environment
- Test tools
- Test amount

Evaluation //

- User-related
- Technical
- In traffic

Impact Assessment //

- Safety
- Environment

// Technical Assessment
Evaluation Approach

Classification of automated driving functions:

- **Event based operating**
  - Function that is only active for a short period in time (typically vehicle stands still at the end or the automat driving ends)
  - Examples: Parking, Minimum Risk Manoeuvres

- **Continuously operating**
  - Function that is active for a longer period in time (typically vehicle is still moving at the end of an manoeuvre respectively automated driving is continued)
  - Example: Highway Pilot

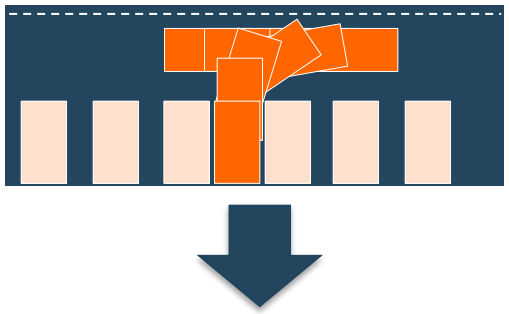
//Evaluation
Tools and Methods

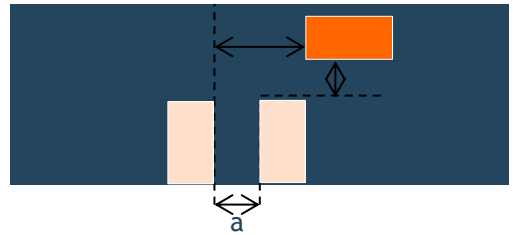
Tool	Application			
Field Operational Test	▪ Impact assessment in reality ▪ Assessment of behaviour/components/systems	R	R	R
Controlled Field	▪ Assessment of components and systems ▪ Assessment of driver behaviour	R	R	R \ V
Dynamic Driving Simulator	▪ Assessment of driver behaviour ▪ Human machine interaction	R	V	V
Simulation	▪ Virtual layout and assessment ▪ Potential impact assessment	V	V	V

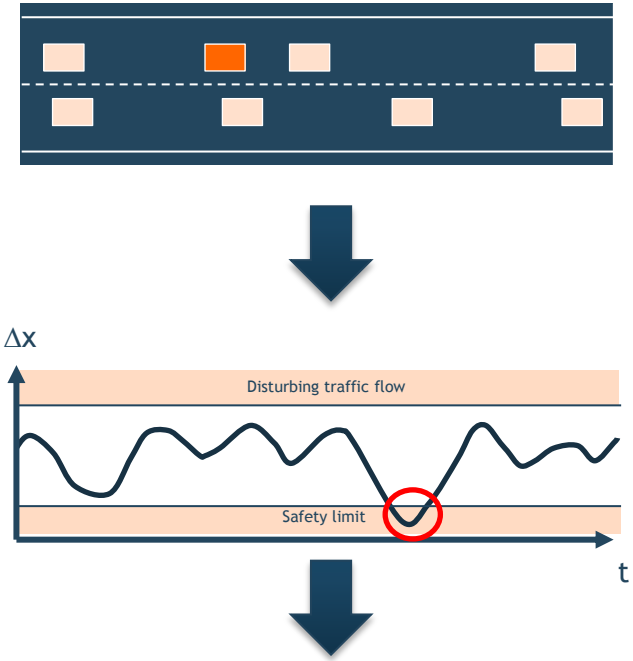
R: Real, V: virtual

//Technical Assessment
Evaluation Approach

	Event Based Operating	Continuously Operating
Example		
Main focus of the evaluation	Use Case	
Definition of hypotheses		
Definition of test scenarios	Test Case	
Evaluation criteria		





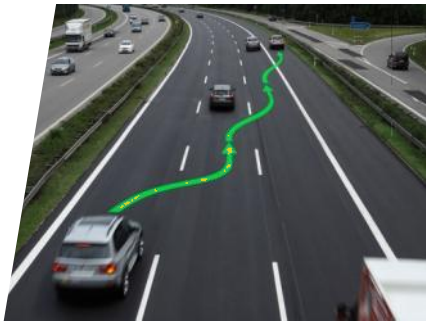


- Relevant Situation detected per driven distance / driving time
- Decide on the severity

//Safety Impact Assessment
Evaluation Approach

- Classical approach for ADAS
  - Scenario based approach
  - Accident data are analysed
  - Certain accidents are reconstructed and re-simulated accident considering function under study
  - Effect is determined by comparison of accident consequences with and without the function

- Approach for automated driving
  - Open issues
    - Today's accident data do not consider collisions of automated vehicles
    - Automated driving function operated already before a critical situation occurs
  - Consider different driving situations and not only accidents
  - Analyse how the traffic flow is affected by means of simulations
    - Identify (new) critical situations and analyse them



Co-funded by
the European Union

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Technologies for Intelligent Vehicles

Thank you.

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