// 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
AdaptIVe

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
## Motivation for automated driving functions

| **Zero emission** | Reduction of fuel consumption & CO₂ 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 |
AdaptIVe

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

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

![Traffic Complexity Diagram](image)

**Application Domains**:

- **SPEED**
  - Low
  - Mid
  - High

**Traffic Complexity**

- Exclusive area
- Dedicated lane
- Motor vehicles
- All road users

- **Highway Assistant**
- **Urban Assistant**
- **Parking Assistant**
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.
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

Evaluation framework
AdaptIVe
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

Focus of Evaluation
(depending on classification)
- Research Questions
- Hypotheses
- Indicators

Test Methods
(depending on classification)
- Test environment
- Test tools
- Test amount

Impact Assessment
- Safety
- Environment

Classification
- Operation time
- Level of automation

Function / System

Evaluation
- User-related
- Technical
- In traffic

Test environment
Test tools
Test amount
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 automated 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**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Application</th>
<th>R</th>
<th>R</th>
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<th>R</th>
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</thead>
<tbody>
<tr>
<td>Field Operational Test</td>
<td>• Impact assessment in reality&lt;br&gt;• Assessment of behaviour/components/systems</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Controlled Field</td>
<td>• Assessment of components and systems&lt;br&gt;• Assessment of driver behaviour</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R/V</td>
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<tr>
<td>Dynamic Driving Simulator</td>
<td>• Assessment of driver behaviour&lt;br&gt;• Human machine interaction</td>
<td>R</td>
<td>V</td>
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<tr>
<td>Simulation</td>
<td>• Virtual layout and assessment&lt;br&gt;• Potential impact assessment</td>
<td>V</td>
<td>V</td>
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</tr>
</tbody>
</table>

R: Real, V: virtual

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// Technical Assessment
Evaluation Approach

<table>
<thead>
<tr>
<th>Event Based Operating</th>
<th>Continuously Operating</th>
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<tbody>
<tr>
<td><strong>Example</strong></td>
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<tr>
<td><strong>Main focus of the evaluation</strong></td>
<td></td>
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<tr>
<td><strong>Definition of hypotheses</strong></td>
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<tr>
<td><strong>Definition of test scenarios</strong></td>
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<tr>
<td><strong>Evaluation criteria</strong></td>
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**Use Case**

**Test Case**

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

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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