EVALUATION METHODOLOGY OF AUTOMATED DRIVING

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Current Challenges and Research Activities for the Introduction of Automated Driving

1. What is the safety level of automated driving? → Safety Impact Assessment

2. How is safety of automated driving assured? → Safety Assurance Methodology
EVALUATION METHODOLOGY
DIMENSIONS FOR LEVEL 3 VEHICLE AUTOMATION

Impact Assessment

Effectiveness

Acceptance

Efficiency

Operational Safety

SOTIF

Controllability & Functional Safety

Behavioral Safety

Safety Assurance

Ultimate Design Goal

Necessary Prerequisite
1,000 drivers
100 cars
10 countries
→ Field Data Collection
**IMPACT ASSESSMENT**  
**EVALUATION SCOPE IN L3PILOT**

- Overall evaluation of automated driving function with respect to the influence on technical, user & acceptance and driving & travel behavior aspects
- Assessment of long-term effects of automated driving on user attitudes and acceptance
- Assessment of the readiness and reliability of automated driving functions

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<th>Socio-Economic Impact Evaluation</th>
<th>Single Vehicle</th>
<th>Fleet</th>
<th>Europe</th>
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<tr>
<td>Impact Evaluation</td>
<td>Frequency of relevant situations</td>
<td>Interaction</td>
<td>Intercultural difference</td>
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<td>User Evaluation</td>
<td>Transition of control</td>
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<td>Long term effects</td>
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<td>Technical &amp; Traffic Evaluation</td>
<td>Security</td>
<td>Analysis of driving situations</td>
<td>System effect</td>
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<tr>
<td>Data Management</td>
<td>Individual data (vehicle data)</td>
<td>Fleet data center (vehicle data and Pls)</td>
<td>Aggregated data (Pls)</td>
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Research project PEGASUS

Database of relevant scenarios as a tool for safety assurance of automated driving
VALIDATION OF AUTOMATED DRIVING
PROPOSAL FOR VALIDATION METHODOLOGY

Database of Relevant Scenarios

- Validation
- Proposal
- Methodology

Traffic Simulation
Dynamic Driving Simulator
Software in-the-loop
Hardware in-the-loop
Component Development

Field Operational Tests
Test Track

Real Traffic

Motivation
Extractions

A1
A2
A3
A4
A5

B1
B2
B3
B4

Recordings

Severity
Accident Reconstruction
Critical Real-World Situations
Critical Test Situations
Generation of New Constellations

Idea

Functional Concept

SOP

Recording into the DB
Extracting from the DB

Test Levels
STORING THE SCENARIOS
LAYER MODEL

Layer 5
Environment conditions (L5)
• Influence on properties of other levels

Layer 4
Movable objects (L4)
• Interactions
• Maneuvers

Layer 3
Temporal modifications L1 and L2 (L3)
• Geometry and topology overlay
• Time dependent < 1 day

Layer 2
Traffic infrastructure (L2)
• Construction barriers
• Signs, traffic guidance

Layer 1
Street level (L1)
• Geometry

Source: Gerrit Bagschik, Till Menzel and Markus Maurer, 2018
Ontology based Scene Creation for the Development of Automated Vehicles
PROCESS TO UPLOAD DATA INTO THE DATABASE

Vehicle following with critical sudden braking

- Signals according to JSON definitions
- Minimum requirements on dataset
- Format: 📄Mat or HDF5
SAFETY ASSURANCE OF AUTOMATED DRIVING
EXAMPLE: TESTING A CONCRETE SCENARIO IN SIMULATION

• Extraction of concrete scenario from database
• The selected concrete scenario can be reproduced in the simulation. A HAD-function integrated in the simulation can be tested
• Here: Vehicle following with sudden critical breaking maneuver (from input data example)
SUMMARY

• Prospective safety **impact assessment** for automated driving requires new methodologies
  • Current research activities start data collection for safety impact assessment

• **Safety assurance** also requires new methodologies
  • Scenario based data base approach is under research within different international projects
THANK YOU FOR YOUR ATTENTION!

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QUESTIONS?