Automated and connected driving is an ethical imperative if the systems cause fewer accidents than human drivers (positive balance of risk) [Ethics Commission on automated driving 2017]

The effectiveness evaluation of a function of active safety must …

… consider variations in boundary conditions of traffic situations,

… quantify positive and possible negative effects,

… and so take into account the sum of all effects.
PROSPECTIVE SAFETY ASSESSMENT. COMPARISON OF APPROACHES.

Proof of positive balance of risk requires an assessment of a technology’s impact on traffic safety prior to its market introduction!

**Analysis of accident data**

Only accidents.
No near-accidents, critical driving situations or general HAF-relevant traffic scenarios are considered.

**Simulation**

Driving situation / traffic simulation.
Investigations of all situations from accident over critical to normal driving situation.
Number of tested driving situations can be scaled as desired.

**Driving Simulator**

Targeted investigation of driver behavior in relevant traffic scenarios.
Controlled and standardized test environment.
Number of tested driving situations is usually scaled over the number of subjects.

**Field Operation Test (FOT)**

Examination of the function takes place in real traffic.
Only critical and normal driving situations are examined.
The number of investigated situations scales over the scope of the experiment.
METHODOLOGY.
ACCIDENT- VS. TRAFFIC-BASED APPROACH.

1) Accident-based

1. Initial constellation
2. Accident reconstruction
3. Simulation of reconstructed case with ADAS

\[ \Delta \text{Single-Case} \]

2) Traffic-based

1. Identification of relevant traffic scenarios
2. Relevant traffic scenarios
3. Stochastic simulation of traffic situation without ADAS
4. Stochastic simulation of traffic situation with ADAS

\[ \Sigma \Delta_{\text{pos}} - \Sigma \Delta_{\text{neg}} \]
METHODOLOGY.
P.E.A.R.S.

- Representative assessment of active safety requires harmonized methods.
- Harmonization enables comparable and comprehensible assessments.
- For simulation: methods, processes, and models for prospective assessment have to be harmonized.
- Objective of this open working platform is the creation of a worldwide standard for the evaluation of systems within the pre-crash phase, which is created, discussed, and finally accepted by all relevant stakeholders.
- ISO Technical Report 21934 “Prospective safety performance assessment of pre-crash technology by virtual simulation”
Stochastic Cognitive Model (SCM) – driver behavior model for the simulation within the safety assessment
Objective: realistic implementation of the information acquisition

– Definition of different view area
  – Recognition of the objects in the area towards the driver is looking

– Stochastic view control based scientifically founded distribution matrix

– Integration of both top-down and bottom-up gaze control
TOOL.
SIMULATION FRAMEWORK OPENPASS.

- OpenPASS is a new software framework for simulation and evaluation of ADAS and automated driving
- Join initiative of OEMs (Daimler, VW and BMW) + other Partners (itk) with scope of harmonization of simulation tools
- Realistic traffic models and simulation → investigate interaction between different traffic participants
- Fast and efficient simulation → consider a high number of situations
- Open source approach → generate trust and acceptance by authorities and public
  (Eclipse project: sim@OpenPASS)
METHODOLOGY.
IDENTIFICATION OF TOP-SCENARIOS FOR AUTOMATED DRIVING.

Accident data (e.g. GIDAS) / Critical situations (FOT)

Based on specification of function

Simulation of traffic scenarios

Top Scenarios
## APPLICATION.
### TOP 7 SCENARIOS.

<table>
<thead>
<tr>
<th>Top 1</th>
<th>Top 2</th>
<th>Top 3</th>
<th>Top 4</th>
<th>Top 5</th>
<th>Top 6</th>
<th>Top 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut-In</td>
<td>End of Lane</td>
<td>Obstacle in the lane</td>
<td>Traffic jam</td>
<td>Highway entrance</td>
<td>Rear-end accident</td>
<td>Single driving accident</td>
</tr>
</tbody>
</table>

![Diagram of scenarios](image-url)
# Results

## Adaptive – Impact Assessment

- Analysis of the AdaptIve automated driving function:

<table>
<thead>
<tr>
<th>Top 1</th>
<th>Top 2</th>
<th>Top 3</th>
<th>Top 4</th>
<th>Top 5</th>
<th>Top 6</th>
<th>Top 7</th>
<th>Not considered</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="92%25">-83%</a></td>
<td><a href="83%25">-14%</a></td>
<td><a href="97%25">-40%</a></td>
<td><a href="89%25">-40%</a></td>
<td><a href="95%25">-49%</a></td>
<td><a href="96%25">-73%</a></td>
<td><a href="93%25">-100%</a></td>
<td>0%</td>
</tr>
</tbody>
</table>

- Limitation and assumptions of the study (see AdaptIve Deliverable D7.3) must always be taken into account!

1: Accidents within the operation conditions including accidents at speeds outside operation conditions

2: Determined based on the assumption

### Open Issues for the safety impact assessment in AdaptIve:

- Situations (e.g. transition of control) with potentially negative effects are not considered

- Effects along the penetration rate need to be not considered

- Usage is not considered

- Available data

<table>
<thead>
<tr>
<th>Accidents within the operation conditions</th>
<th>-72% (92%)</th>
<th>-61% (83%)</th>
<th>-70% (97%)</th>
<th>-90% (89%)</th>
<th>95% (95%)</th>
<th>69% (96%)</th>
<th>67% (93%)</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected change in the accident scenario</td>
<td>-60% (-76%)</td>
<td>-9% (-12%)</td>
<td>-31% (-39%)</td>
<td>-32% (-36%)</td>
<td>-47% (-47%)</td>
<td>-51% (-70%)</td>
<td>-67% (-93%)</td>
<td>0%</td>
</tr>
</tbody>
</table>
PROCESS AND ROLES. VISION OF ACTIVE SAFETY EVALUATION.

Neutral (scientific) institutions

- Accident data
- Traffic data
- Human factor data

Industry

- Stochastic scenarios
- Simulation and analysis
- ADAS model

Results

- Weighting of simulated results
- Rating

Test institute

- Case selection
- Spot testing
- Results

3rd SIP-adus Workshop | 15th November 2017 | Fahrenkrog, BMW
THANK YOU FOR YOUR ATTENTION!