INSTITUT FÜR KRAFTFAHRZEUGE
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AdaptIVe

Automated Driving Applications and Technologies for Intelligent Vehicles

Evaluation methodology for automated vehicles in AdaptIVe and beyond

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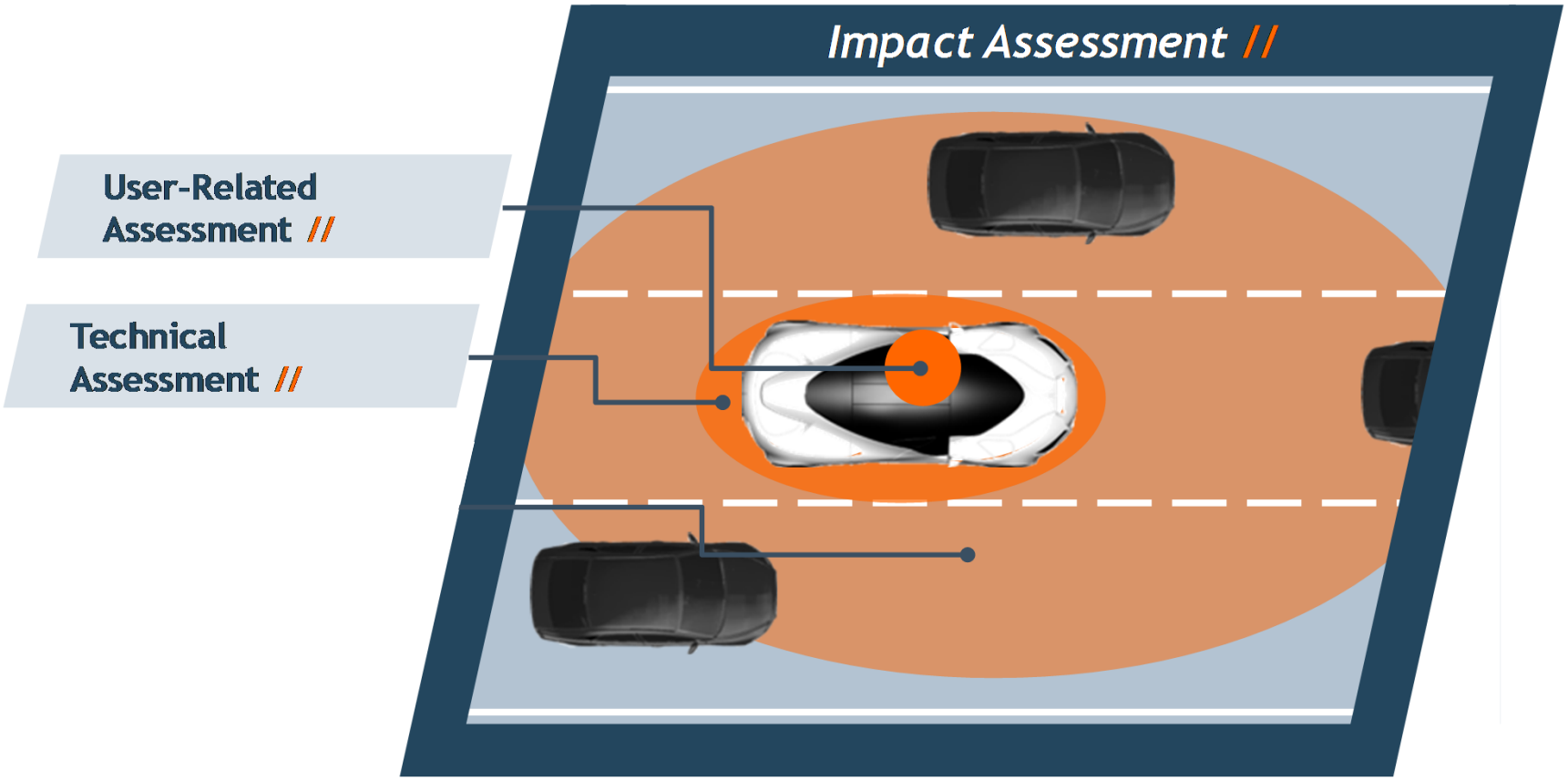
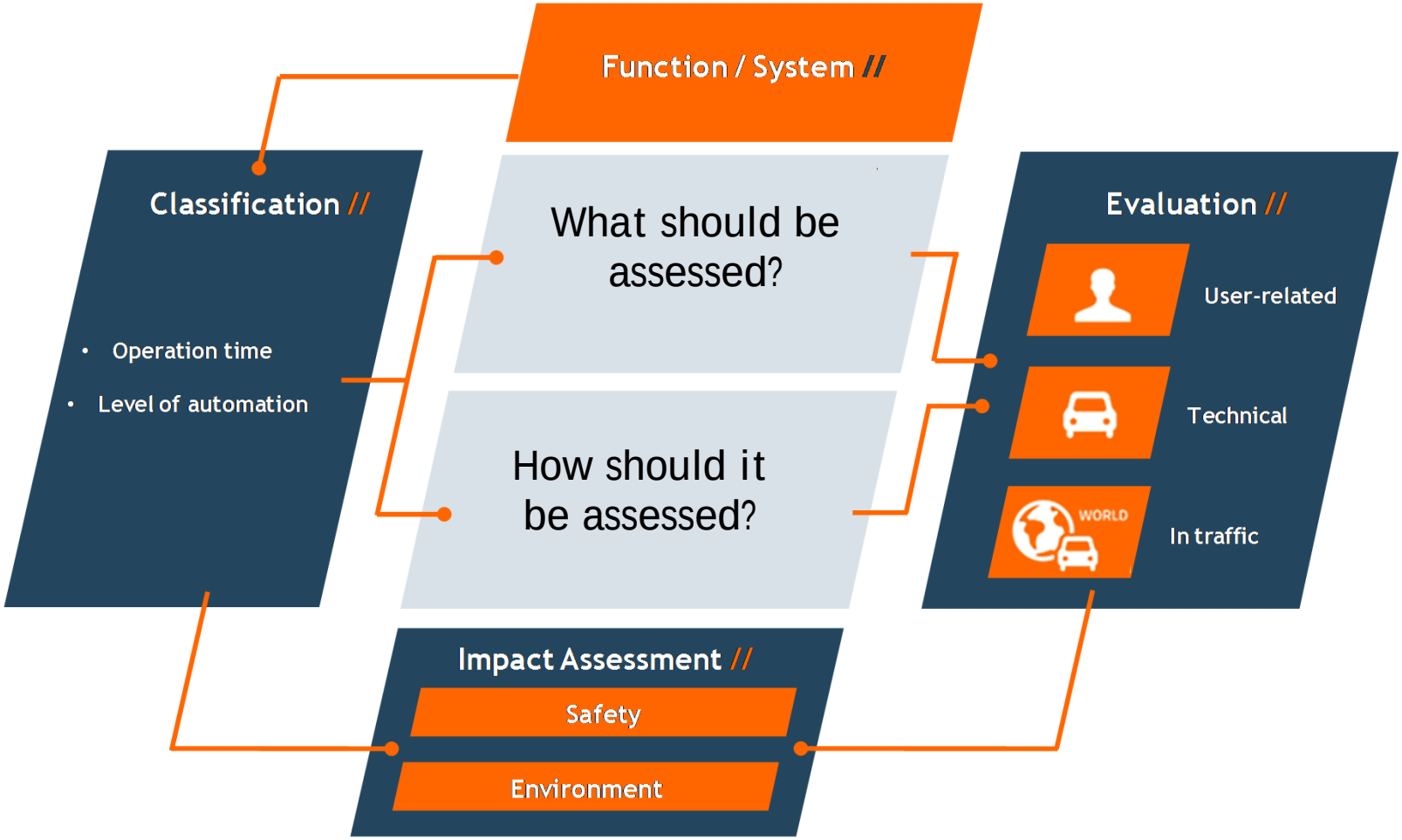
// Evaluation Areas



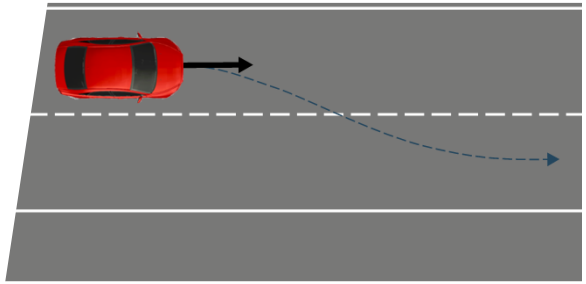
// Evaluation Approach in AdaptIVe



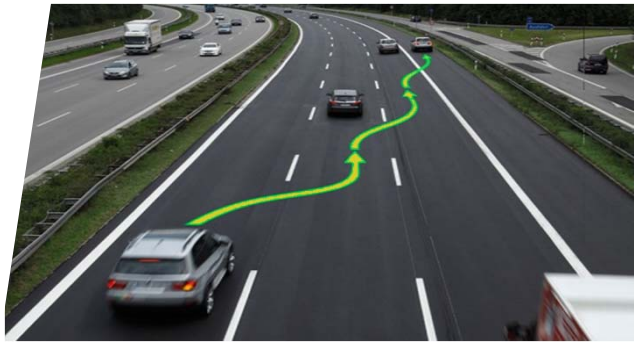
// Definitions for the Evaluation

- **Traffic Scenario**: A traffic scenario describes a larger traffic context, which includes different (not pre-defined) driving scenarios.

- **Driving Scenario**: A driving scenario is the abstraction and the general description of a driving situation without any specification of the parameters of the driving situation.



- **Driving Situation**: A driving situation is a specific driving manoeuvre (e.g. a concrete lane change with defined parameters).



// Classification of Automated Driving Functions

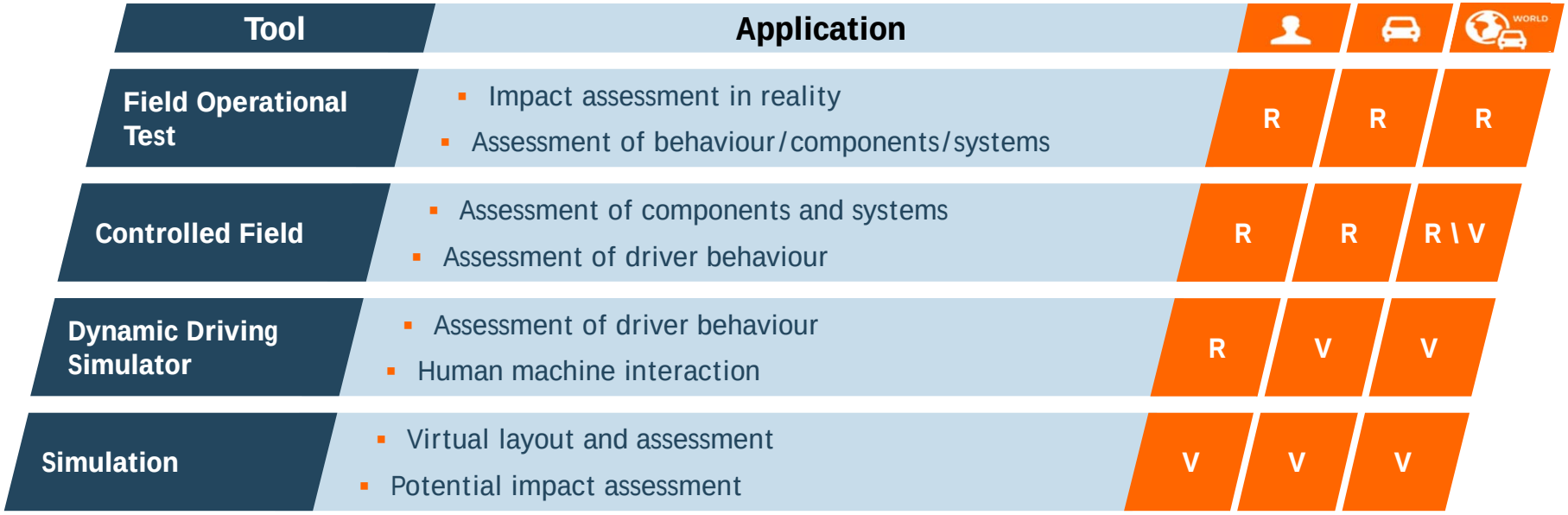
- Classification by SAE levels

- Classification by operation time:
  - **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

- Several evaluation tools are available today
  - Relevant elements (driver, vehicle & function, environment) are either real oder virtual
- Which tool should be applied for which type of assessment?



// Evaluation Tools in AdaptIVe

- Identification of an appropriate evaluation methodology for the technical, user-related, in-traffic behaviour and impact assessment
  - Systematic analysis of the different test tools
  - Consideration of automation level and operation time

Tool	Technical	User-related	In-traffic	Impact			
Field Operational Test	Yes Continously	Yes	(Yes)	No	R	R	R
Controlled Field	Yes Event-based	Yes	No	No	R	R	R \ V
Dynamic Driving Simulator	No	Yes	No	No	R	V	V
Simulation	No	No	Yes	Yes	V	V	V

R: real, V: virtual

// Evaluation Methodology Technical Assessment

- Identification of an appropriate evaluation methodology for the technical, user-related, in-traffic behaviour and impact assessment
  - Example for technical assessment

Event-based//

1. **Defining evaluation scope**
   - Definition of research questions, hypotheses & indicators
2. **Planning of assessment**
   - Analyse system description and adaption of hypotheses
   - Planning of test cases
   - (Risk assessment)
3. **Tests in controlled field**
   - Number of test variations
   - Logging of test data
4. **Assessment of tests**
   - Analysis of hypotheses based on test data & indicators

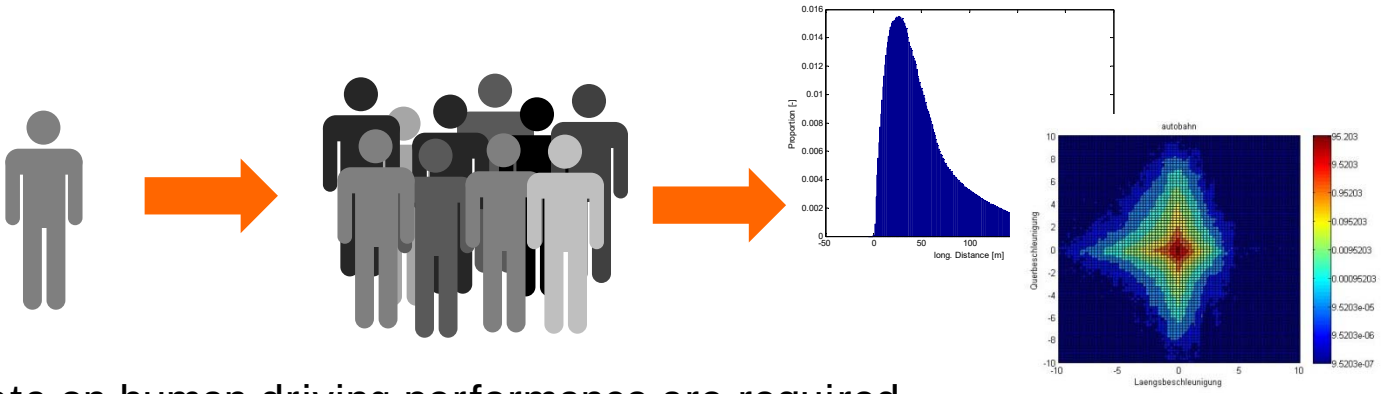
Continuous//

1. **Defining evaluation scope**
   - Definition of research questions, hypotheses & indicators
2. **Planning of assessment**
   - Analyse system description and adaption of hypotheses
   - Planning of test cases and test route
   - Definition evaluation criteria (distributions & boundaries)
   - Risk assessment
3. **Pre-/component tests in controlled field**
   - Basic tests of functionality
   - Sensor tests
4. **Tests in real traffic**
   - Test route and test amount to be determined
5. **Assessment of tests**
   - Analysis of hypotheses based on test data & indicators

// Solutions - Baseline for the evaluation

- Description of the baseline for the evaluation
  - Objectives of automated driving functions
    - Objective is a collision free traffic
    - Operation in mixed traffic conditions (→ not disturbing normal traffic)

    → The functions have to be operated within range of normal driver behaviour (and beyond)

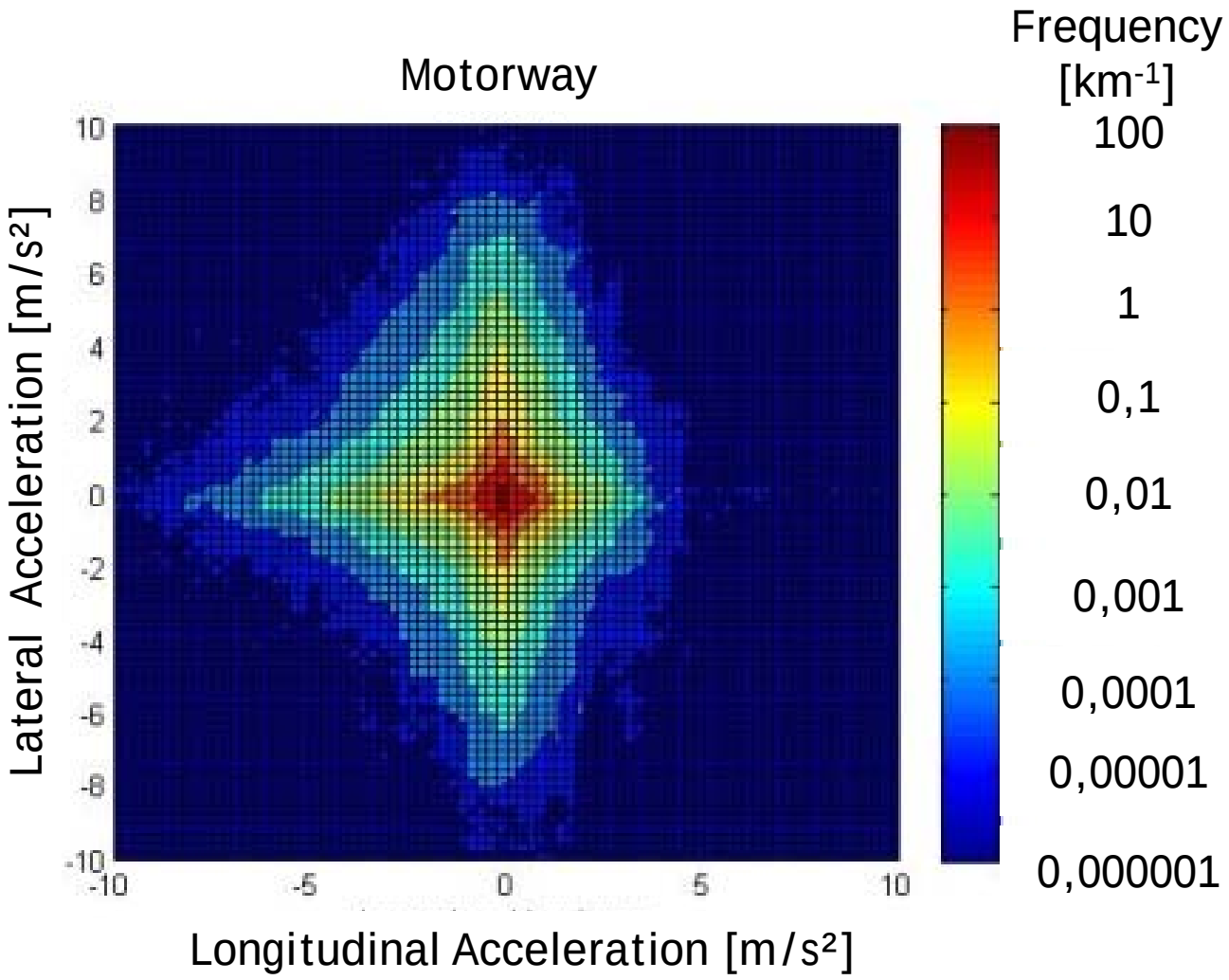


→ Data on human driving performance are required

Analysis of field tests data (euroFOT), in-field observations (parking behaviour), studies and test drives (lane change)

// Baseline for the evaluation

- Analysis of euroFOT data
- Acceleration during normal driving
- Data from 98 vehicles
- Motorway, rural roads and urban roads



// Evaluation beyond AdaptIVe

- Challenge for the evaluation of automated driving:
  - How to ensure a comprehensive evaluation of automated driving functions, which covers nearly all possible driving situations?

// Evaluation beyond AdaptIVe

- Why using simulation:
  - Limitation of resources of real world tests effort
  - Variation of the situations can be covered (Monte Carlo Approaches)

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Thank you.

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