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# A Story of Scenarios – From Data and Knowledge to Scenarios for Testing

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Federal Ministry for Economic Affairs and Climate Action

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# **A Story of Scenarios**

# From Data and Knowledge to Scenarios for Testing









### 6-Layer Model as Basis for Structured Traffic Environments





### **Context of the Advanced Scenario Engine in VVM**





## **Advanced Scenario Engine – From OMEGA to Scenarios**





## **Advanced Scenario Engine – Workflow with Scenario Types**





# Advanced Scenario Engine Components of a Processed Scenario





- Enveloping Scenarios
  - Enveloping structure of drives based on ego-vehicle within Layer 1 boundaries
- ► GDEA Attributes
  - Logical representation of infrastructure attributes (L1-L3)
  - Event-based representation of dynamic behavior and relations in scenario
- Semantic Decomposition Attributes
  - Classification of scenarios by forming Base Scenarios as building blocks
- Focus Scenarios
  - Specific constellations of decomposed Base Scenarios to add further relevant details
  - E.g., assigning roles to vehicle according to PEGASUS challenger approach





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#### **Derivation of Base-Scenarios**





Derived from König et al. 2020, Evidence-Based Derivation of Basic Scenarios for Controlled-Access Highways, Workshop slides https://www.fka.de/en/competences/automated-driving/highlights/594-evidence-based-derivation-of-basic-scenarios-for-controlled-access-highways.htm

#### **Scenario Rollout into the Test: Example**





### **From Data to Scenarios**





# **From Functional Scenarios to Logical Scenarios**





#### Problem:

To prepare scenario execution, the parameter space needs to be described
Assumptions about the domain lead to many (parametric) constraints that must be met in a scenario

#### **Challenges:**

- Assumptions must be explicitly documented and consistent throughout the development process
  - Each scenario has to be built based on these assumptions

#### Approach:

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- Formalization of assumptions for scenario generation based on an ontology
  - Automated detailing of functional scenarios
    - Specification of scenario parameters
    - Identification of parameter constraints
- Conversion of concrete scenarios into the data formats for simulation
- In the first step: focus on traffic infrastructure





















### **Transforming Scenarios to Test Cases**







### **Summary**



#### Scenarios are one of the main factors in the overall V&V-strategy

- The V&V-strategy can use evidences from test cases for argumentation
- Scenarios are one approach to link testing activities to an argumentation strategy

#### **Our approach**

- A common overall process from data & knowledge to relevant scenarios for testing
- Structure scenarios based on PEGASUS abstraction layers (functional, logical, concrete)
- Identify, detail, concretize scenarios with different approaches
- Transform scenarios into test cases

#### Outlook

- Concretization & extension of our approaches
- Harmonize the different approaches presented, including the connection to the overall V&V-process is necessary and to be continued



# Thank you!

Andreas Bussler, Volkswagen; Nicolas Wagener, RWTH Aachen University Andreas Pütz, Ford; Till Menzel, TU Braunschweig; Thilo Braun, Julian Fuchs, FZI Franziska Körtke, ZF; Hendrik Weber, Christoph Glasmacher, RWTH Aachen University



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