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CREATING IDEAS &
DRIVING INNOVATIONS

ika

**RWTHAACHEN
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SCENARIO CATALOG AND DATA PROCESSING FOR SCENARIO DATABASES

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Motivation & Introduction

- Basic Scenarios
- Scenario Database
- Edge Case Database



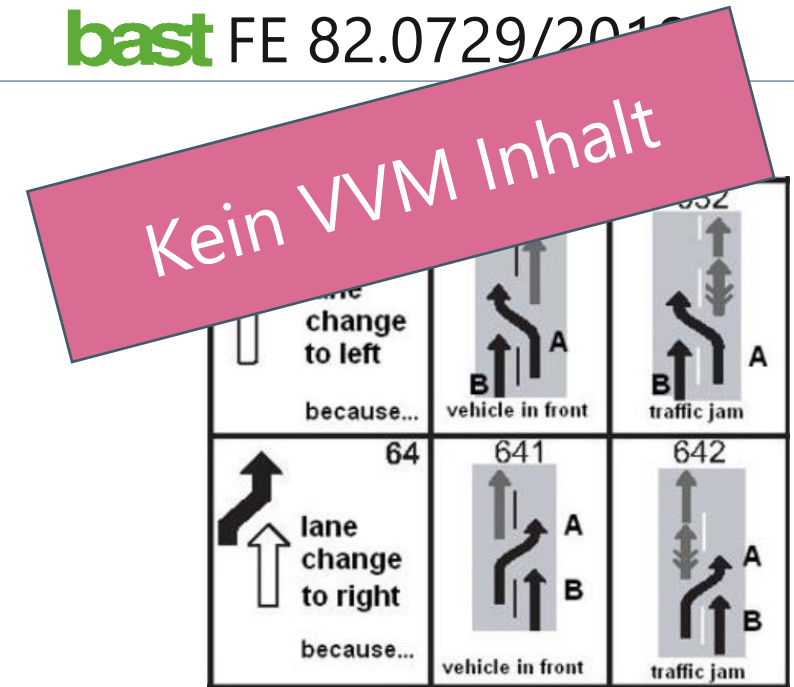
Building on concepts established in PEGASUS project:

- Scenario databases as enabler for safety assurance of automated driving
 - Extension to urban scenarios
- 6-Layer-Model structuring relevant entities of traffic situations
- Scenarios concepts for structuring driving data in database

Scenario Concept – Motivation & Scope

- Motivation: Creation of Codebook for basic scenarios
 - Analogy to crash types for driving on controlled-access highways
 - Basic scenarios as central elements to cover more complex scenarios
- How are scenarios different from crash types?
 - Crash serves as distinct, universal event triggering the analysis
 - Crash reports can be collected without the catalog of crash types
 - For driving in general, discrete events to not always exist
 - Especially, driving on highways is rather a continuous control action
 - Scenario should account for multiple outcomes of a situation
 - Scope of scenarios can consist of multiple vehicles and cover different temporal extents

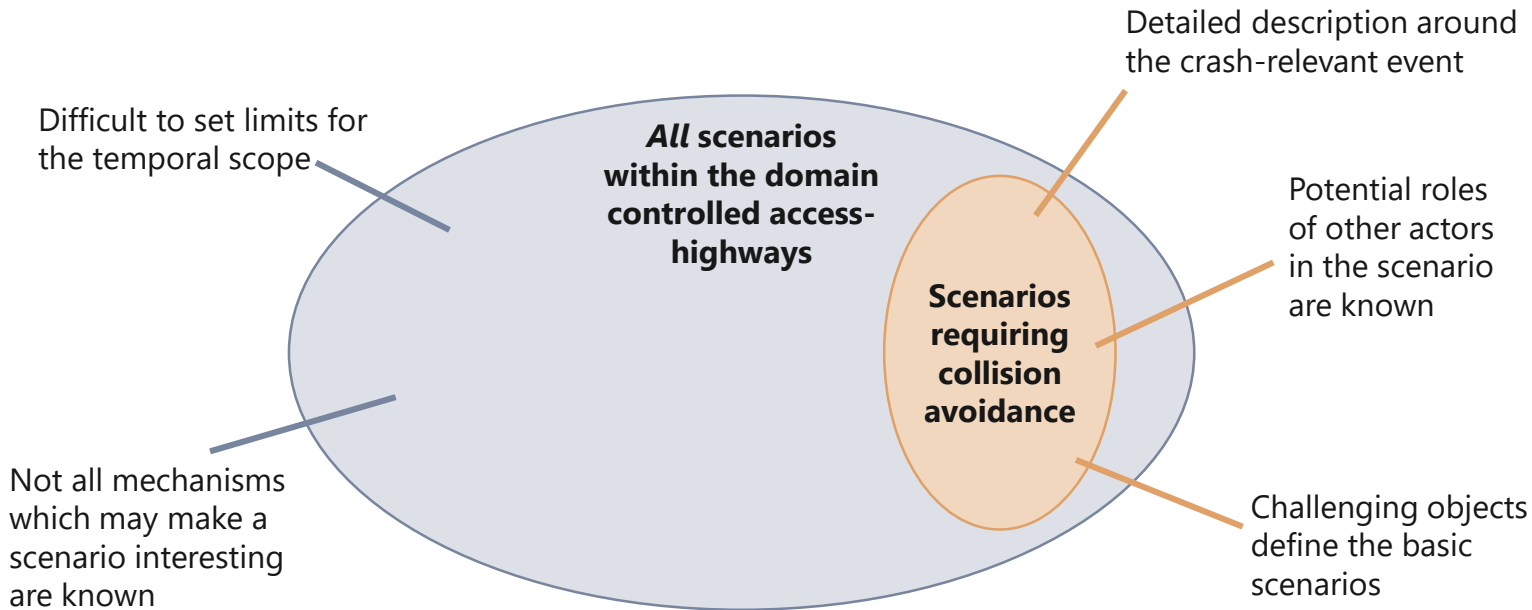
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Example from IGLAD codebook [IGL19]
considering more than one vehicle

Scenario Concept – Core Idea

- Distinction between two types of scenarios
 - Scenarios requiring collision avoidance action
 - „Crash-relevant“ scenarios
 - Scenarios not requiring immediate collision avoidance
 - Covering the entire driving domain



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General Basic Scenario

Challenges

- Missing scenario definitions
- Realistic level of granularity

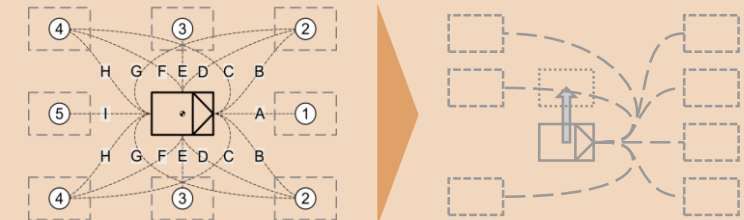
Lane change left	Passing vehicle on the right	Lane change right
Overtaking		

Validate consistency between the approaches

Validate by applying to highD dataset

Crash-relevant Basic Scenarios

- Starting from "Challenger approach" applied in PEGASUS scenario database
- Extension to cover lane changes by ego vehicle



Covering *a//* scenarios in the domain motorway

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- Deriving scenario building blocks using a tree structure
 - Each building block inherits the description properties and the detection criteria of its parent
 - Example: „Approaching a traffic jam“ inherits the properties of „Approaching“
- Top-level distinction

– **Driving state**

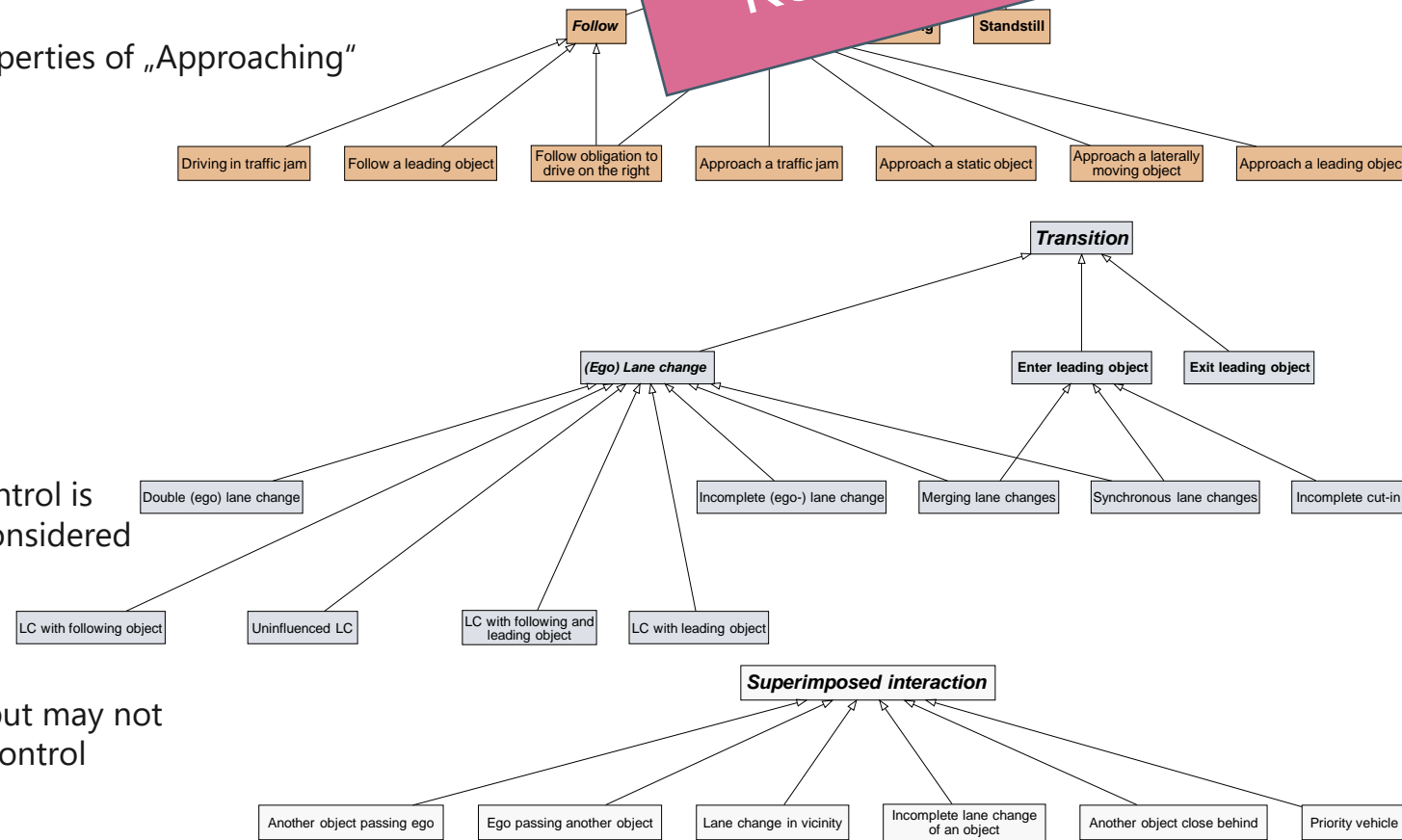
- State with an unambiguous leading object as reference for longitudinal control
- Example: *Following*

– **Transition**

- State in which the reference for longitudinal control is ambiguous, multiple objects may need to be considered
- Example: *Lane change*

– **Superimposed interactions**

- Interactions that are relevant for the scenario but may not necessarily serve as reference for longitudinal control



Building sequences of basic scenarios

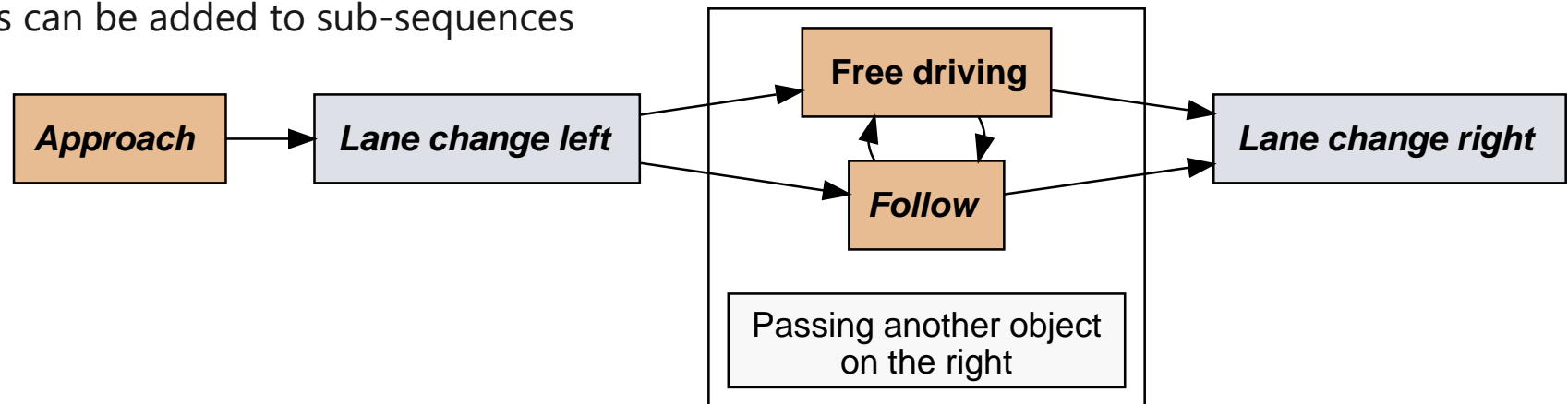
- Composite scenarios can be derived from the building blocks
- Sequences of states and transitions
 - Transitions can also follow on each other (e.g. leaving following state as lead vehicle accelerates)

Kein VVM Inhalt

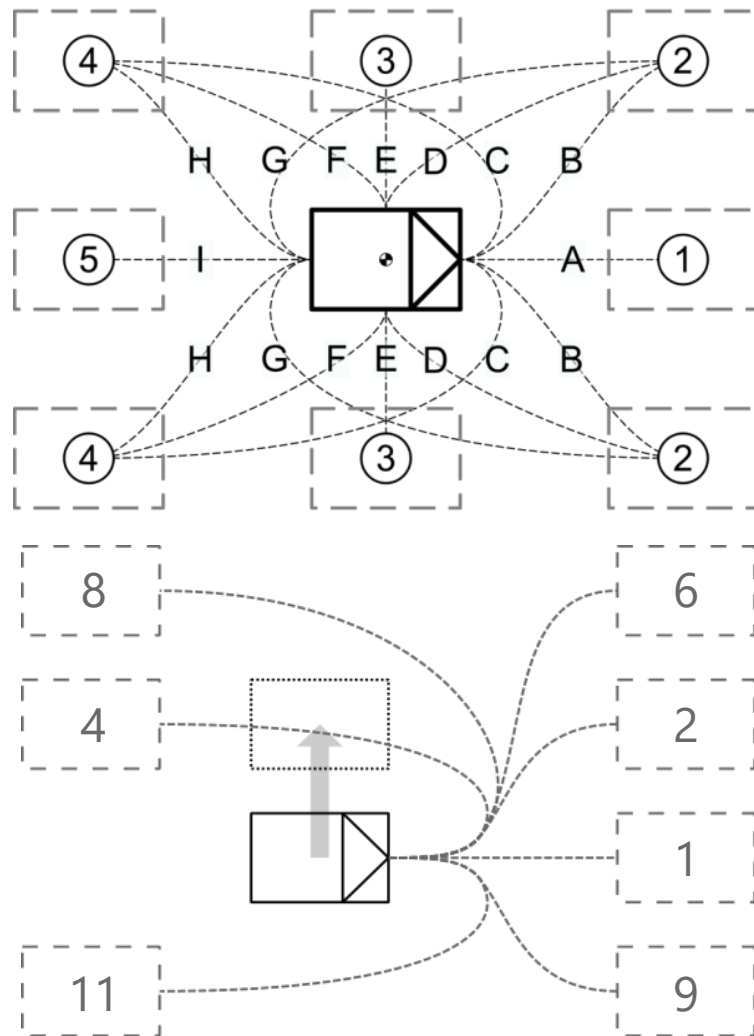
- Example – „Cut-out“:



- Superimposed interactions can be added to sub-sequences
- Example – „Overtaking“:



Extending the challenger approach to lane changes



Going straight

Impact	Initial Position	Path	
Front	1	A	
	2	B	
	4	C	into path challenger
Side	2	D	Slower side swipe challenger
	3	E	Side swipe challenger
	4	F	Overtaking side swipe challenger
Rear	2	G	Slower rear end challenger
	4	H	Rear end turning into path challenger
	5	I	Rear end challenger

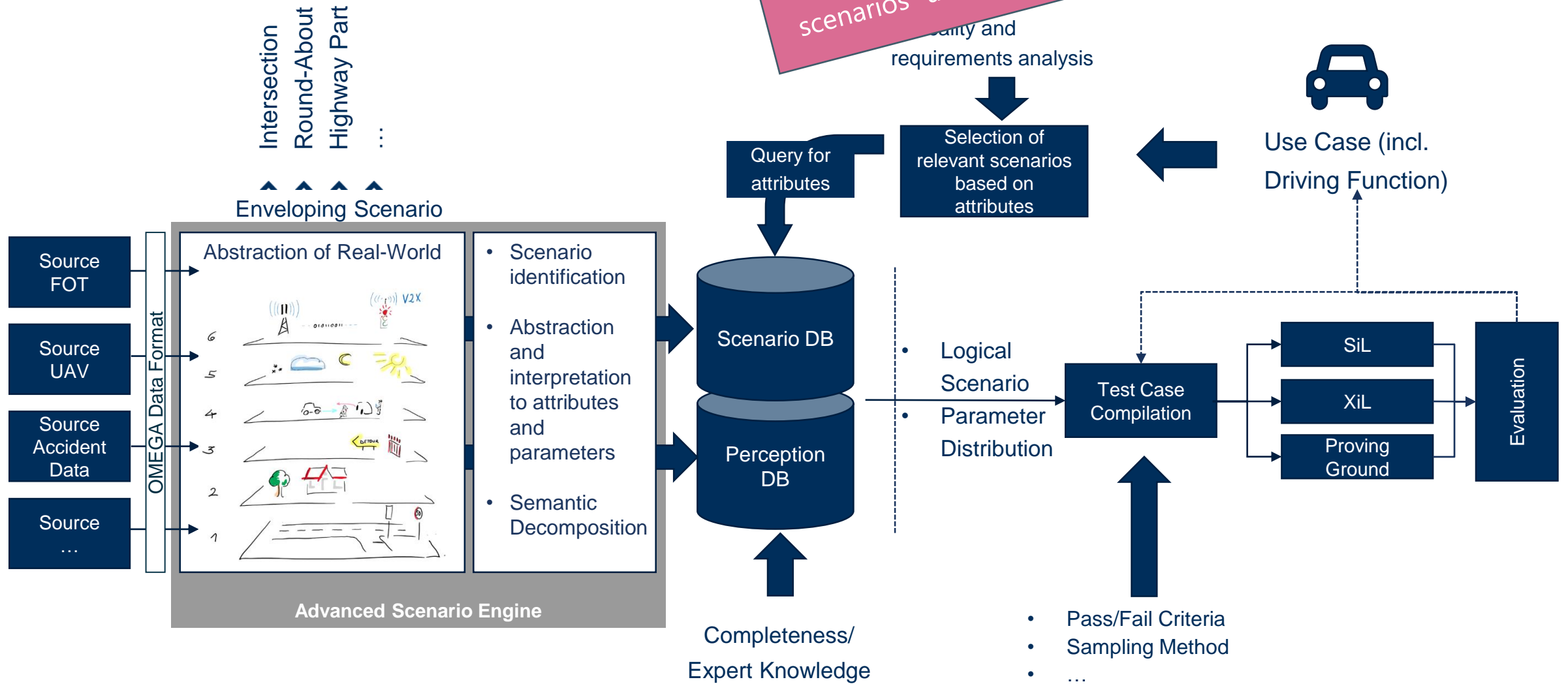
(Ego-) Lane Change

Impact	Initial Position	Path	Indication
Front	1	$A_{LC, sync}$	Synchronous Lane Change
	2	$B_{LC, near}$	Merging behind a slow or decelerating object
	6	$B_{LC, far}$	Merging Cut-In
	4	$C_{LC, near}$	Merging behind an overtaking vehicle (then decelerating)
	8	$C_{LC, far}$	Overtaking merging Cut-In
	9	$B_{LC, sync}$	Synchronous Cut-In
	11	$C_{LC, sync}$	Overtaking synchronous Cut-In

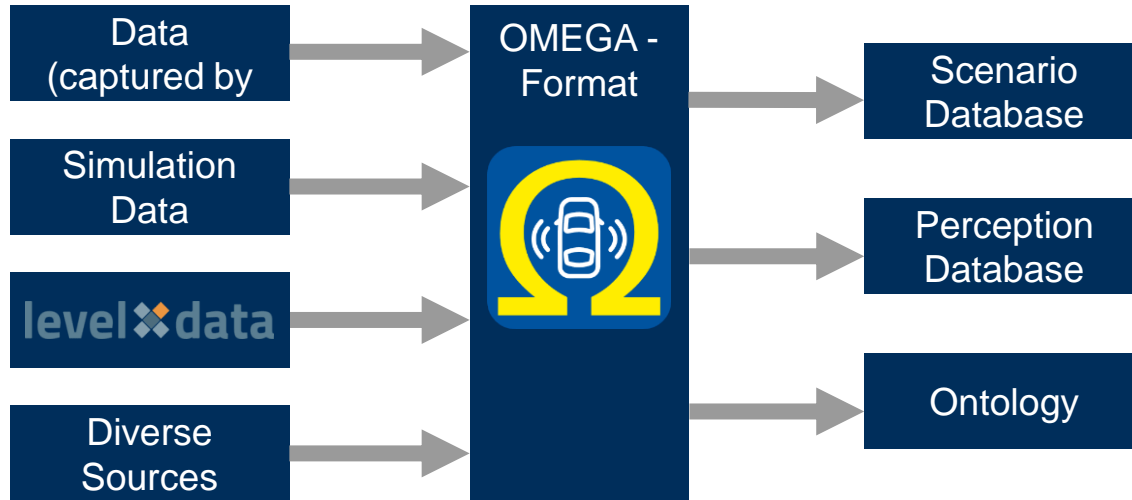
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Context of the Advanced Scenario Engine in V&V

Teil des Vortrags „A story of scenarios“ auf dem Halbzeitevent.



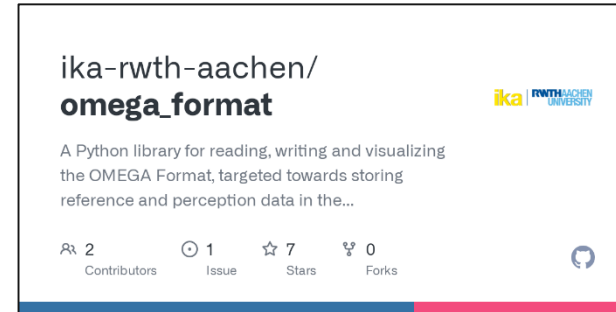
Omega Format as an Interface



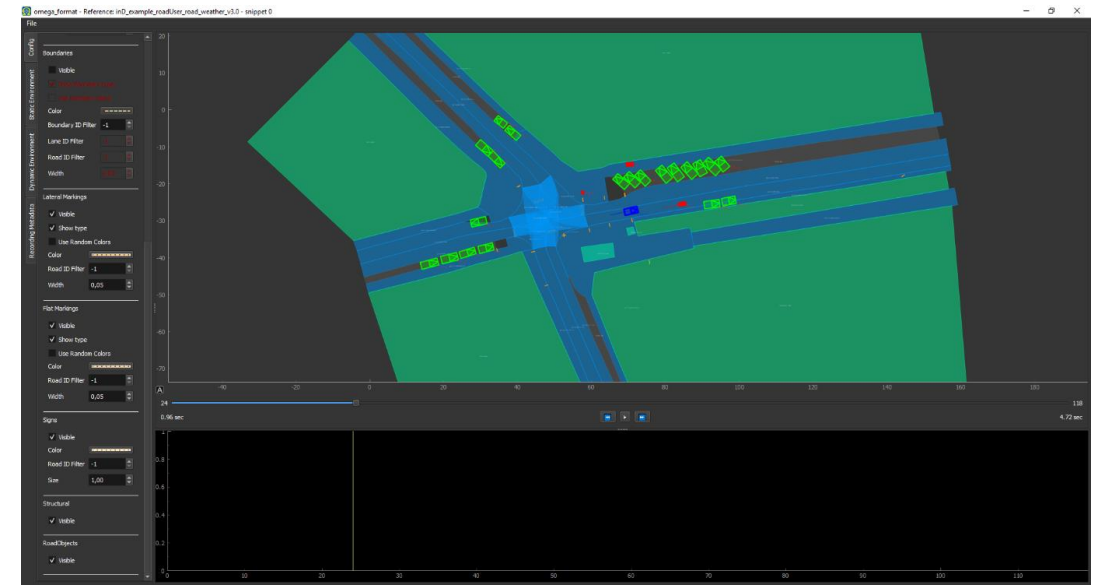
- Object-list-based data structure for reference data on all layers of the layer model
 - Includes map information
 - Includes detailed weather information
 - Includes L3 (temporal modifications L1 & L2)
- Converters for most popular formats (OpenDrive, Lanelet2, LevelXData)

Kombination zweier Folien zum Omega Format am HZE.

github.com/ika-rwth-aachen/omega_format



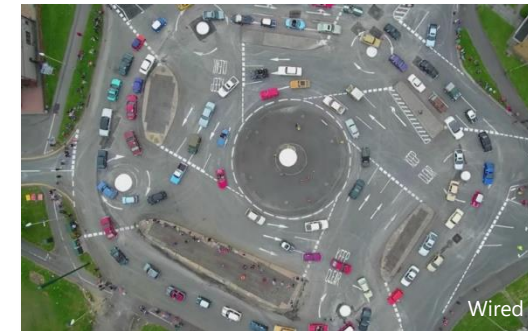
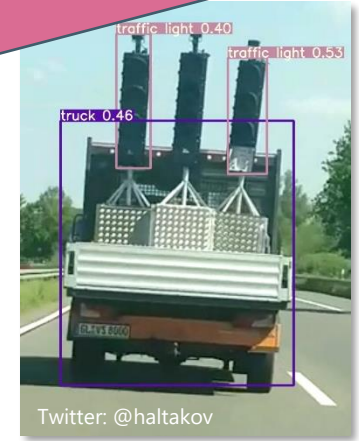
- Python API
- C API
- Data Verification
- Visualization



Hi-Drive's Edge Case Database

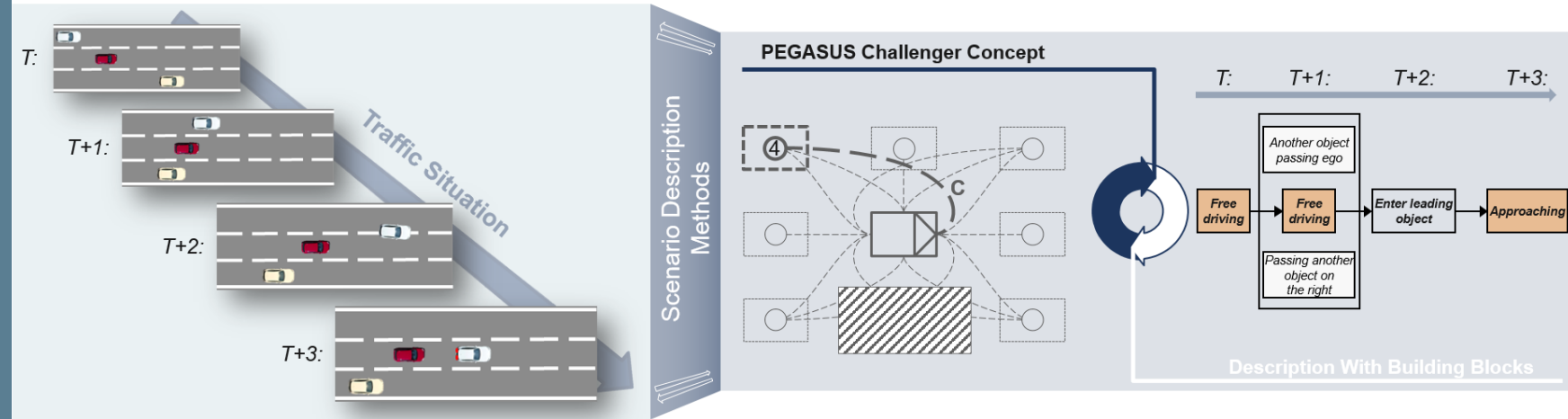
- Supporting the evaluation of effects in Hi-Drive, driving scenarios are collected in a dedicated database and investigated the data for **edge cases**
- Ongoing work: Defining the term and scope of edge cases within the project
- We consider all operations as potentially delivering edge cases:
 - On-road
 - Test Track
 - Simulator studies
 - Virtual simulations
- Storage of scenarios and edge cases in an aggregated data format

Kein VVM Inhalt



Conclusion

- Basic Scenarios
 - Scenario Database
 - Edge Case Database
- Codebook for motorway scenarios soon to be available
 - Data format addressing all layers of 6-layer-model for database ingress
 - Scenario Engine building on established concepts
 - Collecting and sharing extreme occurrences of scenarios and unknown situations



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The logo for fka, featuring the lowercase letters 'fka' in a bold, white, sans-serif font.

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