Database of relevant traffic scenarios for highly automated vehicles

Autonomous Vehicle **Test & Development** Symposium 2017

PEGASUS

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fka

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Key Figures

42 Months Duration	January 1st , 2016 – June 30th , 2019
17 Partners	▪ OEM: Audi, BMW, Daimler, Opel, Volkswagen ▪ Tier 1: Automotive Distance Control, Bosch, Continental Teves ▪ Test Lab: TÜV SÜD ▪ SME: fka, iMAR, IPG, QTronic, TraceTronic, VIRES ▪ Scientific institutes: DLR, TU Darmstadt
12 Subcontracts	▪ i.a. IFR, ika, OFFIS
Project Volume	▪ approx. 34,5 Mio. EUR ▪ Funding: 16,3 Mio. EUR
Personnel Deployment	▪ approx. 1,791 man-month or 149 man-years

Current State of Development of HAD

Prototypes

- Multitude of prototypes built by OEM with HAD-functionality
- Evidence, that HAD is technologically possible
- Partially tested in real traffic situations
- Test drives involve backup safety driver at all times

Lab / Testing Ground

- Individual analyses to optimize prototypes
- Current test stands/ testing grounds do not provide enough test coverage for all HAD features currently in focus
- There is no procedure for adequate testing (particularly performance) of HAD-systems

Products

- No release or introduction of variety of HAD features without sufficient assurance

current status

Central Issues of the Project

What level of performance is expected of an automated vehicle?
How can we verify that it achieves the desired performance consistently?

Scenario Analysis & Quality Measures

- What human capacity does the application require?
- What about technical capacity?
- Is it sufficiently accepted?
- Which criteria and measures can be deducted from it?

Implementation Process

- Which tools, methods and processes are necessary?

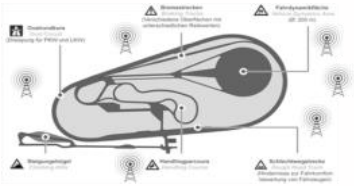
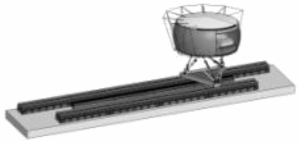
Testing

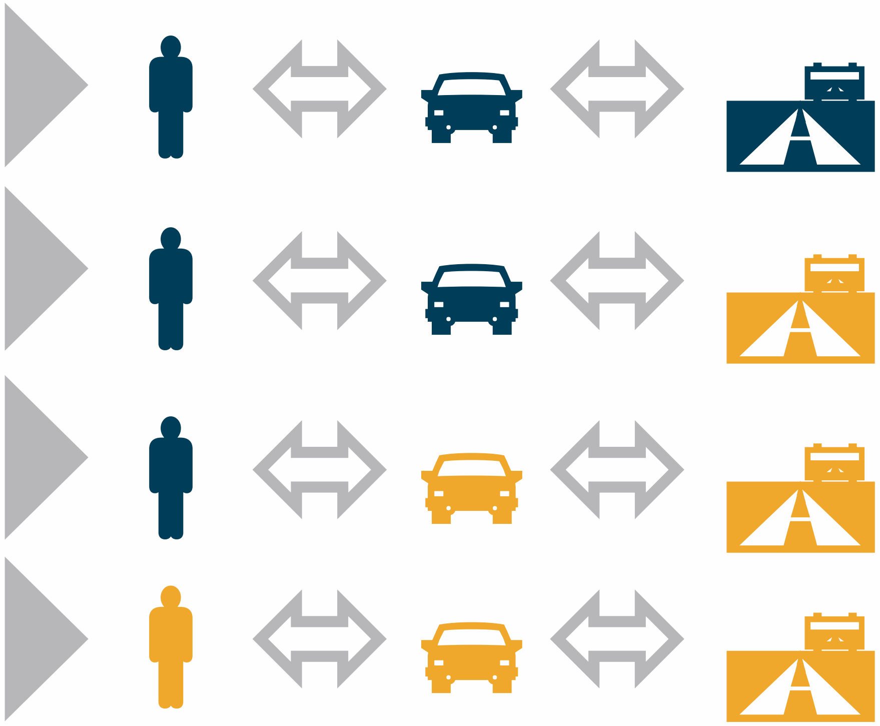
- How can complete-ness of relevant test runs be ensured?
- What do the criteria and measures for these test runs look like?
- What can be tested in labs or in simulation? What must be tested on test grounds, what must be tested on the road?

Reflection of Results & Embedding

- Is the concept sustainable?
- How does the process of embedding work?

Currently available Methods and Tools

Infrastructure	Methods	DRIVER VEHICLE ENVIRONMENT
	Field Operational Test	
	Controlled Field	
	Dynamic Driving Simulator	
	Simulation	



REAL

Increase of Validity

Increase of Costs

VIRTUAL

Challenges on Validation Methodology for HAD

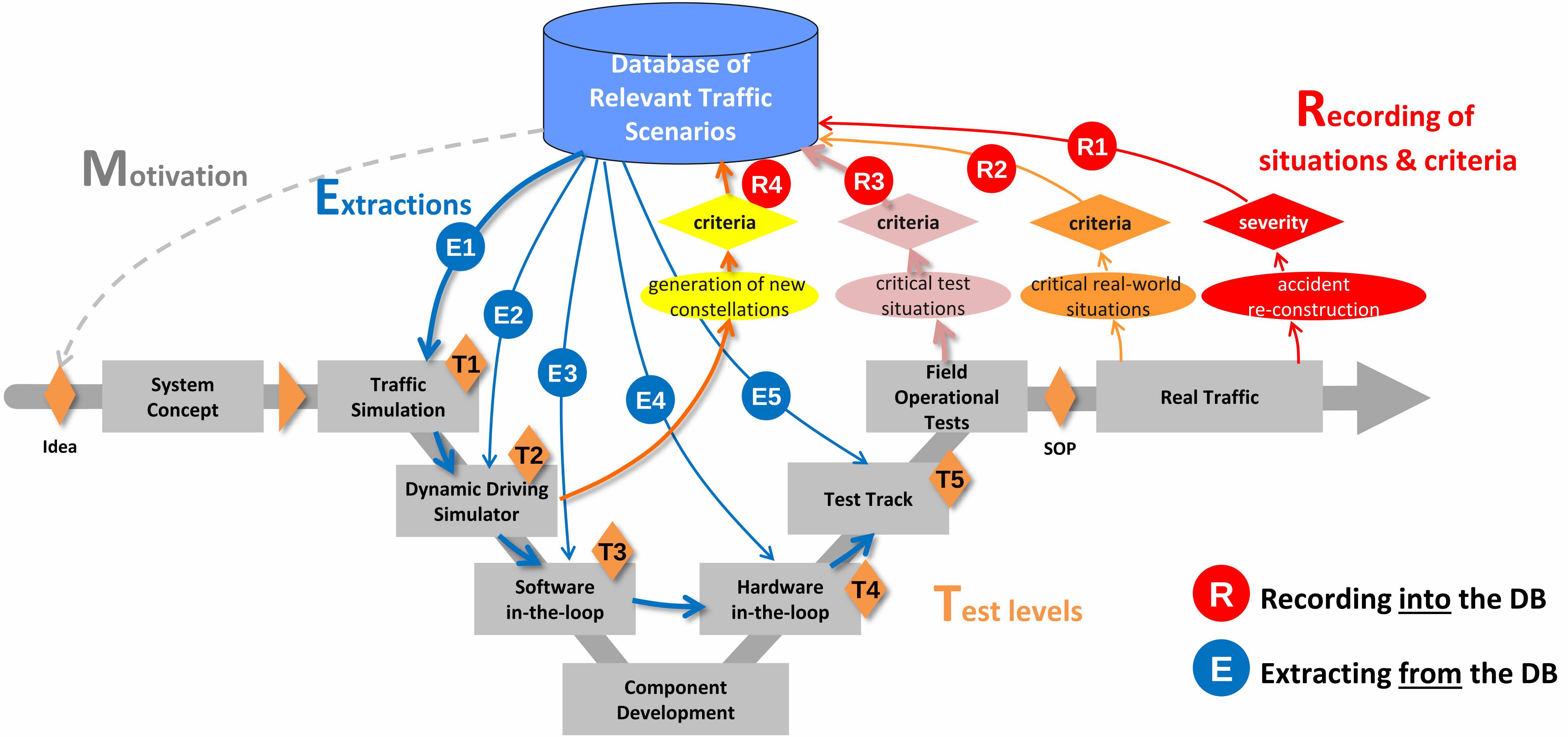
PEGASUS

- **No accepted evaluation framework** for ADAS is available balancing effectiveness, controllability and acceptance (<Level 3)
- **No evaluation methodology** available for **automated driving** (≥Level 3)
- **Safety impact** of automated driving is difficult to determine, no measurements possible
- Often **user related issues** are the limit of automated functions (e.g. take over, mixed mode)

Approach

- **Database** of Relevant Traffic Scenarios

Circuit of relevant Scenarios



Data Sources

- Relevance
  "Which scenarios are relevant?"
  - Differentiation between human behaviour leading to a critical situation (e.g. low distance to preceding vehicle) and critical scenarios due to traffic constellation (e.g. unstable behaviour of other vehicles)
  - Consideration of exposure frequency (→ FOT, NDS) and potential accident severity
  - Possibility to use expert knowledge for test case generation
- Reference
  "What is the reference for the capability of automated driving functions? How good is good enough?"
  - Evaluation of human capability in a scenario. „How large is the amount of driver population, who can avoid an accident?" (→ accident data, driving simulator, traffic data)

real
- Traffic Data
  - Real world driving
  - Field Operational Test (FOT)
  - Naturalistic Driving Study (NDS)
- Proving ground test
- Accident Data

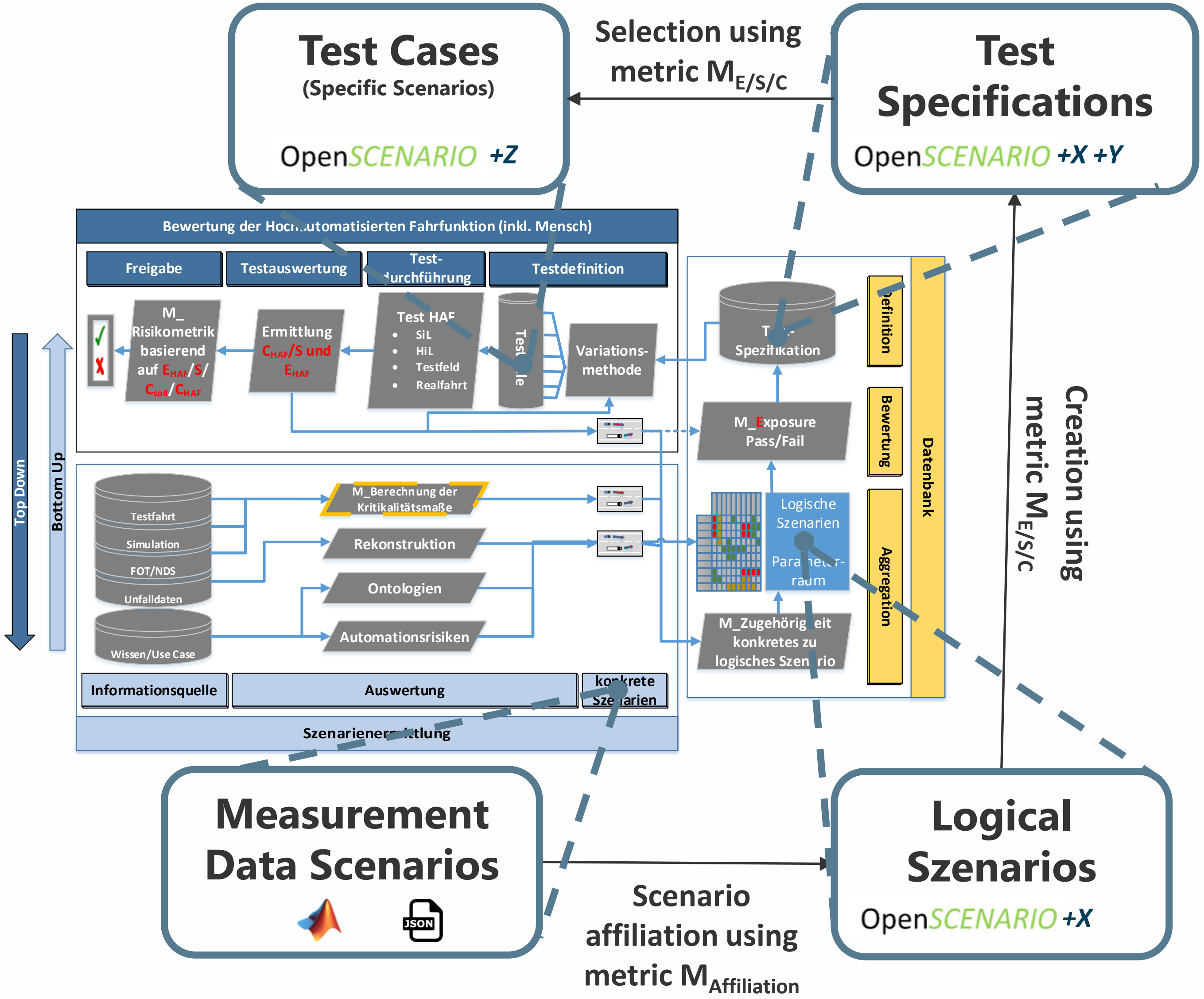
virtual
- Traffic Simulation Data
- Driving Simulator Data

verbal
- Expert Knowledge

Data Sources - Examples

Data Sources	Situation Description	Situation Relevance	Situation Reference

Metric Perspective – From Data to Test Cases

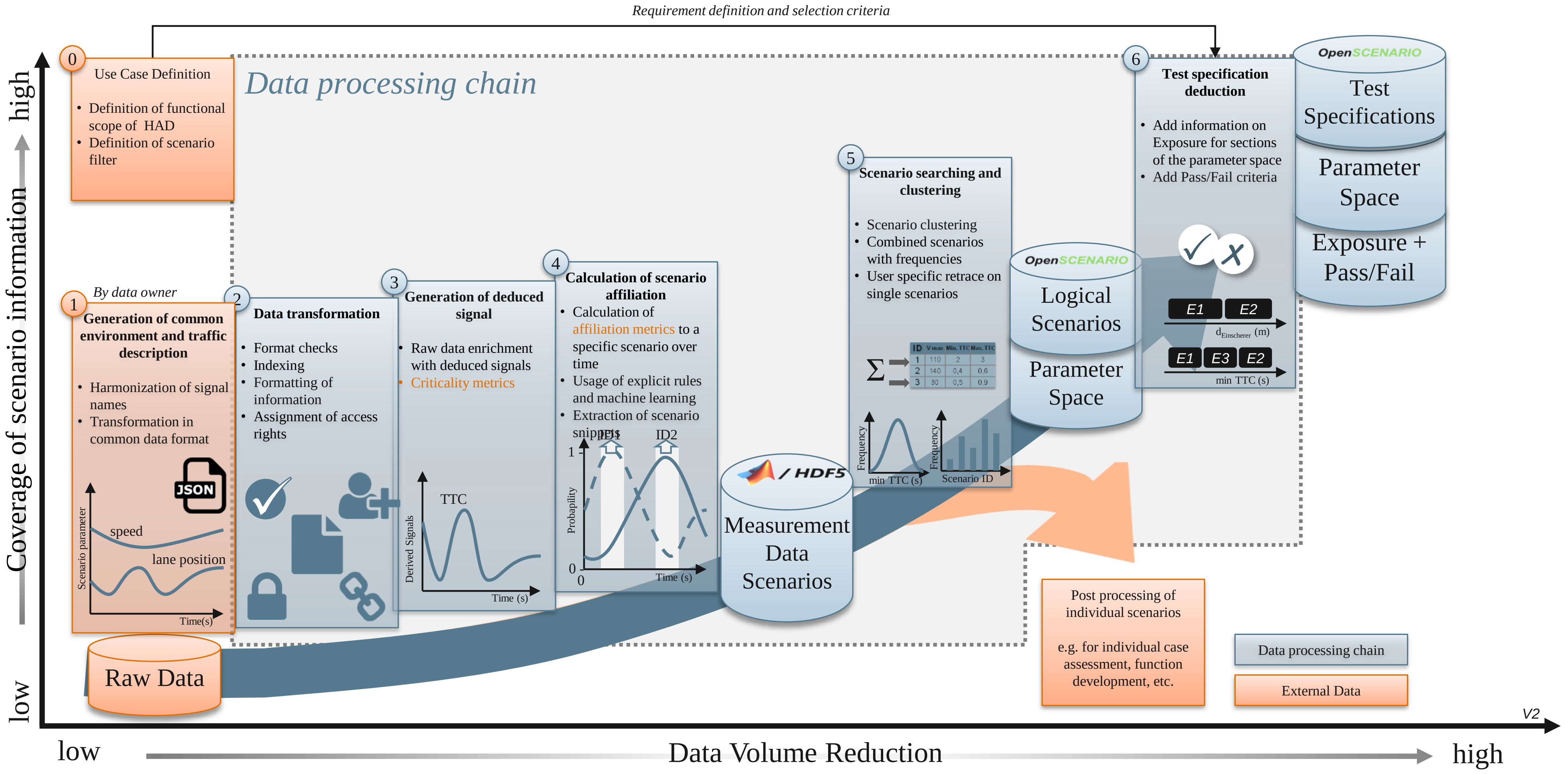


X: Parameter space

Y: Information on exposure and pass/fail-criteria on logical scenarios

Z: Relevant information for test performance (selection test environment etc.)

Data Base + Data Process Chain



Technical Implementation - User Interface

Summary

- Test and evaluation of highly automated vehicles requires new methods and tools for an efficient safety approval process.
- Safety approval cannot be achieved for highly automated vehicles with available methods and tools within a limited time and budget. Therefore a new method is proposed: the circuit of relevant scenarios.
- Today‘s available methods and tools can be integrated in a circuit of relevant scenarios for safety approval and therefore increase the effectiveness of the new approach.
- The central element of the circuit of relevant scenarios is a data base and an according data base processing toolchain, which is currently created in the research project PEGASUS.
- The toolchain must be capable to include and use different data sources and therefore heterogenic data and data quality.
- The proposed data base concept can realise an efficient and effective data processing in a common framework with a common tool chain.

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