www.pegasusprojekt.de

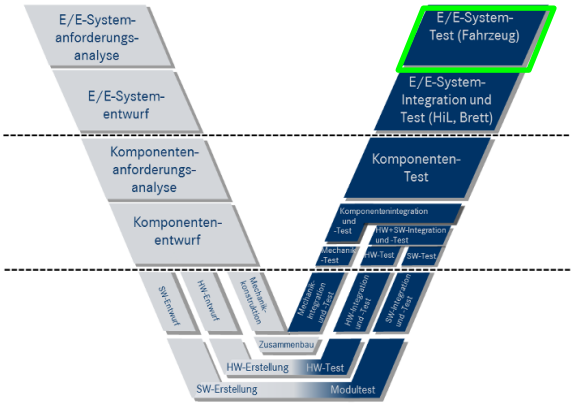
BASICS FOR TESTING – Booth No. 16

TEST CONCEPT – GENERAL V-MODEL AND SCOPE OF PEGASUS

PEGASUS

PEGASUS Method for Assessment of HIGHLY Automated Driving Functions

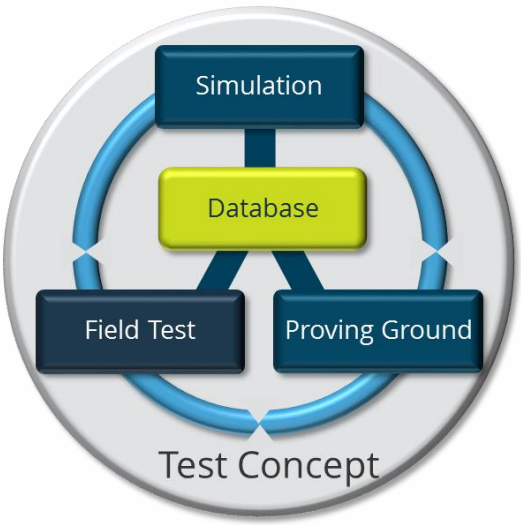
General V-Model and Scope of pegasus



Scope of PEGAUS

- Safequarding the AD-Function regarding risk of collision
- Sensor performance as an input for system performance

Goal of PEGASUS: development of a method to generate an evidence regarding the safeguarding of a Level-3-system (Autobahnchauffeur, max. 130km/h)



Other HIGHLY Autamated Driving Functions relevant topics covered by OEM, Suppliers or regulations: (examples)

- Testing according ISO26262
- Direct safeguarding of the sensor performance
- Safeguarding of
  - Interaction with driver
  - Meet traffic rules

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TEST CONCEPT – OVERVIEW OF PEGASUS-TOOLS

PEGASUS

Data base

Goal:	Collection of all relevant scenarios (e.g. cut-in) metrics (e.g. TTC) and pass criteria (e.g. no accident)
Input:	Data from field, derived test cases from knowledge, certification, automation risks
Output:	Scenarios and parameters (incl. distributions), pass criteria

Simulation

Goal:	Testing of all scenarios from the data base including variation of parameters (e.g. speed, duration of cut-in) Identification of scenarios with risk of collision Number of test cases: >> ~10.000
Input:	Scenarios and parameters (incl. distributions), pass criteria/metrics for criticality,
Output:	Original OEM-SW Code as system under test Evaluated Scenatios and the probability for accident scenarios

Proving ground

Goal:	Test of selected scenarios A) Special or critical test cases, e.g. derived from automation risks or certification B) critical test cases identified in simulation to validate the result of the simulation Number of test cases „~30“
Input:	Vehicle Trajectories derived from scenarios, pass criteria, original vehicle as system under test
Output	Evaluated Scenatios and data for the validation of the simulation

Field test

Goal:	Test of the AD-function in real wolrd traffic (e.g. long term testing at OEM)), but no guidance regarding scenarios or test cases, data collecting for data base
Input:	Guidance of routes or surrounding conditions (if possible), pass criteria, original vehicle as system under test
Output	Evaluated real world test drive, measurement data as input for data bases

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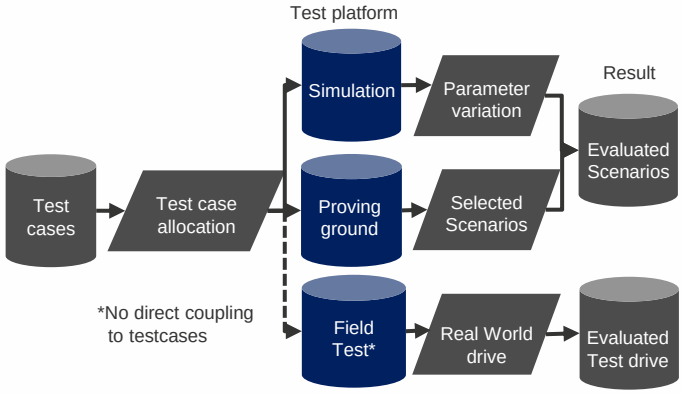
TEST CONCEPT

From a logical scenario to a test case.

Parts of a conclusive test concept, how does the test case allocation take place and how does the test procedure works?

Test case allocation:

- **Simulation:**
  - All logical test cases regarding scenario based testing with a high number of scenarios but a low relevance regarding real sensor performance
- **Proving ground:**
  - Pre selected tests, e.g. certification tests
  - Test with a high relevance regarding drive dynamics and real sensor performance
  - Rare events which can hardly be seen in field tests
- **Field tests:**
  - Tests with a high relevance regarding real system performance under a high variation of surrounding conditions



Starting from the space of test cases, the test cases get assigned to the PEGASUS test platforms.
Hereby “all” logical scenarios within the space of logical test cases get tested in the simulation. (refer to column on the left side)
Based on the automatized/stochastic variation of the logical scenarios parameter, concrete test cases are created. These test cases get evaluated regarding the Pass-/Fail-Criteria. For end conditions refer to the bottom of this poster)

Deviation of test cases for simulation by stochastic parameter variation and test automatization respectively, for the test ground based on manual selection or identification of relevant scenarios within the simulation

Critical cases (i.e. not fulfilled or close fulfilled Pass-criteria) get retested in real cars on a **proving ground (PG)**. In addition, manually selected concrete test cases can be evaluated on the test ground (i.e. accident scenarios, rating or certification tests).

Within **field tests** it is not possible to test specific test cases. Instead, the behavior of drive features get tested in real traffic. The major target is to find “surprises” (i.e. new scenarios, new parameters). These surprises may be enforced by different guidelines in route (i.e. tunnel) or time (i.e. low sun).

Test result:

Based on Pass/Fail criteria evaluated concrete scenarios for simulation, test ground and field test Probability for accident scenarios

Test end criteria regarding simulation (suggestion):

- Create transfer function between scenario parameters (input) and test result (output, e.g.accident yes/no, distance between ego-vehicle and relevant target):
  Target value for quality of transfer function (e.g. R_Qd-value) ≥ 80%*
- Calculate standard deviation σ of computed probability for accident scenarios: **Target value for σ ≤ 20%***

→ Refer to Booth 21 for Details

*according state of the art

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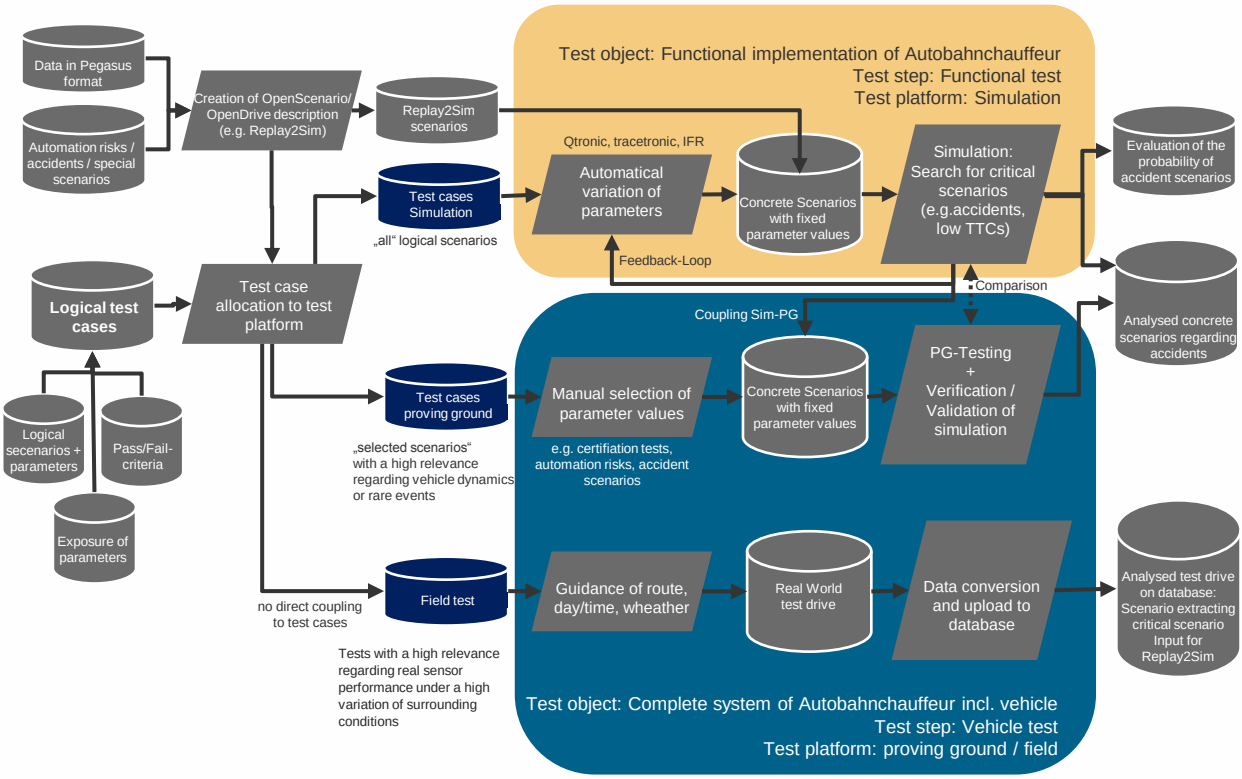
TEST CONCEPT

PEGASUS

Test concept: Detailed illustration



Examples for PASS-/FAIL-Criteria

No Accident
→ distance to surrounding traffic etc. >0

Correct distance to ahead driving traffic
Not leaving Ego lane
(except for a lane change)

Meet with speed limits or other traffgic regulations

Main criteria for Simulation / Proving ground in Pegasus

Additional criteria for field testing

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