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GOAL – Booth No. 31

INTEGRATION OF PEGASUS TOOLS INTO UNECE-CERTIFICATION

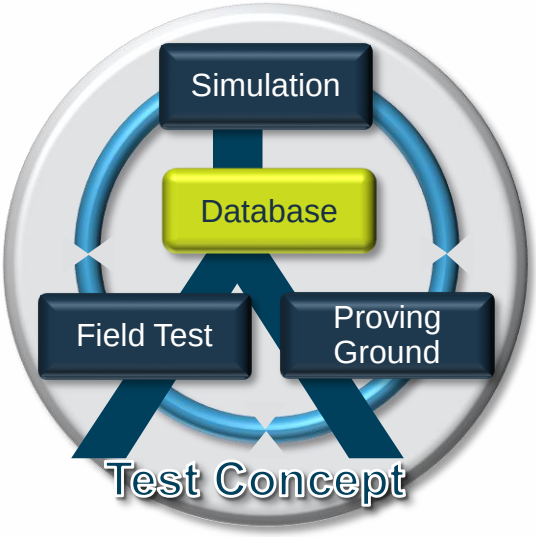
PEGASUS

PEGASUS Method for Assessment of HIGHLY Automated Driving Functions

- The objective of PEGASUS Testing was to develop the PEGASUS method regarding completeness, correctness and consistency.

- The method consists of the components:
  - Simulation incl. Test Automation
  - Proving Ground
  - Field Test
  - Database
  - Test Concept

The method could be used in two ways:
- During the development phase for assessing the current status.
- At the end of the development to derive the Safety Statement.



Database

Goal:	Representative collection of all relevant scenarios, metrics, pass criteria
Input:	Data from field, derived test cases from knowledge, certification, automation risks …
Output:	Logical Scenario and parameters (incl. distributions), pass criteria, Metric

Simulation

Goal:	Testing of all scenarios from the data base (scanning the parameter space for identification of scenarios with risk of collision)
Input:	Scenarios, parameters, pass criteria/metrics, ECO-SW-Code as system under test
Output:	Evaluated Scenarios and the probability for collision scenarios

Test Automation

Goal:	Based on stochastic variation within the parameter space of the logical scenario, concrete parameter sets are created automatically. The target is to execute a detailed search in the parameter space for critical parameter sets. A variance/probability based robustness analysis is performed in parallel. (part of simulation)
Input:	Logic Scenario and parameters (incl. distributions), pass criteria, Metric
Output:	Concreate Scenario (Parameter Set for Logical Scenario)

Proving Ground

Goal:	Test of selected scenarios A) Special or critical test cases, e.g. derived from certification B) critical test cases identified in simulation to validate simulation results
Input:	Vehicle Trajectories from scenarios, pass criteria, original vehicle as system under test
Output:	Evaluated Scenarios and data for the validation of the simulation results

Field Test

Goal:	Test of the AD-function in real wolrd traffic (long term testing)
Input:	global guidance of conditions, 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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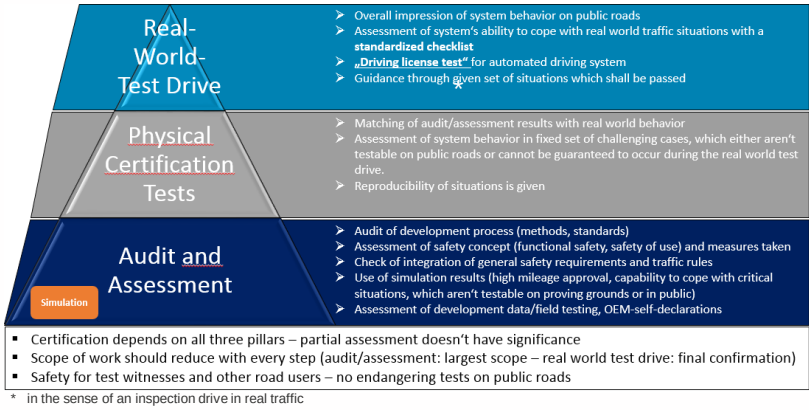
Mapping the PEGASUS Method for Assessment of HIGHLY Automated Driving Functions in the current discussion on type approval

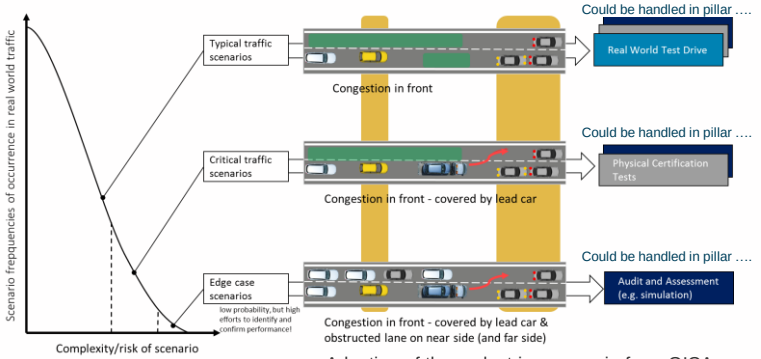
- The three pillar concept for Certification of Automated Driving Functions (Horizontal Homologation Approach of OICA)

- An ‘one-to-one transfer’ of the PEGASUS components into the Homologation process is not directly possible. But Key Components of the PEGASUS Method for the Assessment of HIGHLY Automated Driving Functions are contained in the proposals of OICA:
  - Scenario-Database
  - high-precision, robustly reproducible tests on Proving Ground (edge cases)
  - Core component becomes Simulation

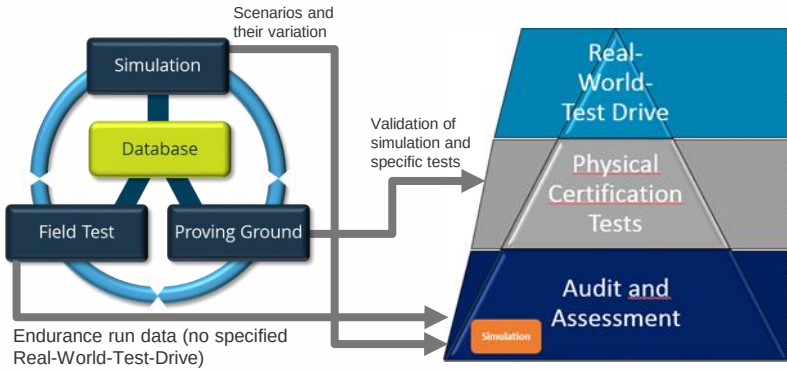
- Example of different pillars´function

- Pillar *Real-World-Test Drive* as certificate-specific proof with focus on safe traffic flow and compliance with traffic regulations.
  The validating scenarios of the simulation and specific tests are used in the *Physical Certification Tests* pillar.
  PEGASUS simulation component and endurance data are used as subset in the *Audit & Assessment* pillar.





Adaption of the pedestrian scenario from OICA



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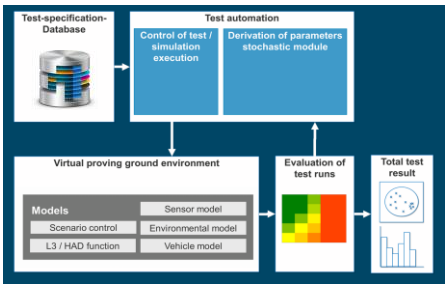
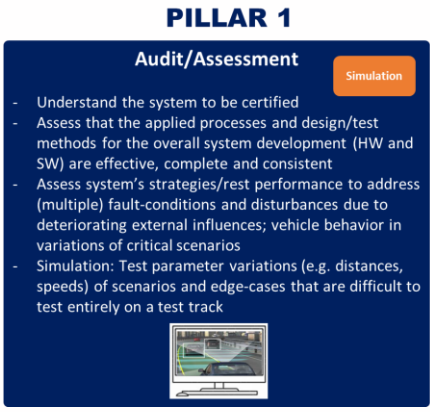
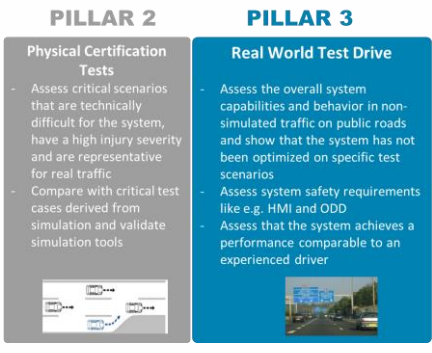
The new role of Simulation

- Variants/variations of certain scenarios for an automated driving functions are extremely comprehensive/multifaceted and can not be reproduced completely/practically in a reasonable timeframe on the proving ground (e.g. different driving speeds, curve radii, environmental influences/weather, distances)
  - ➢ The objective of the simulation is therefore the identification of collision-relevant characteristics of scenarios on the basis of criticality metrics (e.g. residual distance) by parameter variation (scenario diversity).
- The physical assessment of individual components (e.g. sensors) should not be part of the simulation within the scope of certification, because individual requirements for components and their performance (even in the event of a fault) can vary greatly depending on the overall system.
  - ➢ The aim of the simulation should therefore be the evaluation of the overall system reaction.
- Simulation does not have the aim of replacing the field test 1:1
  - ➢ Objective is the evaluation of specific individual situations within the framework of event-based simulation
  - ➢ Furthermore, faults/impairments of the system as a result of environmental influences cannot currently be simulated directly via models, as no suitable physical models are yet available.
- Simulation challenges: System failures/impairments due to environmental influences are currently not fully simulable via models. Supplementation via field tests makes sense thus also continuous improvement of environmental/sensor models
- Standardization of simulation tool chain: useful and possible in many areas. No or only conditional standardization of manufacturer-proprietary simulation models and tools for e.g. vehicle behavior, sensors and driving functions.
- Validation Simulation tool chain for certification purposes: Possible through comparison with results of specific proving ground tests based on overall system reaction.
  - ➢ Use of PEGASUS modules as a component for future certification of automated driving functions in the "Audit/Assessment" and "Proving Ground Tests" pillars







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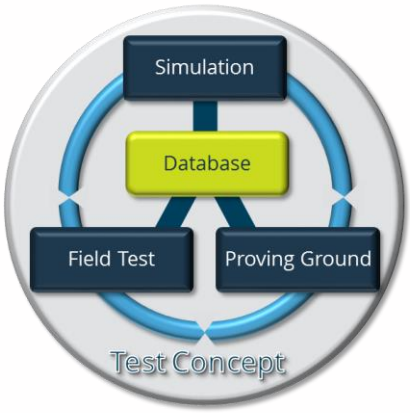
The role of the database

➡ The database is a key element in the PEGASUS Method for Testing Highly Automated Driving Functions.

- ➢ is the basis for testing variants/variations of relevant scenarios for an automated driving functions.

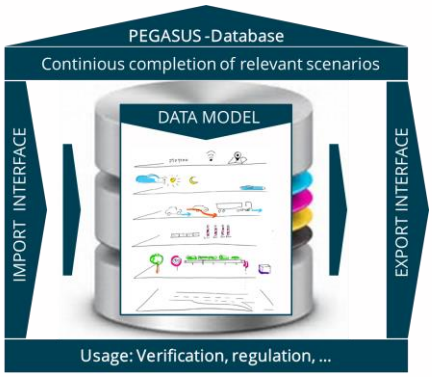


PEGASUS Method needs

- ➢Generalized, systematical model for parameterizable scenarios
- ➢Data on relevance of scenarios
- ➢Data on relevance of scenario parameters
- ➢Data on relevance of criticality in scenarios

PEGASUS specified in its work and discussed in workshops and bilateral meetings with international partners:

- ➢common harmonized input format that could be applied to different data sources and measurement requirements
- ➢Common harmonized output formats
- ➢Data model that allows storage and filtering



PEGASUS implemented a robust database mechanics that processes data and executes data filtering.

- ✓Comparable with the *necessity of having a representative data base with scenarios that automated vehicles could experience* of the multi pillar approach for certification of automated vehicles.

➡ The Role of the database after the end of the PEGASUS project:

In discussion different options for organizing the operation of the PEGASUS database, concretization: second half of 2019

- ➢independent non-profit Society, optionally as private / public partnership (model GIDAS)
- ➢open to anyone who is interested in participating
- ➢collection of representative scenario data of integrity
- ➢integrity sharing, generalized scenario data

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