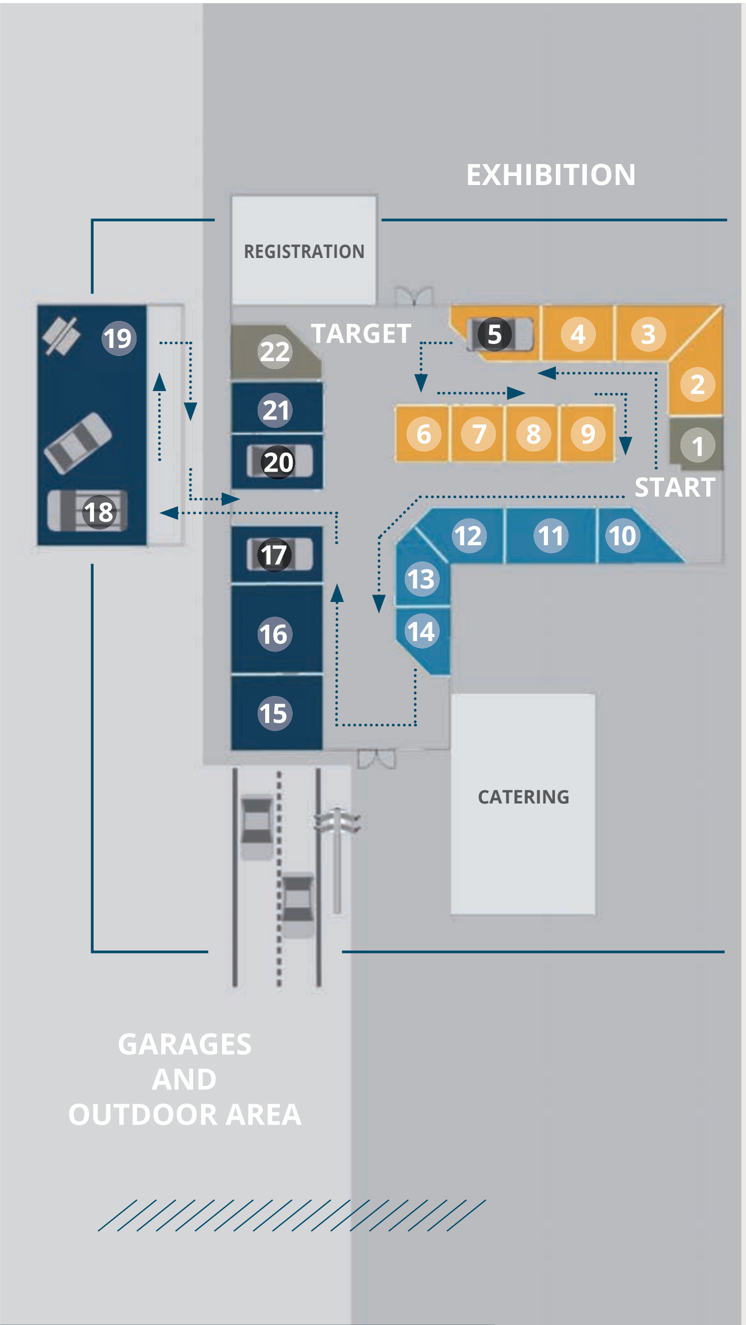

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PEGASUS

PEGASUS Symposium

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PEGASUS SYMPOSIUM – TOPICS

REQUIREMENTS AND CONDITIONS

„How good is good enough?" This is a simple question which is very difficult to answer when it comes to HAD (Highly Automated Driving). We currently don't know the necessary performance of an HAD system that can be socially accepted and is needed for the release. A second question builds up on the first one and simply reads **„How can we prove it?"** Starting from current state-of-the-art development processes, the PEGASUS project tries to provide a method to prove that a Level 3 HAD system can fulfill its requirements for safe operation in traffic.

In this exhibition we show selected (intermediate) results from the project. We begin with an introduction to existing state-of-the-art development processes (2) and then describe the example HAD system to be tested, the Highway Chauffeur (3). We then describe scenarios, the building blocks our method is based on (4), and also show first results of a study that analyzes the performance of human drivers (5), which serves as a comparison and a benchmark. In the following, we will go into detail about the potential risks that a HAD function might introduce (6) and also talk about the risks that are socially accepted when we want to release those systems to the market (7).

Finally, we analyze the limitations of a scenario-based approach (8) and propose a method to reduce the number of test cases (9).

BASICS FOR TESTINGN

A small amount of uniform and consistent tests sufficient for safeguarding a HAD-function is one target of PEGASUS. **"What are the necessary basics for carrying out the actual testing?"** In the overall process of PEGASUS, virtual testing of the relevant scenarios plays a central role. In order to support this, a standardized description format for scenarios has been developed that can be used at different level of abstraction (11). Thus, scenarios can be stored in a database and can be used within the overall process for function specification, use case analysis, test derivation / execution in the simulation and on the test site.

In addition, simulation requires standardized integration and access to geometry and infrastructure elements of real roads and test tracks on proving grounds as well as tools to customize them for virtual testing (14).

By using a test specification database relevant basic test scenarios are provided for safeguarding HAD-functions. For this purpose, data from different type of sources is harmonized and further processed using a uniform process chain. In this way, parameter spaces and test specifications based on them can be derived (12).

Key challenge of using a scenario-based approach is generating a sufficient small number of test cases. This task is assigned to the test automation (13). For a basic test scenario, test automation varies parameters for the tests carried out. The used values depend on observed distributions and extreme values. At the same time, it is validated whether the tests that had been carried out already cover sufficiently the underlying parameter space. If the test depth is not sufficient new runs are generated recursively.

The test concept (10) assigns the test cases to the test instances with a corresponding test target, including assessment metrics and pass criteria. Thereby, the strengths of the test instances and also methods for reducing the test effort are taken into account.

TESTING AND SAFEGUARDING

Simulation, in particular, offers a wide range of possibilities for time- and cost-efficient implementation. **„What is the intelligent realization of the process by which we provide evidence?"** A high degree of virtualization and parallel further development and intelligent integration of traditional test tools such as simulation, proving ground and field tests offer ideal prerequisites for covering the test space. In doing so, the topic area „Requirements & Conditions" provides release criteria and „Basics for Testing" provides the basics and prerequisites for the development of the test tools as described here.

Improvements in the field of phenomenological sensor simulation models (15) are associated with extensions to the presentation of the environment. For this purpose, material properties, object geometries and structural details have to be integrated intelligently. The first tests of the HAD function start in „software-in-the-loop" (16) or „hardware-in-the-loop" (17) frameworks. Key elements are the coupling with the test specification database, the integration of test automation and effort reduction plus an automatic verification of pass criteria.

The systematic transfer from simulation to real traffic events requires an extension of the test methodology on proving grounds (18). A high precision, exactly reproducible execution of script-based maneuvers becomes important. A coupled interaction with the simulation enables parallel, continuous validation. On the test site, novel support tools (19) such as independent collision avoidance (19a) or infrastructure-based monitoring for testing (19b) are added to the repertoire. The „Wizzard-of-Oz-Vehicle" (20) is an innovative test instance enabling an examination of human interaction with the HAD system at a very early stage. The example „Influence of Traffic Intensity" shows an integration in real life traffic tests. The final step in the overall verification process is the validation of test results by means of real life field tests (21). Here, concepts for an investigation of vehicle fleets equipped with HAD-functions are presented.