

Mid-Term Presentation 15 / 16 March 2022

From PEGASUS to VVM Where do we come from and why the PEGASUS Journey has not yet reached its Final Destination

Ulrich Eberle, Opel Automobile / Stellantis

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

The Starting Point



- SAE Level 2 System
 - Partial Driving Automation



ADS-equipped vehicle



Need of validation and safety proof of the vehicle + intended functionality of automated driving system within predefined operational design domain

N. Weber et al. "A simulation-based, statistical approach for the derivation of concrete scenarios for the release of highly automated driving functions", in AmE 2020 - Automotive meets Electronics; 11th GMM-Symposium, Dortmund, Germany, 2020, pp. 1-6, DOI:10.13140/RG.2.2.15306.31683/1

How good is good enough – How safe is safe enough?







Distance-based test approach is **NOT FEASIBLE** for automated driving functions A systematic **SCENARIO-BASED TEST APPROACH** is needed

PEGASUS Family and Sceanrio-Based Development & Testing







Bitte noch Titel hinzufügen!





More Refinement Needed

- Extension of OD to URBAN
- Knowledge and requirements analysis
- Regulatory and Legal Aspects
- Database architecture
- Test Distribution and Orchestration



- Coherent Overall Methodology
- Coherent Safety Argumentation

VVM Enables the Required Next Steps

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Why is the Urban Environment so Different?



Event-triggered TL Path Path B Y1 Path Path V1 Path B Vehicle 1 Optimized Approach Unknown Intentions Communication Infrastructure Difficult Structures Vehicle 2

New challenges emerging due to high situational complexity



Traffic Environment Missing Information on Driver Intentions Complex Road Structure Signal Phases & Queues

Also pedestrians, cyclists and playing children etc. need to be considered



ASKING THE RIGHT QUESTIONS ON CRITICALITY, BENCHMARKS & TARGETS

MASTERING COMPLEXITY AND PARAMETER EXPLOSION

DRIVING IN AN URBAN ENVIRONMENT

SAFETY THROUGH DECOMPOSITION, TRACEABILITY AND ARGUMENTATION

TEST DISTRIBUTION, ORCHESTRATION AND ANALYSIS

How can we cope with the OPEN-CONTEXT?





Goal I – Reduction of test cases Open World Challenge $\infty \rightarrow n$

Goal II – Industrial interfaces



Goal III – Shift to simulation



Beyond Technology: What do we mean by Safety or Acceptance Criteria? Society, Standards, Regulations ...





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A World Called Operational Domain



SAE J3016 OPERATIONAL DESIGN DOMAIN (ODD)

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The specific conditions under which a given driving automation system or feature thereof is designed to function, including, but not limited to, driving modes, under which a given driving automation system or feature thereof is designed to function.

→ The Operational Domain OD can be the full world or a subset



Six Layers to Structure Them All





M. Scholtes et al., "6-Layer Model for a Structured Description and Categorization of Urban Traffic and Environment," in IEEE Access, doi: 10.1109/ACCESS.2021.3072739

Structure is needed to understand the world and to decompose the complex challenges

Possible Interference

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Scenarios are Episodes featured in "Movies" called Functional Use Cases







From **PEGASUS Highway Chauffeur** functional description

to

Exemplary PEGASUS VVM "Customer Function" requirements document



Customer Function is the Actor coping with the World's Challenges



Refining Our Worlds





Development Phase

Our Plan for Today



| Day 1: Project, Goals and Topics | | | |
|----------------------------------|-----------------|---------------------------------------|---------------|
| Pegasus Family | | | |
| VVM Main Approach | | | uo |
| Argumentation Framework | | | hibiti |
| Methodological Approach | | | er Ex |
| Stream 1 Requirements | Stream 2 v&v | Stream 3 Data Processes & Tools | Virtual Poste |
| Wrap up | | | |

Deriving the building blocks out of the framework





Different Test Instances and Seamless Interplay





Databases and International Interoperability





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Thank you!

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