DSC 2023 EUROPE VR

Driving Simulation & Virtual Reality Conference & Exhibition

DLR

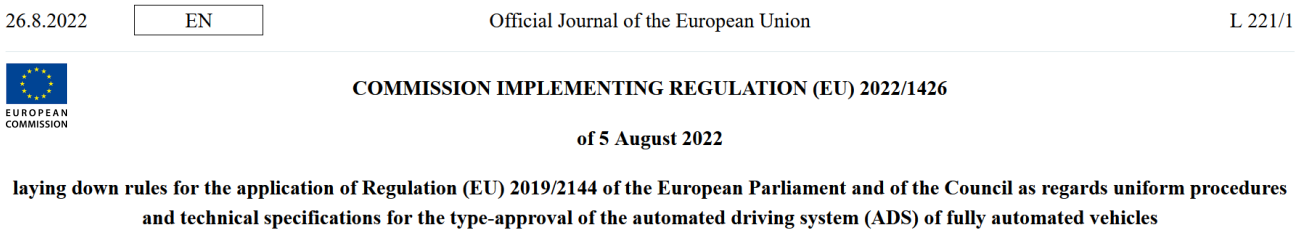
PEGASUS Project Family Perspective – Supporting the release of Automated Driving in Europe

Martin Fischer, Frank Köster, Henning Mosebach

Antibes

September 6th – 8th 2023

Status and Motivation for PEGASUS Family Projects



26.8.2022 EN Official Journal of the European Union L 221/1

EUROPEAN COMMISSION

COMMISSION IMPLEMENTING REGULATION (EU) 2022/1426

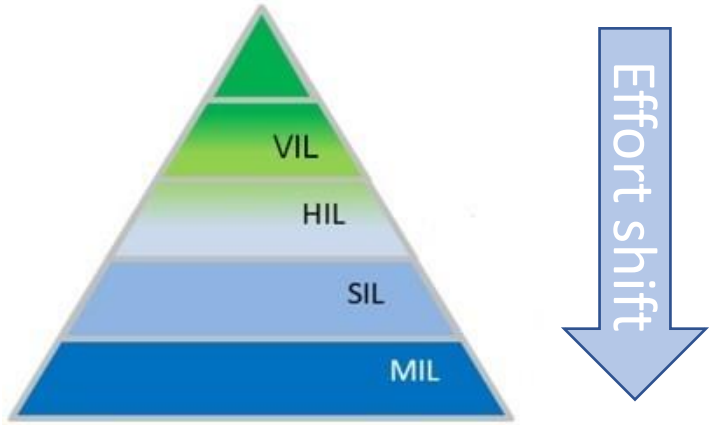
of 5 August 2022

laying down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of the automated driving system (ADS) of fully automated vehicles

- **The European automated driving deployment strategy** requires processes, verification and validation methodologies and technical frameworks for all stakeholders involved in the release process

- Verification and validation of automated driving functions requires a complete and interoperable **formalized safety assurance architecture/framework** with s**eamless toolchains,** V&V processes, generation of test scenarios and data on an **international harmonized basis**

- With PEGASUS, SET Level and VV Methods **the PEGASUS Family** projects are defining both – methodologies and frameworks matching the needs of release processes for the scenario based safety case



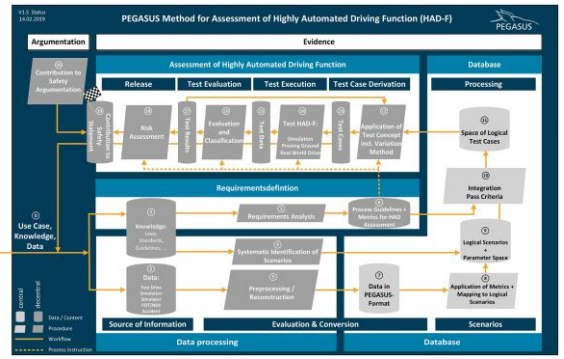
Goal: Assurance framework covering all needs of the safety case based on balanced virtual elements and real world data

The PEGASUS Family – Main Project Scope

PEGASUS FAMILY

PEGASUS

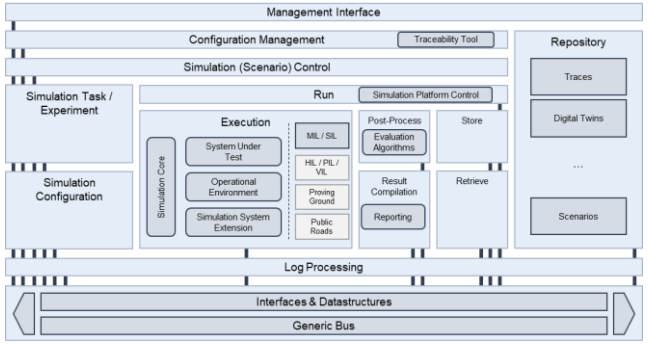
2016 - 2019



Basic methodological framework

SET Level

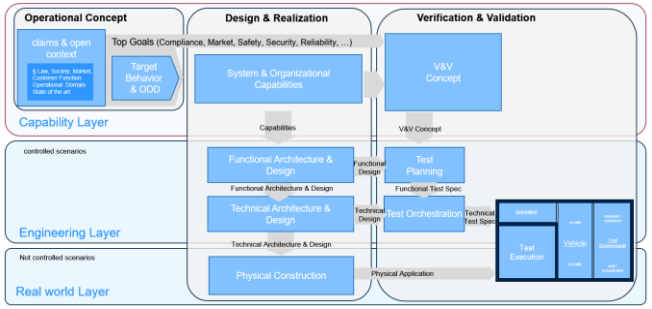
2019 - 2022



Ready to use configured simulation toolchain and framework

VERIFICATION VALIDATION METHODS

2019 - 2023

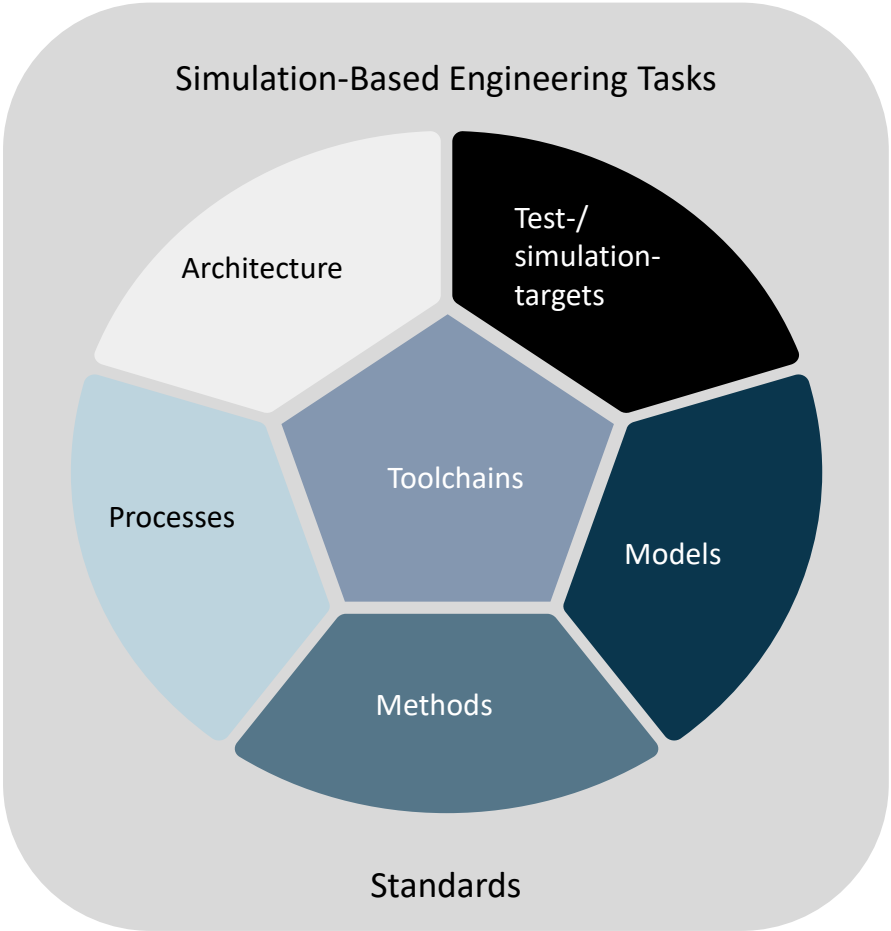


Overall methodology for the safety case containing a complete safety argumentation and corresponding processes

The SET Level Simulation Engineering Framework

SET Level

- Provides an environment for **simulation-based systems** exploration and understanding as well as verification & validation as a service
- Platform with highly **generic components** – open, flexible and extendable
  - Scenario-based approach
  - Adaption and configuration for special projects with low effort
  - Easy to use / “no experts needed”
- Supports a wide range of **development tasks, assessment & testing**
- Provides insights to support **safeguarding and homologation**
- OEMs, suppliers and IT vendors benefit from **standards** (drafts) / standardization activities initiated



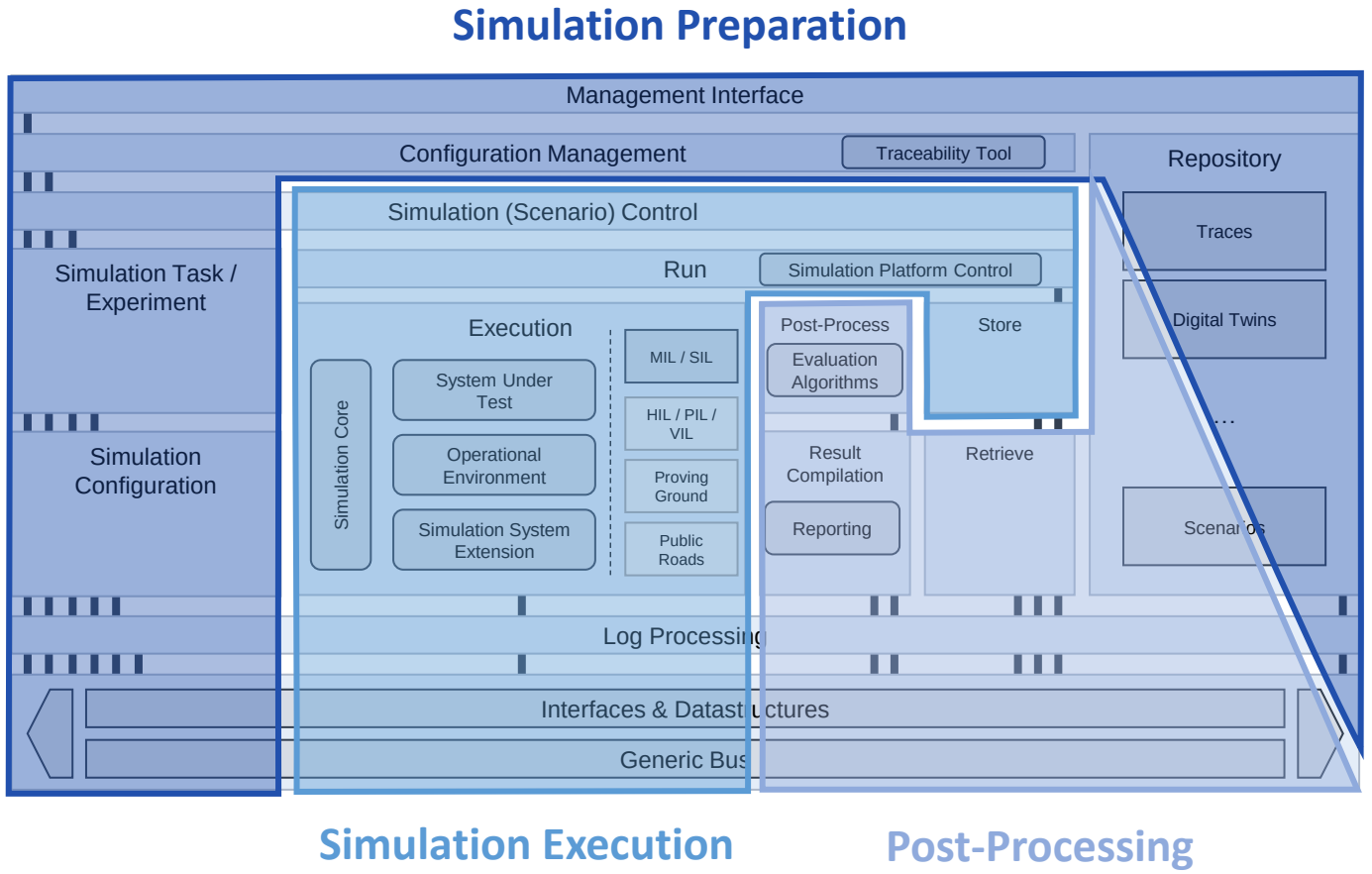
https://setlevel.de/en

SET Level Generic Open Architecture for Testing and Analysis Tasks

SET Level

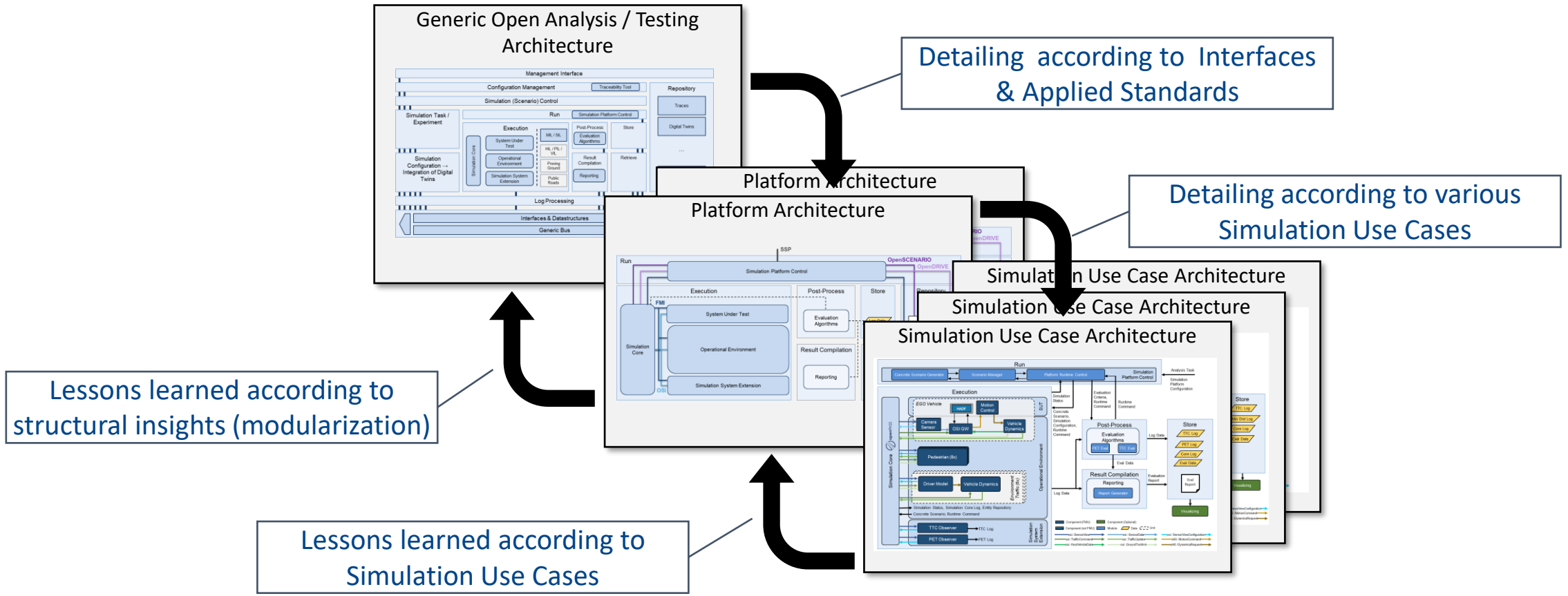
The **SET Level architecture** shall…

- … allow for references between **high-level architecture** and **concrete implementations**
- … apply up-to-date **simulation standards**
- … support **exchange of** separate **software modules, models and scenarios**
- … comprehend a **clear definition** of **interfaces and modules**



From Generic Open Architecture to Simulation Use Case Architecture

SET Level



SET Level - Standardization Activities

SET Level

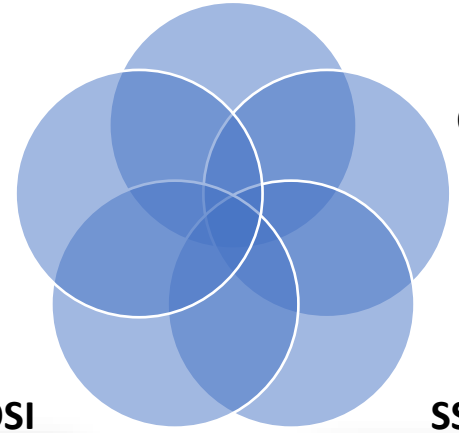
- Enabler for Modularity and Seamless Integration

Description of the scenario

OpenSCENARIO

Models are wrapped as FMUs

FMI



OpenDRIVE

Description of the map

OSI

All simulation models communicate through OSI messages

SSP

Specification of agent composition by multiple FMUs using SSP

Core fields of application for standards

- Simulation configuration (Scenario and map)
- Specification of parameter variation
- Programming interfaces
- Data exchange

Example of simulation model integration

The integration of various simulation models has been proven to work using OSI messages for communication and wrapping models as FMUs according to the FMI standard.

Contribution to standardization projects

SET Level not only uses the standards but actively develops further extensions and contributes to the standardization projects (e.g. ASAM, Modelica, SmartSE)

FMI = Functional Mockup Interface, OSI = Open Simulation Interface, SSP = System Structure and Parameterization

VV-Methods Goals

VERIFICATION VALIDATION METHODS

Goal I **Systematic control of test space**
- Understand relevant hazardous phenomena
- Involve traffic-law perspective
- Identify a target behavior & ODD

Goal II **Consistent interfaces**
- Systematic breakdown of technical contracts, requirements & tests
- Common interfaces for component exchange

Feasibility

Control of ODD

System Decomposition

V&V Distribution & Generation

Efficiency

Changeability

Goal III **Shift to simulation**
- Seamless use of virtual and real artefacts
- Efficient integration of simulation into the test-infrastructure

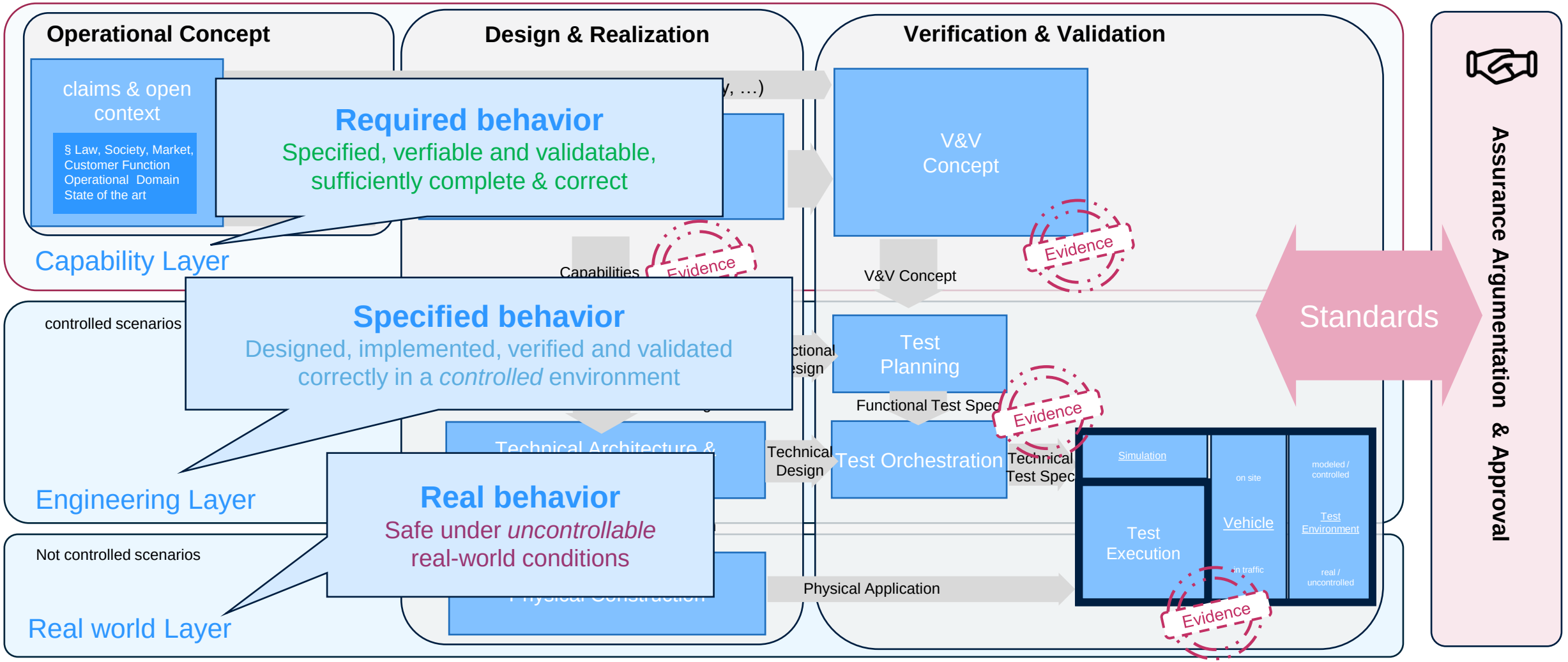
Goal IV – **Argumentation**
- Explainable Compliance

https://www.vvm-projekt.de/en/

VV Methods Assurance Framework

VERIFICATION VALIDATION METHODS

- Synchronisation between Assurance Argumentation Development/Operation, Design and V&V

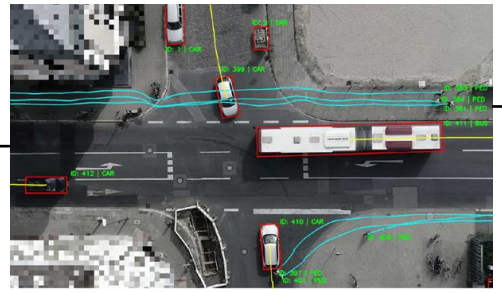


VV Methods Databases & International Interoperability

VERIFICATION VALIDATION METHODS

Scenario Data Source → Scenario Database & Processing → Scenario Selection & Test Instance Assignment → Scenario Execution → Assessment

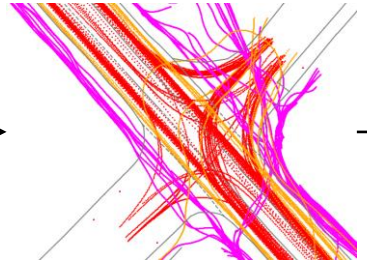
Real World Traffic Data



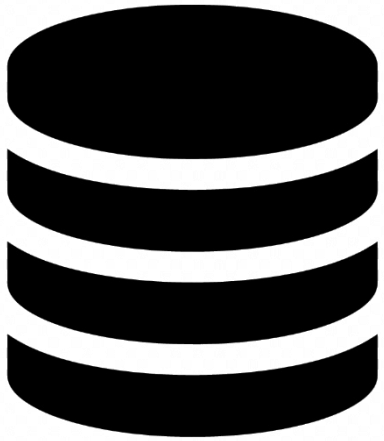
Extracted Data

Calibration

Traffic Simulation Data



Generated Synthetic Data



Database for Raw Data plus Semantic Scenario Database

Deployment of Scenario-Based Simulation Platform for Testing Level 3/4/5 ADS

- Focus on innovative test methodologies for the validation and verification of ADS in urban areas
- Real world scenario extraction
- Analysis based scenario generation
- Databases for Raw Data and Semantic Databases
- International Interoperability to be ensured

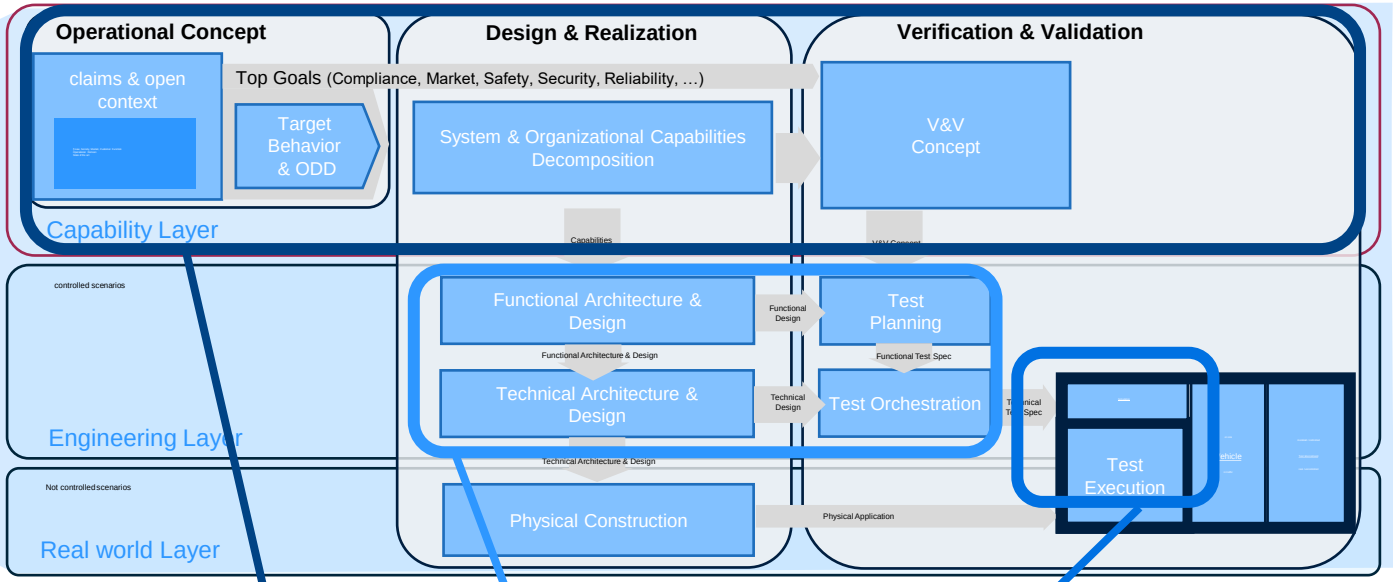
Scenarios are the glue!

Enables New Approaches for Development, Training and Validation of Automated Driving

Project Connections

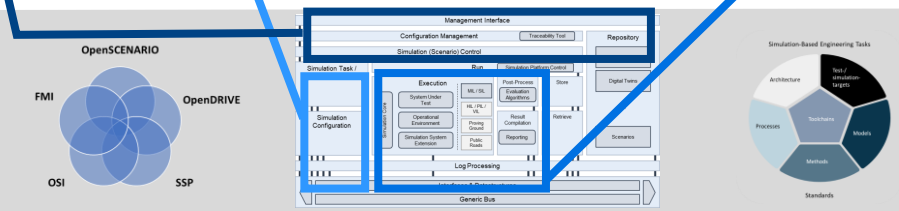
PEGASUS FAMILY

Safety argumentation layer structure



SET Level

Simulation-based Engineering Task



Linked projects

Scenario-based V&V

Data and Scenario Marketplaces

Safety Argumentation for AI

Open data and Service Pipeline

PEGASUS, SET Level and VV Methods – what's next?

PEGASUS FAMILY

VERIFICATION VALIDATION METHODS

Overall methodology for the safety case containing a complete safety argumentation and corresponding processes

Final Event Nov. 2023

SET Level

Ready to use configured simulation toolchain and framework

Final Event Oct. 2022

SIS 43 - Automated driving safety assurance – aligning methods, tools and databases

Future goals

- Stimulating the **application of VVM building blocks** to product and application driven use cases
- Connecting the VVM assurance framework process to **open data- and scenario marketplaces**
- Stimulating **continuous integration chains** linking assurance process steps with product release management (incorporating risk and law)
- Identification of B2B ecosystems linking **data- and scenario driven approaches** with V&V frameworks
- Identification of needs, gaps, hurdles, **future perspectives** applying the safety case and stimulating innovation projects

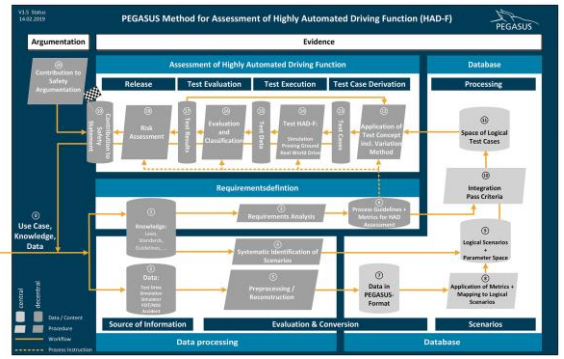
Shaping a continuous integration story

The PEGASUS Family

Contributions towards AD release in Europe

PEGASUS FAMILY

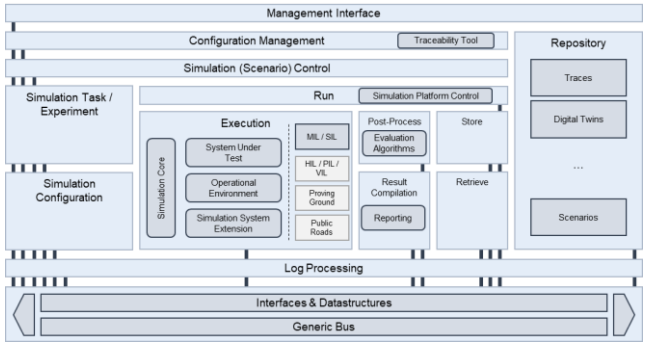
PEGASUS



Basic methodological framework

6 layer model, scenario-level definition (functional, logical, concrete)

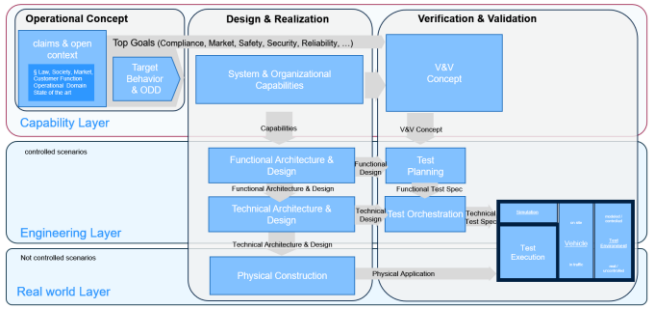
SET Level



Ready to use configured simulation toolchain and framework

standards, architecture, simulation framework

VERIFICATION VALIDATION METHODS



Overall methodology for the safety case containing a complete safety argumentation and corresponding processes

Safety argumentation
Extended methodological framework

VVM Final Event on 21st and 22nd of November 2023 in Sindelfingen, Germany

VERIFICATION VALIDATION METHODS

- The overall and final V&V Methodology of VVM
- The VVM Safety Assurance Framework
- Deep-Dives covering all layers of the argumentation architecture
- Selected demonstrations applying the methodology to test and simulation
- Panel discussions and links to safety assurance initiative worldwide

SAVE-THE-DATE:
https://www.vvm-projekt.de/en/

Mercedes-Benz Event Center, Sindelfingen, Germany

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THANK YOU

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