SET Level

Simulation-based Development and Testing of Automated Driving

Methodologies for Simulation-Based Engineering Tasks Towards a SET Level Methodology

Prof. Frank Köster (DLR), Dr. Stefan Rude (BMW), Dr. Sven Hallerbach (DLR)

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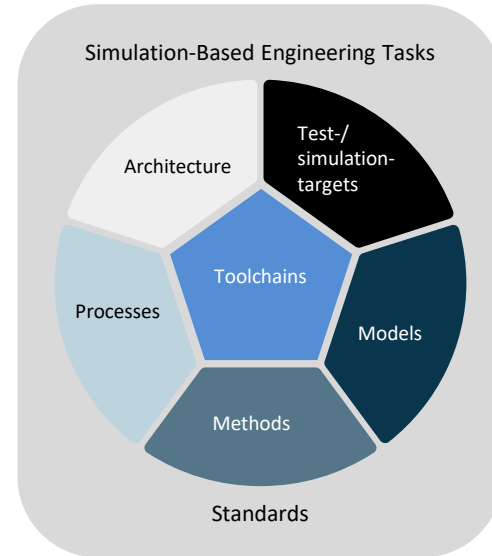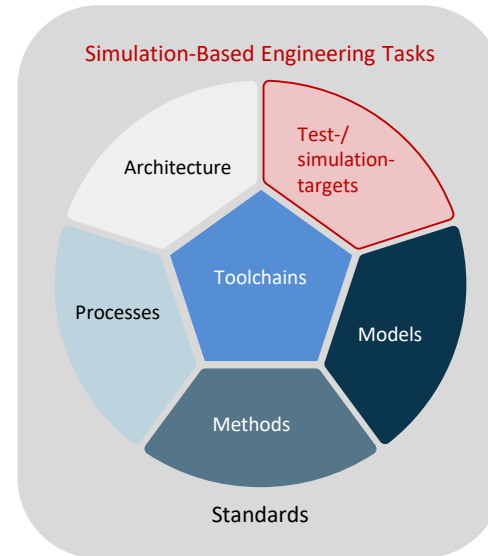
Towards a SET Level Methodology

- What are you striving for?

- What are your sub-tasks?

- How do you address your sub-tasks?

- What do you utilize?

Simulation-Based Engineering Tasks

Test-/simulation-targets

Architecture

Toolchains

Processes

Models

Methods

Standards

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Simulation-Based Engineering Tasks

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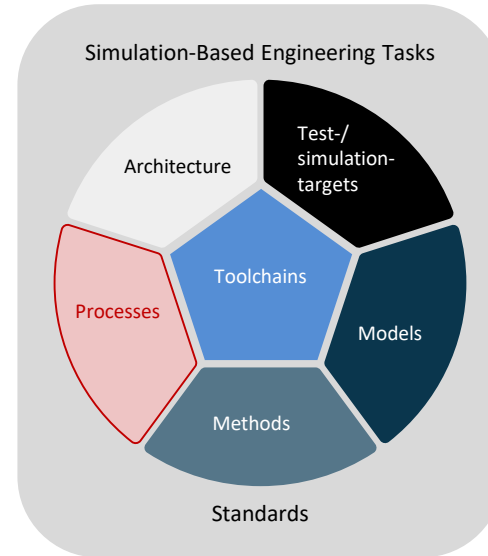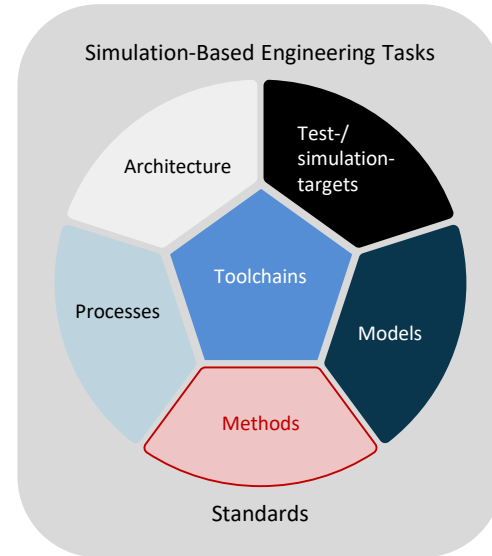- How do you address your sub-tasks?

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Simulation-Based Engineering Tasks

Test-/simulation-targets · Architecture · Toolchains · Processes · Models · Methods · Standards

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Simulation-based Development and Testing of Automated Driving

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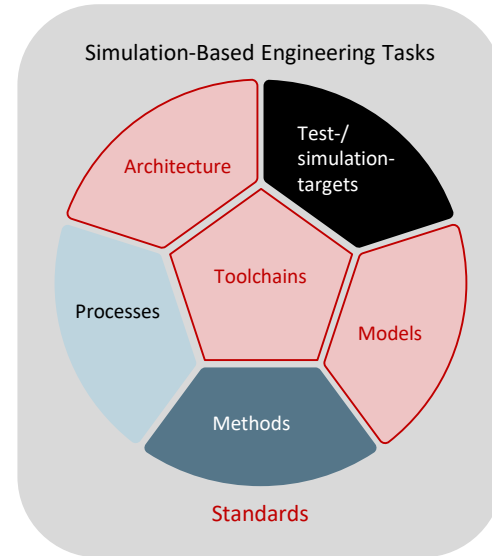- How do you address your sub-tasks?

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Simulation-Based Engineering Tasks

Architecture

Test-/simulation-targets

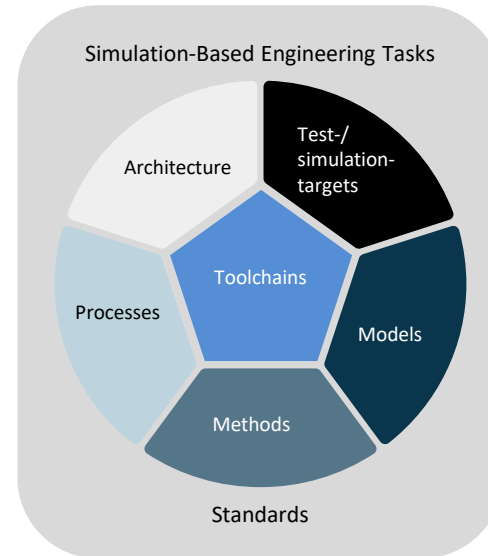Toolchains

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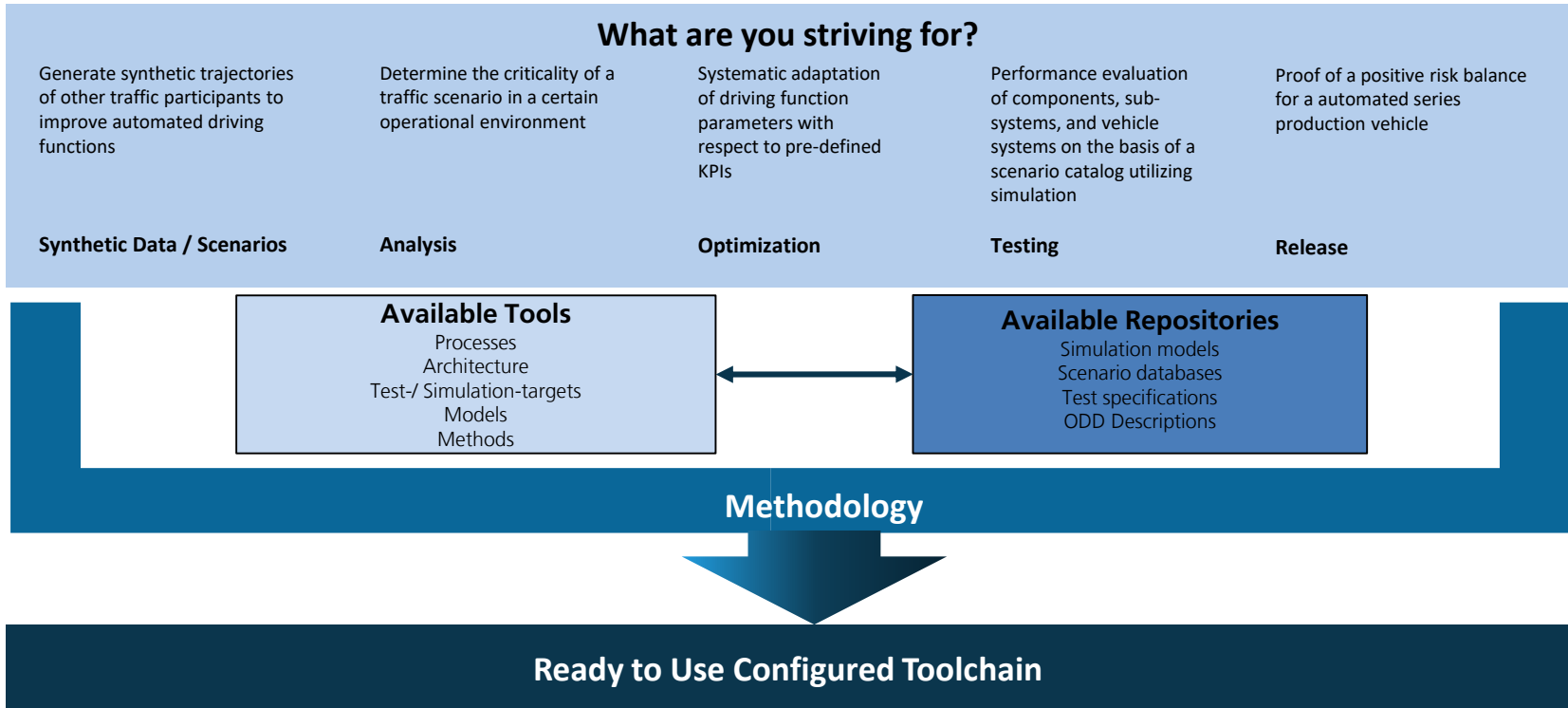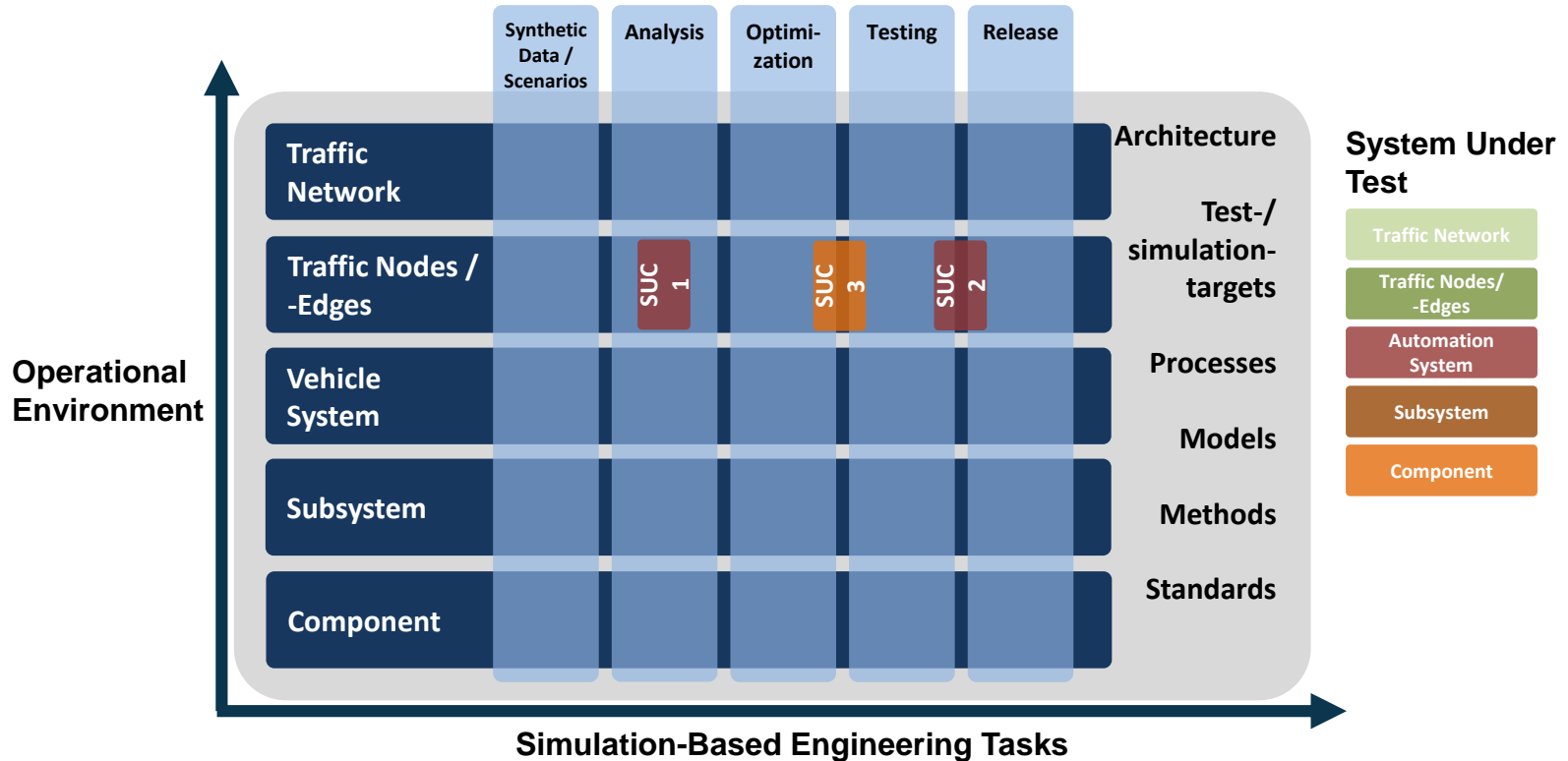- How do you address your sub-tasks?

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Simulation-based Development and Testing of Automated Driving

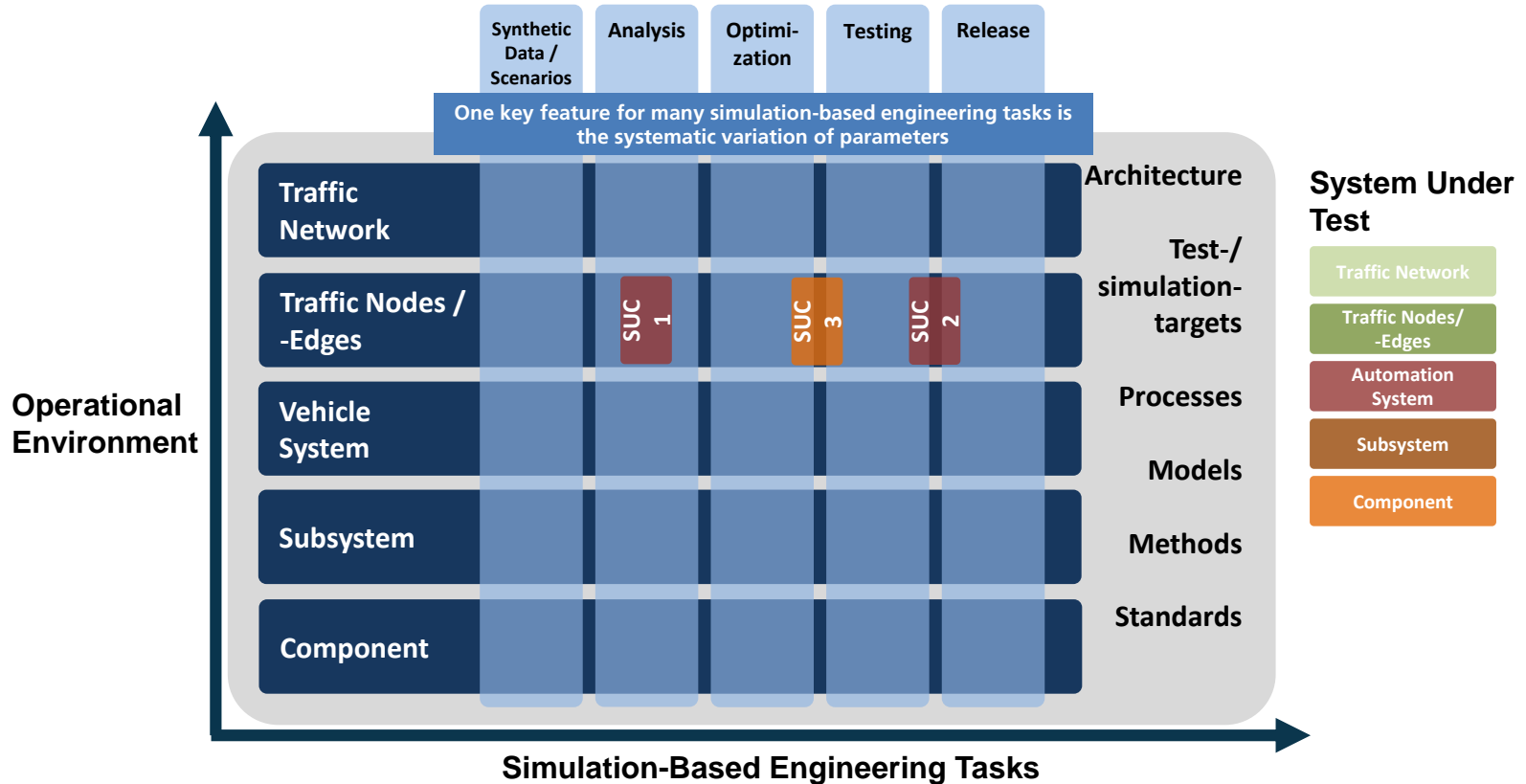# Towards a SET Level Methodology – Big Picture

SET Level

- Generic open testing architecture with suitable components
  for a wide range of simulation-based engineering tasks → simulation as a service

What are you striving for?

Synthetic Data / Scenarios	Analysis	Optimization	Testing	Release
Generate synthetic trajectories of other traffic participants to improve automated driving functions	Determine the criticality of a traffic scenario in a certain operational environment	Systematic adaptation of driving function parameters with respect to pre-defined KPIs	Performance evaluation of components, sub-systems, and vehicle systems on the basis of a scenario catalog utilizing simulation	Proof of a positive risk balance for a automated series production vehicle

Available Tools
Processes
Architecture
Test-/ Simulation-targets
Models
Methods

↔

Available Repositories
Simulation models
Scenario databases
Test specifications
ODD Descriptions

Methodology

Ready to Use Configured Toolchain

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Towards a SET Level Methodology – Itemization Matrix Core Dimensions of the Configured Toolchain
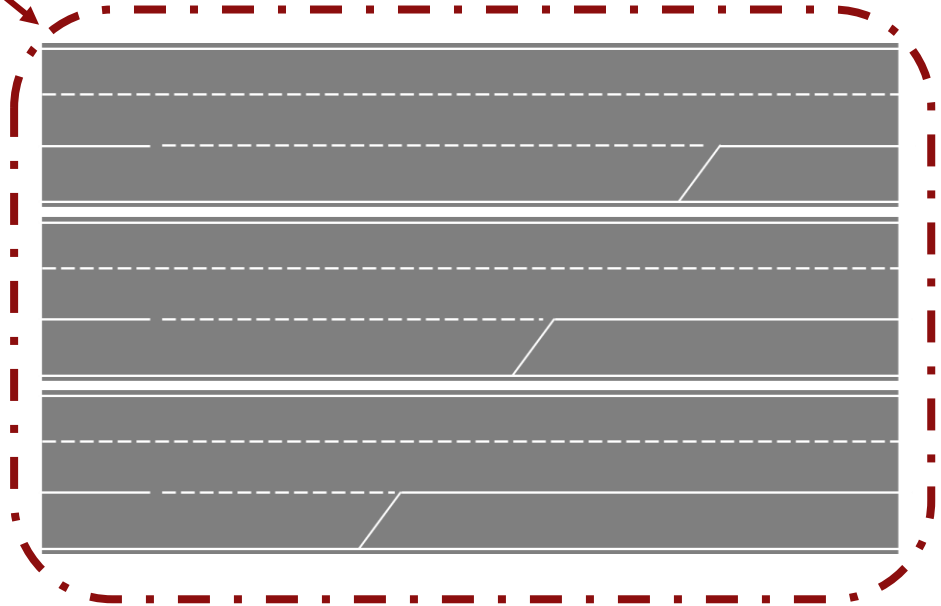
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Towards a SET Level Methodology – Itemization Matrix Core Dimensions of the Configured Toolchain

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Towards a SET Level Methodology

Road level (L1)
- Geometry and topology
- Condition, boundaries

Traffic infrastructure (L2)
- Construction barriers
- Signs, traffic guidance

Temporal modifications L1 und L2 (L3)
- Geometry and topology overlay
- Time dependent > 1 day

Objects (L4)
- Dynamic, movable
- Interactions, maneuvers

Environment (L5)
- Weather
- Lighting

Digital Information (L6)
- V2X-Information
- Digital Map

Parameter Variation: Entrance Ramp Length

Source: PEGASUS Project

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Parameter Variation: Number of Lanes

Source: PEGASUS Project

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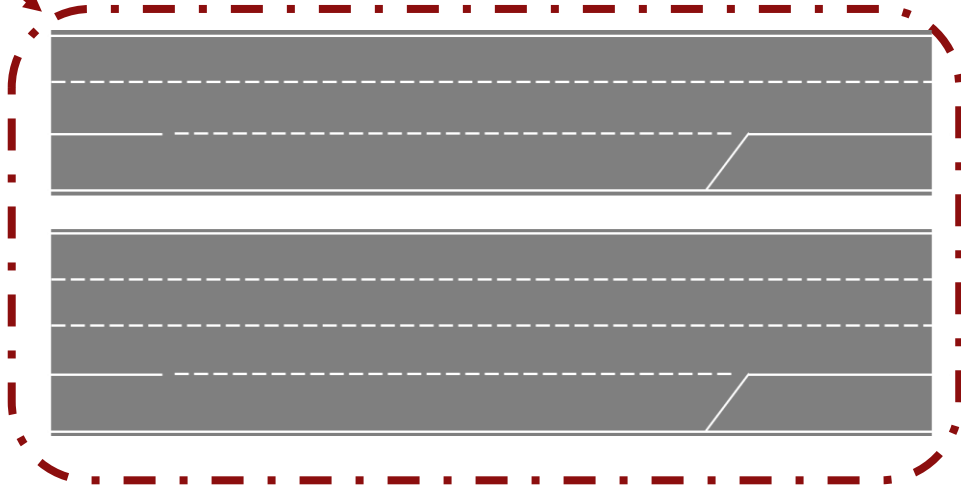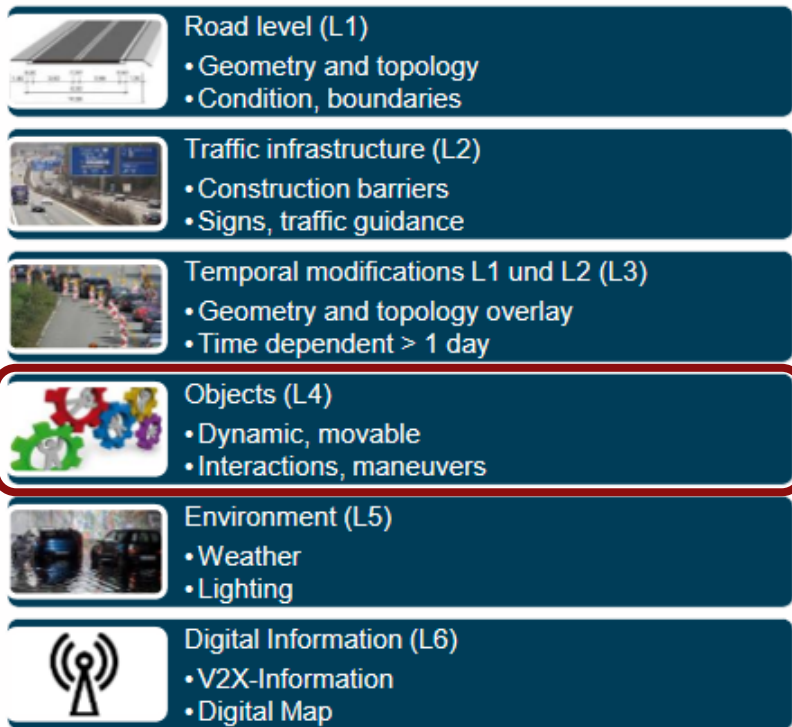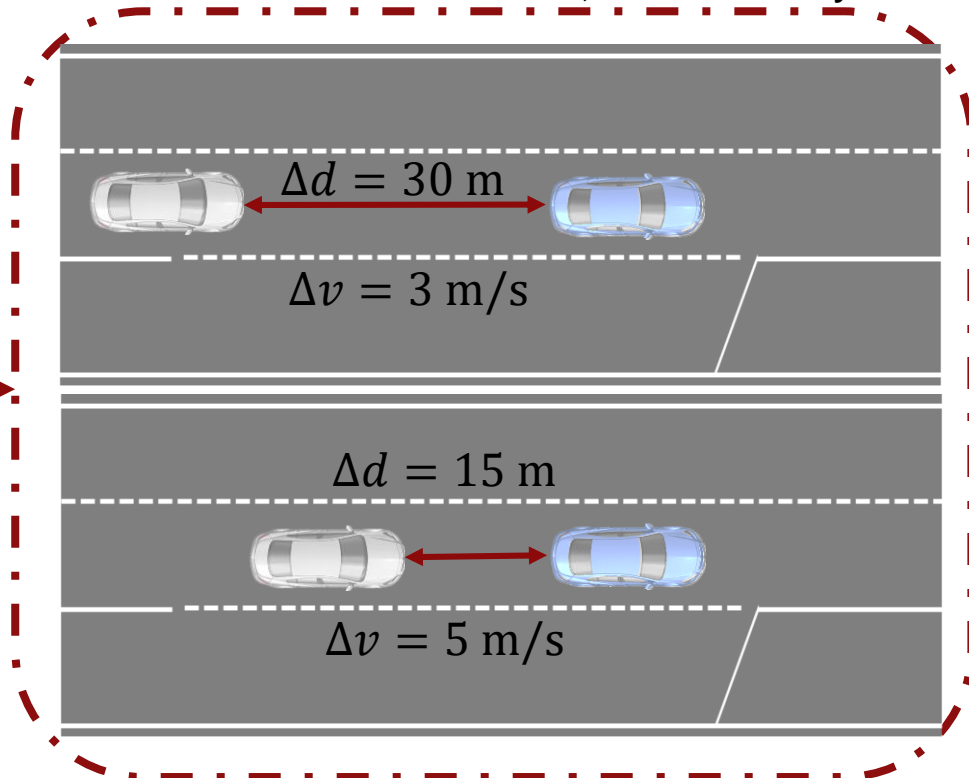
Digital Information (L6)
- V2X-Information
- Digital Map

Parameter Variation: Distance, Relative Velocity

$\Delta d = 30$ m

$\Delta v = 3$ m/s

$\Delta d = 15$ m

$\Delta v = 5$ m/s

Source: PEGASUS Project

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Towards a SET Level Methodology – a generic Open Testing Architecture
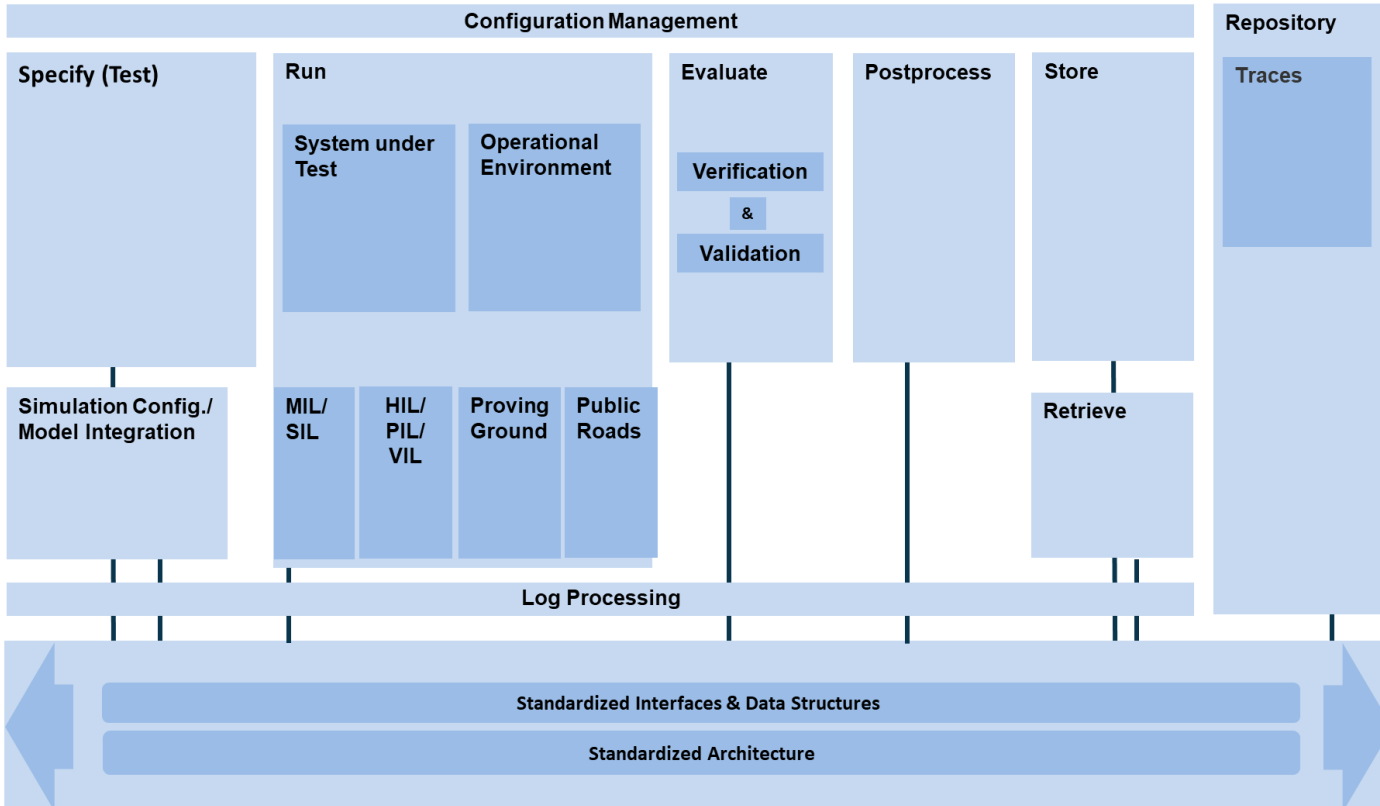
cf. F. Köster, S. Hallerbach, P. R. Mai, B. Engel: ASAM SIM:Guide: ASAM OpenX in Context, 2021.

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Towards a SET Level Methodology – Summary

- In order to solve simulation-based engineering tasks systematically and sufficiently the following questions need to be addressed

  - What are you striving for?
  - What are your sub-tasks?
  - How do you address your sub-tasks?
  - What do you utilize?

- SET Level provides a open testing architecture with generic components

- The System Under Test`s itemization needs to be specified and arranged with respect to its operational environment

- The SETLevel Itemization Matrix provides a framework for the systematic configuration for the simulation toolchain with respect to the simulation-based engineering tasks

Thank you for your Attention …

Contact

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