

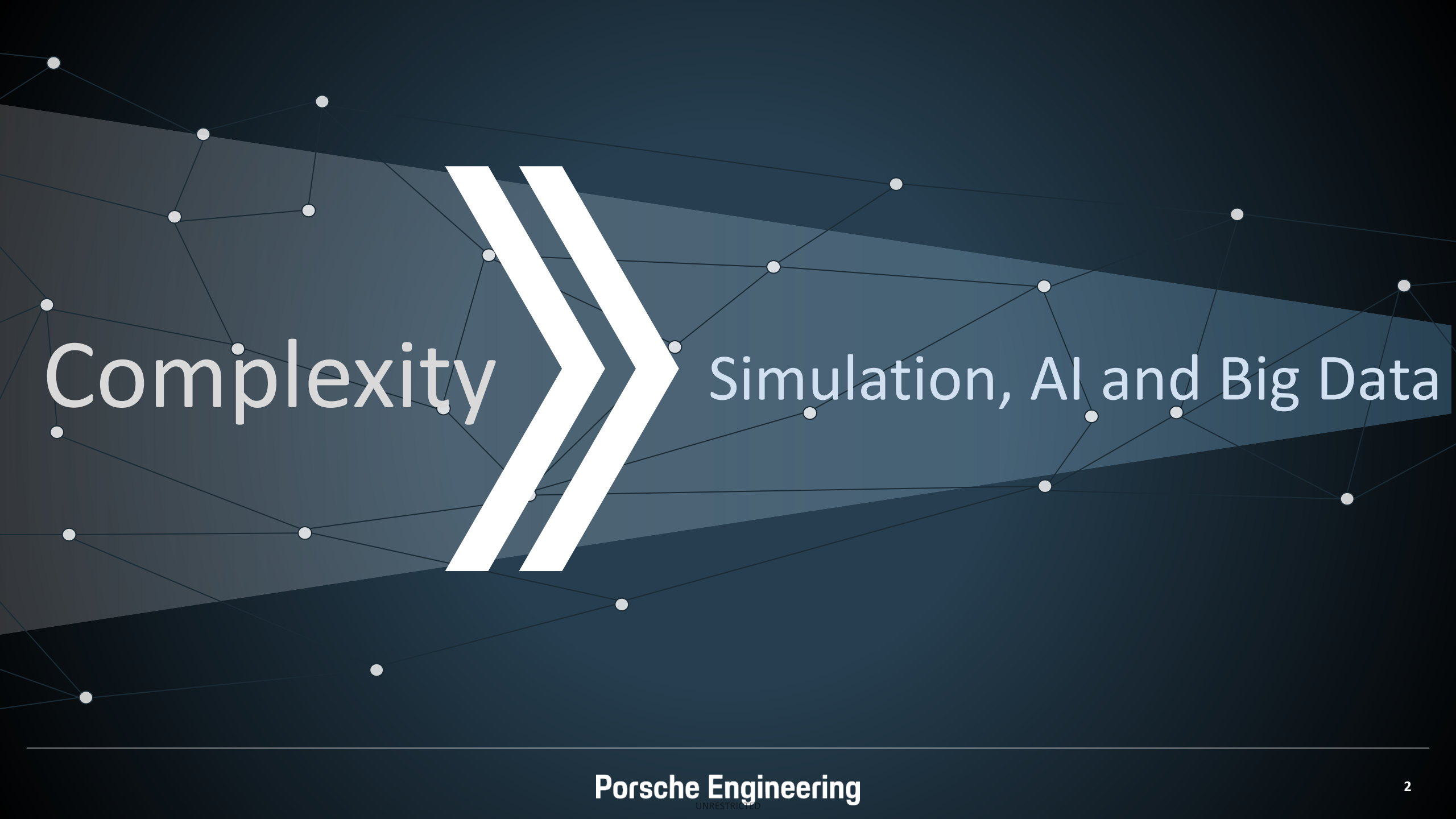
The background image is a composite of a realistic driving simulation and a technical wireframe overlay. The realistic part shows a multi-lane highway with a truck in the distance, overhead road signs for Karlsruhe, Stuttgart, and S-Möhringen/-Degerloch, and a modern stadium-like building in the background. A speed limit sign of 80 is visible on the right. The wireframe overlay, in yellow and cyan, shows a 3D grid of the road and surrounding environment, with a semi-transparent car model positioned in the foreground on the right side.

Driving Innovation: Accelerating Automotive Development and Validation with a Modular Toolchain and Advanced Driving Simulators

Porsche Engineering @ 2025 VI-GRADE ZERO PROTOTYPES SUMMIT, Udine

Tille Karoline Rupp
Head of Simulation

Lars Töttel
Development Engineer



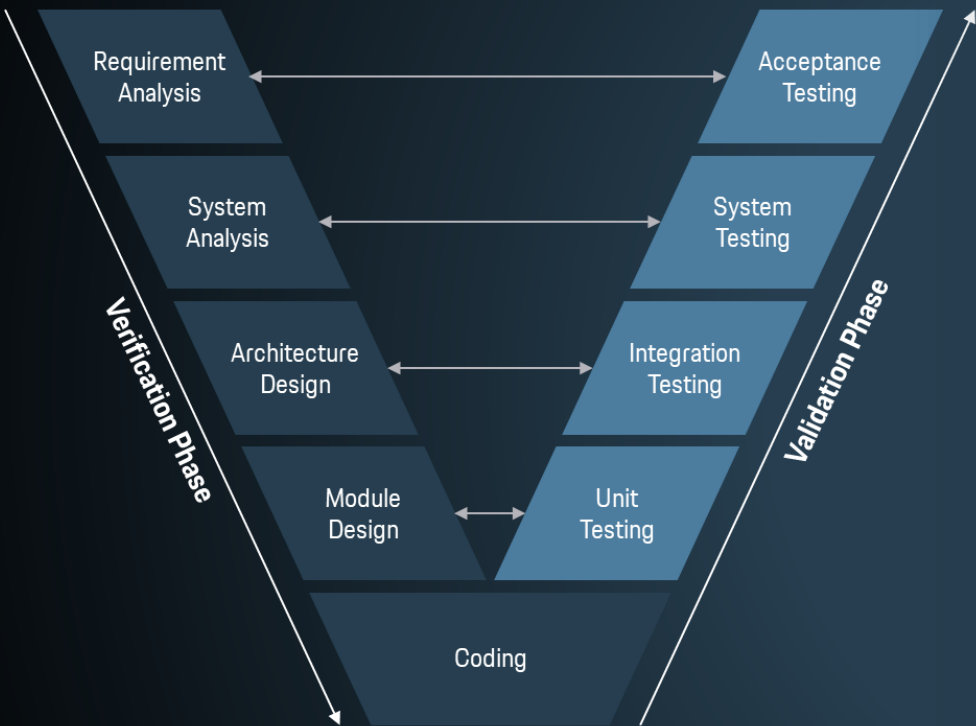
Complexity



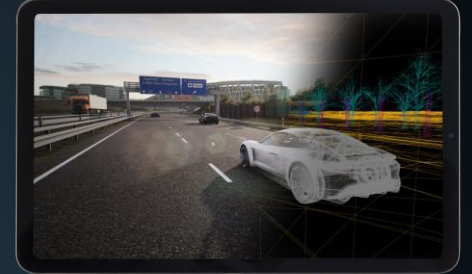
Simulation, AI and Big Data

X-in-the-Loop | Early, Automated, Virtualized

Virtual and Hybrid Testing – Continuous Throughout Development and Validation



- » left-shift with SiL, HiL, ViL and DiL
- » early detection & faster iteration
- » standardized models & tools
- » automated test execution and analysis
- » human-in-the-loop with **driving simulators**
- » seamless transition from virtual to real

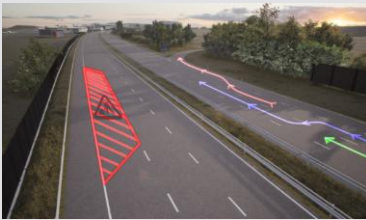


Choosing the Right Method – From Virtual to Real

Test Scope vs. System Realism

Feasible number of executable tests

SiL



HiL



ViL & DiL



Real



Maximum realism in test scenarios

Increased liberty to choose test scenarios
Maximum flexibility to test different technologies

Larger dependency on real system availability

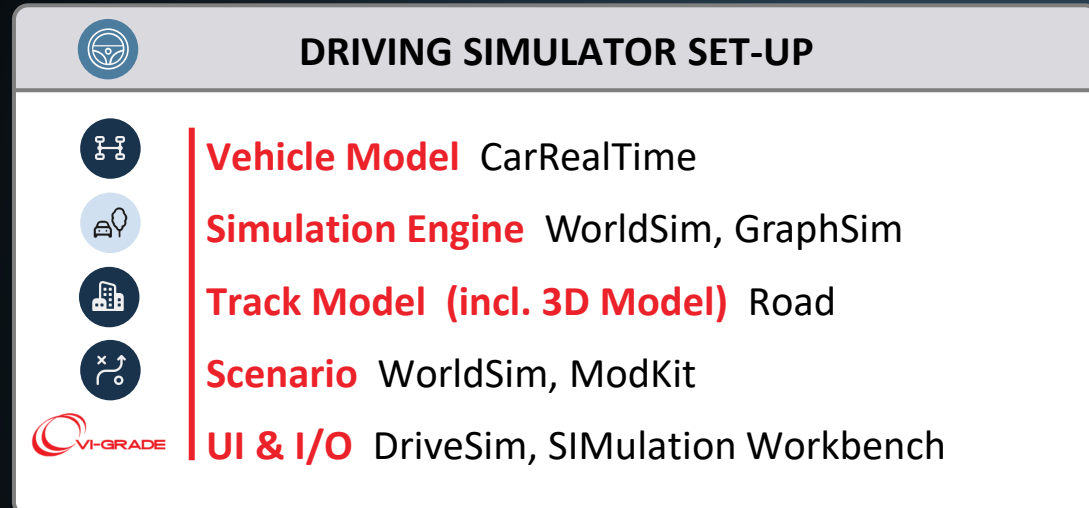
Fastest test speed and efficiency

Real time speed test

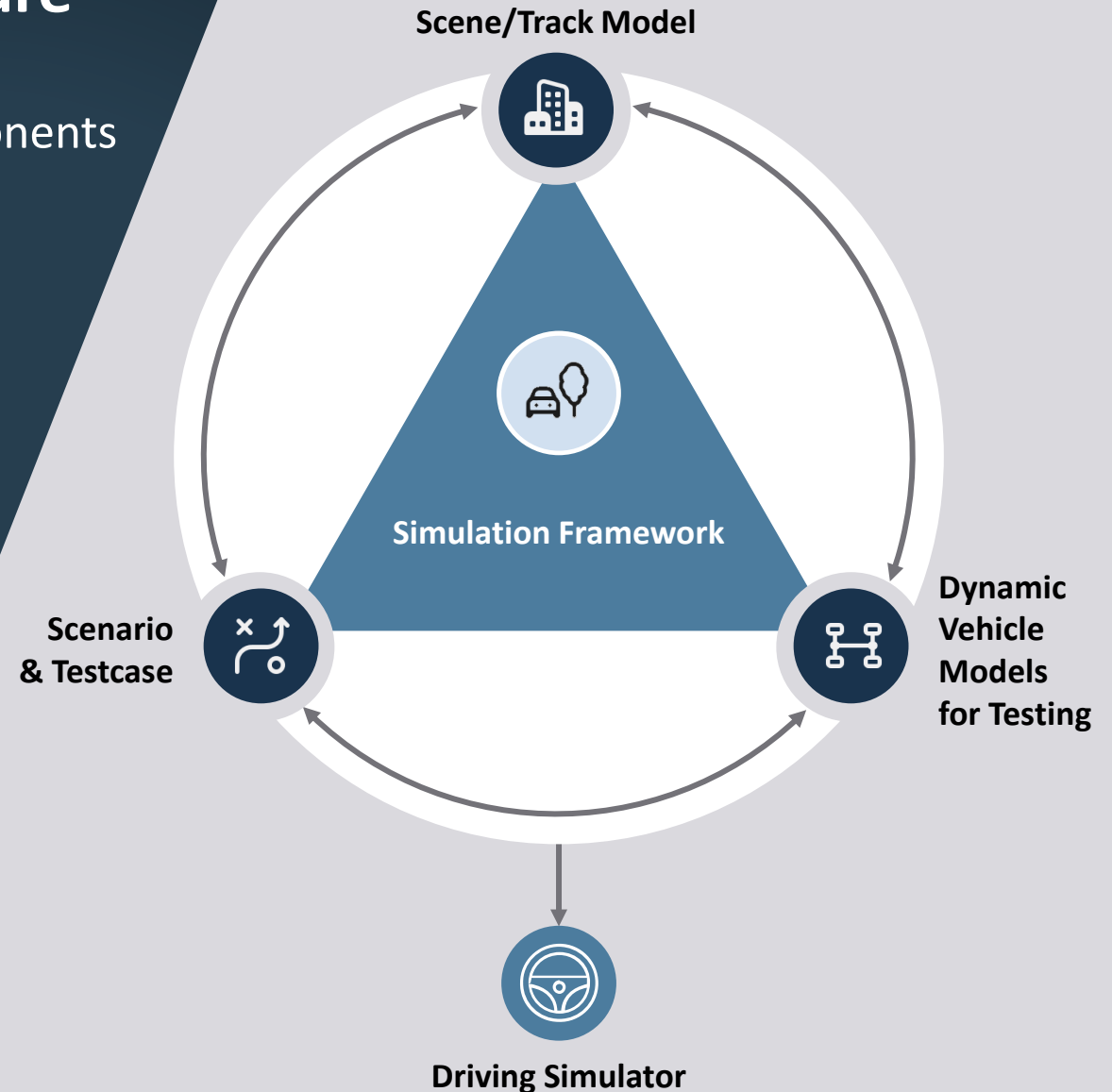
Relation to reality

Standard XiL Setup – Modular Architecture in the Default VI-grade Framework

Track – Scenario – Vehicle Model: Core Simulation Components

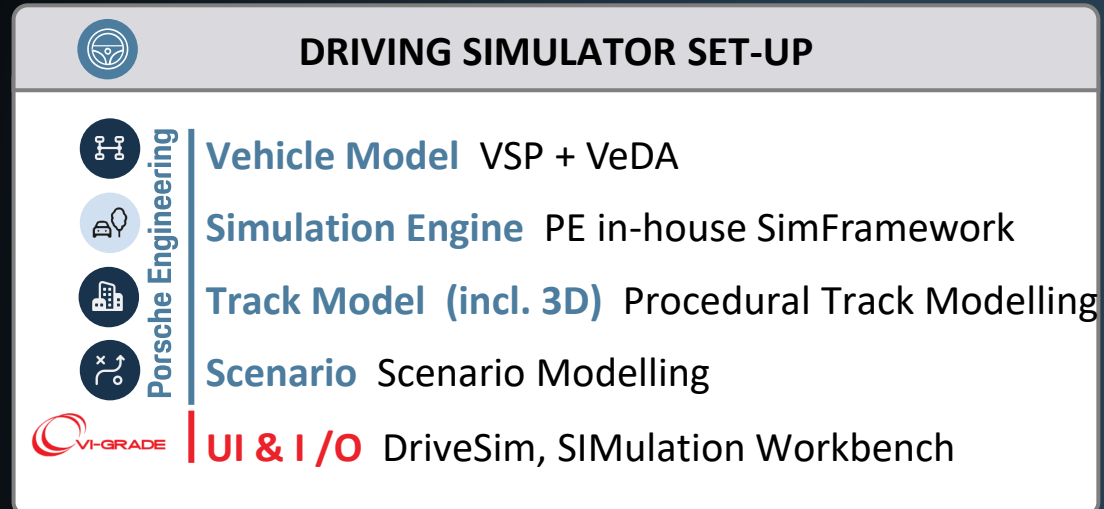


- modular XiL architecture with defined components
- proven real-time driving simulator set-up
- separation of vehicle model, track and scenario logic
- VI-grade framework as ideal reference for integration and extension

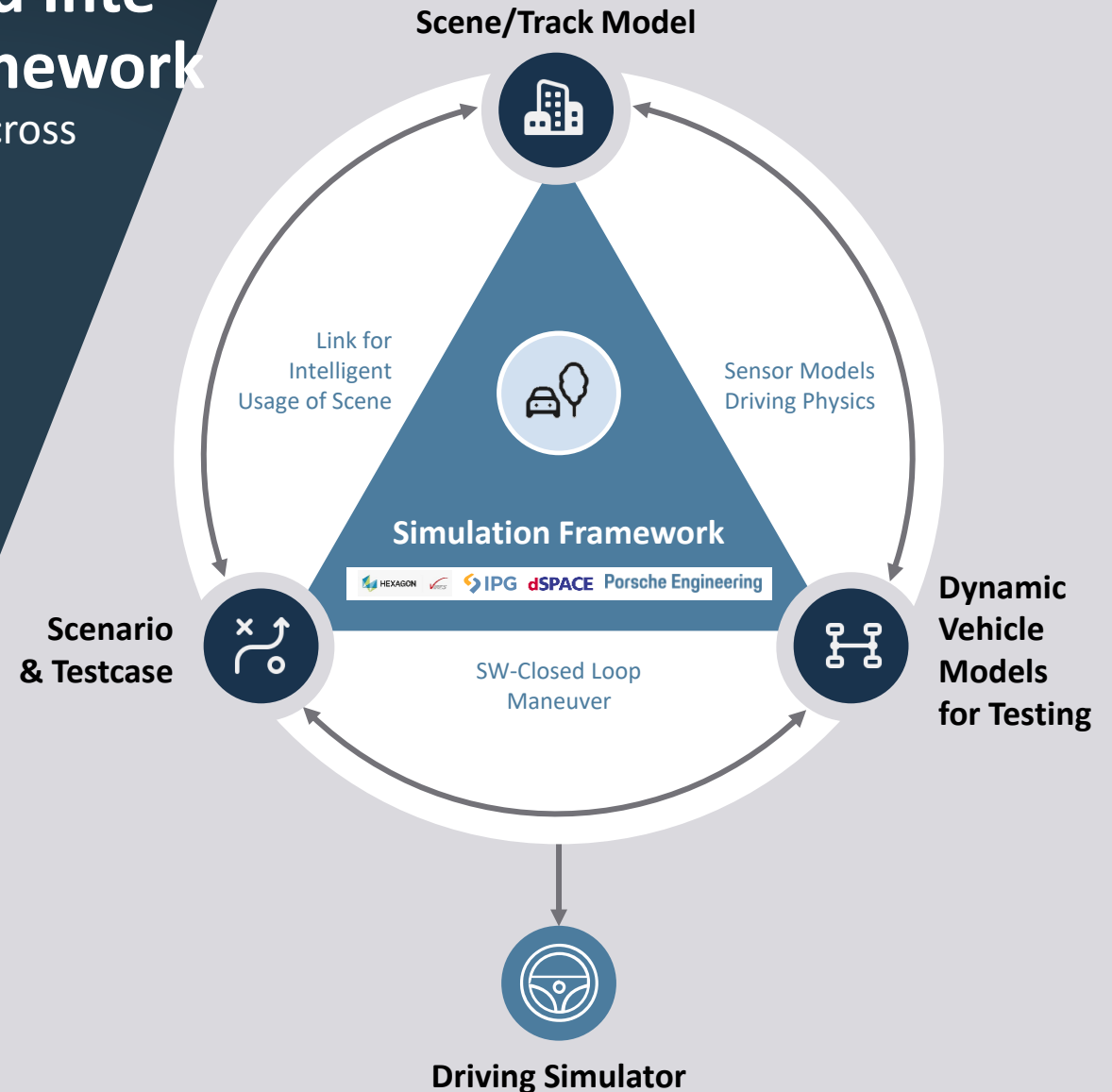


Customized XiL Setup – Standardized and Integrated with PE In-House Simulation Framework

Track – Scenario – Vehicle Model: Standardized and Reusable Across SiL, HiL and DiL

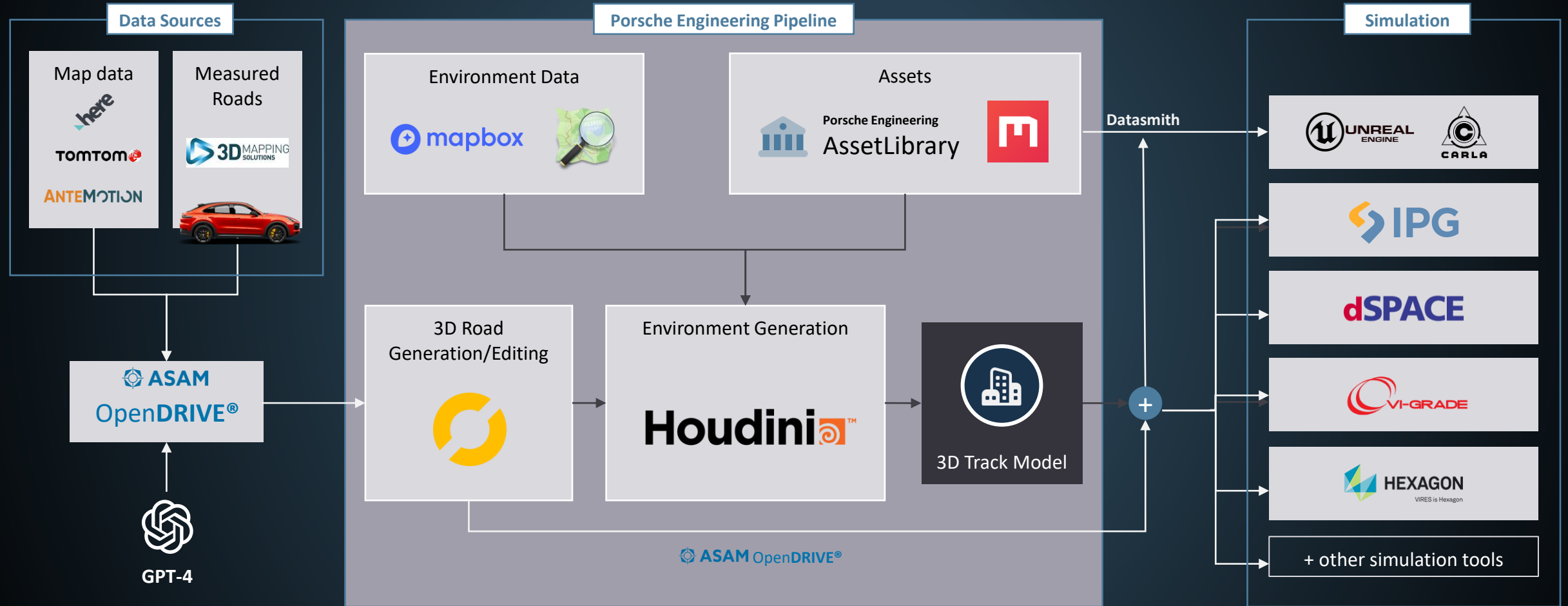


- default setup not compatible with internal toolchains
- integration of PE models, pipelines and standards
- track and scenario generation based on standards (ASAM OpenDRIVE® and OpenSCENARIO®)
- unified model use across SiL, HiL and DiL



Procedural Track Modelling Pipeline

Scalable Generation of Standardized Track Models and 3D Worlds



Procedural Track Modelling Pipeline

Simulation-Ready Track Models – in Action and Created in Minutes



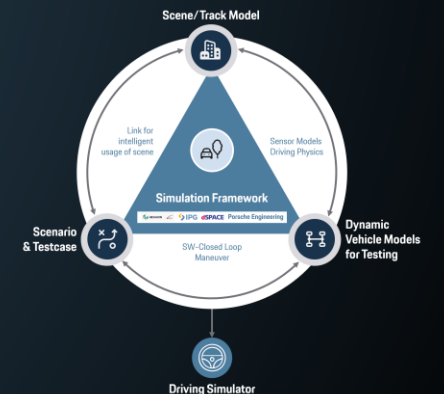
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Procedural Track Modelling Pipeline

Examples of Simulation-Ready Road, Environments and 3D Models for XiL Use



Visual examples of generated test tracks – integrated into a standardized XiL setup alongside scenario and vehicle models.



Conclusion and Outlook

01

The modular architecture of the VI-grade platform enables integration and reuse, forming a solid foundation for hybrid and scalable XiL validation workflows.

02

Modularity and standardization enable scalable simulation, across all test stages from software to real-world environments, with clearly defined interfaces and flexible component exchange.

03

Reusable track, scenario and vehicle models ensure consistency across SiL, HiL and DiL, making testing more efficient, traceable and simulation framework independent.

04

Open standards ensure interoperability, enabling tool-independent exchange and reuse of test content – such as ASAM OpenDRIVE® tracks or ASAM OpenSCENARIO®-based situations.

05

Procedural generation accelerates environment creation, supporting automated, reproducible and scalable generation of simulation-ready 3D tracks.

06

Driving simulators bridge development and validation, enabling immersive testing of complex driving functions – from early tuning to ADAS handover evaluation.

07

XiL toolchains become strategic innovation drivers, supporting fast, cost-effective and robust validation in increasingly complex development programs.

Porsche Engineering



Tille Karoline Rupp

Head of Simulation, Porsche Engineering
tille.rupp@porsche-engineering.de

