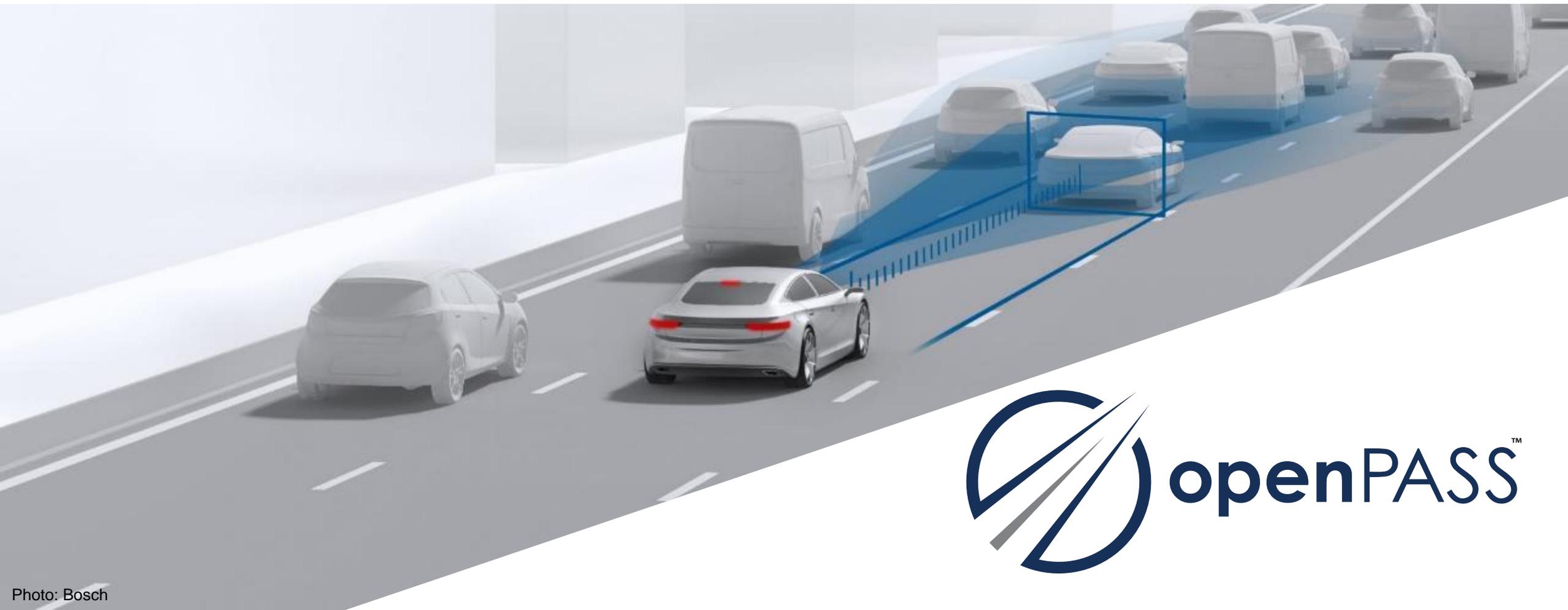


OPENPASS



TARGET OBJECTIVES

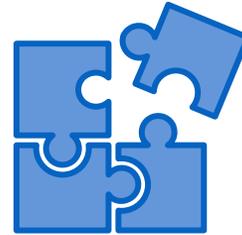
openPASS – open Platform for Assessment of Safety Systems

Harmonized and flexible platform for scenario-based traffic simulation of advanced driver assistance systems and automated driving systems



Traffic simulation

Stochastic variation



Modularity and flexibility

Reproducibility through determinism



Standardized interfaces

High level of transparency and acceptance through publicly available open source platform by using open standards and building up a modular ecosystem

WORKING GROUP



openPASS Working Group

2014: Idea for openPASS within 

BMW GROUP

Driver member
since 08/2016
(founding member)



Driver member
since 11/2018



Mercedes-Benz Tech Innovation

Driver member
since 08/2016
(founding member)



Driver member
since 01/2018

VOLKSWAGEN

AKTIENGESELLSCHAFT

Driver member
since 08/2016
(founding member)

Former members



Service provider
since 08/2016
until 07/2022
(founding member)

TOYOTA

User member
since 06/2018
until 05/2023

Eclipse Automotive Working / Interest Groups



TIMELINE



Eclipse openPASS
opSimulation

03/2017
Initial
Commit

09/2017
PCM
mod.

02/2018
V0.5
PCM

02/2020
V0.6
OSI

06/2020
V0.7
Urban

11/2021
V0.8
CI

06/2022
V0.9
Quality
I

08/2022
V0.10
FMI

07/2023
V0.11
Quality
II

11/2023
V1.0
OSE



Eclipse openPASS
subprojects

03/2021
Initial
Commit

mantle-
api

10/2021
Initial
Commit

open
scenario1-
engine

01/2022
Initial
Commit

yase

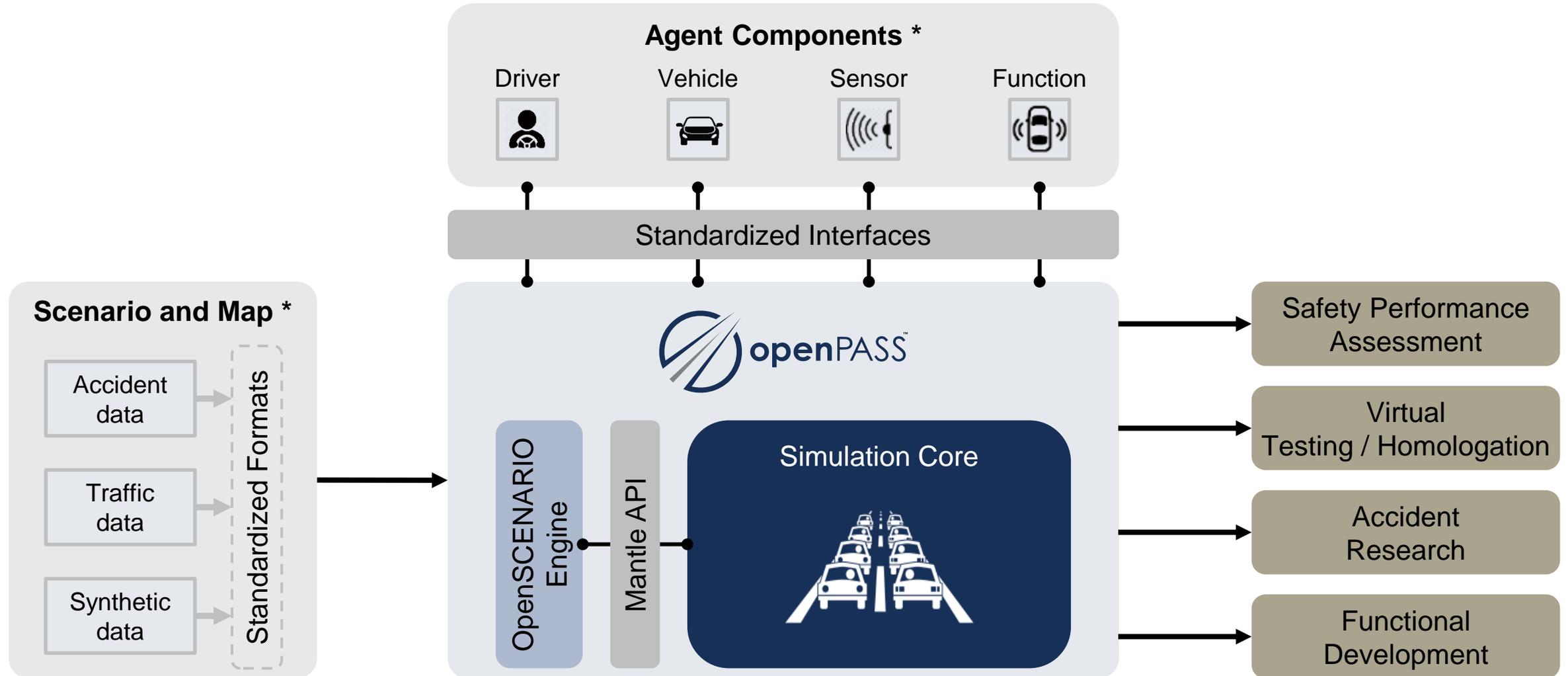
10/2022
Initial
Commit
V3.0

opVisualizer

08/2023
Initial
Commit

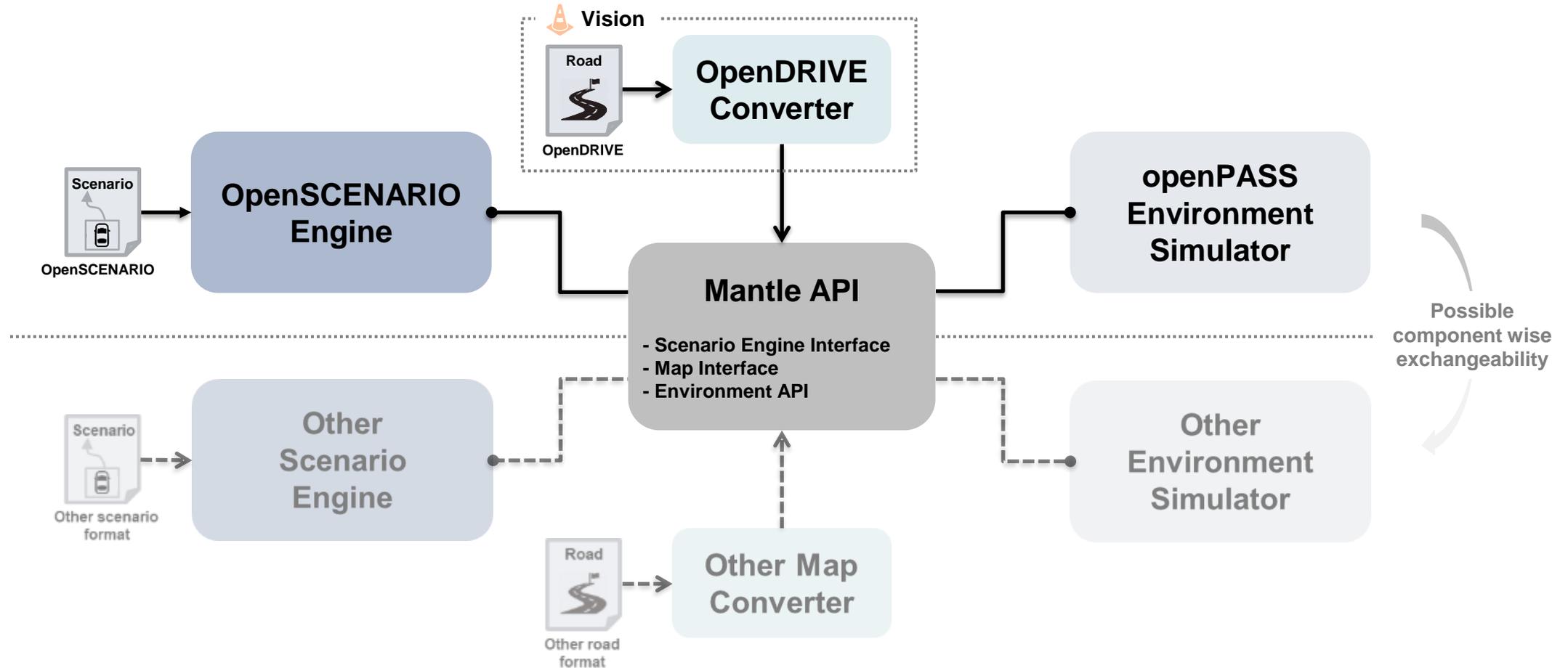
opGUI

PLATFORM CONCEPT



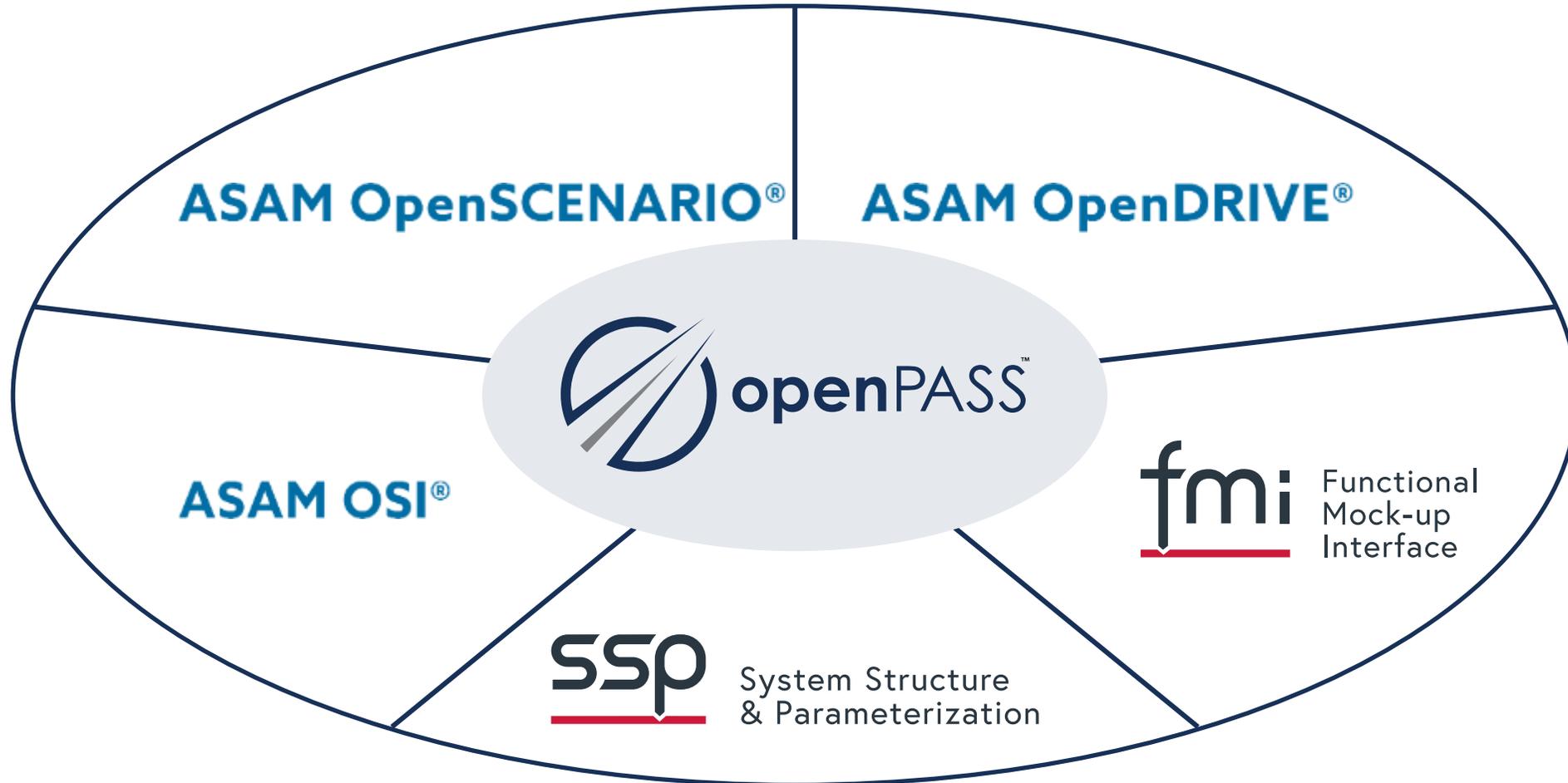
* Simple examples are provided

SCENARIO-BASED SIMULATION TOOLCHAIN

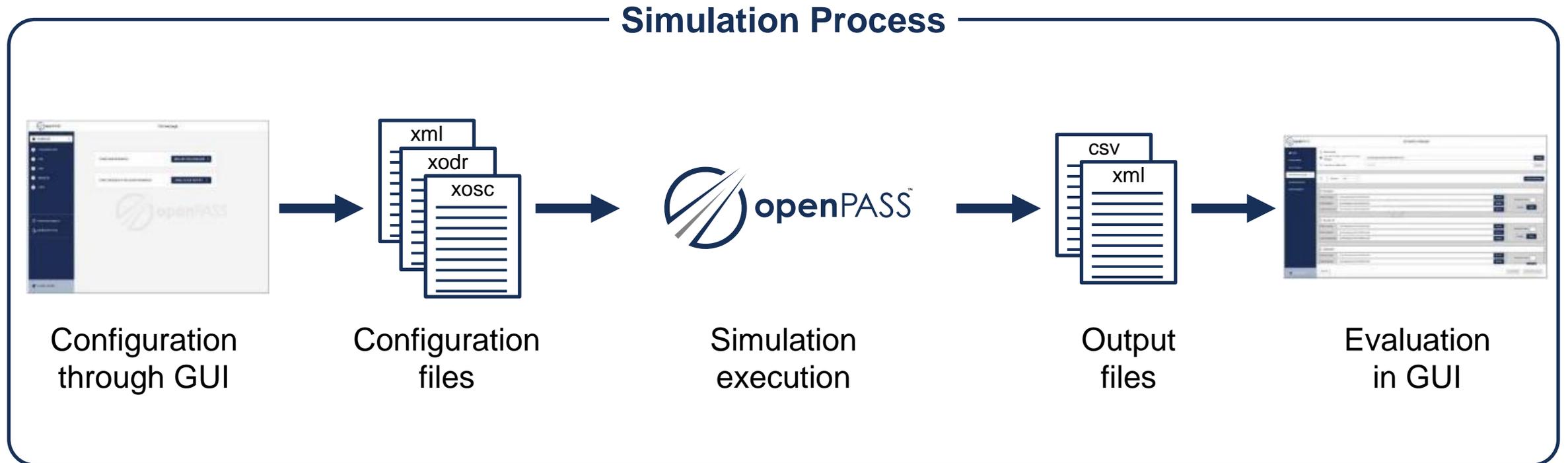


The modular architecture based on the Mantle API allows for the exchangeability of scenario engines, map converters and environment simulators.

SUPPORTED STANDARDS



SIMULATION PROCESS



Crash Re-Simulation

- Pre-specified behavior through trajectories
- Low degree of interaction
- Evaluation of driving systems in short, fixed scenarios



Event based scenario modelling

- Mixture of pre-specification and model based behavior
- Manipulative interventions to force certain behavior (e.g. Cut In)
- Longer and dynamically evolving scenario spaces

Stochastic Traffic Simulation

- Sophisticated behavior models
- No pre-specified behavior / manipulation in the scenario
- Strong, model based interactions between traffic participants
- Evaluation of driving systems in dynamically evolving (yet unknown) scenarios

Low

Medium

High

Level of interaction between traffic participants

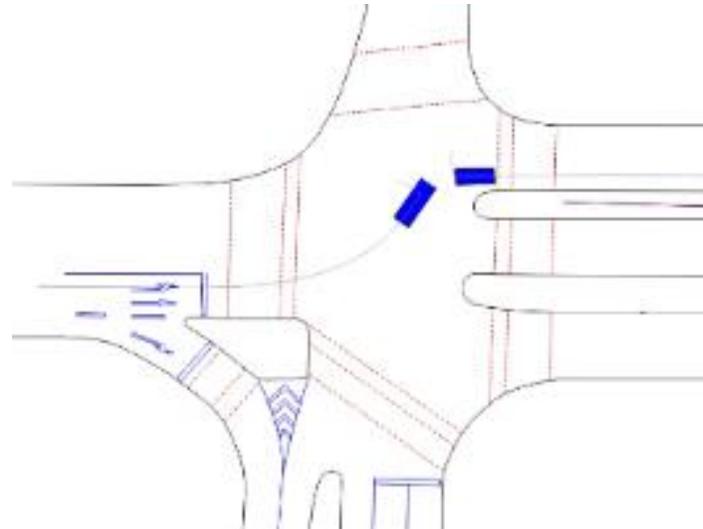
EXAMPLE FOR CRASH RE-SIMULATION



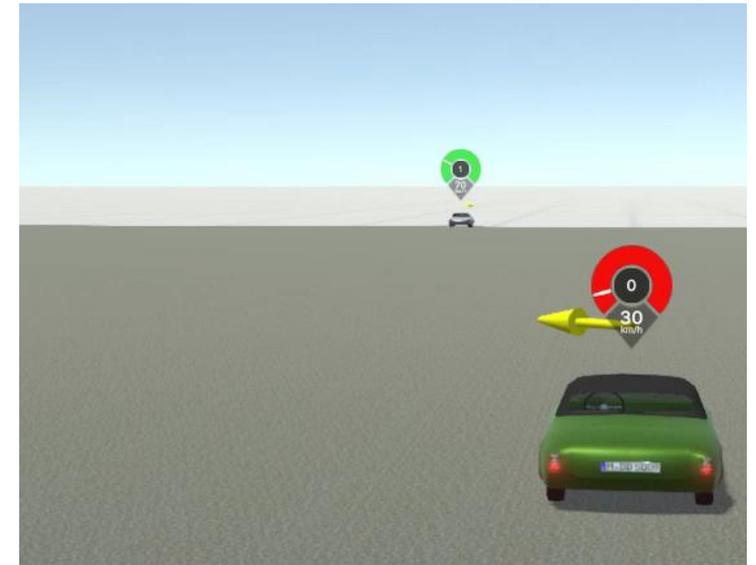
- Re-simulation of recorded / reconstructed trajectories from real-world scenarios
- Extension to “what-if simulation” e.g. with user-specific AEB system
- Evaluation of impact without and with safety systems
- *Outlook “Replay2Sim”: conversion of any trajectory to OpenSCENARIO*

Tool-based
conversion to
OpenSCENARIO

OpenSCENARIO
defining the traffic
participants and their
behavior



GIDAS sketch of accident



Simulation with openPASS

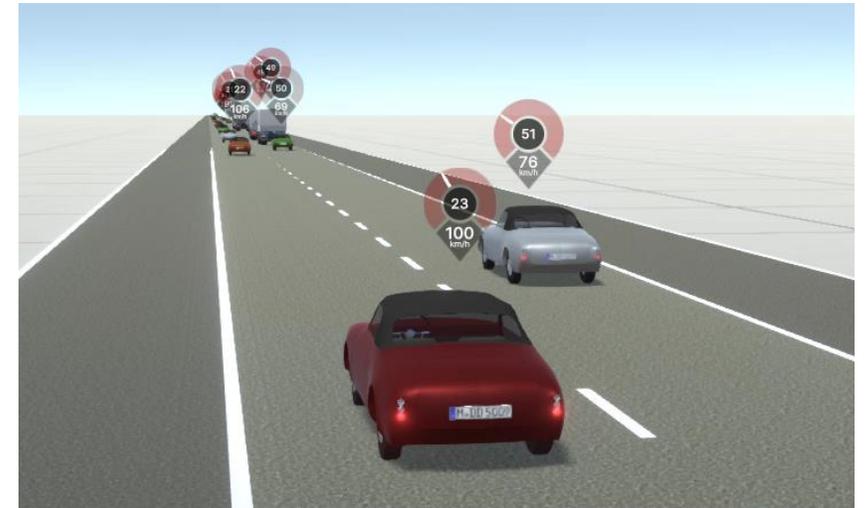
EXAMPLE FOR STOCHASTIC TRAFFIC SIMULATION

Expert knowledge,
scenario databases &
standards (e.g. ALKS)

Manual modelling
/ script based
generation of
scenarios

OpenSCENARIO
defining the traffic
participants and behavior
models as external
controllers

- Strong stochastic influence on many levels:
 - Initialization of traffic (e.g. positions, velocities, system equipment)
 - Scenario parameters (e.g. traffic volume)
 - Stochastic agent behavior models (e.g. Stochastic Cognitive Model)
- Interaction between traffic participants in a realistic manner
- Evaluation of system behavior and traffic safety
- Discovery of new, yet unknown critical scenarios



Simulation with openPASS

EXAMPLE USAGE OF OPENPASS IN PUBLIC PROJECTS - I



Project duration:

- 09/2017 – 10/2021

Project objectives:

- Largest European project on automated driving at the time
- Piloting, collecting data and conducting impact assessment for automated driving

Application of openPASS:

- Simulation of different scenarios concerning typical motorway situations

Project duration:

- 06/2018 – 11/2021

Project objectives:

- Analysis of occupant vehicle safety requirements for HAVs
- Prediction of remaining crashes / future ODD-specific relevant crash configurations

Application of openPASS:

- Simulation with motorway traffic model including human imperfection
- Realistic collision frequency to validate motorway test case

Project duration:

- 03/2019 – 10/2022

Project objectives:

- Simulation-based engineering and testing for automated driving
- Standardization of interfaces

Application of openPASS:

- Embedding of simulation models (e. g. pedestrian, driver, automated driving system, ...)
- Exemplary application for running a criticality analysis

Project duration:

- 07/2019 – 12/2023

Project objectives:

- Development of a methodical approach to proof safety for HAVs in urban environment
- Significant shift from real-world testing to simulation

Application of openPASS:

- Using openPASS as an exemplary simulation tool for the criticality analysis
- Scenario-based simulation with openPASS

EXAMPLE USAGE OF OPENPASS IN PUBLIC PROJECTS - II



Project duration:

- 09/2021 – 08/2025

Project objectives:

- Develop technology to enable a longer and less defragmented automated drive (follow up of L3Pilot)
- Code of practice & evaluation

Application of openPASS:

- Simulation of different scenarios for the safety impact assessment (motorway and urban)

Project duration:

- 10/2022 – 09/2025

Project objectives:

- Safety assessment framework by simulation
- Covering different safety solution (in-vehicle, infrastructure, behavioral)

Application of openPASS:

- Application in at least one use case

CONCLUSION

Status Quo:

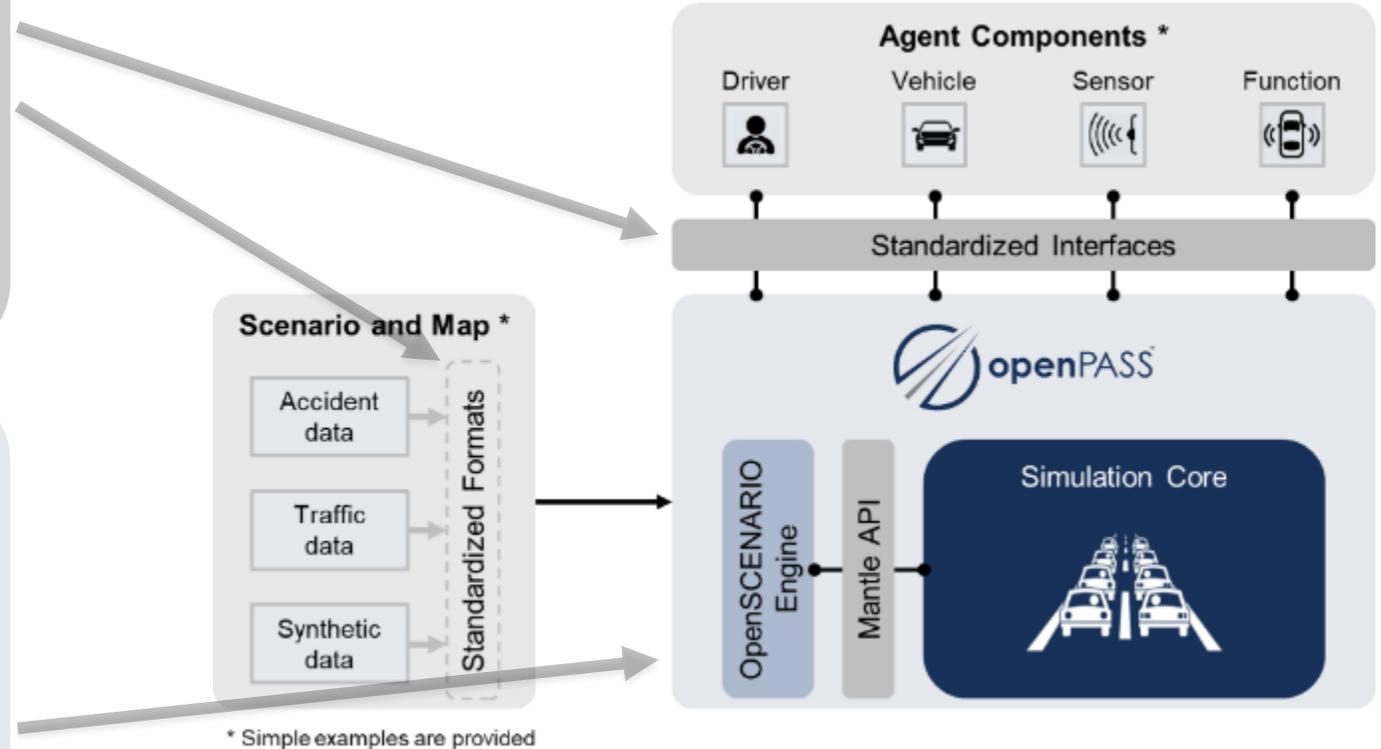
- Standardization of simulation configuration
- Standardization of simulation model interfaces (e.g. OSI, FMI)

Remarks:

- One big simulation core
- No reuse of core components

We are taking the next steps:

- Enable reuse of tool-internal components
- Share development efforts through open source collaboration
- Generate common understanding for interpretation of standards (e.g. OpenSCENARIO)
- Align tool-internal interfaces



OpenPASS has evolved from an open source platform to a modular ecosystem for scenario-based traffic simulation for advanced driver assistance systems and automated driving systems.

PARTICIPATION IN THE WORKING GROUP



The company should be at least an Eclipse Solution Member

- Networking and learning
- The annual membership fee for Solutions Members is tiered based on revenue



Working Group participation agreement

- Contribution in development of openPASS
- Discussion of the roadmap
- Active collaboration with the working group

Membership Privileges

Privilege	Driver Member	User Member	Service Provider Member	Project Manager
Steering Committee	X	Elected	Elected	-
Architecture Committee	X	-	-	X
Quality Committee	X	Elected	Elected	X
General Assembly	X	X	X	-

For more information, look at the openPASS charter:

https://www.eclipse.org/org/workinggroups/openpasswg_charter.php

COMMUNICATION WITH THE WORKING GROUP



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For more information, contact us or subscribe to the public WG mailing list:

<https://accounts.eclipse.org/mailling-list/openpass-wg>