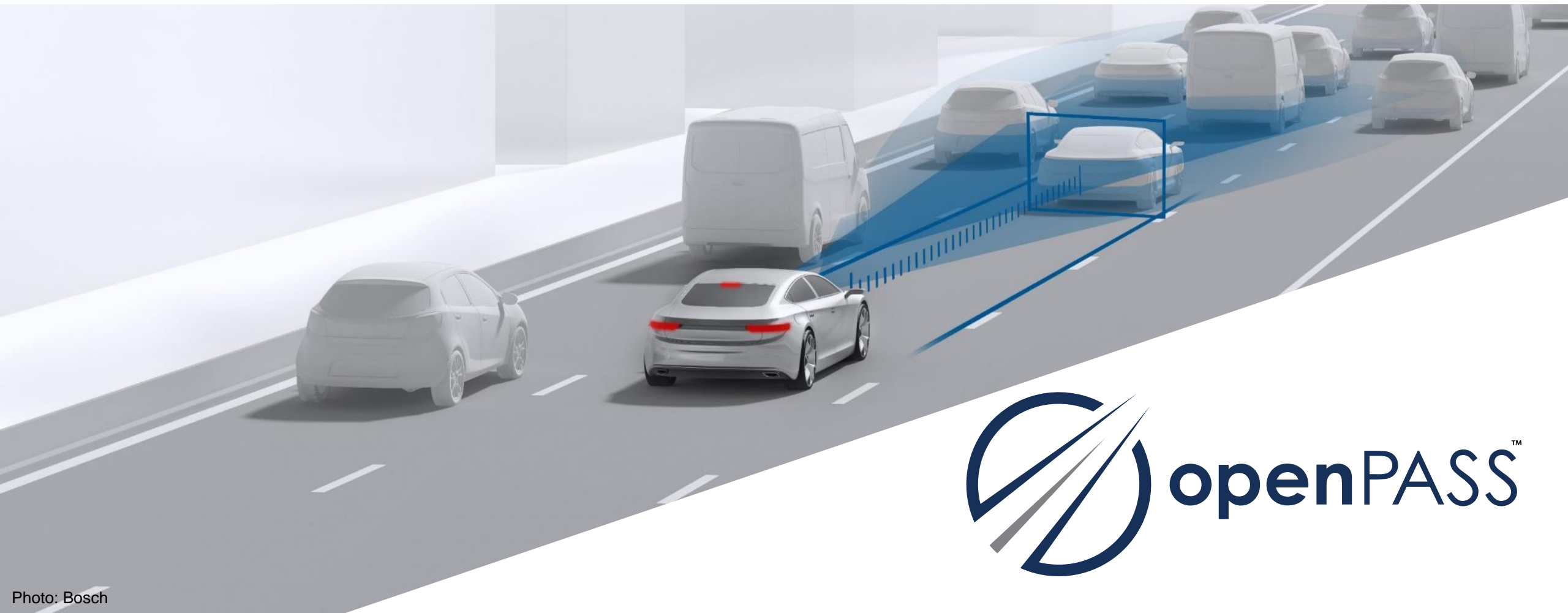


OPENPASS



TARGET OBJECTIVES

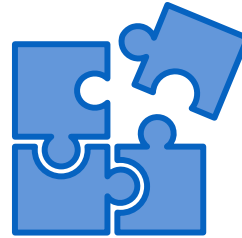
openPASS – open Platform for Assessment of Safety Systems

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



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 and founding member
since 08/2016



Driver member
since 11/2018

Mercedes-Benz

Driver and founding member
since 08/2016



Driver member
since 01/2018

VOLKSWAGEN
AKTIENGESELLSCHAFT

Driver and founding member
since 08/2016



Former members



Founding member and
service provider
since 08/2016
until 07/2022

TOYOTA

User member
since 06/2018
until 05/2023



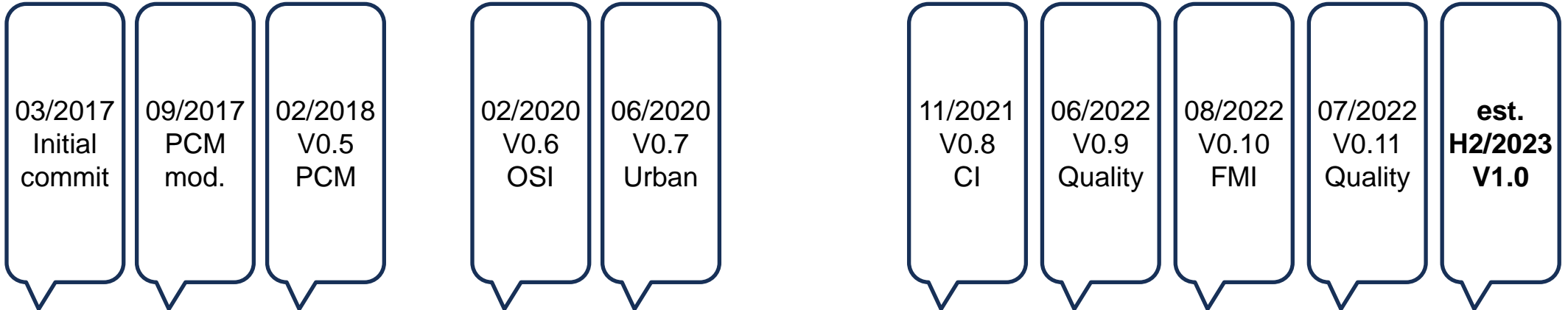
Eclipse Automotive Working / Interest Groups



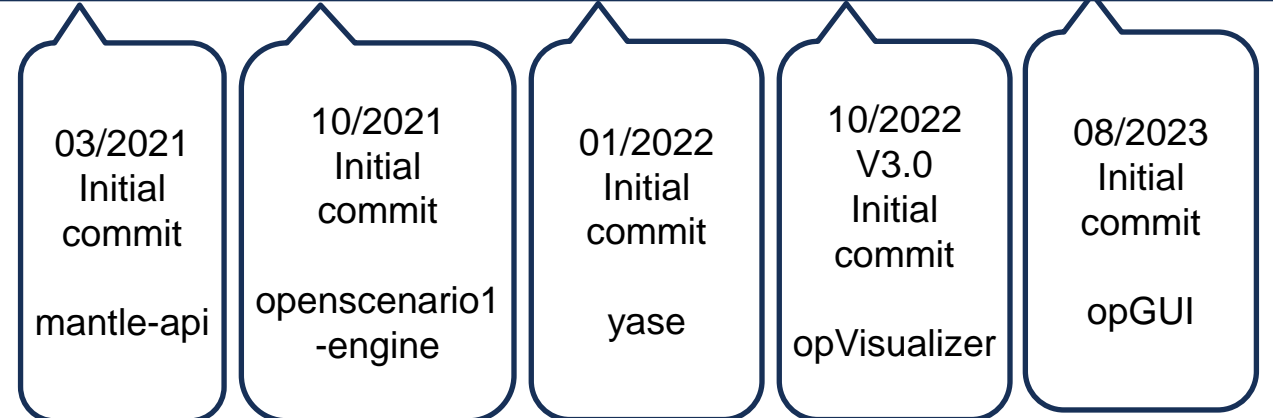
TIMELINE



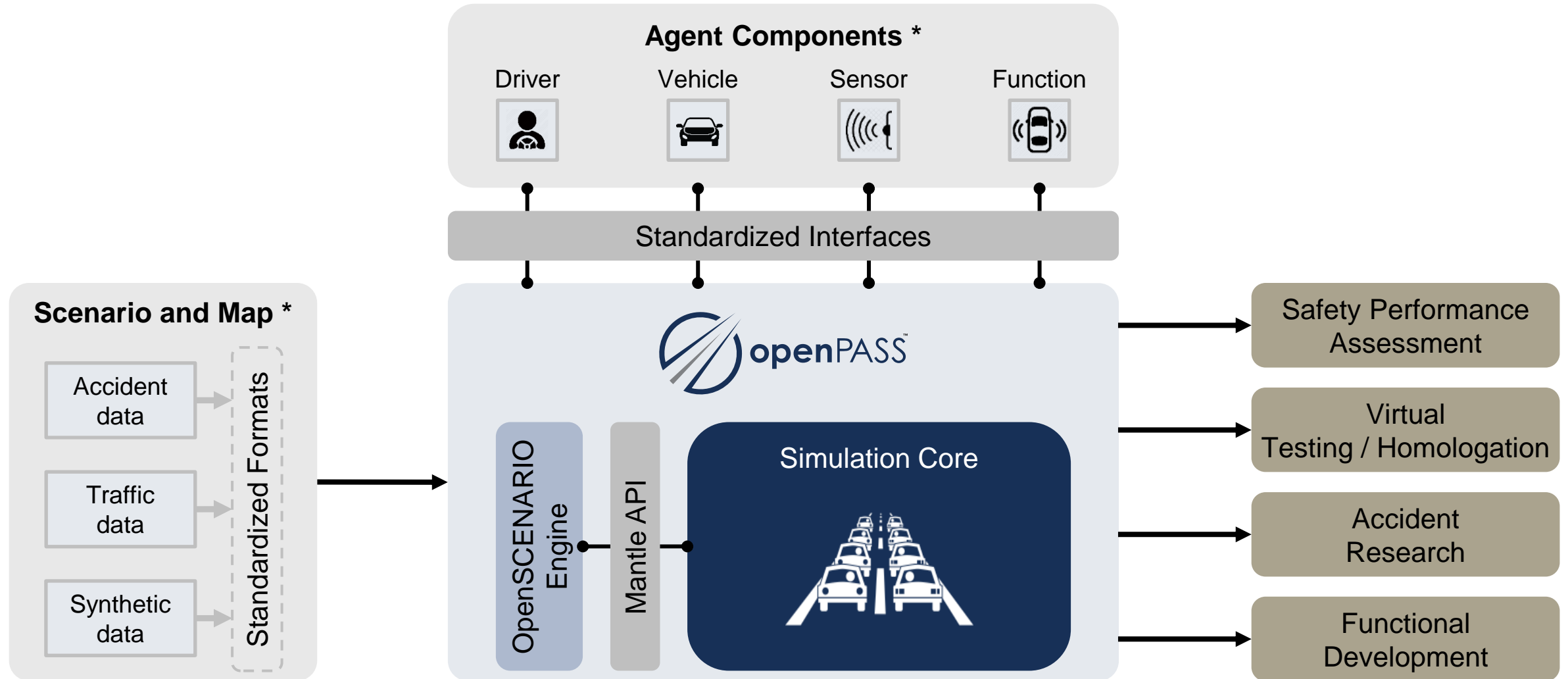
Eclipse openPASS
opSimulation



Eclipse openPASS
subprojects

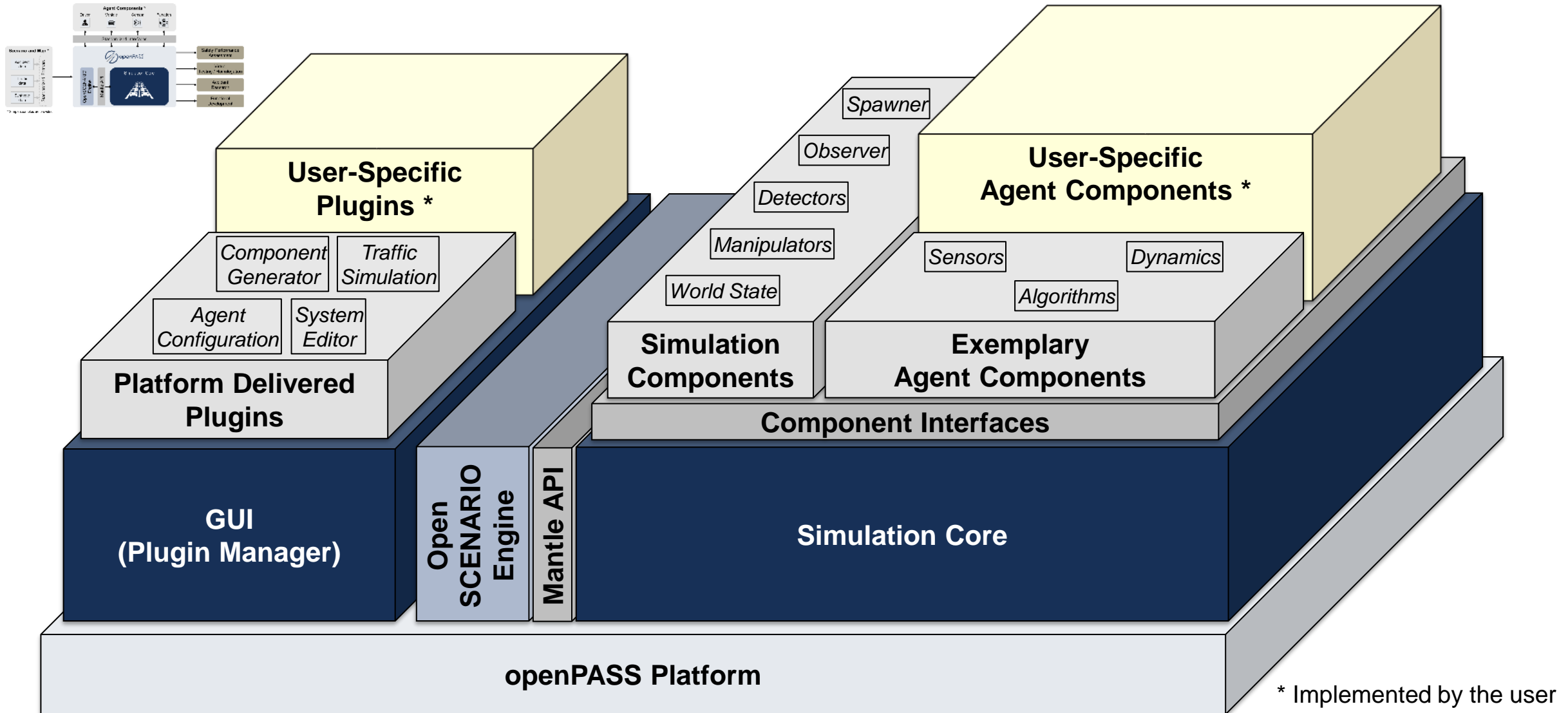


PLATFORM CONCEPT

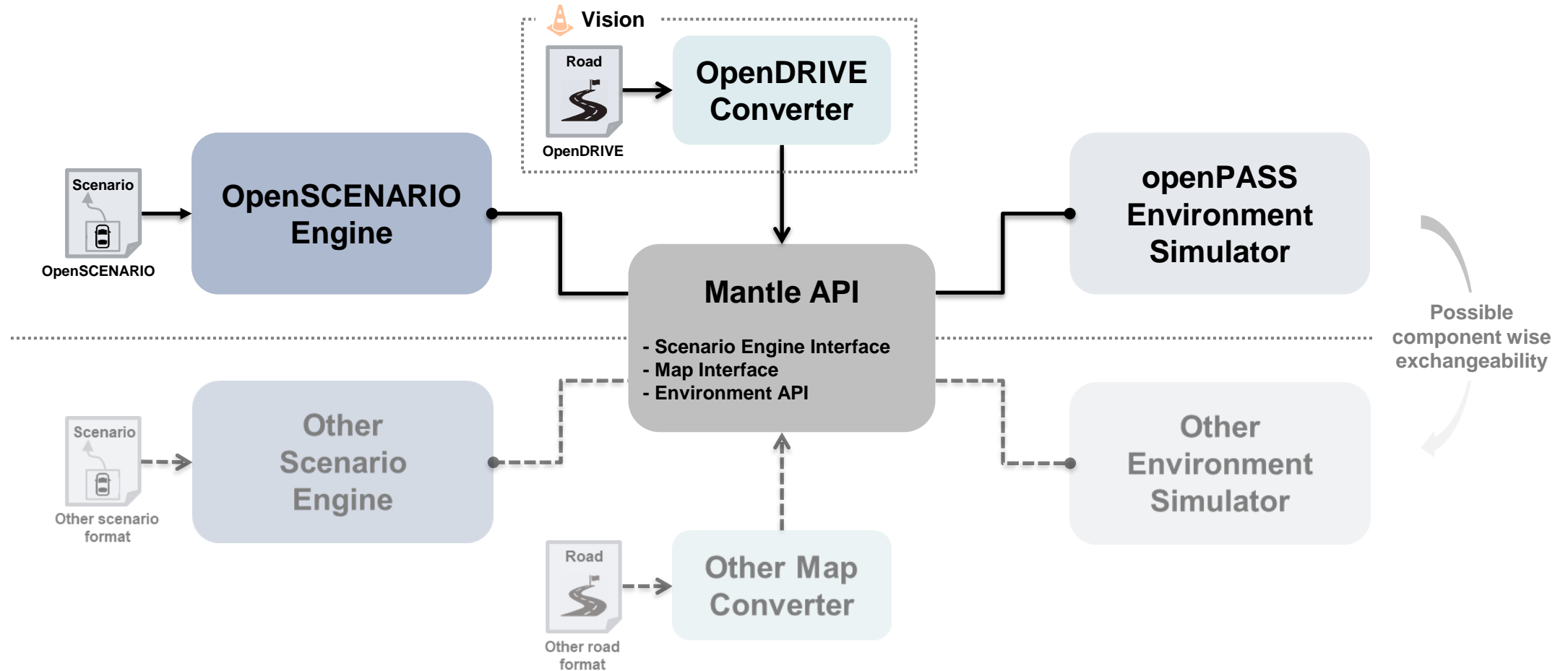


* Simple examples are provided

PLATFORM STRUCTURE

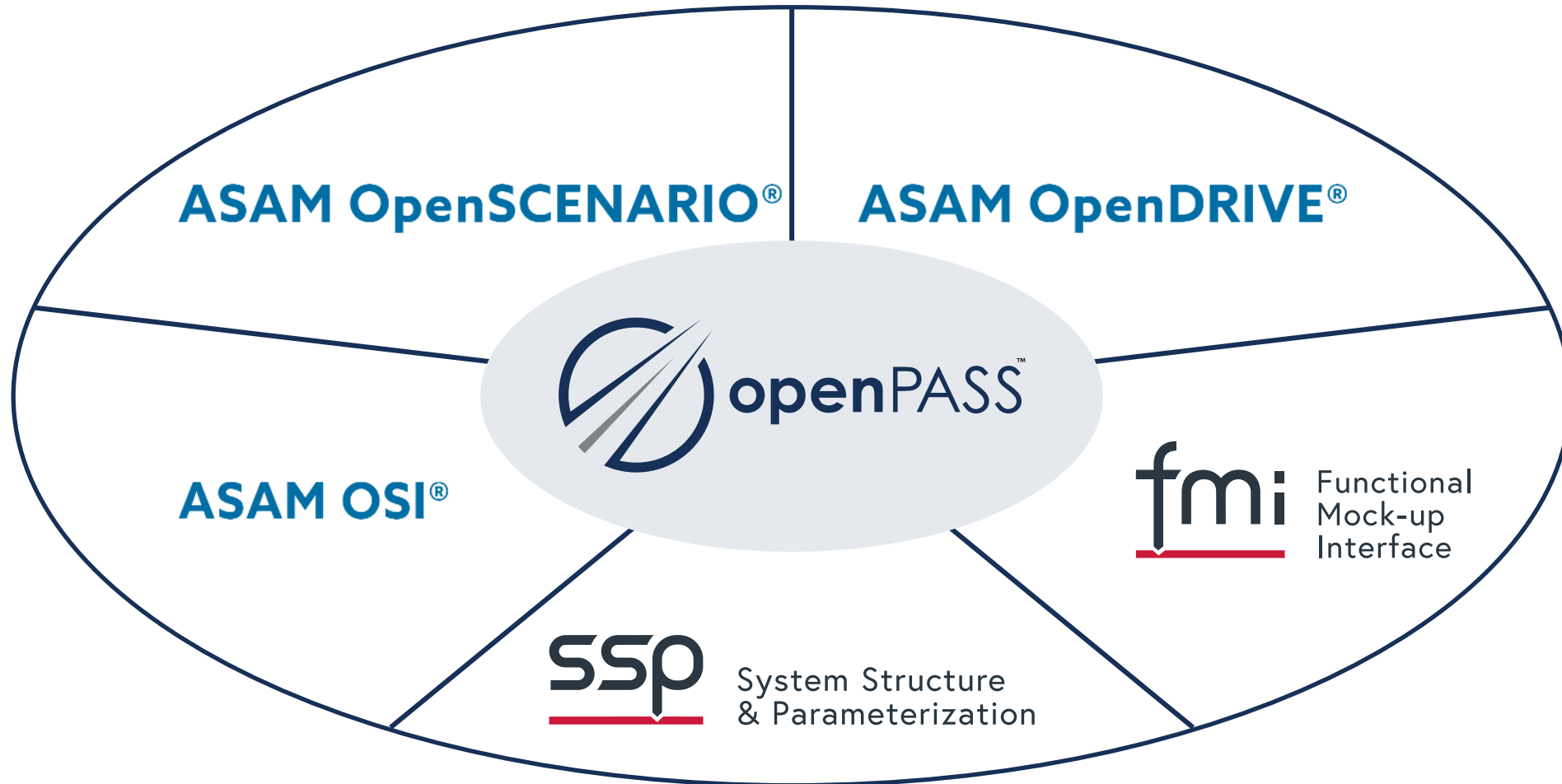


SCENARIO-BASED SIMULATION TOOLCHAIN



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

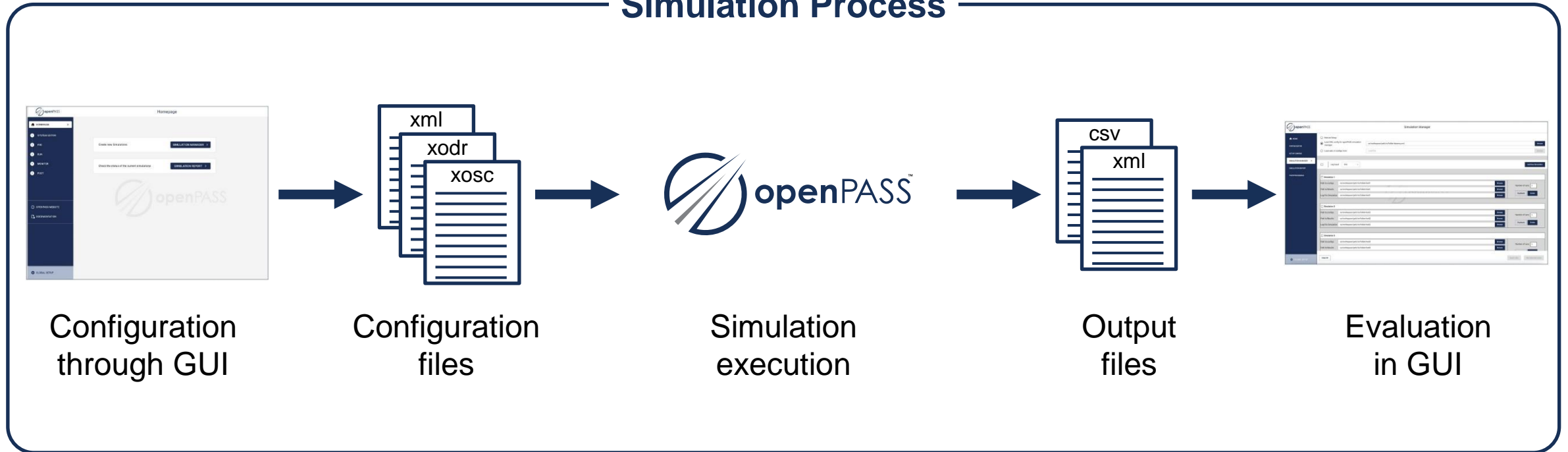
SUPPORTED STANDARDS



SIMULATION PROCESS



Simulation Process



SCENARIO MODELLING APPROACHES

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 scenarios 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

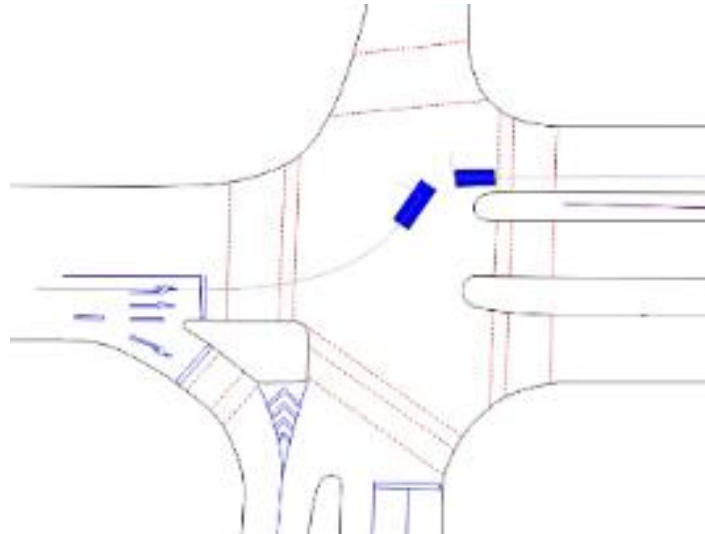
EXAMPLE FOR CRASH RE-SIMULATION



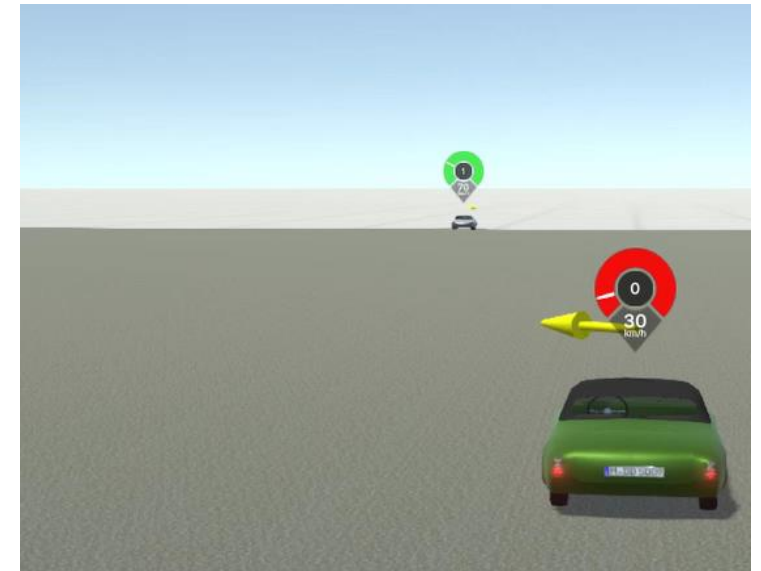
Tool-based
conversion to
OpenSCENARIO

OpenSCENARIO
defining the traffic
participants and their
behavior

- 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*



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

EXEMPLARY USAGE OF OPENPASS IN PUBLIC PROJECTS



Project duration:

- 09/2017 – 10/2021

Project objectives:

- Largest European Project on automated driving
- 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 function, ...)
- 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

CONCLUSION

Status Quo:

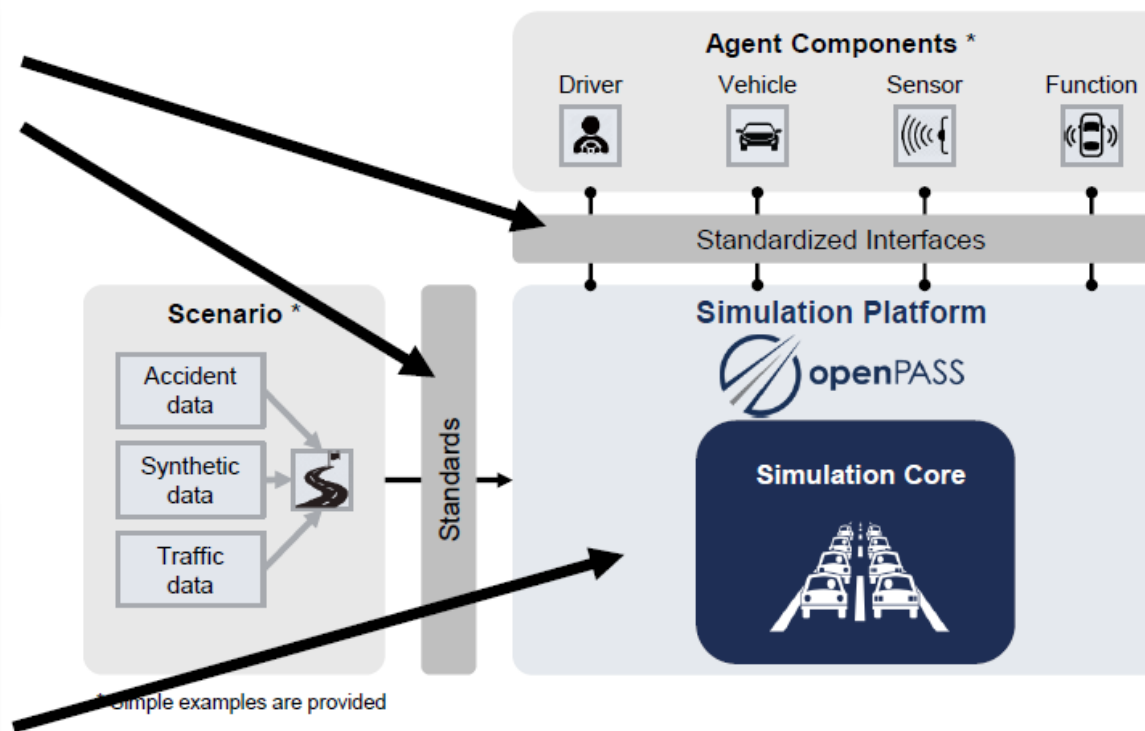
- Standardization of simulation configuration
- Standardization of simulation model interfaces (e.g. OSI, FMI)

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 ADAS and AD**

CONCLUSION

- openPASS is an open source platform for scenario-based traffic simulation of advanced driver assistance systems and automated driving functions
- Open source platform for high level of acceptance and transparency by using open standards
- Modular structure for easy platform extension und inclusion of user-specific models
- Support for standards and standardized interfaces for a flexible simulation setup
- Exemplary applications of openPASS:



Traffic-scenario simulation



Crash re-simulation

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