PROJECT of the PEGASUS FAMILY

VERIFICATION VALIDATION METHODS

Mid-Term Presentation 15 / 16 March 2022

Deriving and Simulating Scenarios

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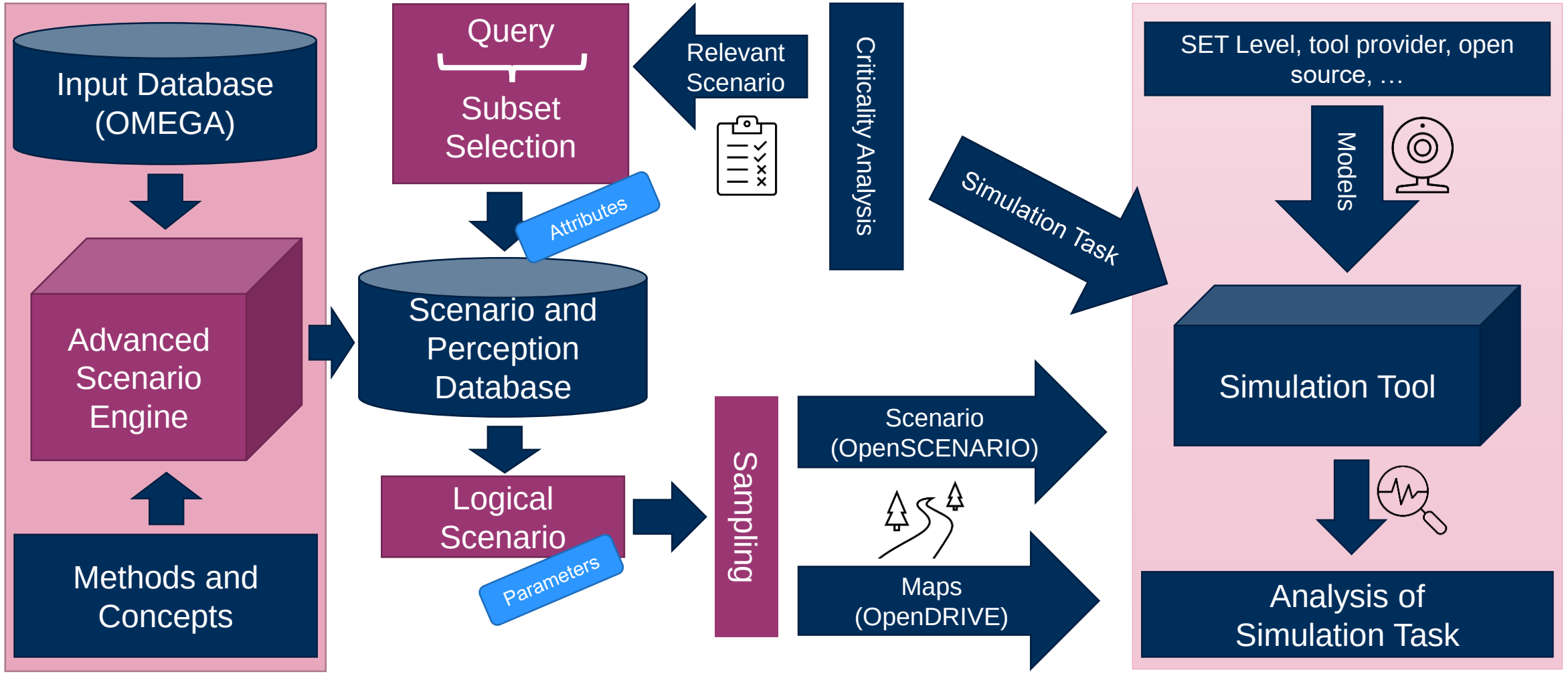
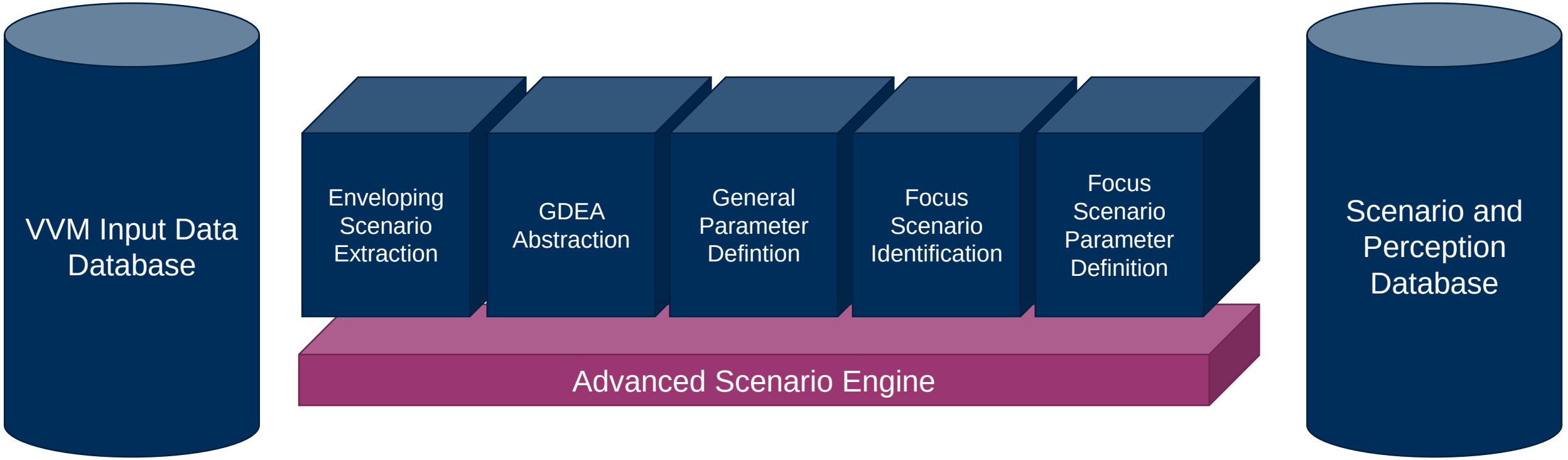
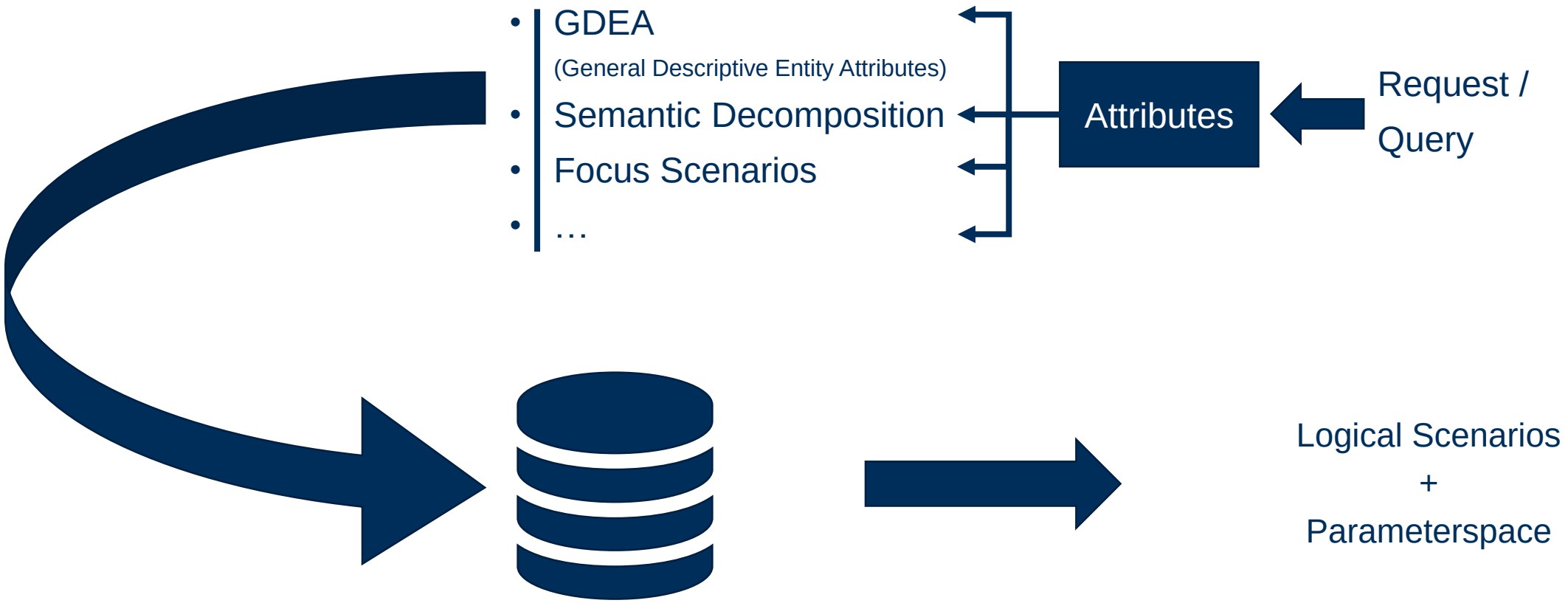
Deriving and Simulating Scenarios



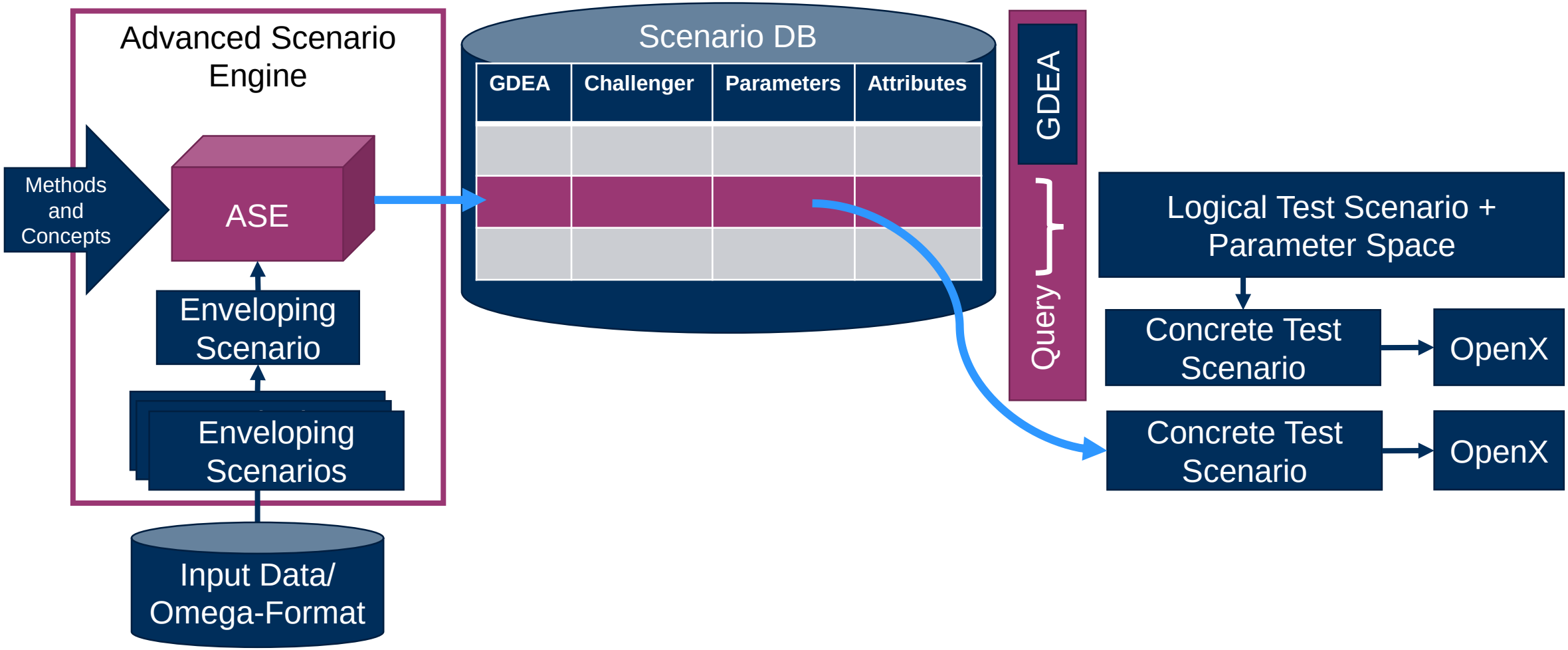
Advanced Scenario Engine - Overview



Advanced Scenario Engine – Attributes and Parameters



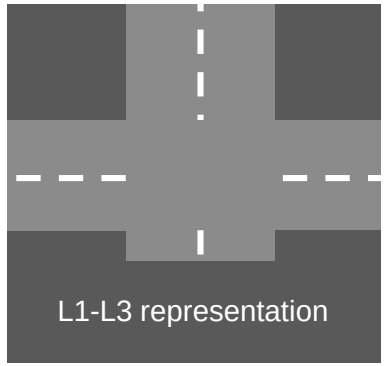
Scenario and General Descriptive Entity Attributes

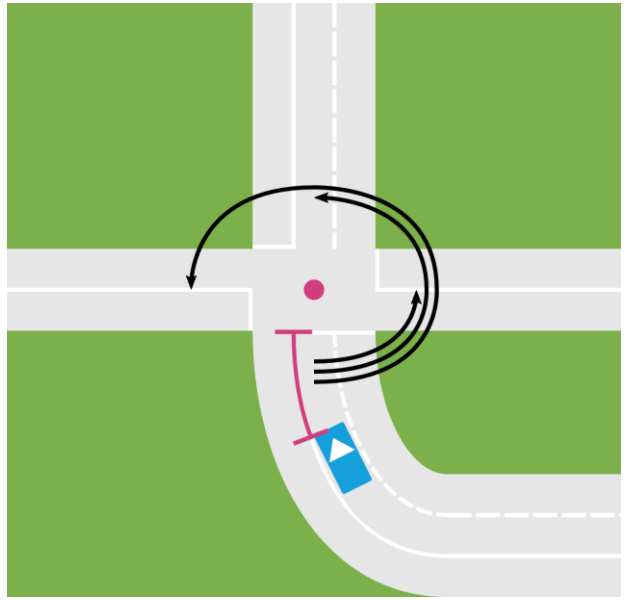


General Descriptive Entity Attributes (GDEA)

- Represents Ground Truth
- Add Semantics
  - Relative to ego vehicle path
  - Translate Trajectory to Lane Coordinates
  - Only abstract Topography
- Positioning
  - Allocation to Lane
  - Distance on Lane→ Frenet Coordinates (as in RSS)
- Trajectories
  - Summary Statistics
    - Min/max/mean/std of Velocity and Acceleration
  - Anything else through TSE-Storyboard

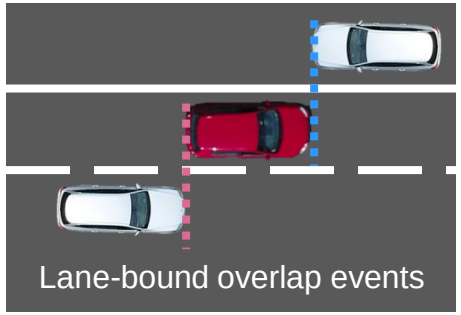
Enables Efficient Understandable Search In Database



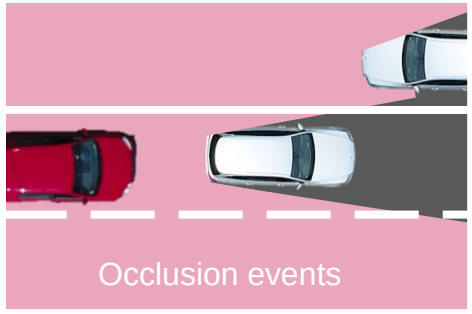


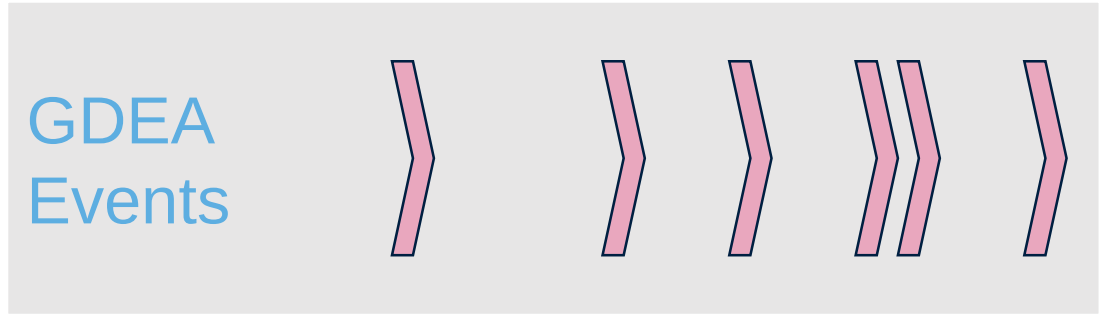
General Descriptive Entity Attributes (GDEA)

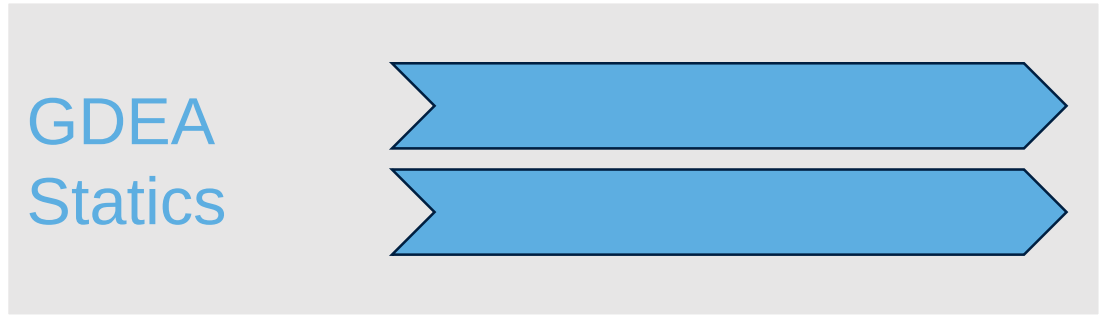
- Events in Temporal Scenario Entity (TSE) - Storyboard
  - Lane-Change / Intersection Entering
  - Overtaking / Passing
  - Occlusion
  - Direction Change / Standstill
  - Traffic Light / Sign change
  - Weather
  - V2X Update
- Summary Attributes over whole Scenario


Lane-bound overlap events

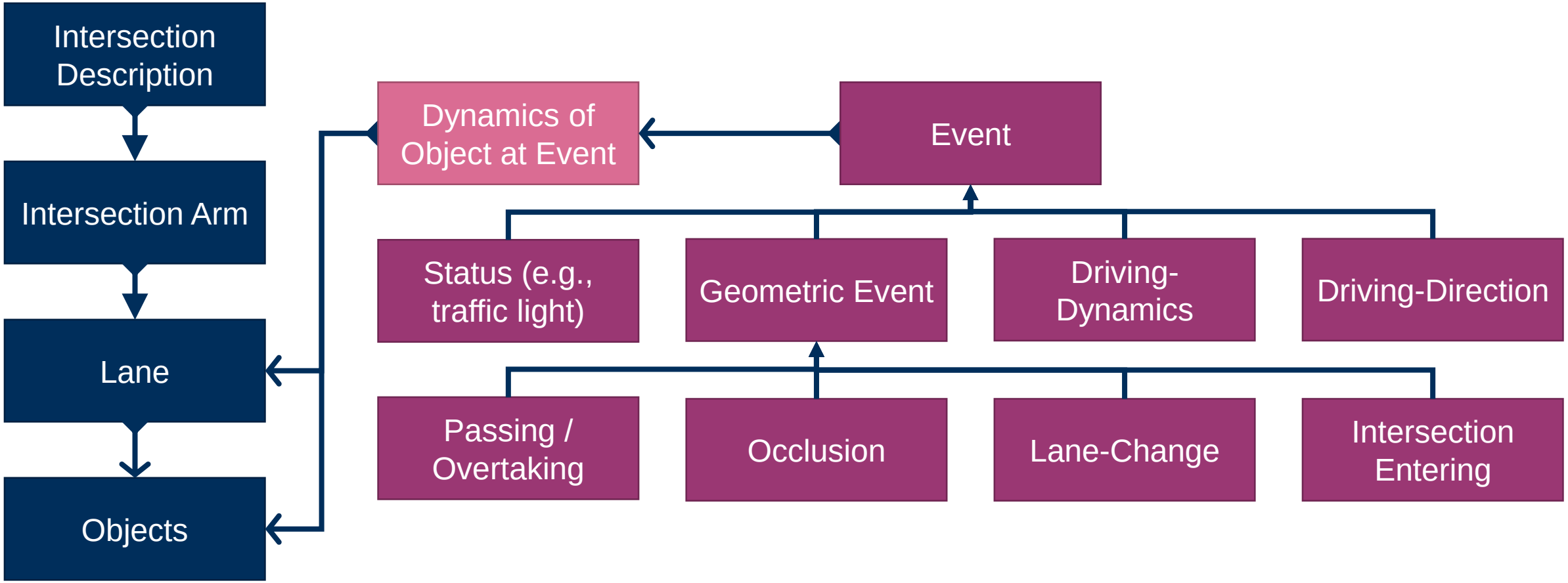

Lane overlap event


Occlusion events

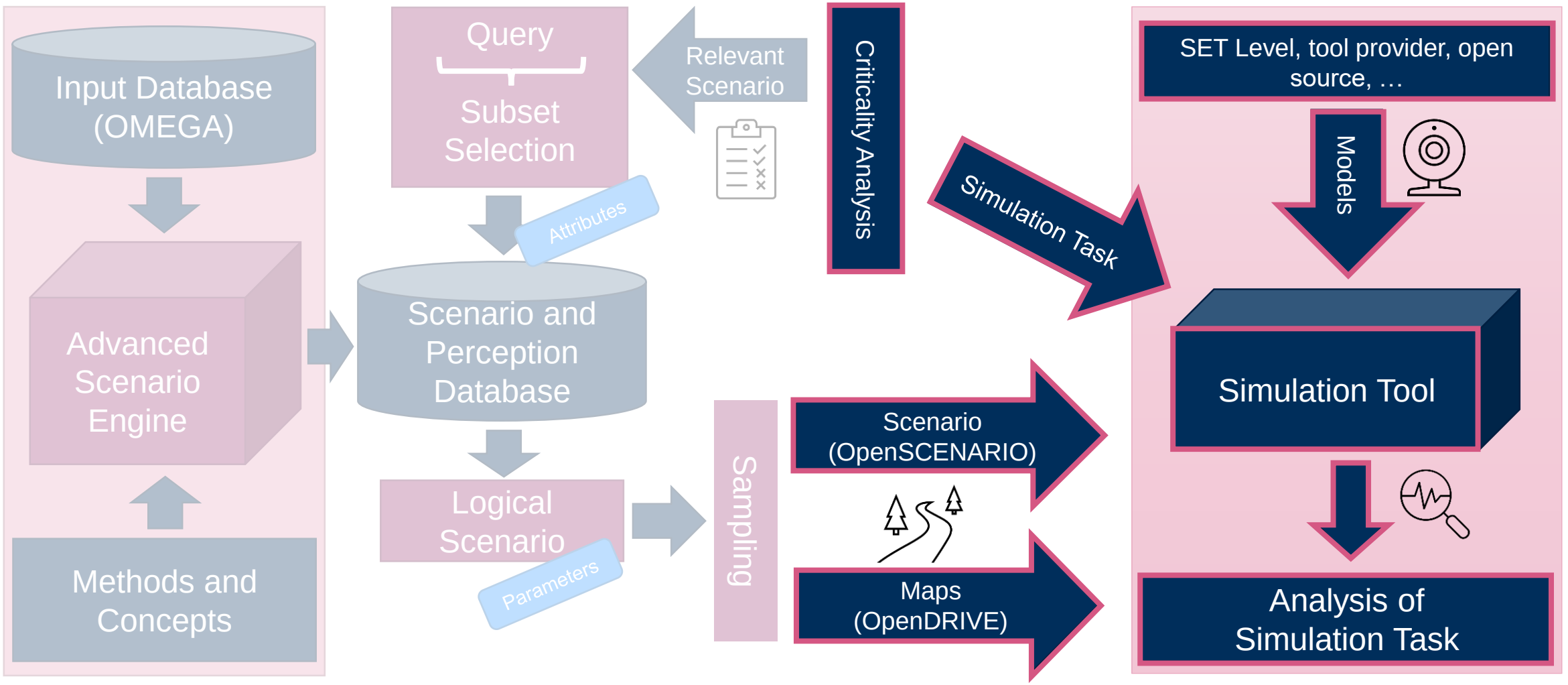




GDEA - Structure



Deriving and Simulating Scenarios



Simulation of Scenarios within the Criticality Analysis

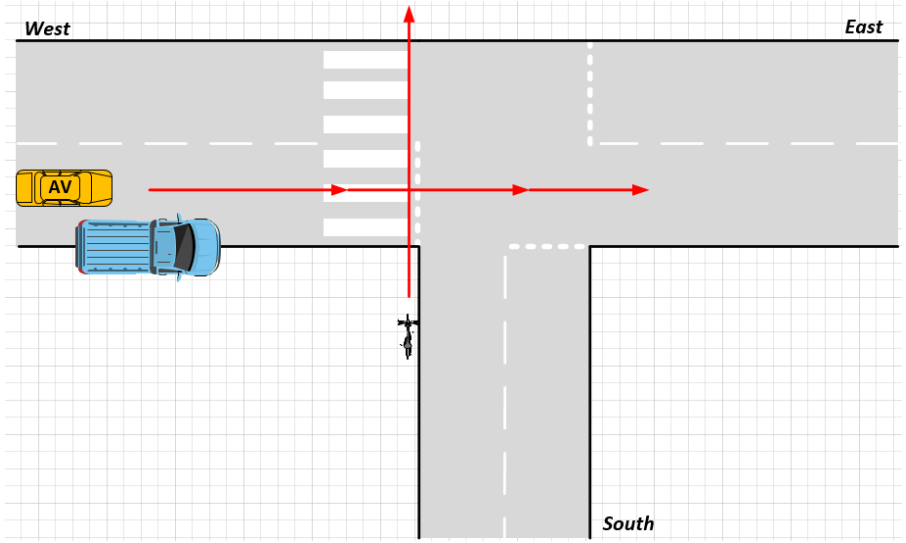
- the criticality analysis as developed and conducted in VVM aims at **structuring the complex and open context** of the traffic world by eliciting a **finite & manageable set of artifacts**, namely

$\infty \rightarrow n$

  - **criticality phenomena**
    - phenomena associated with increased criticality
  - **causal relations**
    - plausible explanations of the causality underlying these phenomena
  - **abstract scenarios**
    - featuring criticality phenomena and their causal relations

- simulation of traffic scenarios can **play a vital role** in **identifying** and **analyzing these artifacts**, e.g. for
  - **engineering, calibration** and **comparison** of criticality metrics
  - **plausibilization** of causal relations
    - including quantification of effect sizes

Plausibilization of Causal Relations of Occlusion using Simulation



causal graphs are used to model the **assumptions** about the underlying **causal relations** of criticality phenomena

simulation task: generate evidences for the causal relations of „occlusion“

approach: execute sufficiently many simulation runs

- using stochastic **variation** of adjustment variables (orange)
- evaluate criticality metrics (blue)

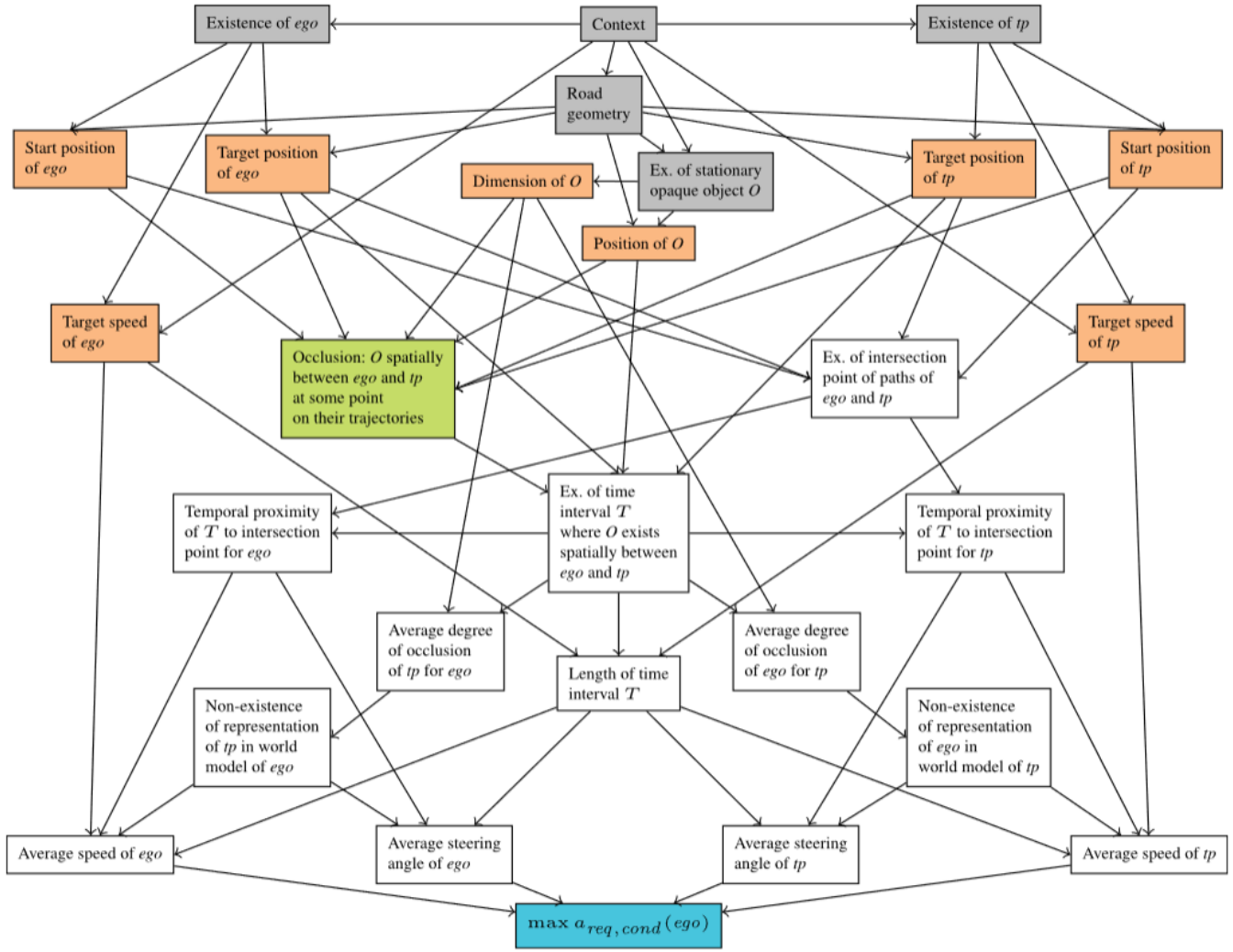
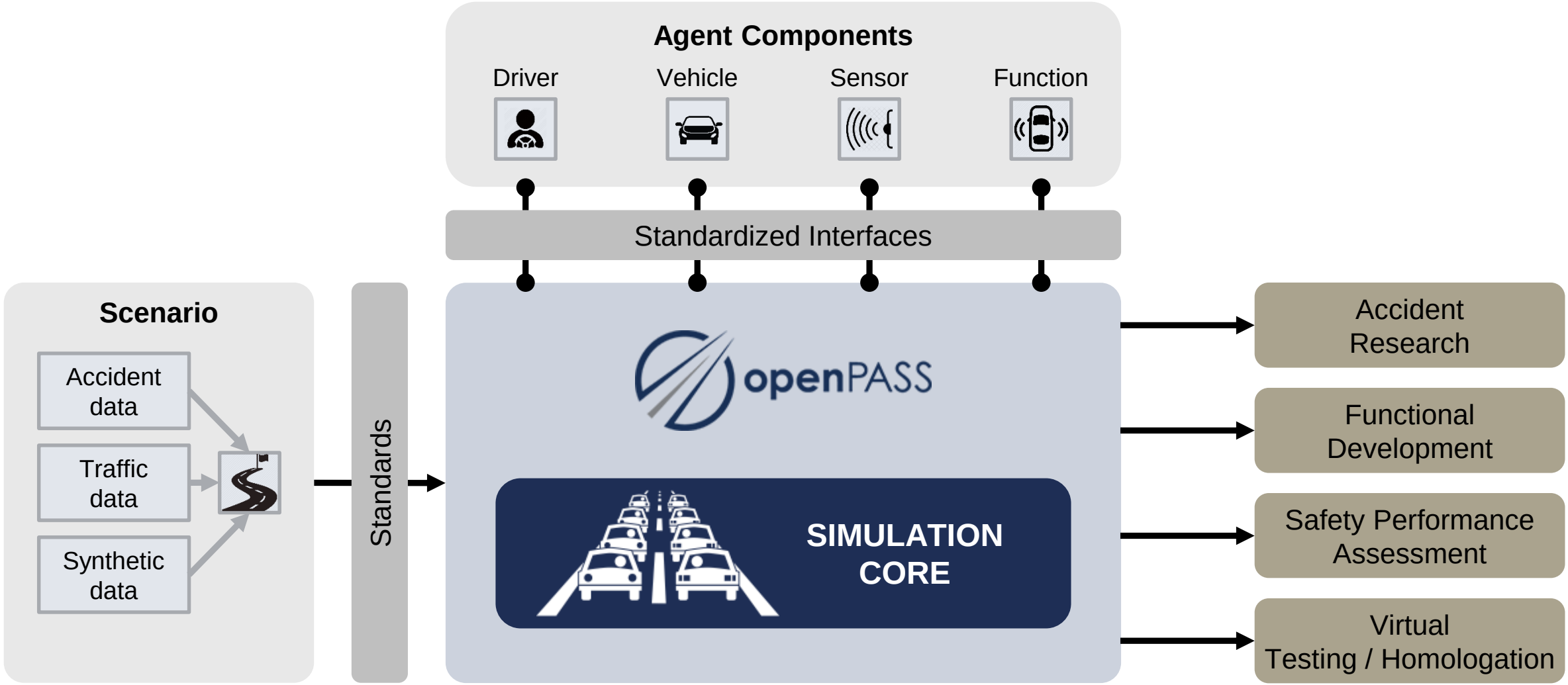


Figure: causal graph for evaluating the causal effect of „occlusion“ on the criticality metric $a_{req,cond}(ego)$.

openPASS – Platform Concept



Simulation Setup with openPASS

VERIFICATION VALIDATION METHODS

VVM

SET Level

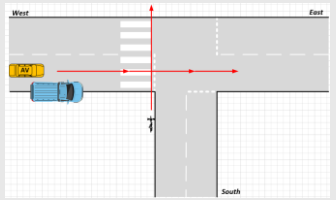
openPASS

Agent Components *

Bicycle | Car | Camera | HAD function

OSI/ FMI/ openPASS interface

Scenario



Occluded Bicyclist at T-crossing

OpenDRIVE and OpenSCENARIO

openPASS

SIMULATION CORE

Criticality Analysis

Developments in VVM

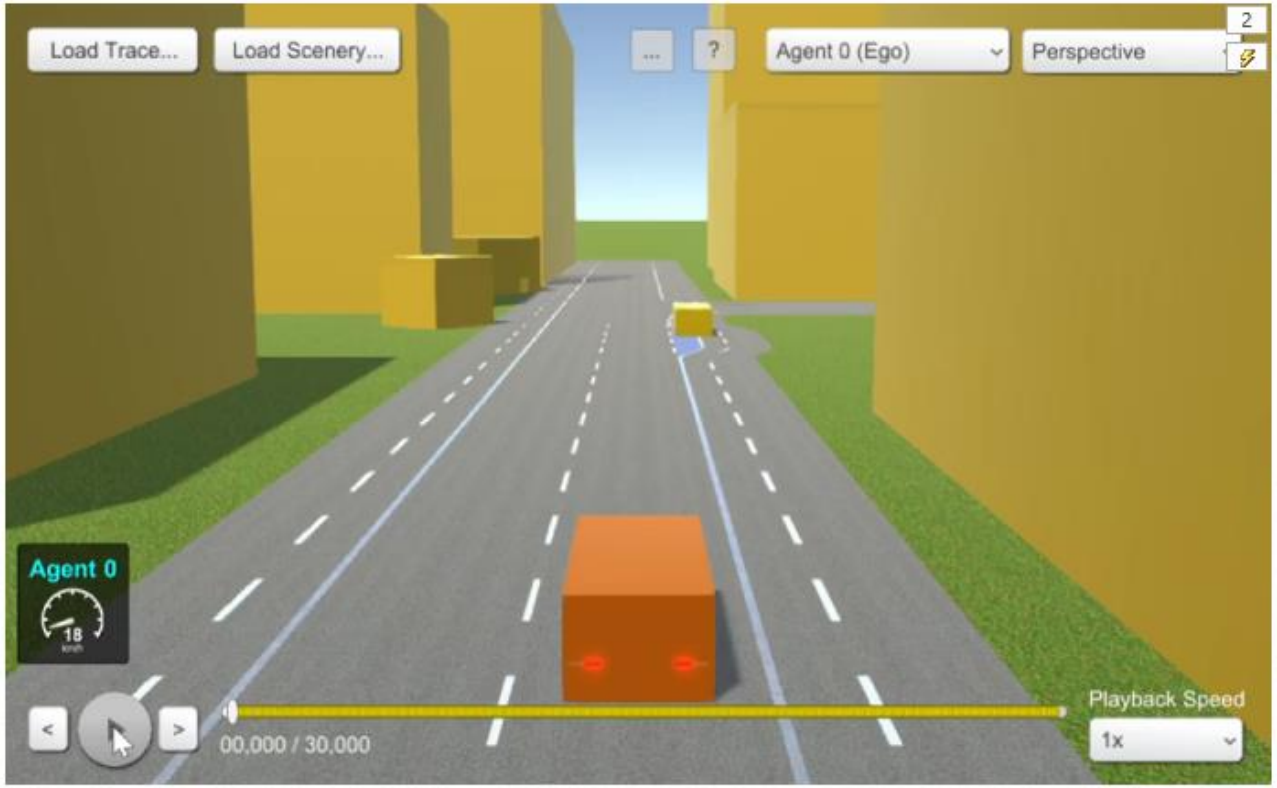
Implementation of a **bicycle model** with stochastic behavior. Either the cyclist pushes or rides the bicycle over the pedestrian crossing.

Interpretation of **pedestrian crossing** from OpenDRIVE.

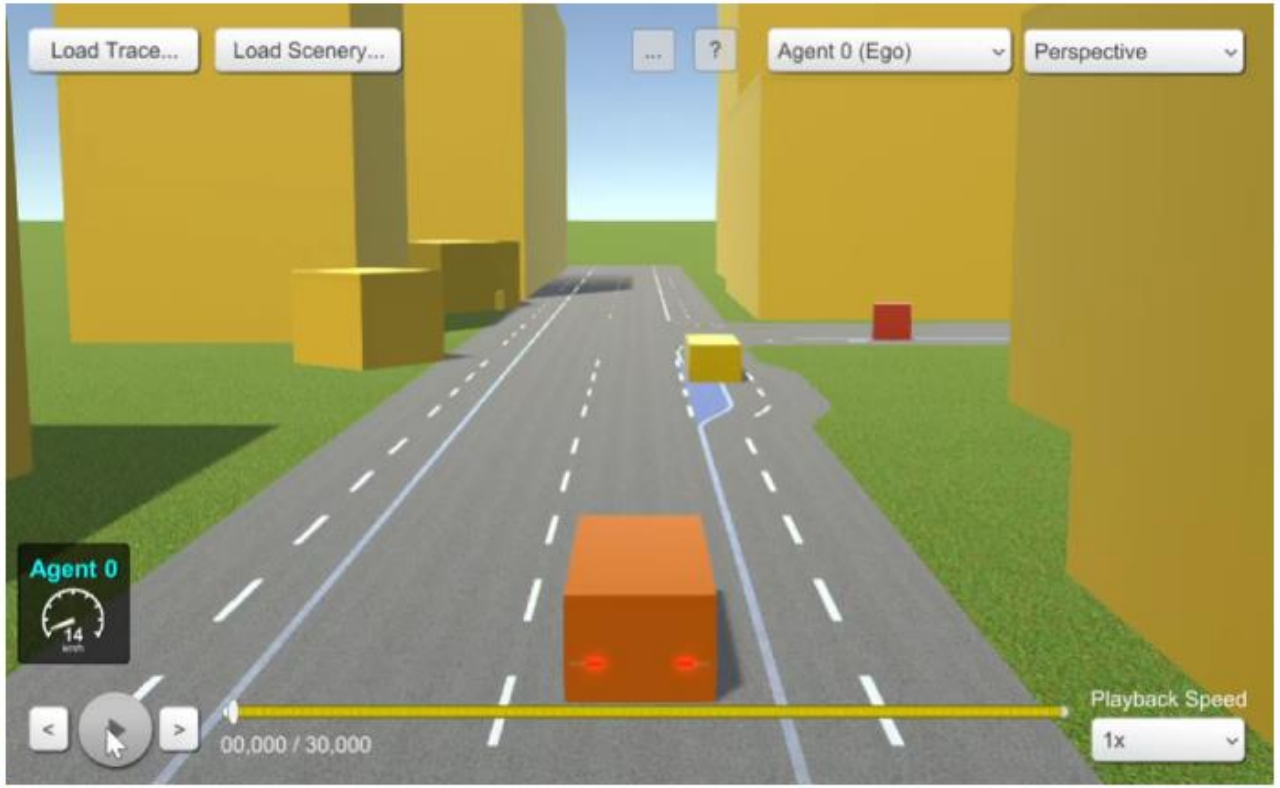
Import of **traffic lights** from OpenDRIVE and OpenSCENARIO and its transformation into OSI format.

Status quo: Parameter Variation within openPASS

Video 1: descending bicyclist crosses the pedestrian crossing



Video 2: bicyclist crosses the pedestrian crossing



Summary

VERIFICATION
VALIDATION
METHODS

Messages “Data”:

- The creation of a scenario database is key for deriving appropriate test cases
- GDEA providing efficient scenario search
- The Scenario Database as a tool to generate logical scenarios and create testable OpenX simulation instructions

Messages Simulation:

- Simulation is used as an evidence generating method
- Usage of virtual methods to plausible the causal relations of “occlusion”
- Open source approach via demonstration of openPASS
- Adaptations in the simulation environment are necessary to cope with the simulation task

VERIFICATION
VALIDATION
METHODS

Thank you!

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A project developed by the VDA Leitinitiative autonomous and connected driving

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