Research Project PEGASUS.

Test Case Variation and Execution.

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PEGASUS

Supported by:

Federal Ministry
for Economic Affairs
and Energy

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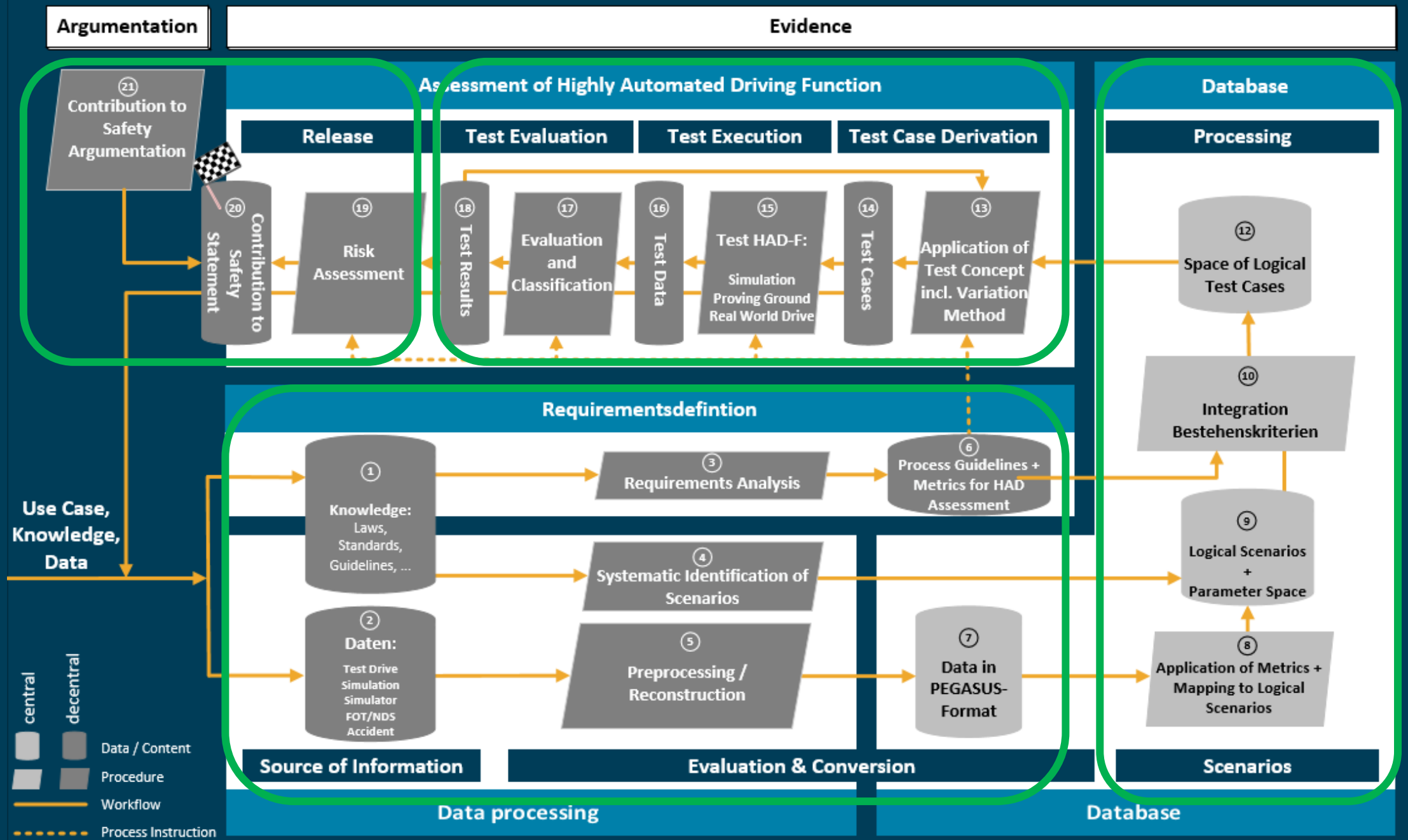
by the German Bundestag

V1.5 Status
14.02.2019

PEGASUS Method for Assessment of Highly Automated Driving Function (HAD-F)

PEGASUS



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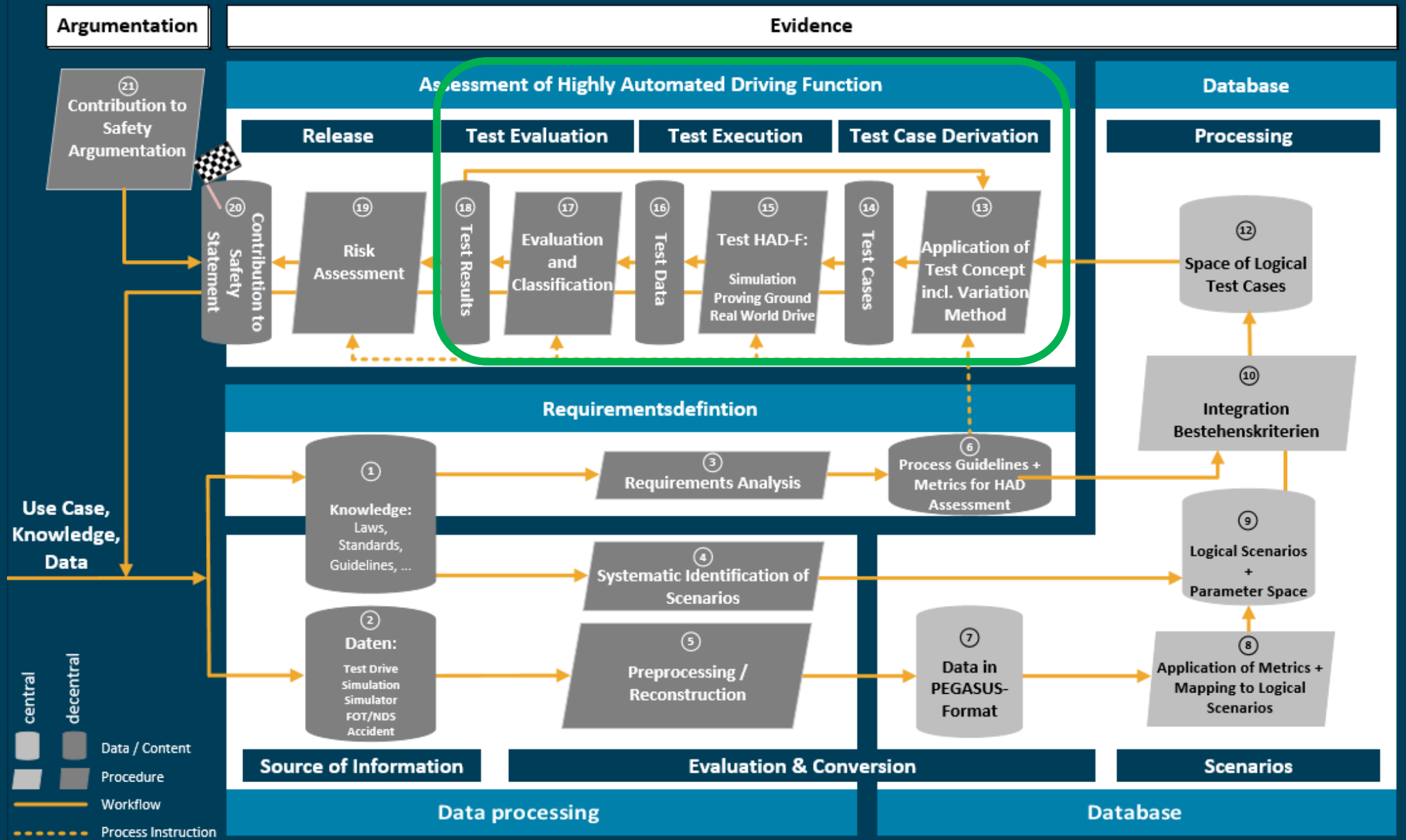
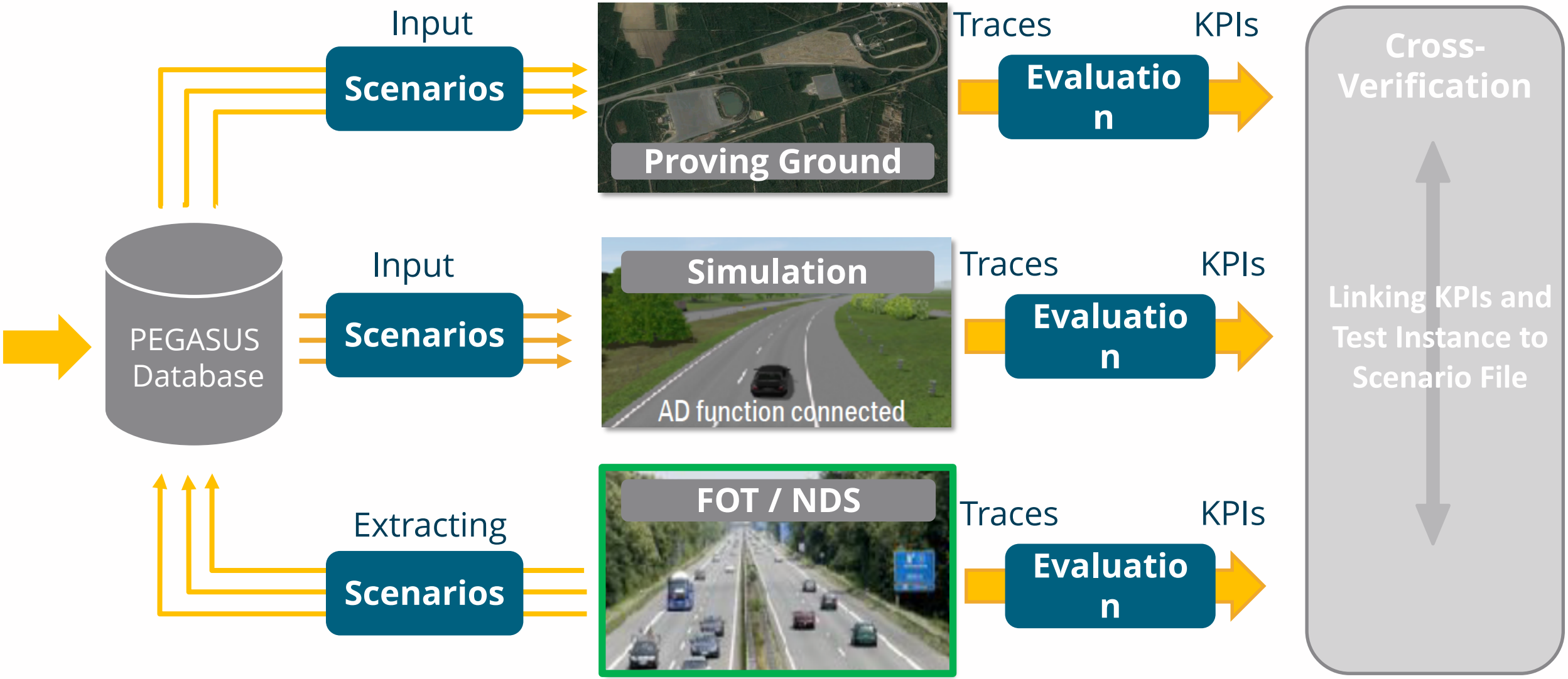


Assessment of AD – Methodology.



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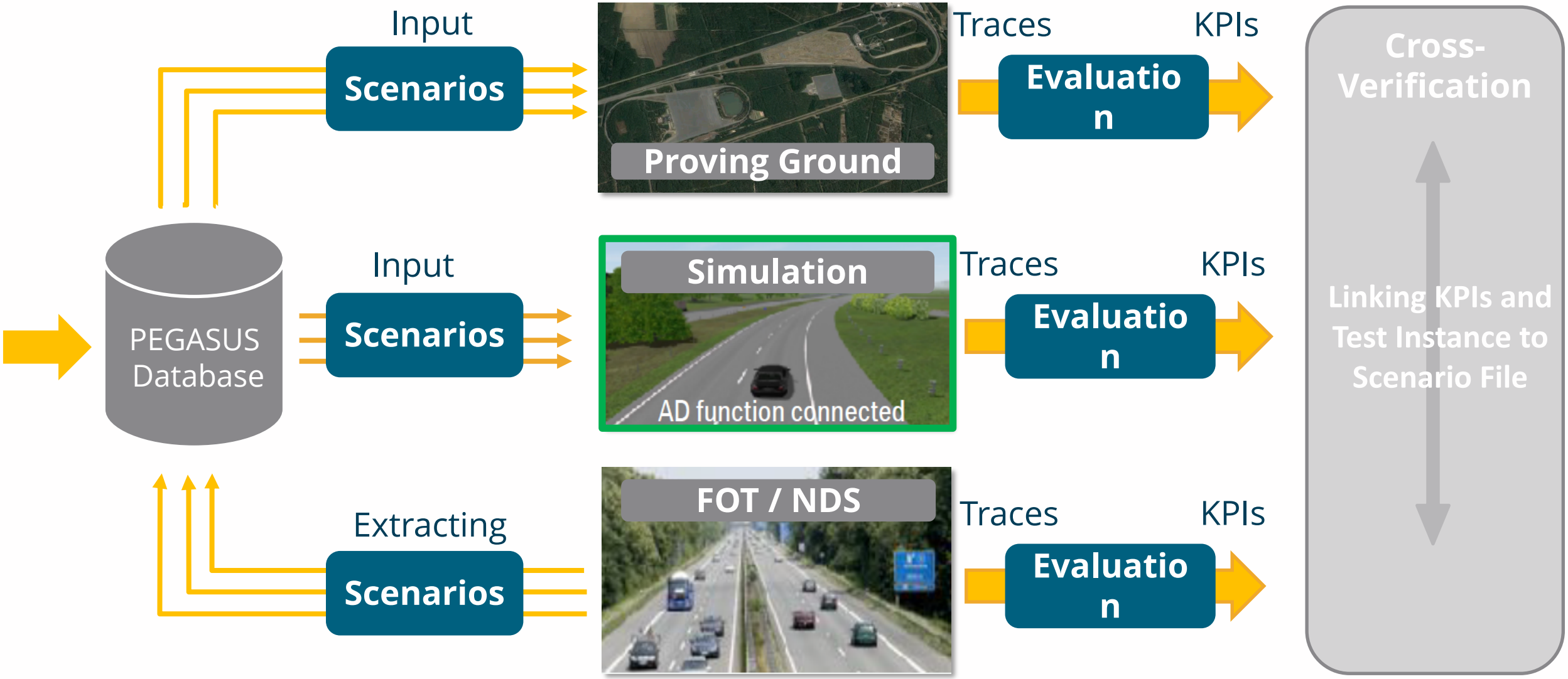

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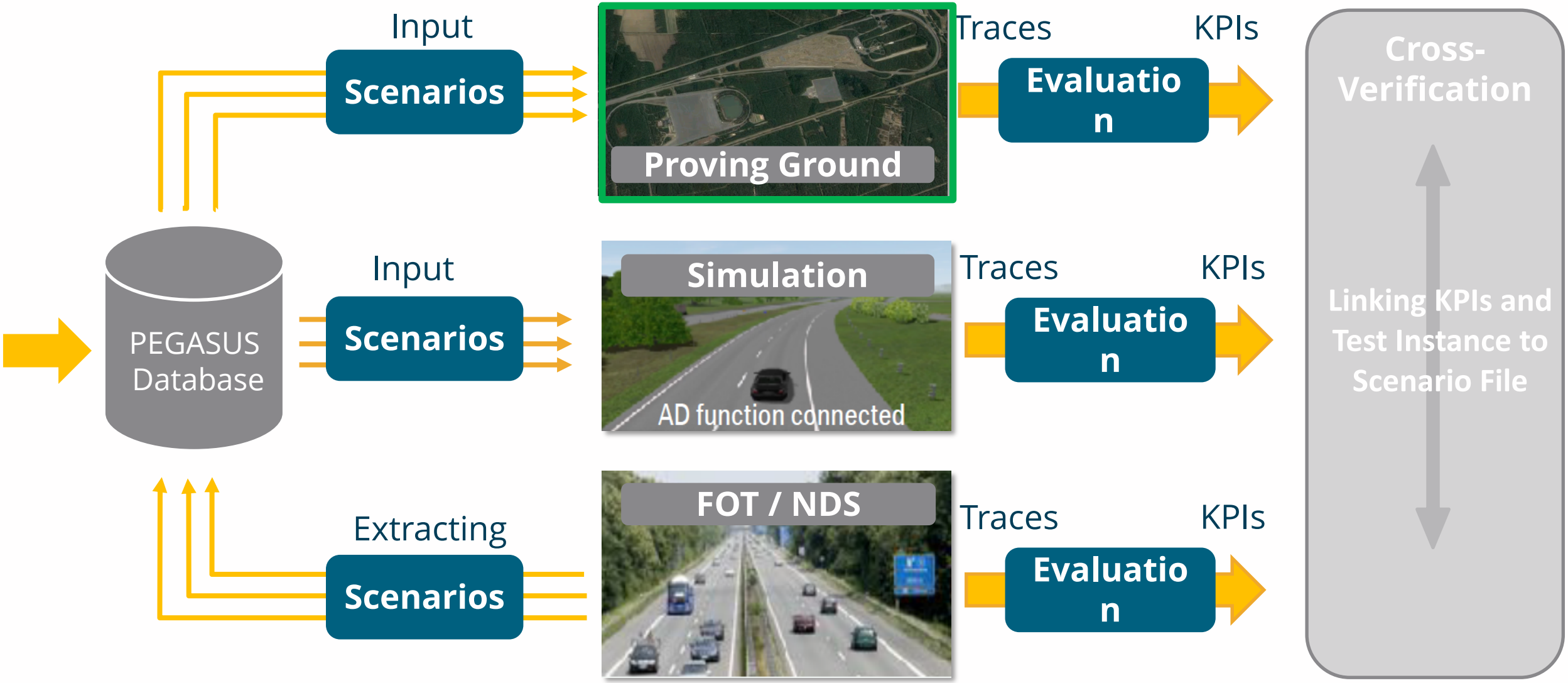
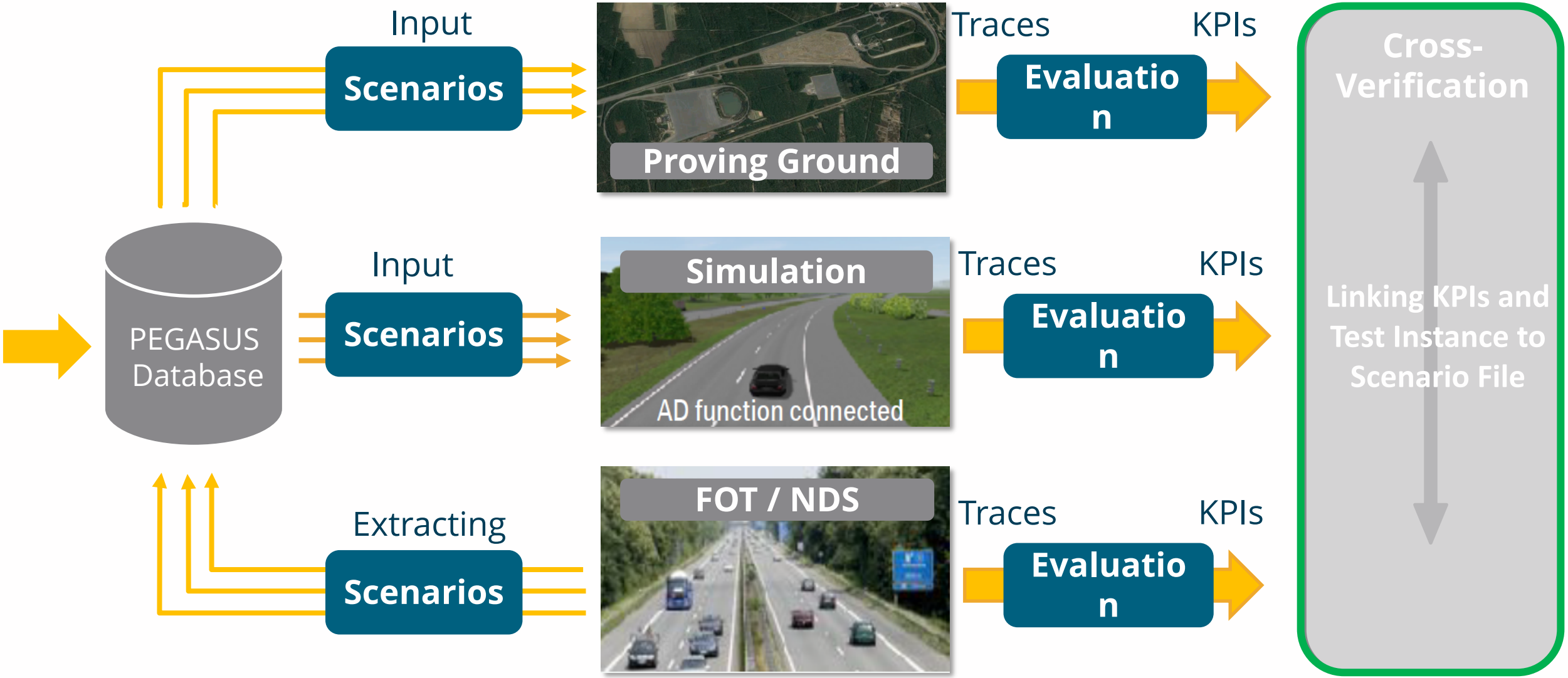


Assessment of AD – Methodology.



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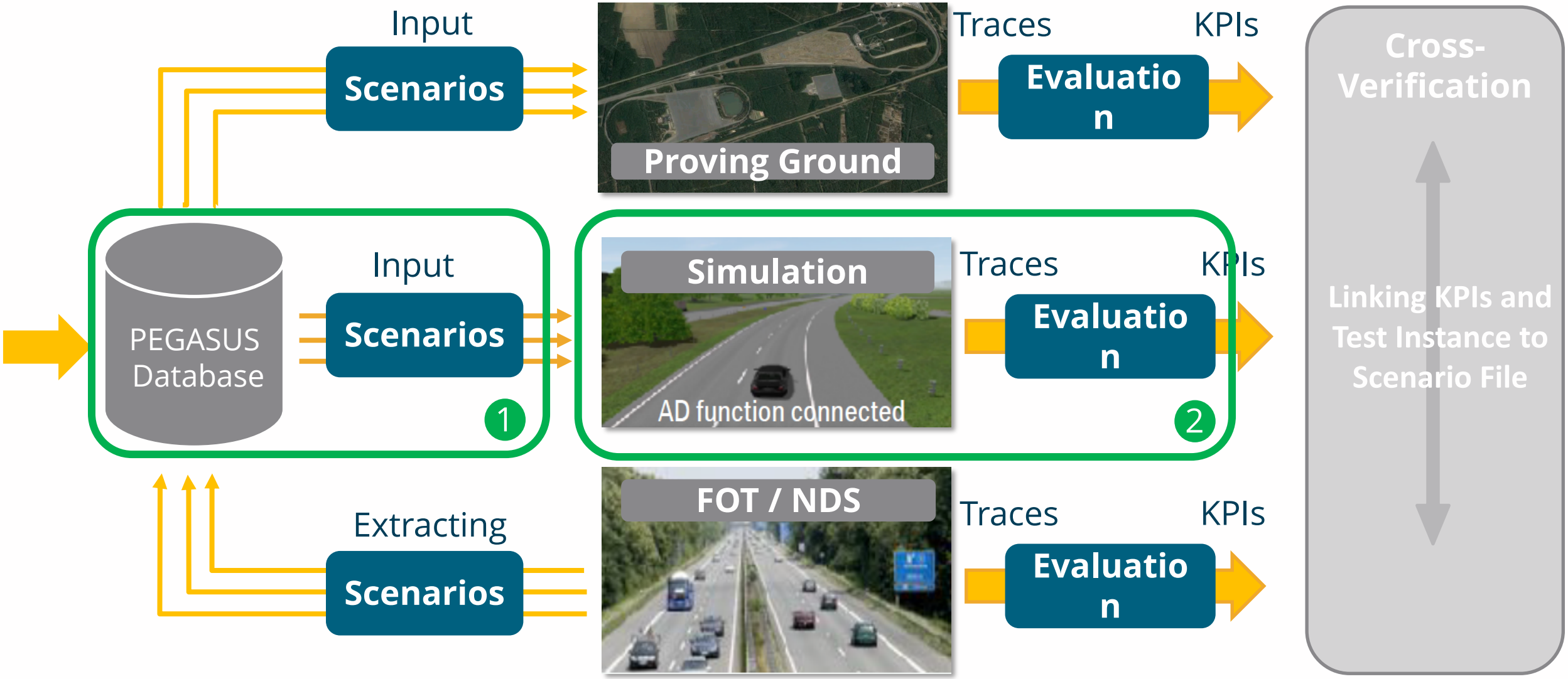
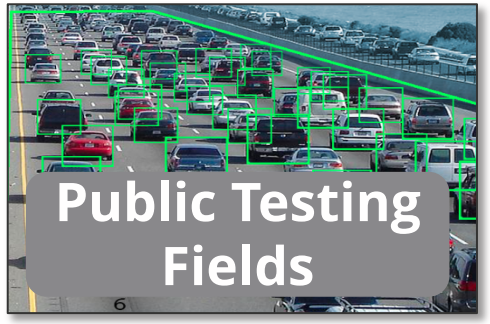


1 Information Basis for AD Assessment.

GIDAS
GERMAN IN-DEPTH ACCIDENT STUDY

Accident Database



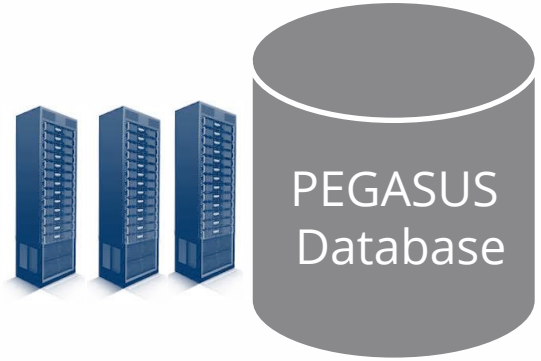
Public Testing Fields

Laws/ Standards/ Guidelines

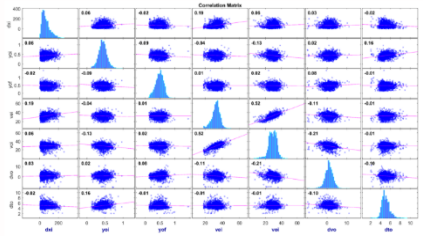
FOT / NDS

Expert Knowledge

Scenario data model enrichment with a-priori knowledge about reality:



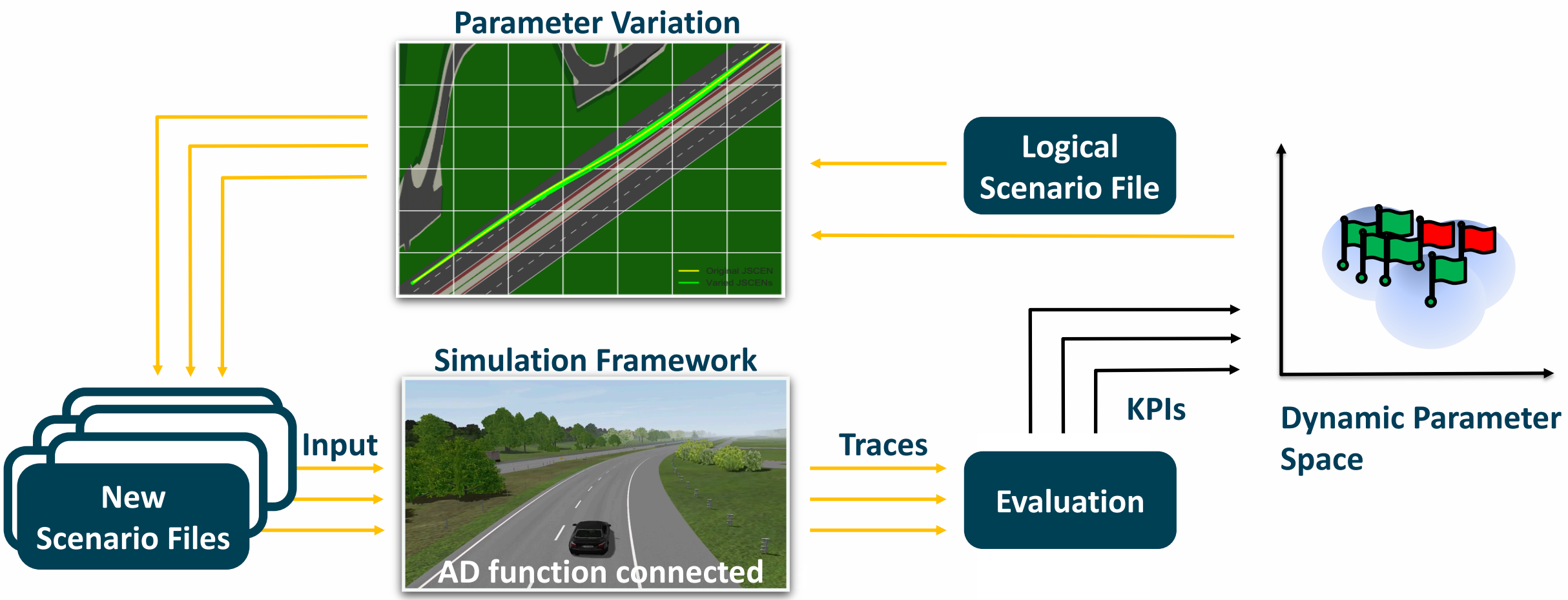
→ **A-priori probabilities and correlations.**



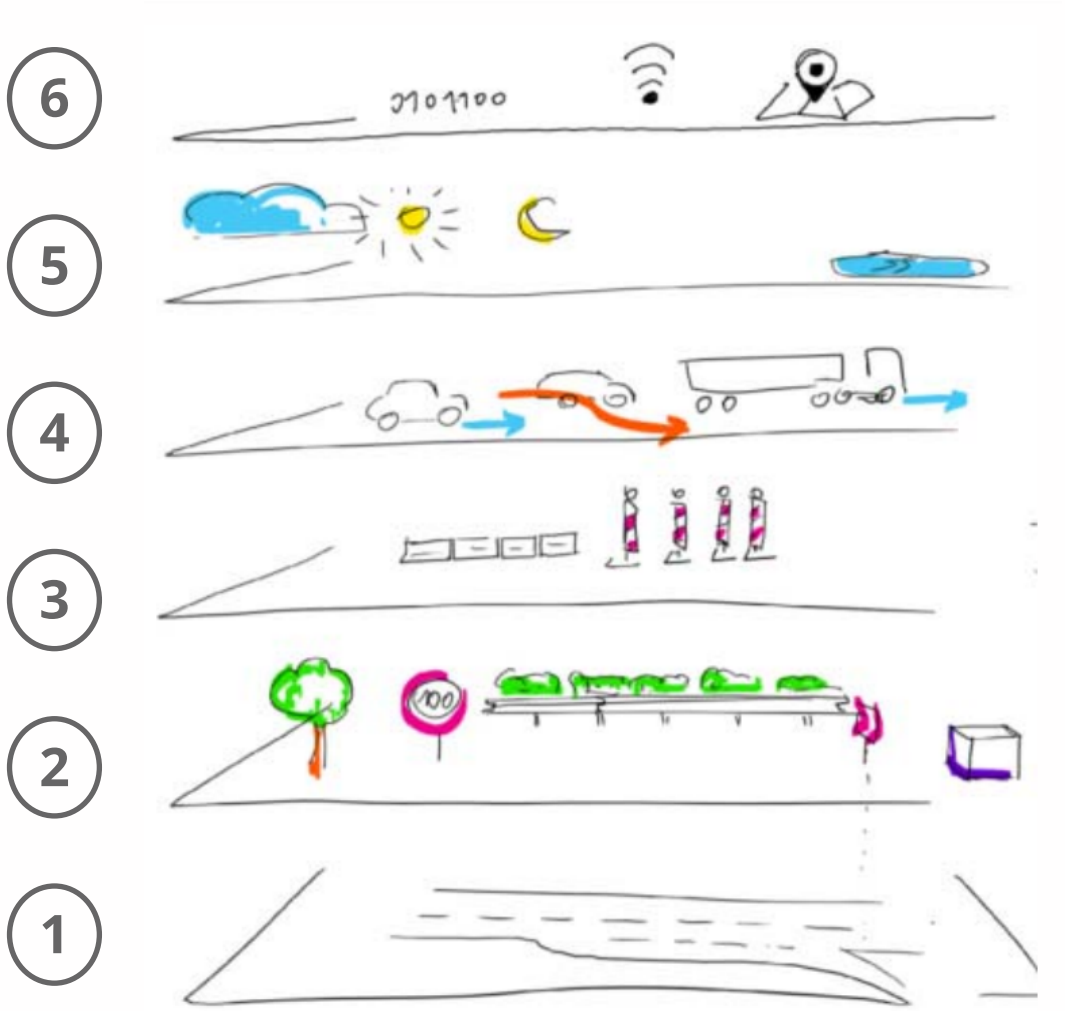
Test Case Data:

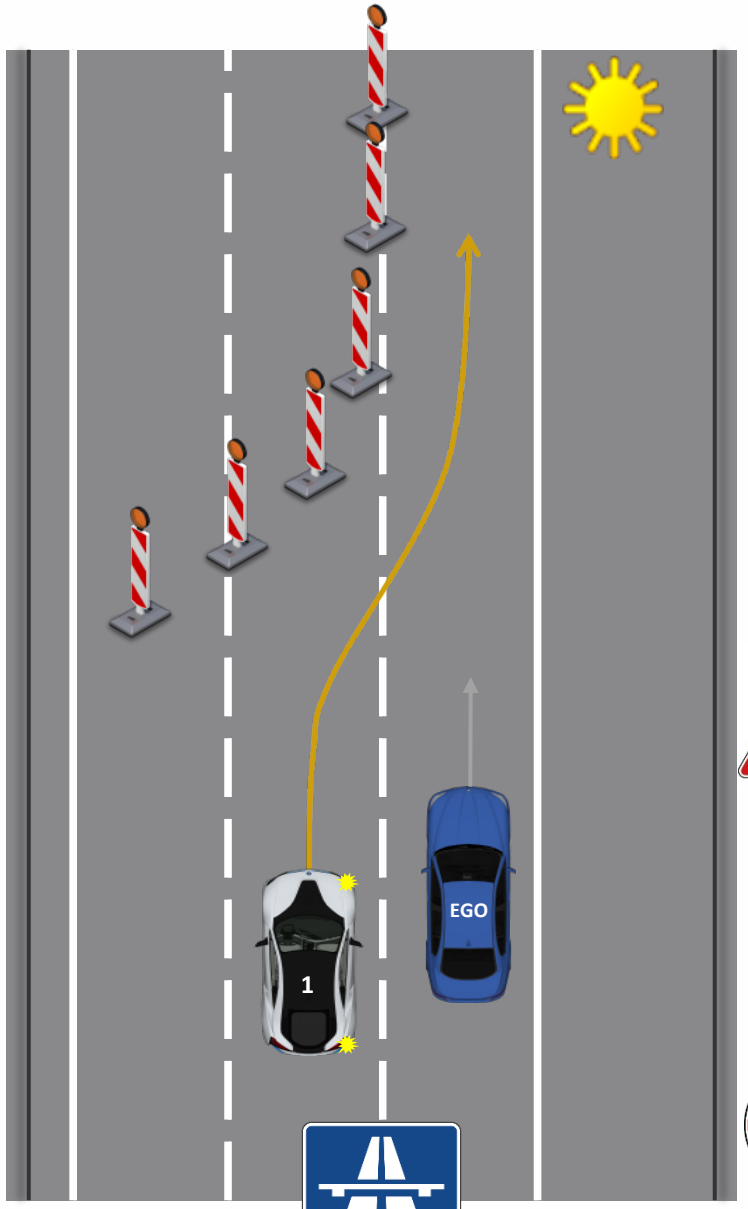
- logical scenario spaces,
- parameter lists with distributions,
- known critical concrete scenarios labelled within the logical spaces,
- metrics / KPIs,
- pass/fail criteria.

❷ Stochastic Variation – Methodology.



Scenario Data Model for exchangeable and reproducible Scenarios.



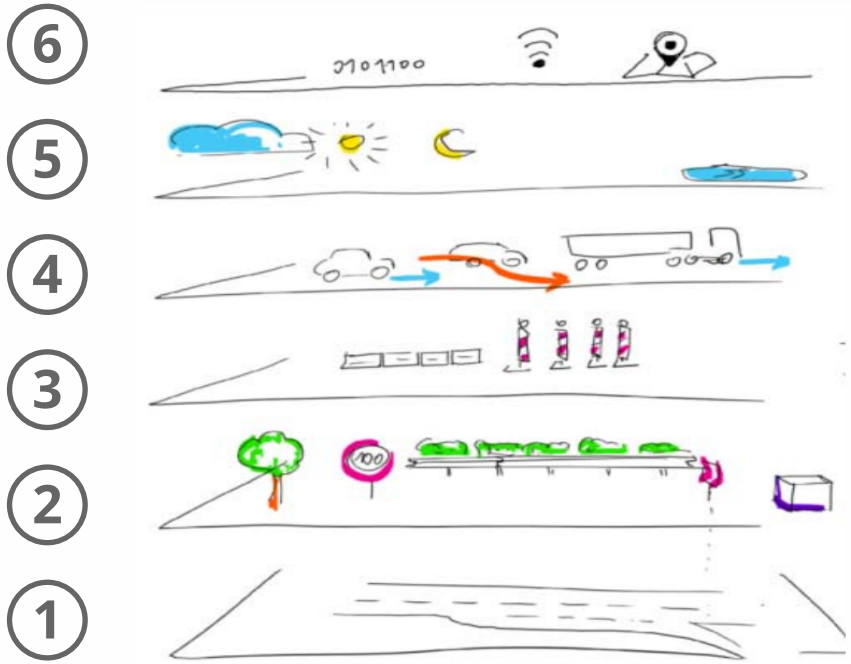


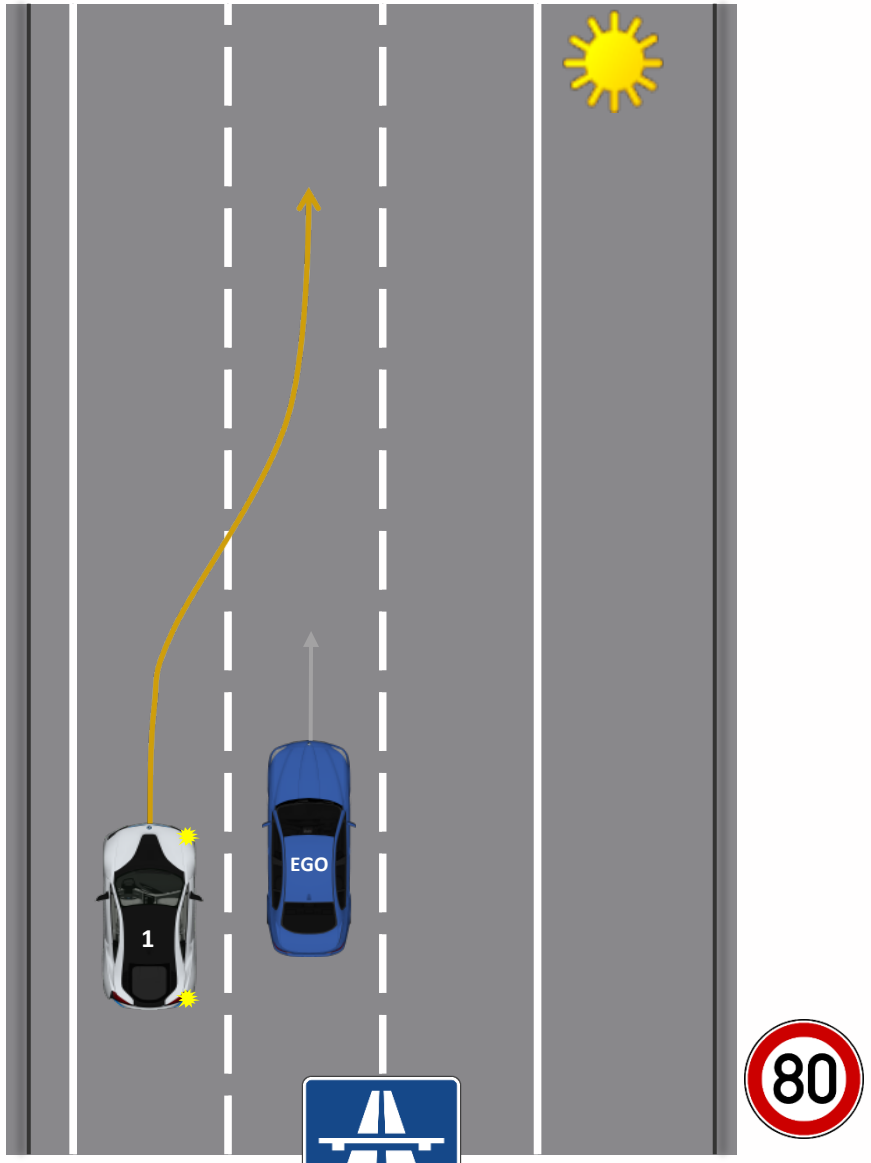
What is varied? – Example.

Concrete Scenario:

- Highway, 3 lanes, speed limit 80 km/h,
- EGO drives const. 80 km/h,
- Vehicle 1 flashes and cuts in,
- sunshine, dry road, etc.

Levels of PEGASUS Scenario Data Model.



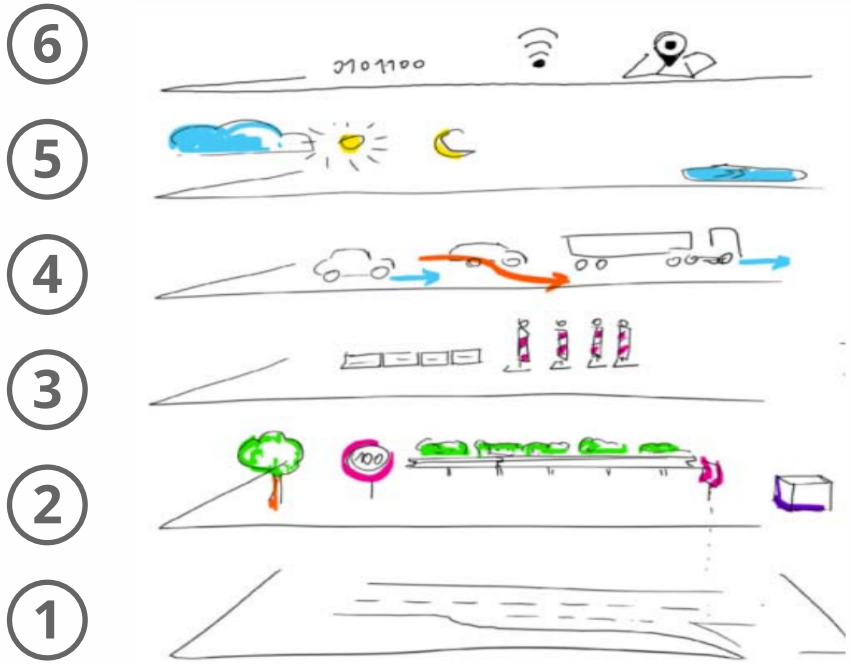


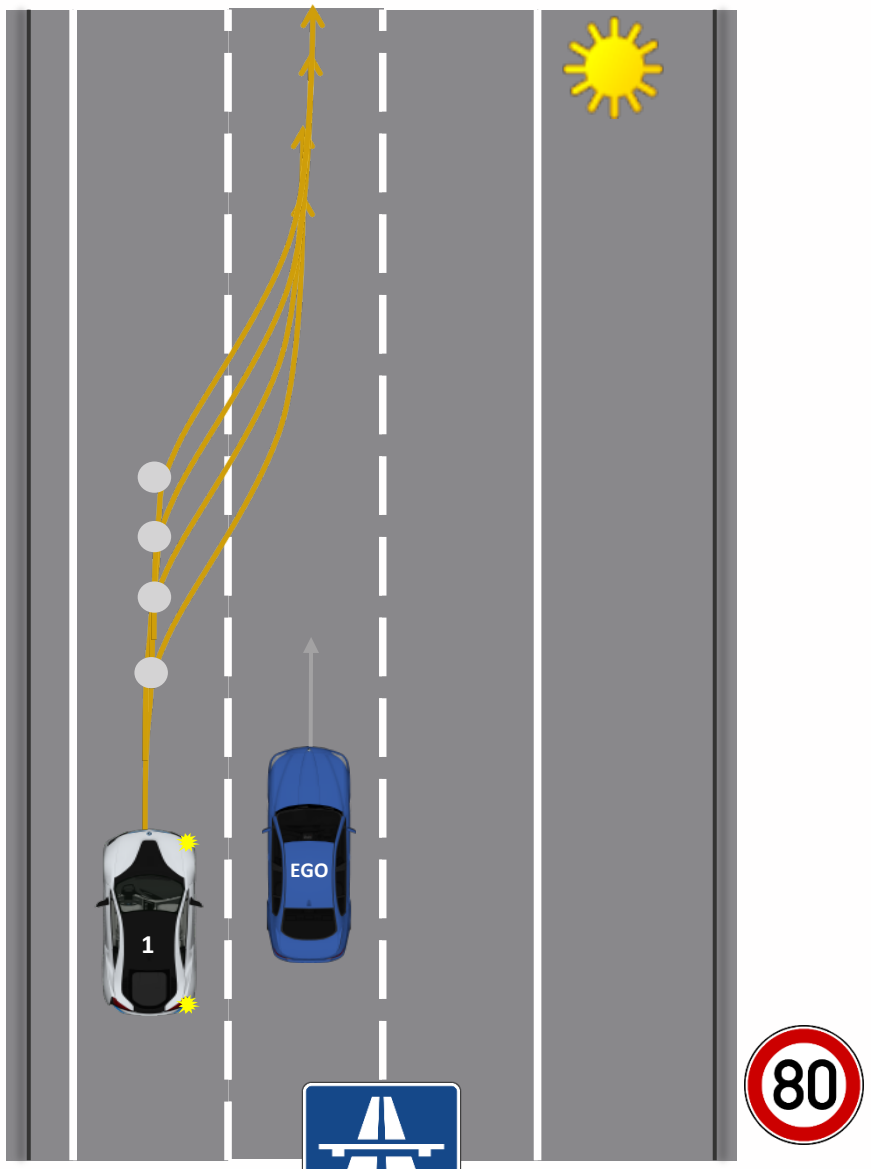
What is varied? – Example.

Concrete Scenario:

- Highway, 3 lanes, speed limit 80 km/h,
- EGO drives const. 80 km/h ,
- Vehicle 1 flashes and cuts in at different starting positions with different trajectories.

Levels of PEGASUS Scenario Data Model.



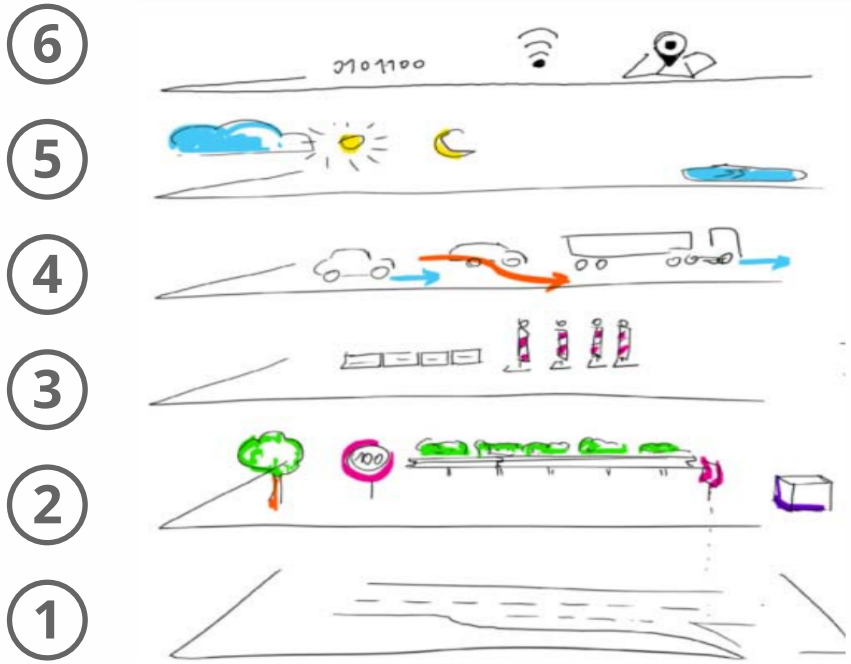


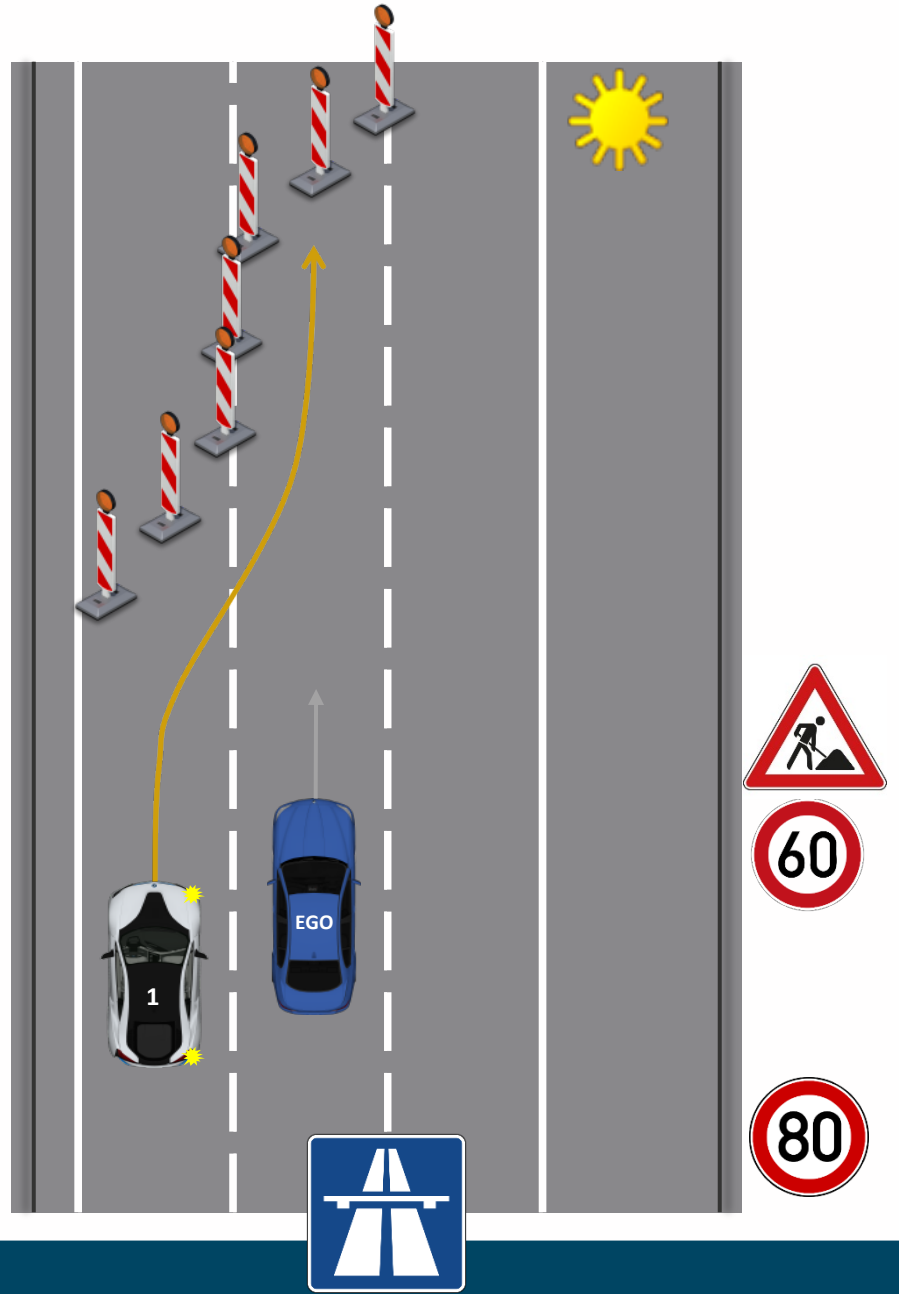
What is varied? – Example.

Concrete Scenario:

- Highway, 3 lanes, speed limit 80 km/h,
- EGO drives const. 80 km/h,
- Vehicle 1 flashes and cuts in,
- new static elements.

Levels of PEGASUS Scenario Data Model.



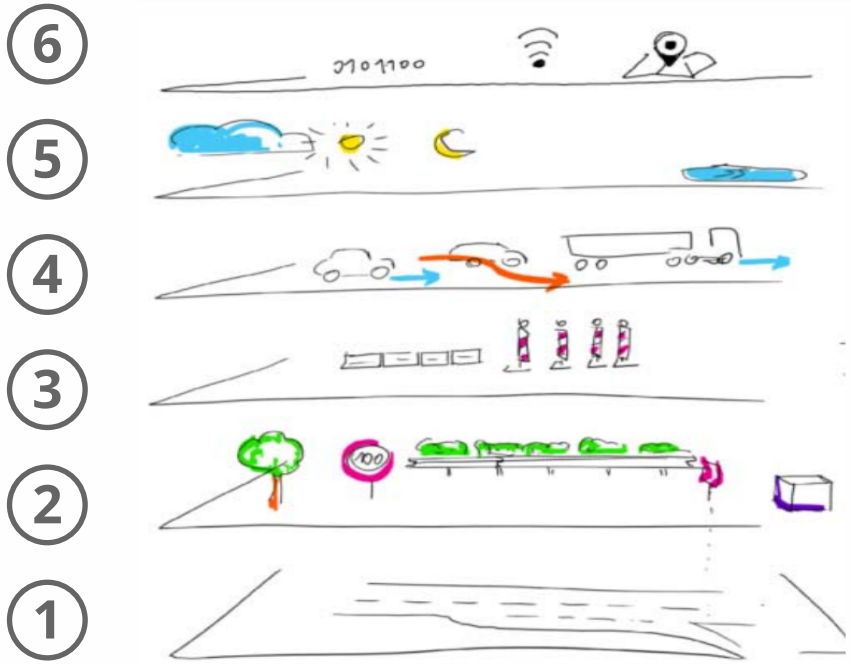


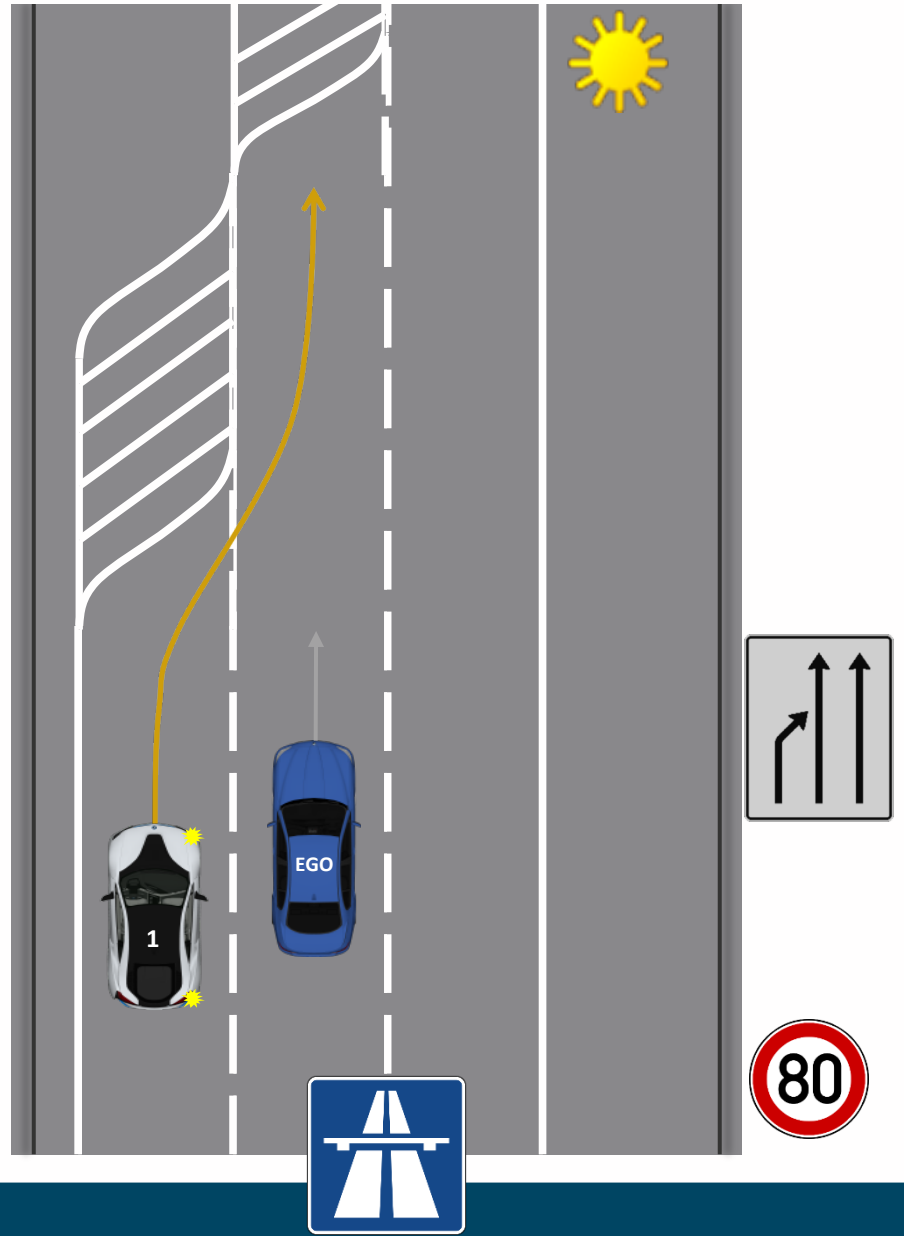
What is varied? – Example.

Concrete Scenario:

- Highway, 3 lanes, speed limit 80 km/h,
- EGO drives const. 80 km/h,
- Vehicle 1 flashes and cuts in with 100 km/h,
- lane closes.

Levels of PEGASUS Scenario Data Model.



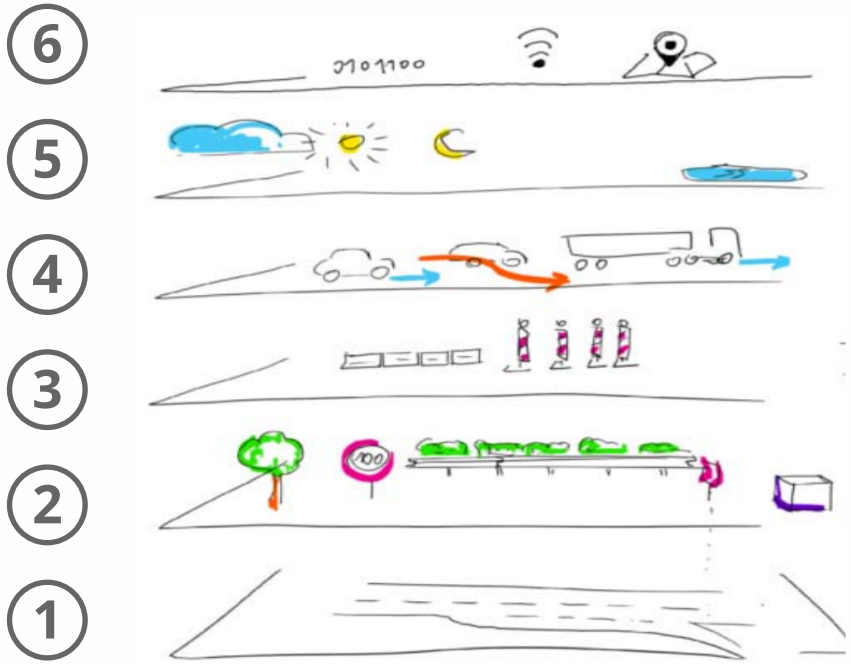


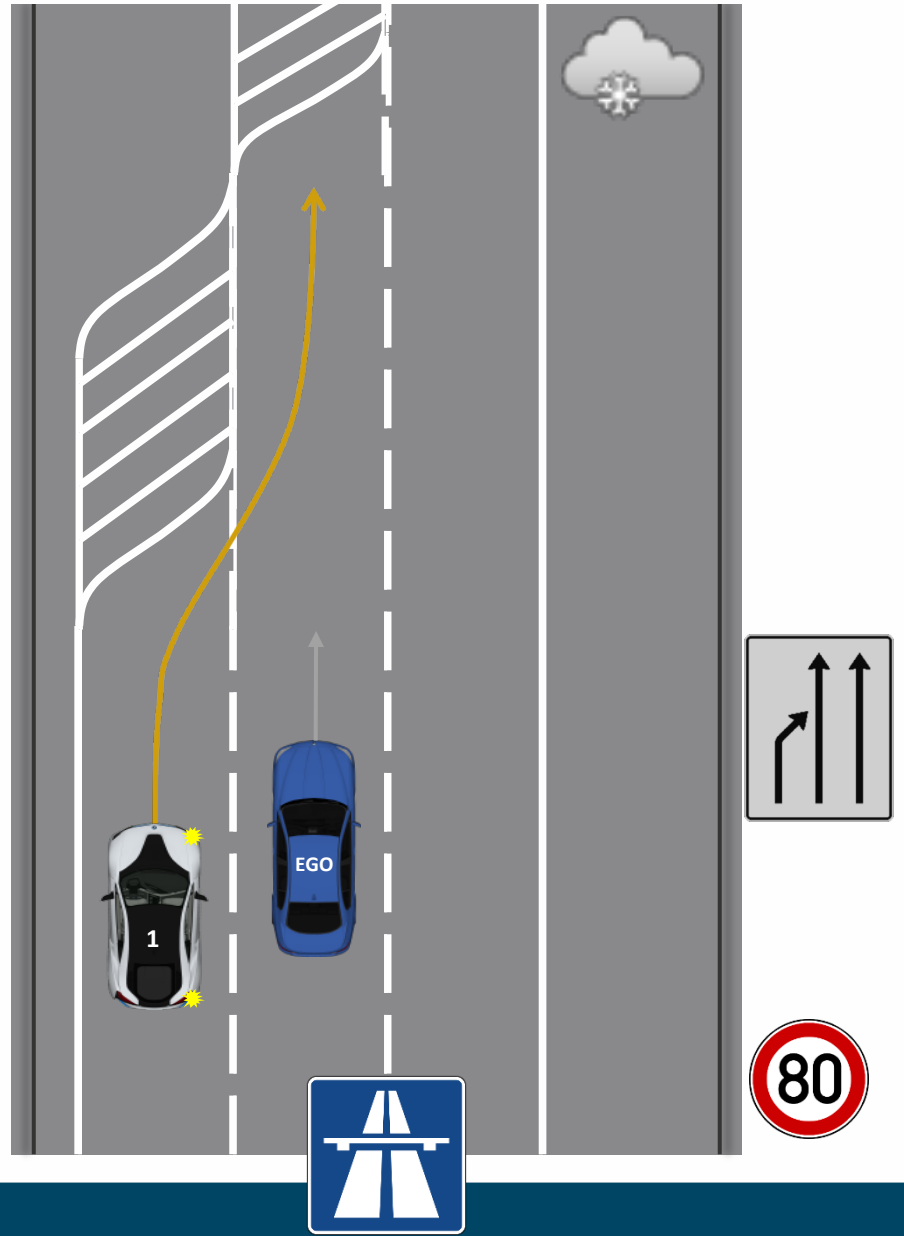
What is varied? – Example.

Concrete Scenario:

- Highway, 3 lanes, speed limit 80 km/h,
- EGO drives const. 80 km/h,
- Vehicle 1 flashes and cuts in with 100 km/h,
- snow.

Levels of PEGASUS Scenario Data Model.





Stochastic Variation – Goal.

Main Goal:

Find all relevant critical parameter subsets within each logical scenario space, that are within the use-case of the AD function.

The stochastic variation within the PEGASUS project has two tasks:

- **Exploration:** Find critical parameter sets in the sense of a certain safety metric in the defined subspace.
- **Characterization:** Goal is to deliver a description of the parameter subspace where a metric reports a safety violation.

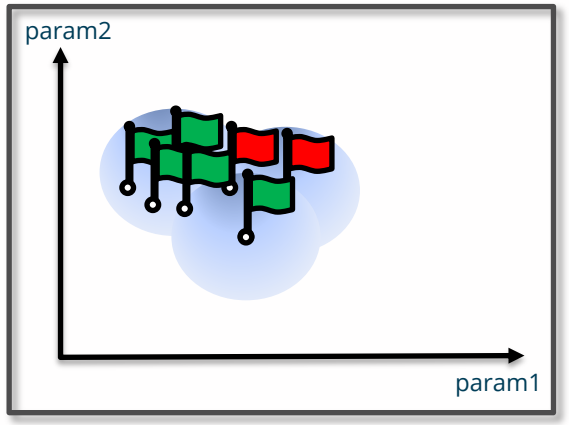
Stochastic Variation – Exploration.

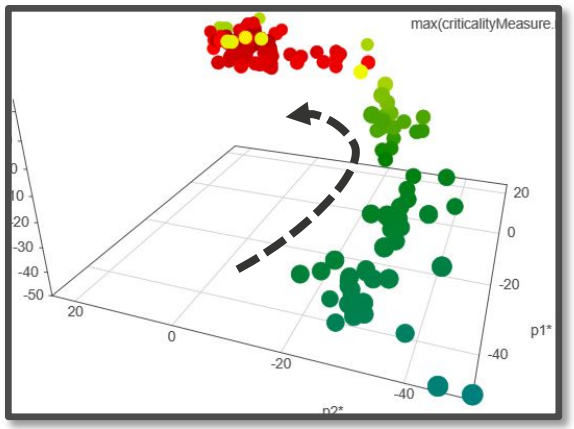
PEGASUS focused on two approaches of parameter space exploration:

1. **Explore known critical scenarios,** also with local variation of parameters.

2. **Explore a given abstract parameter subspace (logical scenario)** with optimization methods in order to find one or more worst cases of the safety metrics.

   Starting points for iterative search may be chosen as known critical parameter subsets from real traffic data.

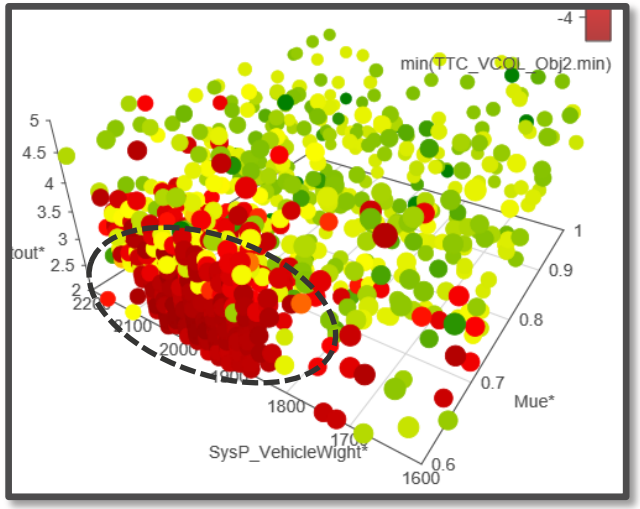


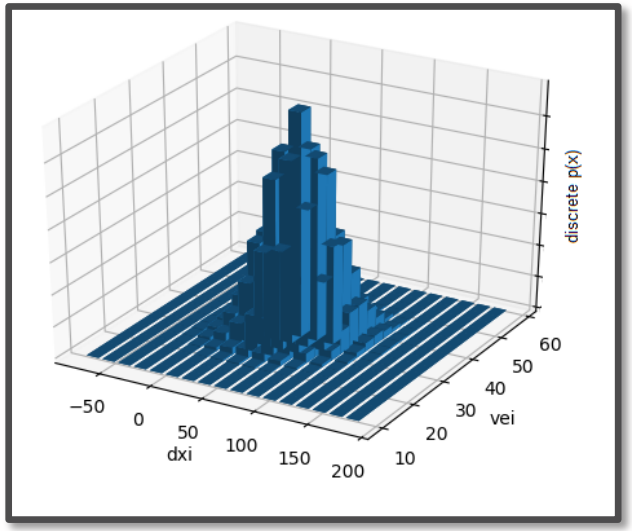


Stochastic Variation – Characterization.

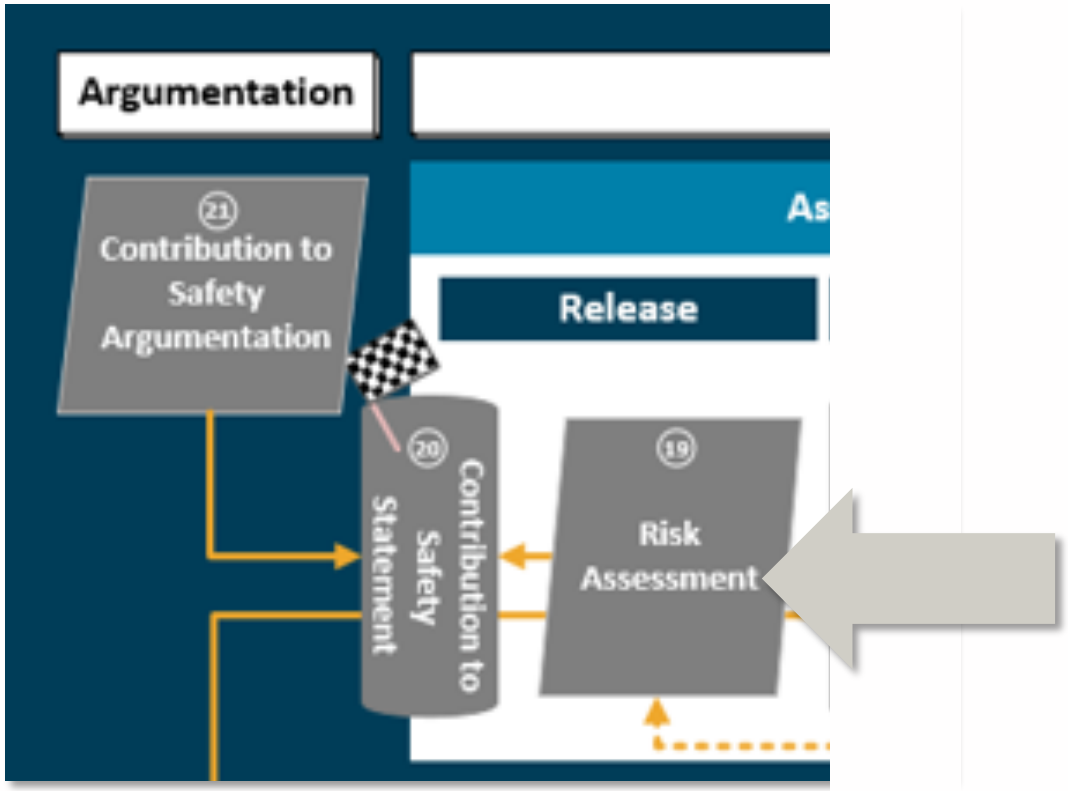
1. **Characterization** means assessing the probability of safety violations for a logical scenario space with a given confidence measure.

2. Test result is a **description of the critical parameter subspace** where a metric reports a safety violation including an approximation of probability.





Next Processing Step – Risk Assessment.



Test Results:

- concrete test results per critical scenario

or

- description of the parameter subspace where a metric reports a safety violation including an approximation of extension and probability.

Contact:
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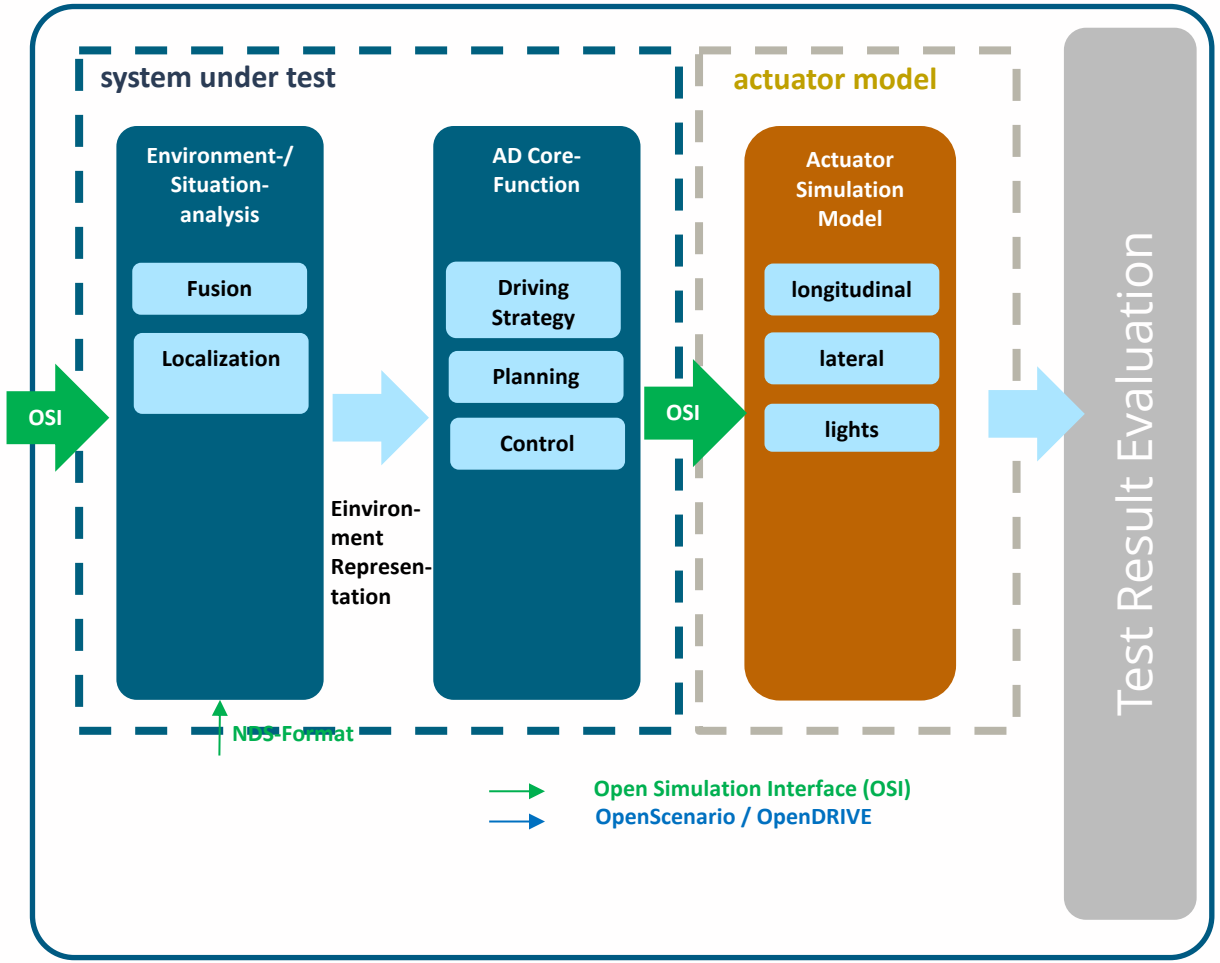
www.pegasusprojekt.de

❷ Resimulation Architecture

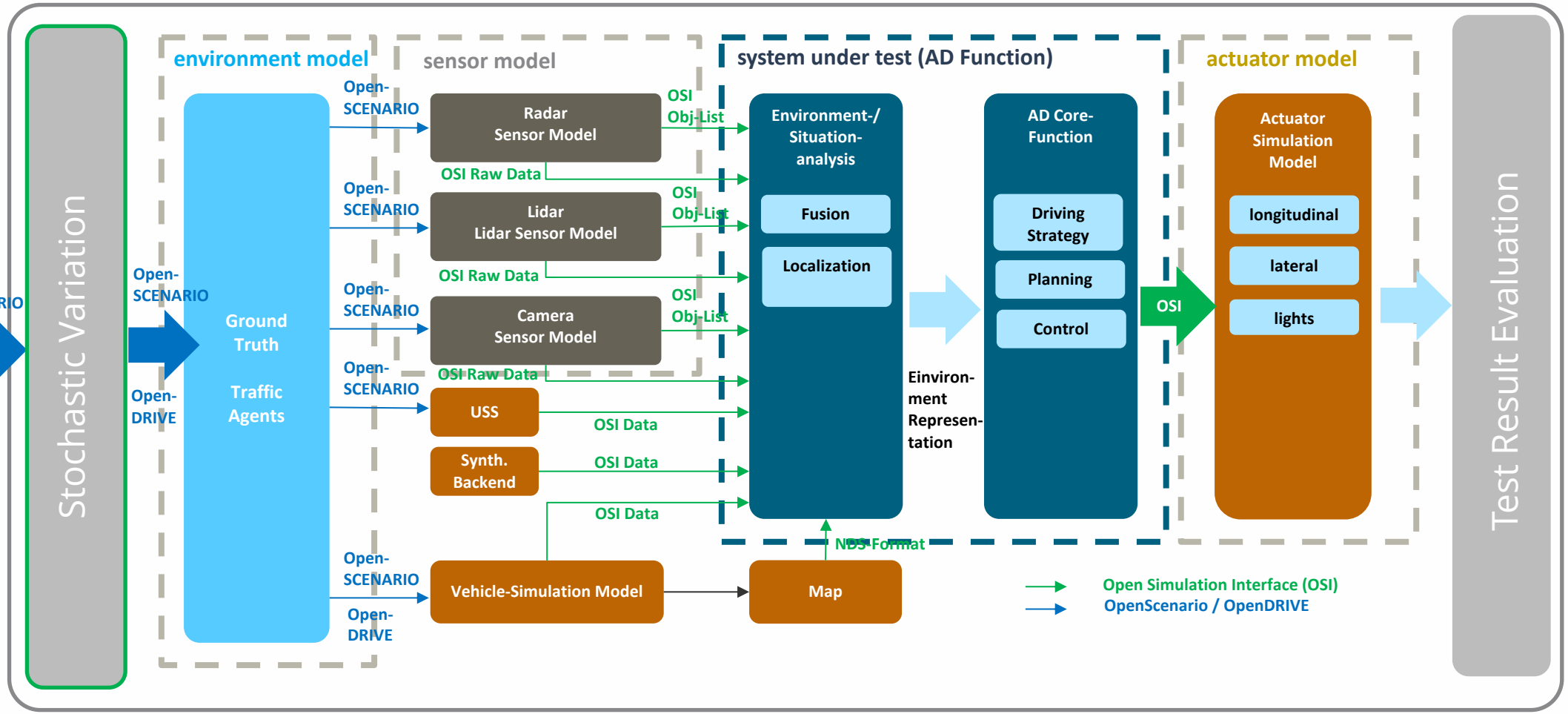
- Real measurement data of relevant scenarios.



Simulation Framework

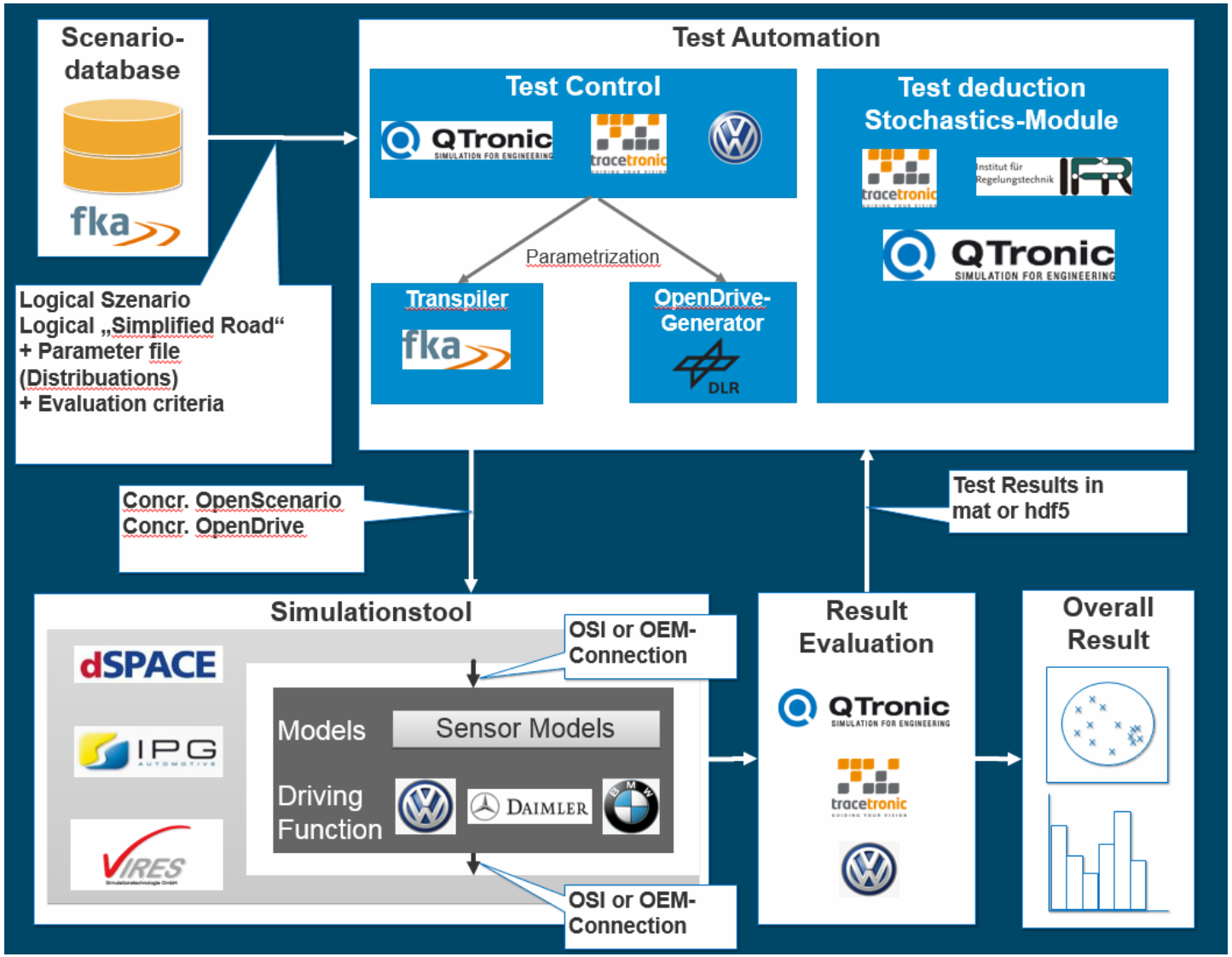
❷ Simulation Architecture – Full Parameter Variation

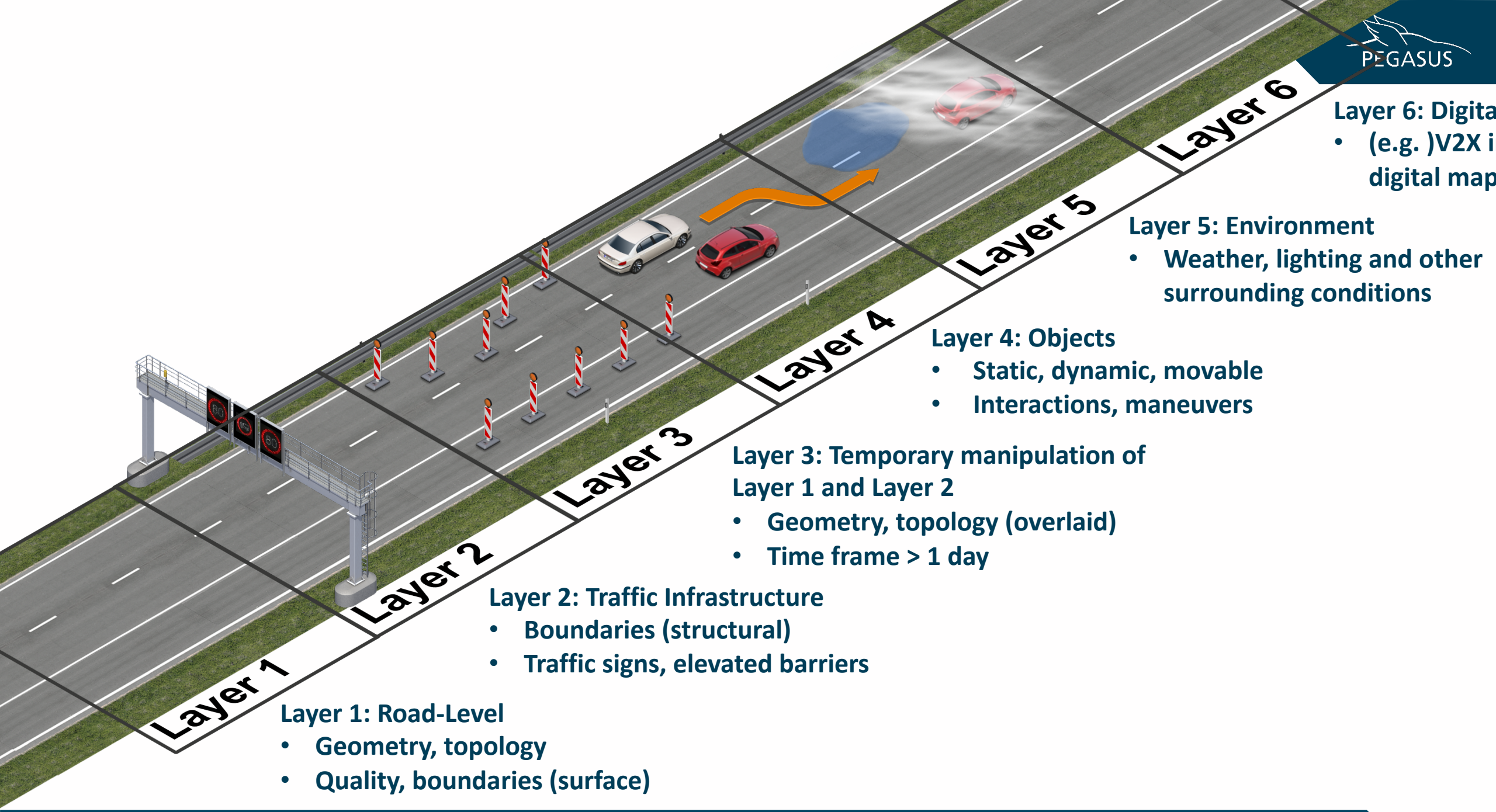
- Logical scenario
- Parameter distributions
- Metrics
- Pass/fail criteria



Simulation Framework

PEGASUS Simulation Architecture





PEGASUS

Layer 6: Digita
- **(e.g.)V2X i digital map**

Layer 5: Environment
- **Weather, lighting and other surrounding conditions**

Layer 4: Objects
- **Static, dynamic, movable**
- **Interactions, maneuvers**

Layer 3: Temporary manipulation of Layer 1 and Layer 2
- **Geometry, topology (overlaid)**
- **Time frame > 1 day**

Layer 2: Traffic Infrastructure
- **Boundaries (structural)**
- **Traffic signs, elevated barriers**

Layer 1: Road-Level
- **Geometry, topology**
- **Quality, boundaries (surface)**