



Technical Representation of Scenarios:

How can scenarios be represented technically to fulfill the requirements on various layers of abstraction?

Different levels of abstraction for scenarios demand distinct requirements on representations and data formats of scenarios. Similarly, an efficient conversion between the data formats has to be ensured.

➔ **Functional Scenarios:**
Functional scenarios are the basis for expert-based analysis methods. For representation of functional scenarios, a structure for a linguistic description has been developed. This structure enables a stepwise definition of scenarios.

➔ **Logical Scenarios:**
Logical scenarios define the parameter space to be tested and provide the essential information for test case generation. Logical scenarios are represented with the help of three data formats. The road is being described referring to the German standard for constructing motorways. The traffic participants are modeled via OpenSCENARIO. Both data files are augmented with a description of the parameter ranges and parameter probability distributions to be considered.

➔ **Concrete Scenarios:**
Concrete scenarios are used as input data for the simulation-based test. Concrete scenarios are represented by the quasi-standards OpenDRIVE and OpenSCENARIO.

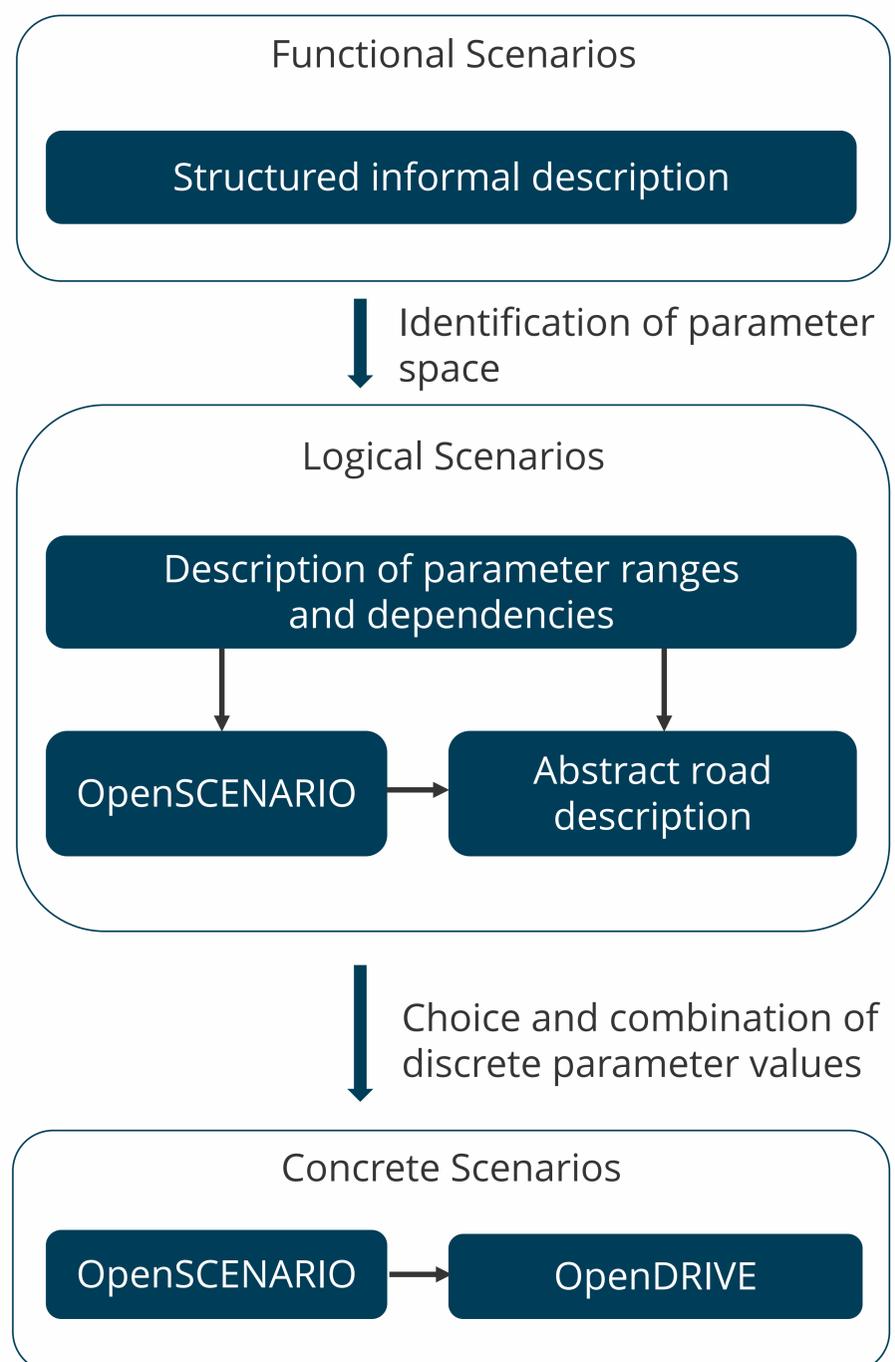


Figure 1: Data formats along the levels of abstraction for scenarios as well as relations between the data formats.



SCENARIO FORMATS



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Logical scenarios are the basis for generation of representative test cases. To choose adequate discrete parameter values as well as parameter combinations, the parameter space has to be described in detail. To achieve this detailed description, the parameter space includes the following information:

➔ **Parameters:**

The variable scenario parameters as well as their value ranges are described.

➔ **Probability distributions:**

For each parameter a probability distribution, with which the parameter is occurring in reality, can optionally be specified.

➔ **Numeric dependencies:**

To exclude contradictory value combinations, numeric dependencies can optionally be modeled.

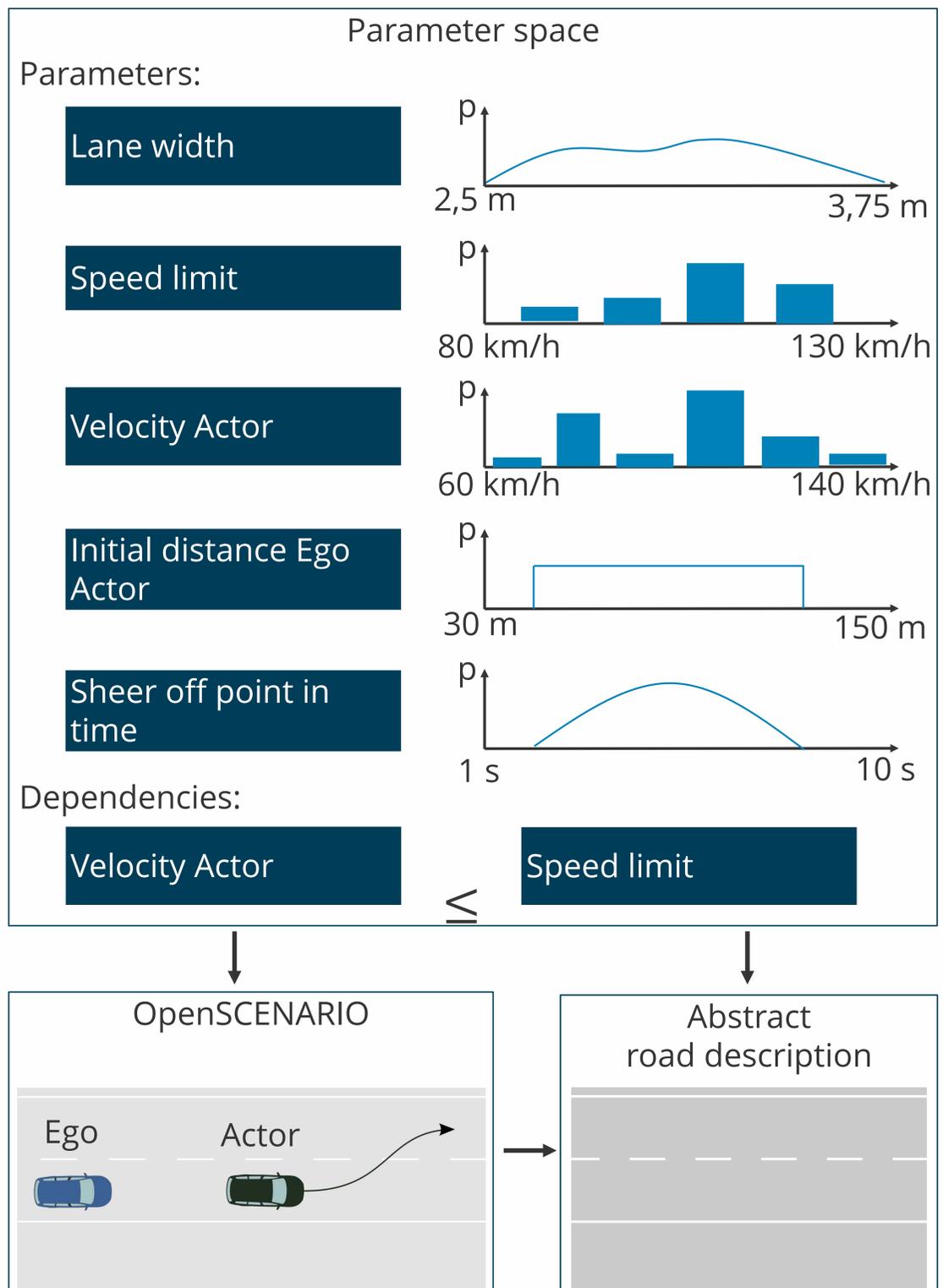


Figure 2: A logical scenario contains the description of the parameter space including the probability of occurrence p of each parameter as well as an abstract road description and a description of traffic participants (OpenSCENARIO).





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OpenDRIVE®:

The open XML based file format OpenDRIVE® represents complex road networks including static objects for the defined scenarios in a detailed topographical and topological way. It is commonly used in Industry and research, thus a extensive support in simulation tools is given. 3D exports facilitate various usage e.g. in driving simulators. With OpenDRIVE® the representation of a wide spectrum of road types such as motorways and complex urban environments are possible.

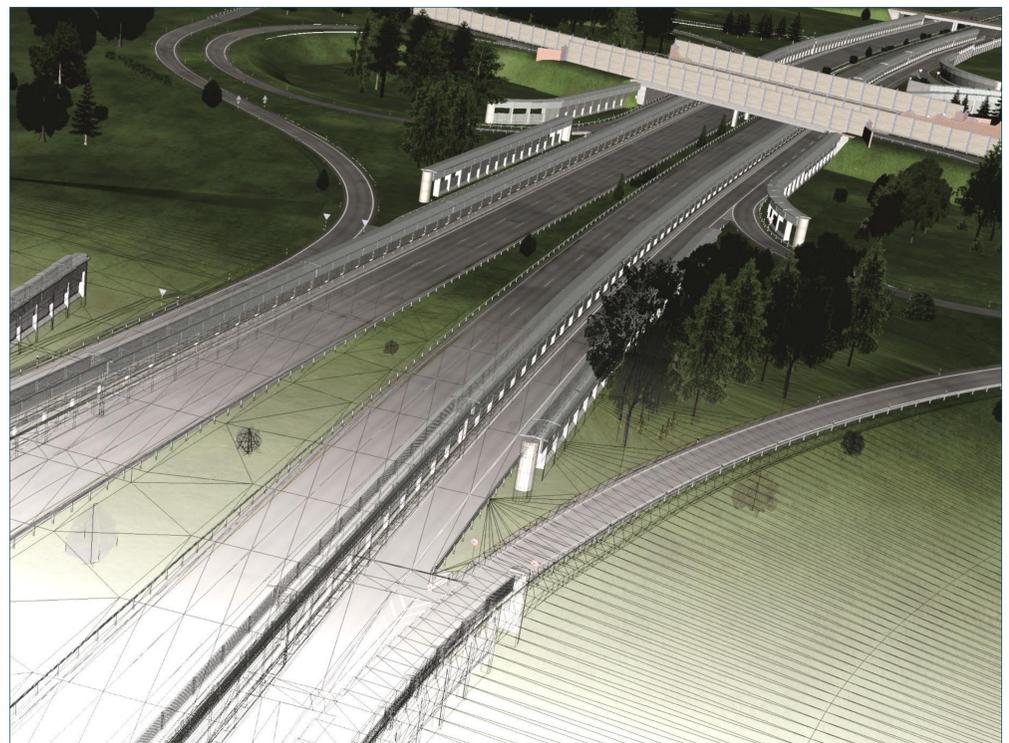


Figure 1: 3D model of a road including infrastructure and vegetation. The road was generated using lane detailed OpenDRIVE®.

Simplified Road Description:

The simplified road description reduces the effort and complexity to represent simple road sections to facilitate the execution of tests.

The simplified road descriptions are transformed into OpenDRIVE® using various macros and a parametrized processing.

This approach enables a fast generation of road sections, which vary only in some characteristics to provide different road variants for the test cases.

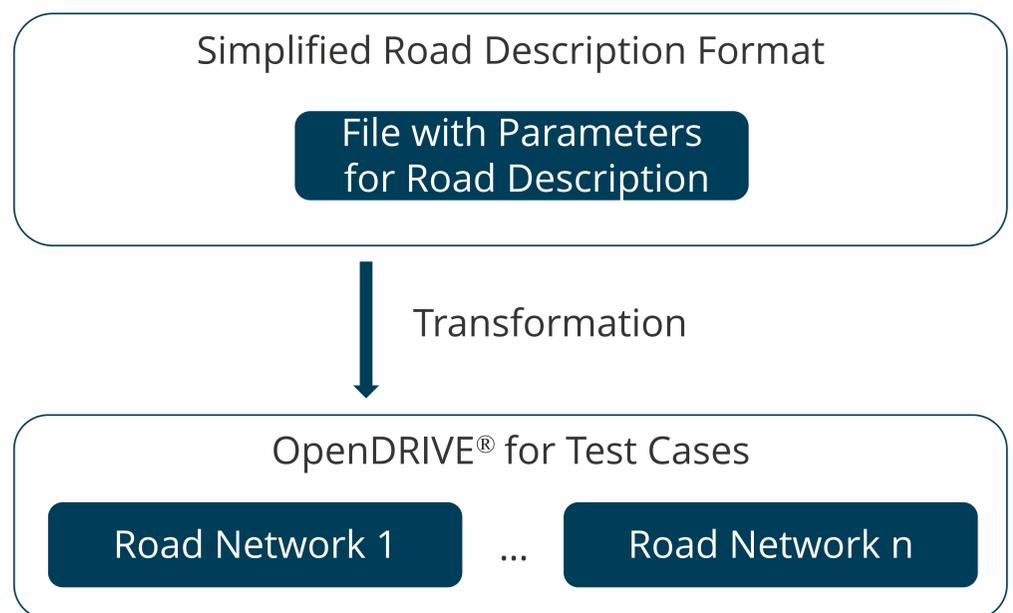


Figure 2: Generation of roads for test case variation.



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OpenSCENARIO:

As a tool independent open file format OpenSCENARIO specifies the time-variant behavior of entities during one simulation. State changes of traffic participants, infrastructure and other dynamic objects are described as **actions** triggered by **conditions**.

Due to the powerful language range, complex traffic situations, from highway to urban areas can be described.



Figure 1: Dynamic behavior of a traffic entity – lane change

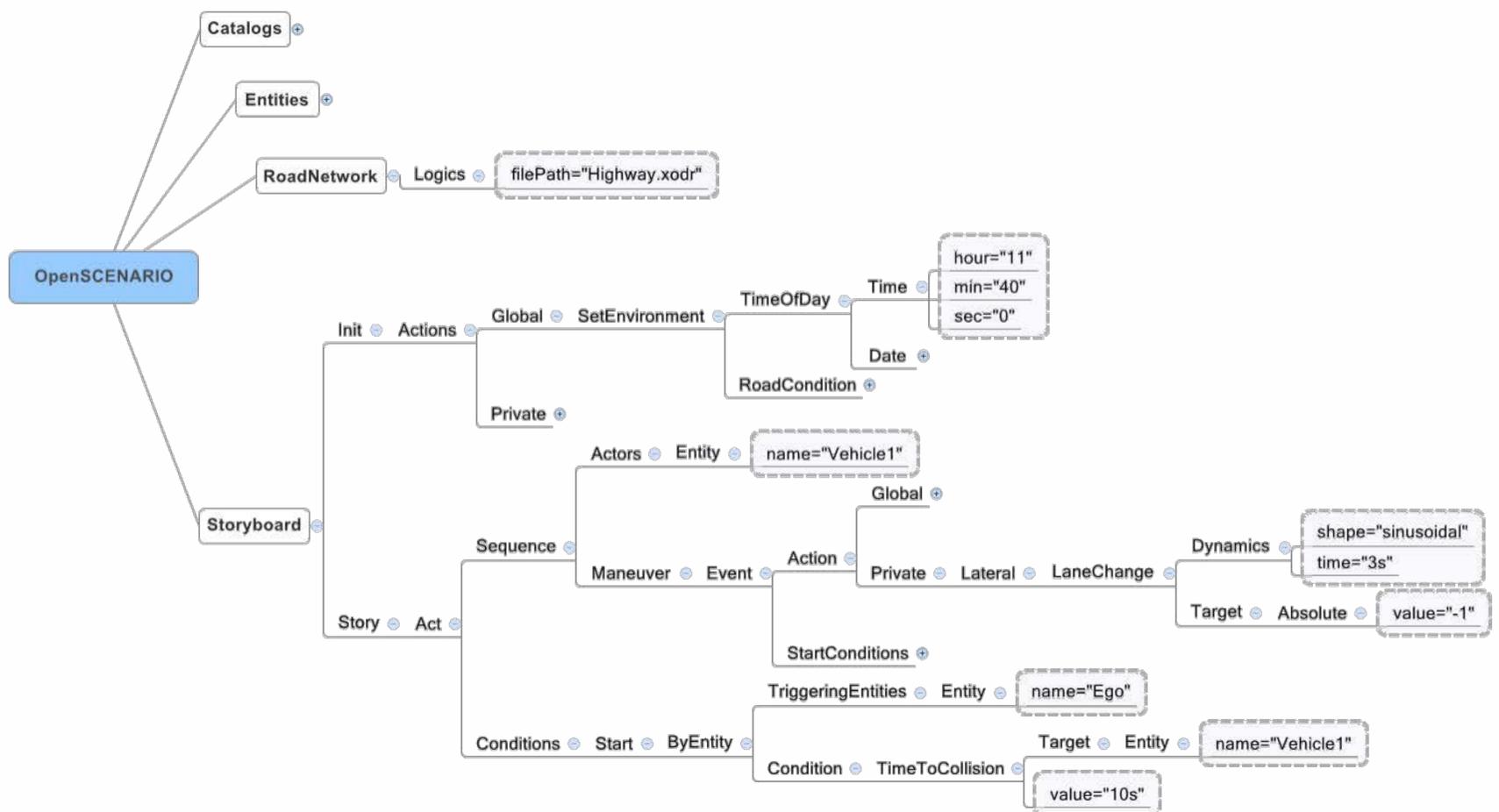


Figure 2: Exemplary lane change action triggered by a time-to-collision condition with specific parameter expressions

