Scenario-based Representation of the ODD

5.2 | Ontology-based Structuring of the Operational Domain

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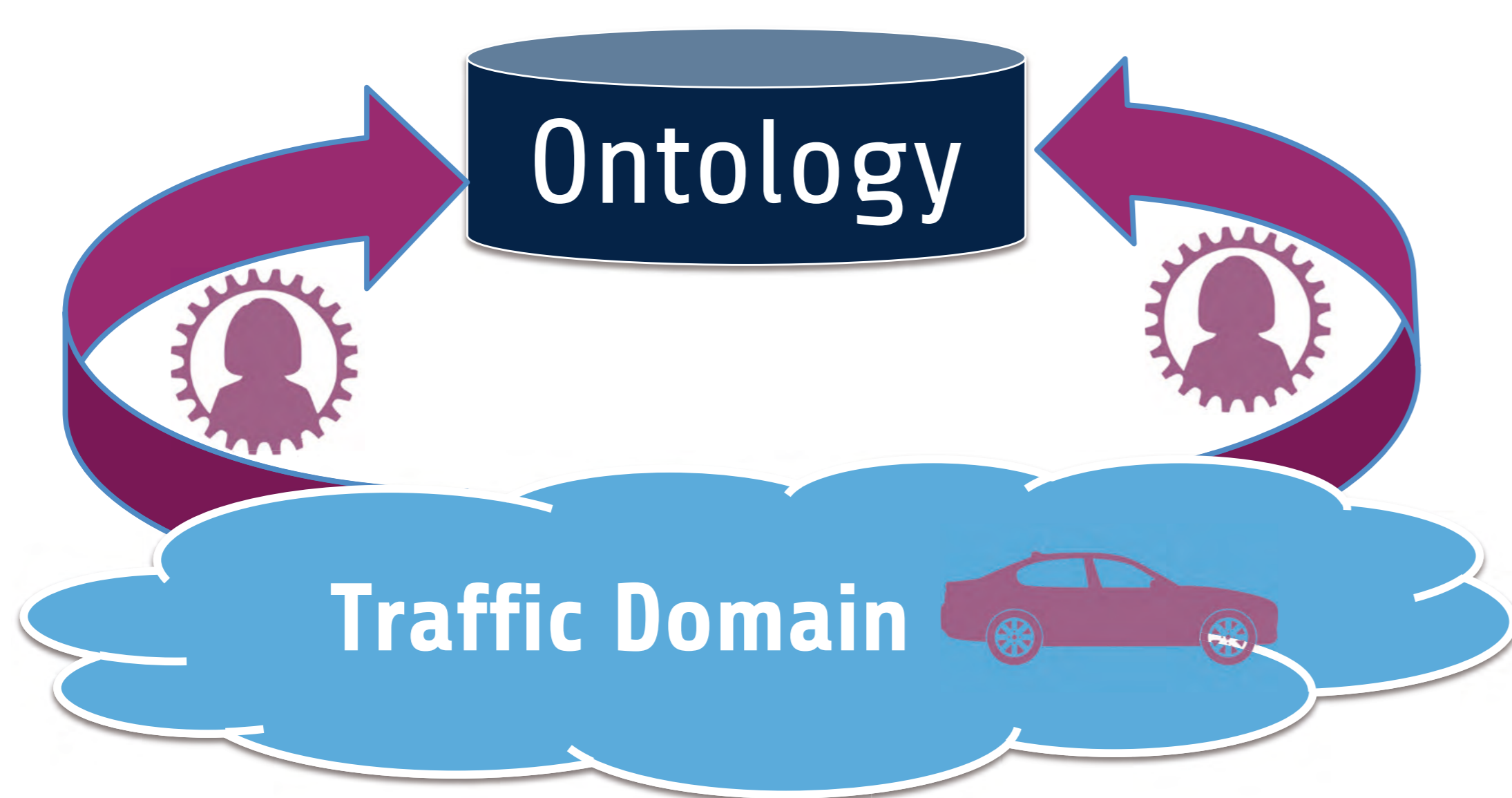
Structuring Operational Domain

Questions

- **What** tools can be used to describe and formalize the operational domain (OD)?
- **What** are possible decompositions of the OD?
- **Which** are the safety-relevant factors within the OD?

Ontologies as a Tool for OD Description

Ontologies allow users to store their conceptualization of a domain of discourse (here, traffic) in a formal way. Ideally, this happens in a collaborative process between all stakeholders.

Example

- The StVZO defines any non-motorized transport-tation modality with a maximum speed of 6 km/h not as a vehicle (e.g., children's bicycles) [1]
- Has implications on the system (requirements) and has to be written down traceably.

How to Write Down Ontologies?

An ontology forms the basis for describing an OD. In VVM we used OWL2 (Web Ontology Language), an established mechanism for describing ontologies
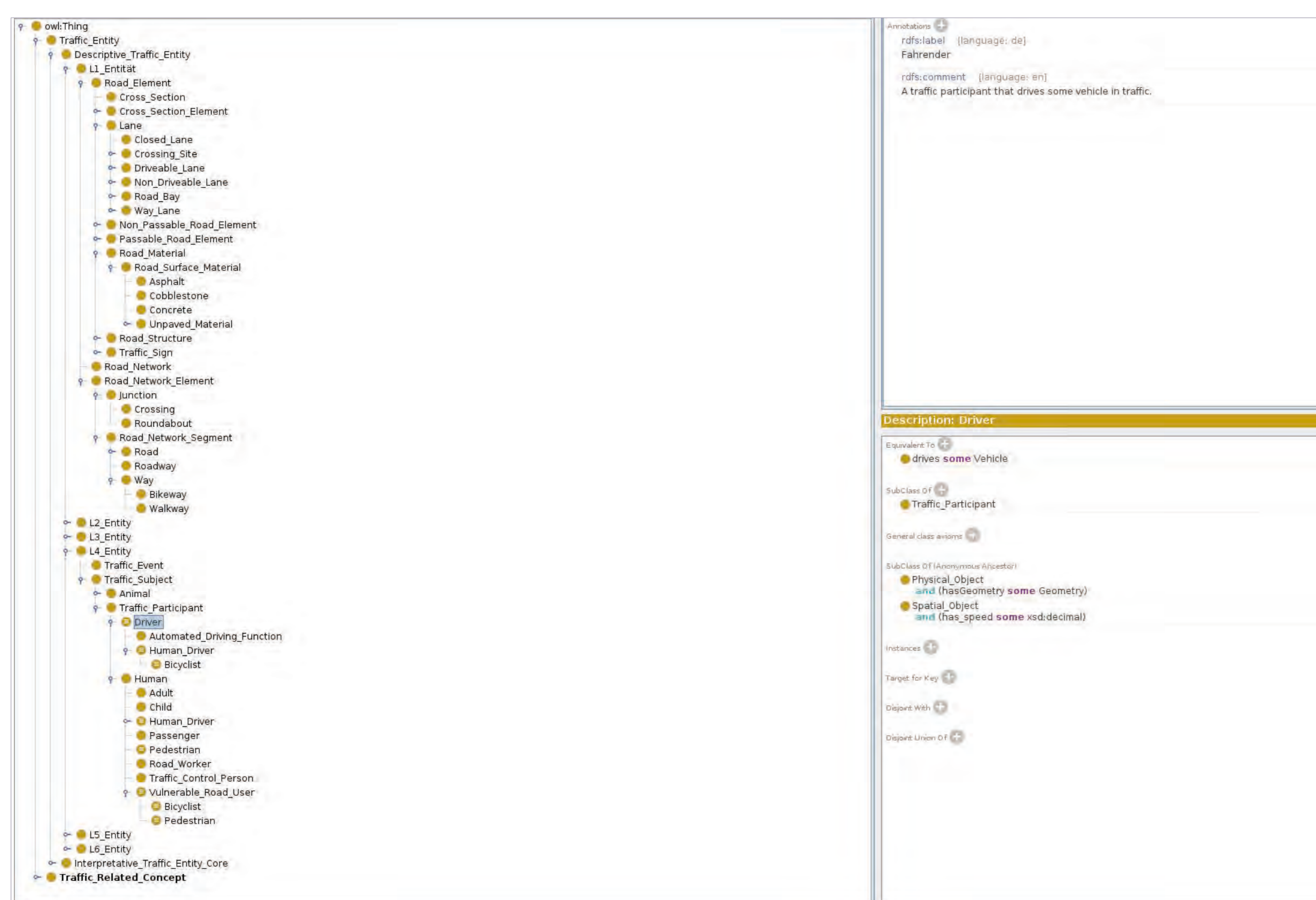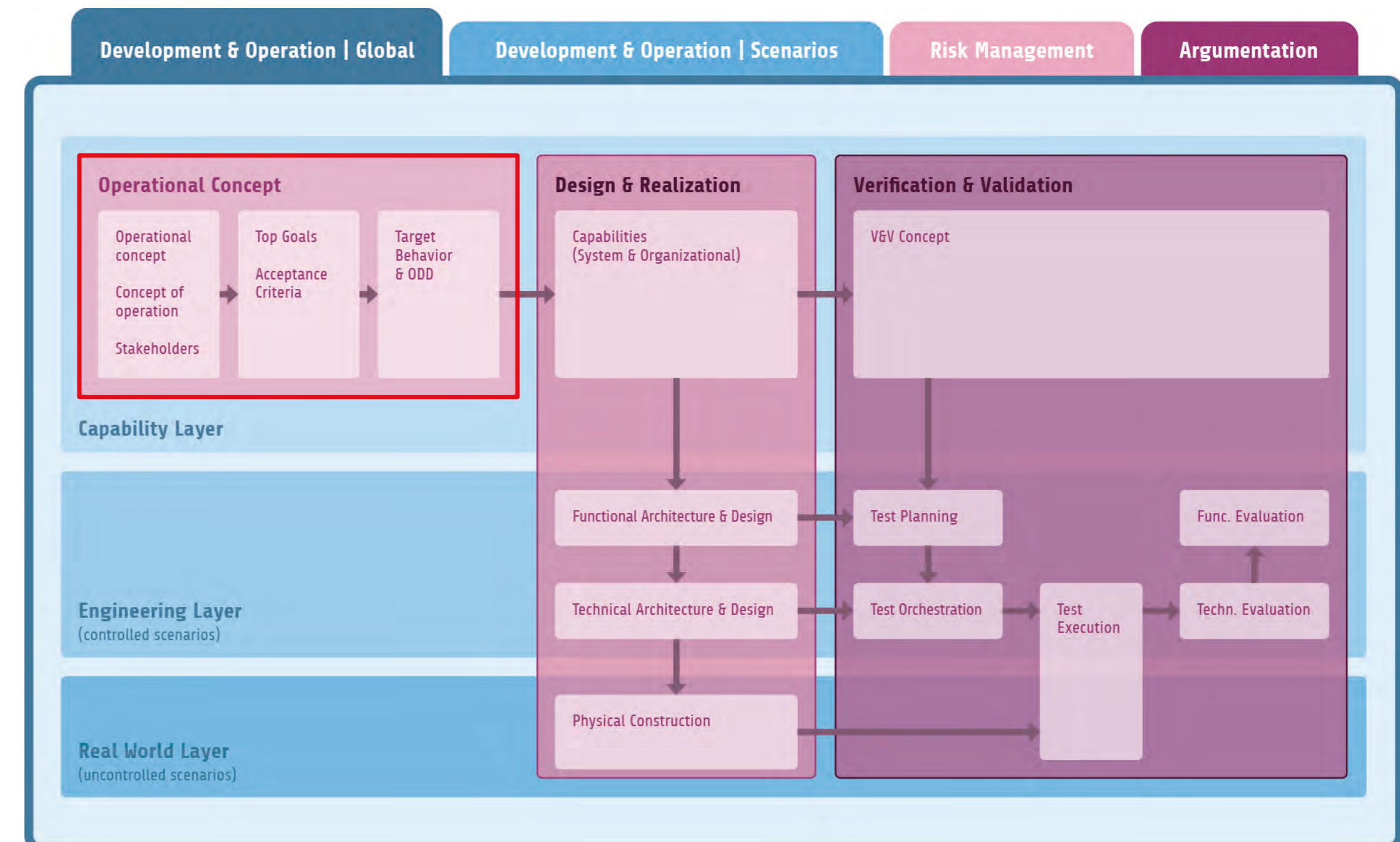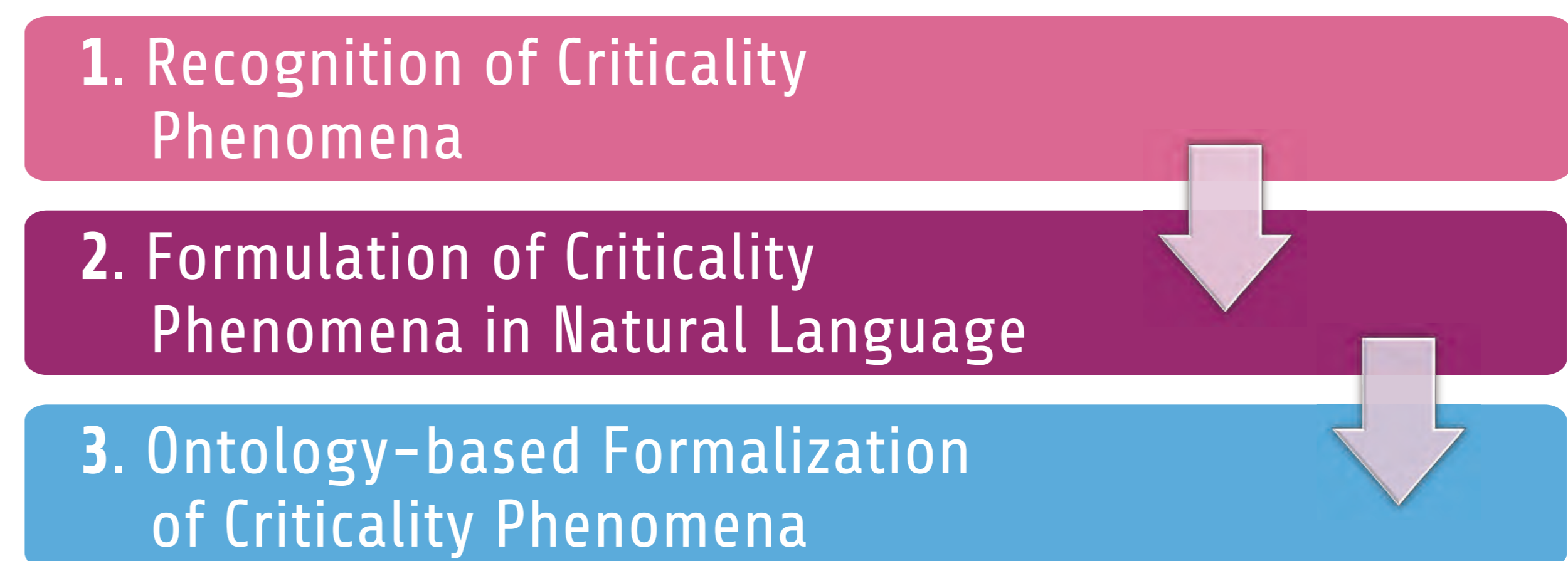

Figure 1: Excerpt from VVM ontology in OWL2 (© DLR e.V.)

How to Arrive at an OD Ontology?

Base process on criticality phenomena (CP)! [2,3]

1. Recognition of Criticality Phenomena

2. Formulation of Criticality Phenomena in Natural Language

3. Ontology-based Formalization of Criticality Phenomena

Results in a vast network of interrelated safety-critical factors within the OD („knowledge graph")
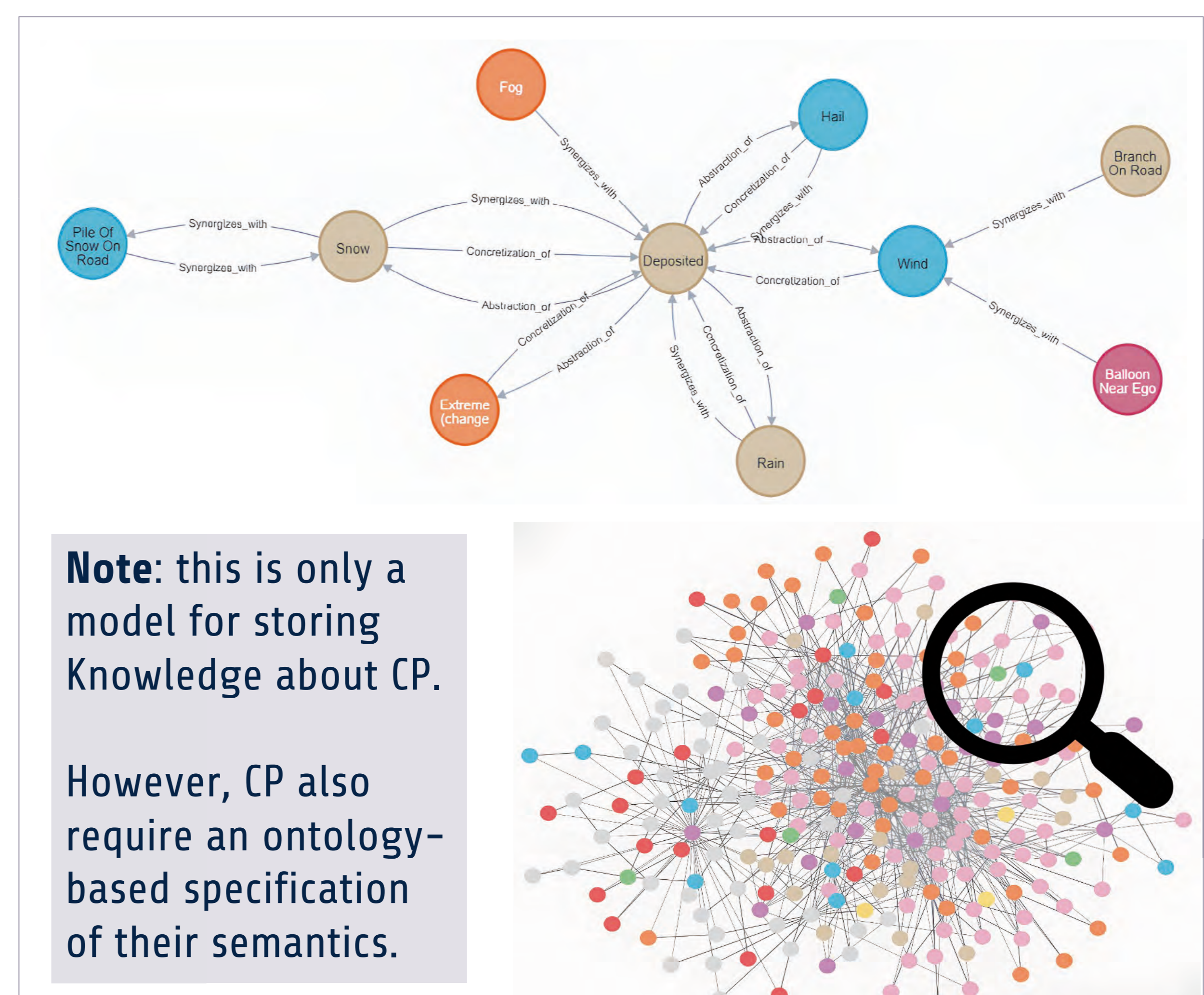
Note: this is only a model for storing Knowledge about CP.

However, CP also require an ontology-based specification of their semantics.

Figure 2: Relations among criticality phenomena in graph database (© DLR e.V.)

Solution for Ontology Construction:

Each specification has multiple components. Extract these ontological components and build a formal ontology from them (e.g., using OWL2).

Example

Specification:
„Heavy rain" is a rainfall with an intensity of at least 20 mm/h.

Extension of Ontology:
- add a class: rainfall
- add an attribute to rainfall : intensity in mm/h
- add an attribute to the environment: rainfall

References:
[1] StVZO § 16 (2), 20. Juli 2023, BGBl
[2] Westhofen et al., Using ontologies for the formalization and recognition of criticality for automated driving, IEEE OJITS, 2022
[3] A. Wellßow, Entwurf eines Prozesses zur Formalisierung sicherheitsrelevanter Phänomene für das automatisierte Fahren, 2022

Key Artefacts

Partners

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