ASAM OpenX: Status Update

Why OpenX Standards

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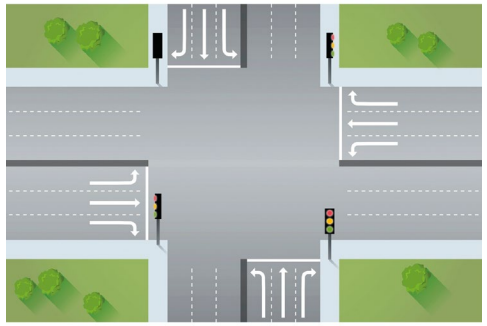
Online

ASAM Association for Standardization of Automation and Measuring Systems

An Overview of ASAM OpenX…

8 individual standard initiatives

ASAM OpenDRIVE®

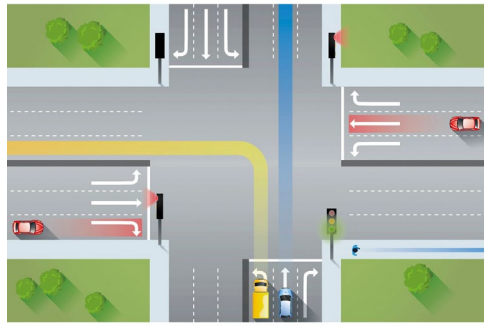


Static Road Network Desription

ASAM OpenCRG®

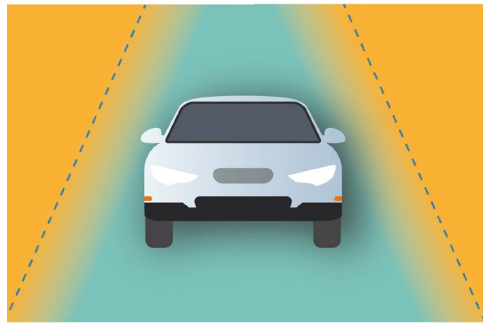
Static Road Surface Desription

ASAM OpenSCENARIO®



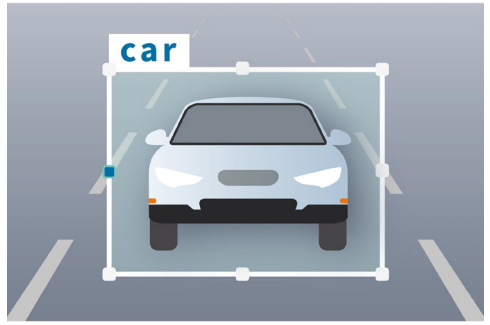
Dynamic Scenario Desription

ASAM OpenODD



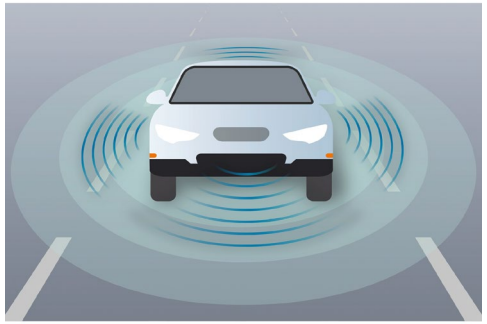
Defining the Operational Design Domain
for Automated Vehicles

ASAM OpenLABEL



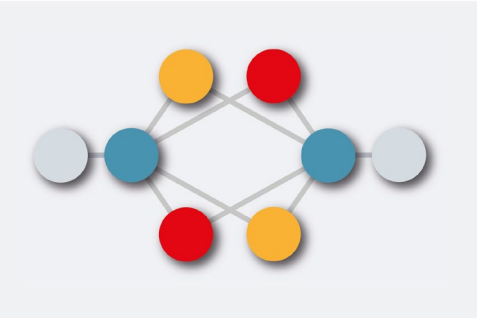
Standardized Labeling
for objects and Scenarios

ASAM OSI®



Interface for Simulation

ASAM OpenXOntology



Core Domain Model for the
ASAM Simulation Domain

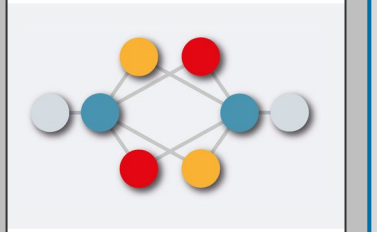
ASAM Study Project Test Specification

Analysis and harmonization of automotive
testing techniques and standards

Vison of ASAM OpenX…

Domain Ontology

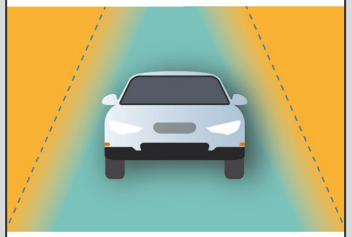
ASAM OpenXOntology



Core Domain Model for the ASAM Simulation Domain

Operational Design Domain

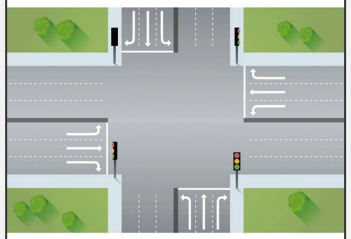
ASAM OpenODD



Defining the Operational Design Domain for Automated Vehicles

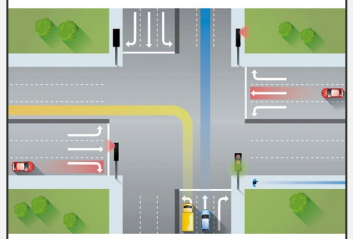
Static and dynamic content of a scenario

ASAM OpenDRIVE®



Static Road Network Desription

ASAM OpenSCENARIO®



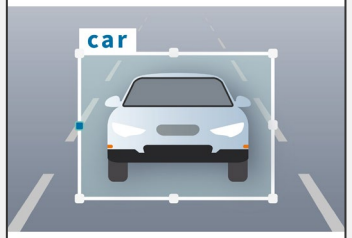
Dynamic Scenario Desription

ASAM OpenCRG®

Static Road Surface Desription

Annotation

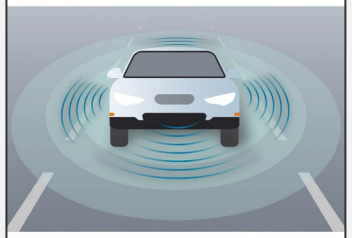
ASAM OpenLABEL



Standardized Labeling for objects and Scenarios

Interface

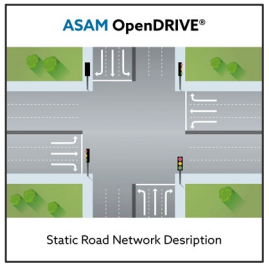
ASAM OSI®



Interface for Simulation

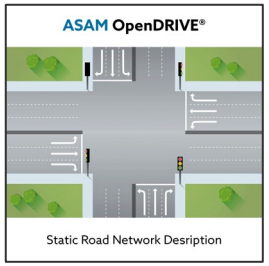
How the ASAM OpenX Standards can be used in combination

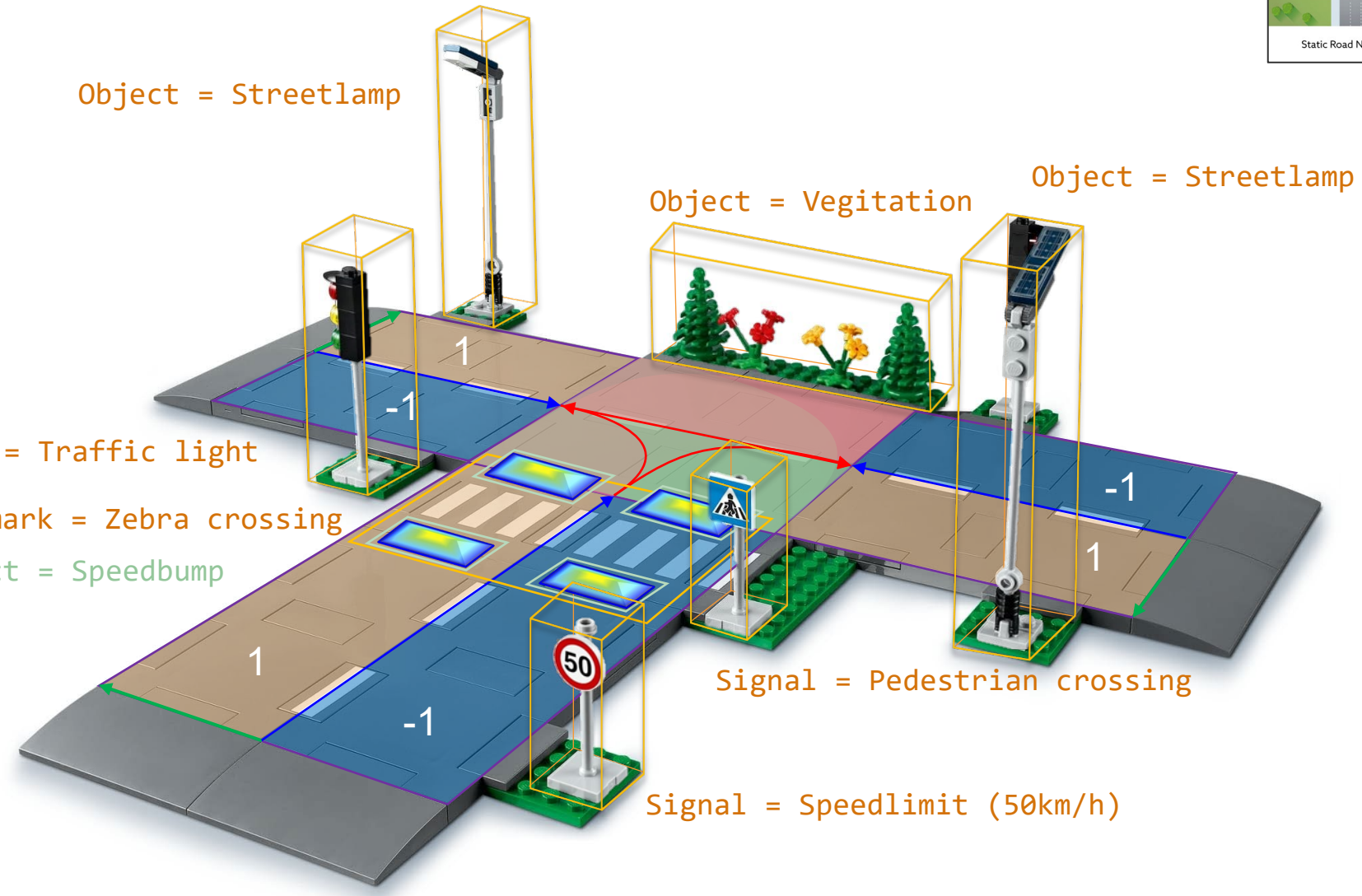
ASAM OpenDRIVE Example: T-Junction



Quelle: https://www.stonewars.de

ASAM OpenDRIVE Example: T-Junction





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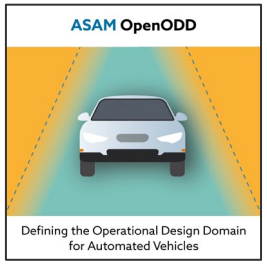
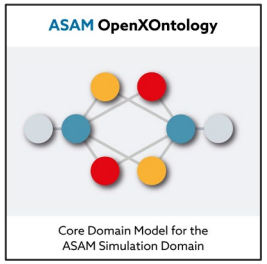
ASAM OpenODD Example: T-Junction



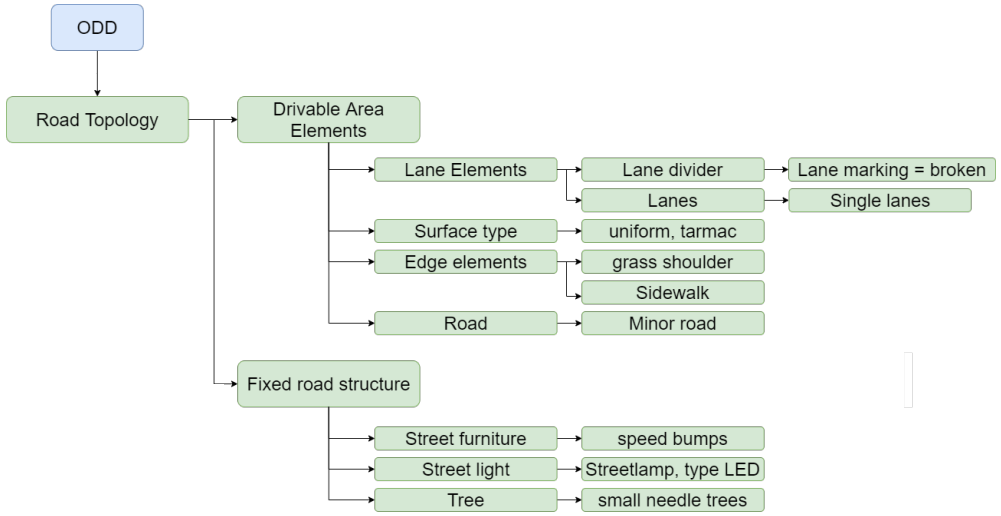


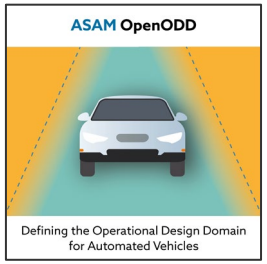
Quelle: https://www.stonewars.de

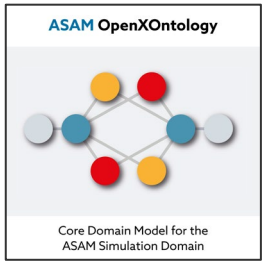
! ASAM OpenODD is still in the concept phase !

ASAM

ASAM OpenODD Example: T-Junction







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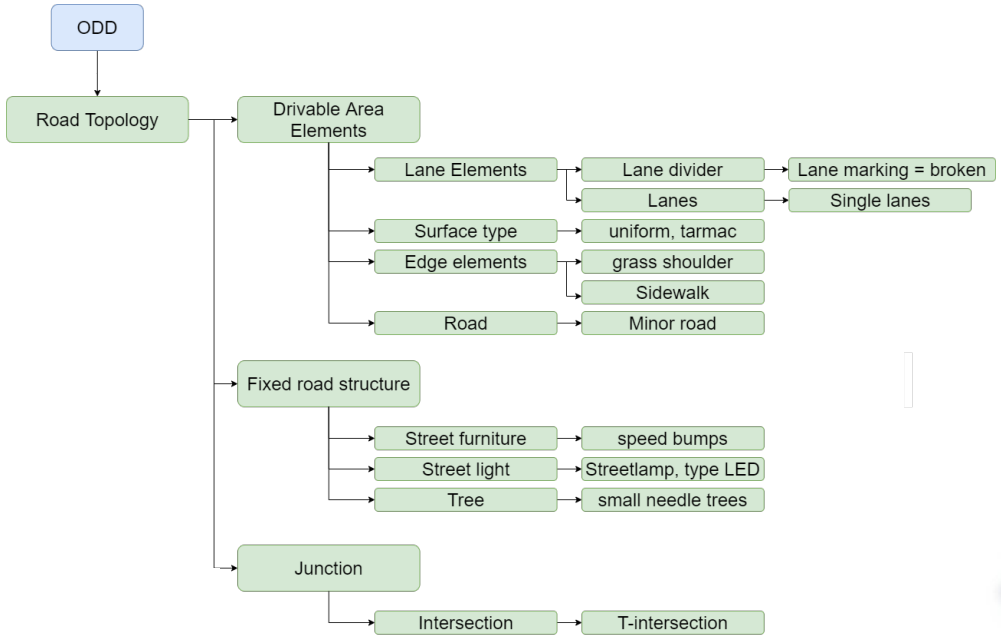

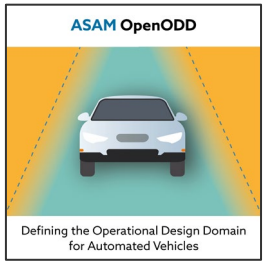

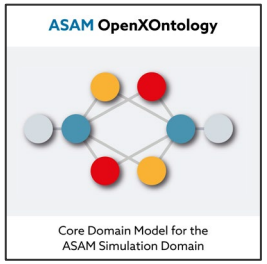

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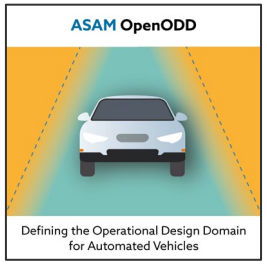

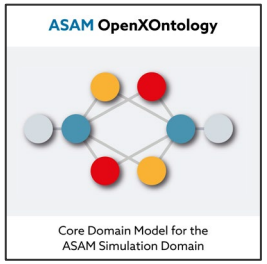

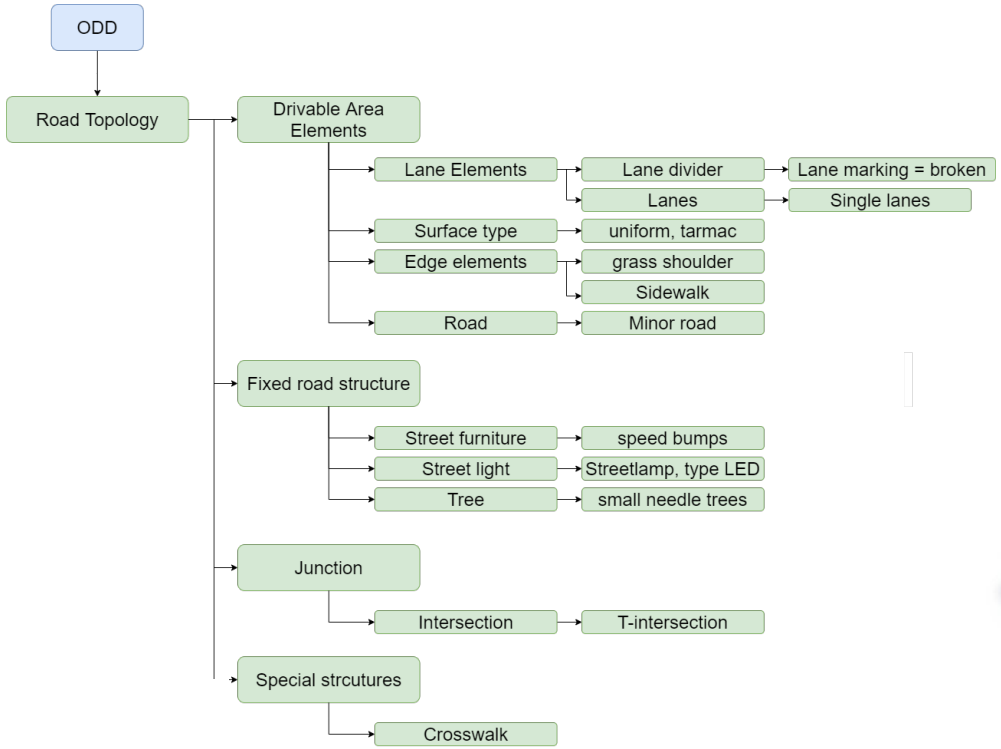

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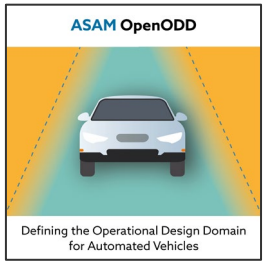

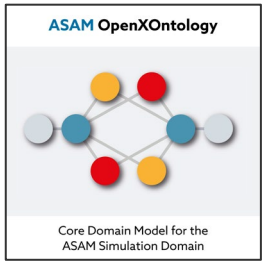

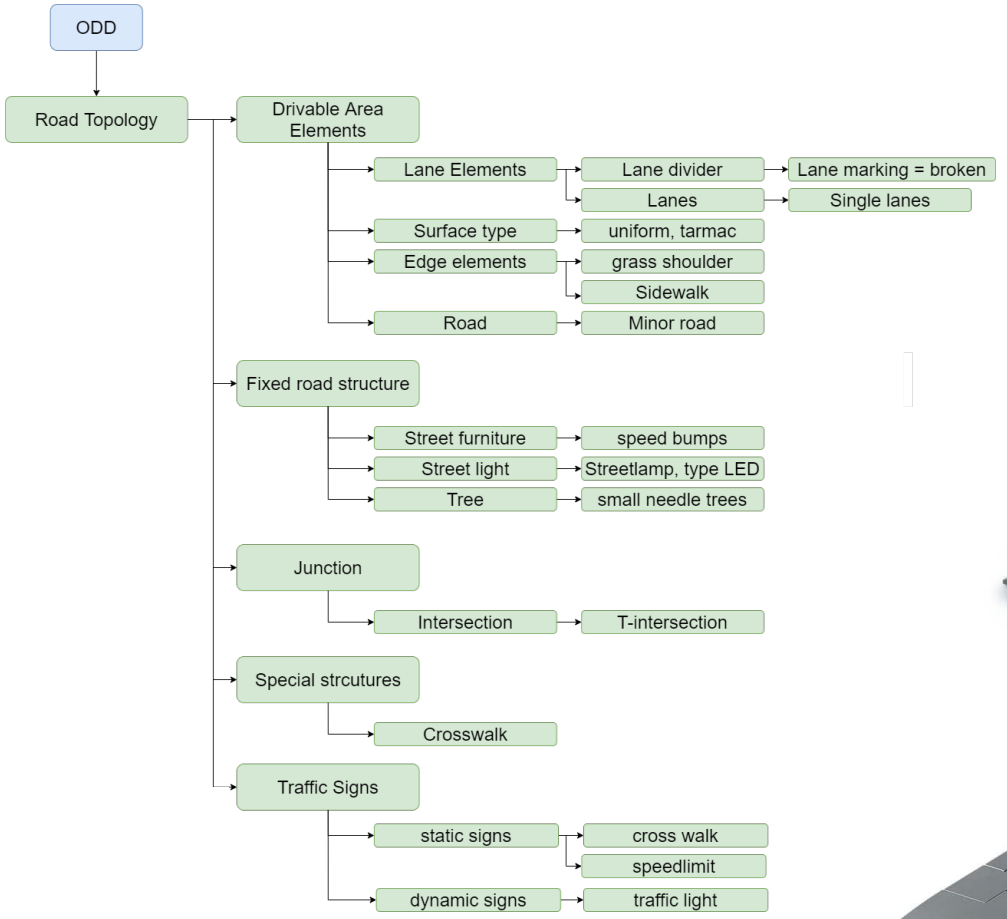

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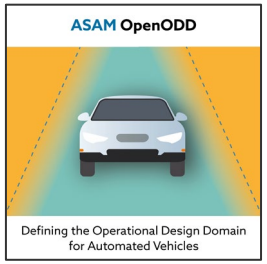
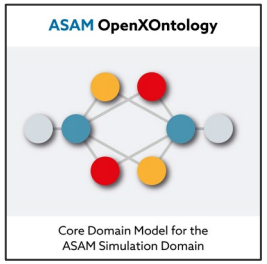




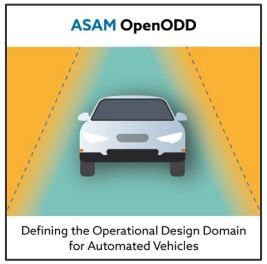
- ODD
  - Road Topology
    - Drivable Area Elements
      - Lane Elements
        - Lane divider
          - Lane marking = broken
        - Lanes
          - Single lanes
      - Surface type
        - uniform, tarmac
      - Edge elements
        - grass shoulder
        - Sidewalk
      - Road
        - Minor road
    - Fixed road structure
      - Street furniture
        - speed bumps
      - Street light
        - Streetlamp, type LED
      - Tree
        - small needle trees
    - Junction
      - Intersection
        - T-intersection
    - Special strcutures
      - Crosswalk
    - Traffic Signs
      - static signs
        - cross walk
        - speedlimit
      - dynamic signs
        - traffic light
    - Properties
      - driving direction
        - Right hand traffic
      - lane dimensions
        - range [min, max]
      - number of lanes
        - range [min, max]
      - lane marking color
        - [white]

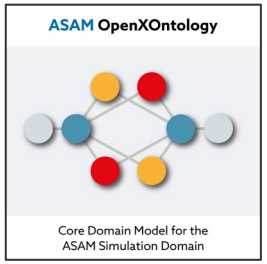
Quelle: https://www.stonewars.de

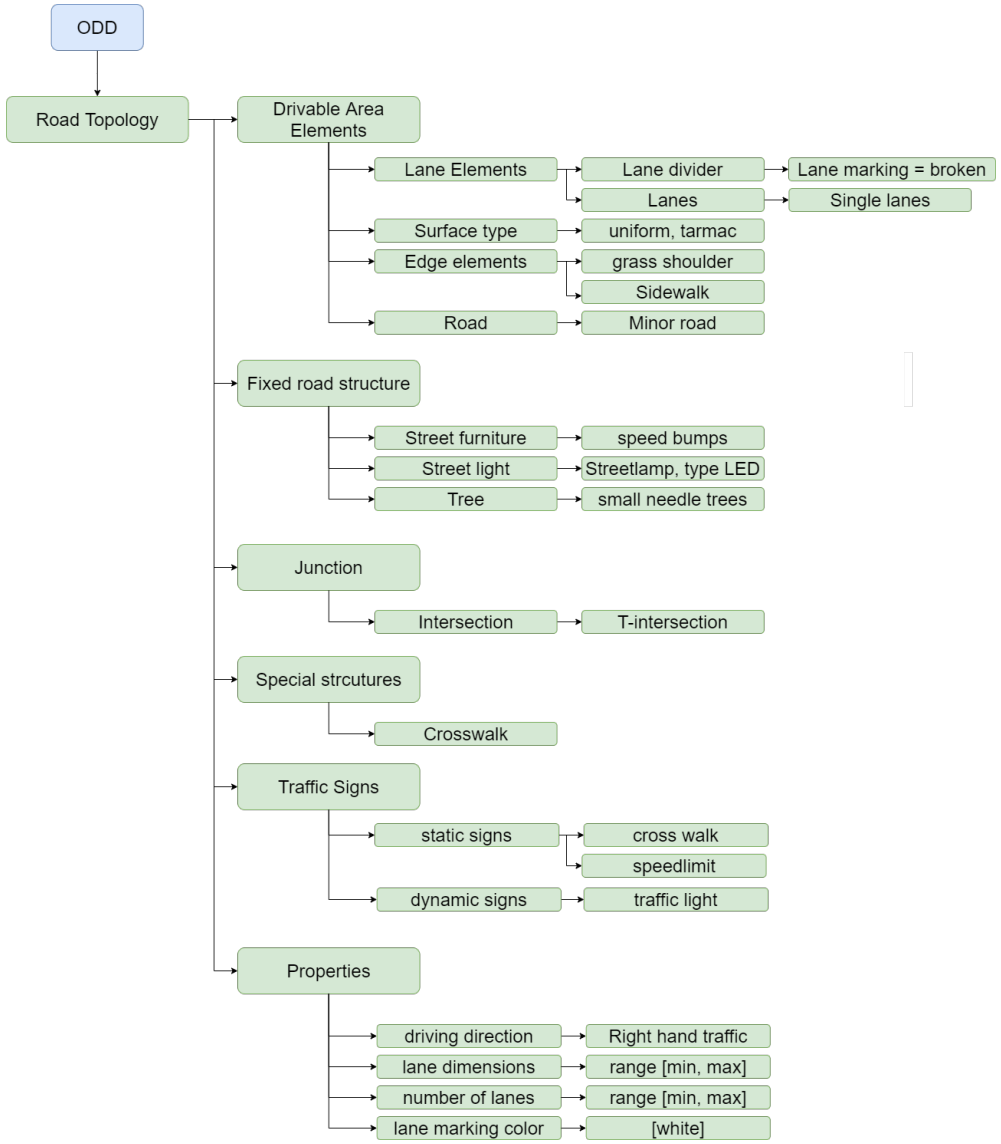
! ASAM OpenODD is still in the concept phase !

ASAM

ODD Definition for the T-Junction: Permissive







Example with Pseudo code:

```
include odd_ontology

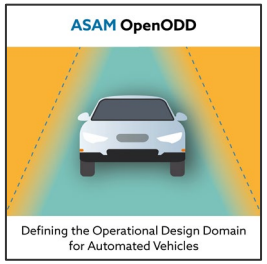
#permissive definition
myODD(
  mode: ‘permissive‘;
  SUITABLE laneDimensions WHEN {min: 3.0, max: 5.0};
);
```

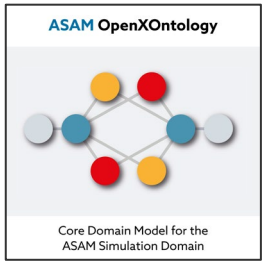
Quelle: https://www.stonewars.de

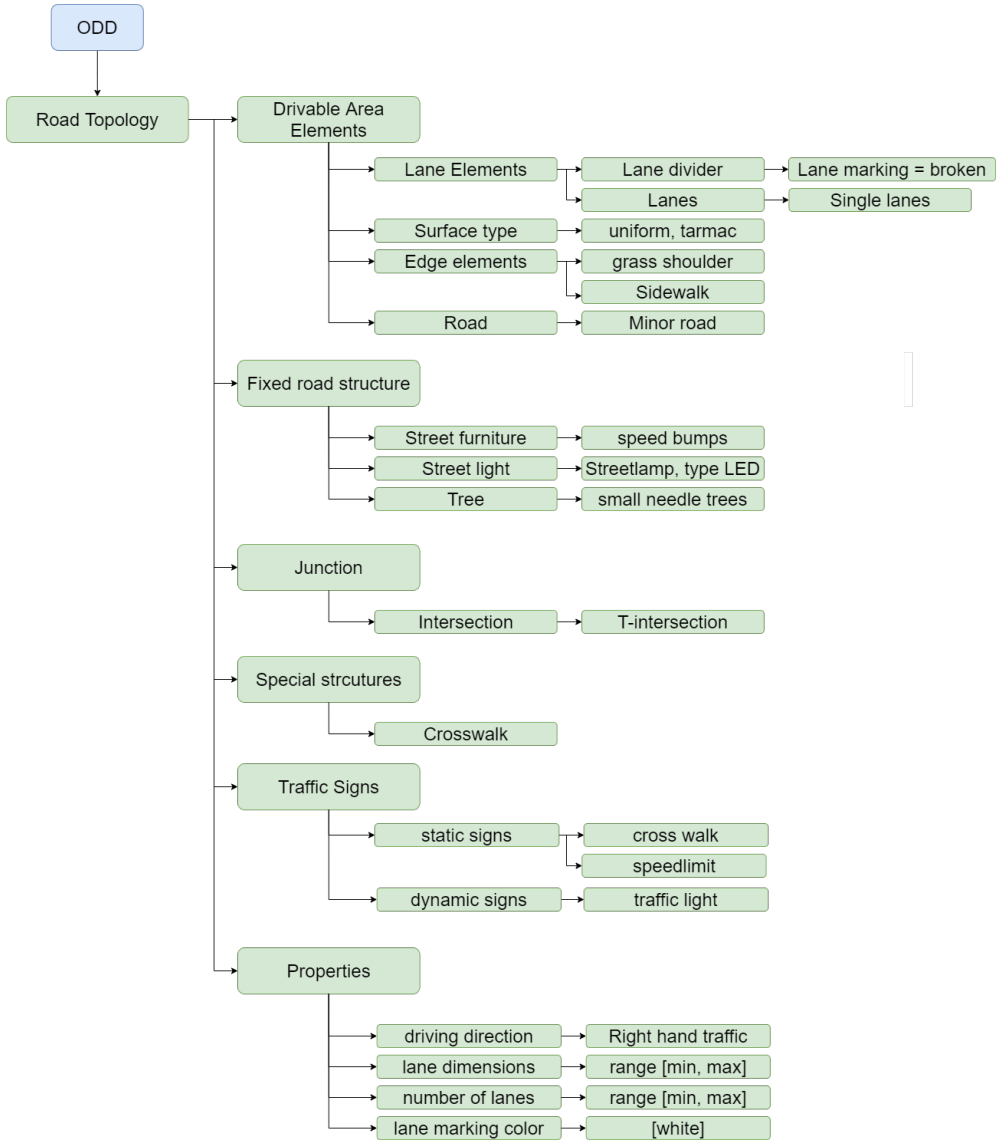
! ASAM OpenODD is still in the concept phase !

ASAM

ODD Definition for the T-Junction: Restrictive







Example with pseudo code:

```
include odd_ontology

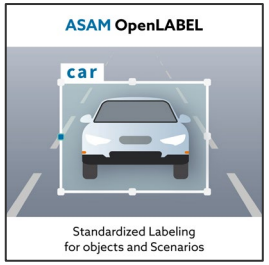
#restrictive definition
myODD(
  mode: ‘restrictive‘
  SUITABLE Lanemarking WHEN ‘broken‘;
  SUITABLE Lanes WHEN ‘single lanes‘;
  …
  SUITABLE driving_direction WHEN ‘right_hand_traffic‘;
  SUITABLE laneDimensions WHEN {min: 3.0, max: 5.0};
);
```

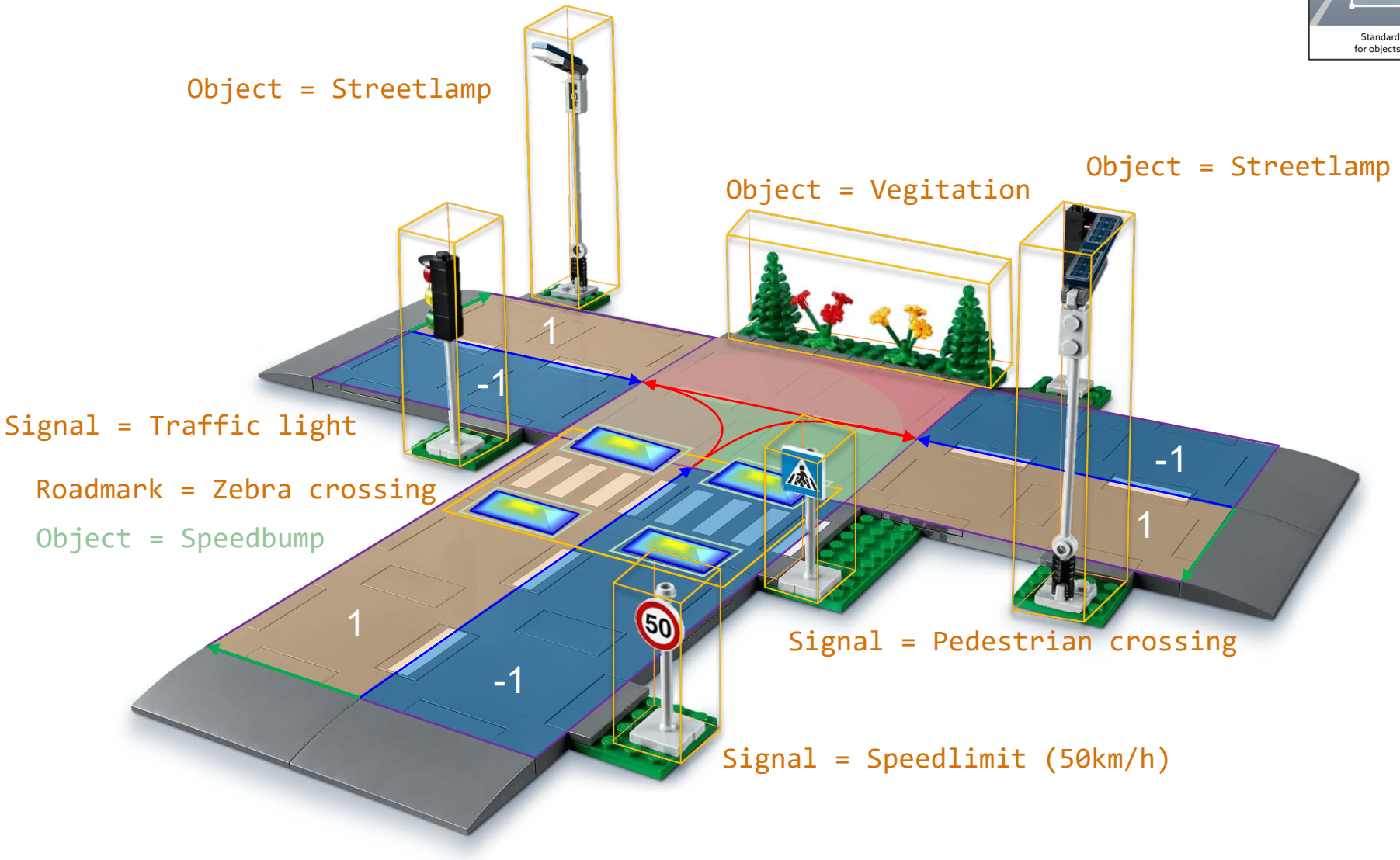
Quelle: https://www.stonewars.de

! ASAM OpenODD is still in the concept phase !

ASAM

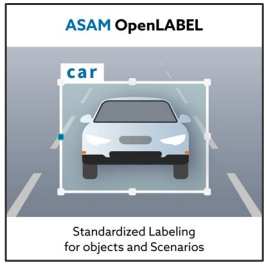
ASAM OpenLABEL: Object labeling

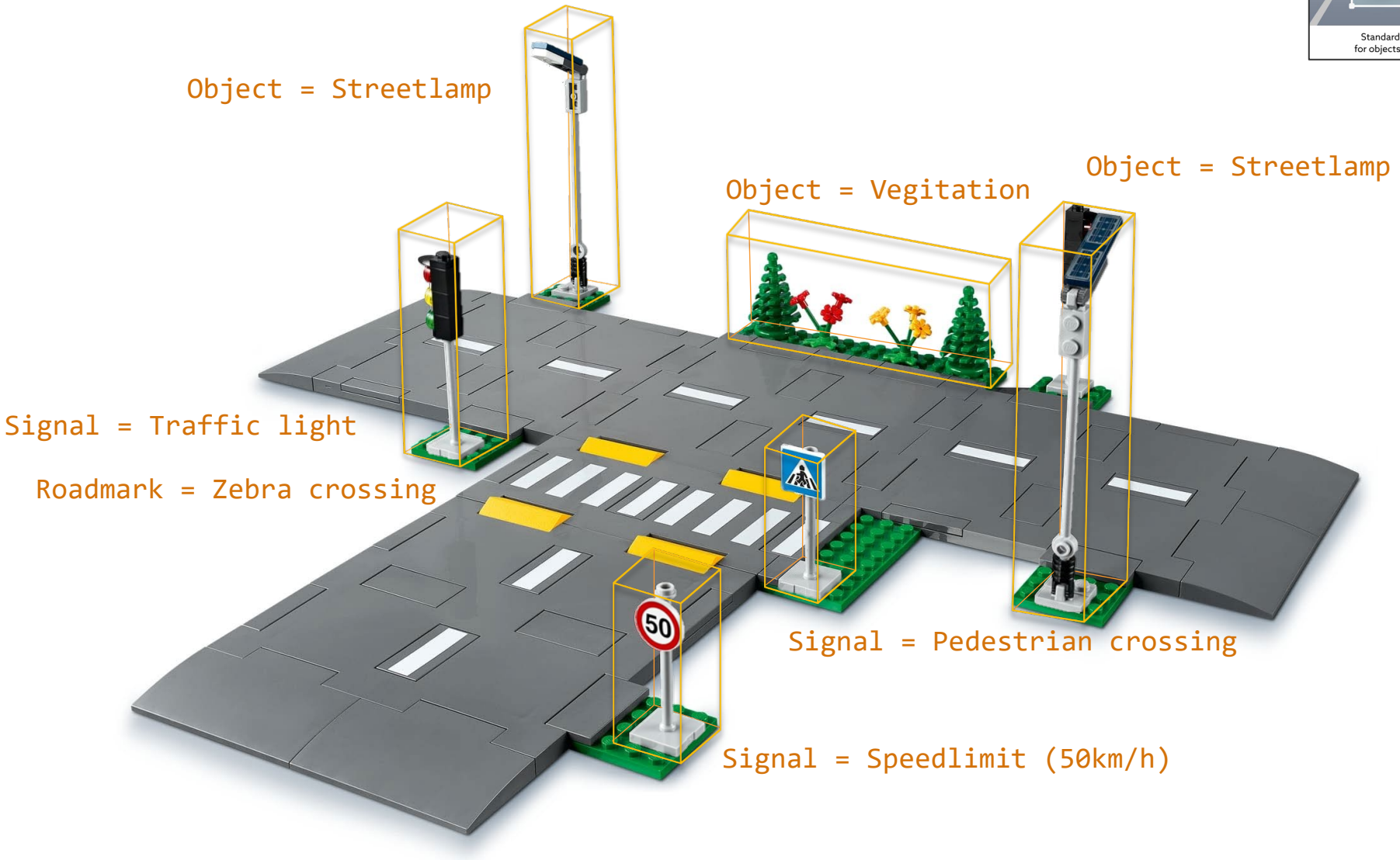




Quelle: https://www.stonewars.de

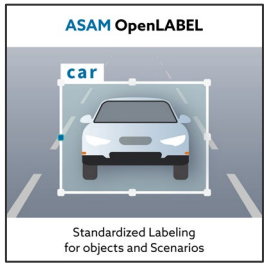
ASAM OpenLABEL: Object labeling

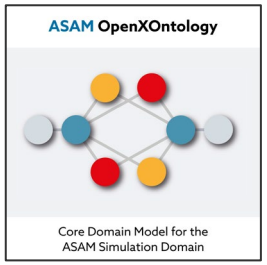




Quelle: https://www.stonewars.de

ASAM OpenLABEL: Object labeling



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                      "val": [x, y, z,
                              qa, qb, qc, qd,
                              sx, sy, sz],
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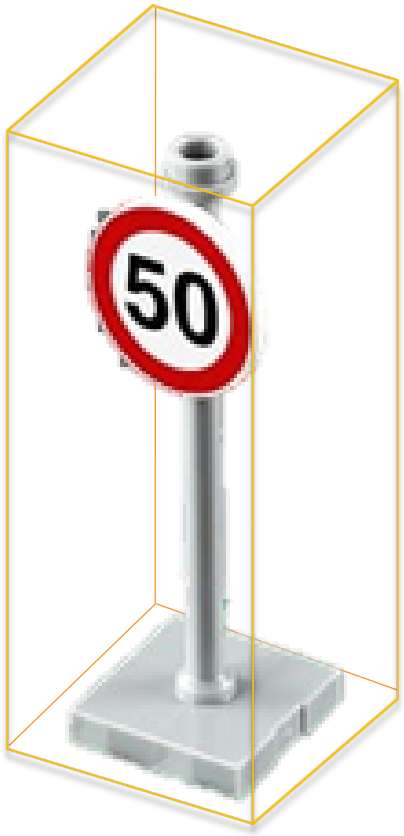
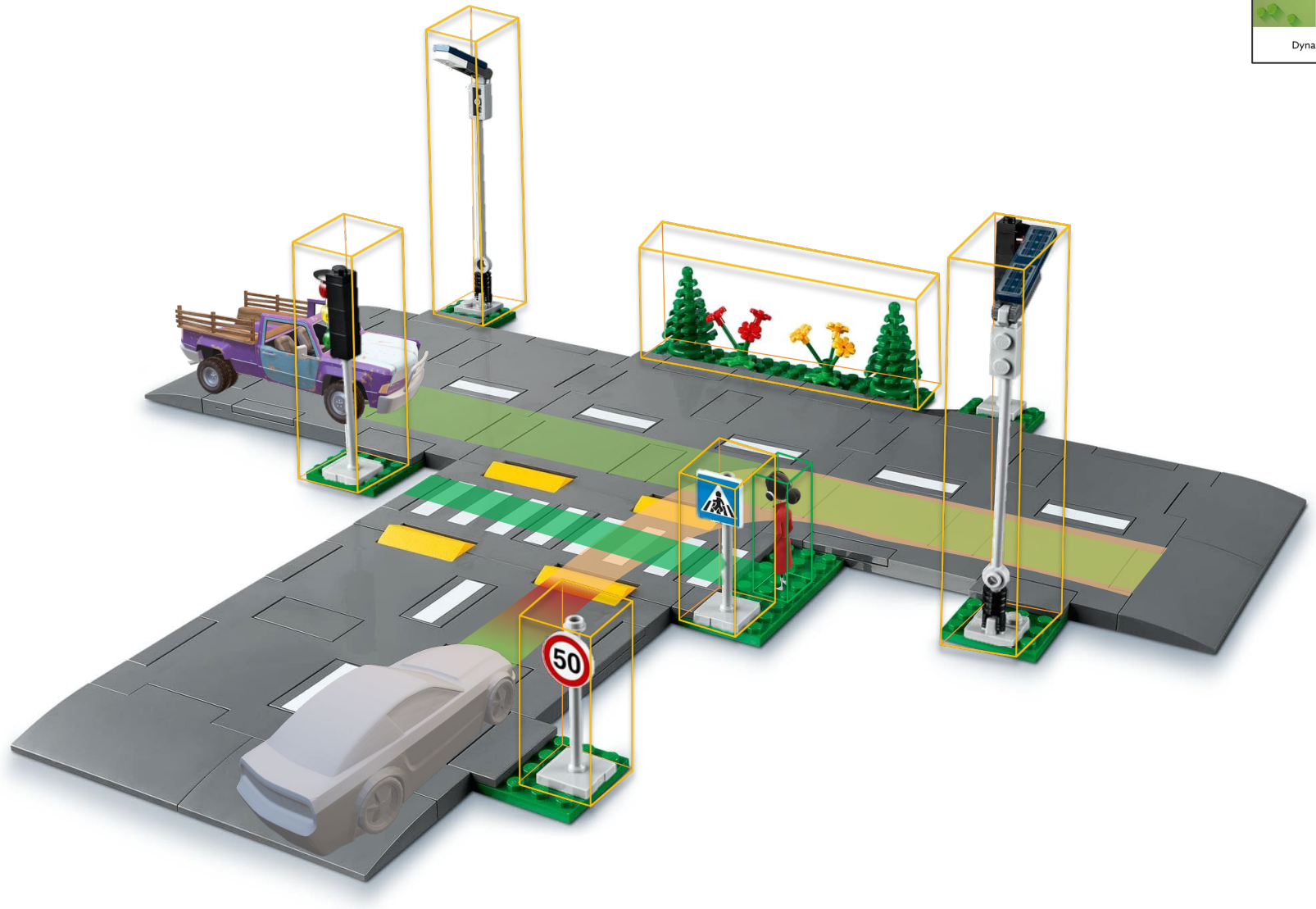
                         "name": "visible",
                         "val": true }],
                   }]
                }
             }
          }
     }
  }
```



ASAM OpenSCENARIO



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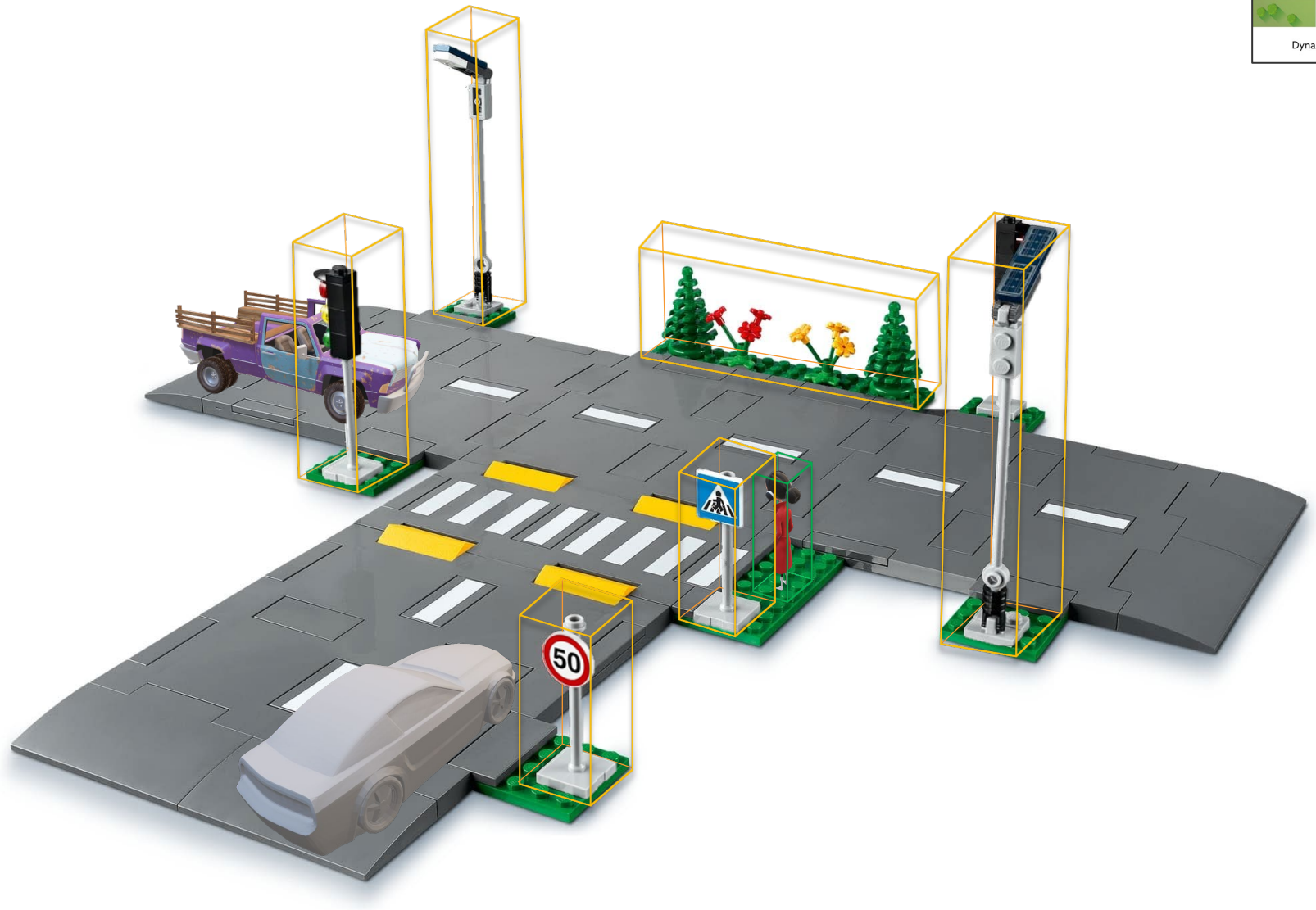


Quelle: https://www.stonewars.de

Scenario Level Overview

	Concrete	Logical	Abstract	Functional
				✓
OpenSCENARIO 1	✓ Executable In Simulator	✓		
OpenSCENARIO 2	✓ Executable In Simulator	✓	✓	

Scenario Abstraction Levels

A simplified view of abstraction levels as supported by OSC2… [Neurohr et al.]

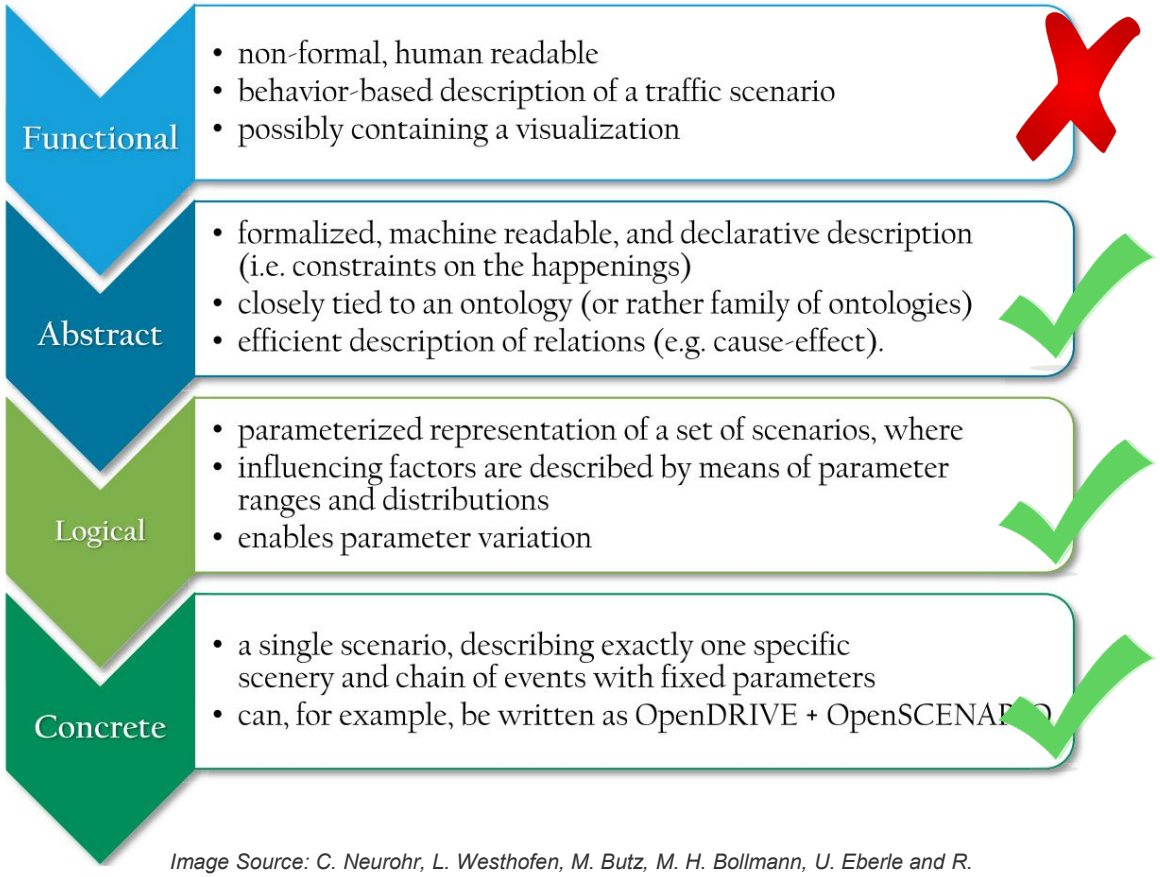


Image Source: C. Neurohr, L. Westhofen, M. Butz, M. H. Bollmann, U. Eberle and R. Galbas, "Criticality Analysis for the Verification and Validation of Automated Vehicles," in IEEE Access, vol. 9, pp. 18016-18041, 2021, doi: 10.1109/ACCESS.2021.3053159.

- Clarification - This is a spectrum not a set of discrete levels
- Concrete scenarios
  - How concrete is a concrete scenario? (concrete vs executable)
  - Two valid options:

    a) A scenario is concrete if everything an author is interested in observing is defined

    b) A user wants full control of a scenario and assigns all parameters values
- Abstract scenarios
  - Scenario A is an abstract form of scenario B if its legal scenario space is a superset of that of scenario B

Functional Scenario

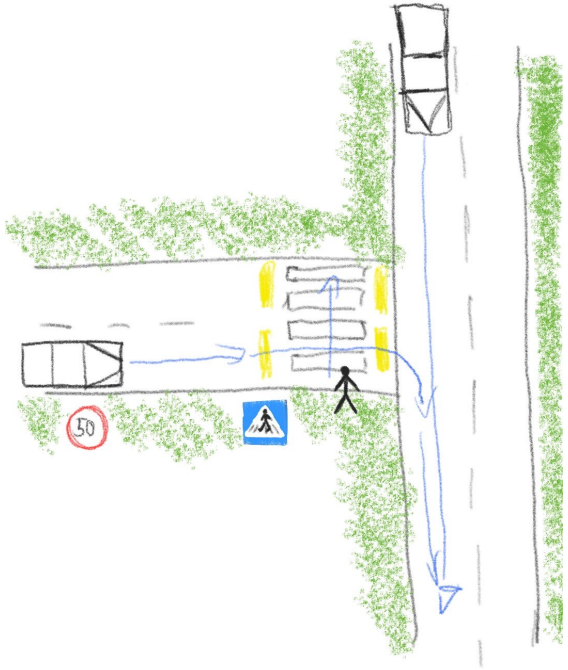
A functional scenario can provide a very large solution space, lower levels of scenario abstractions (e.g. logical scenario) are subsets of this solution space.

```
Scenario:

- The ego vehicle turns
  right at a t-junction

- A pedestrian crosses
  the street, leading
  into the t-juction at
  the pedestrain
  crossing

- A further traffic
  participant drives on
  the main road
```



OpenSCENARIO

OpenSCENARIO 2.0

```
# Concrete
ego.drive() with:
    speed(10kph)
    # note that a fully concrete scenario
    # would have many more fields defined

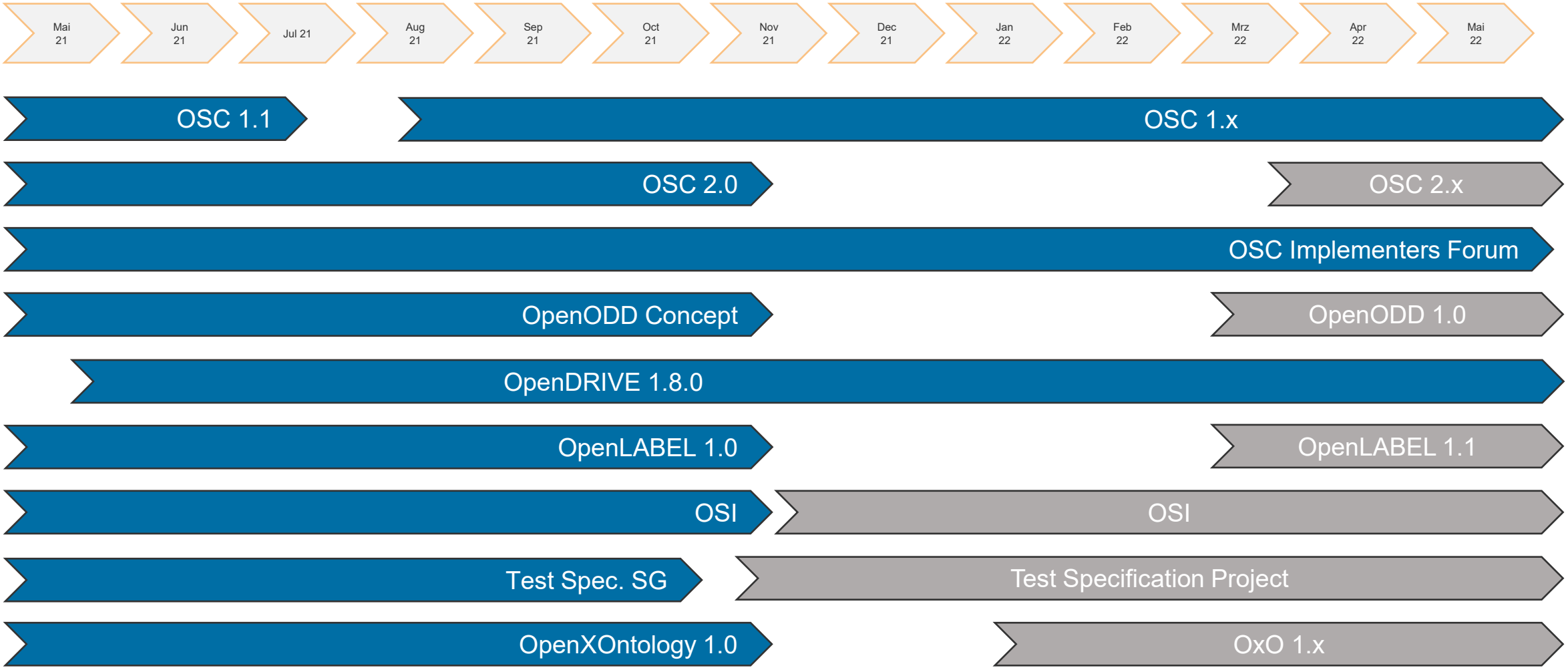
# Logical
ego.drive() with:
    speed([10..50kph])

# Abstract
ego.drive() with:
    keep(it.speed <= 50kph)
```

OpenSCENARIO 1.1

```
<!-- Concrete -->
    <Actions>
    <Private entityRef="Ego">
        <PrivateAction>
        <LongitudinalAction>
            <SpeedAction>
            <SpeedActionDynamics dynamicsShape="step"
dynamicsDimension="time" value="0" />
            <SpeedActionTarget>
                <AbsoluteTargetSpeed value="50.0 / 3.6" />
            </SpeedActionTarget>
            </SpeedAction>
        </LongitudinalAction>
        </PrivateAction>
    </Private>
    </Actions>
```

Roadmap OpenX



Running Planned

ASAM

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