

ASAM OpenODD Concept Project

Introduction and Structure of ASAM OpenODD

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Agenda

1	About OpenODD: scope and objectives
2	ASAM OpenODD structure
3	Deliverables

ASAM OpenODD

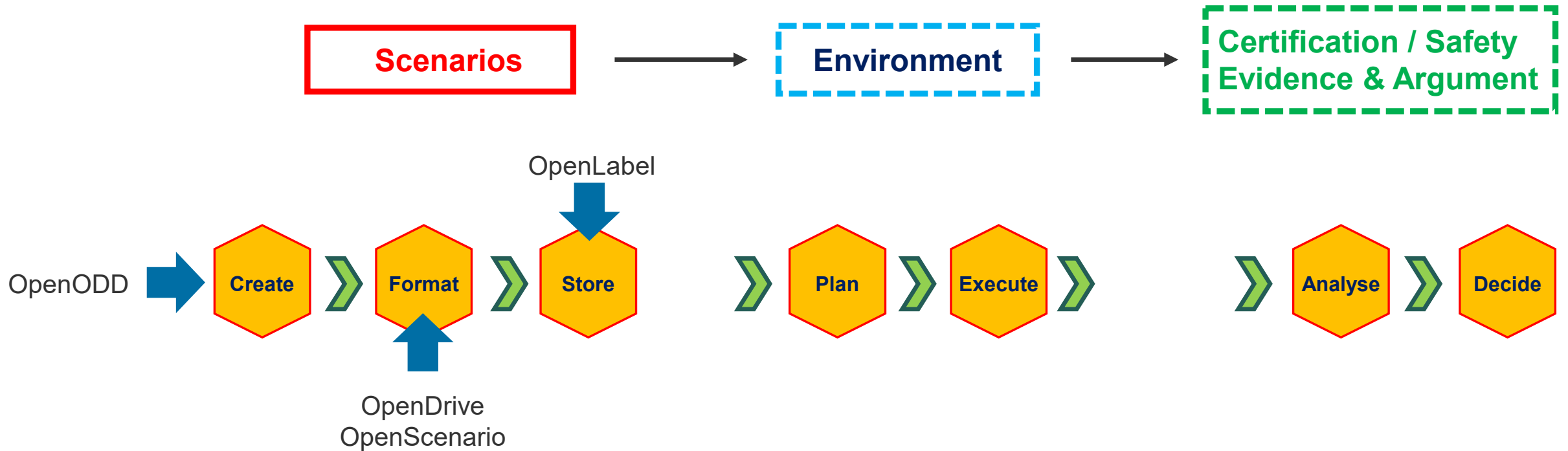
Scope and Objectives

ASAM OpenODD: Scope and Objectives

The aim is to provide a format that is capable of representing a defined Operational Design Domain for connected automated vehicles (CAV) for *simulation based testing*.

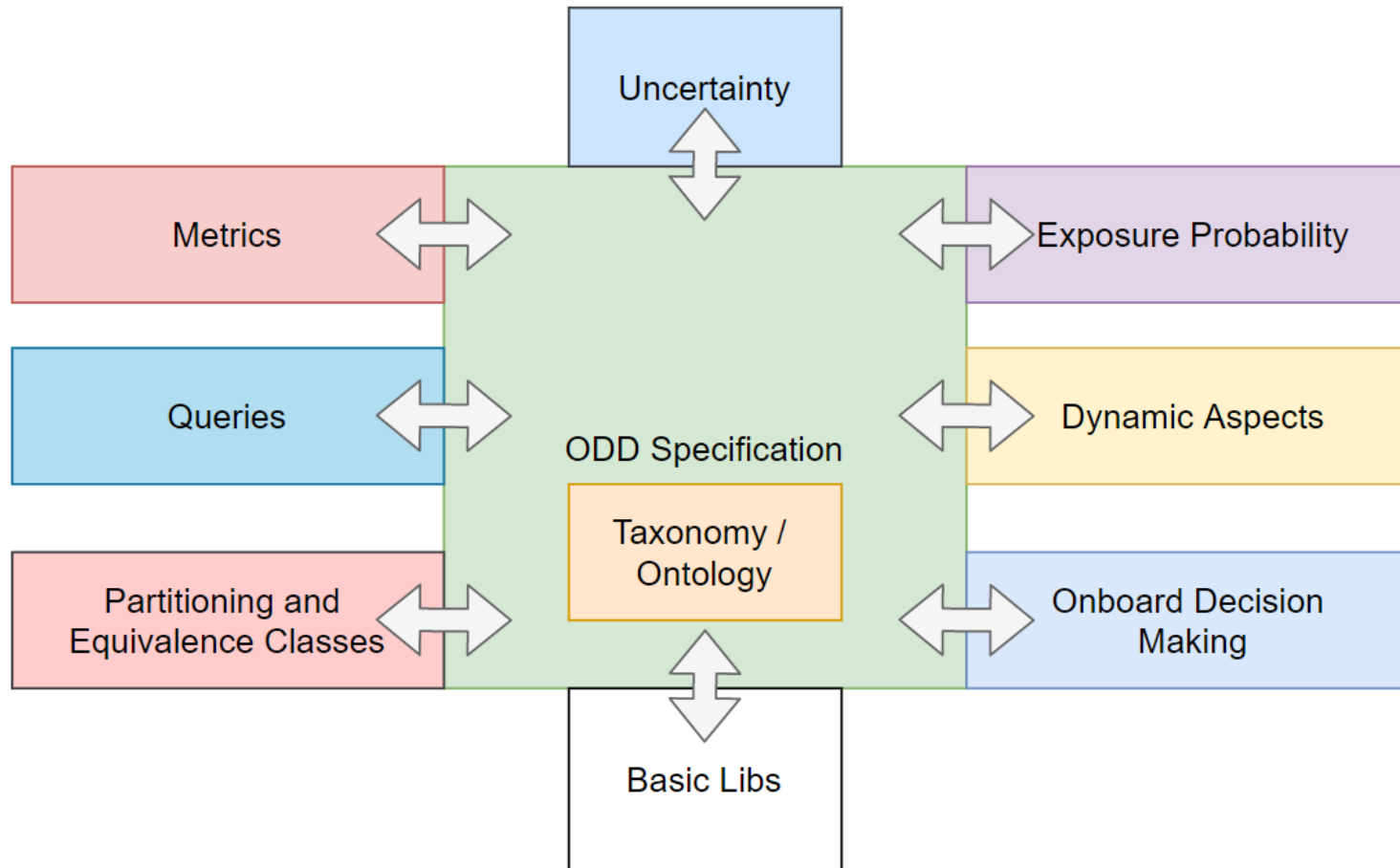
ASAM OpenODD: Scope and Objectives

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ASAM OpenODD: Scope and Objectives

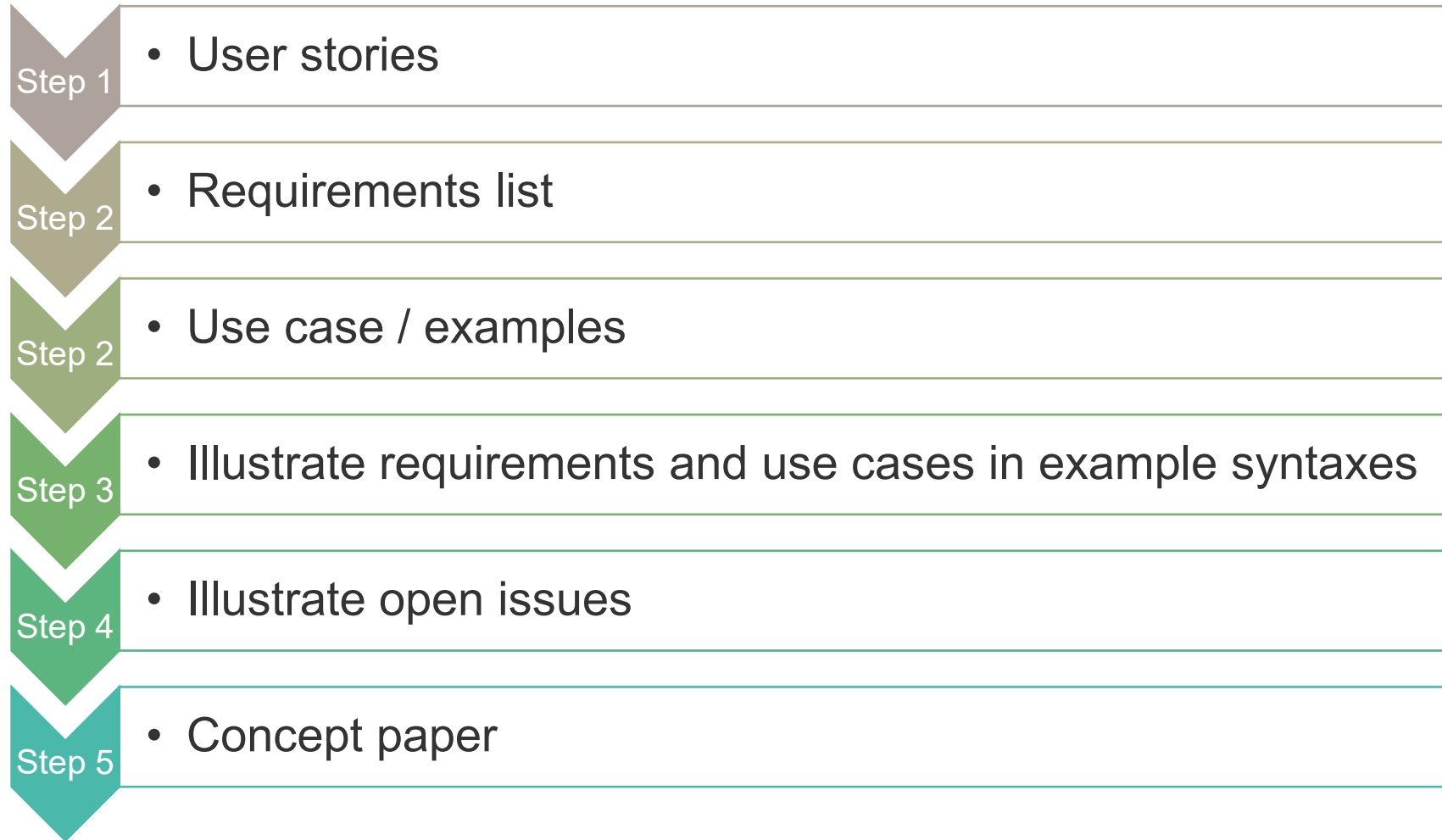
ASAM OpenODD Language
(including aspects accessible through extension mechanisms)



ASAM OpenODD work packages

- Four work packages
- **Work Package 1: Attributes:**
 - Ensure alignment with BSI PAS 1883, ISO 34503, and the ongoing ASAM OpenXOntology Project
- **Work Package 2: Specification/format**
 - Describe the semantic and syntactic description of the ODD description for format for simulation execution
- **Work Package 3: Metrics / Measurement**
 - Define and describes Metrics associated with ODD
- **Work Package 4: Uncertainty**
 - Define and describes uncertainty attributes associated with ODD

ASAM OpenODD: workflow



ASAM OpenODD: Requirement & Syntax illustration

REQUIREMENT: Human and machine readability

Example Use case:

An example ODD states that motorway is only suitable when there is no rain, up slope is not suitable as the vertical geometry.

Syntax 1

```
keep(road_type == motorway => odd_5.weather.rain == none)
keep(geometry.vertical != up_slope)
```

Syntax 2

```
SUITABLE Motorway EXCEPT WHEN Rain
UNSUITABLE Up_slope
```

Deliverables OpenODD Concept project.

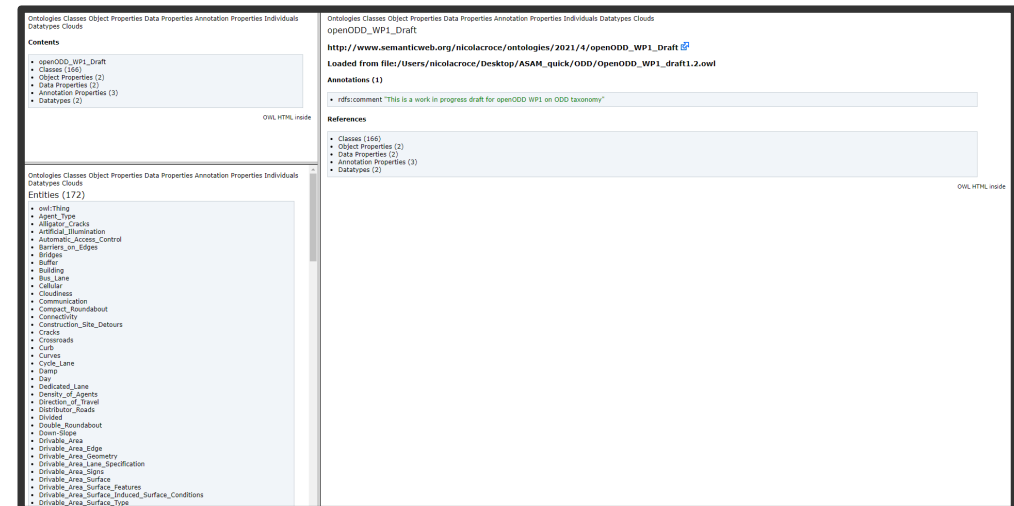
What Is Being Released

Concept Paper

- Documentation
- Illustration in 2 example syntaxes

Ontology Web App

- Online portal with detailed ODD attributes and their ontological relationships



ASAM OpenODD

Concept paper structure

ASAM OpenODD Concept Paper

Structure



Concept Paper

ASAM OpenODD Concept Paper

Structure



ASAM OpenODD Concept Paper

Structure



2. Introduction

2.1. Overview

2.2. Normative and non-normative statements and deliverables


2.3. Conventions

2.4. Understanding ODDs

2.5. Use cases for ASAM OpenODD

ASAM OpenODD Concept Paper

Structure



ASAM

Concept Paper

ASAM OpenODD

Version 1.0, 01.10.2021

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1. Foreword

Association for Standardization of Automotive Systems (ASAM) is a leading organization in the field of standardization for the automotive industry. Our standards enable easy integration of different systems and components, ensuring interoperability and safety. Our standards focus on the development, maintenance, and testing of systems for the data exchange between different global systems.

2. Introduction

2.1. Overview

Safety is fundamental to the development of an Automated Driving System (ADS). In order to ensure the safe operation of the system, the ADS must be able to handle a wide range of operating conditions and time-of-day restrictions. This paper provides an overview of the ASAM OpenODD standard, which defines the operating conditions and time-of-day restrictions for the ADS.

In order to establish the trust in the ADS, the system designer must define the Design Domain. An ODD defines the operating conditions and time-of-day restrictions for the ADS. For example, for a Level 3 ADS, the Design Domain is defined by the predefined routes that include a lane divided motorway and a lane divided motorway. This is fundamental to any safety analysis.

- A more formal definition of the Design Domain, system or feature thereof, including the operating conditions, restrictions, and/or the requirements for the ADS.

In order to enable stakeholders to understand the Design Domain, the system designer must provide a taxonomy for the Design Domain. This taxonomy is used for standardization activities and simulation.

ASAM OpenODD is a representation of the Design Domain to interpret and perform the simulation. It attributes its specifics.

2.4. Understanding ODDs

2.4.1. What is an ODD Specification?

An ODD defines the operating conditions and time-of-day restrictions for the ADS. It includes the dynamic elements (mainly the ego vehicle), the static elements (mainly the road and the weather conditions), and the time-of-day restrictions. The ODD must be capable of handling the operating conditions and time-of-day restrictions. This paper provides an overview of the ASAM OpenODD standard, which defines the operating conditions and time-of-day restrictions for the ADS.

According to SAE J3016 an ODD is defined as:

Operating conditions under which the system is designed to function, including the operating conditions, restrictions, and/or the requirements for the ADS.

2.4.2. Operational Domain (OD)

A specific type of terminology misuse in the literature is the use of the term "Operational Domain (OD)" to refer to the intended ADS capabilities. This is incorrect. The term "Operational Domain (OD)" refers to the intended ADS capabilities. The term "Operational Domain (OD)" refers to the intended ADS capabilities.

Thus, when the real world (OD) is outside the Design Domain, the system designer must be able to define an ODD which is not only capable of handling the operating conditions and time-of-day restrictions, but also ensure safe operation.

2.4.3. Difference between ODD and Scenario

It is important to highlight that while ODDs and scenarios are related, they are not the same. As mentioned earlier, an ODD essentially defines the operating environment for which a system is designed. It may also be seen from the perspective of the end-user (e.g. city council authority) as the operating environment in which a system should be able to operate safely. It is essential that there is an overlap between the two perspectives of the ODD, manufacturer (or the system designer) and the end-user for ensuring the safe deployment of CAVs.

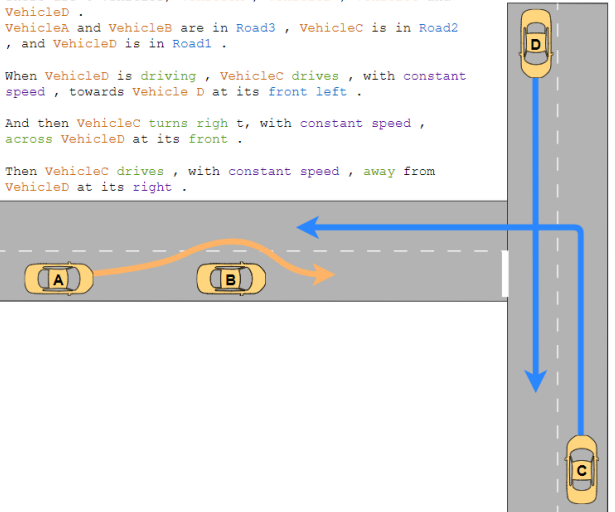
A scenario defines the behavior of various actors and entities in an ODD. Below the difference between scenario and ODD is highlighted graphically. [\[fig-simple-odr-odd\]](#) depicts a part of an ODD with single lane non-divided road which has passenger cars. [Simple scenario with passenger cars](#) depicts a scenario which illustrates the behavior of the vehicles in the ODD of [\[fig-simple-odr-odd\]](#). In summary, once the behavior of the actors is defined in a part of an ODD, it becomes a scenario. This has no influence on the fact that a scenario is a stand alone entity regardless of the ODD definition and therefore can be defined independently.

There are 4 vehicles, **VehicleA**, **VehicleB**, **VehicleC** and **VehicleD**. **VehicleA** and **VehicleB** are in **Road3**, **VehicleC** is in **Road2**, and **VehicleD** is in **Road1**.

When **VehicleD** is driving, **VehicleC** drives, with constant speed, towards **VehicleD** at its front left.

And then **VehicleC** turns right, with constant speed, across **VehicleD** at its front.

Then **VehicleC** drives, with constant speed, away from **VehicleD** at its right.



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2.2. Normative and non-normative statements and deliverables


2.3. Conventions

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2.5. Use cases for ASAM OpenODD

ASAM OpenODD Concept Paper

Structure



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ASAM OpenODD

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2. Introduction

3. Relations to other standards

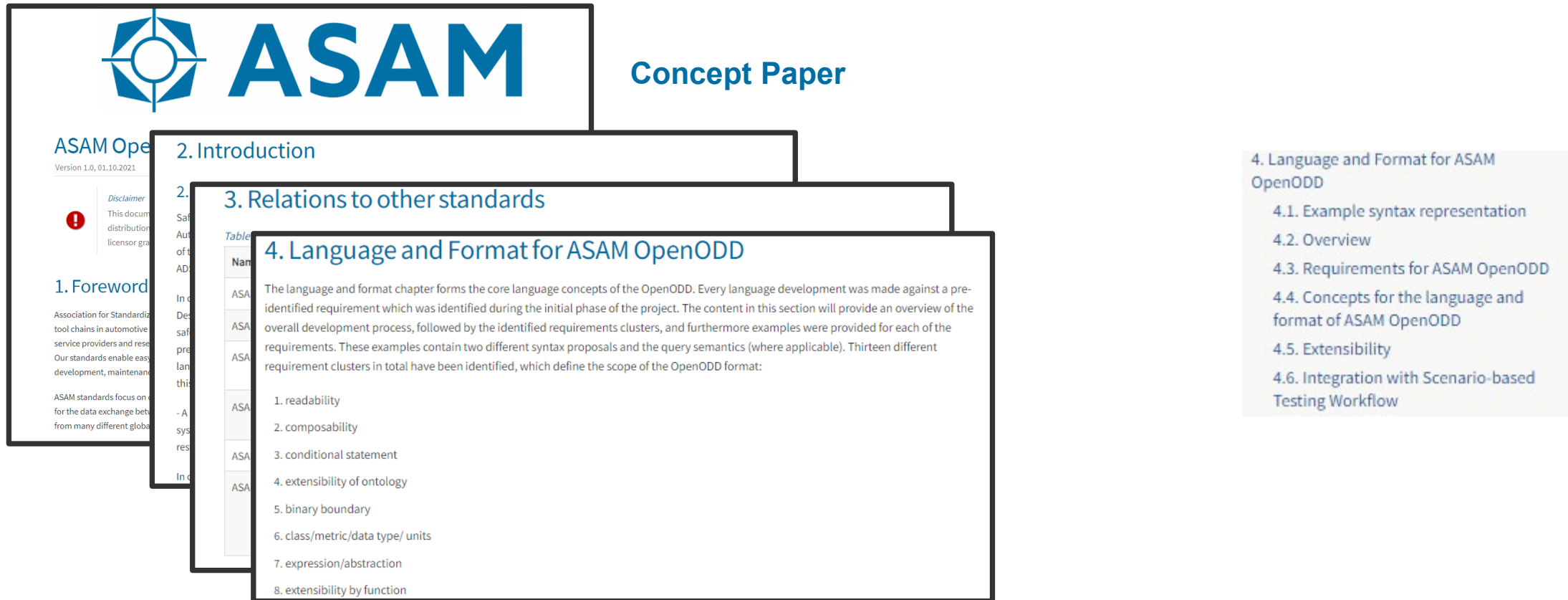
Table 3. relations to ASAM Standards

Name of the Standard	Description
ASAM OpenSCENARIO	Description and exchange format for scenario descriptions
ASAM OpenXOntology	defines an ontology (and set of attributes) for the ASAM OpenX Domain
ASAM OpenLABEL	defines a standardized format for multi-sensor data labelling and scenario tagging. The format is based on a JSON schema
ASAM OpenDRIVE	standardized exchange format for the description of road-networks and the static entities on and along the road. ASAM OpenDRIVE is based on a xsd schema, using xml as an format
ASAM OpenCRG	a binary format to define road elevation or friction profiles
ASAM ODS	allows to store information in a database context and exchange it between tools. Based on a standardized meta-model (the base model) application-domain specific data models (the application models) may be defined. This may lead to consistent data sets e.g. combining ODDs with scenario based test definitions and corresponding test results for evaluations and long term storage.

3. Relations to other standards
3.1. Positioning of ASAM OpenODD within ASAM activities
3.2. References to other standards

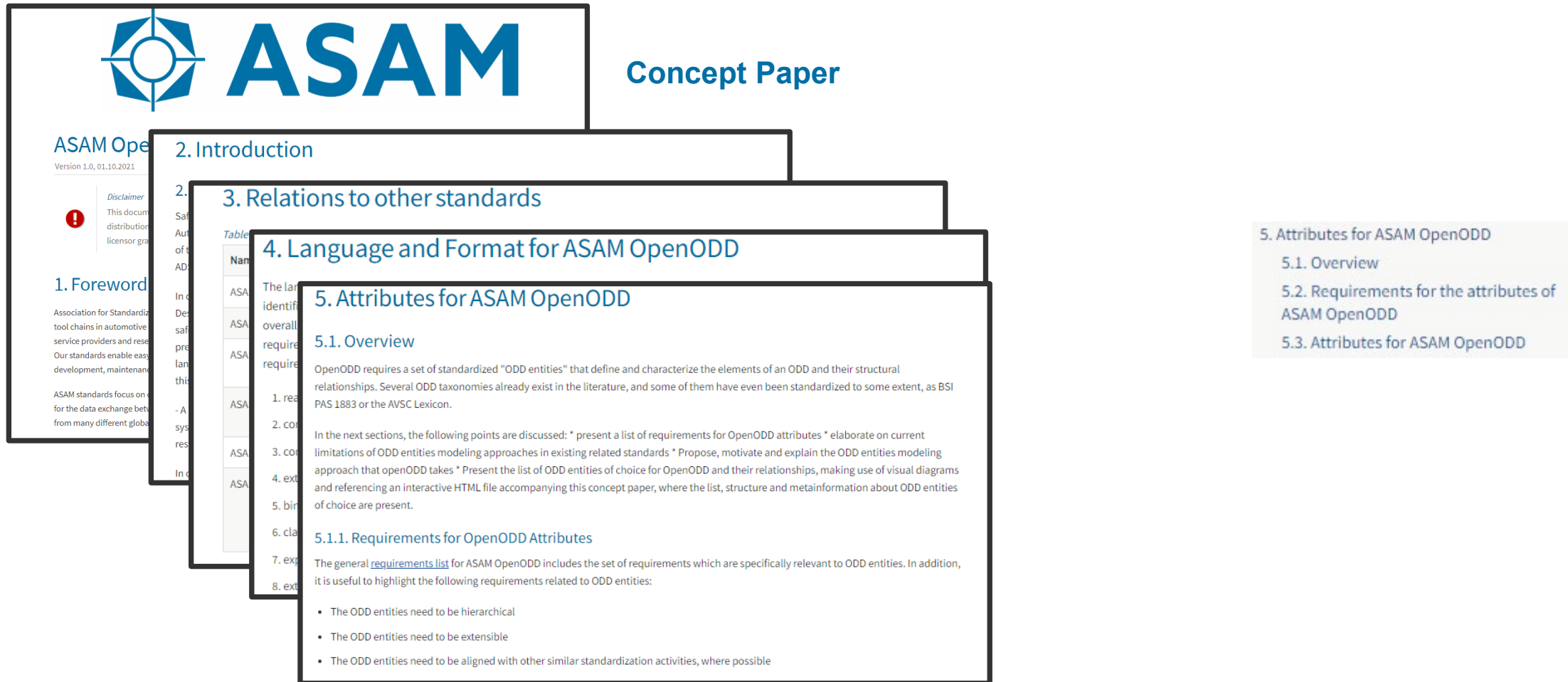
ASAM OpenODD Concept Paper

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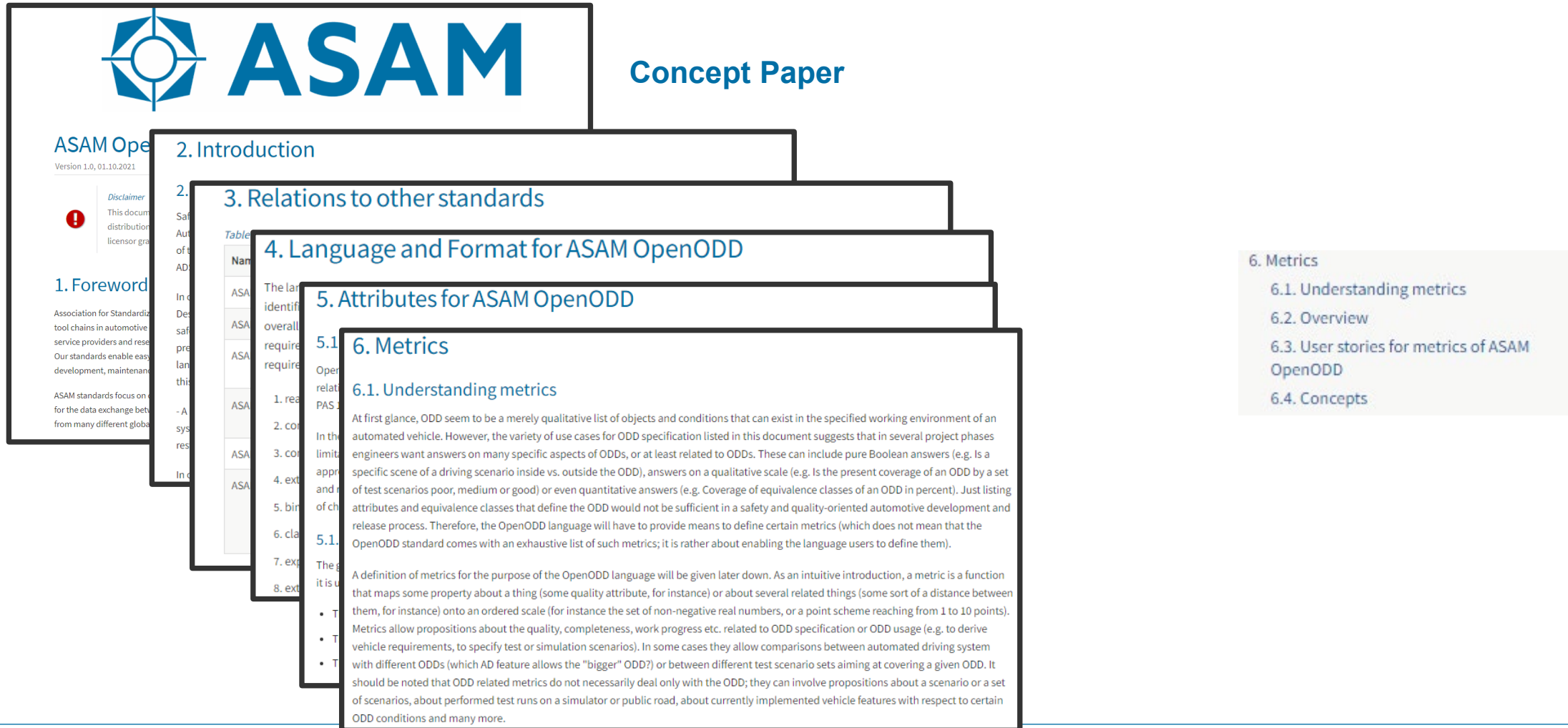
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1. Foreword

Association for Standardization of Automotive Manufacturers (ASAM) is a non-profit organization that promotes the development of standards for the automotive industry. Our standards enable easy integration of different systems and components, which is essential for the development, maintenance and operation of modern vehicles. Our standards focus on the data exchange between different systems and components, which is essential for the development, maintenance and operation of modern vehicles.

2. Introduction

3. Relations to other standards

Name	Description
ASAM OpenODD	The latest version of the ASAM OpenODD standard, which defines the overall structure and content of the OpenODD file.
ASAM OpenScenario	The ASAM OpenScenario standard, which defines the structure and content of the OpenScenario file.
ASAM OpenMission	The ASAM OpenMission standard, which defines the structure and content of the OpenMission file.
ASAM OpenRoad	The ASAM OpenRoad standard, which defines the structure and content of the OpenRoad file.
ASAM OpenTraffic	The ASAM OpenTraffic standard, which defines the structure and content of the OpenTraffic file.
ASAM OpenWeather	The ASAM OpenWeather standard, which defines the structure and content of the OpenWeather file.

4. Language and Format for ASAM OpenODD

5. Attributes for ASAM OpenODD

6. Metrics

7. Uncertainty representation in ASAM OpenODD

8. Queries

While ODD definitions can be done by OpenODD files alone, queries and metrics on ODDs may sometimes relate only on information given in the OpenODD file alone, but sometimes also rely on external data sources (e.g. databases providing details on road types and geometries or weather conditions in a certain target country). While the technical access to external data sources like files and databases is performed via standard libraries, there must be a means to formulate queries like "select all roads with at least two lanes of at least 2.0 m lane width". This requires a query mechanism and an appropriate query language syntax (e.g. similar to the well-known SQL language). But also the use case of querying details on an ODD itself needs to be supported (e.g. for reporting or metrics), which can be achieved by the same query language.

8.1. User Stories for queries

8.1.1. Scenario Editor

Inclusion of a scenario within the ODD

As a scenario editor, given an ODD, I need to determine if a scenario lies entirely within the ODD.

Example	Approach
Given an ODD specification and a scenario (e.g. in OpenScenario language), check whether or not (Boolean answer) the scenario is entirely within the ODD boundaries.	Form the intersection of the scenario and the ODD (note that one has the appearance of a line whereas the other has the appearance of an area or a space , so additional considerations like giving a width to a scenario by making a shift from concrete to logical scenarios, or

- 9. Partitioning and equivalence classes
- 10. Exposure and probability
- 11. Dynamic aspects
- 12. Onboard decision making
- 13. Annex to ASAM OpenODD

Thank you for your attention!

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