The ASAM OpenX Landscape

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ASAM Regional
Meeting China

ASAM Association for Standardization of Automation and Measuring Systems

Quick Intro…

Ben Engel

CTO @ ASAM

Feel free to reach out if you have any questions!

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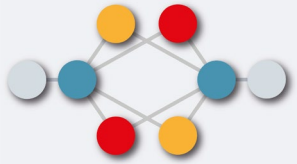
Vison of ASAM OpenX…

Domain Ontology

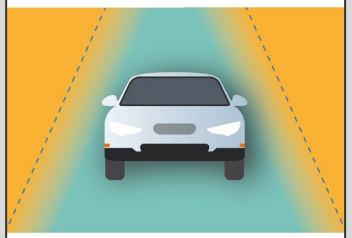
ASAM OpenXOntology



Core Domain Model for the ASAM Simulation Domain

Operational Design Domain

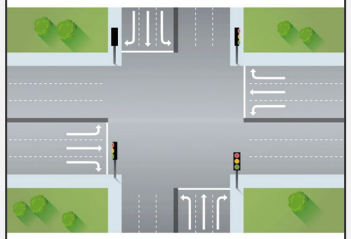
ASAM OpenODD



Defining the Operational Design Domain for Automated Vehicles

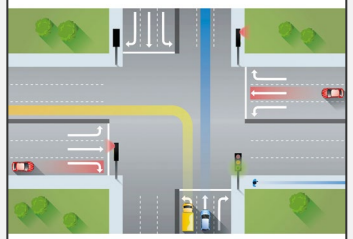
Static and dynamic content of a scenario

ASAM OpenDRIVE®



Static Road Network Desription

ASAM OpenSCENARIO®



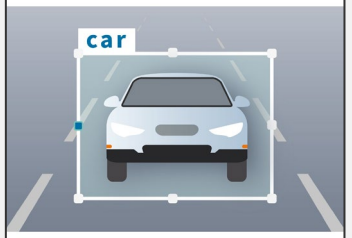
Dynamic Scenario Desription

ASAM OpenCRG®

Static Road Surface Desription

Annotation

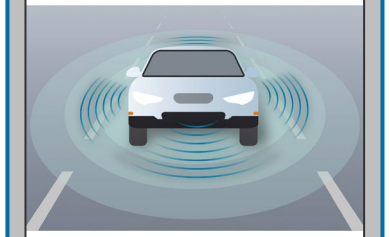
ASAM OpenLABEL



Standardized Labeling for objects and Scenarios

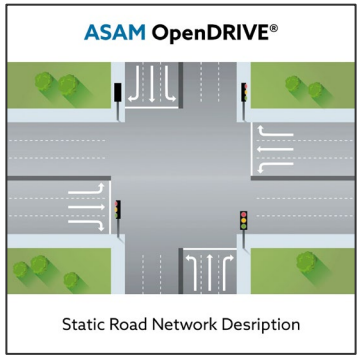
Interface

ASAM OSI®



Interface for Simulation

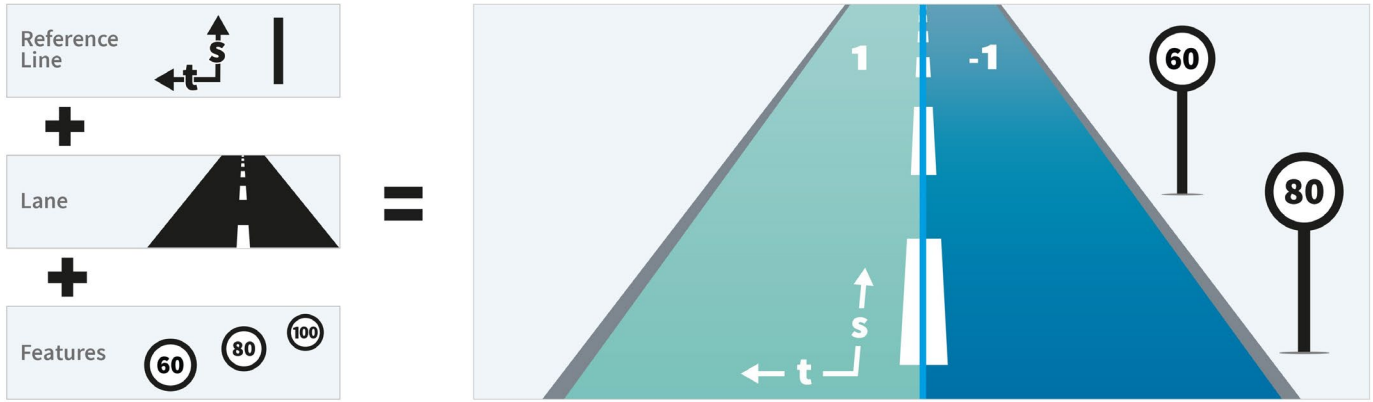
OpenDRIVE



- File format for the **description of road networks**.

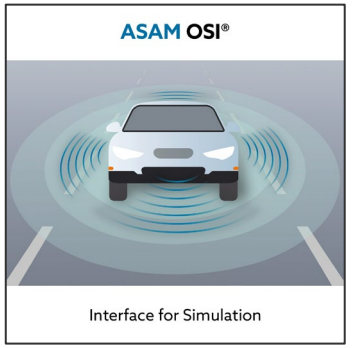
- V1.6.1 released March 2021
  - Integration of OpenCRG
  - Bug fixes & clarifications

- New project started in May 2021 [Proposal]
  - Two releases:
    - V1.7.0 in July 2021
      - Address known issues in V1.6.1
    - V1.8.0 planned for June 2023
      - New features based on concepts from the OpenDRIVE Concept Paper



ASAM

Open Simulation Interface (OSI)

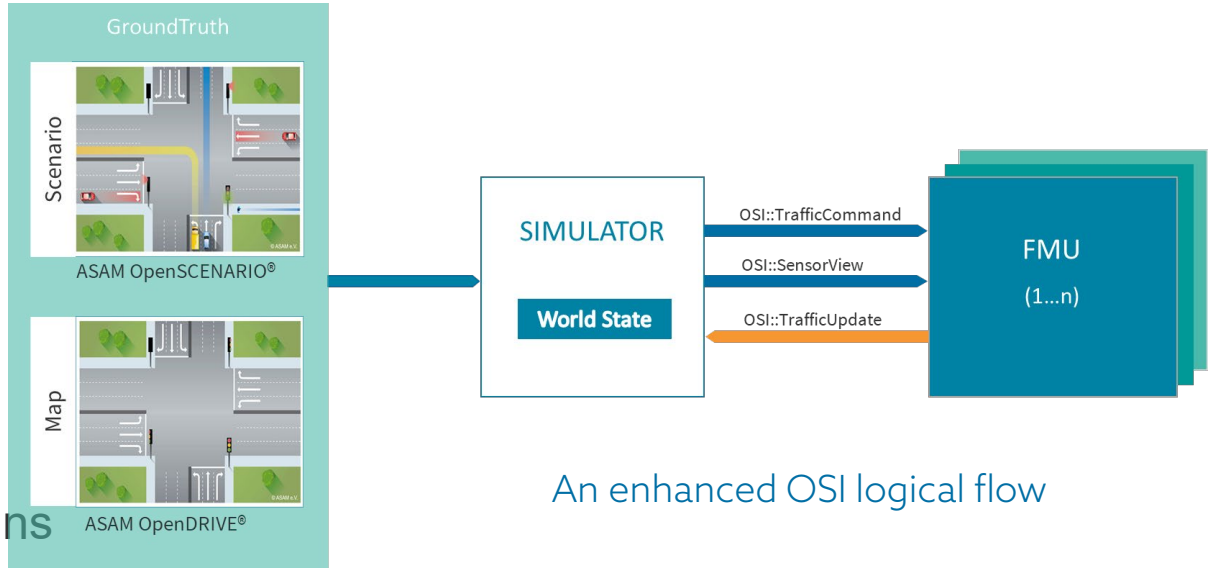


- **Open-source interface between models (e.g. sensors, traffic participants) and simulation environments**

- V3.5.0 released July 2022

- Followup project running from September 2022 to early 2024
  - V3.6.0 planned for March 2023
  - V4.0.0 for January 2024

  - Planned features:
    - Further alignment with other ASAM standards
    - Performance improvements
    - Streaming Interface for Visualization
    - Improvements to existing interfaces
    - Support for additional use cases and other domains
    - Support for vehicle internal interfaces



An enhanced OSI logical flow

ASAM

Test Specification

- Enrollments to participate are open (ASAM website -> proposals -> Test Specification
- Two goals

1. Testing blueprint.
   Long term goal: A blueprint for development and type approval authorities on testing to make the safety argumentation for ADAS systems.
   - Fault injection, fault propagation & robustness testing
   - Integration of V2X in scenario-based testing

2. Standardization
   - At least one project proposal to be prepared for March 2023.
   - Proposal will outline a project for a test specification standard and maybe development of an ontology for test specification

Define Test Strategies for ADAS/AD and SDV

Test Method	Model-in-the-Loop	Software Reprocessing	Closed-Loop-SIL	Hardware Reprocessing Data Replay	Closed-Loop-HIL	Vehicle-in-the-Loop	Driver-in-the-Loop	Proving Ground	Open Road Testing Field Monitoring
	Test Environment								
Requirements-based Tests	Requirement-based testing MIL	Software testing open loop	Software Stack testing closed loop		Testing of complete effect chains closed loop	Requirement-based testing VIL		Testing in controlled proving ground environment	Testing under real life use cases in the field
Interface Tests			Software Integration tests	Hardware Reprocessing Data Replay	Higher-level integration tests	Testing of complete effect chains on system level			
Fault Injection	1) Detailing out testing using fault injection, fault propagation & robustness								
Resource Usage Performance Test				Reaction of the ECU to high data rates	Testing of vehicle network performance				
Scenario-based Test	Validation of control components		Validating functions on large scale		Validation of electronics integration	Validation on system level	Validation of drivers' interactions with safety-relevant functions (HARA)	2) Integrating V2I	

ASAM

OpenSCENARIO

OpenSCENARIO

- Exchangeable scenario descriptions

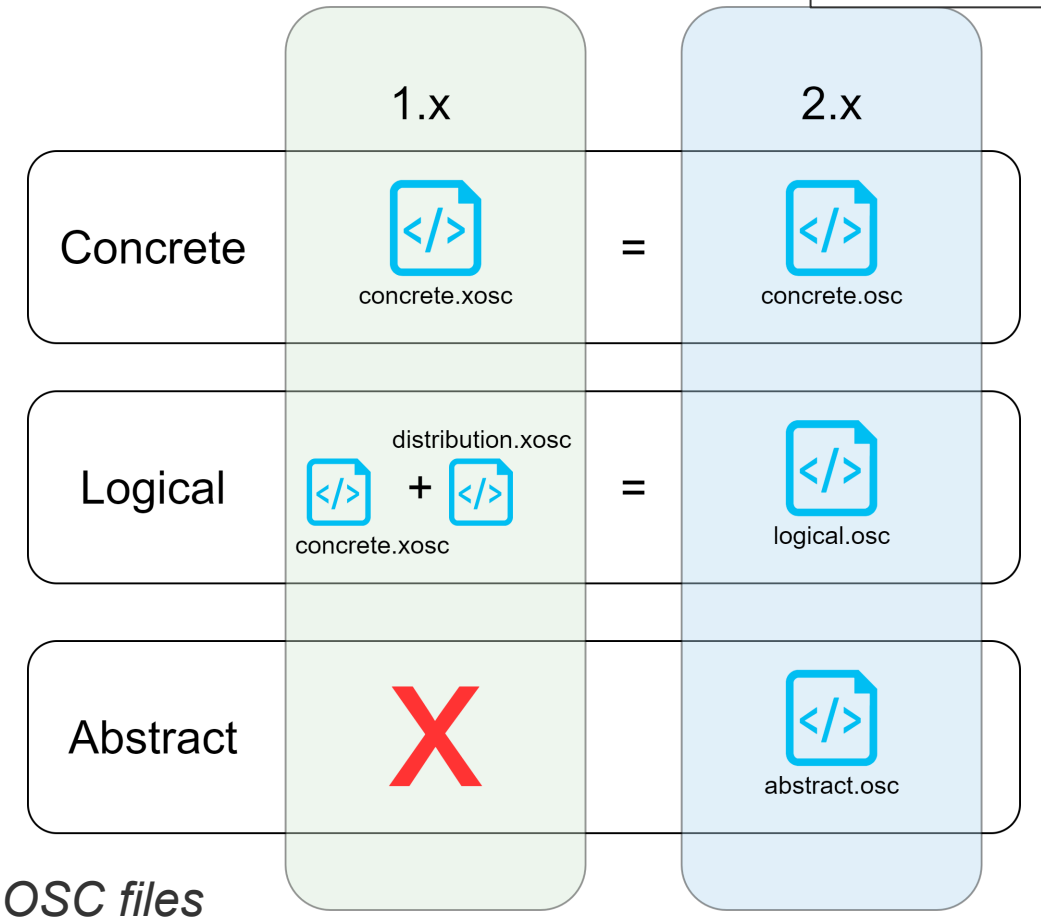
- V1.2.0 released May 2022
  - Many clarifications in the specification
  - Support for virtual sensor recognition algorithm testing
  - Support for sensor error injection

- V2.0.0 released July 2022
  - Shift to a DSL together with a domain model
  - Support for abstract scenarios

- **Followup project aiming to start in January 2023!**
  Focus on migration first, new features second

Intro

- OSC 2.x offers additional features that enrich the scenario description
- Neither version of OSC guarantees exact reproducibility across different tools
- The focus of OSC is on enabling exchange and re-use of scenario descriptions
- This does not change across the versions



Exchangeability of OSC files

Roadmap (07.2022)

OSC 2.x

V2.0.0 Concepts

2020

V1.0.0

2021

V1.1.0
Runtime improvements,
support for logical scenarios.

V2.0.0 Public Release
Candidate (PRC) made
available for feedback

V2.0.0 PRC closed
Significant feedback gathered

2022

V1.1.1
Bugfixes

V1.2.0
New actions,
clarifications & harmonization.

V2.0.0
First release
Migration guidelines for 1.2 to 2.0

Mappings provided for all
OSC V1.2 elements to V2.0
(see section 10.8 in V2.0.0).

Joint ASAM OpenSCENARIO project

V2.0.1
Bug fixes

2023

V2.1.0*
Features from shared backlog

V1.3.0*
Features from shared backlog

2024

Future development focused on y.x
1.x to be placed in maintenance mode.
Bug fixes only.

OSC y.x

2025

Vy.x.z
Release of converged version of
ASAM OpenSCENARIO based on
DSL & domain model.
Includes full migration support for 1.x scenarios.

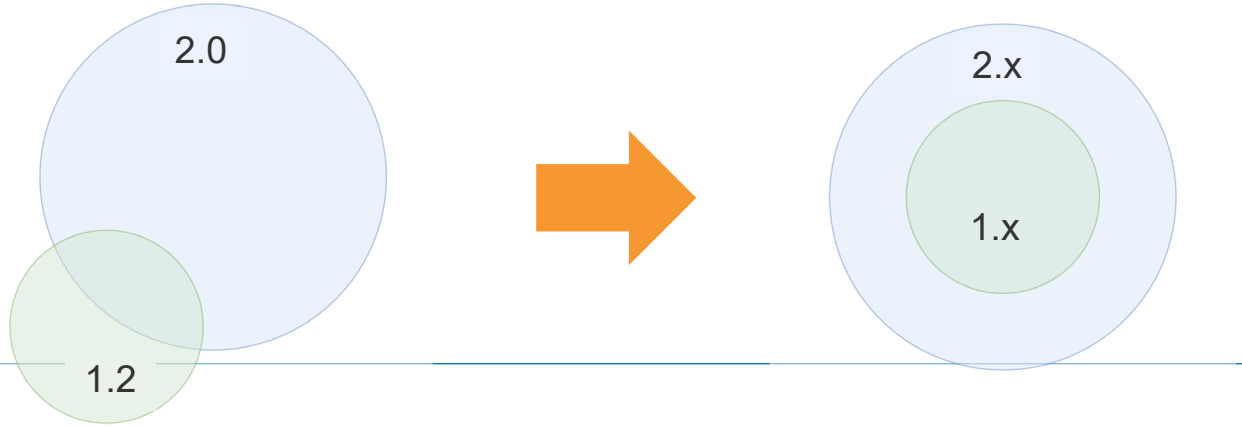
OSC 1.x

** It is possible that further releases may be needed in the run up to a single converged ASAM OpenSCENARIO*

We are here...

Convergence of versions

- ASAM will not stop supporting OSC 1.x or 2.x until it is clear that everything that needs to be covered in a converged version can be covered
- Assuming 2.x covers all use cases of 1.x and more, it does not make sense to develop two standards in parallel that do the same thing
- Overall goal is thus: converge to one version, based on 2.x
- One joint version ensures the most efficient allocation of member resources and least amount of confusion in the industry
- BUT: We need to ensure the requirements previously set are met! (and likely more…)



OpenSCENARIO

- Joint ASAM OpenSCENARIO 1.x and 2.x project

- Start 15.01.23 / End 02.10.23 (Goal: Pending TSC approval on 05.12.2023)

  Goals

  1. Migration
     - Improve and close gaps in the migration guidelines OSC 1.x → 2.x
     - Ensure the same semantic meaning of a scenario in 2.x and 1.x
     - Approval for migration tooling pending TSC discussion
     - Decide on additional steps needed to reduce the migration/implementation hurdles

  2. Bug fixes, clarifications & new features for both versions
     - Based on a shared backlog of features

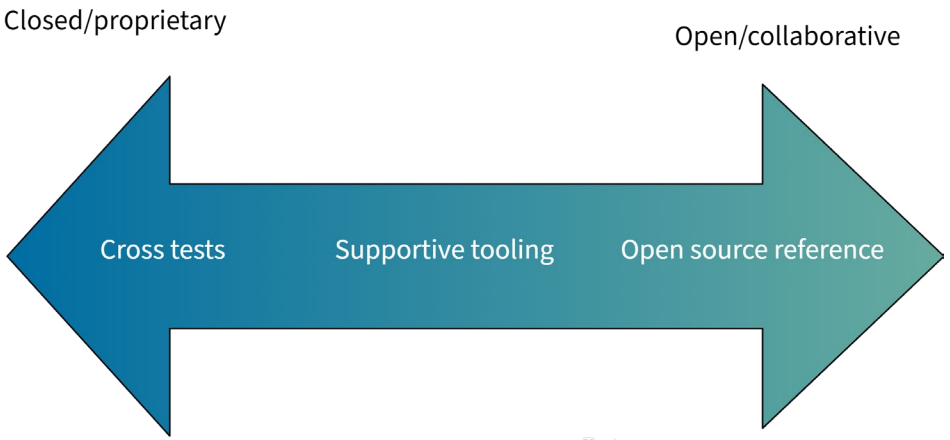
  3. Detail out the ongoing roadmap for OpenSCENARIO

Some comments on migration

- Migration guide is non-normative & provides mapping for elements from OSC 1.0 to 2.0
- It is not complete. The current theory is that everything domain-related has at least one mapping, but there was not sufficient time to do this mapping in all cases for 2.0.
- Some elements already have unpublished concepts for how to map them (some do not)
- What about further elements from >1.0?
- Some exceptions are named where a mapping is not needed
- Minimum for this project: Aim to finish the guidelines to cover the most recent versions of OSC 1.x
  → Clear overview of mappings, open points and when these will be addressed (in order of prio.)
- Separate the migration document, make it a standalone document

Some comments on migration - forward looking

- These are all currently ‘just’ guidelines. A great start, but what next?
- We think that more than guidelines is needed. → proposal pending to provide a migration tool
- What can be done to reduce the hurdle of migration?
- How about other alignment topics? Terminology? Domain model?



Some comments on migration

- Suggestions brought up in the proposal workshop:
  - Reference scenarios described in both versions with reference results. Automated pipeline to check submitted results against reference with series of tests.

  - Complete mapping of OSC1 elements available in OSC2 domain model could be made available by 51World → potential for significant time savings

  - Extending reference open source solutions with support for both versions (e.g. esmini)

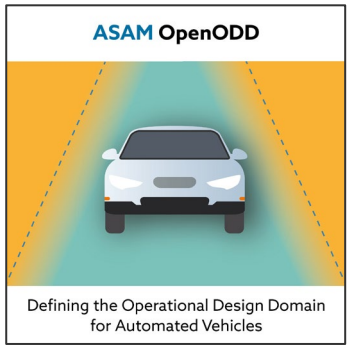
These solutions are out of scope for the next project BUT what is in scope is figuring out what the members are interested in pursuing in future

- Last phase of migration work package will focus on these questions.

OpenODD

What is OpenODD?

A machine and human readable format for representing a defined Operational Design Domain that is measurable and verifiable



A list of attributes and values, based on a taxonomy or ontology

```
weather
  temperature:single(-20..40) [°C]
  rain
    light:(droplet_size:single,
        density:single) ((0..1),
        (0..1k)) ([mm^3], [1/m^3])
```

+

Constraints

keep(lane_dimensions in [3..5]m)

+

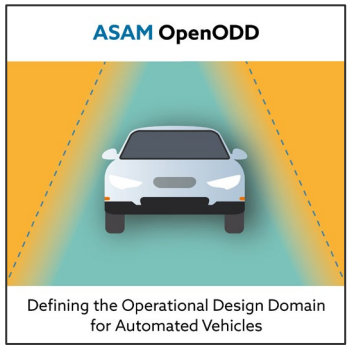
Conditional Expressions

If brightness.day.midday then weather.rain.light

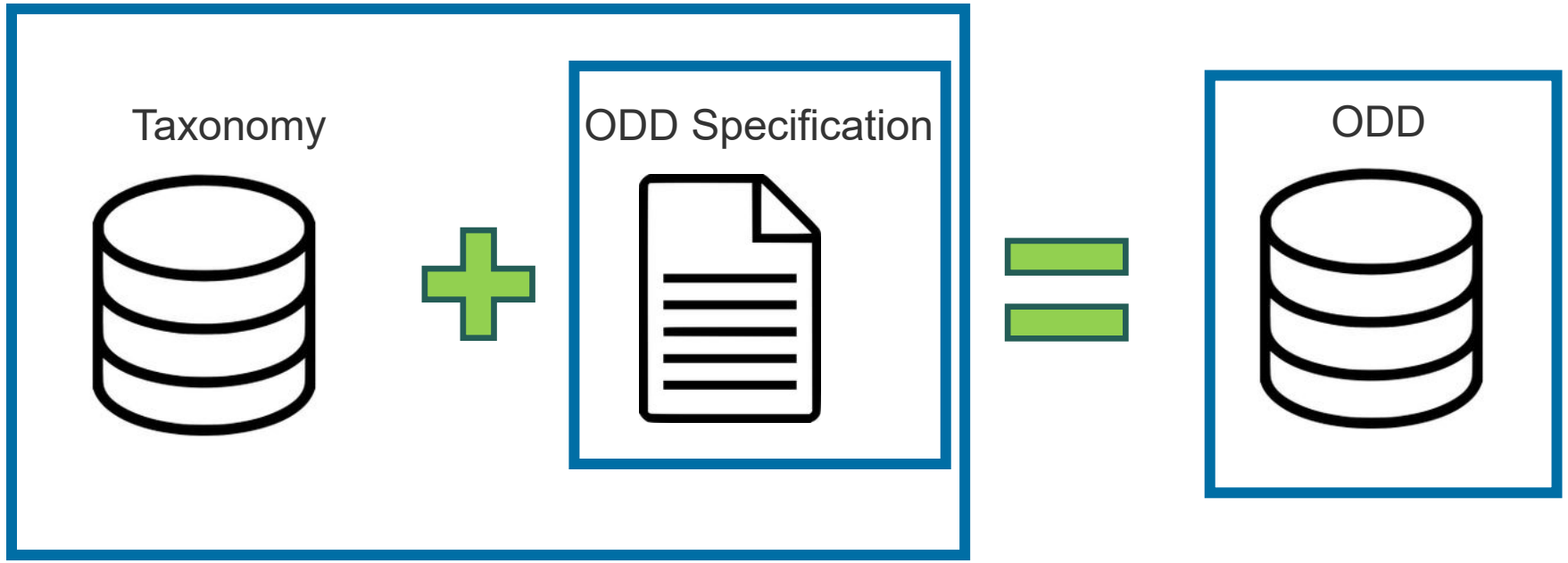
=

ODD

What is OpenODD



How do we exchange ODD specifications? Another way to look at it…



OpenX as a whole...

Name	Planned Version	Domain	Project Type	Status	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
OpenDRIVE	1.7.0;1.8.0	OpenX	Minor	Running	■	■	■	■	■	■	■	■						
OpenODD	1.0.0	OpenX	Major	Running	■	■	■	■	■	■	■	■	■	■	■	■	■	■
OSI	3.6.0;4.0.0	OpenX	Major	Running	■	■	■	■	■	■	■	■	■	■	■	■	■	
OpenSCENARIO	2.0.1;1.3;2.1.0	OpenX	Minor	Enrollments open			■	■	■	■	■	■	■	■	■	■		
Testing Study Group		OpenX		Enrollments open			■	■	■	■	■	■	■					
Study project Off-road Applications of OpenX		OpenX		Planned						■	■	■	■	■	■	■		
OpenLabel FVD		OpenX		Planned									■	■	■	■	■	■
OpenDRIVE + CityGML Concept		OpenX	Concept	Proposal Phase									■	■	■	■	■	■

New releases this year:

- OpenSCENARIO 1.2.0
- OpenSCENARIO 2.0.0
- OSI 3.5.0

Some highlights:

- Pilot activity for harmonization → description of dynamic traffic signals
- Next OSI project kicked off in September
- Application of OpenX for Off-road Workshop in Feb. 2023
- CAV Testing Expert group starting in Jan. 2023

Thank you for your attention!

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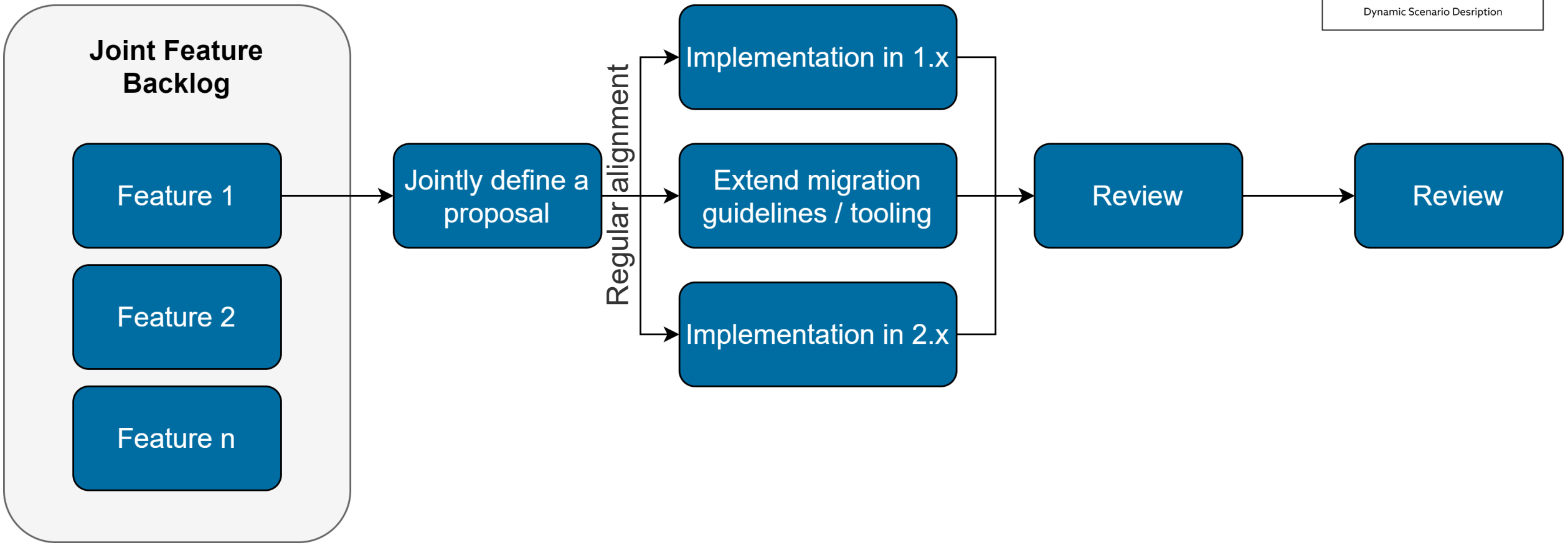
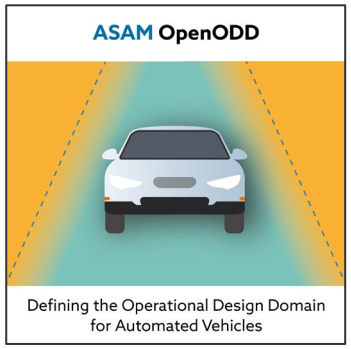
Process guidelines for OSC Feature Development

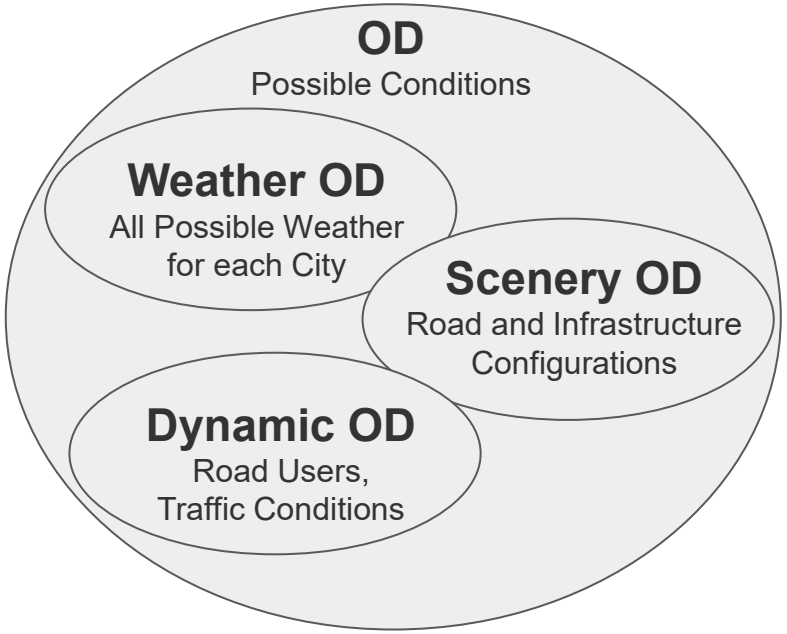


Operational Domain (OD)
What is it?



What circumstances is the ADS expected to experience?

- Weather: Temperature, Rain, Snow, Visibility, etc.
- Scenery: Roads, Intersections, Infrastructure
- Traffic: Vehicles, VRUs, etc
- Which combinations are expected?



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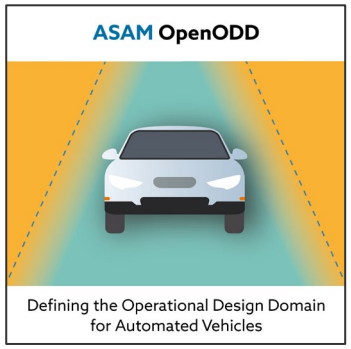
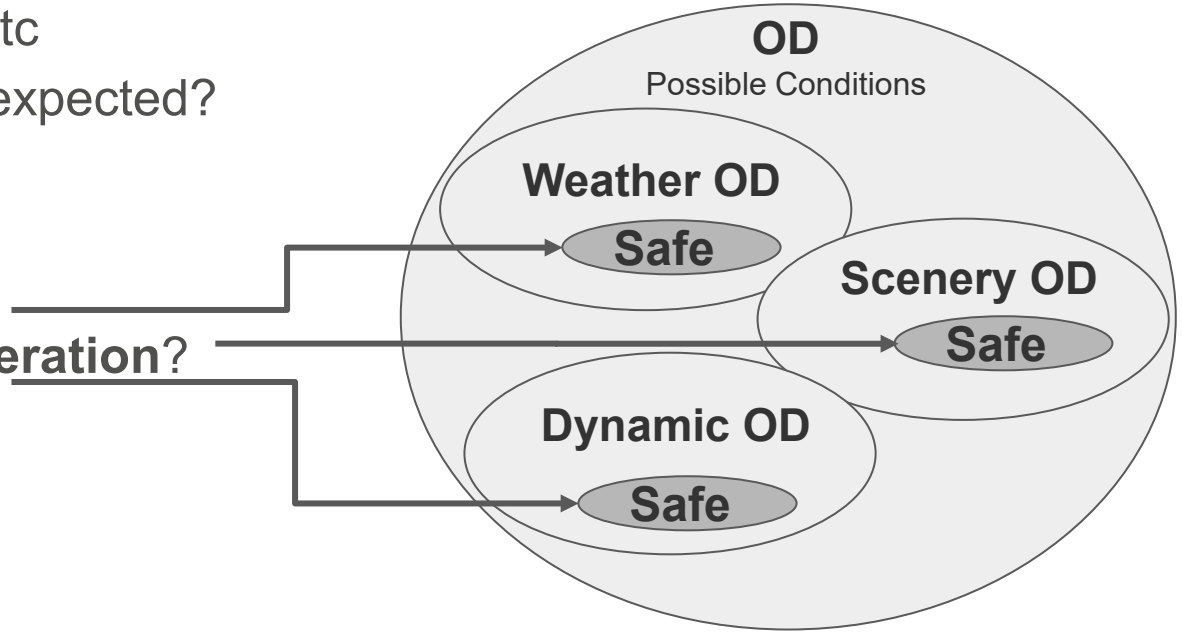


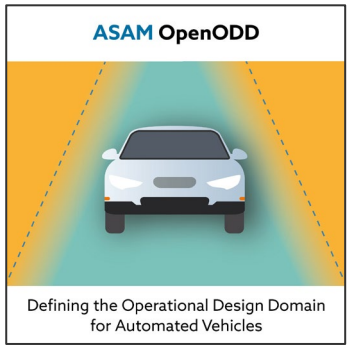
What circumstances is the ADS expected to experience?

- Weather: Temperature, Rain, Snow, Visibility, etc.
- Scenery: Roads, Intersections, Infrastructure
- Traffic: Vehicles, VRUs, etc
- Which combinations are expected?

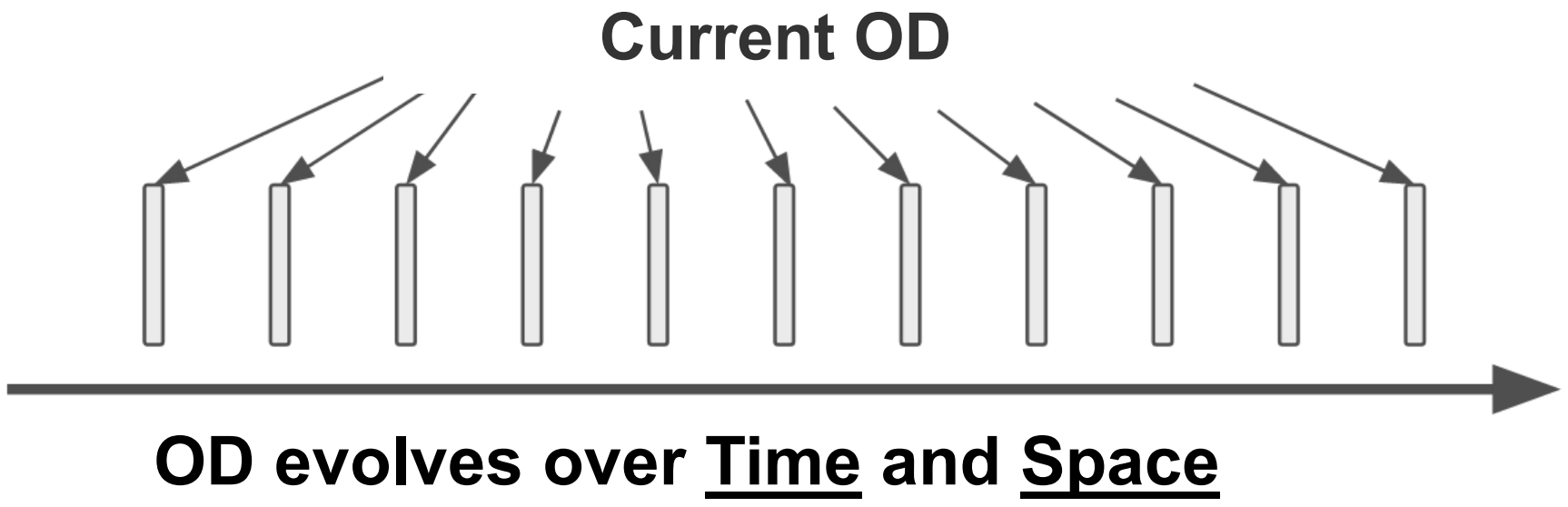
Which subset admits **safe operation**?



Operational Domain (OD) and Current Operational Domain (COD)



The data replay / recorded data approach



$$OD = COD_{t_0} + COD_{t_1} \ldots + COD_{t_n}$$