ASAM OpenX

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8th October 2020
ASAM Technical Seminar

ASAM
Association for Standardization of
Automation and Measuring Systems

The OpenX portfolio so far…

OpenSCENARIO
- Dynamic scene description

OpenDRIVE
- Static road network

OpenCRG
- Detailed Road surface description

Open Simulation Interface
- Interface for environmental perception of AD functions

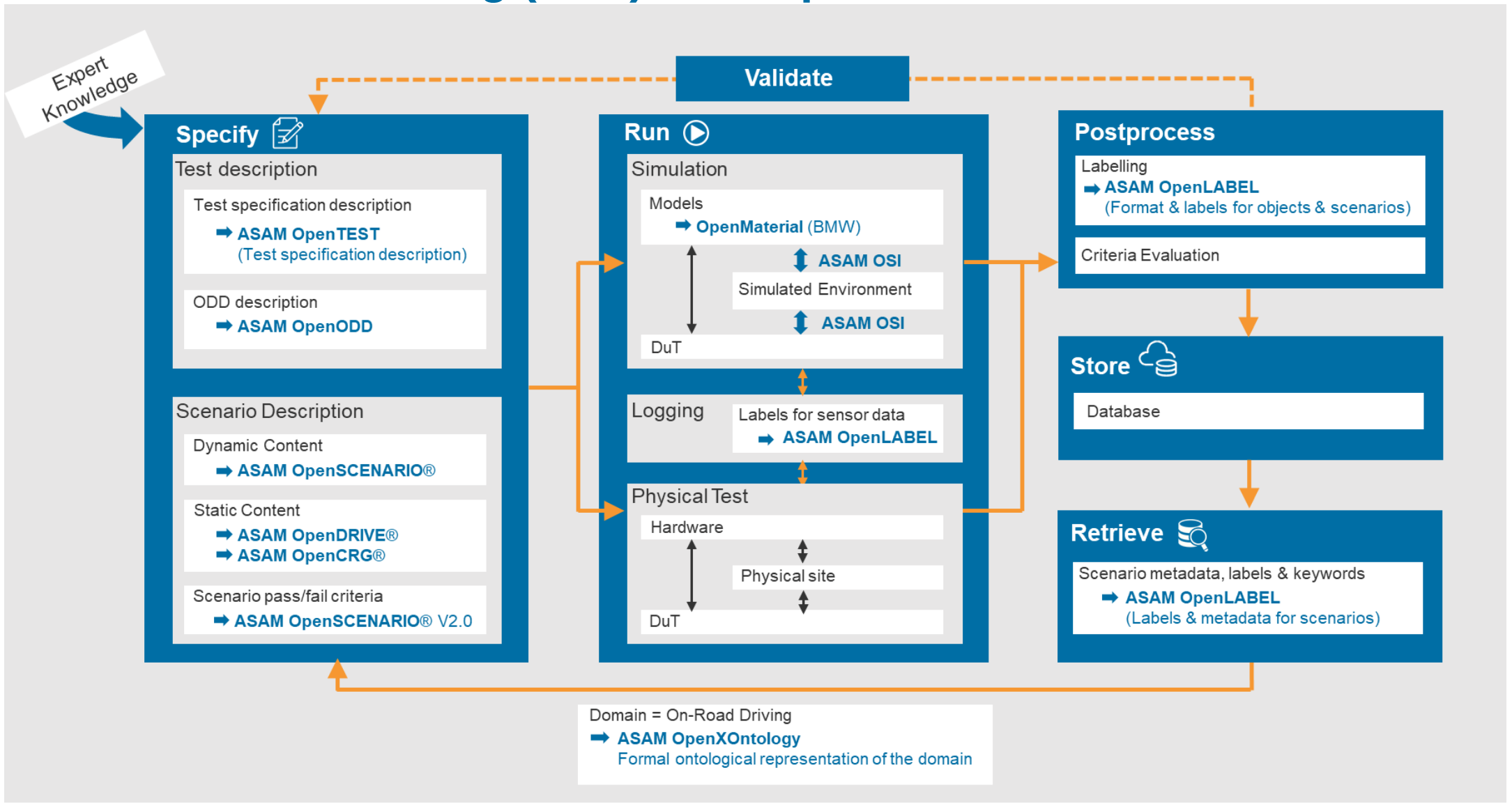
OpenLABEL
- Labels and labelling format for objects & scenarios

OpenODD
- ODD definition format

OpenXOntology
- Extendable domain ontology for on road driving

[OpenTest]
- TBD…

Scenario-Based Testing (SBT) with OpenX



Latest project developments...

1. OpenDRIVE
2. OpenCRG
3. OpenSCENARIO 1.x
4. OpenSCENARIO 2.0
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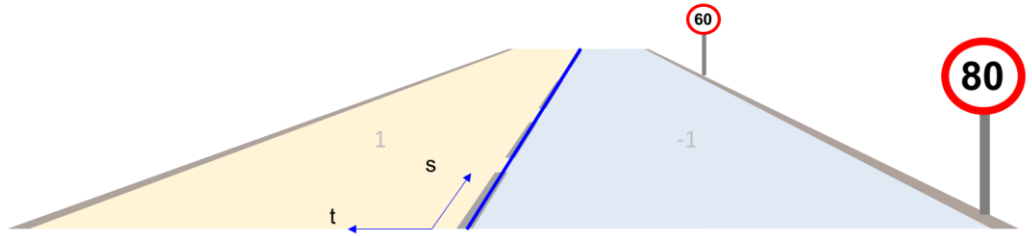
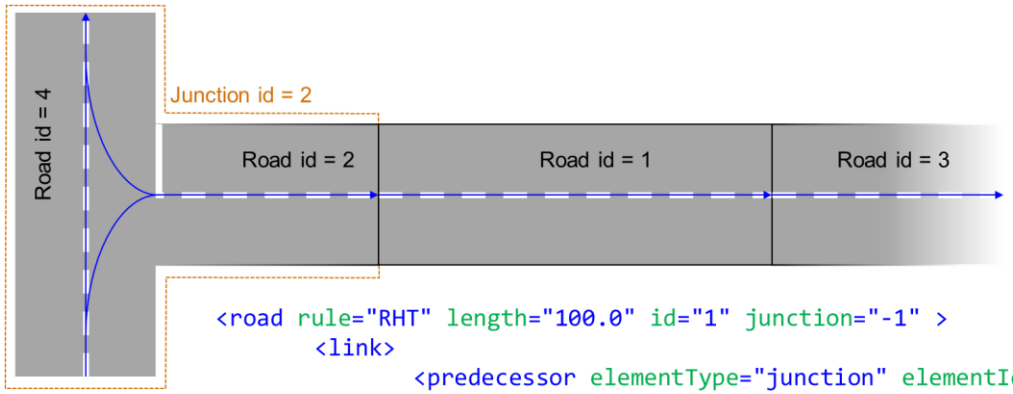
9. OpenTest…

ASAM OpenDRIVE

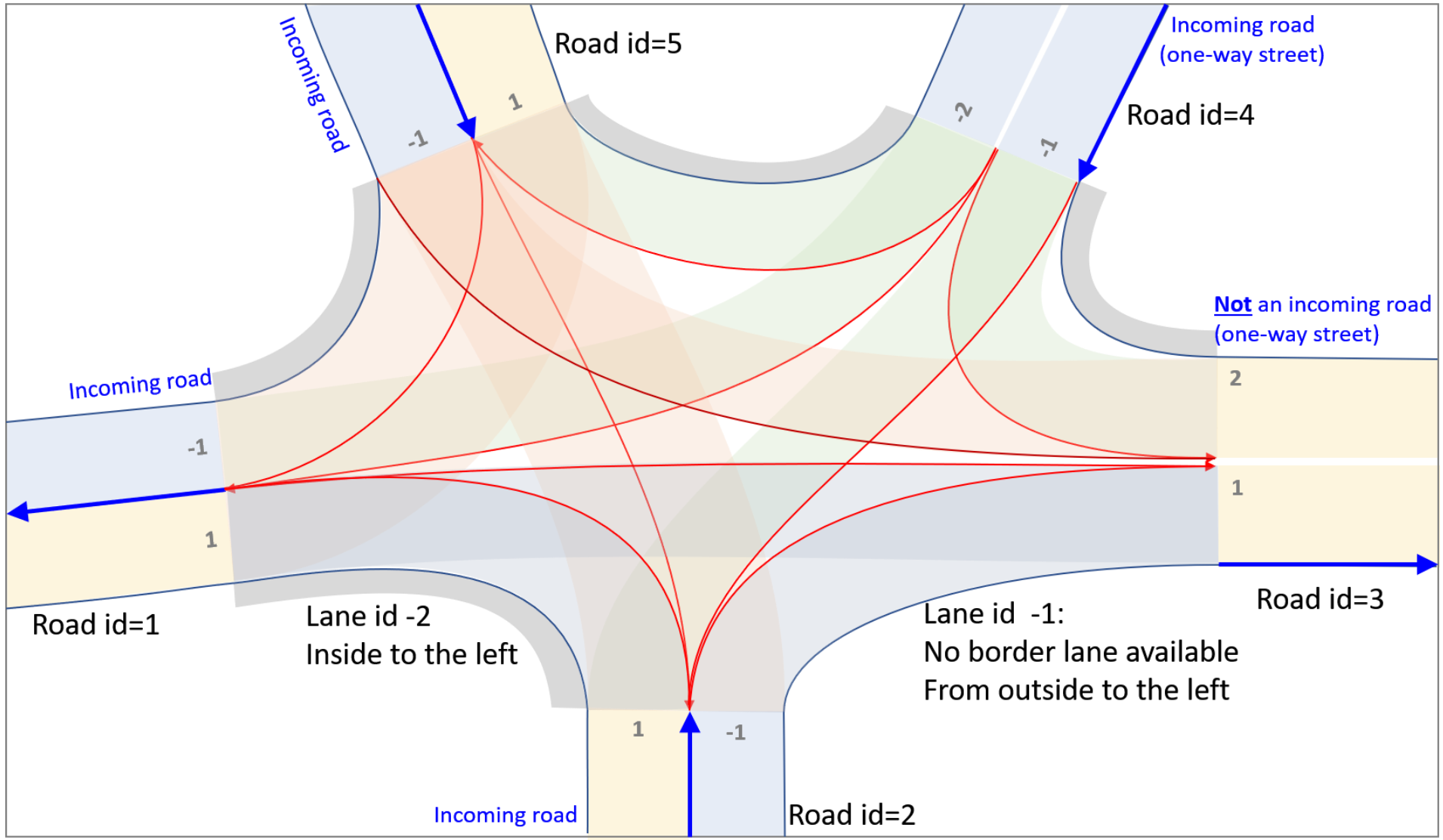
- OpenDRIVE: Open Dynamic Road Information for Vehicle Environment
- File format for the **description of road networks**.
- Used for simulators in the area of
  - Drive simulation
  - Traffic simulation
  - Sensor simulation
- Based upon XML and a hierarchical data model.
- Basic elements:
  - Roads
  - Junctions
  - Controller
- Not covered: entities acting on or interacting with the road network.



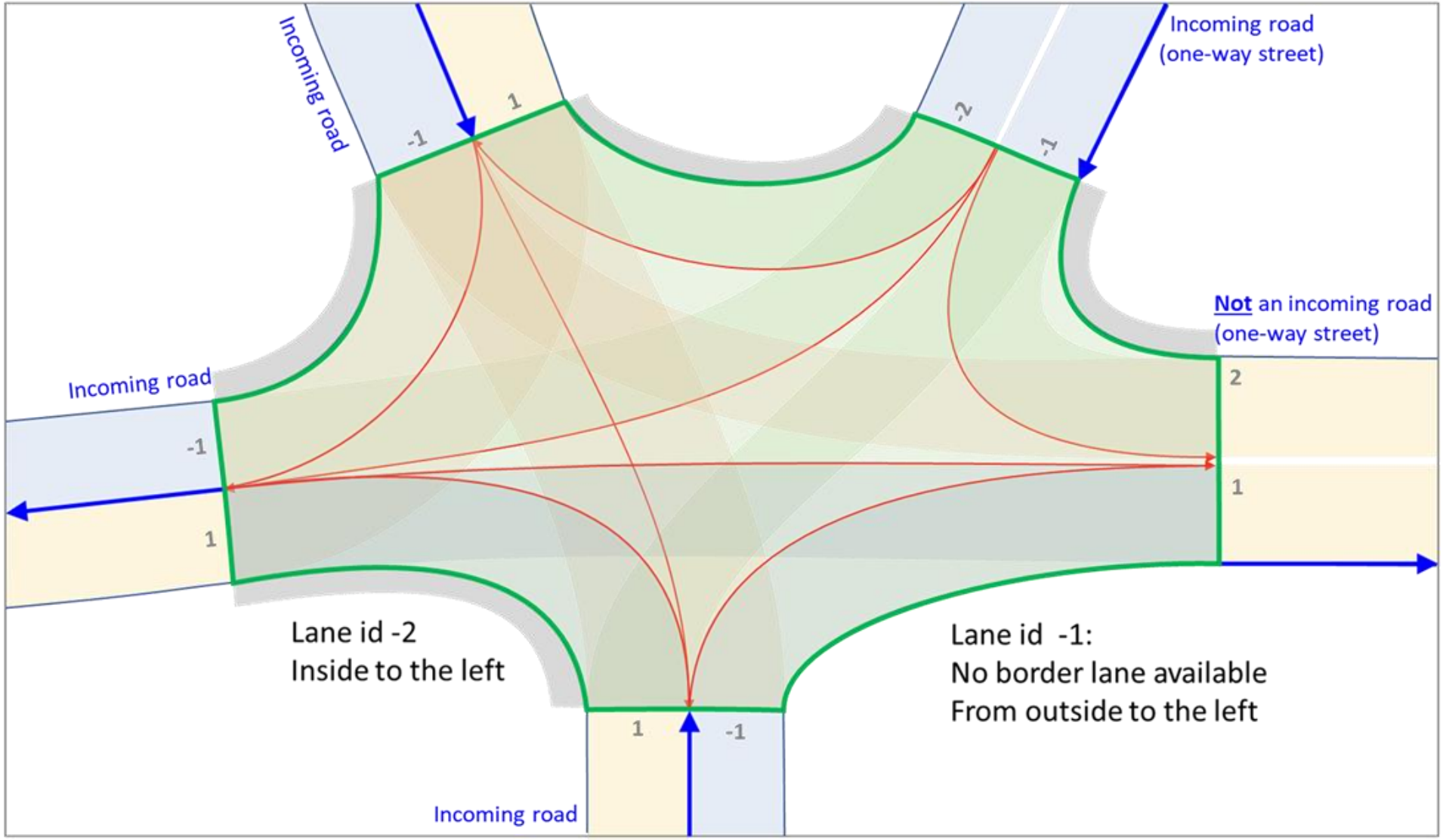



```
<road rule="RHT" length="100.0" id="1" junction="-1" >
        <link>
                <predecessor elementType="junction" elementId="2" />
                <successor elementType="road" elementId="3" />
         </link>
```

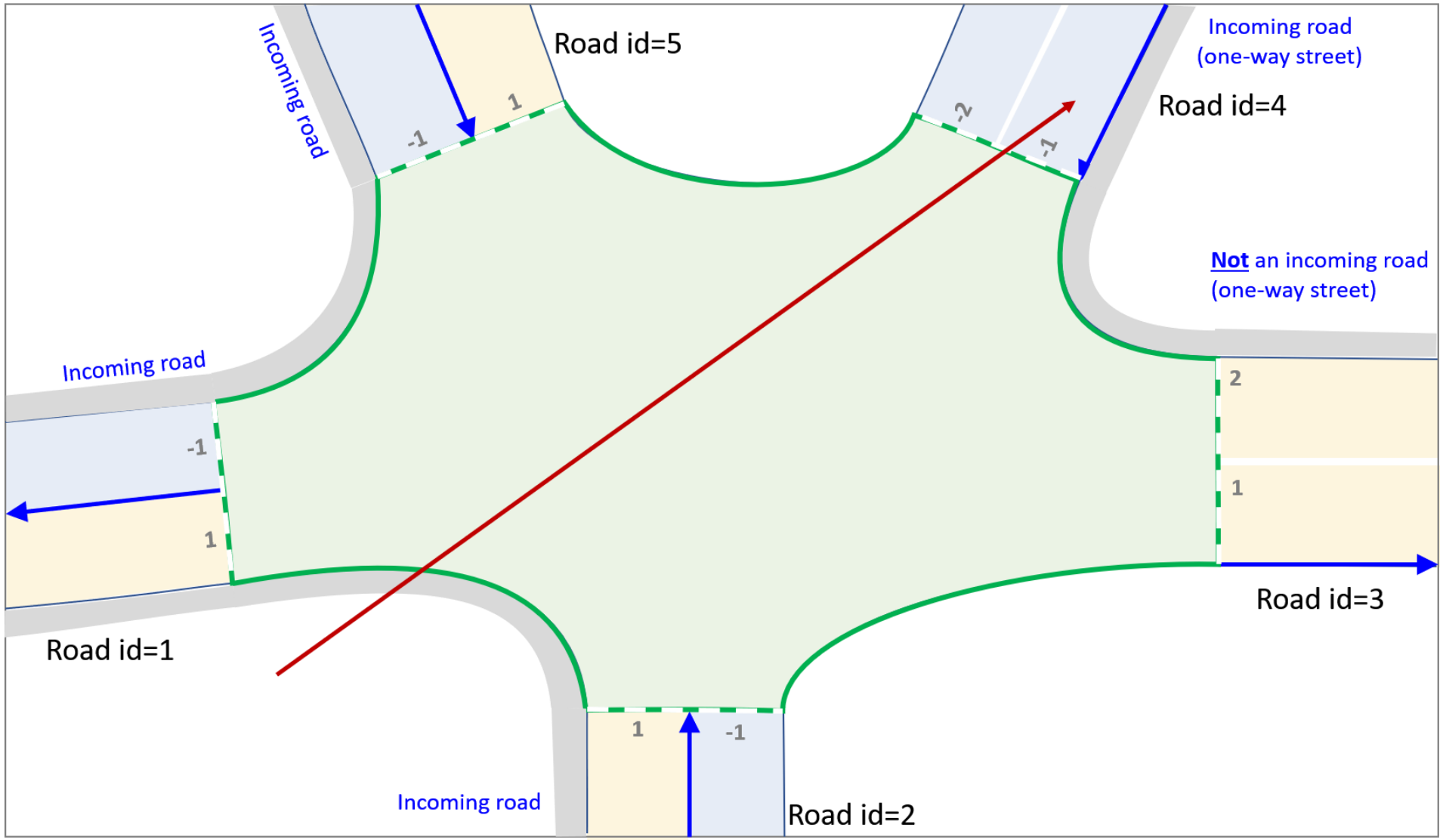
OpenDRIVE: Junction Modeling



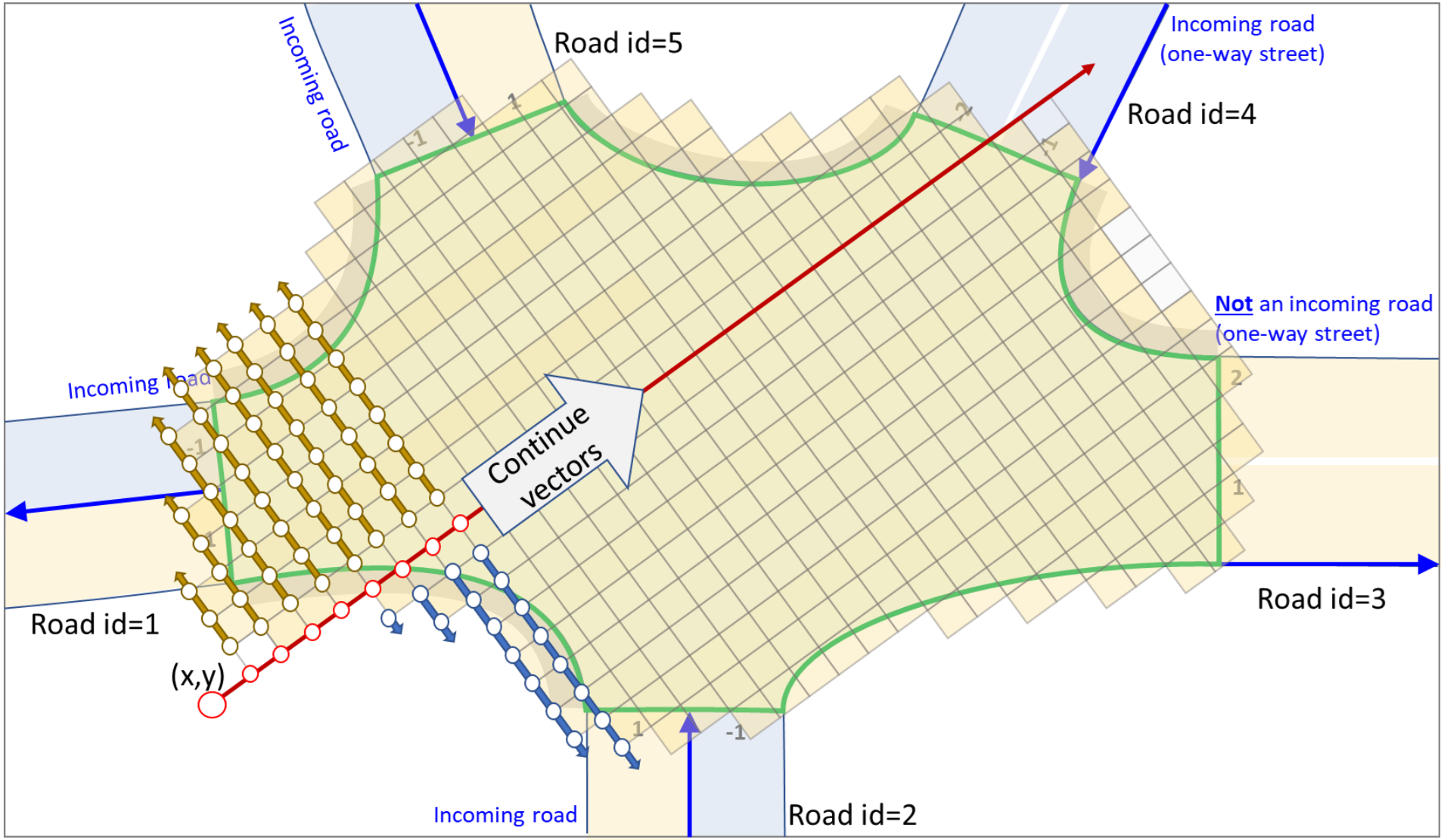
OpenDRIVE Concept: Junction Border



OpenDRIVE Concept: Junction Road



OpenDRIVE Concept: Junction Grid



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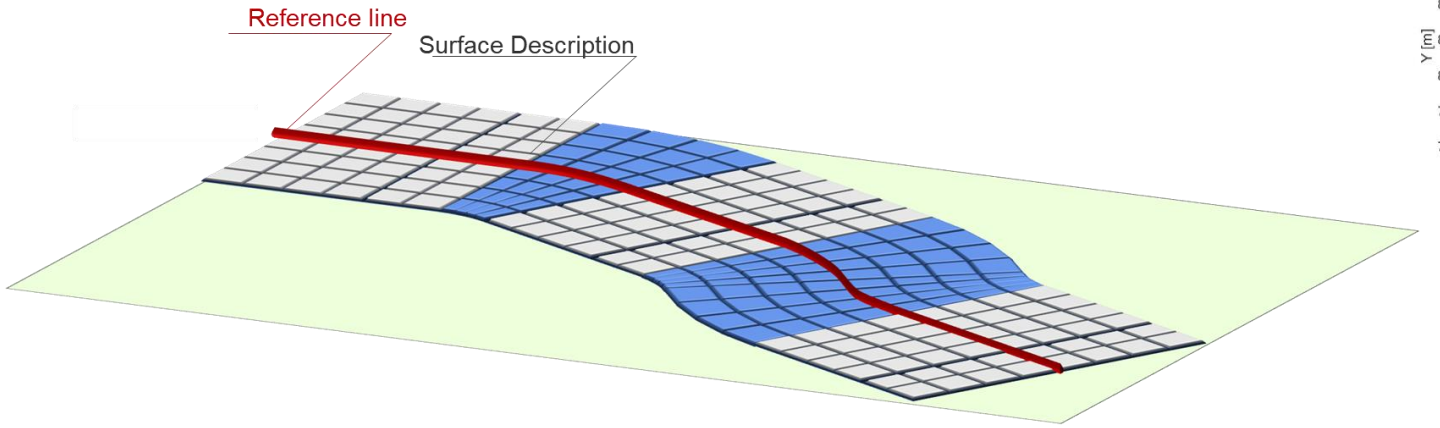
Introduction to OpenCRG

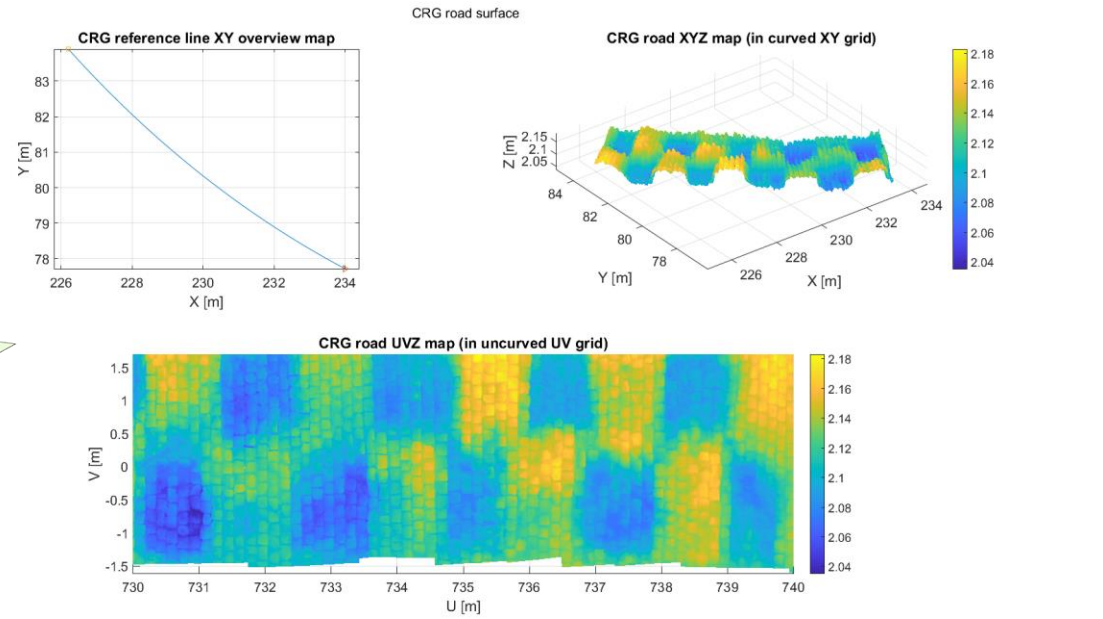
OpenCRG

- CRG = "Curved Regular Grid„
  - Developed by Daimler AG
  - open source C-API for data handling and evaluation
  - open source MATLAB® API for data manipulation and generation

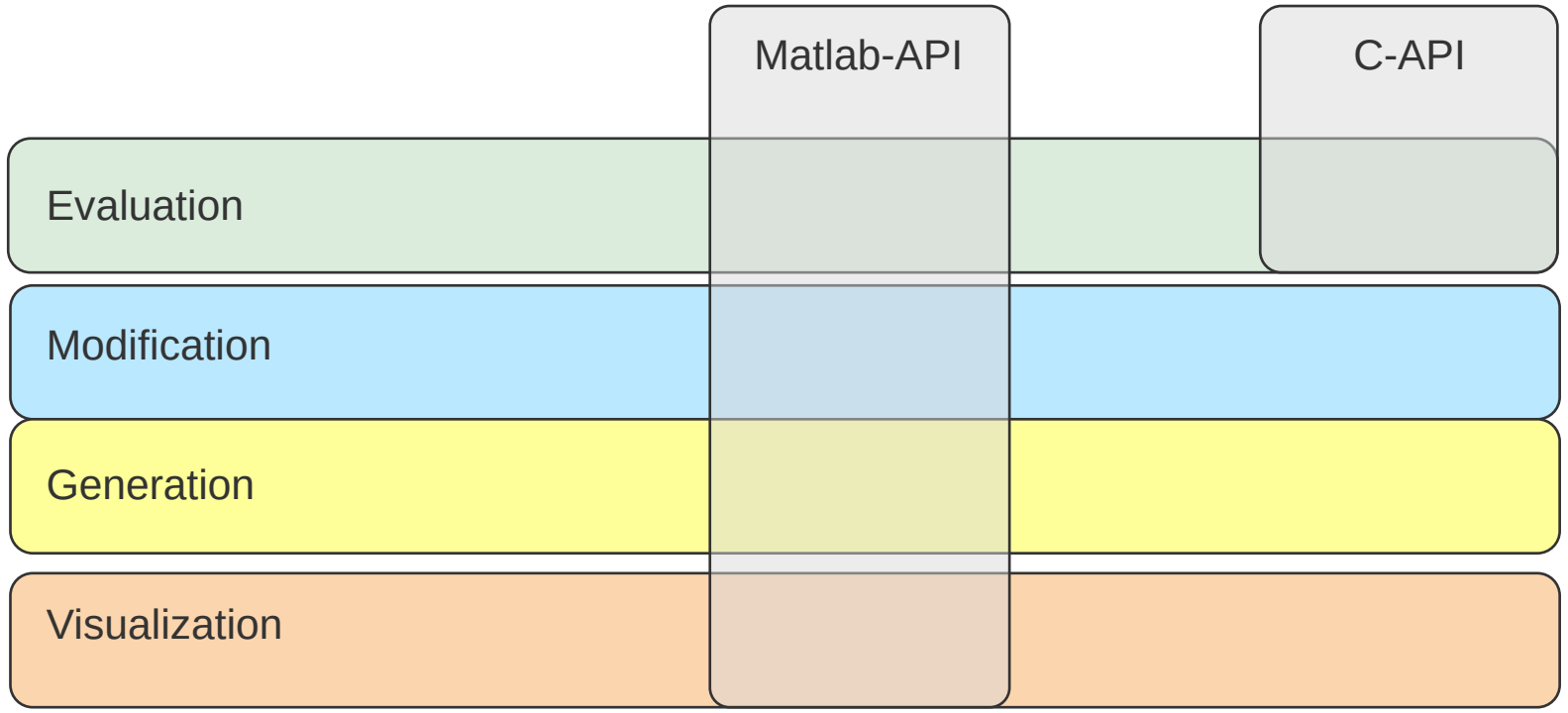
Usage

- Vehicle dynamics
- Tire simulation
- Driving simulation (Combination with OpenDRIVE !)
- Vibration simulation





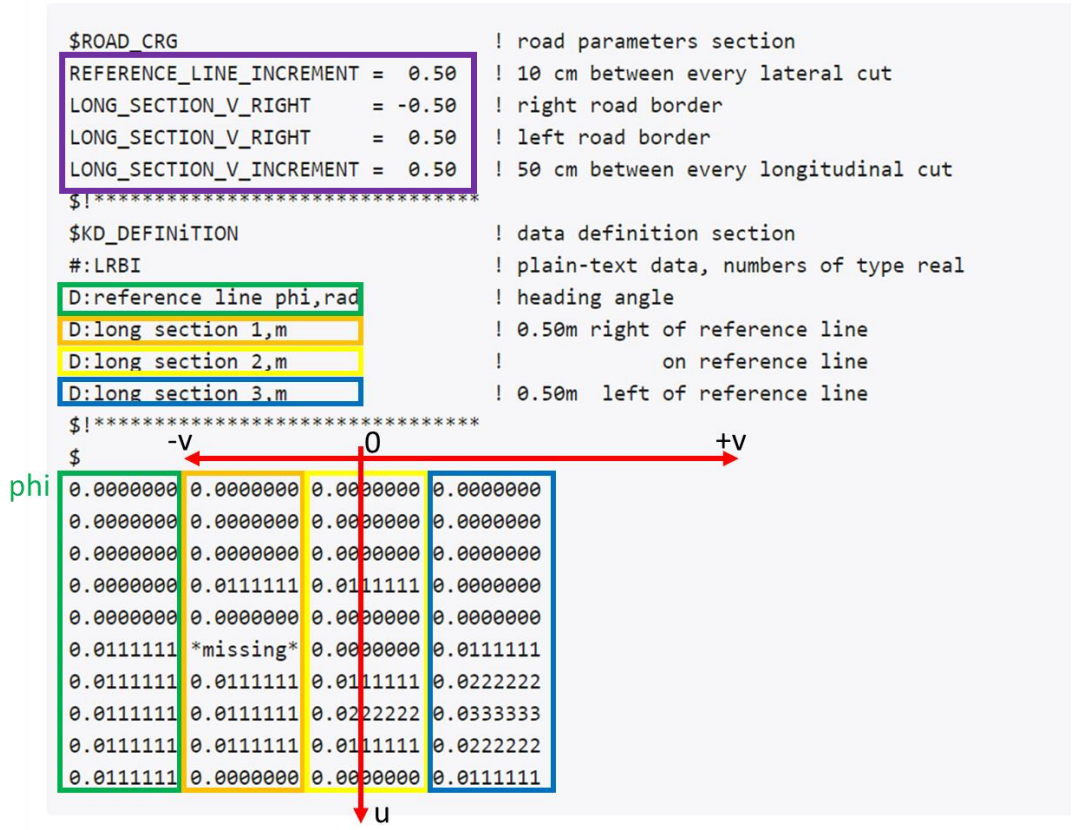
ASAM OpenCRG: Matlab API, C-API



File Format OpenCRG

- The OpenCRG File Format looks like the following:

- The dimensons of the sections is defined on the top
- Options for the road sections are defind in the green box
  - heading
  - Banking
- Each long section has an individual column



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OpenSCENARIO V1.x

- V1.1 Releasing in March 2021
- Significant extensions and clarifications in user guide based on feedback
- Very active discussion and collaboration on issues
- > 100 issues under active discussion!
- Some highlights:
  - Runtime clarifications
    - Interactions between an Action, an Entity and a Controller.
  - Parameters, distributions & expressions
    - Deterministic & statistical distributions (e.g. normal, poisson, uniform, lists, etc.)

```
<parameter name="$x0" unit="m" type="continuous">
  <distribution>
    <uniformDistribution lowerLimit="-2" upperLimit="2"/>
  </distribution>
</parameter>
```

Early concept of parameters in OSC 1.1

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OpenSCENARIO 2.0

- V2.0 Releasing Summer 2021
- DSL for scenario descriptions (concrete <-> abstract)
- Domain Model for the domain addressed by the DSL → closed-loop system testing for automotive functions
- Guidelines on using OpenSCENARIO 2.0 in different scenario-driven workflows
- Fully compatible with V1.x versions
  → “The runtime behavior of scenarios converted from 1.x to 2.0 will be the same”

OpenSCENARIO 2.0 – Feature Subsets

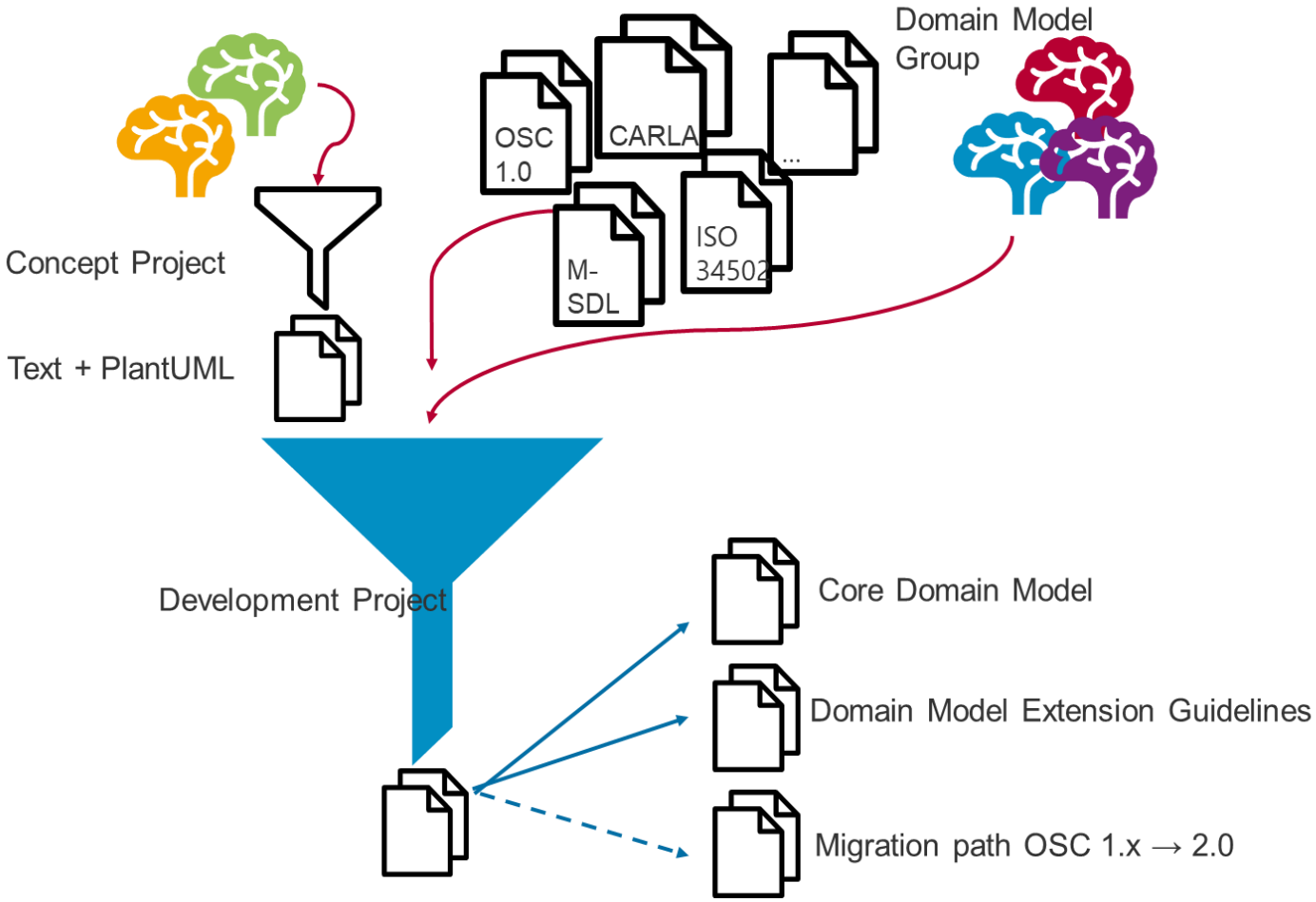
- Modular language support through feature subsets

Feature subsets in OSC 2.0

Source: OSC 2.0 Project meeting (Michael Kluge)

OpenSCENARIO 2.0 – Domain Model

- OpenSCENARIO targets the **domain of closed-loop system testing for automotive functions**.
- A domain model provides the semantics for the **terms that are used in the Language component** of OSC 2.0”
- Entities are “actual things in the domain. These can be activities, events, conditions and information, as well as physical objects”
- Goal: clear and unambiguous definitions of all key entities,



A unifiying approach to defining a domain model for OSC 2.0

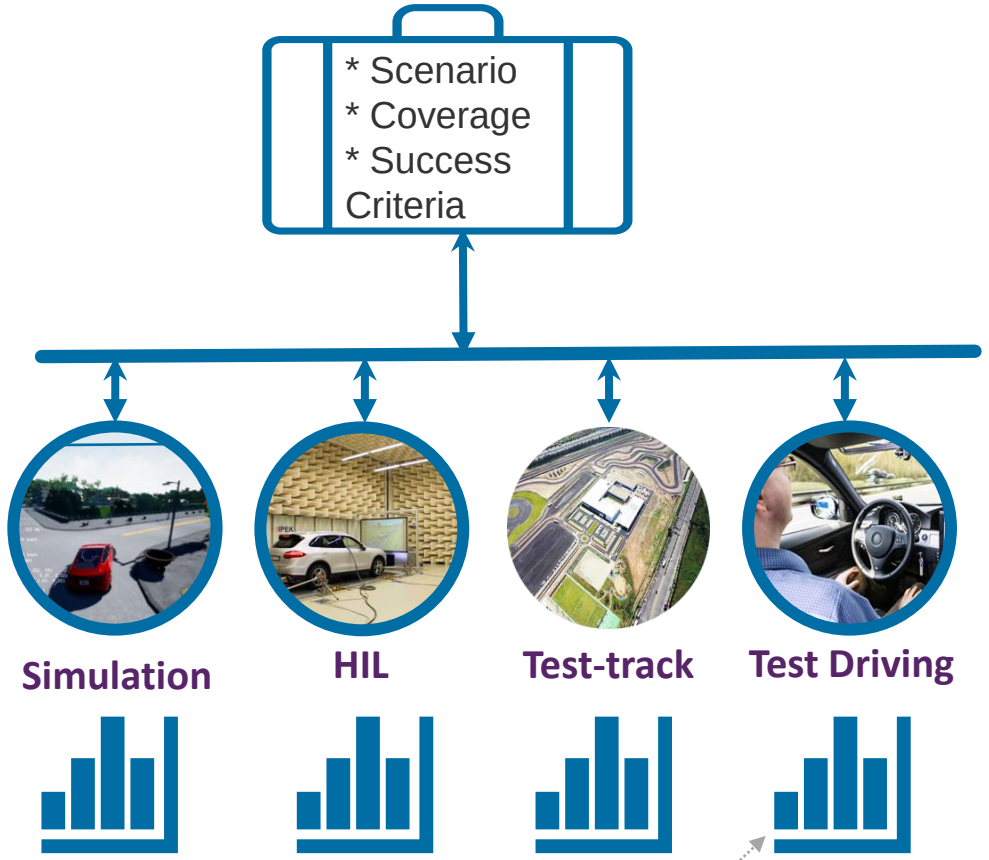
Source: OSC 2.0 Project meeting (Jakob Kaths, Nicolas Ochoa)

OpenSCENARIO 2.0

Coverage & Success Criteria

- Coverage and reporting
  - Coverage
    - Provides a data-driven measurable process of setting development and validation goals and working to achieve them
    - Be able to measure which scenarios are exercised and how
    - Formal definition that is both human and machine readable
  - Reporting
    - Collect data for review, statistical analysis, distribution, checking and more
- Valid for all execution platforms (physical testing, HIL, simulation etc.)
  - Can set goals for each platform and can observe the complete picture involving different platforms
- Portability and reuse are key
  - The same definitions are valid and portable across platforms
  - Can extend and tune for specific platform or ODD needs

"Every OSC container (struct, actor, scenario, test) should be able to contain coverage definitions"

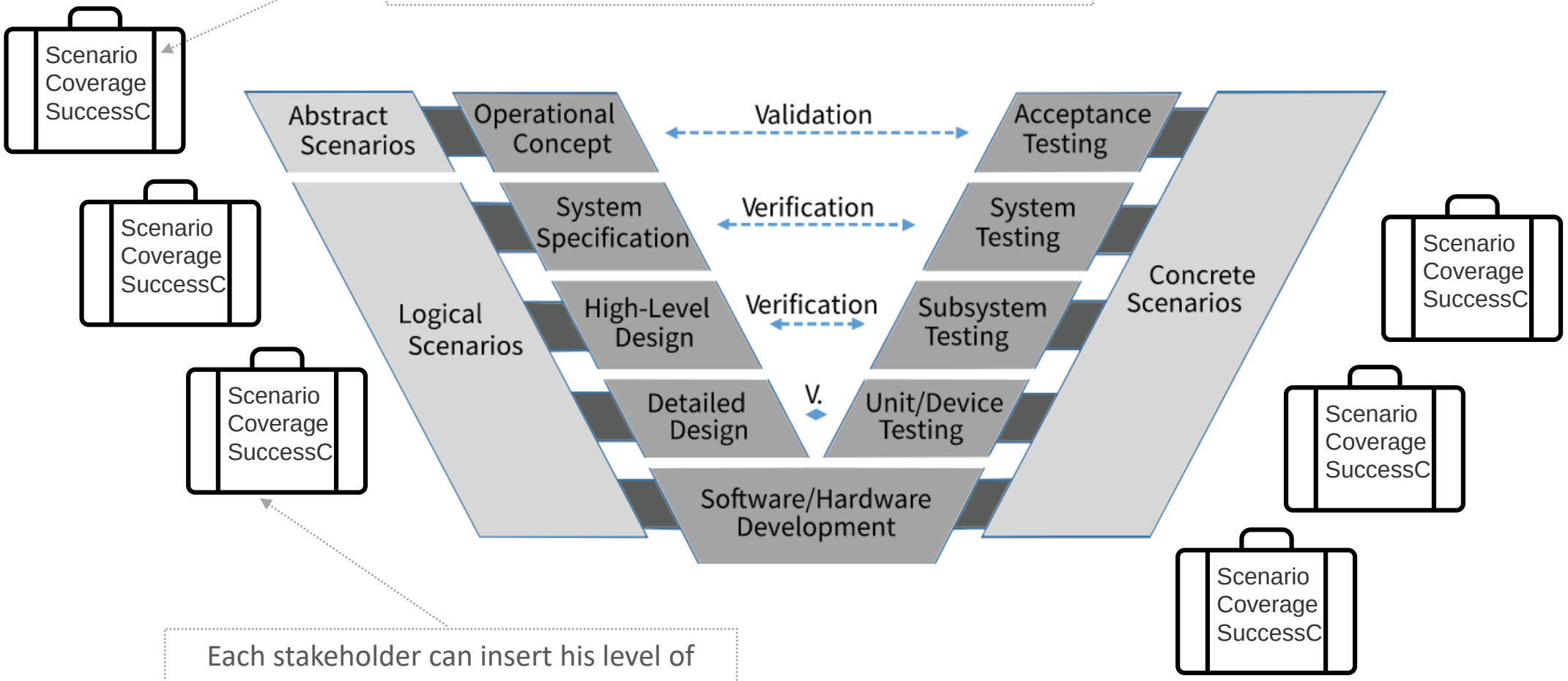


Platforms can leverage the common scenarios and tune them to their needs

Source: OSC 2.0 Project meeting (Sharon Rosenberg)

Ideal Development Flow for Coverage and Success Criteria

Each stakeholder delivers with the scenario the functionality expected behavior and the functionality that needs to be demonstrated in executable format



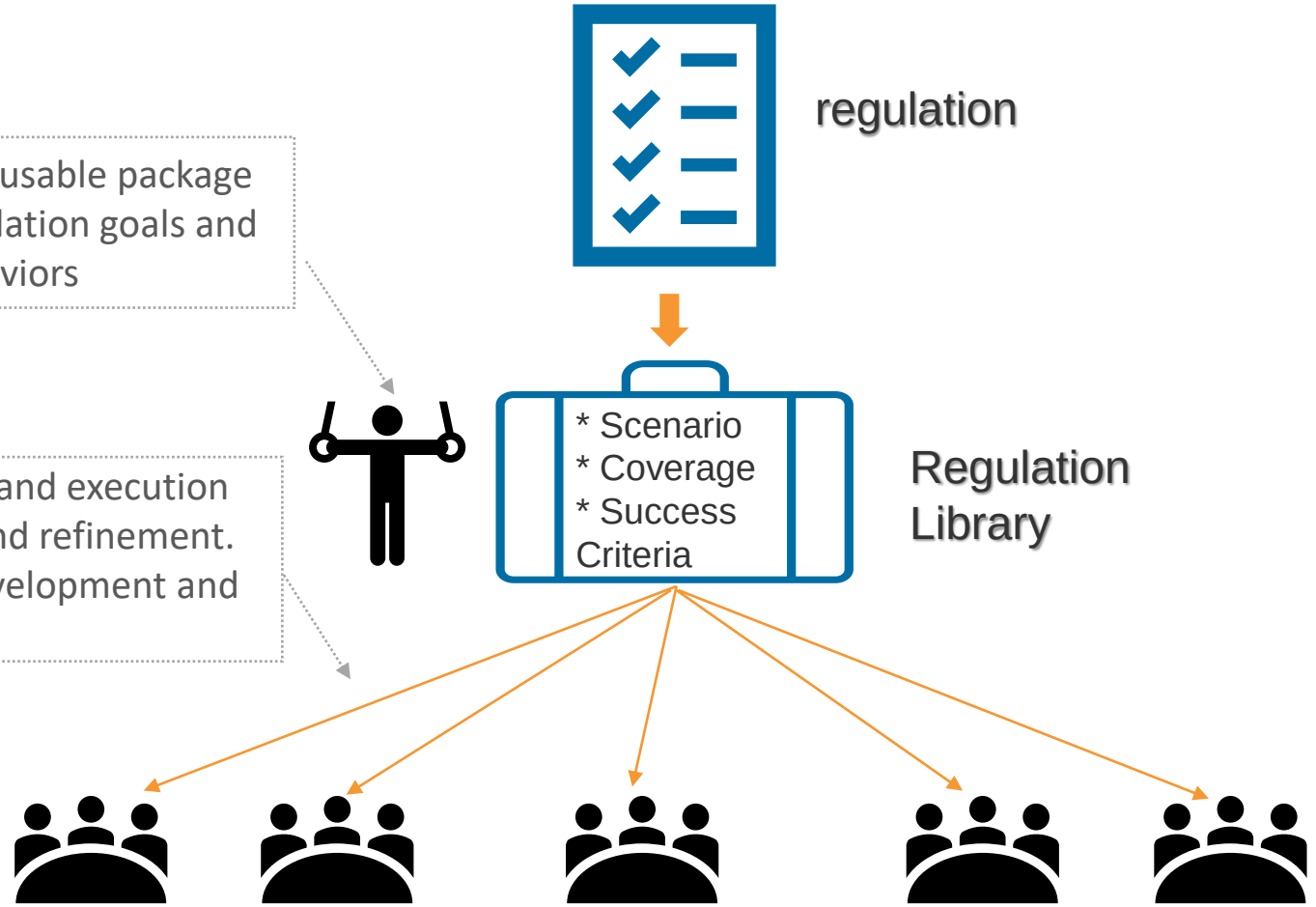
Each stakeholder can insert his level of expected behavior or considerations

Source: OSC 2.0 Project meeting (Sharon Rosenberg)

Regulation Use-Model

One body can create a reusable package capturing scenarios, regulation goals and expected behaviors

Use by multiple projects and execution platforms with running and refinement. For both architecture, development and testing



Source: OSC 2.0 Project meeting (Sharon Rosenberg)

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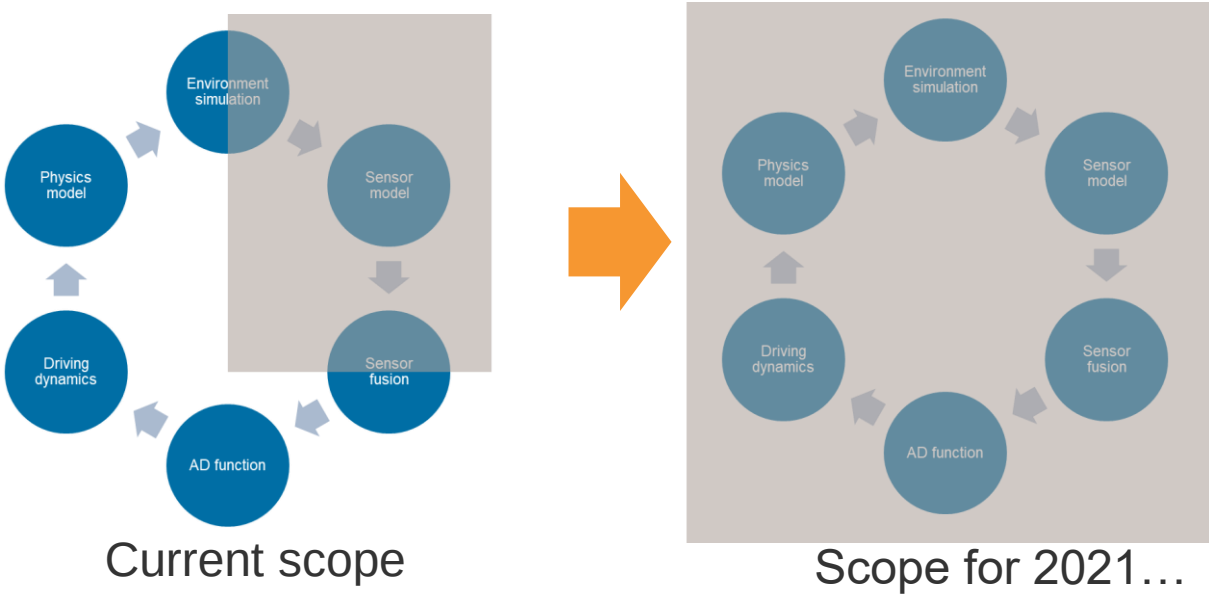
OSI

- Support for more detailed sensor models → Stochastic & physics based sensor models
- More interfaces, e.g. for:
  - Individual traffic participants
  - Driving simulator frameworks
  - Agent models (e.g. driver model)
- V2X communication
- Increased performance for real time simulation – Google Flatbuffer, data traffic reduction, delta encoding
- OpenX ID management - uniform and unique ID management for all OpenX standards



Current scope

Scope for 2021…

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OpenXOntology

- First version will cover domain addressed by OpenX standards

- Minimal working example of ontology to be released for public review by Q1 2021

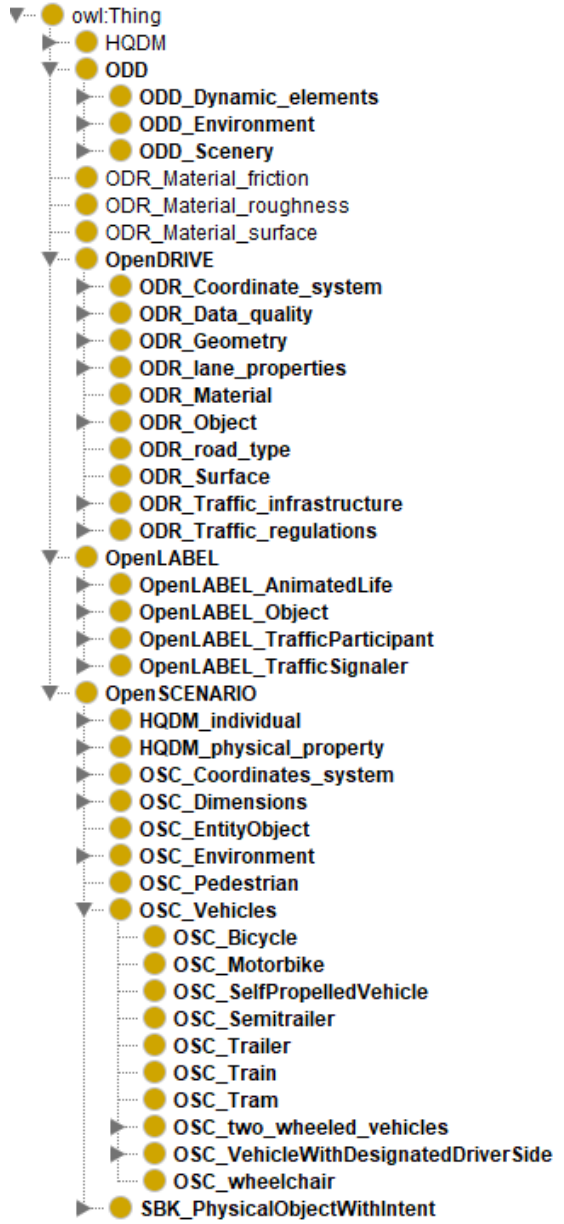
- Includes:
  - Guidelines on usage with other OpenX standards, e.g.:
    - Using the ontology to check OpenSCENARIO scenario descriptions
    - Using the ontology for object labels in OpenLabel
  - Extension guidelines – how to extend the ontology

Current status:

- Transferring domain content from OSC, OpenLabel, OpenDRIVE & OSI

- HQDM standard likely to become foundation for ontology structure

- Collaboration with OSC 2 Ontology WG – Identifying use cases for an ontology in OSC 2.0
  → Checking scenario descriptions



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ASAM OpenLABEL

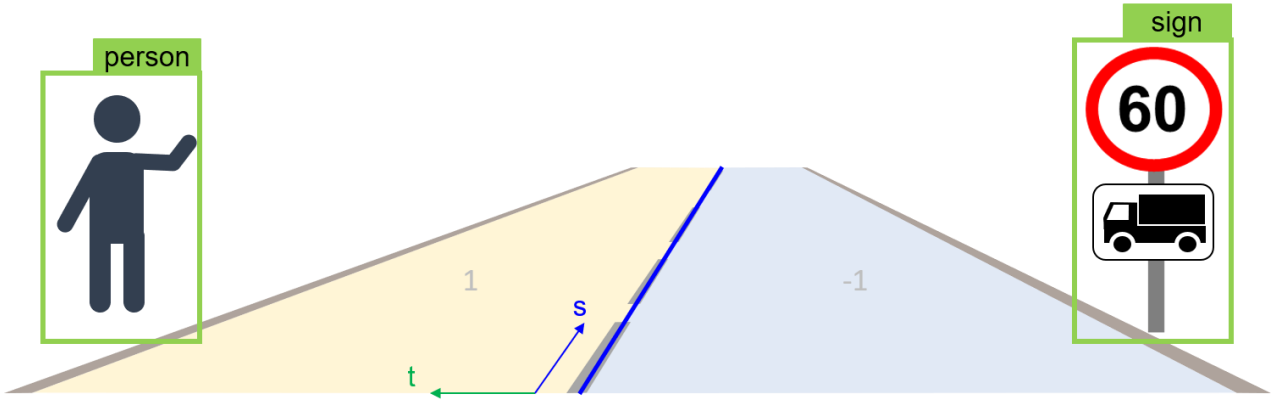
new Standard initiative

The ASAM OpenLABEL Concept Project will provide the basis for the Standard development of OpenLABEL 1.0.

Focus on the HOW to label → Labeling formats for objects of interest and scenario data

The project is divided into 4 work packages:

1. Annotation Format
2. Labeling Methods
3. Taxonomy -> linked to OpenXOntology
4. Scenario Labels



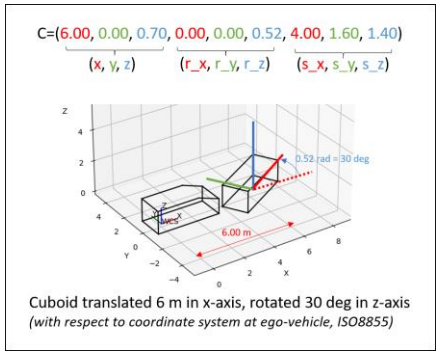
Concept paper releasing November 2020
Standard development project starting Dec. 2020

ASAM OpenLabel

WP1: Annotation Format

```
{
    "openlabel": {
        "metadata": {
            "annotator": "John Smith",
            "file_version": "0.1.0",
            "schema_version": "1.0.0",
            "comment": "Annotation file produced manually",
        }
    }
}
```

WP2: Labeling Methods

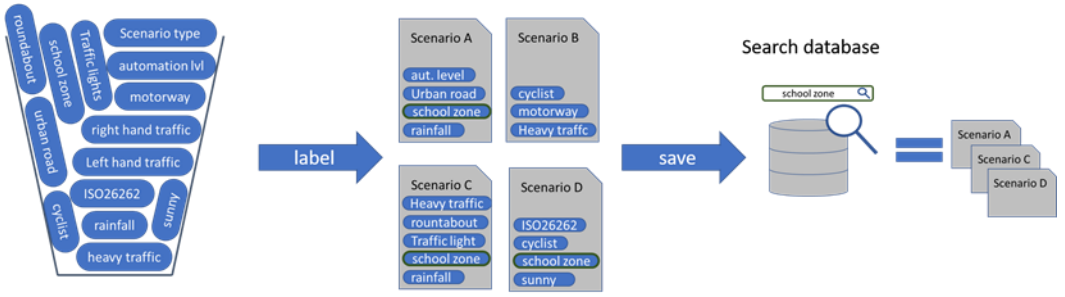


Cuboid translated 6 m in x-axis, rotated 30 deg in z-axis
(with respect to coordinate system at ego-vehicle, ISO8855)

WP3: Taxonomy

The elements of the taxonomy shall be used as labels within OpenLABEL. The Taxonomy can be found within the OpenXOntology

WP4: Scenario Labeling



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OpenODD

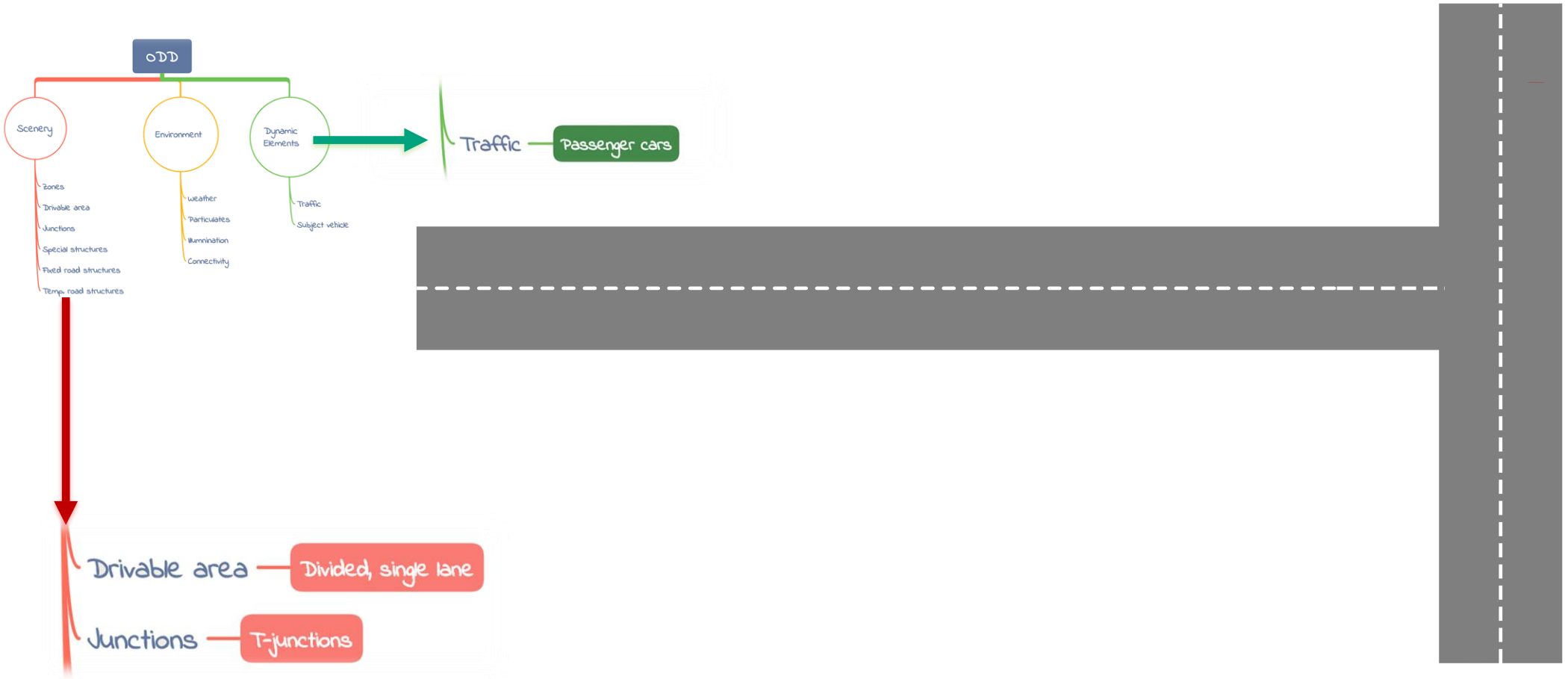
- Concept Project started on 9th September 2020
- Runs until August 2021
- Standardized format for definition of Operational Design Domains (ODDs)
- Proposal link
- Deliverables include:
  - Attributes for ODD definition
  - KPIs for determining whether a scenario, actor or action is within a given ODD
  - Investigation into using ODDs for safety analysis (uncertainty, rare risks, etc.)
  - Usage guide

Operational Design Domain

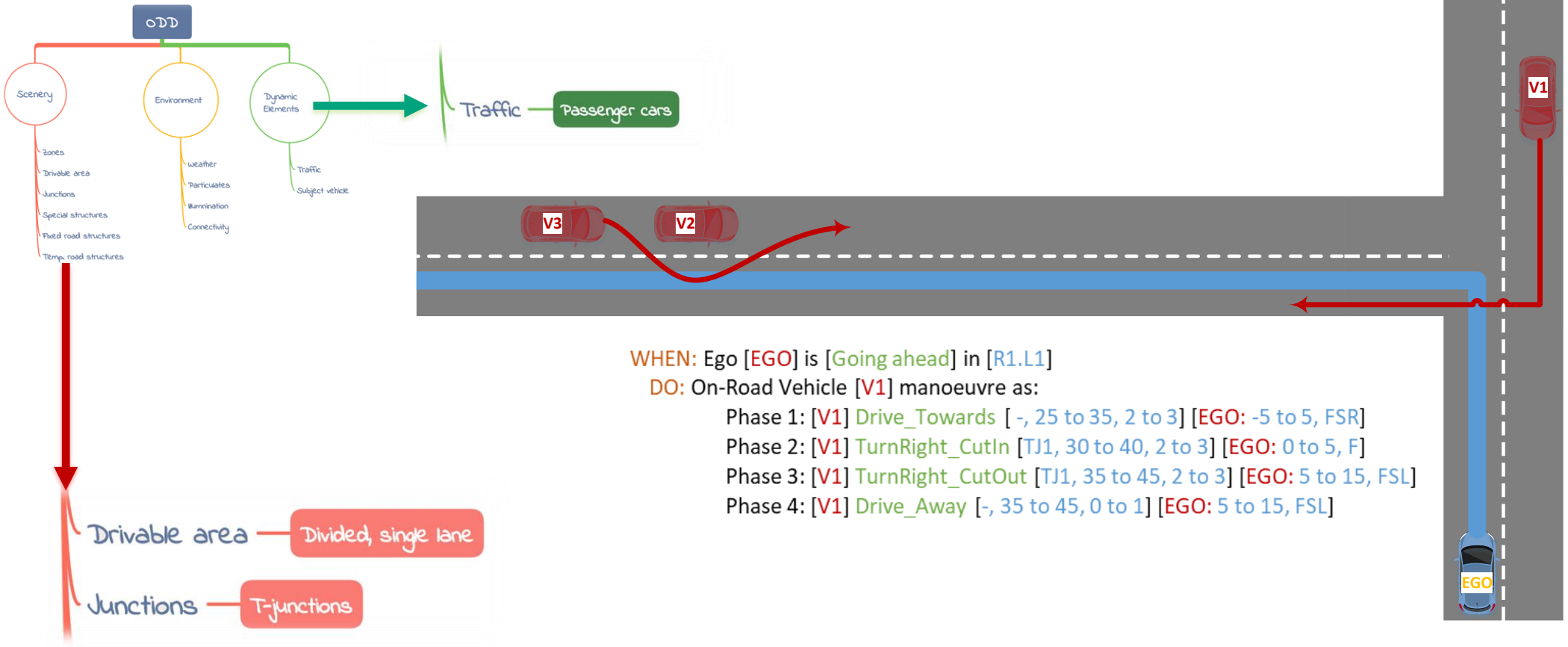
"Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics."

- SAE J3016 (2018)

Scenario mapping to ODD



Scenario mapping to ODD



Other standardisation activities

- Need for common understanding
- Need for collaboration
- Crowded landscape

Major activities

- BSI (UK): PAS 1883: ODD Taxonomy
- SAE: ORAD, AVSC: ODD Lexicon
- ISO: ISO 34503: ODD Taxonomy and definition format
- ASAM: OPENODD: simulation level ODD definition

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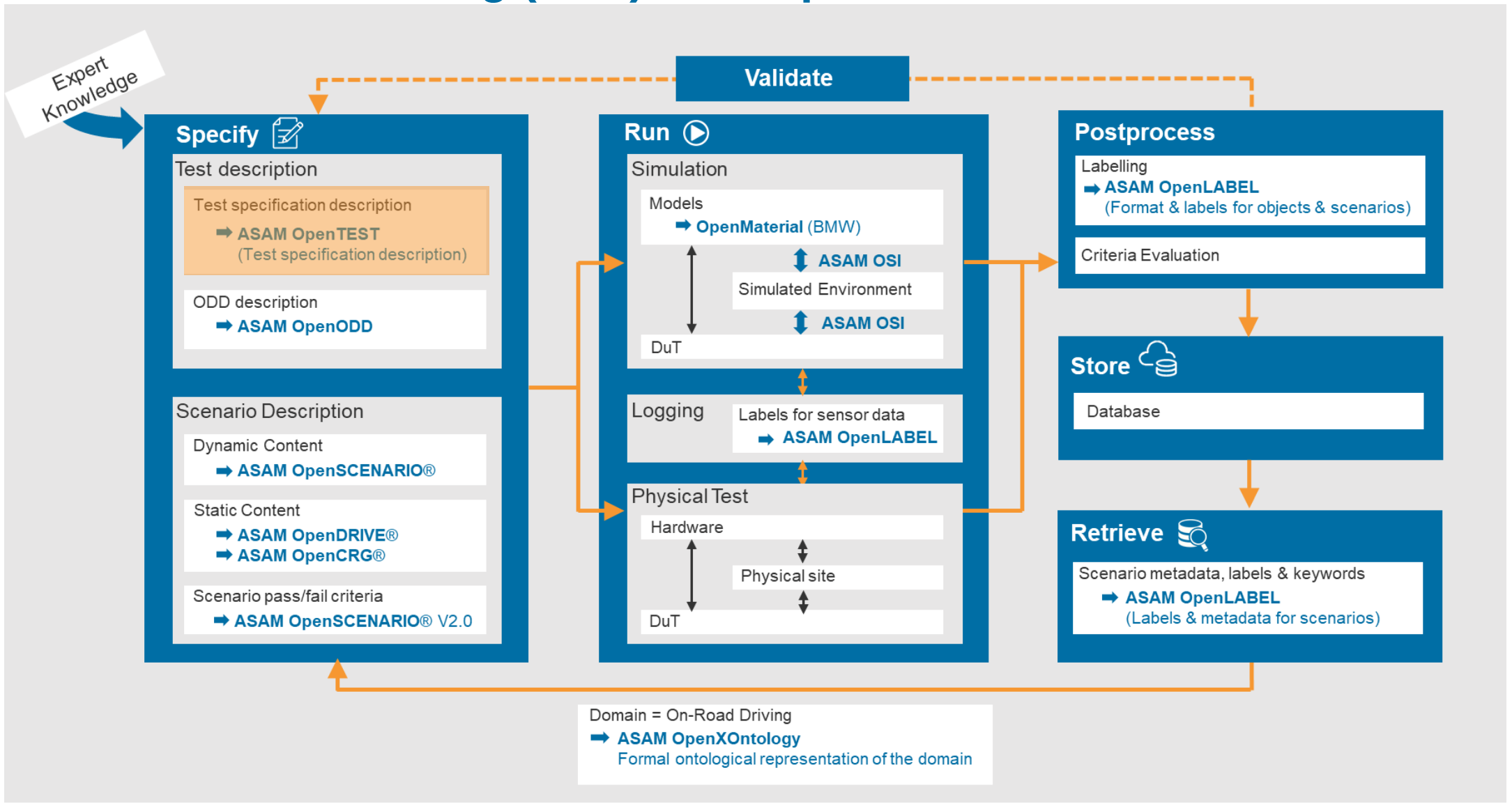
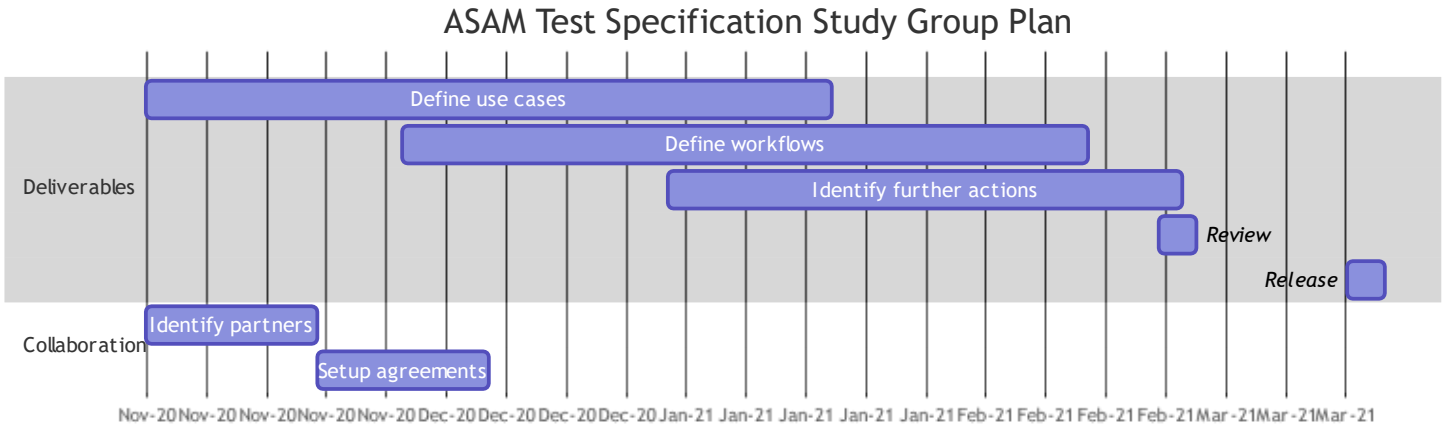


ASAM OpenTest Specification…



- Study group to analyse the scenario-based testing workflow
  - What is scenario-based testing?
  - Gain a better understanding of the borders between scenario & test
  - Analyse potential alignment with “classical” testing methodologies & standards

- First draft of proposal available (repository/download)
  → Feedback and input welcome!

- Planned deliverables:
  1. Refined Set of Use Cases for Scenario-based Testing
  2. Set of Reference Workflows for Scenario-based Testing
  3. Gap Analysis and Recommendations on Further Actions

Other Developments in OpenX…

Harmonisation across OpenX

- Increasing need for harmonization across the OpenX projects
- Multiple steps taken @ ASAM so far…:
  - Coordination group – (Overview presented by Oliver Philipp)
    → high level internal and external alignment, “connect the right people”
  - Shared project access (chat channels and issue platform) – allow for quick communication between projects for smaller technical discussions
  - Shared “OpenX” calendar – all OpenX meetings open to all participants of an OpenX project
    → Quick access to discussions with other groups on relevant topics
  - Homogenised workflows – same workflow & structure across OpenX projects makes it easy to join other project development activities. Joint documentation via simulation wiki

Document Development for OpenX

- All ASAM OpenX Standards are now written using the AsciiDoc format and released as html
- AsciiDoc is a mature, plain-text writing format for authoring documents based on Markdown
- Main advantages:
  - Openable in any text editor
  - Focus on content not on formatting!
  - Versionable and diffable – i.e. we can tell who did what, when and where!

- Modern development platform – Gitlab (repository) and Teams (chat, file sharing, conferencing)

- Docs-as-code approach

- Modern Continuous Integration (CI):
  - Automated compilation of AsciiDoc to html format – instant download of pre-release changes
  - Automated checks:
    - To ensure contributions comply with the format
    - To ensure licensing requirements for contributions are fulfilled (OSI)
    - Commit message format and content
  - Automated changelog management

OpenX Service Providers

- Final voting last week in ASAM TSC
- Cross project alignment supported through SP participation in multiple projects
- SPs passively participating in project meetings to catch up on status
- Coming weeks – kickoff with WG leads and SPs to determine next steps.
- Next topics for ASAM Office to address:
  - Change process for content
  - Shared information architecture across OpenX
    → Improved content alignment across standards
    → Shared document structures & templates

Some closing remarks…

- Standardization enables collaboration and information exchange
  → This only happens if standards are adopted!

- Conflicting standards from different organizations lead to confusion and lack of adoption
  → Collaboration begins with the standardization organizations
  → More collaboration and alignment amongst standardization bodies worldwide needed…
    - Aligned roadmaps
    - Joint development activities / standards

→ What else can we do to assist adoption of optional, non-regulatory standards?

Benjamin Engel
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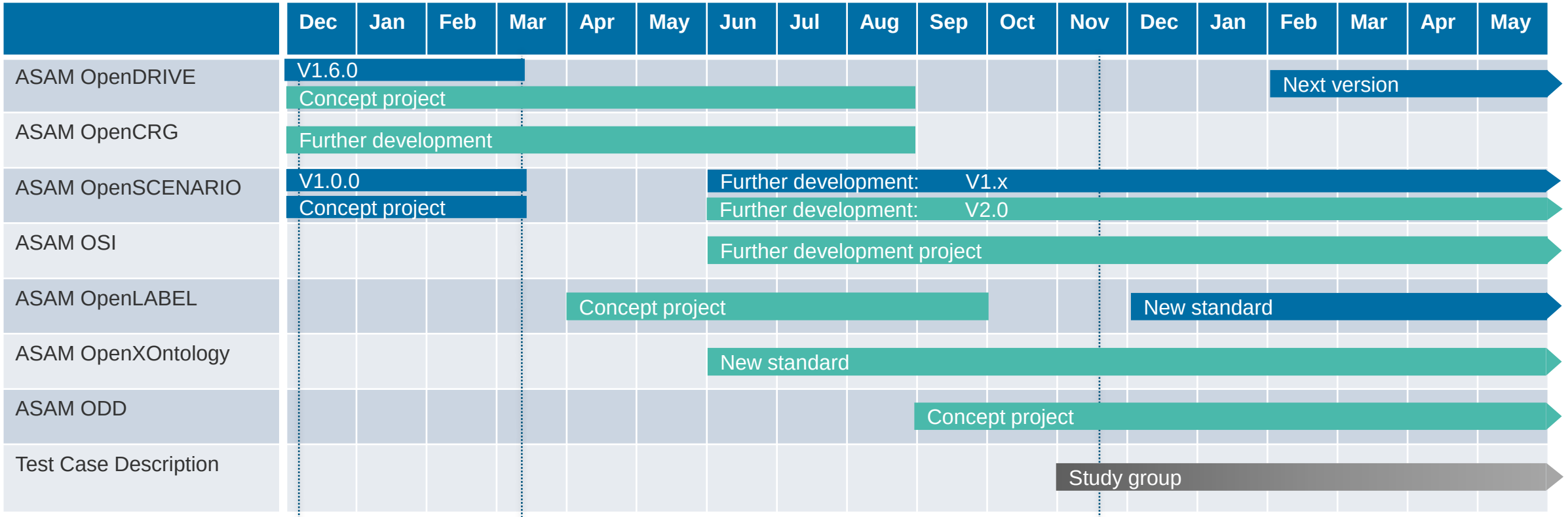
Timeline 2020 / 2021



ASAM International Conference 2019

Releases:
ASAM OpenDRIVE 1.6.0
ASAM OpenSCENARIO V1.0.0
ASAM OpenSCENARIO Concept

Releases:
ASAM OpenCRG
ASAM OpenLABEL Concept
ASAM OpenDRIVE Concept