OpenX-Standards at ASAM

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ASAM

Agenda

1. New Standardization Domain: Simulation
2. OpenDRIVE
3. OpenCRG
4. OpenSCENARIO
5. OSI *)

*) Open Simulaton Interface

ASAM Standards Portfolio

Data Management & Analysis

CEA | ODS

Measurement & Calibration

MCD-1 POD | MCD-1 CCP / XCP | MCD-2 MC | MCD-2 CERP | MDF | CDF | CPX

Test Automation

ACI | ASAP 3 | ATX | GDI | MCD-3 D | MCD-3 MC | XIL

Diagnostics

MCD-2 D | OTX Extensions

Software Development

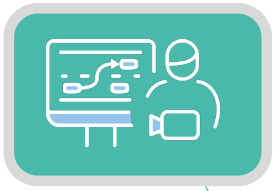
CC | FSX | ISSUE | LXF | MBFS | MDX

ECU Networks

MCD-2 NET

Simulation

New Domain at ASAM: Simulation



Simulation

- Standards for simulation model data exchange.
- High demand for standards for new type of simulation: Drive and Traffic Simulators.
- Public specs driven by tool vendors have emerged in recent years.
- Specs are now being transferred to ASAM in order to:
  - be hosted by a neutral NPO
  - become an official standard for the industry
  - guarantee long-term and professional further development
- Current projects to be transferred to ASAM:
  - OpenDRIVE
  - OpenCRG
  - OpenSCENARIO
  - OSI*)

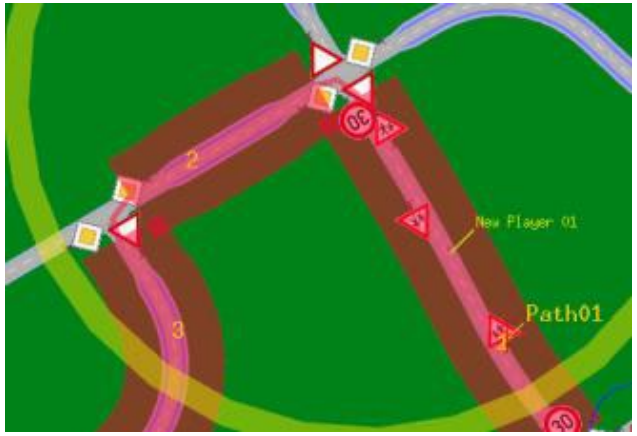
*) Open Simulaton Interface

Positioning of OpenX-Standards

OpenDRIVE
- Road Network

OpenCRG
- Road Surface

OpenSCENARIO
- Driving Maneuvers



Static Content

Dynamic Content

- **Motivation**
- Exchange of data between creation tools (e.g. road network editors) and simulators.
- Use of the data in simulators from different vendors.
- Use with other public standards, such as OpenFlight.

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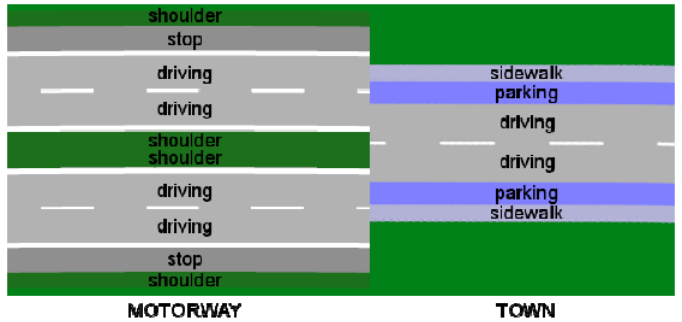
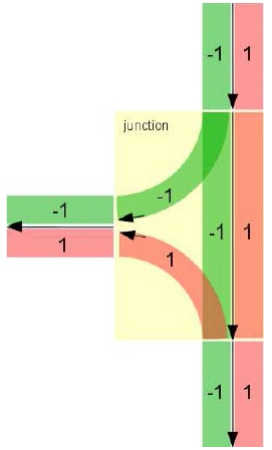
OpenDRIVE

- OpenDRIVE: Open Dynamic Road Information for Vehicle Environment
- File format for the **description of road networks**.
- Initiative started in 2005 by Daimler and VIRES.
- 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.





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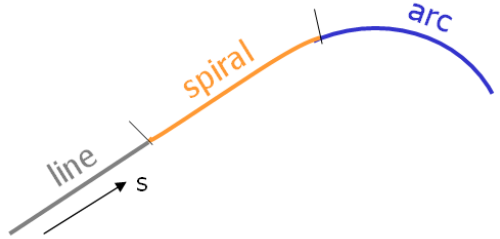
Principal Design Pattern for Roads

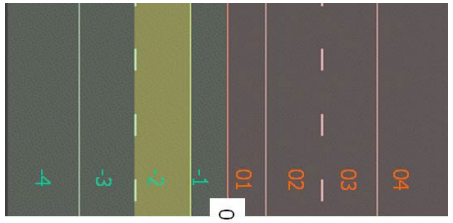
1: Create Reference Line

- Primitives
:
- Line
- Arc
- Spiral
- Poly3



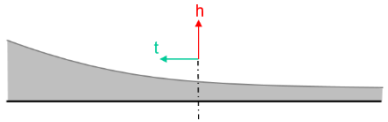
2: Add Lanes Along the Reference Line

Elements:
- Width
- Link
- Material
- Roadmarks

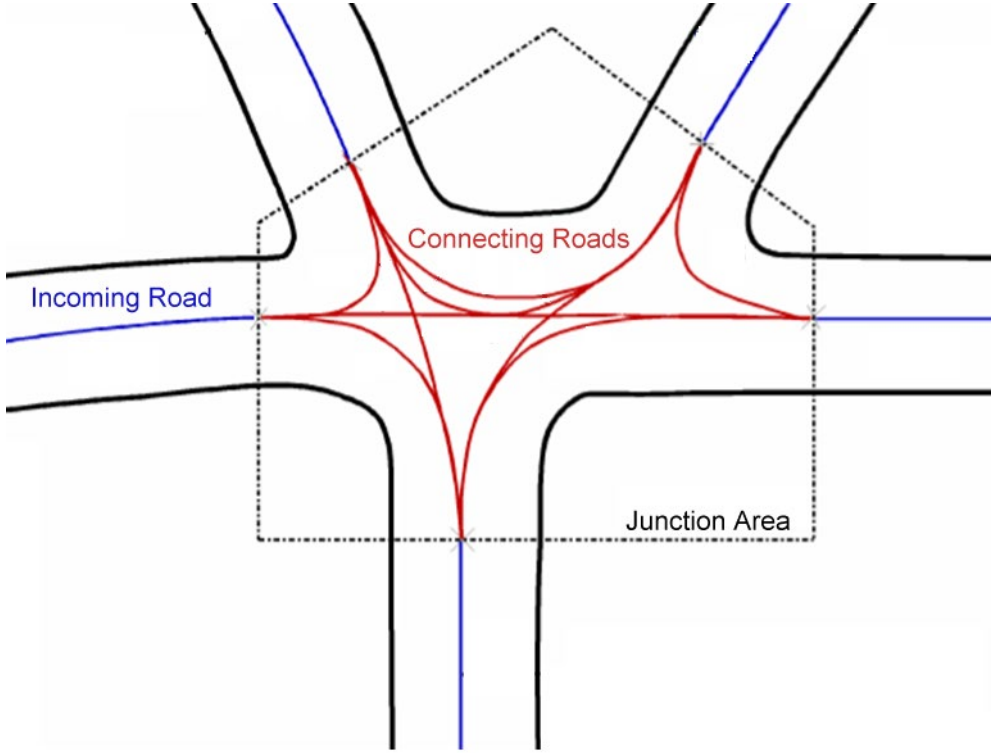


3: Add Features

Elements:
- Sign
- Signal
- Object
- Elevation



Junctions



- Elements:
- Link to lane
- Priority
- Group

Further Development of OpenDRIVE

Results*) of ASAM OpenDRIVE Kick-Off Workshop with industry-experts:

Features

F001: Junction Model

F002: Road Geometry Models

F003: Arbitrary Spaces Model

F004: International Signs Model

F005: Environment Representation

F006: Roundabouts

F007: Parametrization & Variation

F008: Georeferencing

Other Topics

- Reference Visualization and Checker Tool
- Reference Examples
- Best Practices Guide

Requirements

R001: Add more model parameters

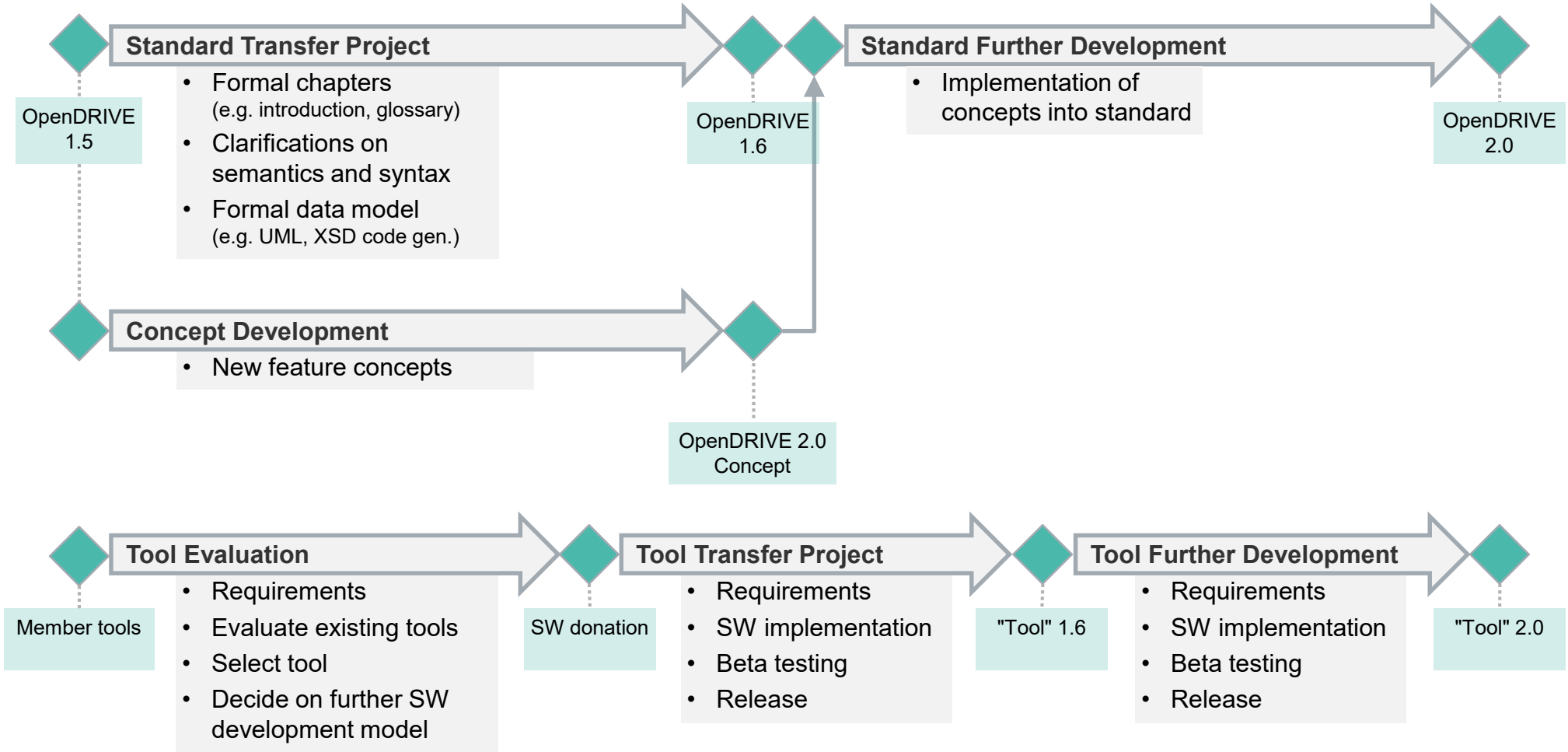
R002: Remove or reduce redundant information

R003: Harmonize OpenDRIVE with other standards

R004: Remove or reduce different ways to model

*) tentative, as meetings are on-going

Roadmap*)



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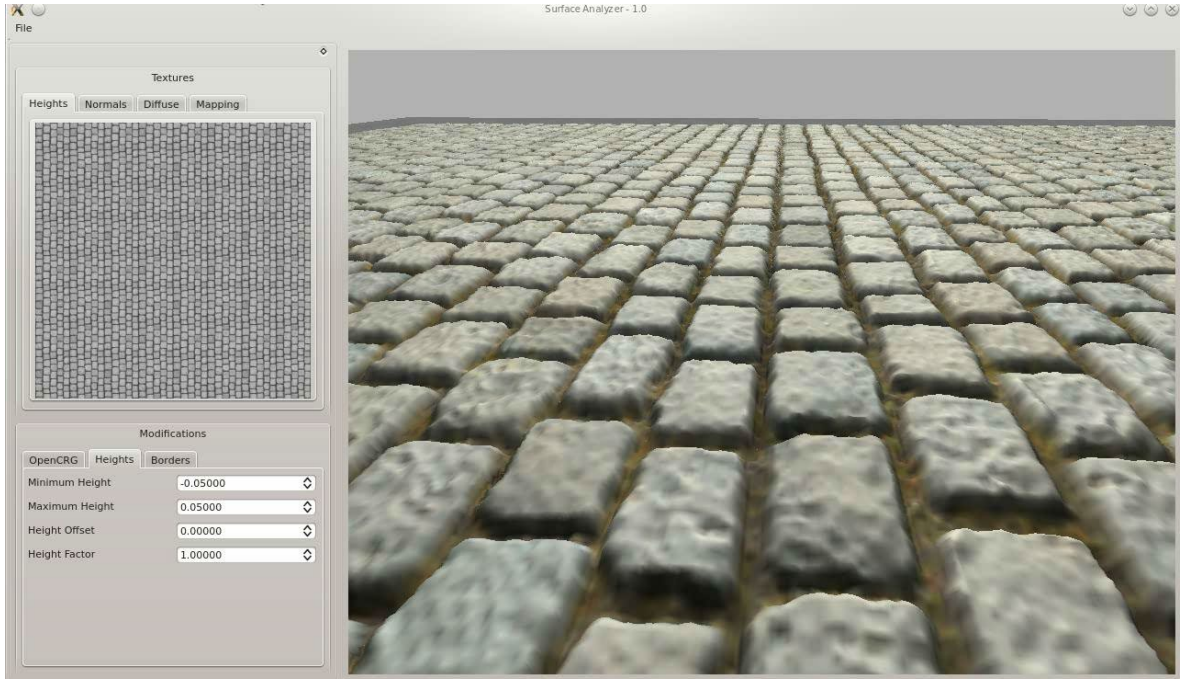
OpenCRG

- OpenCRG: Open Curved Regular Grid
- File format and source-code for the **detailed description of road surfaces**.
- OpenCRG initiative was started in 2008 by Daimler together with AUDI, BMW, Porsche, and Volkswagen.
- The file format of OpenCRG is integrated in OpenDRIVE.
- Used for the description of patches of road surfaces in a very detailed manner, so that it can be used for:
  - Tire simulation
  - Vibration simulation
  - Driving simulation, etc.
- Source-code included:
  - C API for data read/write and evaluation
  - MATLAB API for data read/write, evaluation, generation, modification and visualization
  - Library of sample data



Further Development of OpenCRG

Results*) of pre-standardization meetings with industry-experts:

Features

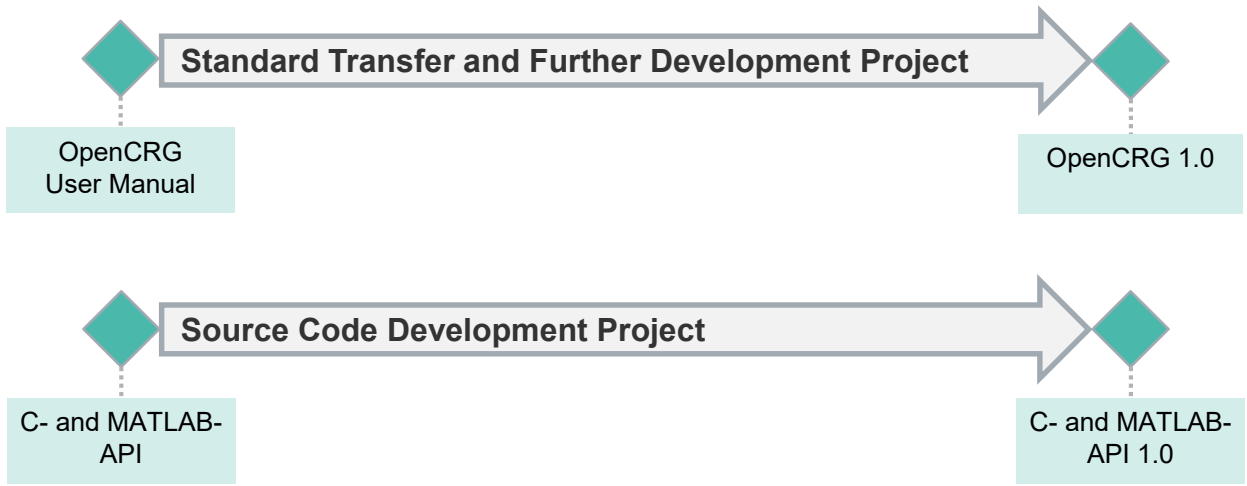
F001: Georeferencing

F002: Multiple Data Layers

Other Topics

- Further Development of the API Source Code

Roadmap*)



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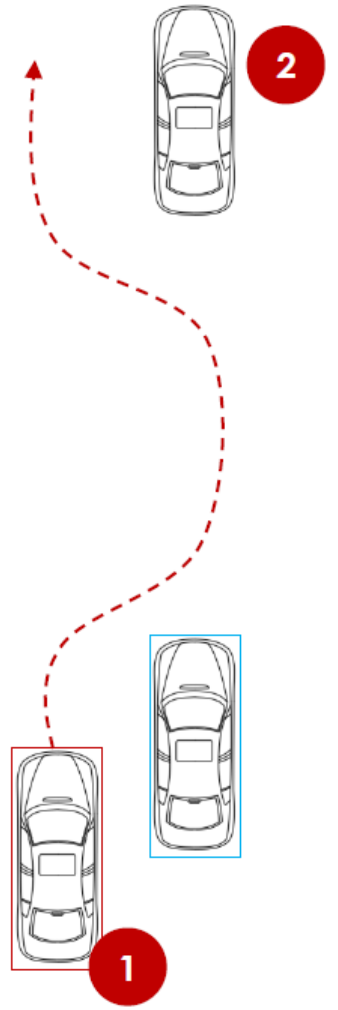
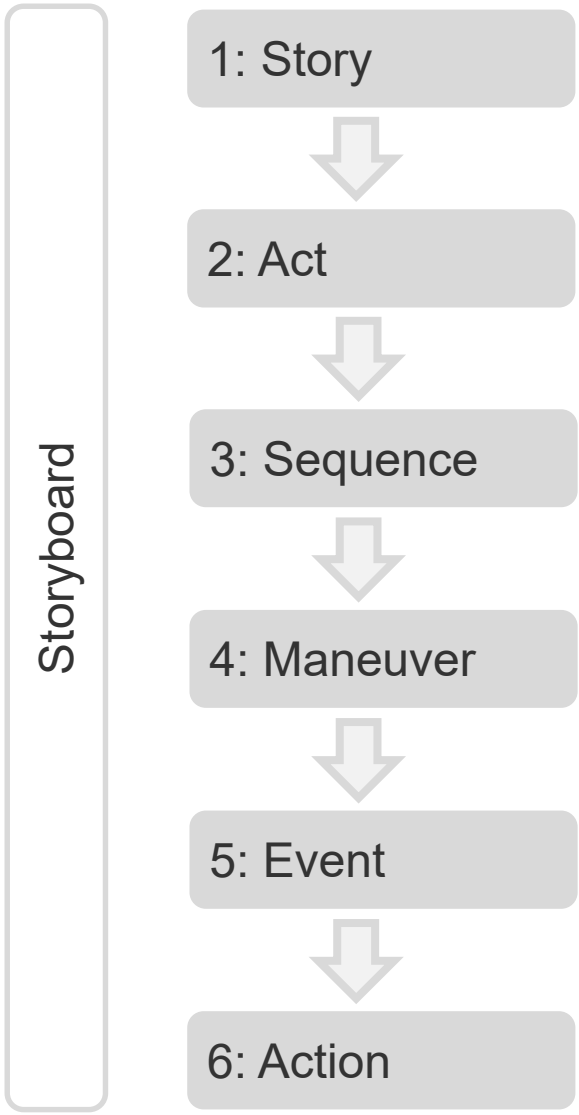
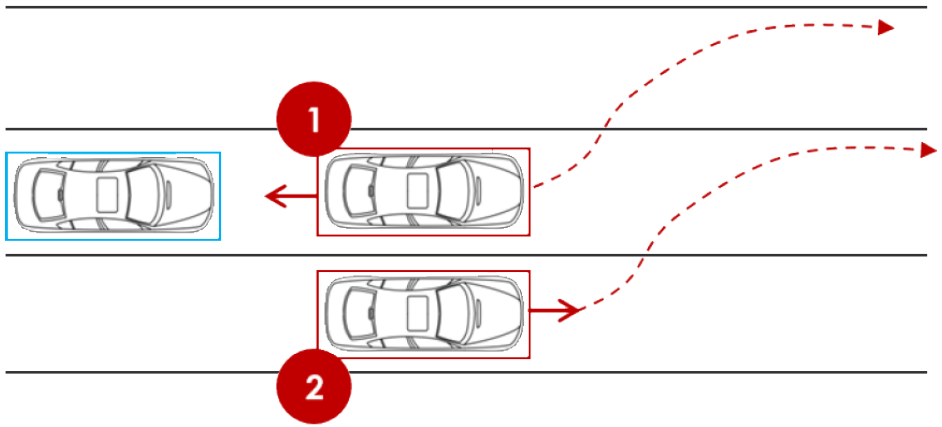
OpenSCENARIO

- File format for the **description of dynamic content in driving simulation applications**.
- Currently: focus on drive maneuver description.
- Project in an early stage (started in 2014).
- Used for drive simulators.
- Description elements:
  - Maneuver
    (complex maneuver descriptions that involve multiple cars)
  - Trajectory
    (polyline, clothoid)
  - Vehicle
    (geometry, type, axes, performance)
  - Driver
    (appearance)
  - Environment
    (weather, time of day, road condition)
- Based upon XML.



Principal Design Pattern for Maneuvers






```
storyboard
 story: owner = Ego
   act 1: condition = TTC to player 1 in front right lane < 3s
     sequence 1.1: actor = player 1
       maneuver 1.1.1: name = complex lane change
         event 1.1.1.1: condition = upon start of act
           action 1.1.1.1.1: slow down by 5kph
           action 1.1.1.1.2: perform lane change to left within
4s
     sequence 1.2: actor = player 2
       maneuver 1.2.1: name = complex lane change
         event 1.2.1.1: condition = 1s after start of act
           action 1.2.1.1.1: increase speed by 5kph
           action 1.2.1.1.2: perform lane change to left within
4s
```

Further Development of OpenSCENARIO

Results*) of pre-standardization meetings with industry-experts:

Features

F001: Maneuver Model
F002: Driver Model
F003: Traffic Model
F004: Weather Model
F005: Environmental Event Model
F006: Vehicle Dynamics
F007: Parameter Stochastics
F008: High-Level Maneuver Descriptions
F009: Replay of Recorded Scenarios
F010: Automatic Parameter Calculation

Other Topics

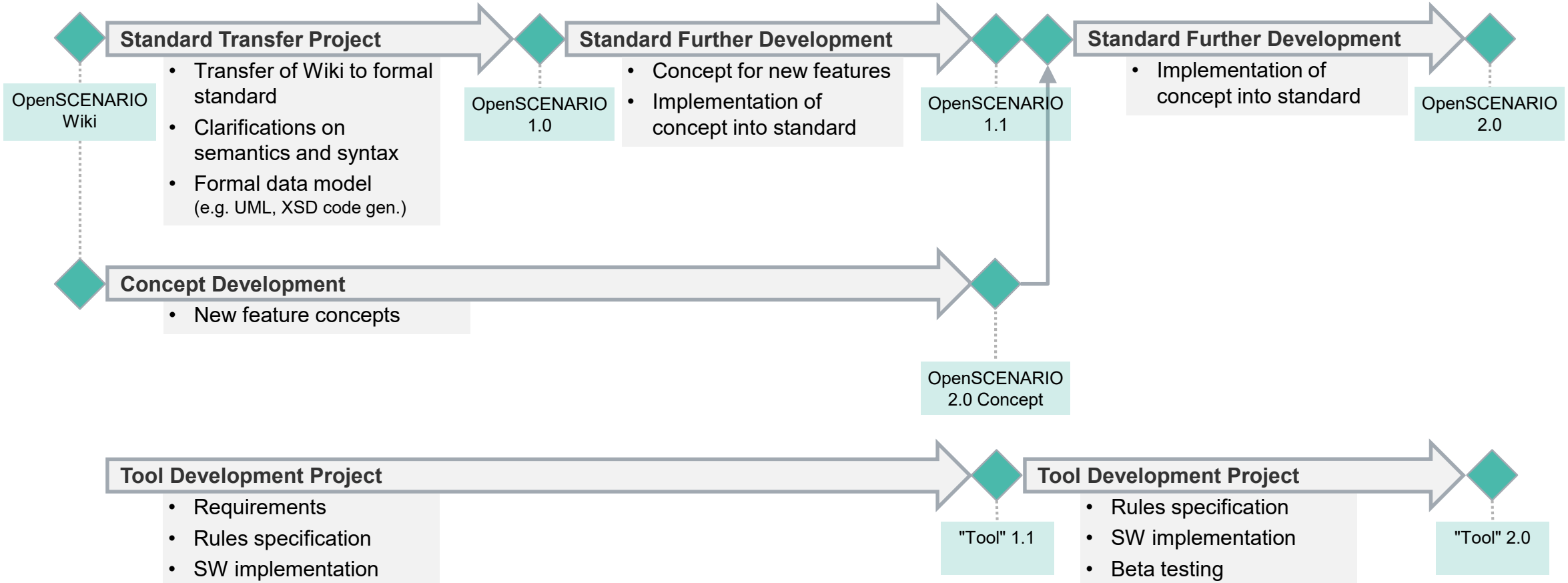
- Checker Tool
- Parser
- Data Access API
- Test Specifications
- Tool Qualification
- Traffic Simulation Driver Reference Models and Implementations

Requirements

R001: Avoid multiple ways of defining the same maneuver
R002: Define elements as 'mandatory' only when absolutely needed
R003: Maintain independence of standards and open linking between standards
R004: Define three levels of control for ego vehicles
R005: Allow tool-vendor specific extensions
R006: Allow definition of feature subsets
R007: Define simulation results reproducibility
R008: Maneuver descriptions shall be suitable for open-loop and closed-loop simulation.
R009: Define parameter boundaries
R010: Synchronize maneuvers
R011: Allow the definition of success criteria for maneuvers
R012: The description format shall be suitable for manual scenario creation in text editors

*) tentative, as meetings are on-going

ASAM OpenSCENARIO Roadmap



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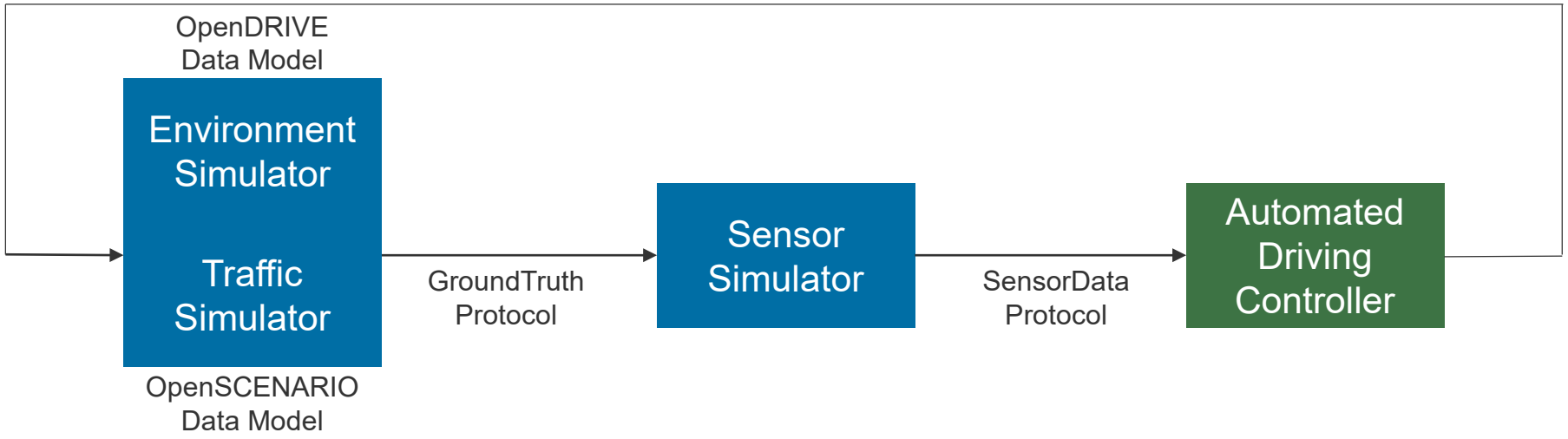
OSI

- OSI: Open Simulation Interface
- A generic interface for the **environment perception of automated driving functions in virtual scenarios**.
- Initiated by BMW and Technical University Munich (TUM).
- Contains an object-based environment description using message formats based on Google Protocol Buffers for two types of data:
  - GroundTruth: gives an exact view on the simulated objects in a global coordinate system.
  - SensorData: describes the objects in the reference frame of a sensor for environmental perception.



- In preparation: code of a run-time environment based on the Open Simulation Interface, including the conversions between GroundTruth and SensorData messages.

Thank you!

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