





# A Simulation Environment using only OpenX standards

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### Using OpenX Standards in Simulation

#### Why?

- Platform independent
- Definition of data (an architecture)
- Automotive specific
- Accepted from industry and research
- Readable / descriptive



## OpenDRIVE vs. OpenSCENARIO vs. Open Simulation Interface OpenDRIVE (ODR)

#### In General

- Description of static information
- XML data format
- Description of the street course with continuous functions
- Description of Positions with s/t/h- and x/y/z-Coordinates

#### **Specific Objects**

- Road
  - Lateral / Longitudinal description
  - Lane (directions, markings, connections, ...)
  - Signals (Traffic Signs, Traffic Lights)
  - Objects (Buildings, Parking Space, individual objects, ...)

#### **Additional Context**

- Controller for traffic light
- Junction
- JunctionGroup for roundabouts



## OpenDRIVE vs. OpenSCENARIO vs. Open Simulation Interface OpenSCENARIO (OSC)

#### In General

- Description of Use-Cases
- XML data format

#### **Specific Objects**

- Entities
  - Object Entities (Environment, Pedestrian, Vehicles, Signals, ...)
- Conditions (Collision, ReachPosition, Trigger, Speed, ...)
- Actions
  - PrivateAction (Description of Object Entities: Vehicle, Pedestrian, ...)
  - GlobalAction (Descrition of Global Entities: Weather, Traffic, ...)
  - UserDefinedAction (Scripts, specific model descriptions)

→ Description of the **behavior (action)** of an **entity** under defined **conditions**.



# OpenDRIVE vs. OpenSCENARIO vs. Open Simulation Interface



Open Simulation Interface (OSI)

#### In General

- Description of Runtime data exchange
- Protobuf data description

#### Specific Objects

- RoadMarking
- MovingObject
- LaneBoundary
- StationaryObject
- TrafficLight
- Occupant
- Lane (Polygon)
- TrafficSign
- EnvironmentConditions

#### Views

- GroundTruth
  - Global coordinate information
- No sensor information
- SensorView
  - Sensor specific

(Radar, Camera, Lidar, Ultrasonic, Generic)

- Detection and classification information for every object
- Relative coordinate information



Simulation Client 1

Simulation Client 2

## OpenDRIVE, OpenSCENARIO AND Open Simulation Interface Can it be a driving Simulator?



### NO!

It's just a format for static description and model behavior data

#### exchange.

X Runtime Environment

X Models



# OpenDRIVE, OpenSCENARIO, Open Simulation Interface AND Unity3D

Can it now be a driving Simulator?

Integration of the OpenX standards into a game engine offers:

- 3D rendering with HW access
- Physics engine
- Sensor environment
- Platform independant development
- Asset Store (Model store)
- Big development Community
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Can it now be a driving simulator? Yes!



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### Development Process Models



(1) Generation of code and implementation of functionality

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(3) Adding models to GameObjects

### **Development Process**

### User Interface and Configuration



Camere movement and 3D control



Configuration tree (left) for OpenDRIVE and OpenSCENARIO; Configuration panel (right) to set all configuration parameters for models

Using OpenX standards as a basic architecture works.

- Native support for OpenDRIVE files, OpenSCENARIO files and interconnection to other simulators (OSI)
- Basic data definition provided for the simulation models
  - No further help on how the OpenX standards should interact
  - The data between the standards does not fit very well to each other
- The standards are work in progress
  - Can be a problem, supporting the standards within a simulator
  - Problems within the standards will be solved in the future!
- The definition on the global environment is very basic





### Contact



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