Of Geodata Challenges in OpenDRIVE Standardization

115th OGC Member Meeting – Smart Roads Summit
June 16th 2020

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Research institutes
- Aeronautics
- Space
- Energy
- *Transportation*
- Security
- Digitalisation

Space administration
Project management agency
Institute of Transportation Systems

Key facts
• In Berlin and Braunschweig
• Around 200 Employees

Research fields
• Automotive
• Railway systems
• Traffic management
• Multi-modal and public transport

Area of work
• Fundamental research
• Conception and strategy development
• Prototyping
Our research infrastructure
Driving simulation
OpenDRIVE and how it works
Fancy driving simulations ...
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... require highly-detailed road network data
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OpenDRIVE?
OpenDRIVE: initial scope of application

- Fast prototyping of simulation tracks → Artificial/imaginary test data
- Restricted (small) spatial extent
- High modelling detail with visual properties → 3D rendering
- Simple, continuous geometry definition → Smooth road course
- Real-time processing capability
OpenDRIVE: open industry standard

- XML-based database
- Hierarchical structure

```xml
<road length="1000.0" id="0">
  <link>
    <successor elementType="road" elementId="1" contactPoint="start"/>
  </link>
  <type s="0.0" type="motorway"/>
  <planView>
    <geometry x="0.0" y="0.0" hdg="0.0"
      length="1000.0">
      <arc curvature="0.004"/>
    </geometry>
  </planView>
  <elevationProfile>
    <lateralProfile/>
    <lanes>
      <laneSection>
        <lane id="7" type="border">
          <link id="4" type="stop">
            <successor id="4"/>
          </link>
        </lane>
        <lane id="6" type="shoulder">
          <lane id="5" type="stop">
            <lane id="4" type="driving">
              <link id="4" type="stop">
                <successor id="4"/>
              </link>
            </lane>
            <roadMark type="solid" weight="bold"
              color="white" width="0.3">
              <type>
                <line length="1.0" space="0.0"
                  width="0.3"/>
              </type>
            </roadMark>
          </lane>
        </lane>
      </laneSection>
    </lanes>
  </elevationProfile>
</road>
```
OpenDRIVE: open industry standard

- XML-based database
- Hierarchical structure
- Detailed lane modelling
- Elements refer to an imaginary reference line
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see OpenDRIVE Format Specification, Rev. 1.5
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- Hierarchical structure
- Detailed lane modelling
- Elements refer to an imaginary reference line
- Road topography (2.5D) and topology
  - continuous geometry definition

see OpenDRIVE Format Specification, Rev. 1.5
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see OpenDRIVE Format Specification, Rev. 1.5
OpenDRIVE: reference line geometry representation

```
| speed |
| -planView |
| -geometry |
| -line |
| -spiral |
| -arc |
| -poly3 |
| -paramPoly3 |
| elevationProfile |
```

OpenDRIVE Format Specification, Rev. 1.5
OpenDRIVE: discrete geometry anchor points

```xml
<planView>
  <geometry s="0.0" x="604944.1037" y="5792860.1272" hdg="3.5148" length="9.7589">
    <arc curvature="9.0884E-4"/>
  </geometry>
  <geometry s="9.7589" x="604935.03" y="5792856.5285" hdg="3.5237" length="12.0">
    <line/>
  </geometry>
</planView>
```
OpenDRIVE: discrete geometry anchor points

```
<planView>
  <geometry s="0.0" x="604944.1037" y="5792860.1272" hdg="3.5148" length="9.7589">
    <arc curvature="9.0884E-4"/>
  </geometry>
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    <line/>
  </geometry>
</planView>
```
OpenDRIVE: continuous geometry evolution

```xml
<planView>
  <geometry s="0.0" x="604944.1037"
y="5792860.1272"
hdg="3.5148"
length="9.7589">
    <arc curvature="9.0884E-4"/>
  </geometry>
  <geometry s="9.7589" x="604935.03"
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length="12.0">
  </line/>
</geometry>
</planView>
```
OpenDRIVE over time

Initial scope of application

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• Simple, continuous geometry definition
  → Smooth road course

• Real-time processing capability
**OpenDRIVE over time**

**Initial scope of application**

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**Current and future trends**

- Real-world data
  - From motorways over
  - inner cities to
  - multi-level parking decks

- Data updates and network merging

- Increasing spatial extents

- “From simulation into the car”
  → Electronic horizon, rejection of many elements

- Linkage to supplementary environmental data
OpenDRIVE challenges
Scalability
Modelling habits

- Gap in reference line
- Overlap in reference line
- Gap in lane
- Overlap in lane

see ASAM OpenDRIVE Format Specification, v. 1.6.0
Modelling habits (numerical restrictions)
Modelling habits (numerical restrictions)
Structural separations, traffic islands
Data consistency

• Different mobile mapping providers
  → Heterogeneous modelling/post-processing
  → Incompatible datasets

• Difficult network merging and updates

• Commercial tools overuse <UserData>
  → Cumbersome exchangeability
Road2Simulation Guidelines
Road2Simulation Guidelines: GIS-backed modelling
Road2Simulation Guidelines: tackling geometry representation

Intermediate geodata model

based on OGC
Simple Features

GIS processing
OpenDRIVE standardization
Standardization activities

2005 - 2019

• Open community-driven de facto standard

• Initiated by Vires GmbH and Daimler AG, maintained by Vires

• Resources:
  www.opendrive.org

• OpenDRIVE versions <= 1.5
  • Latest release February 2019
Standardization activities

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• Maintaining downwards compatibility (not always)

• Version 1.3 \(\rightarrow\) 1.4
  • Adds new geometry type: paramPoly3
  • Extends lane boundary modelling
  • Extends lateral profile modelling
  • Introduces PROJ.4 geo-reference
  • Introduces parking spaces
  • Introduces railroad models for tramways
  • Introduces logic junction groups

• Version 1.4 \(\rightarrow\) 1.5
  • Extends road mark modelling
  • Extends road object and signal modelling
  • Introduces data quality information
Standardization activities

2020 onwards

• Open automotive industry standard

• Association for Standardization of Automation and Measuring Systems (ASAM e. V.)

• Resources:
  https://www.asam.net/standards/detail/opendrive/

• OpenDRIVE versions >= 1.6.0
  • First release March 2020
Standardization activities

• Transfer to ASAM corporate layout → “Refurbishes and professionalizes 1.5”

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- Transfer to ASAM corporate layout
  - “Refurbishes and professionalizes 1.5”

- Version 1.5 → 1.6.0
  - Optionalizes backwards-incompatible elements
  - Reworks basic specification text
  - Adds UML diagrams
  - Adds examples
  - Adds sample files
ASAM OpenDRIVE Concept Project

• April 2019 – August 2020

• WP01: Improve the junction model

• WP02: Rework environmental representation

• WP03: Improve/extend geometry modelling

• WP04: International traffic sign model

• WP05: Area Concept
WP05: layered Area Concept (*fuelled by Road2Simulation*)

- **infrastructure layer**: traffic signs, signals, etc.
- **road mark layer**: markings and restrictions
- **trajectory layer (optional)**: supporting centerlines
- **traffic island layer**: developed traffic areas
- **lane layer (optional)**: containing links
- **traffic area layer**: for each transport mode/type
- **ground layer**: TIN or CRG or height map
Standardization activities summarized

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• OpenDRIVE versions >= 1.6.0
  • First release March 2020
https://youtu.be/diEnIUT6HmA

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Additional resources

• Vires OpenDRIVE (version < 1.6.0): www.opendrive.org

• ASAM OpenDRIVE (version >= 1.6.0): https://www.asam.net/standards/detail/opendrive/

• Road2Simulation Guidelines: https://doi.org/10.5281/zenodo.3375525

• Unofficial GDAL OpenDRIVE extension: https://github.com/DLR-TS/gdal