OpenDRIVE

An Open Standard for the Description of Roads in Driving Simulations

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DSC – Europe
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Open\textit{DRIVE} - managing the road ahead

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The Idea Behind OpenDRIVE

A Road is a Road!

- **Roads**
  - similar throughout all systems and countries
  - elements are not proprietary

- **Current Driving Simulators**
  - use separate but correlated databases for graphics and logics
  - use *standardized* formats for the graphics
  - use *proprietary* formats for the logics

- **Current Road Formats**
  - proprietary
  - incompatible to each other
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The Idea Behind Open**DRIVE** (cont'd)

**Graphics + Logics = Simulator Database**
The Idea Behind OpenDRIVE (cont’d)

- For the graphical representation of road scenarios, standards have long been established (e.g. OpenFlight®)
- Development and installation of visual databases can be significantly faster with standards for graphics and logics
- Increasing the interoperability of different driving simulators will ease the co-operation in cross-company projects

Graphics and logics should be treated in similar ways!
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**Requirements for a new Data Format**

- international
- country-specific elements should be avoided or generalized

- state-of-the-art description techniques
- focus on application in driving simulators
- provision of the most relevant elements

- extensibility
- customization by users without interference with other elements

- public availability
- no licensing

- involvement of actual and potential users in the on-going development
- defined process of incorporating inputs and new requirements
## A Brief History

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>• Introduction of DRIVE format into the DaimlerChrysler Driving Simulator in Berlin</td>
</tr>
<tr>
<td>2005</td>
<td>• Co-operation DaimlerChrysler / VIRES for the development of OpenDRIVE</td>
</tr>
<tr>
<td>2006</td>
<td>• Publication of the OpenDRIVE project and of OpenDRIVE V0.6</td>
</tr>
<tr>
<td></td>
<td>• Launch of the official website: <a href="http://www.opendrive.org">www.opendrive.org</a></td>
</tr>
<tr>
<td>January</td>
<td>• First presentation to simulation professionals</td>
</tr>
<tr>
<td>April</td>
<td>• 2nd OpenDRIVE review meeting with participants from Germany and France</td>
</tr>
<tr>
<td>June</td>
<td>• Release OpenDRIVE V1.0</td>
</tr>
<tr>
<td>July</td>
<td>• 3rd OpenDRIVE review meeting</td>
</tr>
<tr>
<td></td>
<td>• Establishment of a core team of simulation professionals</td>
</tr>
<tr>
<td>August</td>
<td>• KMW joins as partner of OpenDRIVE</td>
</tr>
<tr>
<td>September</td>
<td>• Release of OpenDRIVE V1.1</td>
</tr>
<tr>
<td>October</td>
<td>• OpenDRIVE at DSC-Europe</td>
</tr>
</tbody>
</table>
Basic Principles of OpenDRIVE

- The three basic elements of a road network
  - individual roads
  - junctions
  - controllers

- Each road can be linked to
  - another road
  - junction
Data Format
- XML Format
- Hierarchical structure
- Extensible with user-defined beads
- Floating point numbers in double precision
- All values in SI units
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Data Format

```xml
<OpenDRIVE>
  <header
    west="-4.0000000000000000e+02" maxJunc="27" maxPos="1.1500000000000000e+03" maxRoad="35" revMajor="0" version="1.9.0">
    <road length="1.0400000000000000e+02" junction="1" id="26" name=""/>
    <link/>
    <predecessor contactPoint="end" elementId="0" elementType="road"/>
    <successor contactPoint="end" elementId="10" elementType="road"/>
  </link>
  <planView>
    <geometry x="-2.216152564553741e+02" y="2.3505945528309267e+03" hdg="2.2050157240855150e+00" length="7.000000000000099e+00"/>
    <line/>
  </planView>
  <elevationProfile>
    <elevation a="9.5000000000000000e+00" b="0.0000000000000000e+00" c="0.0000000000000000e+00" d="0.0000000000000000e+00" e="0.0000000000000000e+00"/>
    <laneSection s="0.0000000000000000e+00"/>
      <left>
        <lane type="border" id="3"/>
        <link/>
        <predecessor id="3" />
        <successor id="3" />
      </left>
      <center type="driving" id="0">
        <roadMark sOffset="0.0000000000000000e+00" weight="standard" type="none" color="standard"/>
      </center>
      <right type="driving" id="1">
        <link/>
        <predecessor id="1" />
        <successor id="1" />
      </right>
  </laneSection>
</elevationProfile>
</OpenDRIVE>
```
**OpenDrive** - managing the road ahead

### Elements: Road Center Line

- transition from inertial co-ordinates (xyz) to road-specific co-ordinates (stz)
  - independent of road location in space
  - s value independent of elevation

- **OpenDrive** tags:
  ```xml
  <road>
    <planview>
      <geometry>
        <line>
          <spiral>
            <arc>
              <poly3>
                <line>
                <spiral>
                <arc>
                <poly3>
            </geometry>
      </planview>
  </road>
  ```

![Diagram of Road Center Line](image)
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**Elements: Road Properties**

- **Basic**
  - id / type / length / etc.
- **Profile**
  - elevation
  - superelevation
  - crossfall
- **Lanes**
  - width
  - road marks
  - materials
  - etc.
- **Environment**
  - signals (traffic lights)
  - signs
  - objects (e.g. tunnel)
- **Hierarchy**
  - link

- All Properties are valid until being replaced by the next property of the same type or until the end of the road is reached.
**Elements: Road Properties – Elevation and Superelevation**

- Definition in sub-sections
- Cubic function allows for generalized approach

\[ z = a + b \cdot ds + c \cdot ds^2 + d \cdot ds^3 \]

- Specification:

  Delimiters: `<elevation/`
  
  Arguments:

<table>
<thead>
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<th>name</th>
<th>type</th>
<th>description</th>
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<tr>
<td>s</td>
<td>double</td>
<td>start position (s-coordinate)</td>
</tr>
<tr>
<td>a</td>
<td>double</td>
<td>parameter A (elevation in [m])</td>
</tr>
<tr>
<td>b</td>
<td>double</td>
<td>parameter B</td>
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<tr>
<td>c</td>
<td>double</td>
<td>parameter C</td>
</tr>
<tr>
<td>d</td>
<td>double</td>
<td>parameter D</td>
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</table>
Elements: Road Properties - Lanes

- Lanes are directed with respect to the center line’s direction
  - left / center / right lane

- Lanes can be of various types
  - driving / shoulder / pedestrian / biking / parking etc.
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**Elements: Road Properties – Lanes (cont’d)**

- Lanes are containers of further properties
  - width (defined as cubic function)
  - road mark (type, color, weight, width)
  - height offset
  - etc.
Elements: Road Properties – Lanes (cont'd)

- The validity of road properties can be restricted to certain lanes
  - signals
  - objects

- Lanes carry individual link information
  - predecessor
  - successor
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**Elements: Road Properties - Environment**

- **Signs and Signals**
  - defined at a given road position
  - directed (i.e. orientation relative to road direction)
    - per default valid for all lanes in own direction
    - lane validity may be explicitly restricted with an additional entry
  - unique ID within database
  - dynamic and static signals
  - type information may be coded country-specific
  - linking of signals for mutual dependencies
  - references to signals

- **Bridges**

- **Tunnels**

- **Generalized objects**
  - road objects and road-side objects
  - rectangular, circular or polygonal shape
  - footprint and height information
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**Elements: Junctions**

- Resolving ambiguous road links
- Matrix of possible connections
  - incoming roads vs. connecting roads
  - optional priorities
- Signal controllers may be assigned
## OpenDRIVE - managing the road ahead

### Elements: Overview

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<tr>
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Development Process

new requirement

www.opendrive.org

VIRES

OpenDRIVE meeting (every 6 months)

core team

member

member

member

new release
Implementing OpenDRIVE

- New Applications: use fully integrated tool chains
Implementing OpenDRIVE (cont’d)

- Existing Applications: step-by-step

**status quo**

- "old" format logics
- Application understanding "old" format

**step 1**

- OpenDRIVE logics
- Converter OpenDRIVE to "old" format
- Application understanding "old" format

**step 2**

- OpenDRIVE logics
- Application understanding OpenDRIVE
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**Tools**

Available on [www.opendrive.org](http://www.opendrive.org):

- Format specification
- XML schema file
- XML sample file

Available via linked **partner websites:**

- Road designer for graphics and logics
- real-time libraries for road data evaluation
- road network and data visualizer
- to be continued
Behind the Scenes

Founders

The OpenDRIVE® initiative was started in 2005 by:

VIRES Simulationstechnologie GmbH

and

DaimlerChrysler Driving Simulator

With the publication of the initiative in 2006, other companies joined in so that OpenDRIVE® is now being maintained by an international board.

Core Team

The OpenDRIVE® standard is reviewed and released by a core team of driving simulation experts. The team members as of July 11, 2006 are (alphabetical order by company):

- Martin Strob / BMW Forschung und Technik GmbH
- Hans Grezlkowski / DaimlerChrysler AöB
- Markus Stöbe / Deutsches Zentrum für Luft- und Raumfahrt e.V.
- Dr. Günther Nirsch / Fraunhofer-Institut IV
- Eckhard Klämer / Krauss-Maffei Wegmann GmbH & Co. KG
- Dr. Berhard Bock / Rheinmetall Defence Electronics GmbH
- Marius Dupuis / VIRES Simulationstechnologie GmbH

Partners

The following companies are official partners of OpenDRIVE®.
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The Future of OpenDRIVE

- New releases of OpenDRIVE are scheduled for approx. every six months
- The OpenDRIVE core-team and review board will continue development of the data format
- More tools and simulation systems using OpenDRIVE will be available in the very near future
- OpenDRIVE seeks continuous inputs from the simulation community
- A broader international base would be highly desirable

→ Join us now!
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Further Information

Specification, Overview, Downloads etc.

**www.opendrive.org**

Newsletter

**newsletter@opendrive.org**

Whatsoever

**opendrive@vires.com**

Developers

**marius@vires.com** / **www.vires.com**