OpenDRIVE
managing the road ahead

5th Meeting
19. September 2007
M. Dupuis
Focus of this meeting

- The upcoming release 1.2
- Experiences with "upgrading" to OpenDRIVE
- How to use OpenDRIVE
- New requirements for OpenDRIVE
Presentation of

Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft
OpenDRIVE 1.2

- The Next Standard -
Replacement of numeric IDs with unique names

- Affected tags and arguments
  - Road: id
  - Junction: id
  - Object: type, id
  - Signal: id
  - Lanes: type, level
  - Material: surface
  - Tunnel: id
  - Bridge: id
  - SignalReference: signal id
  - Controller: id
  - Control: signal id

- Unique numeric IDs will be continued to be used for
  - Lane
  - References to lanes
Road marks are signified by "rules"

Specification

Delimiter: <roadMark/>
Parent: <lane>
Maximum Instances: unlimited
Optional: yes

Arguments:

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sOffset</td>
<td>double</td>
<td>start position (s-coordinate) relative to the position of the preceding lane Section record</td>
</tr>
<tr>
<td>type</td>
<td>string</td>
<td>type of the road mark – required</td>
</tr>
<tr>
<td>weight</td>
<td>string</td>
<td>weight of the road mark – optional</td>
</tr>
<tr>
<td>color</td>
<td>string</td>
<td>color of the road mark – optional</td>
</tr>
<tr>
<td>width</td>
<td>double</td>
<td>width of the road mark in [m] – optional</td>
</tr>
<tr>
<td>laneChange</td>
<td>string</td>
<td>{increase</td>
</tr>
</tbody>
</table>
Road marks may be described in more detail

- **Types**
  - cat-eyes (type, distance, height...)
  - ribs (type, roughness ...)
  - etc.

- The tag `<roadMark/>` has been opened to contain child tags

- Child tags have not yet been defined and will be added according to user requirements

```xml
<roadMark type="cat-eye" laneChange="none">
  <cat-eye type="single" distance="0.5" height="0.02"/>
</roadMark>
```
Surface data – key properties

- Derived from real-world measurements
- Complex structure
- Huge amounts of data
- Established data formats which are not compliant with OpenDRIVE XML format (some data sets may be available as binary data only)
- Available for entire roads or parts thereof
- Surface data may replace the following properties of OpenDRIVE
  - elevation
  - super-elevation
  - crossfall
  - material?
Inclusion of surface data into OpenDRIVE

- Surface data is defined as a child of the road record
- Data may be applied to an entire road or parts of it (lat./long.)
- Data is independent of lane definitions
- Surface data is referenced only with customized readers performing the actual data import
- Data exists in various formats

Delimiters: `<surface>  </surface>`
Parent: `<road>`
Maximum Instances: 1
Optional: yes
Arguments: none
Example:

```
<surface>
    <reference to actual data>
</surface>
```
Implementation of CRG (Curved Regular Grid) Data

- The first and preferred format supported by OpenDRIVE
- Definition of a road profile in lateral direction at given longitudinal positions
- Upon application of the data the following modifiers may be defined
  - offset in z-direction
  - scale factor of z values
- Two modes of application have been defined:
  - attached
  - genuine
"Attached" Mode

\[
\begin{pmatrix}
u \\
v
\end{pmatrix}_{CRG} = \begin{pmatrix}
s - s_{Offset} \\
t - t_{Offset}
\end{pmatrix}_{OpenDrive}
\]
"Attached" Mode (cont'd)

- CRG data is aligned with OpenDRIVE chord line
- Longitudinal (s) and lateral (t) offsets may be applied
- CRG values are attached (added) to OpenDRIVE surface
- The outer boundaries of CRG data should all be zero
"Genuine" Mode
"Genuine" Mode (cont'd)

- Start point of CRG data is positioned relative to OpenDRIVE chord line
- Longitudinal (s) and lateral (t) offsets may be applied
- Directional offset (heading) may be applied
- CRG values are used as genuine data, replacing the OpenDRIVE surface
- The outer boundaries of CRG data should all be compatible with underlying OpenDRIVE road
**Features in Open**\textbf{DRIVE 1.2 – CRG} \textit{(cont’d)}

**Specification**

- **Delimiter:** \(<\text{CRG}>\ldots</\text{CRG}>\)
- **Parent:** \(<\text{surface}>\)
- **Maximum Instances:** unlimited
- **Optional:** yes

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>file</td>
<td>string</td>
<td>name of the file containing the CRG data</td>
</tr>
<tr>
<td>sStart</td>
<td>double</td>
<td>start of the application of CRG data [m] (s-position)</td>
</tr>
<tr>
<td>sEnd</td>
<td>double</td>
<td>end of the application of CRG [m] (s-position)</td>
</tr>
<tr>
<td>orientation</td>
<td>string</td>
<td>same or opposite</td>
</tr>
<tr>
<td>mode</td>
<td>string</td>
<td>application mode, \texttt{attached} or \texttt{genuine}</td>
</tr>
<tr>
<td>sOffset</td>
<td>double</td>
<td>s-offset between CRG center line and chord line of the road (optional, default = 0.0) [m]</td>
</tr>
<tr>
<td>tOffset</td>
<td>double</td>
<td>t-offset between CRG center line and chord line of the road (optional, default = 0.0) [m]</td>
</tr>
<tr>
<td>zOffset</td>
<td>double</td>
<td>z offset between CRG center line and chord line of the road (optional, default = 0.0) [m]</td>
</tr>
<tr>
<td>zScale</td>
<td>double</td>
<td>z scale factor for the surface description (optional, default = 1.0). [-]</td>
</tr>
<tr>
<td>hOffset</td>
<td>double</td>
<td>heading offset between CRG center line and chord line of the road (required for mode genuine only, optional, default = 0.0) [rad]</td>
</tr>
</tbody>
</table>
Example

```
<surface>
  <CRG file="fancyData.crg" sStart="0.0" sEnd="100.0"/>
</surface>
```
Scenario 1: Two roads in opposite directions
Scenario 2: Three roads

has left neighbor (opposite)
has left neighbor (opposite), right neighbor (same)
has left neighbor (same)
Specification:

Delimiters: <neighbor.../>
Parent: <link>
Maximum Instances: 2
Optional: yes
Arguments:

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>side</td>
<td>string</td>
<td>[left</td>
</tr>
<tr>
<td>elementID</td>
<td>uint</td>
<td>ID of the linked road</td>
</tr>
<tr>
<td>direction</td>
<td>string</td>
<td>[same</td>
</tr>
</tbody>
</table>
Objects may be extended with a "repeat" option

Specification

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td>double</td>
<td>start position (s-coordinate), overrides argument in &lt;object&gt;</td>
</tr>
<tr>
<td>length</td>
<td>double</td>
<td>length of range in [m]</td>
</tr>
<tr>
<td>distance</td>
<td>double</td>
<td>distance in [m] between two instances of the object</td>
</tr>
</tbody>
</table>

Example

```xml
<object name="post"... >
    <repeat sStart="123.0" length="1200.0" distance="50.0" />
</object>
```
Reference to Objects

- Objects may be relevant for multiple roads
- Instead of providing multiple definitions of the same object, one definition may be given and references to this definition may be included in the road description
Reference to Objects (cont'd)

Specification

Delimiters: <objectReference/>
Parent: <object>
Maximum Instances: unlimited
Optional: yes
Arguments:

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td>double</td>
<td>track position [m] (s-position)</td>
</tr>
<tr>
<td>t</td>
<td>double</td>
<td>track position [m] (t-position)</td>
</tr>
<tr>
<td>id</td>
<td>string</td>
<td>unique ID of the referred object within the database</td>
</tr>
<tr>
<td>zOffset</td>
<td>double</td>
<td>z offset from track level [m]</td>
</tr>
<tr>
<td>validLength</td>
<td>double</td>
<td>extent of object's validity along s-axis in [m] (0.0 for point object)</td>
</tr>
</tbody>
</table>
| orientation| string  | “+” = valid in positive track direction
          |         | “-” = valid in negative track direction
          |         | “none” = valid in both directions               |
Sets of definitions for various features

- Allow the application to switch between various pre-defined configurations of the road network or parts of it

- Possible applications:
  - test different road mark sets of a given road
  - test different road materials of a given lane
  - test sets of signaling
  - etc.

- Parameters/Hierarchy:
  - unique name for identification
  - instances below "set" level
Features in OpenDRIVE 1.2 – Sets (cont’d)

Specification

Delimiters: <set> </set>
Parent: various
Maximum Instances: one per child category
Optional: yes
Arguments:

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>string</td>
<td>name of the set</td>
</tr>
</tbody>
</table>

Delimiters: <instance> </instance>
Parent: <set>
Maximum Instances: unlimited
Optional: no
Arguments:

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>string</td>
<td>name of the instance</td>
</tr>
</tbody>
</table>
Example

Define the signaling of a road for regular configuration and for a road works area

```xml
<road ...>
  <set name="roadWorks">
    <instance name="regular">
      <signals/>
    </instance>
    <instance name="construction">
      <signals>:
      </signals>
    </instance>
  </set>
</road>
```
User Report

by

Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft
User Report

by

vti

FINDING A BETTER WAY
User Report

by
OpenDRIVE
- Style Guide -
Reasons for a Style Guide:

- OpenDRIVE offers alternative ways for describing the "same" thing
- Some tags have a slight "legacy" character
- Users may not implement all alternative features of OpenDRIVE
- Users may expect certain configurations
Sample: Roads with Lanes in Both Directions

two roads with neighbor entry

single road with left and right lanes
Sample: Intersections – Connecting Roads

two connecting roads with right lanes only

one connecting road with left and right lanes
Sample: Intersections – Signals

one signal on incoming road

one instance / reference of the signal on each connecting road
Sample: Intersections – Size

minimize connecting roads

add space e.g. for queueing
Sample: Intersections – Coverage (e.g. Motorway)

one intersection

several intersections
Sample: Road Marks

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</tr>
<tr>
<td>type</td>
<td>string</td>
<td>type of the road mark</td>
</tr>
<tr>
<td>weight</td>
<td>string</td>
<td>weight of the road mark</td>
</tr>
<tr>
<td>color</td>
<td>string</td>
<td>color of the road mark</td>
</tr>
<tr>
<td>width</td>
<td>double</td>
<td>width of the road mark in [m] – optional</td>
</tr>
<tr>
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<td>[increase</td>
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</table>

Which parameters to use? – all / some
OpenDRIVE 1.3

- New Features -
Pedestrian Information:

- Paths for pedestrians
- Pedestrian areas (sidewalk, intersection)
- Special signals / signs (crosswalk)
- Interactions with pedestrians
OpenDRIVE

- Next Steps -
Style Guide
- preparation by core-team and actual users
- presentation of a draft at next meeting

Collecting Ideas for Open DRIVE 1.3
- preparation by core-team
- presentation of a draft at next meeting

Next Meeting of Community
- in 9 months
- location?

Other Topics?
Thank You!