Boosting the Development of OpenDRIVE through Integration Into Standardised GIS Frameworks

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German Aerospace Center (DLR)

Institute of Transportation Systems

German Aerospace Center

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

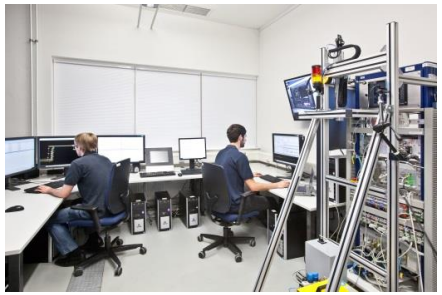
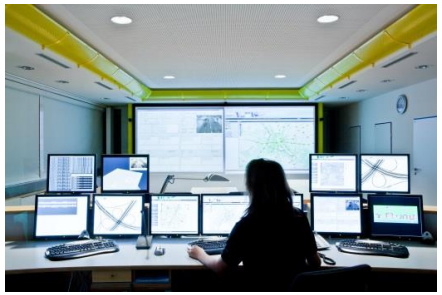
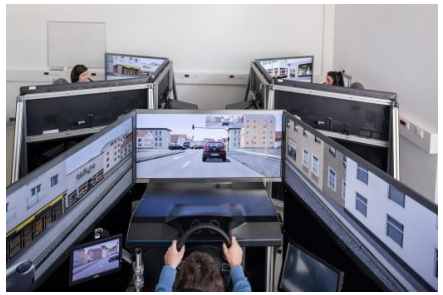
Our research infrastructure ...









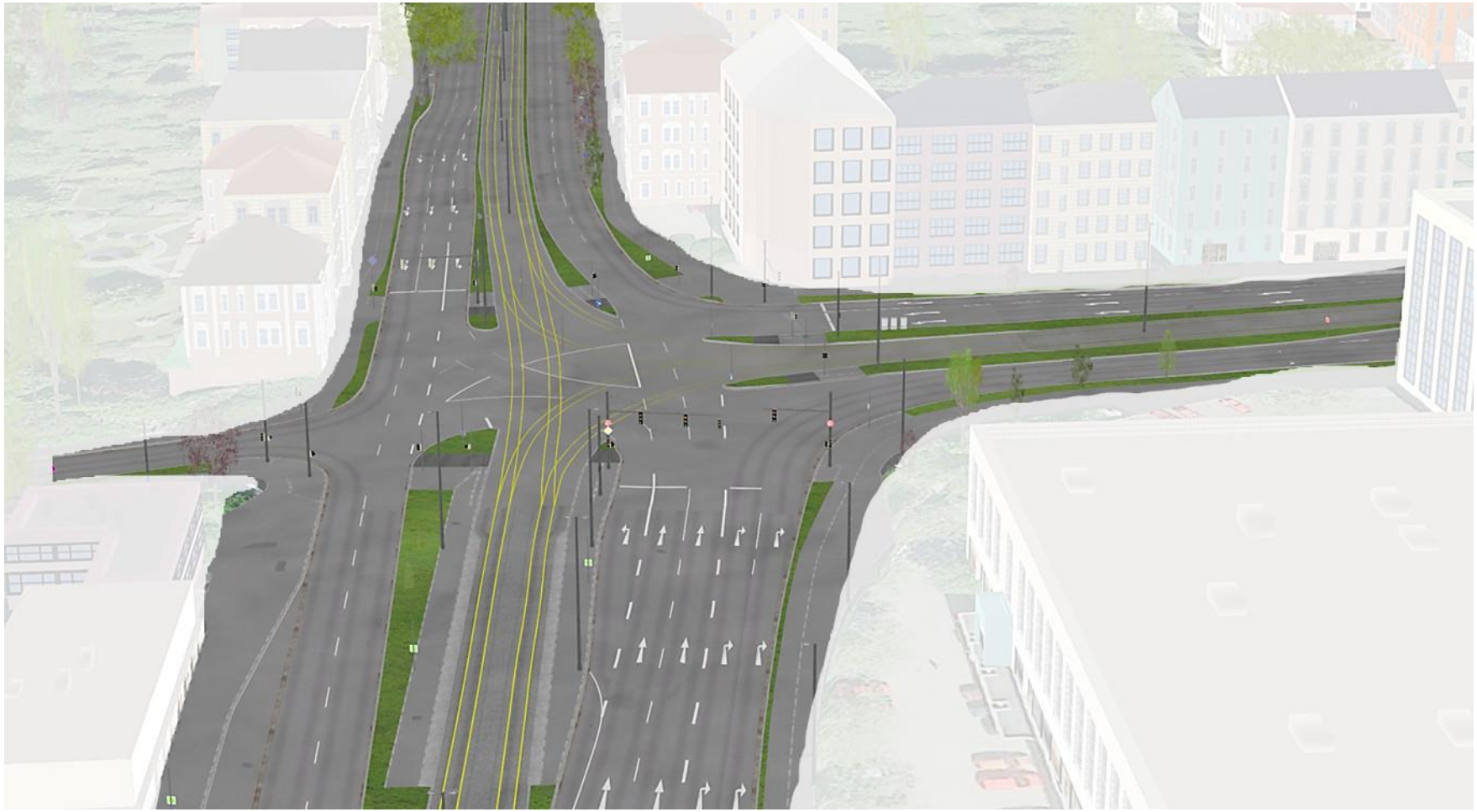






... and our Testbed of Lower Saxony

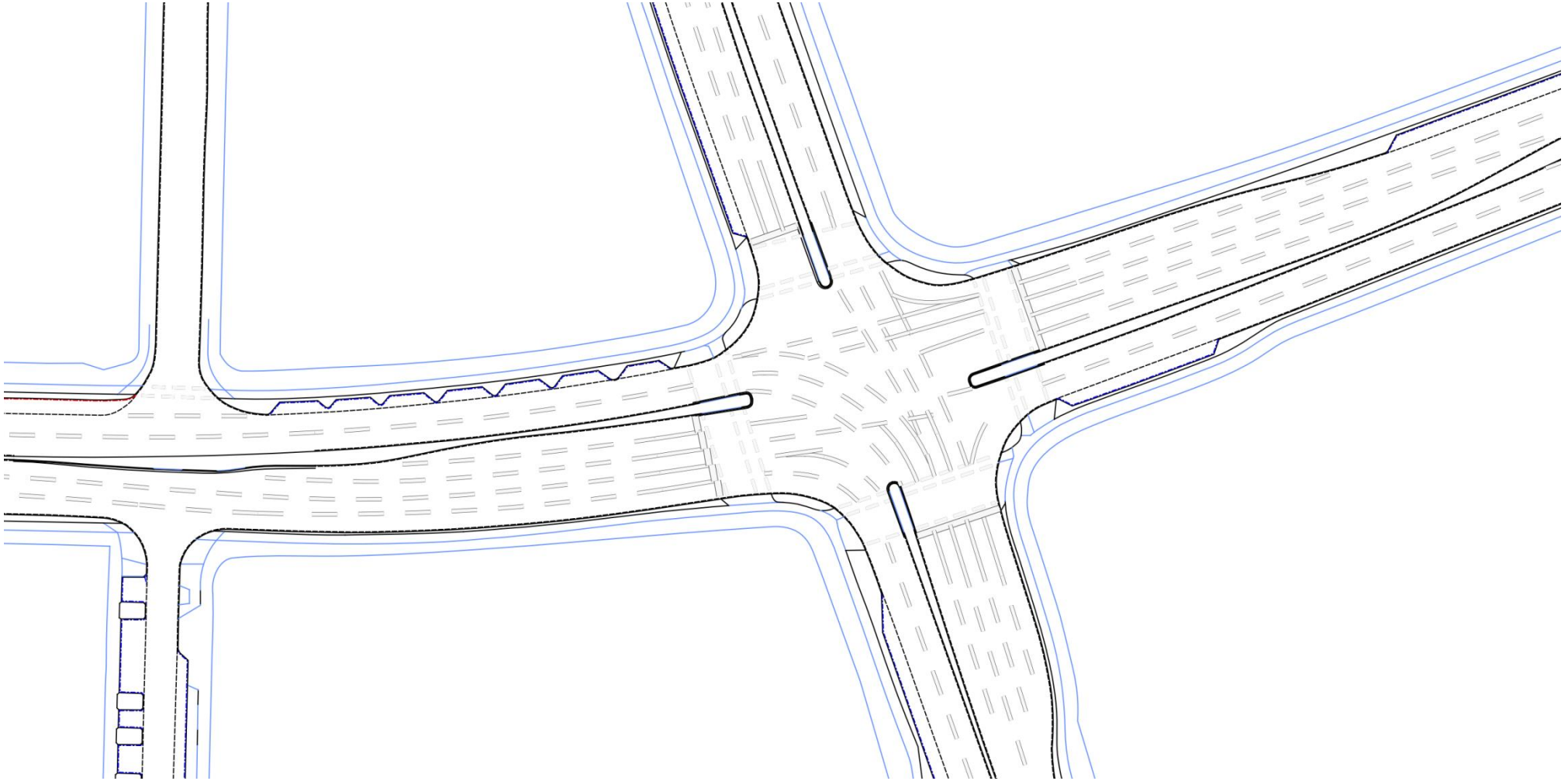
Road networks with OpenDRIVE

Fancy driving simulations ...

... require highly-detailed road network data



... require highly-detailed road network data



OpenDRIVE?

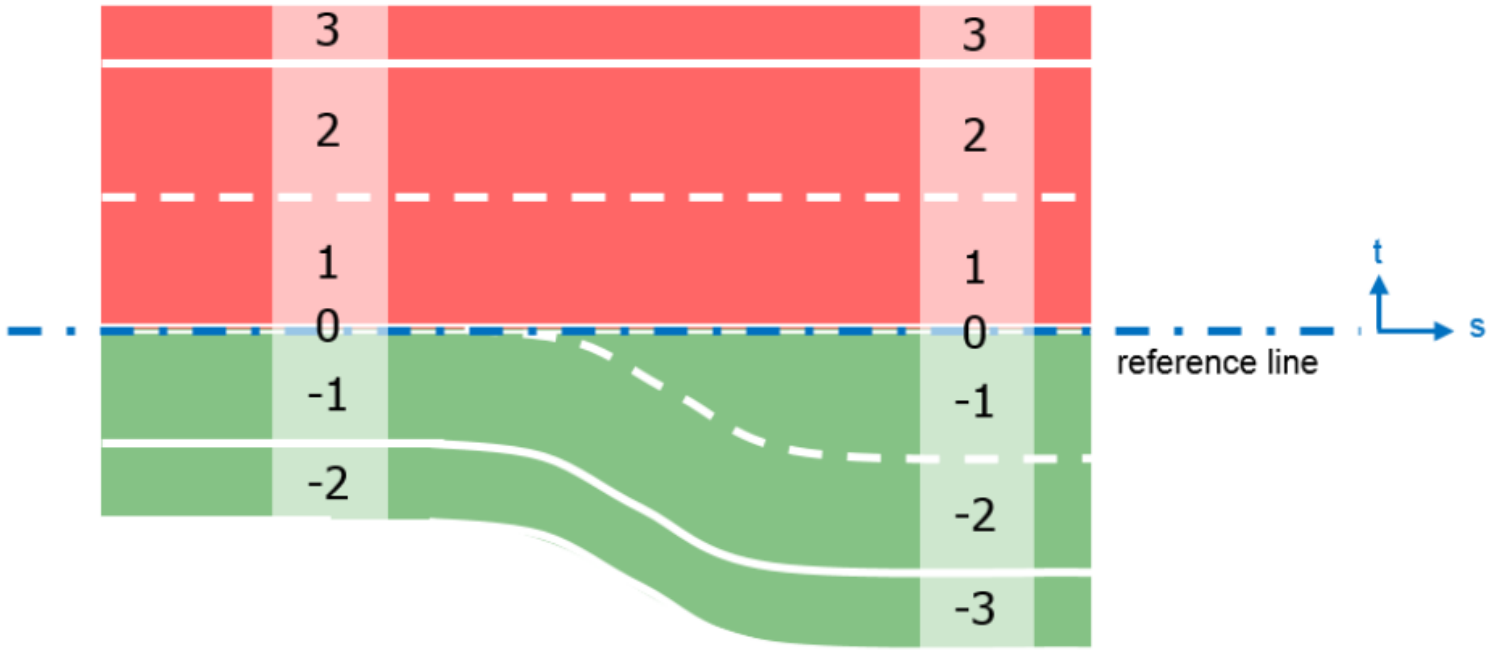
OpenDRIVE: open industry standard

- XML-based database
- Hierarchical structure

```
<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"/>
  <elevationProfile>
  <lateralProfile/>
  <lanes>
    <laneSection>
      <left>
        <lane id="7" type="border">
        <lane id="6" type="shoulder">
        <lane id="5" type="stop">
        <lane id="4" type="driving">
          <link>
            <successor id="4"/>
          </link>
          <width a="3.75"/>
          <roadMark type="solid" weight="bold"
            color="white" width="0.3">
            <type>
              <line length="1.0" space="0.0"
                width="0.3"/>
            </type>
          </roadMark>
```

OpenDRIVE: open industry standard

- XML-based database
- Hierarchical structure
- Detailed lane modelling



see OpenDRIVE Format Specification, Rev. 1.5

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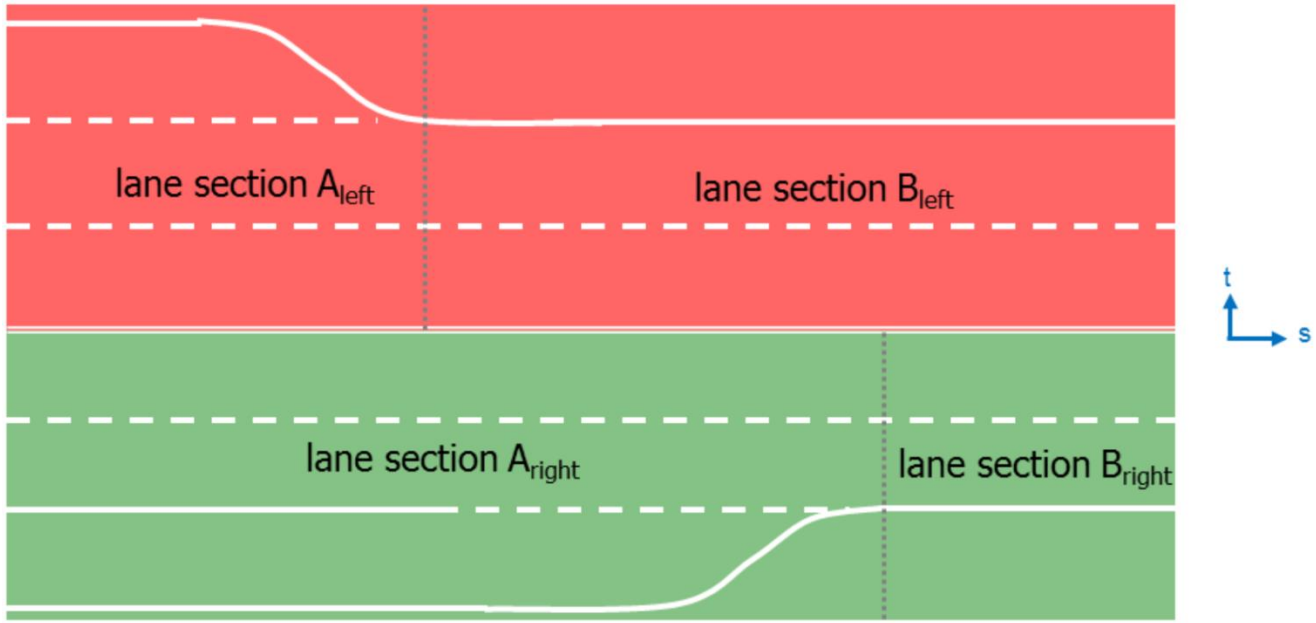

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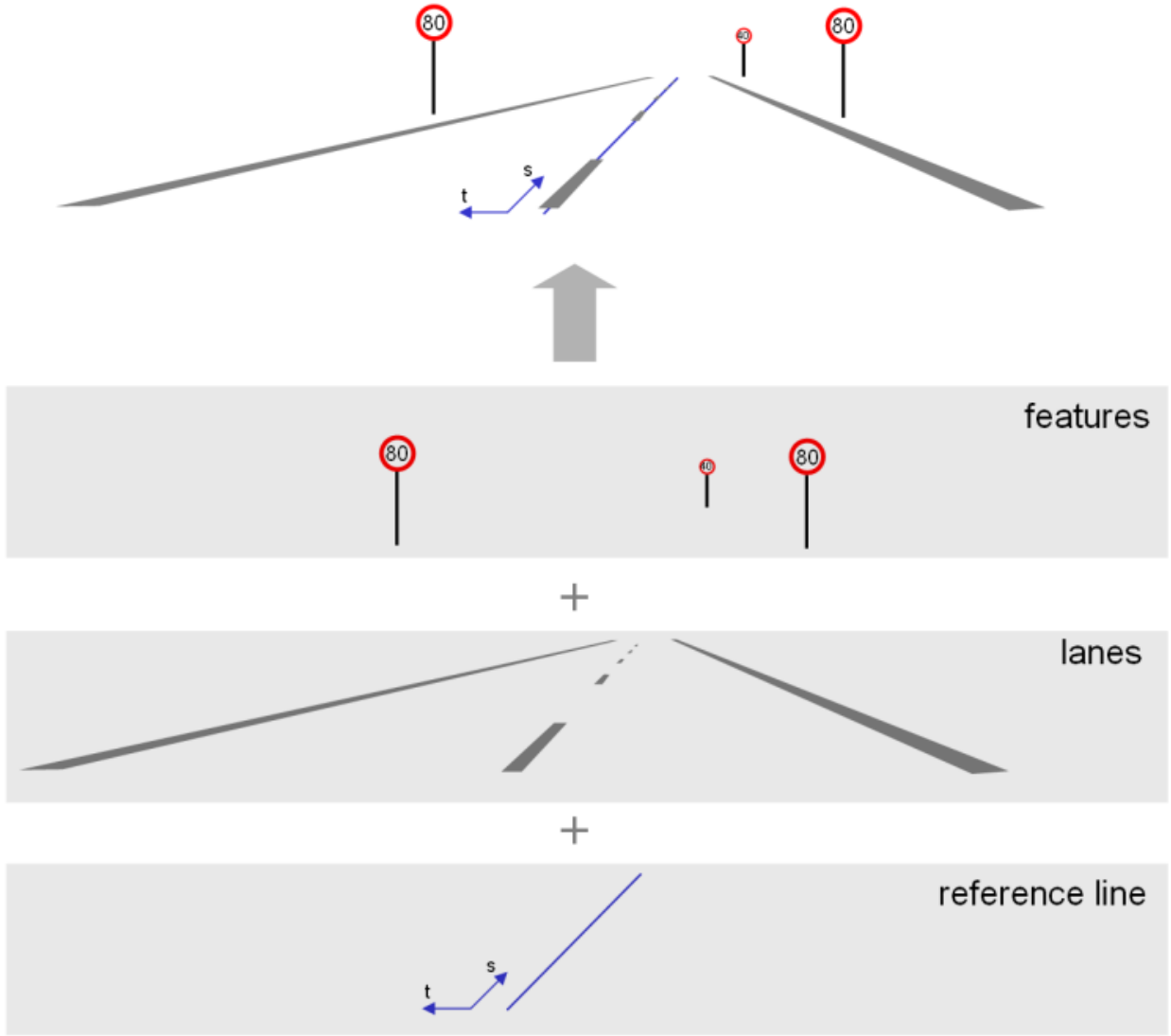
OpenDRIVE: open industry standard

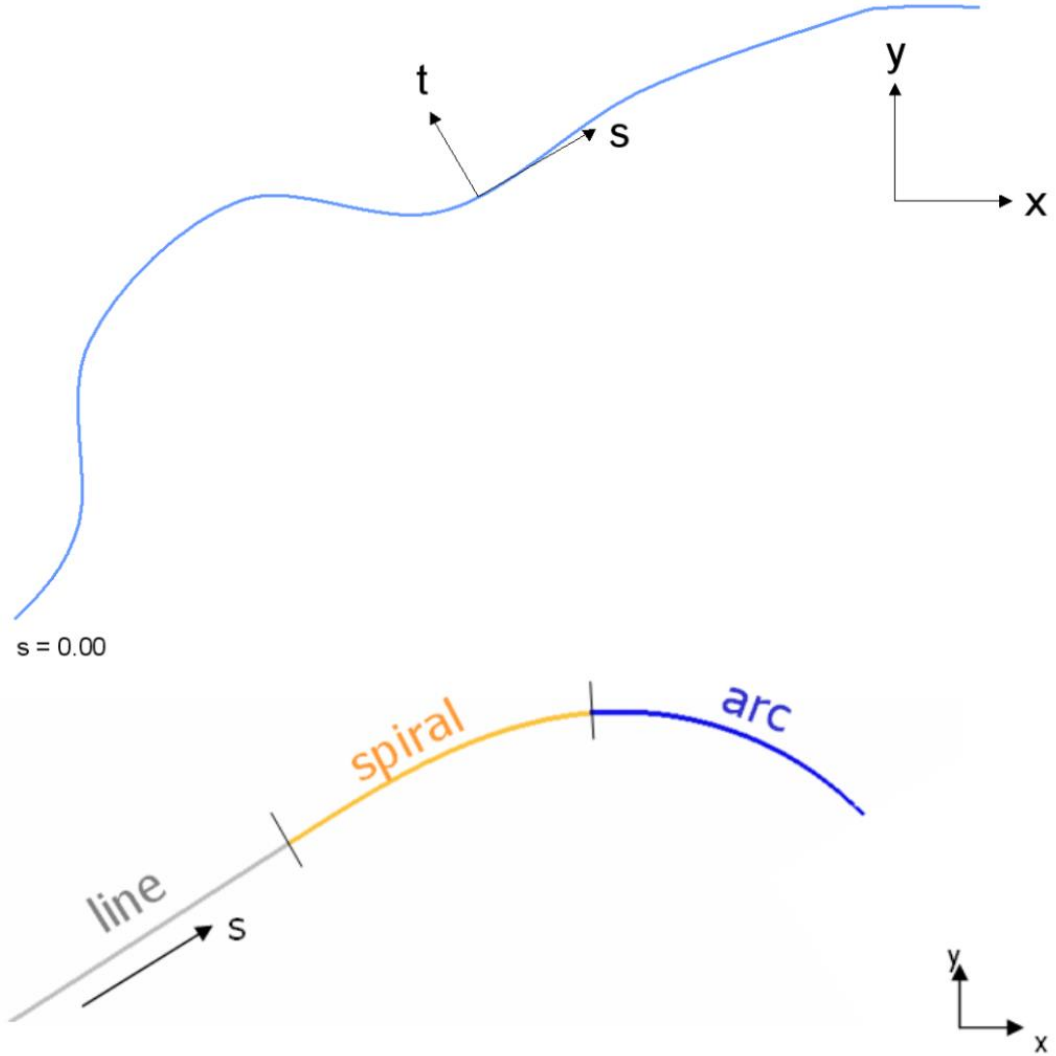
- XML-based database
- Hierarchical structure
- Detailed lane modelling
- Elements refer to an imaginary reference line



see OpenDRIVE Format Specification, Rev. 1.5

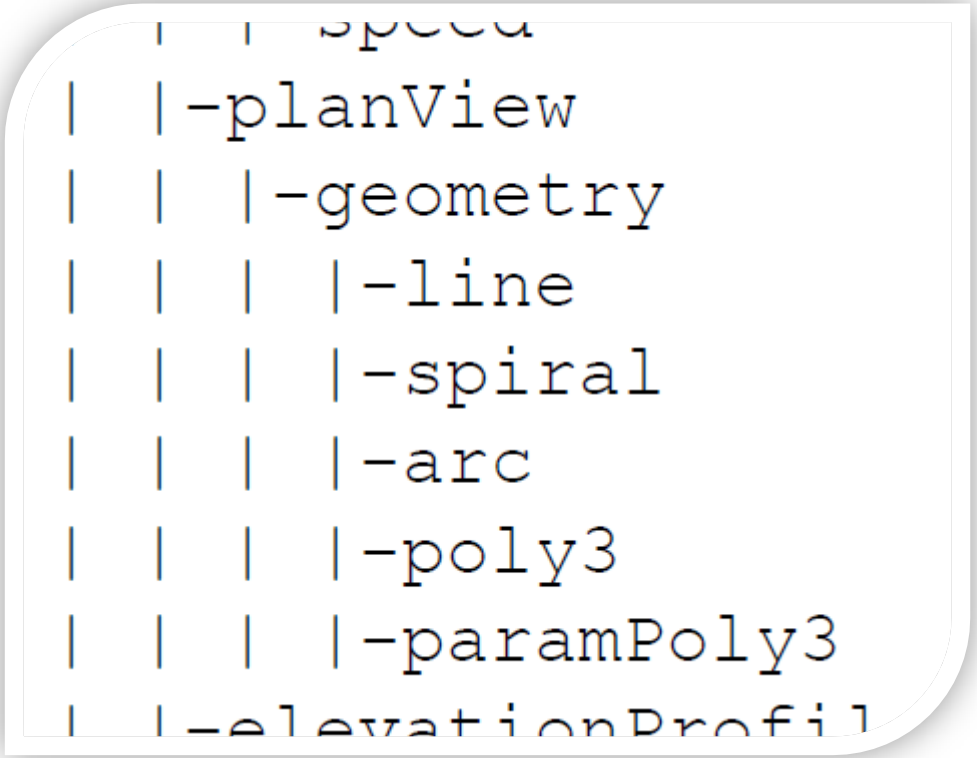
OpenDRIVE: open industry standard

- XML-based database
- Hierarchical structure
- Detailed lane modelling
- Elements refer to an imaginary reference line
- Road topography (3D) und topology
  - continuous geometry definition



see OpenDRIVE Format Specification, Rev. 1.5

OpenDRIVE: reference line geometry representation



OpenDRIVE Format Specification, Rev. 1.4

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>
  <geometry s="9.7589" x="604935.03"
            y="5792856.5285"
            hdg="3.5237"
            length="12.0">
    <line/>
  </geometry>
</planView>
```

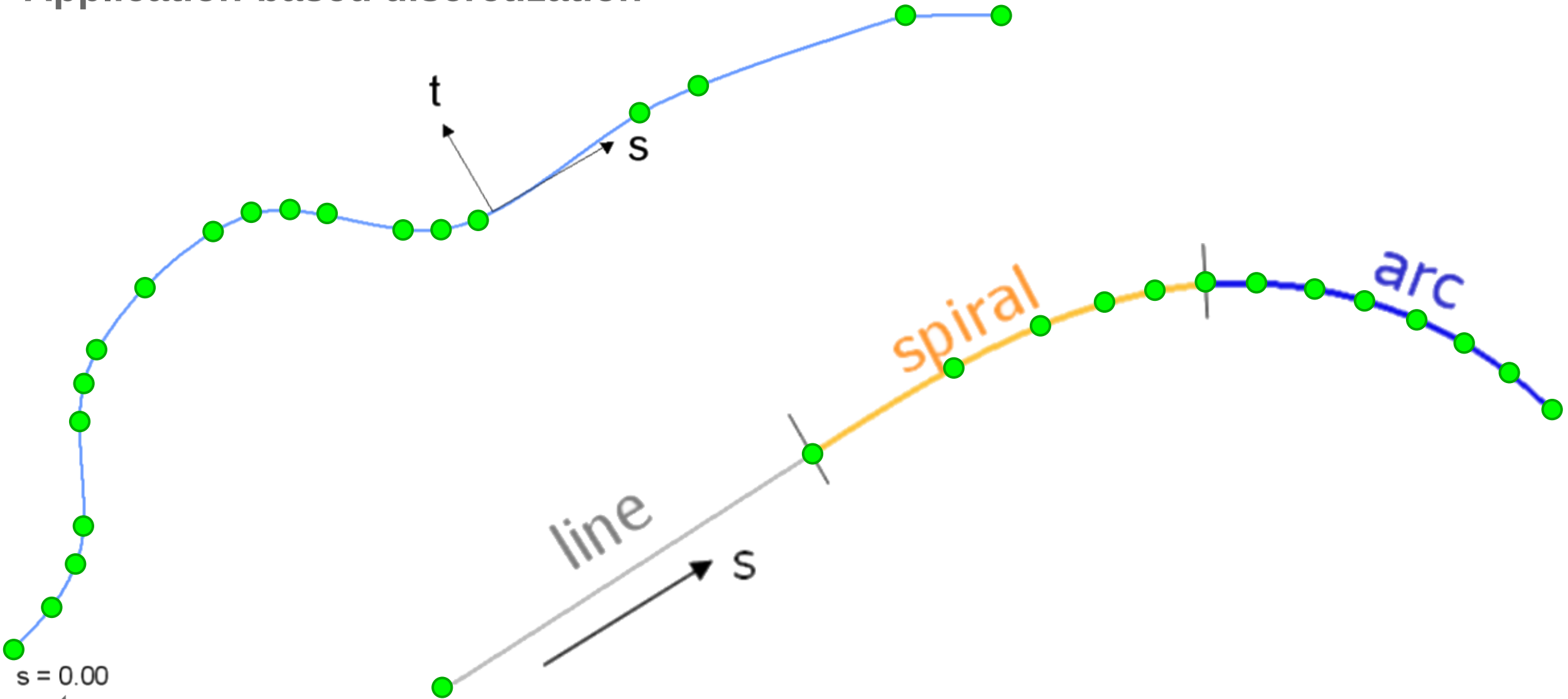
OpenDRIVE: continuous geometry evolution

```
<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>
```

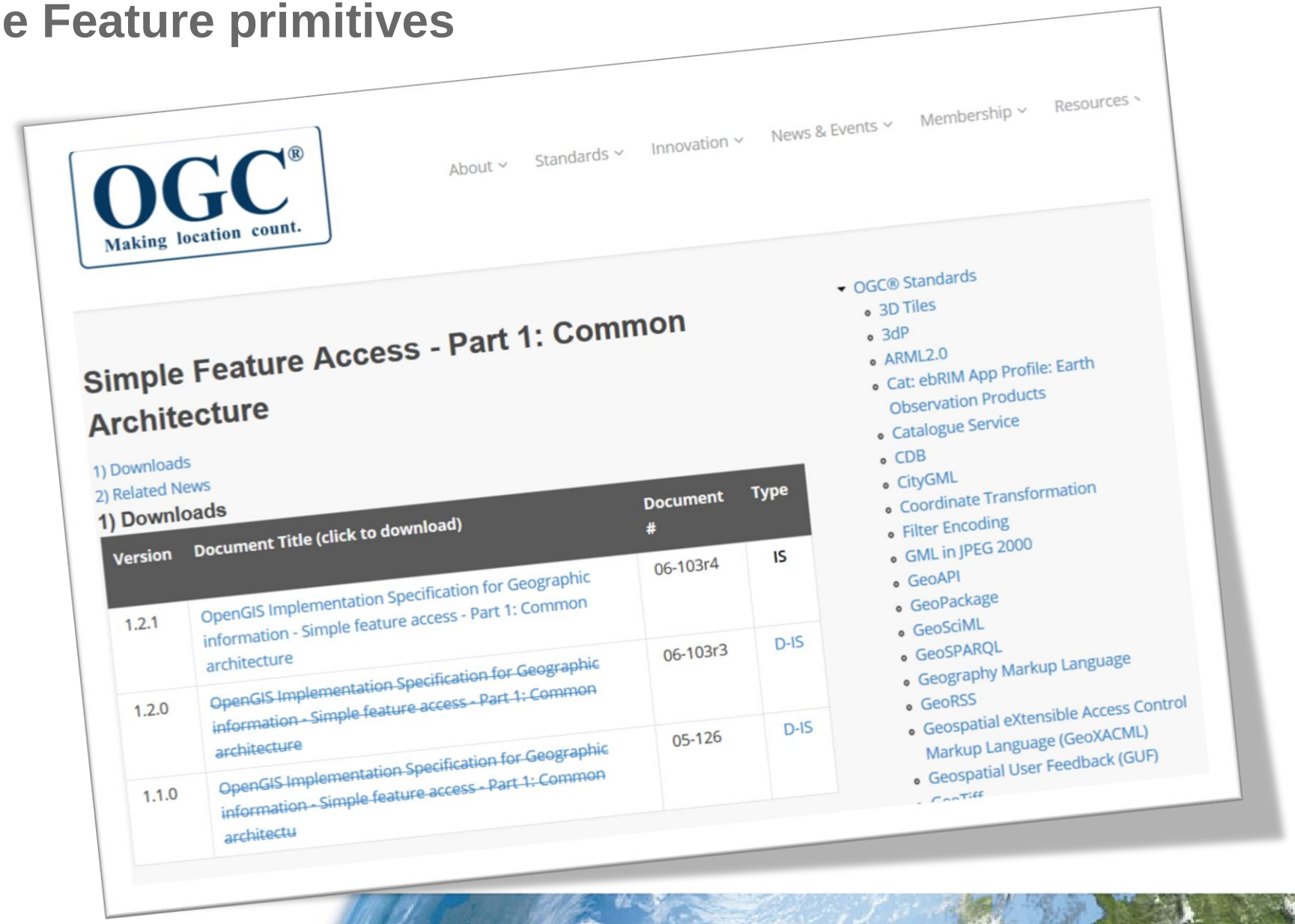
Application-based discretization (sampling)

„Everyone is doing this!“

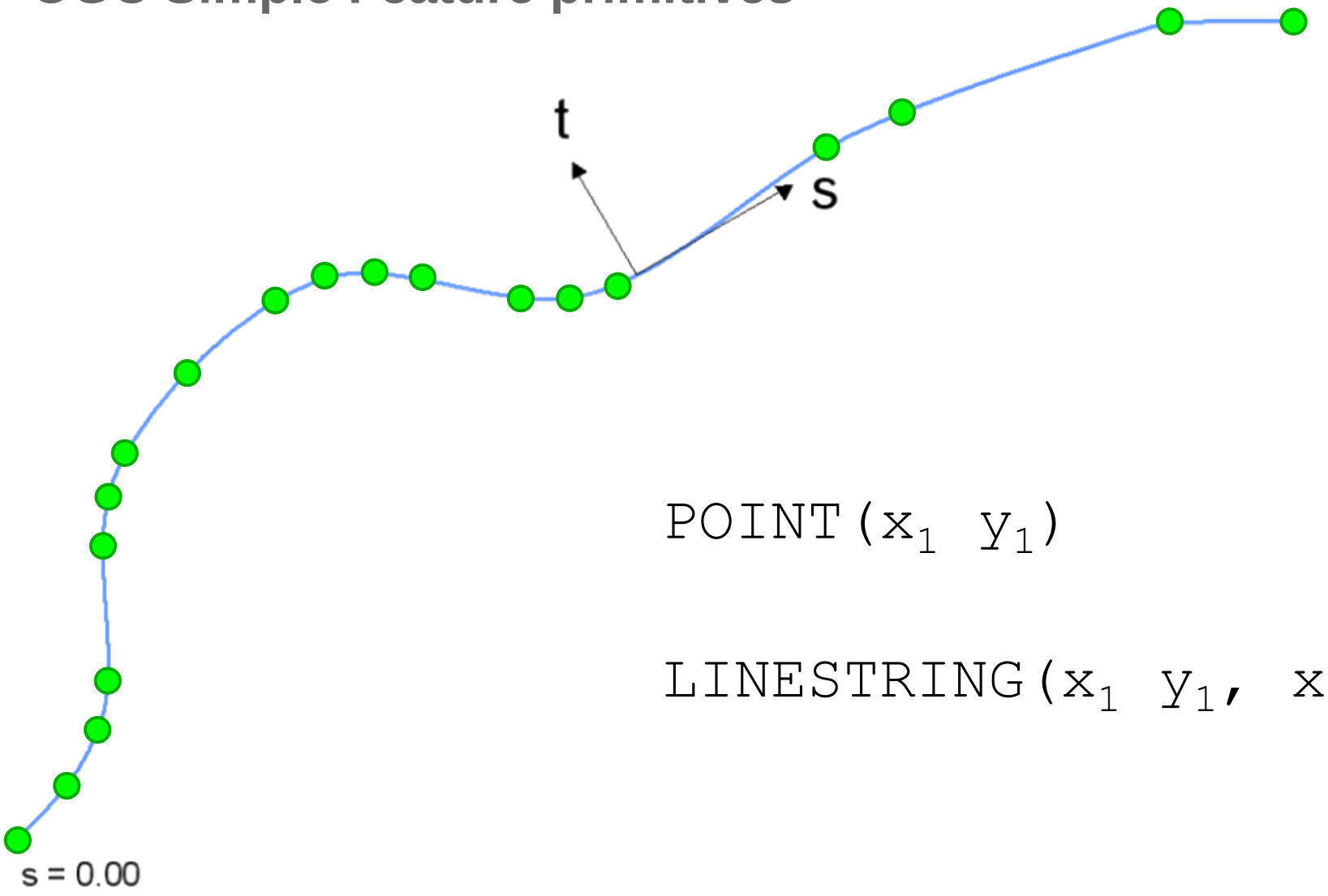
Application-based discretization



OGC Simple Feature primitives



OGC Simple Feature primitives



POINT(x_1 y_1)

LINESTRING(x_1 y_1, x_2 y_2, ..., x_n y_n)

Fitting OpenDRIVE into the Simple Feature model

```
<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>
```

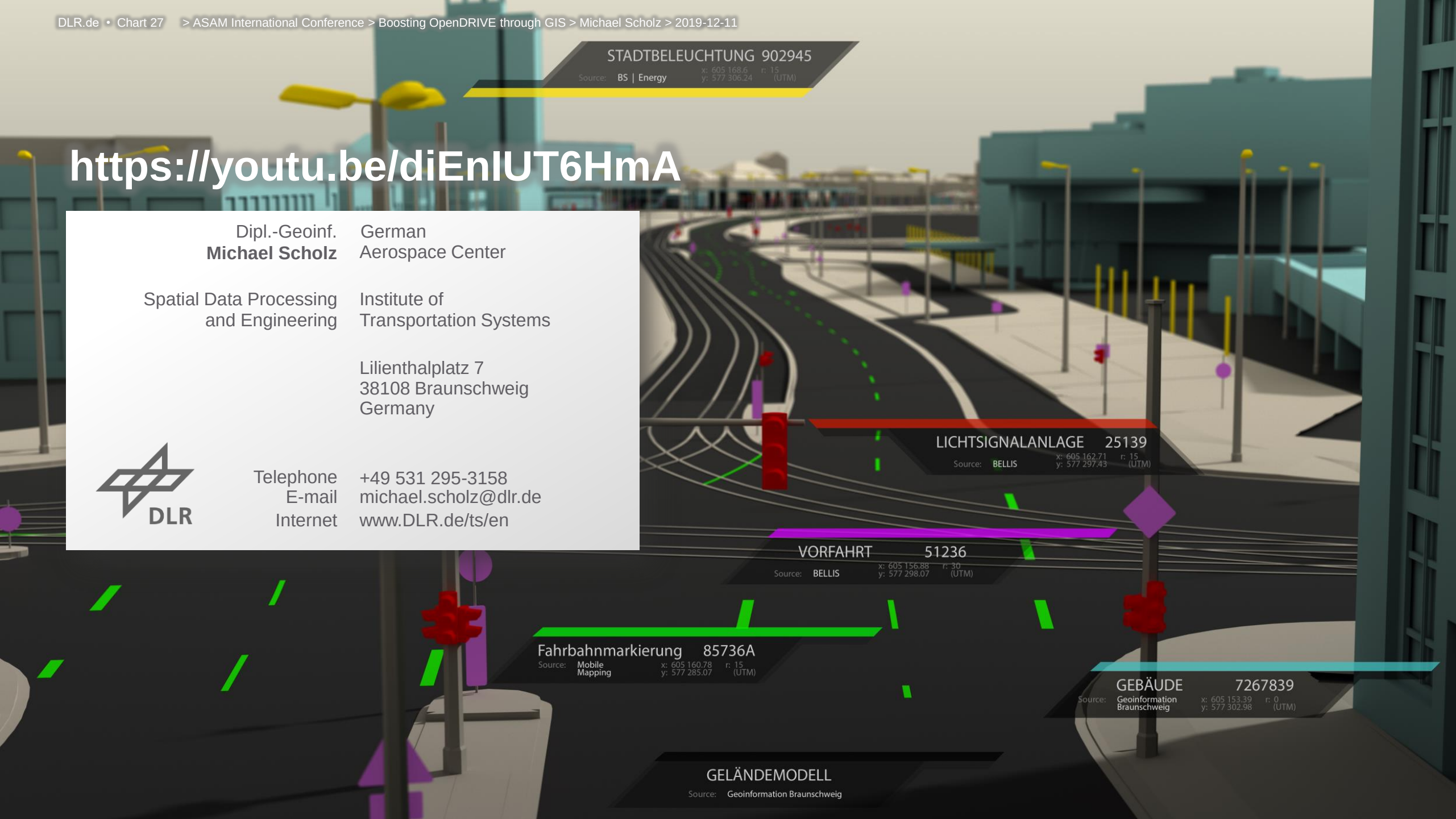
```
LineString(
   604944.1037 5792860.1272,
   604752.81 5792819.10, ...)

LineString(
  604935.03 5792856.5285,
  604754.39 5792810.73, ...)
```

Live demo

QGIS with OGC Simple Features and WMS/WFS

Conclusion: “Don’t re-invent the wheel”

- Geometry discretization could/should be based on OGC Simple Features
- Benefit from well-established tools in GIS domain:
  - Free/open frameworks for Java, C++, Python, … and web development
  - Super-easy ad hoc combination with arbitrary geo-data
  - Direct conversion into 100+ other formats: KML, GML, GeoJSON, CSV, Shapefile, SQLite, XLSX, …
    → GDAL: “One library to rule them all”
  - Standardized web services already available (OGC WMS, WFS, …)
- ASAM OpenDRIVE Area Concept Project introduces GIS aspects into OpenDRIVE



https://youtu.be/diEnIUT6HmA

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