Converting OpenStreetMap geo data into railML® for a Railway Simulation Environment

Christian Rahmig, Andreas Kluge
DLR Institute of Transportation Systems
Braunschweig, Germany

Overview

- Types of Digital Maps
- The Layer Approach
- The Toolchain:
  - Export data from OSM data base
  - Extract railway data and verify track network topology
  - Enhance railway data by layer-specific tags
  - Import railway data into DLR‘s railway map software / RailDriVE® db
  - Export railway data in railML®
- Implementation

Types of Digital Maps
OpenStreetMap

- OpenStreetMap (OSM) project was founded in 2004
- Goal: free world map
- Data model: „the simplest thing that could possibly work“ (Ramm, 2010)

TABLE I

THE BASIC OSM DATA TYPES AND THEIR ATTRIBUTES

nodes	ways	relations
id	id	id
version	version	version
timestamp	timestamp	timestamp
changeset ID	changeset ID	changeset ID
visible	visible	visible
latitude	{wayNodes}	{relationMembers}
longitude		
tile + tags	+ tags	+ tags

Tag: Key-Value pair
e.g. Key = „railway“, Value = „subway“

[Ramm, 2010] Ramm, F.; Topf, J.; Chilton, S.: 'OpenStreetMap. Using and Enhancing the Free Map of the World.' UIT Cambridge, 2010.

Types of Digital Maps
OpenStreetMap

- Railway data are not that exactly modelled like roads and streets
- There are almost **400 different values for the tag „railway“** [4]

TABLE II

COMMONLY USED VALUES FOR THE KEY ”RAILWAY”

abandoned	construction	disused	funicular
light_rail	miniature	monorail	narrow_gauge
preserved	rail ***53.56 %***	subway	tram
halt	station	tram_stop	buffer_stop
derail	crossing	level_crossing	turntable

[4] OpenStreetMap: „taginfo keys railway“; http://taginfo.openstreetmap.org/keys/?key=railway#values

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derail	crossing	leve	

Map-matching: There is no clear topological map representation.

- **How to use these data e.g. for railway-relevant applications?**

The Layer Approach

- Regarding the OSM data model there are only three „layers“:
  - **Nodes**
  - **Ways**
  - **Relations**

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The Layer Approach

- Regarding the OSM data model there are only three „layers“:

Nodes

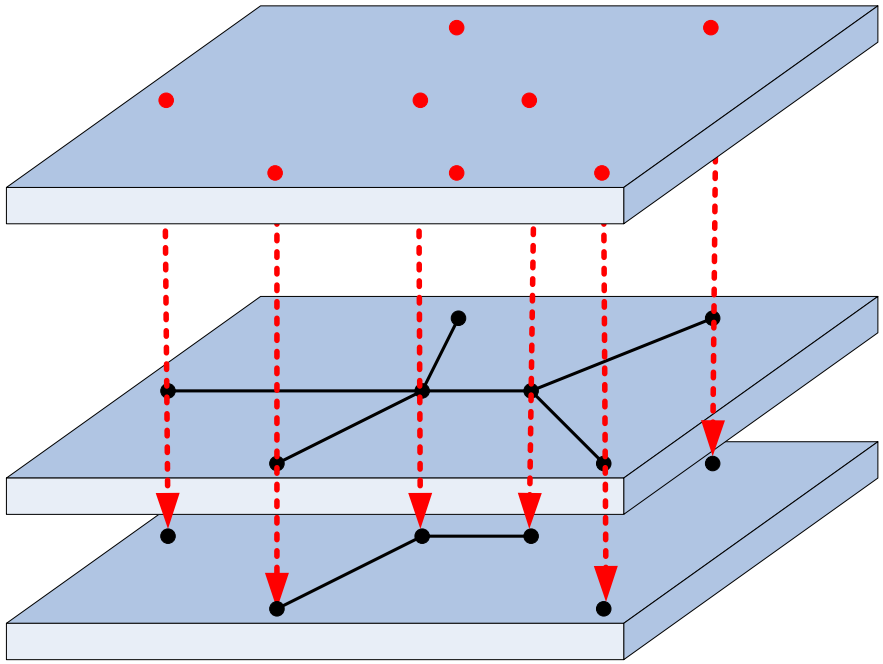
→ Coordinates Layer

Ways

Referencing nodes

Relations

Referencing nodes, ways and relations



The Layer Approach

New layers

- We want to define topic-specific layers:

Nodes

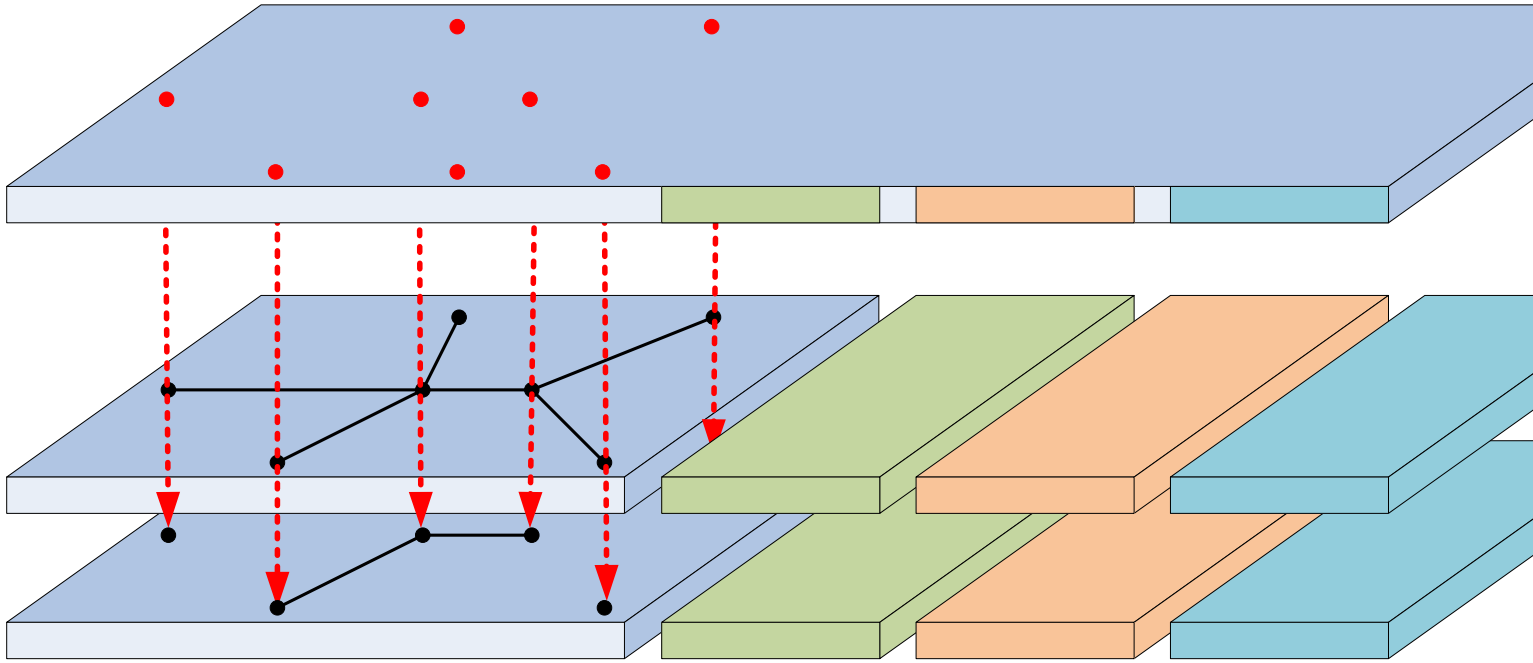
→ Coordinates Layer

Ways

Referencing nodes

Relations

Referencing nodes, ways and relations



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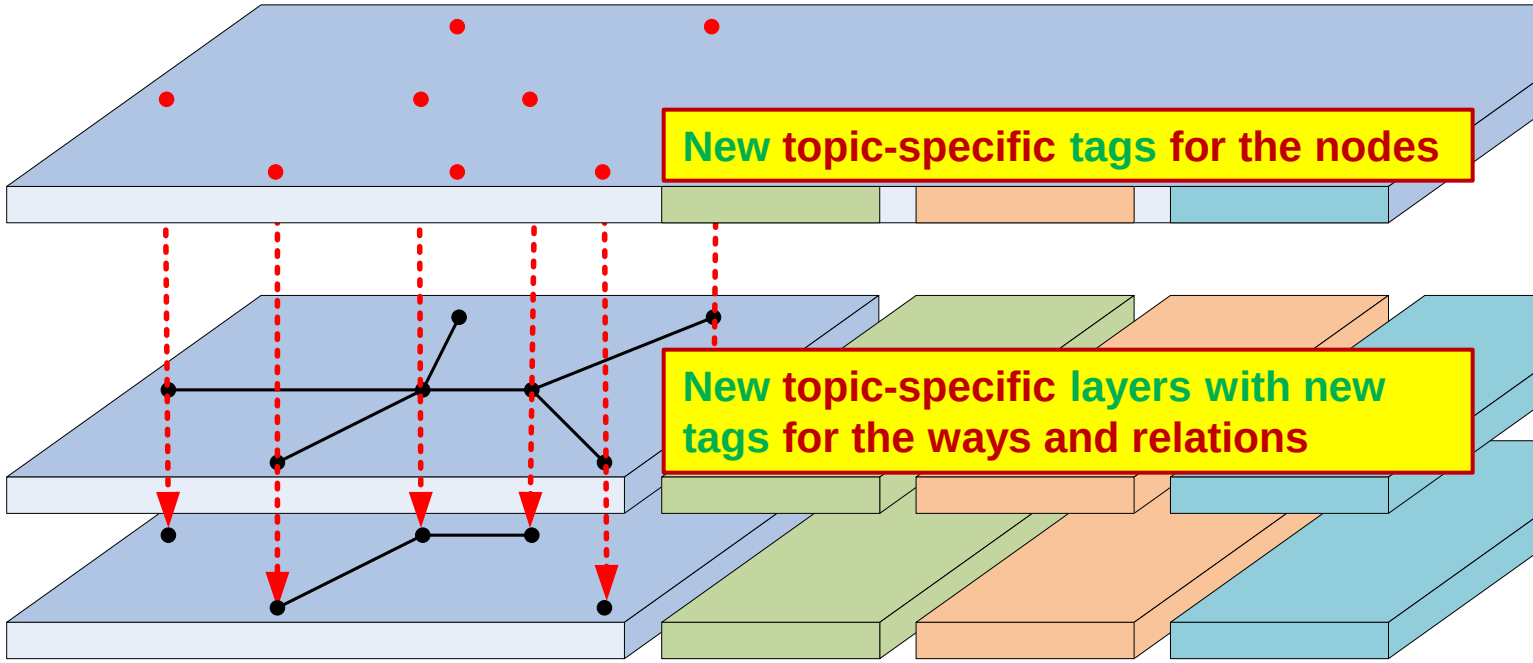


The Layer Approach

Layer-specific OSM tags

Table 1: Keys for railway topology modelling

node	way	relation
topologyName	topologyName	topologyName
	dir	**type** = "connection"
	length	course

The Layer Approach

Layer-specific OSM tags

Table 4: Keys for railway accuracy modelling

node	way	relation
sigmaLon	maxCamber	
sigmaLat		
sigmaAlt		

Table 1: Keys for railway topology modelling

node	way	relation
topologyName	topologyName	topologyName
	dir	**type** = "connection"
	length	course

We define 33 tags for the description of the railway track network as needed by most of the railway geodata applications.

Table 3: Keys for railway topography modelling

node	way	relation
topographyName	topographyName	topographyName
		type = "railNodeElement" / "railWayElement"
pos		elementType
dir		
distanceToTrack	distanceToTrack	

node	way	relation
geometryName	geometryName	geometryName
		type = "complexGeometry"
pos		geometryType
curvature		
gradient	length	
superelevation	curvature	
	gradient	
	superelevation	

OSM screenshot

- Braunschweig, VBV Area
  (OSM Transport Renderer)

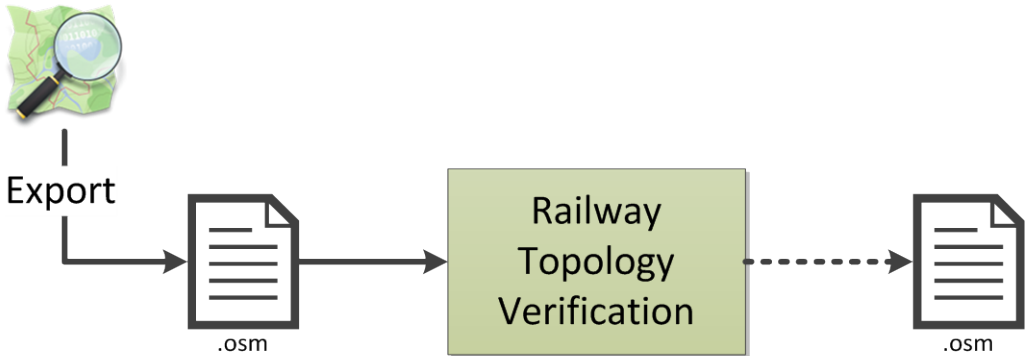
OSM screenshot

```
<node id="1421658233" lat="52.2433732" lon="10.5410844" user="digital0533" uid=
"383858" visible="true" version="1" changeset="9198079" timestamp=
"2011-09-03T05:49:35Z"/>
<node id="1421658235" lat="52.2438647" lon="10.5421583" user="digital0533" uid=
"383858" visible="true" version="1" changeset="9198079" timestamp=
"2011-09-03T05:49:35Z"/>
<node id="1421658237" lat="52.2439353" lon="10.5420485" user="digital0533" uid=
"383858" visible="true" version="1" changeset="9198079" timestamp=
"2011-09-03T05:49:35Z"/>
<way id="42321030" user="Mathias71" uid="83244" visible="true" version="3" changeset=
"2808749" timestamp="2009-10-10T22:22:46Z">
 <nd ref="528414460"/>
 <nd ref="528414477"/>
 <nd ref="528414494"/>
 <nd ref="528155845"/>
 <tag k="railway" v="disused"/>
</way>
<way id="105251408" user="erge50" uid="393959" visible="true" version="2" changeset=
"7637484" timestamp="2011-03-22T14:28:06Z">
 <nd ref="1212936624"/>
 <nd ref="1212936478"/>
 <nd ref="1212936796"/>
 <nd ref="1212936687"/>
 <nd ref="1212936624"/>
 <tag k="addr:city" v="Braunschweig"/>
 <tag k="addr:country" v="DE"/>
 <tag k="addr:postcode" v="38126"/>
 <tag k="addr:street" v="Behringstraße"/>
 <tag k="building" v="yes"/>
</way>
```

- Step 1: Get OSM file from the relevant area

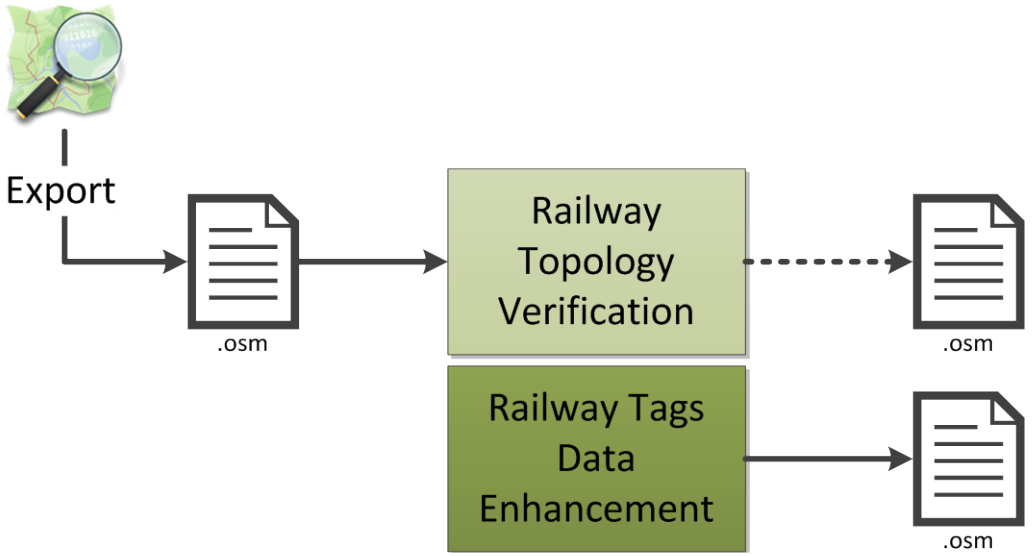
The Toolchain

- Step 2: **Topology Verification** …extract railway network and verify its topology (node egde model)
- Result: OSM file with topologically verified railway track network



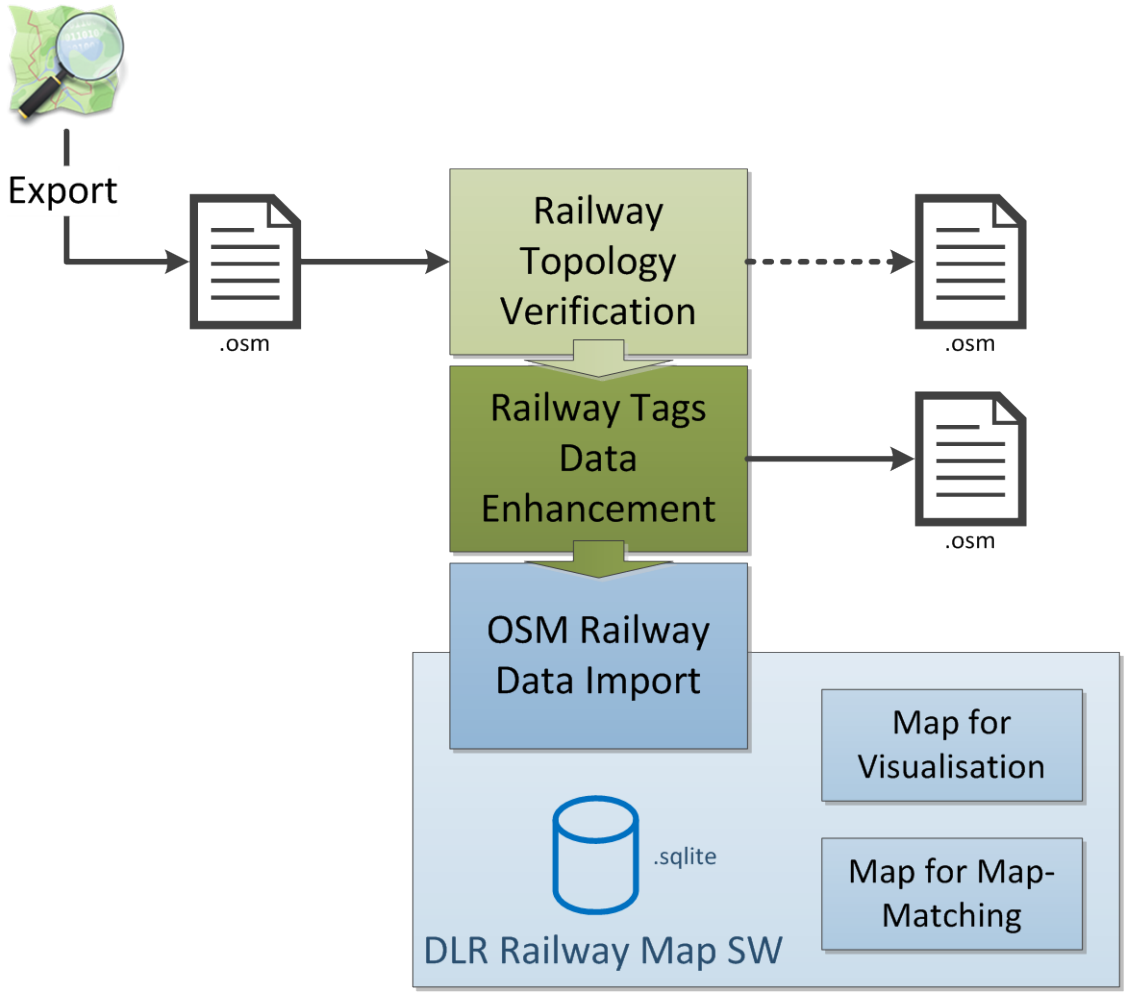
The Toolchain

- Step 3: **Railway Data Enhancement** …add layer-specific tags to the railway elements in the map
- Result: OSM file with enhanced railway track network description



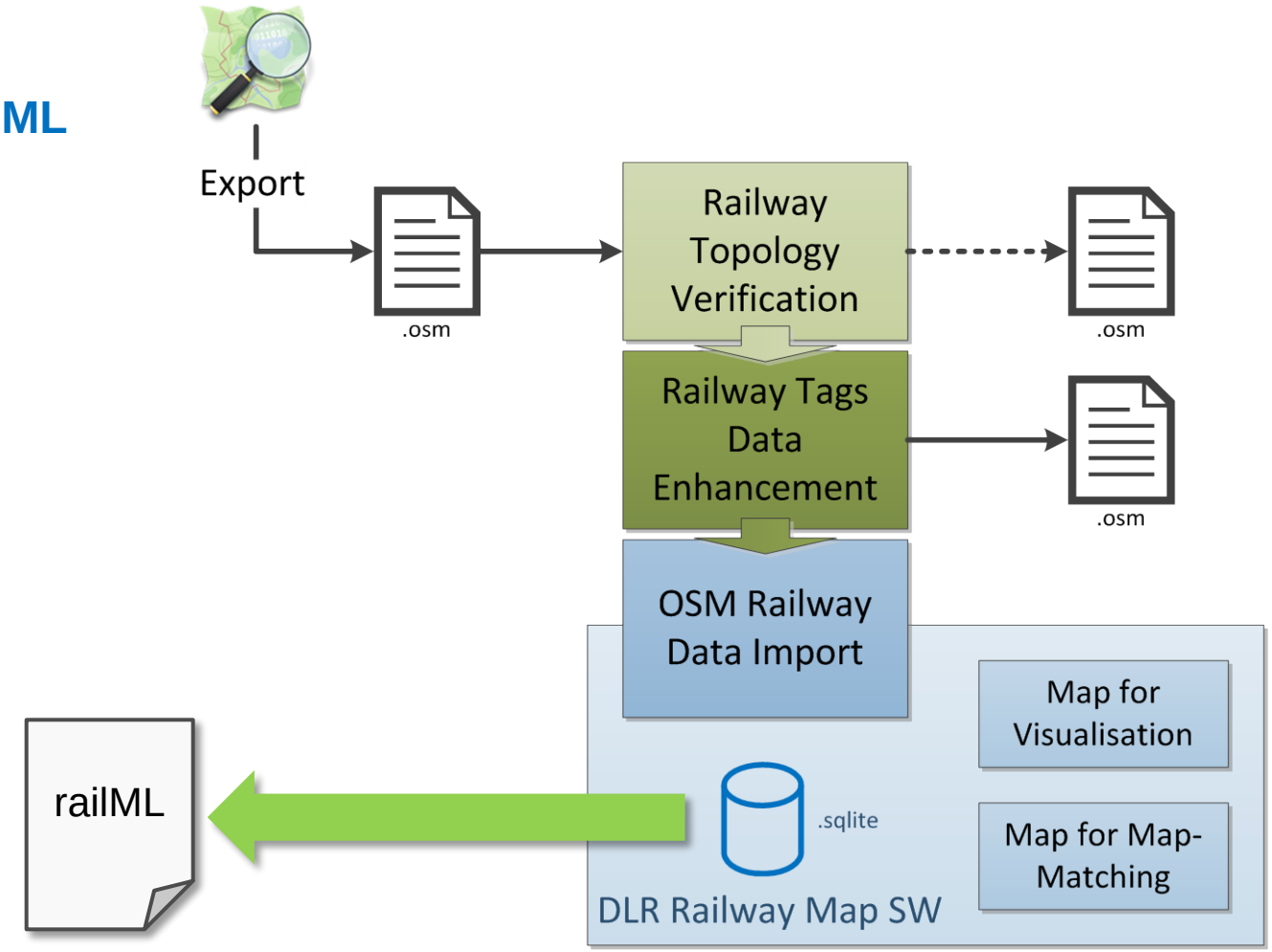
The Toolchain

- Step 4:
  Railway Data Import and Usage
  …import OSM data into DLR‘s railway map software / RailDriVE® db
- Result: usage of imported OSM data for visualization or map-matching applications etc.



The Toolchain

- Step 5: **railML Export**



Implementation
Initial Situation

- Simulation in the RailSET laboratory is based on ZUSI

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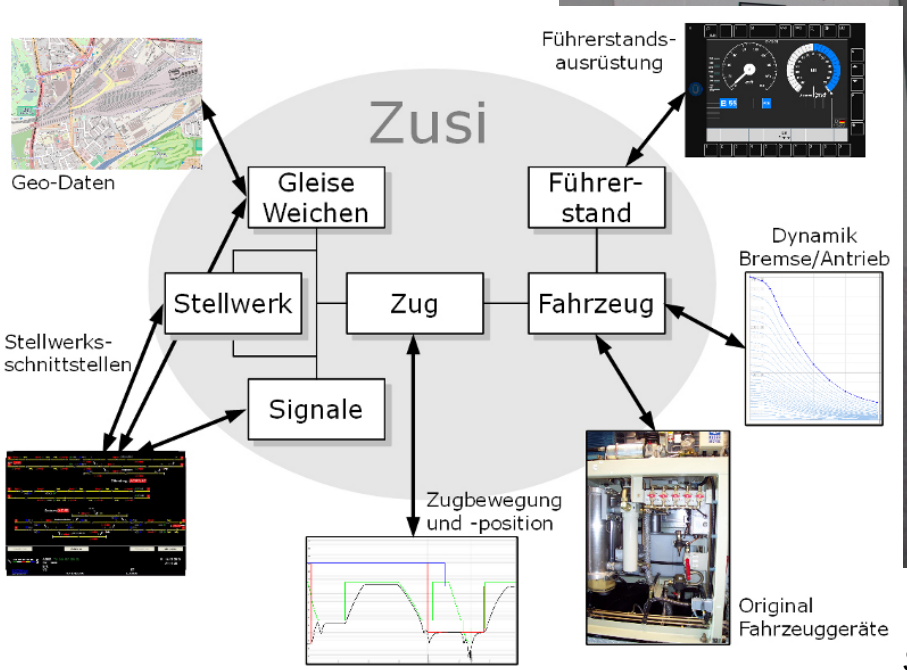


Source: www.zusi.de

Implementation
Initial Situation

- The number of lines to be simulated within the RailSET laboratory environment is limited
- The generation of tracks/lines for simulation is expensive (time, students)
- Currently, it is not possible to model/visualize/simulate arbitrary lines in short term

- **Goal:** to model, visualize and simulate arbitrary tracks within the RailSET laboratory environment
- **Task:** Concept and implementation of a process chain for simulation-based scenario and landscape generation

Implementation

RailSET Simulation Laboratory Environment

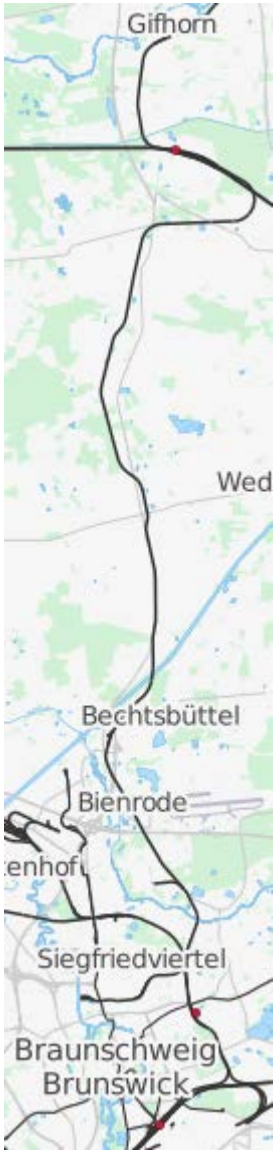
- The RailSiTe/RailSET laboratory is being adapted from ZUSI to Vires

Source: www.vires.com

- Vires-based simulations are used already in the Automotive Department of the Institute

Implementation
Reference Line

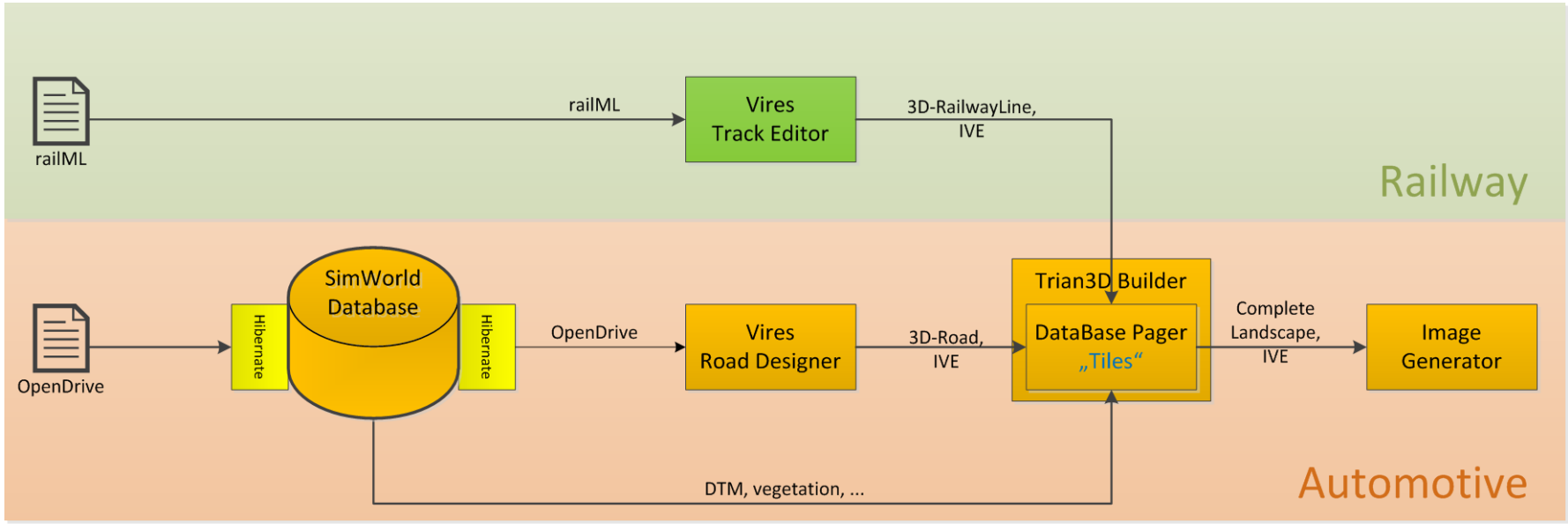
- Additionally, Vires built the railway reference line Braunschweig-Gifhorn within the AIM project for being used in the RailSET laboratory environment



Implementation

Railway Simulation Landscape Creation Tool Chain

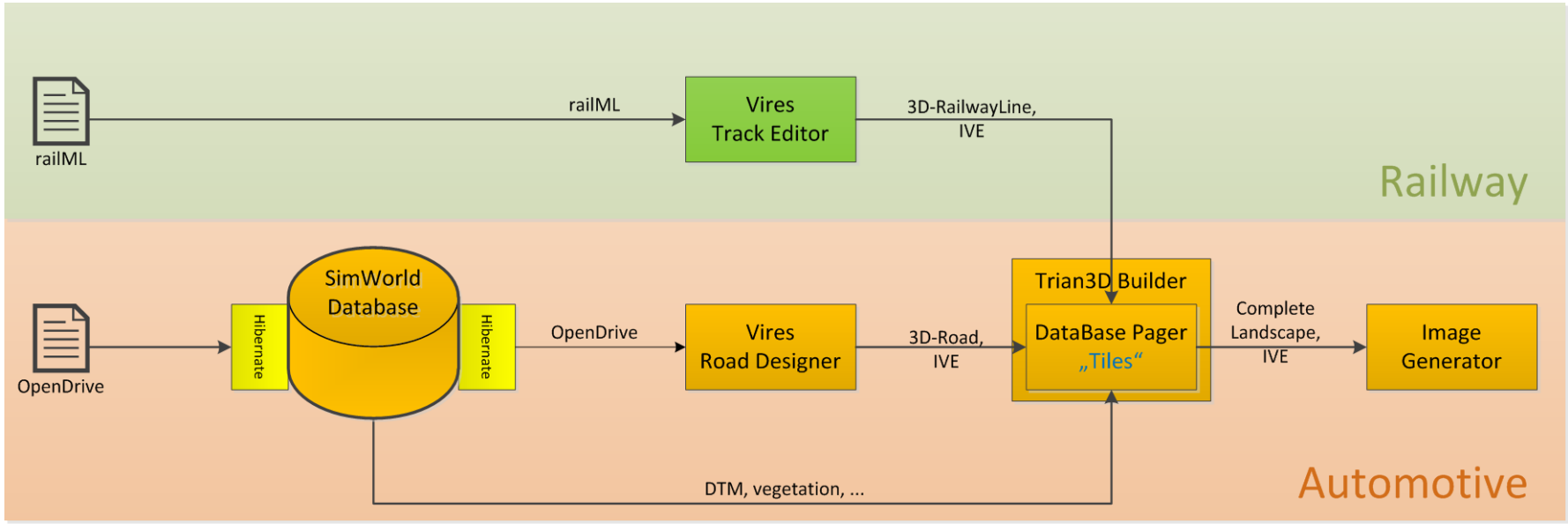
- Use Vires Track Editor to create railway lines for the RailSET simulation
- The result of the Track Editor is a 3D model of the railway line, which is fused with the 3D landscape model in the Trian3D-Builder software.



Implementation

Railway Simulation Landscape Creation Tool Chain

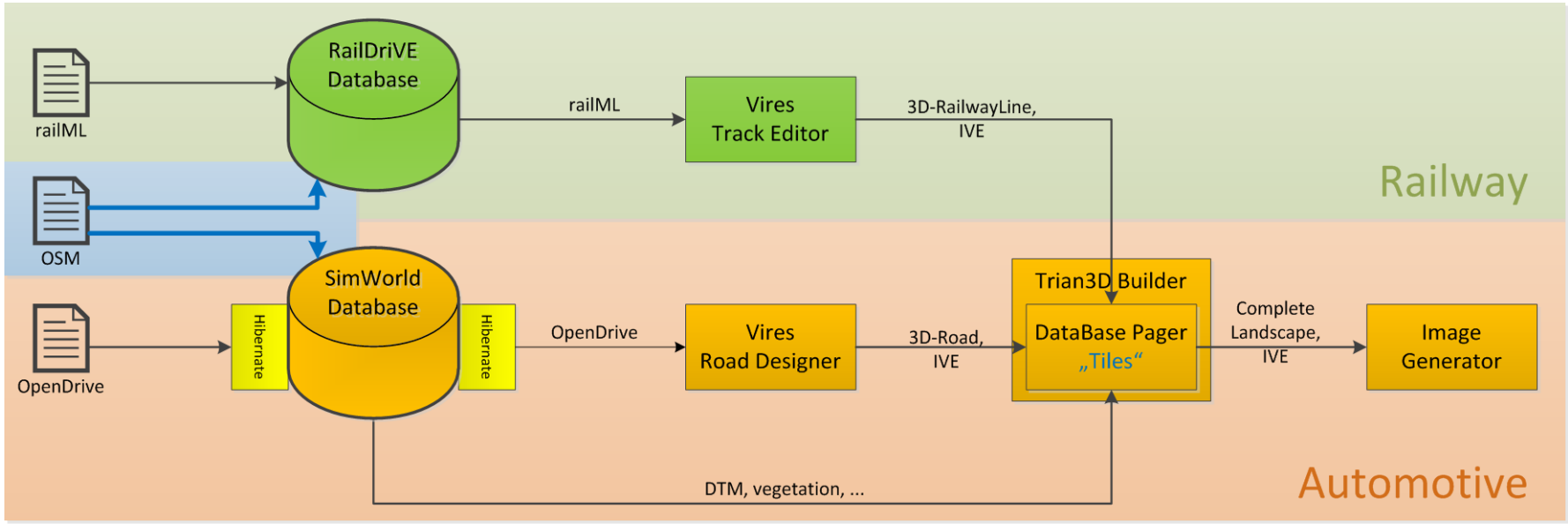
- Level 1: Use an arbitrary railML® infrastructure file from any source



Implementation

Railway Simulation Landscape Creation Tool Chain

- Level 2: Using geo data from the RailDriVE® data base (railML® export)
- Pro: several input sources can be used, including OpenStreetMap



Thank you for your attention!

Christian Rahmig
German Aerospace Center
Institute of Transportation Systems
Braunschweig, Germany
E-mail: christian.rahmig@dlr.de
Phone: +49 531 295 3461