railML.org®

railML® 2.x Infrastructure

Topologic modelling of switches and crossings

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Outline

- What is railML® Infrastructure?
- Topology modelling:
  - The principle of Topology Modelling with railML
  - Modelling of a simple switch
  - Modelling of a simple crossing
  - Modelling of a simple switch crossing
  - Modelling of a double switch crossing

Introduction

What is railML® Infrastructure?

- **Track Topology**
- Track Geometry
- Track Topography and railway service-relevant data

… Graph with Nodes and Edges

Introduction

What is railML® Infrastructure?

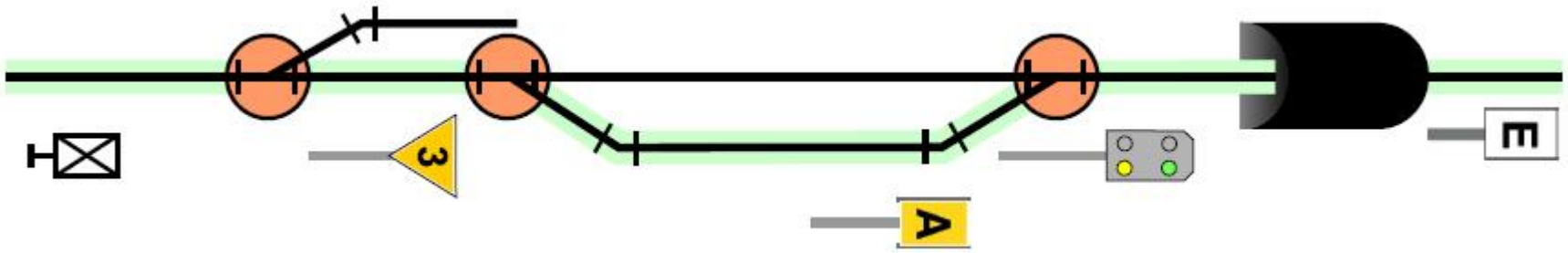
- Track Topology
- **Track Geometry**
- Track Topography and railway service-relevant data

… straight lines, curves, increasing/decreasing slope

Introduction

What is railML® Infrastructure?

- Track Topology
- Track Geometry
- **Track Topography and railway service-relevant data**

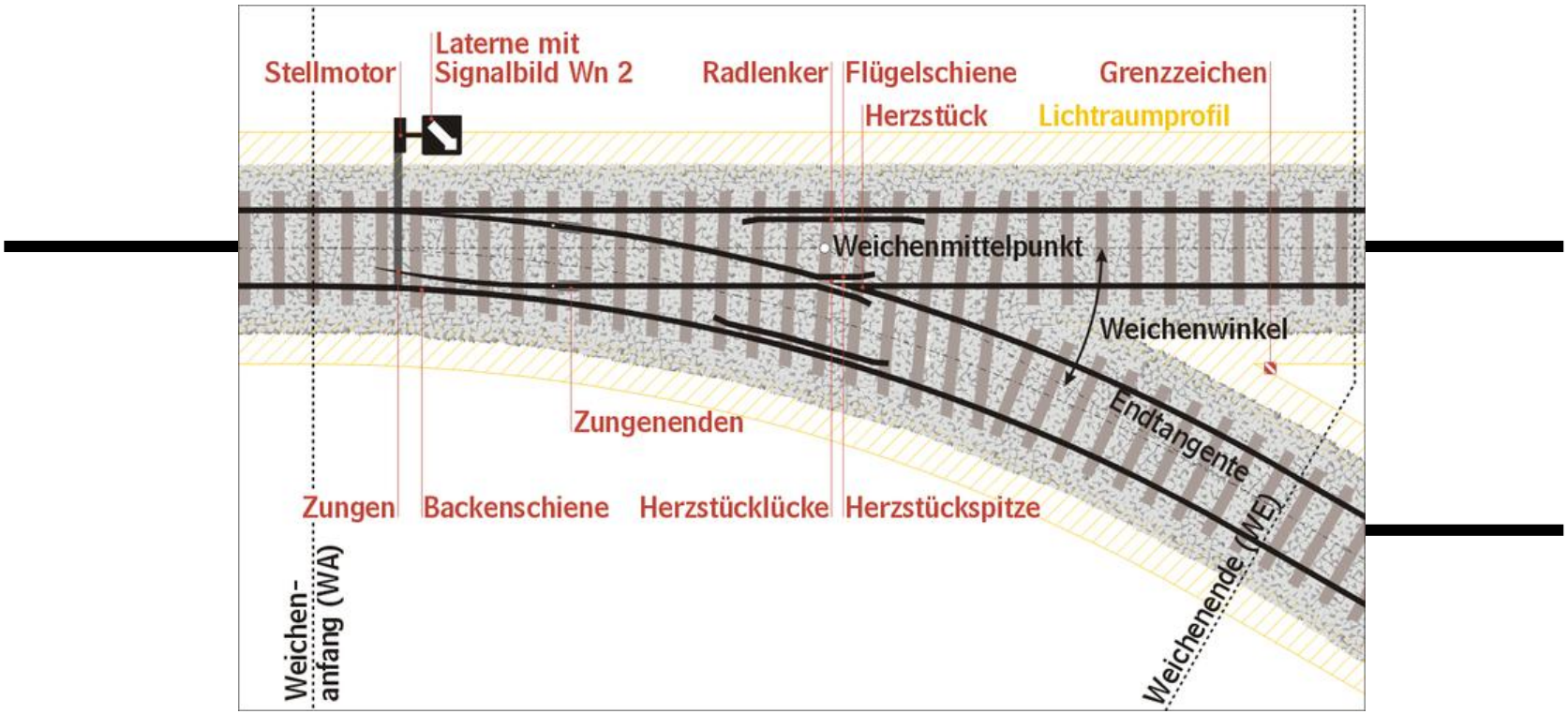


… signals, platforms, tunnels, electrification etc.

Pictures: Böhringer, F.: Gleisselektive Ortung von Schienenfahrzeugen mit bordautonomer Sensorik; Dissertation; Karlsruhe, 2008

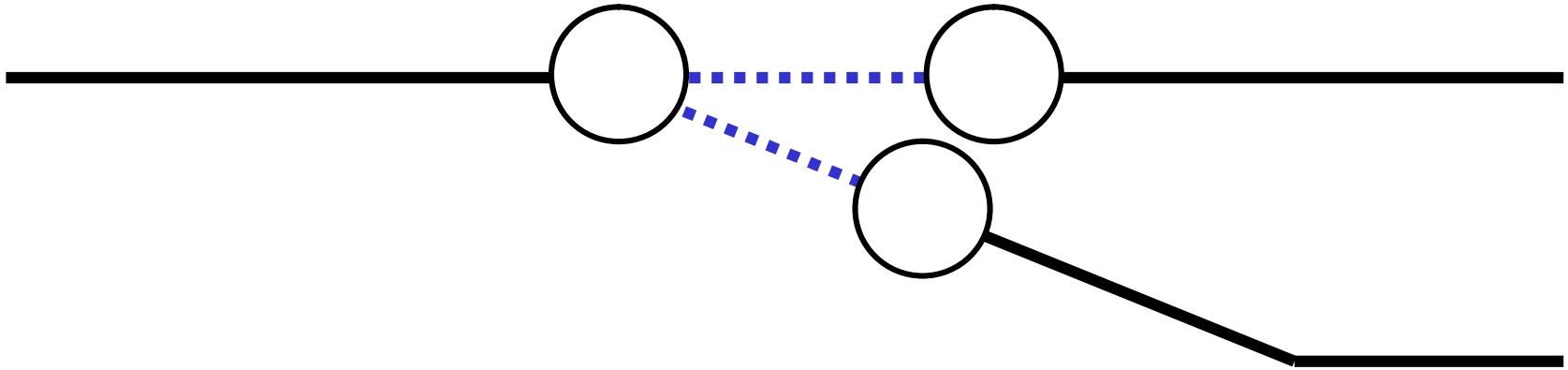
The principle of Topologic Modelling with railML

- Example: simple switch



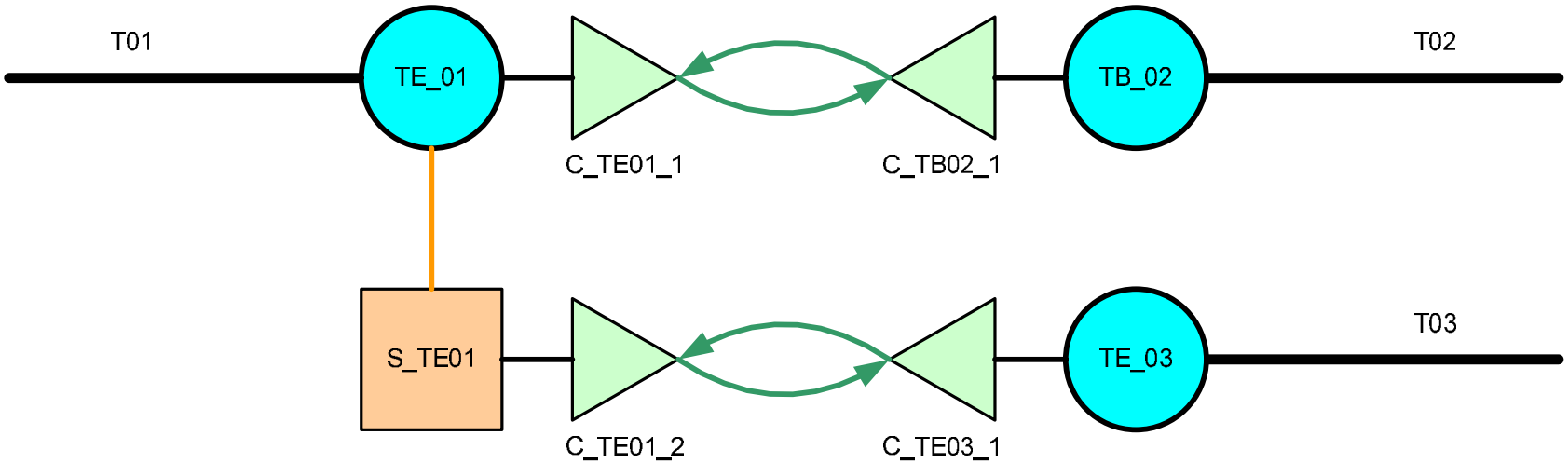
The principle of Topologic Modelling with railML

- Option 1: simple switch at the end of a track



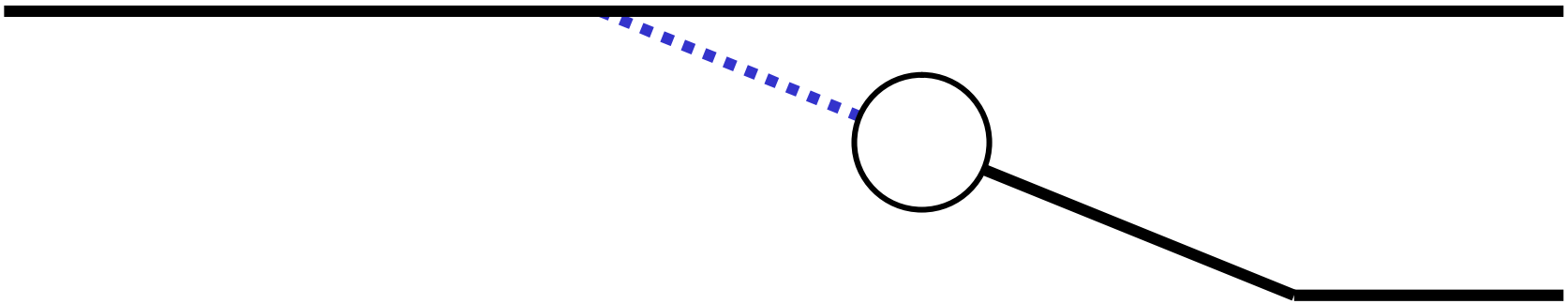
The principle of Topologic Modelling with railML

- Option 1: simple switch at the end of a track



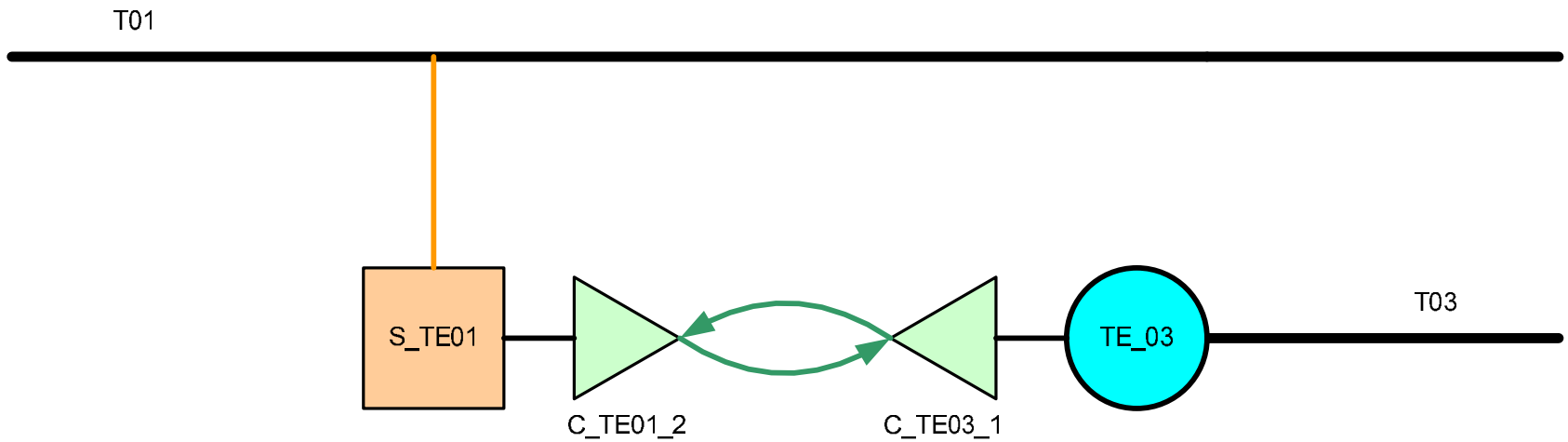
The principle of Topologic Modelling with railML

- Option 2: simple switch in the middle of a track

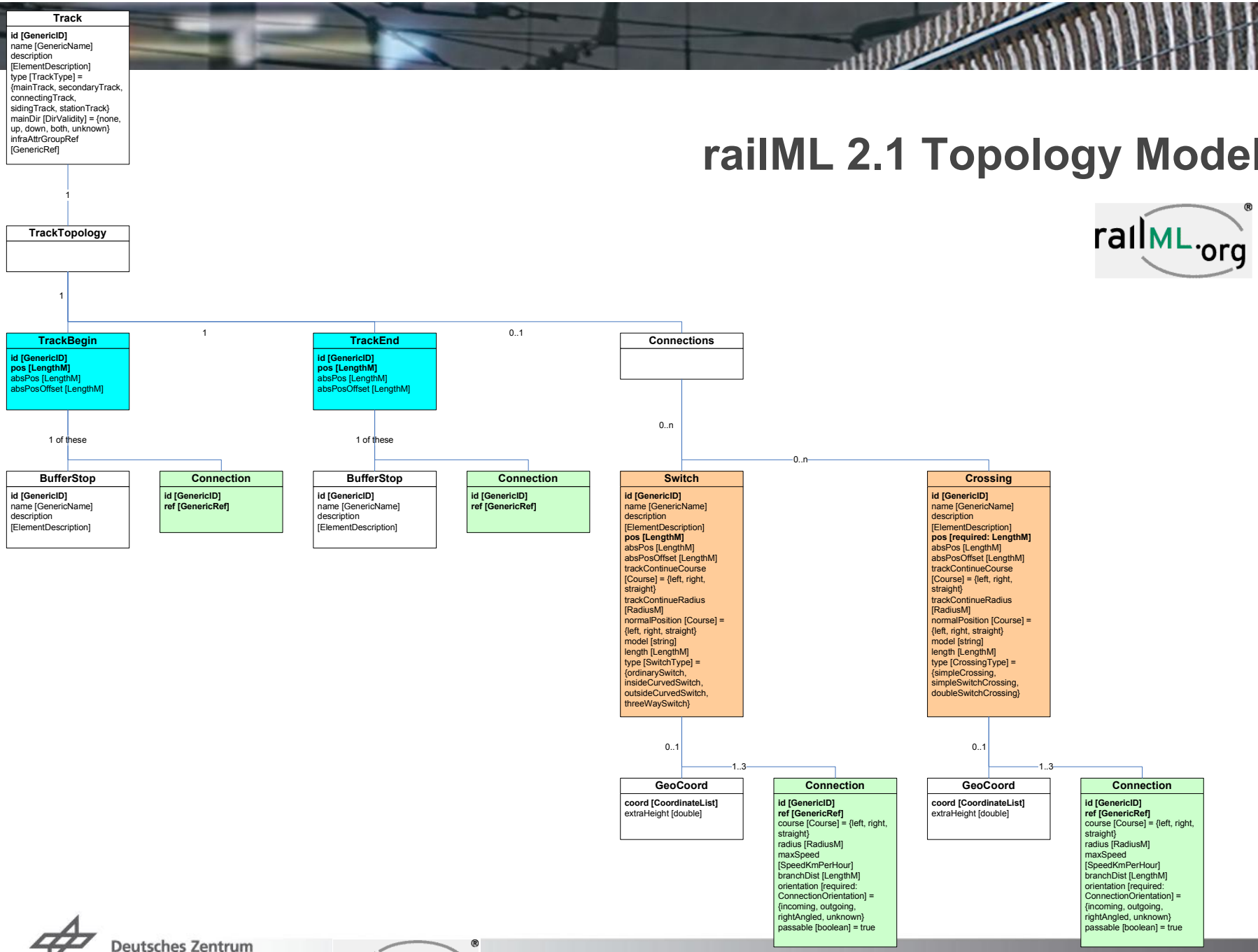


The principle of Topologic Modelling with railML

- Option 2: simple switch in the middle of a track



railML 2.1 Topology Model

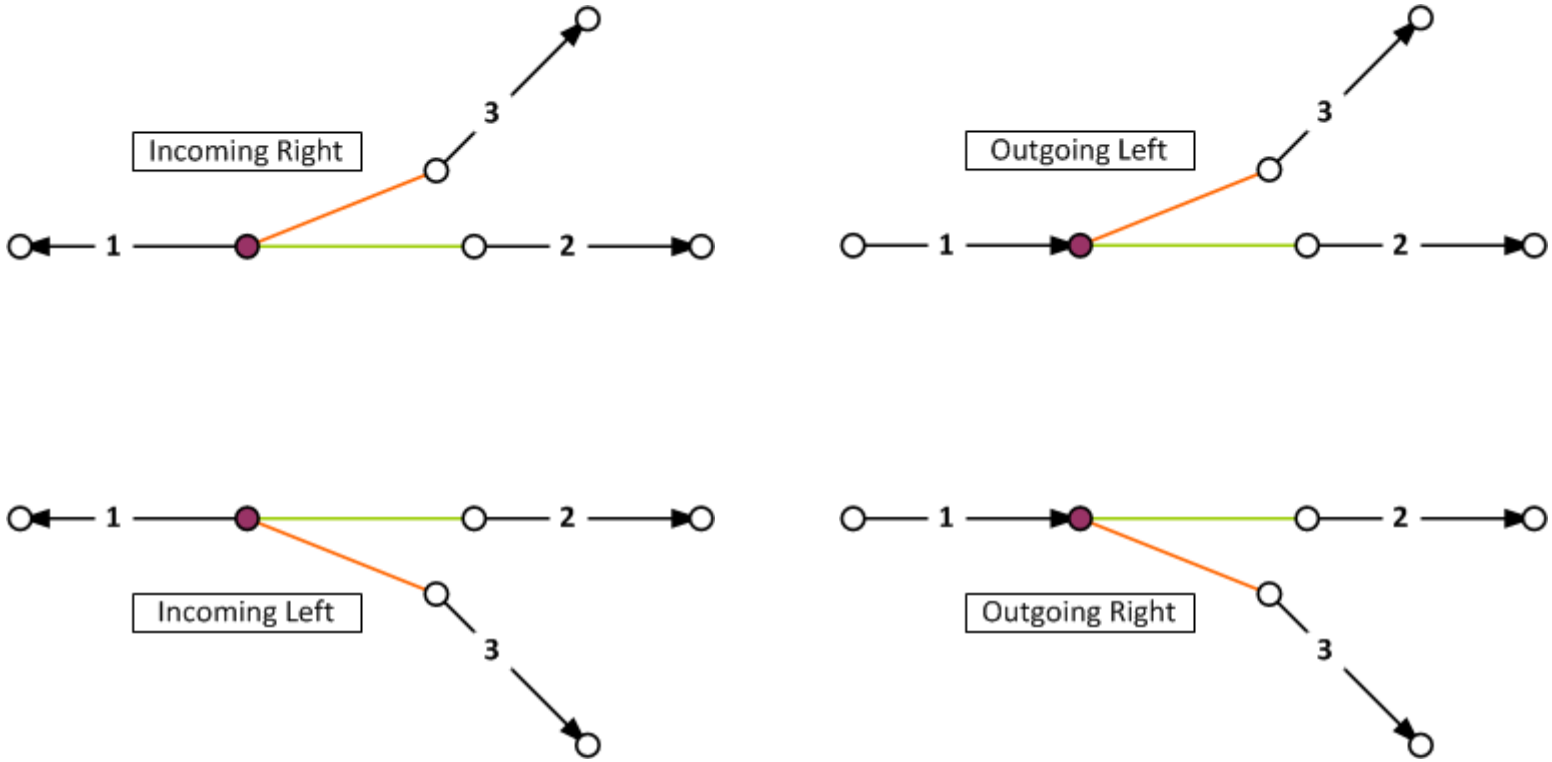


Modelling of a simple switch

```
<tracks>
   <track id="2" name="track_2">
      <trackTopology>
         <trackBegin id="2001" pos="0">
            <!-- ... -->
         </trackBegin>
         <trackEnd id="2002" pos="373.78">
            <connection id="103" ref="104" />
         </trackEnd>
      </trackTopology>
   </track>
   <track id="7" name="track_7">
      <trackTopology>
         <trackBegin id="7001" pos="0">
            <connection id="104" ref="103" />
         </trackBegin>
         <trackEnd id="7002" pos="132.99">
            <!-- ... -->
         </trackEnd>
         <connections>
            <switch type="ordinarySwitch" pos="0" name="switch 8" id="8">
               <connection orientation="incoming" course="right" id="145" ref="142" />
            </switch>
         </connections>
      </trackTopology>
   </track>
   <track id="136" name="track_136">
      <trackTopology>
         <trackBegin id="1361" pos="0">
            <connection id="142" ref="145" />
         </trackBegin>
         <trackEnd id="1362" pos="1">
            <!-- ... -->
         </trackEnd>
      </trackTopology>
   </track>
</tracks>
```

Modelling of a simple switch

- Orientation and course:

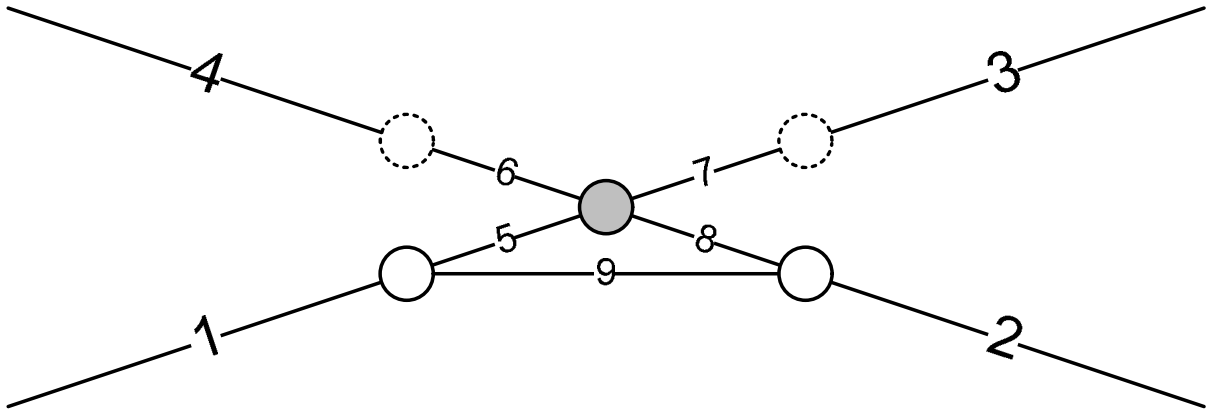


Modelling of a simple crossing

```
<track id="34" name="track_34">
<track id="39" name="track_39">
<track id="55" name="track_55">
<track id="70" name="track_70">
<track id="340" name="track_340">
   <trackTopology>
      <trackBegin id="34001" pos="0">
         <connection id="34099" ref="152" />
      </trackBegin>
      <trackEnd id="34002" pos="31.5">
         <connection id="34098" ref="39099" />
      </trackEnd>
      <connections>
         <crossing type="simpleCrossing" pos="31.5" id="34097">
            <connection orientation="incoming" id="34096" ref="55098" />
            <connection orientation="outgoing" id="34095" ref="70098" />
         </crossing>
      </connections>
   </trackTopology>
</track>
<track id="390" name="track_390">
<track id="550" name="track_550">
<track id="700" name="track_700">
<track id="3470" name="track_3470">
<track id="3955" name="track_3955">
```

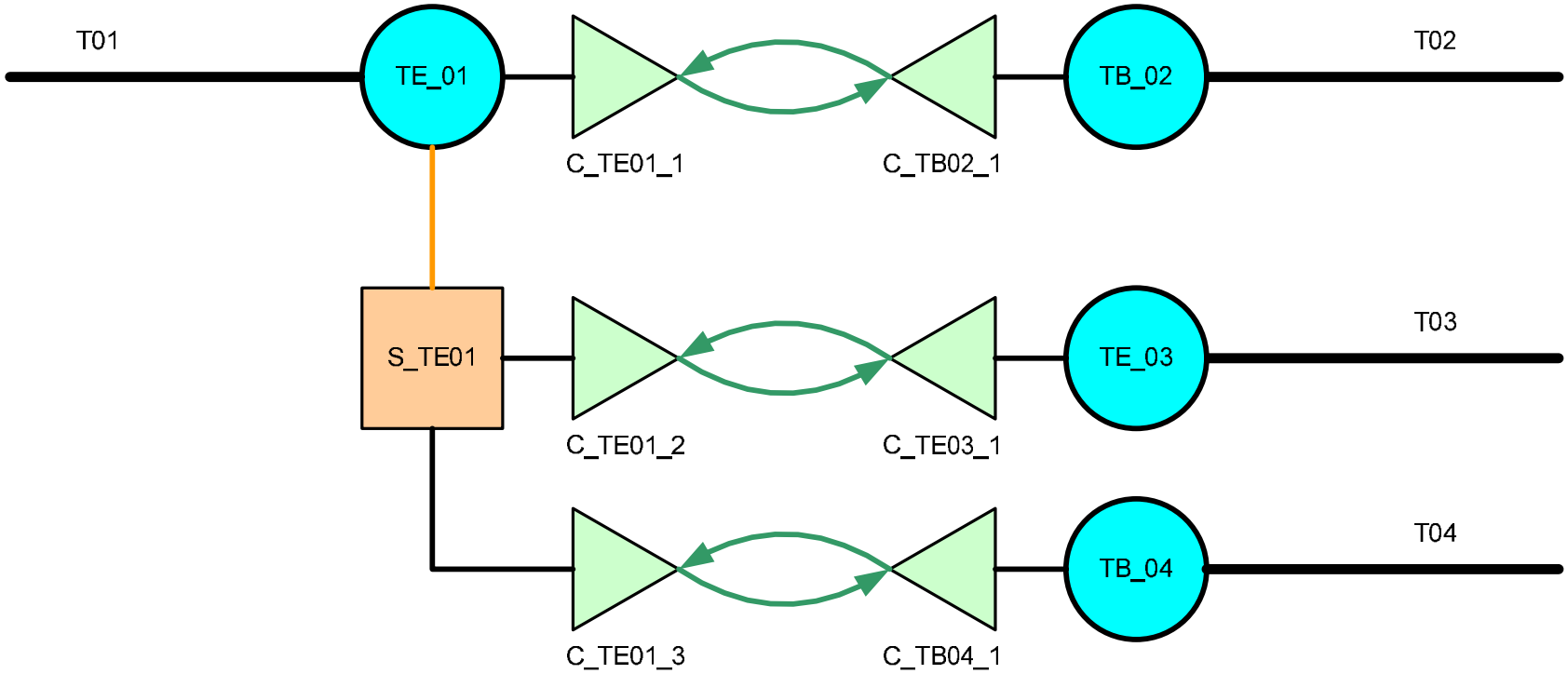
Modelling of a simple switch crossing

- Option 1: use switches and crossings
  - 1 simple crossing
  - 2 ordinary switches
  - 3-5 extra tracks



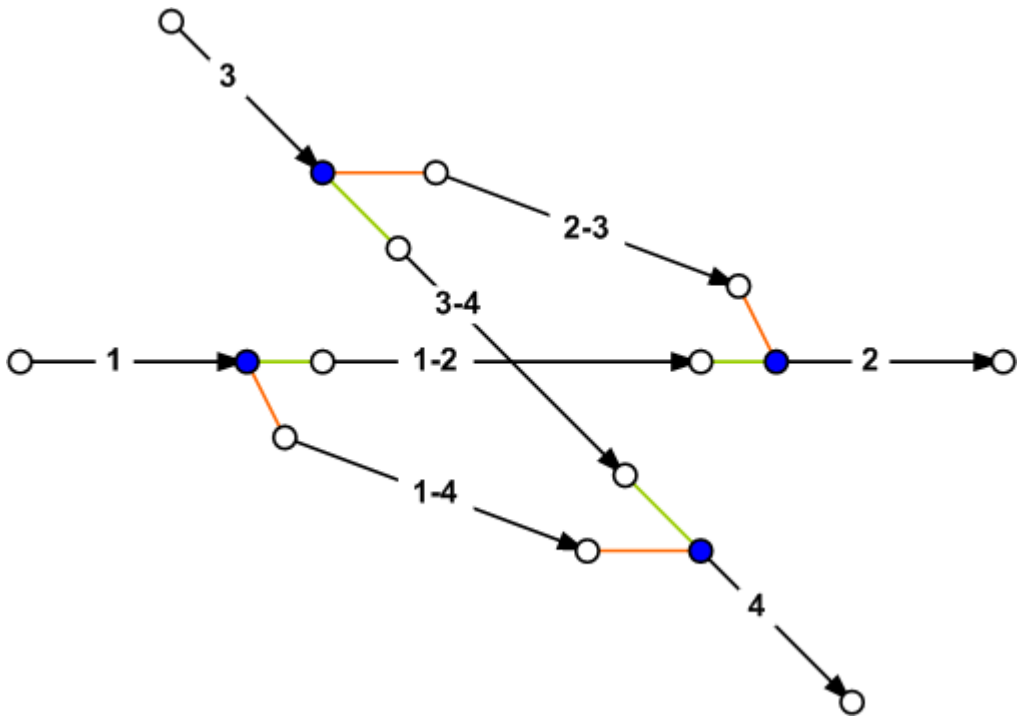
Modelling of a simple switch crossing

- Option 2: the qualified element simpleSwitchCrossing



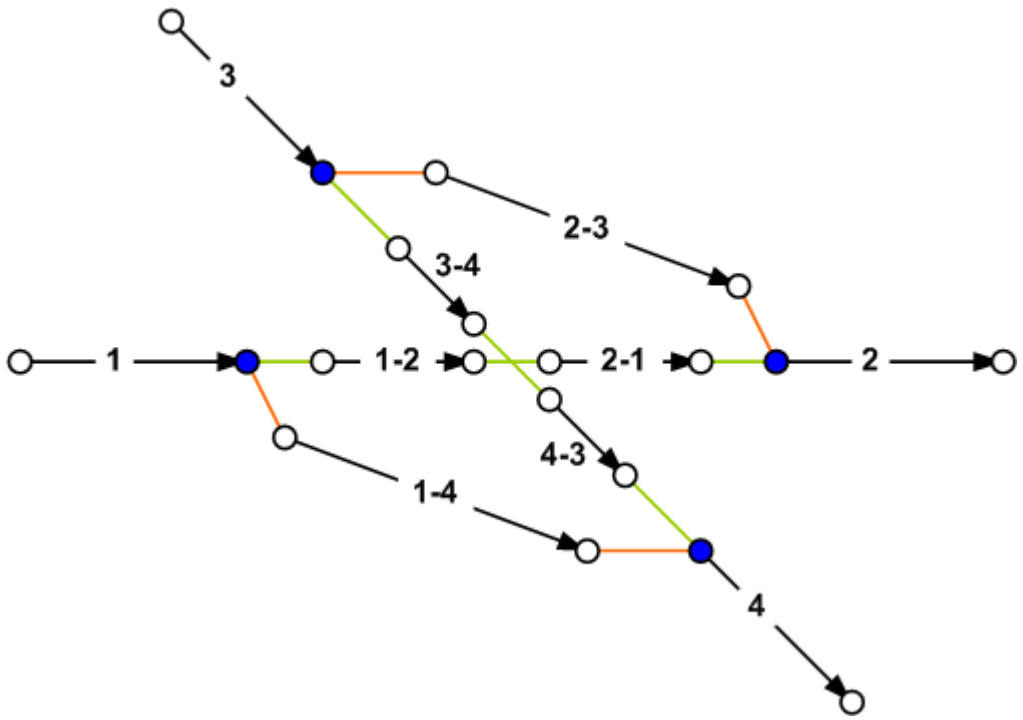
Modelling of a double switch crossing

- Option 1a: use switches and crossings
  - 4 ordinary switches
  - 4 extra tracks



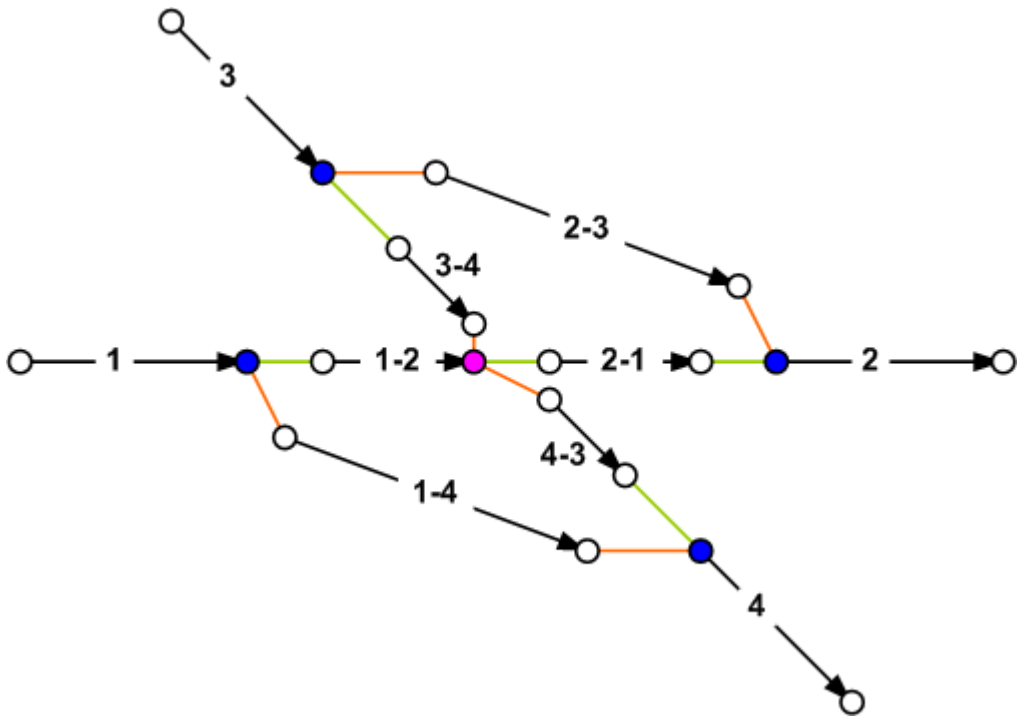
Modelling of a double switch crossing

- Option 1b: use switches and crossings
  - 4 ordinary switches
  - 6 extra tracks



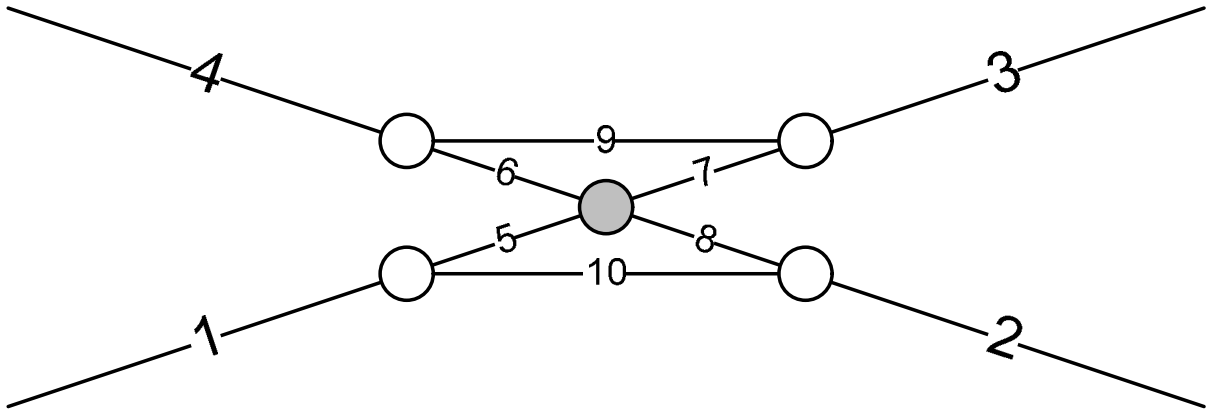
Modelling of a double switch crossing

- Option 1c: use switches and crossings
  - 4 ordinary switches
  - 6 extra tracks
  - 1 simple crossing



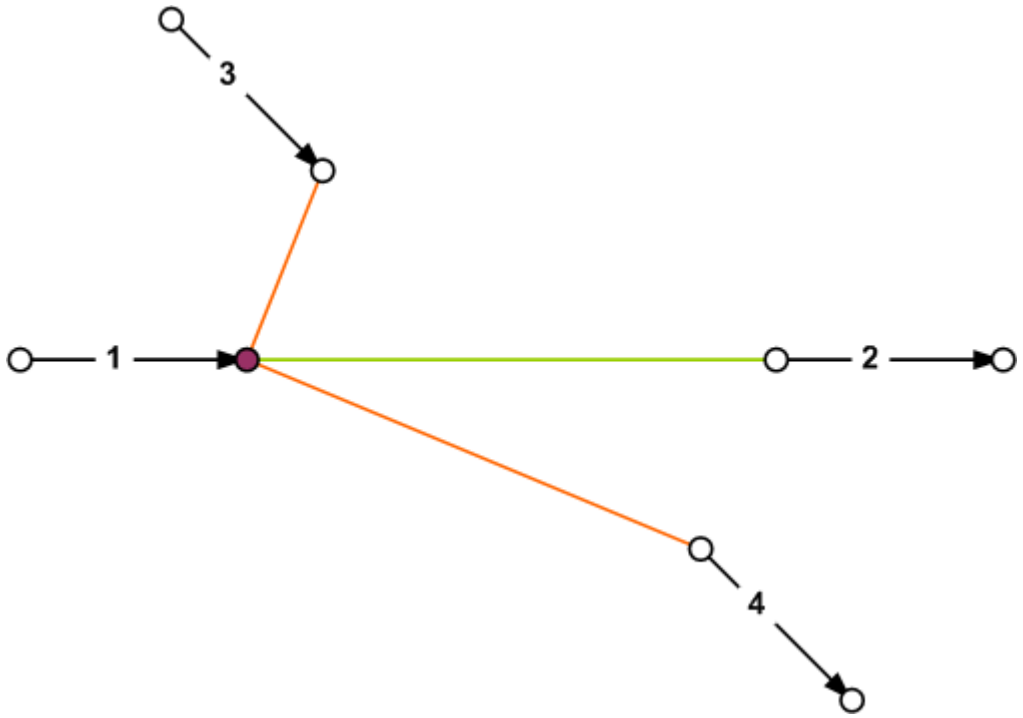
Modelling of a double switch crossing

- Option 1: use switches and crossings
  - 1 simple crossing
  - 4 ordinary switches
  - 6 extra tracks



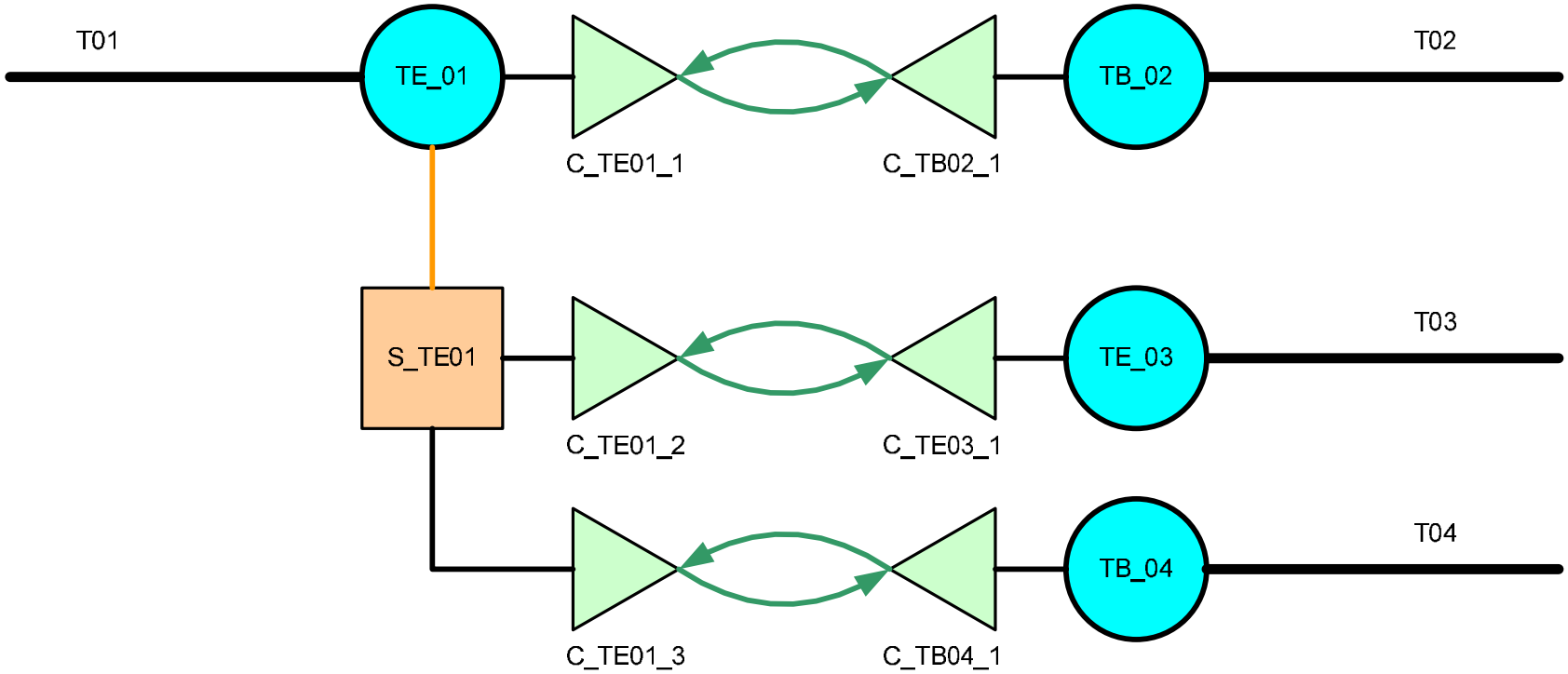
Modelling of a double switch crossing

- Option 2: the qualified element doubleSwitchCrossing



Modelling of a double switch crossing

- Option 2: the qualified element doubleSwitchCrossing



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Thank you for your attention!

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railML® Infrastructure v3 concept

Towards a new infrastructure model

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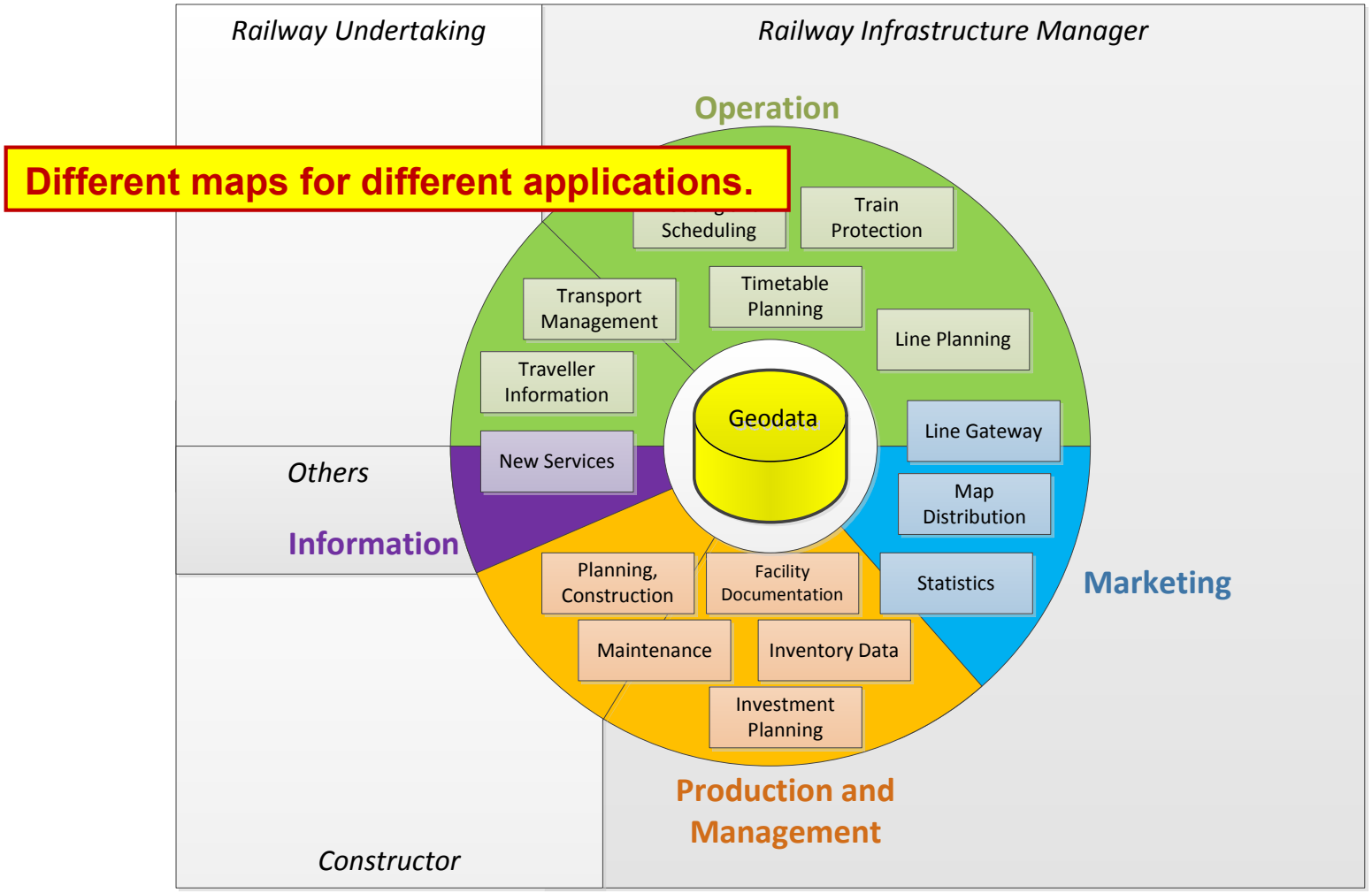
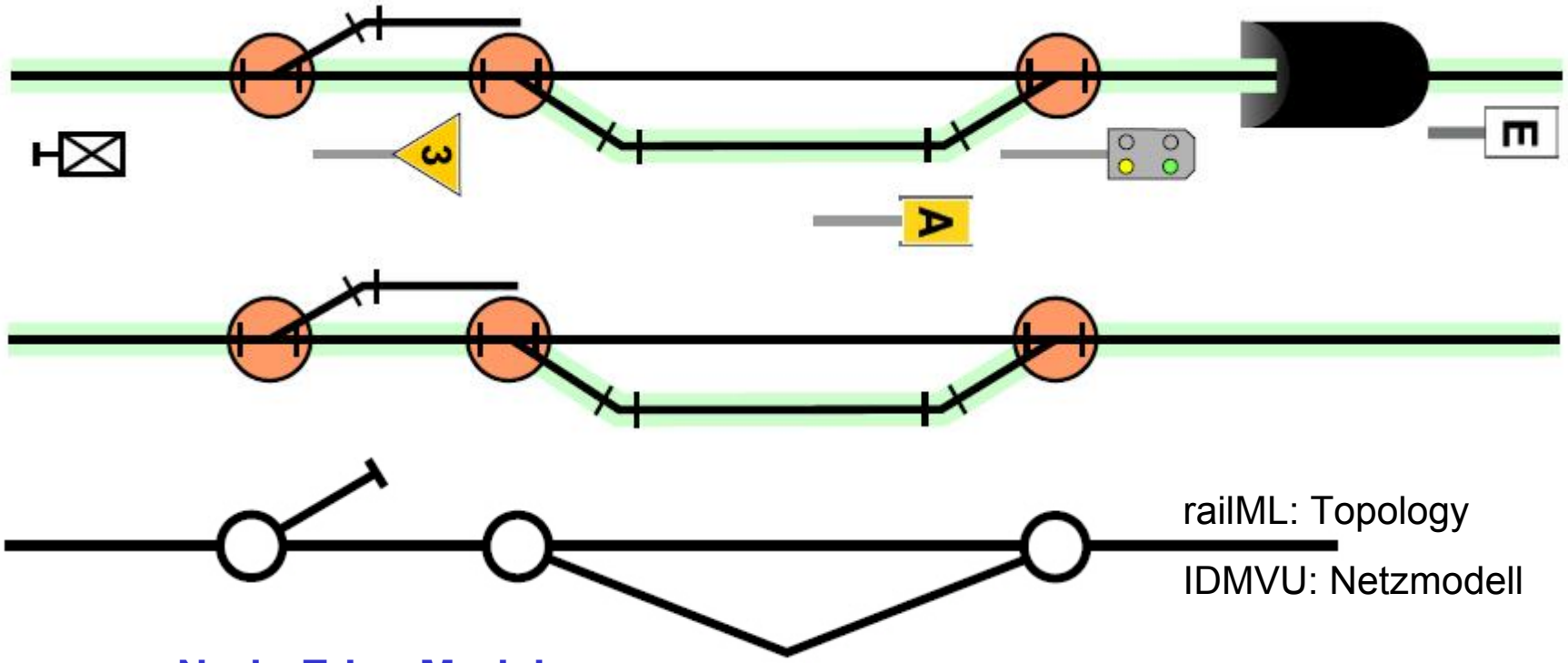
Applications



A New Data Model

Problem

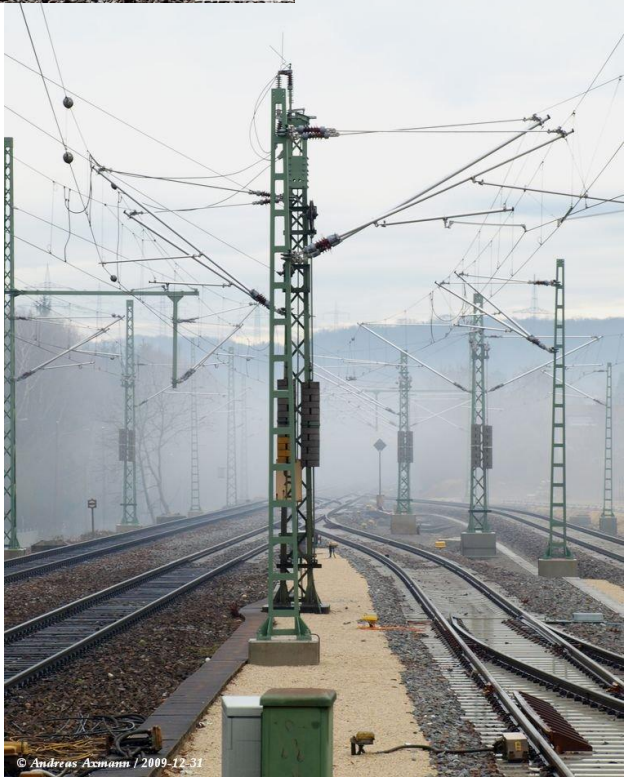


- **Node-Edge Model**
  - Is it sufficient for a complete modelling of the railway infrastructure?

A New Data Model
Problem

- What is the smallest unit?

- *(x, y, z)*

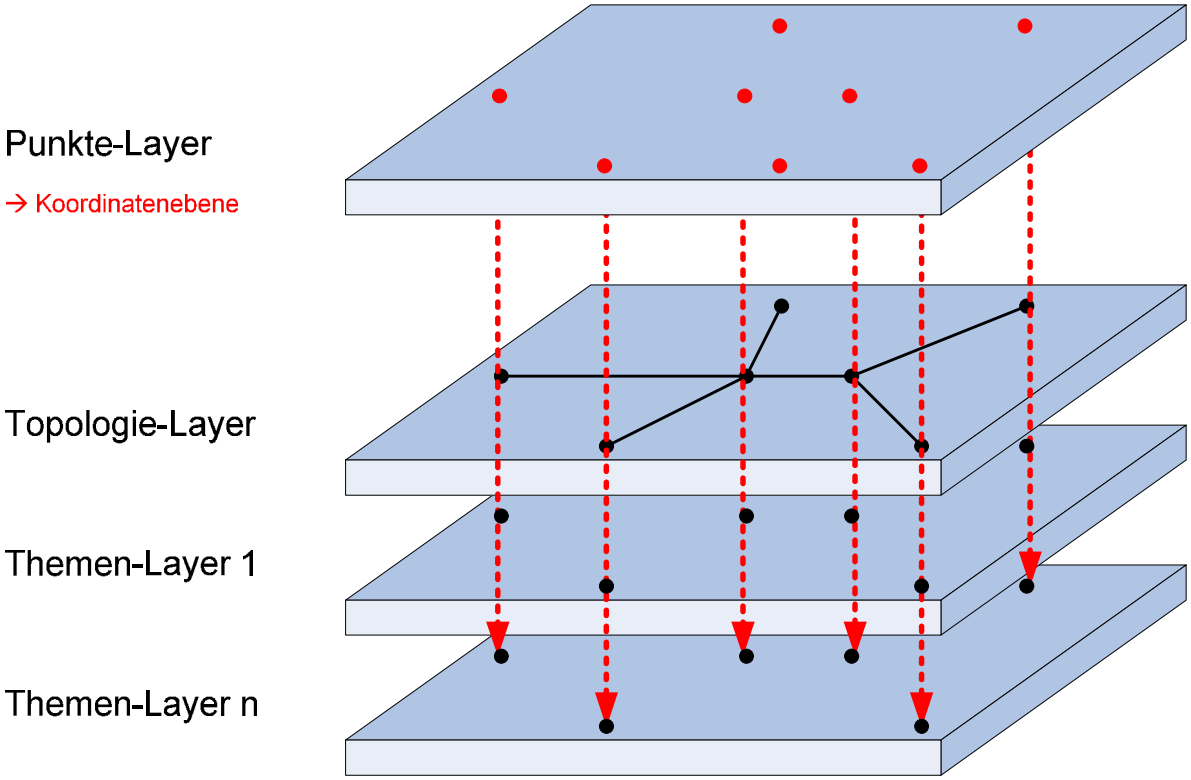


http://kbs761.startbilder.de/

A New Data Model

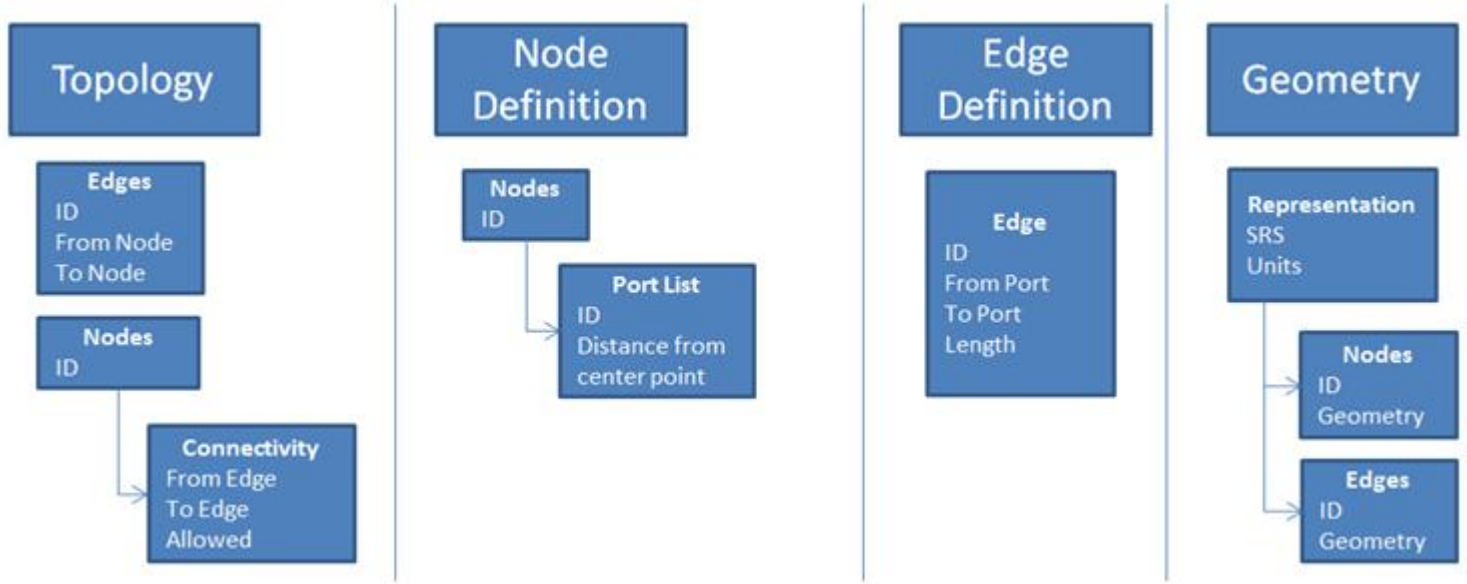
The basis

- Smallest unit is the point in 4D (lat, lon, alt, t)
- All other elements consist of a number of elements of this smallest unit



Topology model

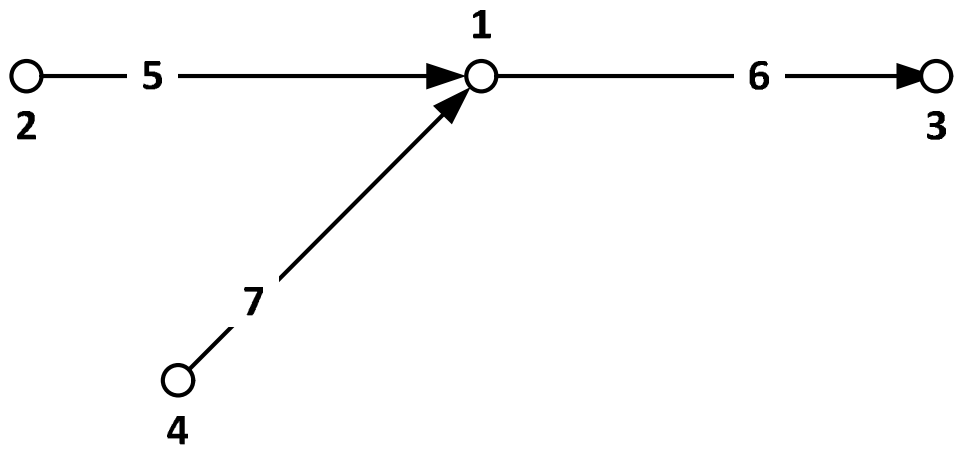
- Concept Infrabel:



Topology model

The basis

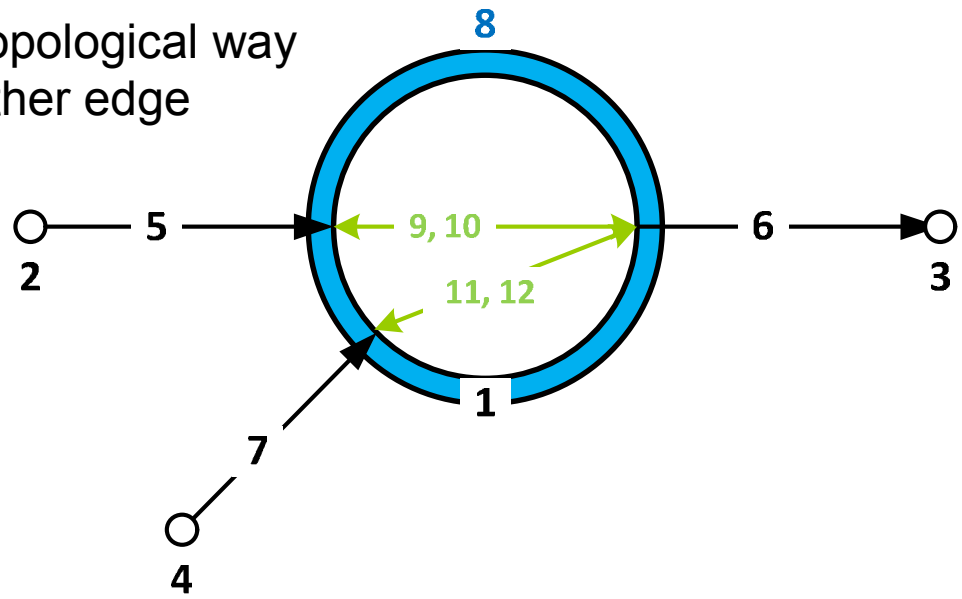
- Possible approach within railML 3.0:
  - node
  - edge



Topology model

The basis

- Possible approach within railML 3.0:
  - node
  - edge
  - **intersection** groups connections
  - **connection** defines topological way from one edge to another edge



Topology model

The basis

- Source:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<railML>
    <infrastructure version="3.0">
        <topology>
            <nodes>
                <node id="1" name="node_1" />
                <node id="2" name="node_2" />
                <node id="3" name="node_3" />
                <node id="4" name="node_4" />
            </nodes>
            <edges>
                <edge id="5" name="edge_5" beginNodeRef="2" endNodeRef="1" />
                <edge id="6" name="edge_6" beginNodeRef="1" endNodeRef="3" />
                <edge id="7" name="edge_7" beginNodeRef="4" endNodeRef="1" />
            </edges>
            <intersection>
                <intersection id="8" name="intersection_8" nodeRef="1">
                    <connections>
                        <connection id="9" name="conn_5_6" fromEdgeRef="5" toEdgeRef="6" />
                        <connection id="10" name="conn_6_5" fromEdgeRef="6" toEdgeRef="5" />
                        <connection id="11" name="conn_6_7" fromEdgeRef="6" toEdgeRef="7" />
                        <connection id="12" name="conn_7_6" fromEdgeRef="7" toEdgeRef="6" />
                    </connections>
                </intersection>
            </intersection>
        </topology>
        <trackNetwork>
    </infrastructure>
</railML>
```

Topology model

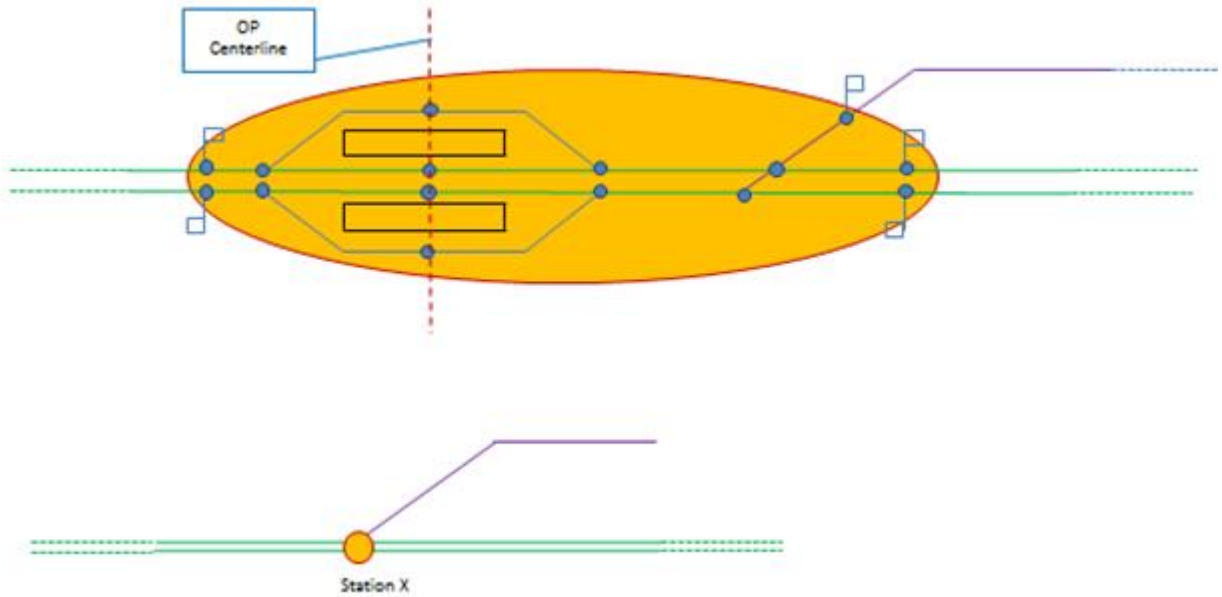
Positioning in the rail network

- Pure topology: there are no coordinates and no geometry → also no length
- New element: **Trail**
  - A trail references an edge and gives it a length
  - Length = distance between the connected nodes
  - But: there is *more than one distance*…

Topology model

Positioning in the rail network

- “Virtual” distances:



Topology model

Positioning in the rail network

- Pure topology: there are no coordinates and no geometry → also no length
- New element: **Trail**
  - A trail references an edge and gives it a length
  - Length = distance between the connected nodes
  - But: there is more than one distance…: **fromNodeLength, betweenNodeLength, endNodeLength**

```
<trailNetwork>
    <trails>
        <trail id="13" name="trail_5" edgeRef="5" fromNodeLength="0" betweenNodeLength="369" endNodeLength="0" />
        <trail id="14" name="trail_6" edgeRef="6" fromNodeLength="0" betweenNodeLength="468" endNodeLength="0" />
        <trail id="15" name="trail_7" edgeRef="7" fromNodeLength="0" betweenNodeLength="123" endNodeLength="0" />
    </trails>
    <trailElements>
</trailNetwork>
```

Topology model

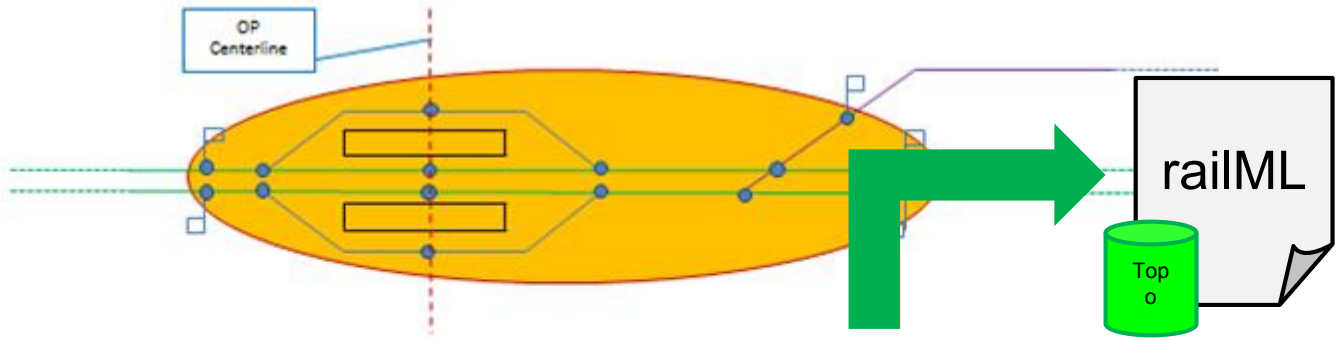
Positioning in the rail network

- Pure topology: there are no coordinates and no geometry → also no length
- New element: **Trail**
  - A trail references an edge and gives it a length
  - Length = distance between the connected nodes
  - But: there is more than one distance…: fromNodeLength, betweenNodeLength, endNodeLength
  - **The trail is the basic element for referencing the railway network's geometry and elements.**

Topology model

Modelling various levels of details

- Micro



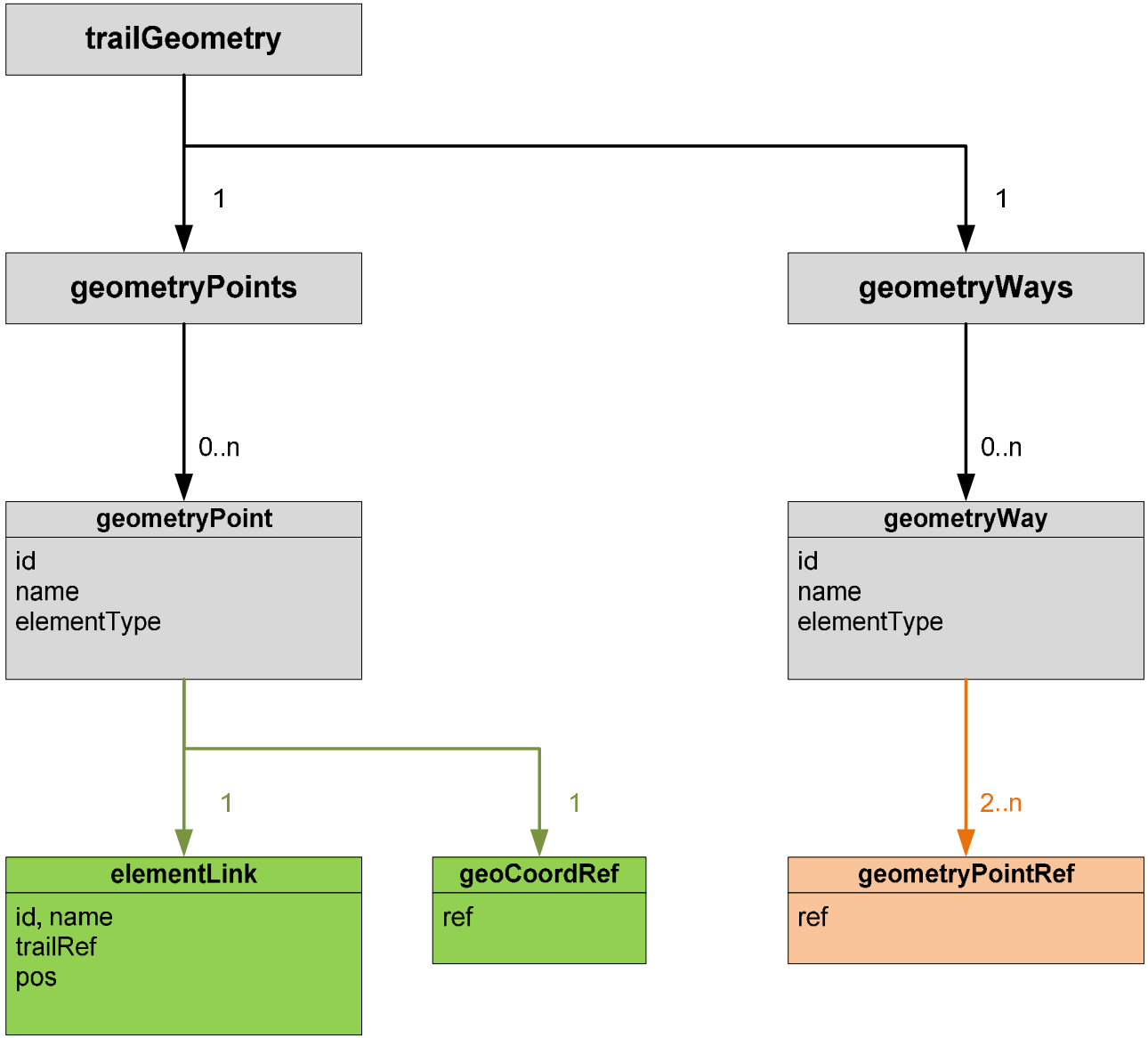
References

- Meso

Geometry model

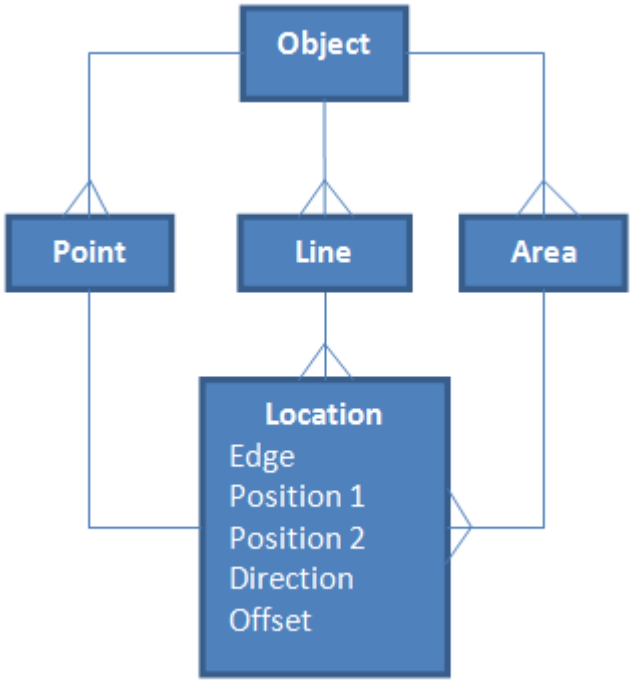
- Railway Geometry in 3D:
  - **Curvature** / Radius [1/m]
  - **Slope** [Promille]
  - **Superelevation** [mm]

- Aim: it should be possible to determine the 3D geometry in every point along the track.
- Alignment approach: **geometry ways** (arcs, straight lines, transition bends)
- Measurement approach: **geometry points** (3D geometry in that point; geometry ways can be determined by “reverse engineering”)

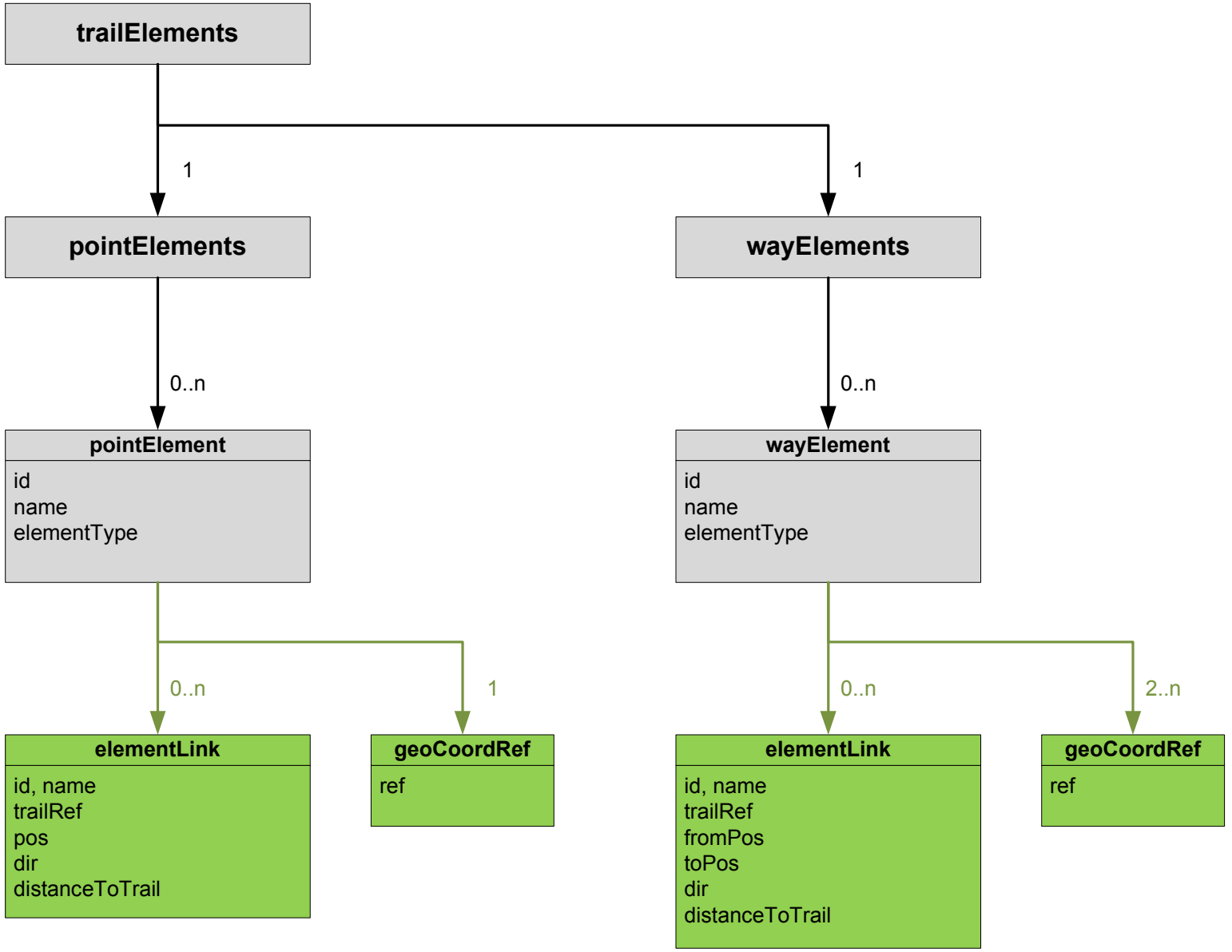

trailGeometry
1
1
geometryPoints
geometryWays
0..n
0..n
geometryPoint
id
name
elementType
geometryWay
id
name
elementType
1
1
2..n
elementLink
id, name
trailRef
pos
geoCoordRef
ref
geometryPointRef
ref

Railway Elements Model

- Concept Infrabel:



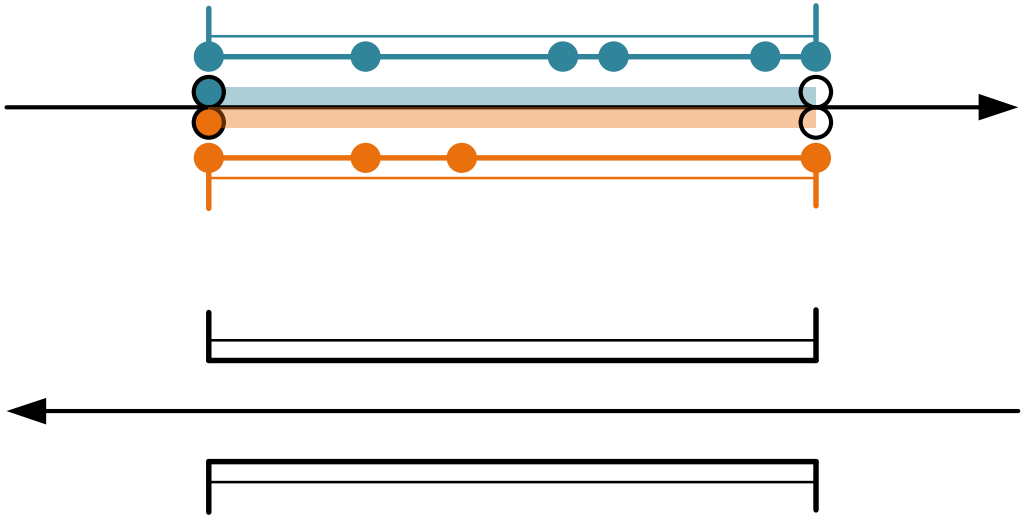
- The model proposed by railML does not differ much…


trailElements
1
1
pointElements
wayElements
0..n
0..n
pointElement
id
name
elementType
wayElement
id
name
elementType
0..n
1
0..n
2..n
elementLink
id, name
trailRef
pos
dir
distanceToTrail
geoCoordRef
ref
elementLink
id, name
trailRef
fromPos
toPos
dir
distanceToTrail
geoCoordRef
ref

Railway Elements Model

Example

- Example platform:



- geoCoordRefs

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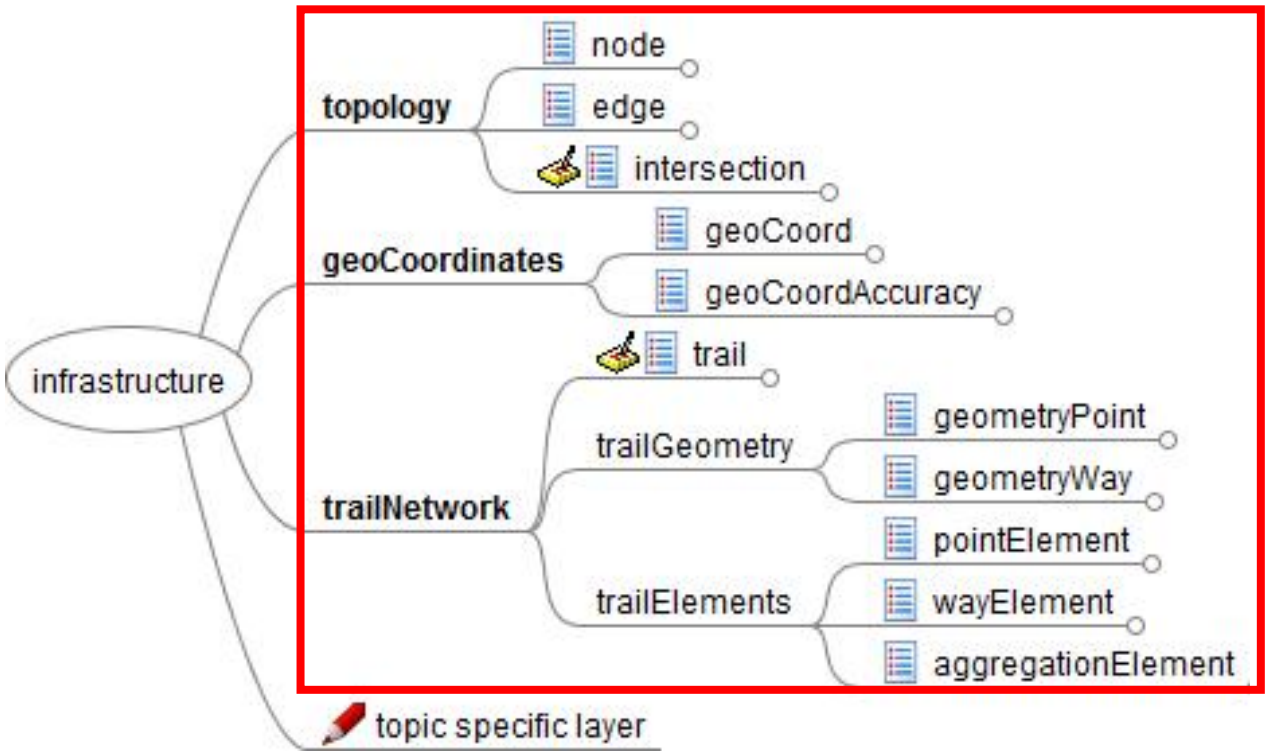
Extensions

- The core:



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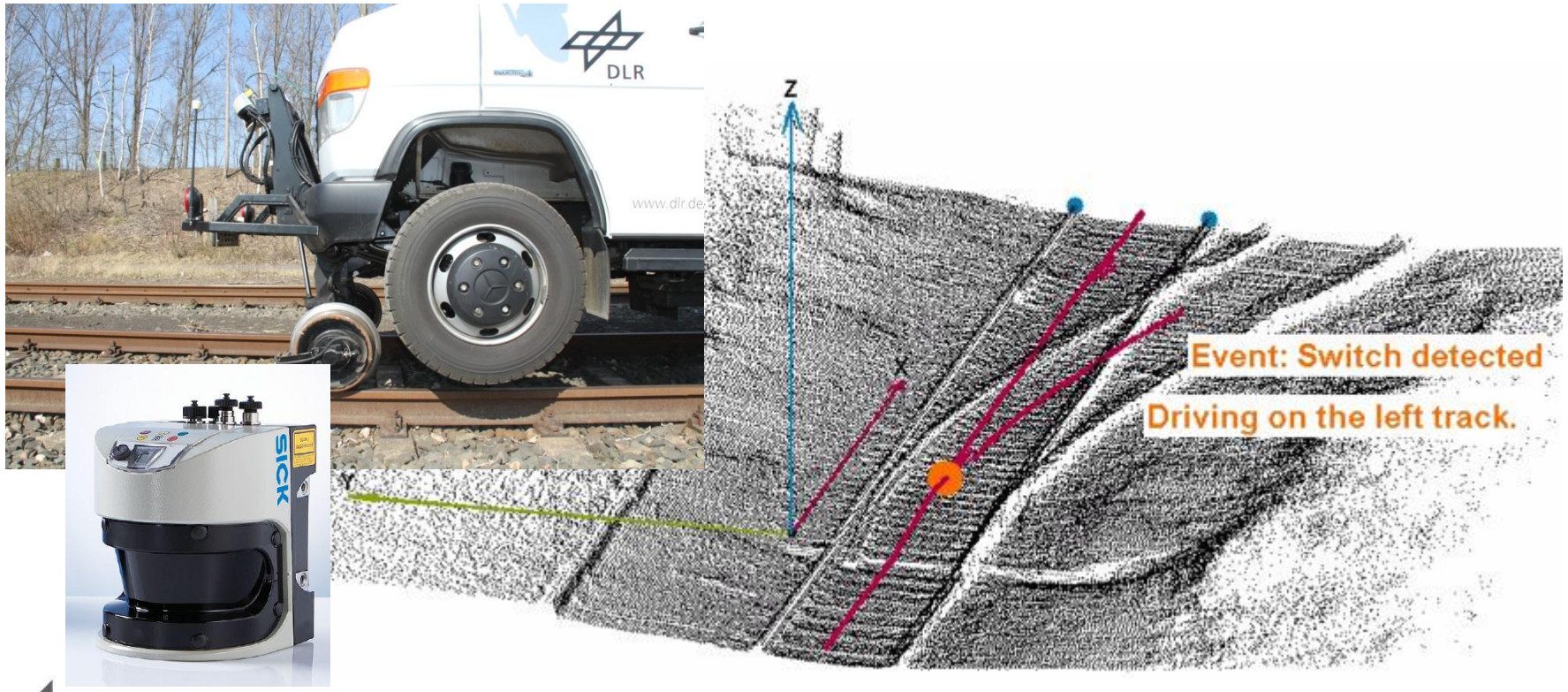
Extensions

- Example **SwitchLayer** for Map-matching purposes:



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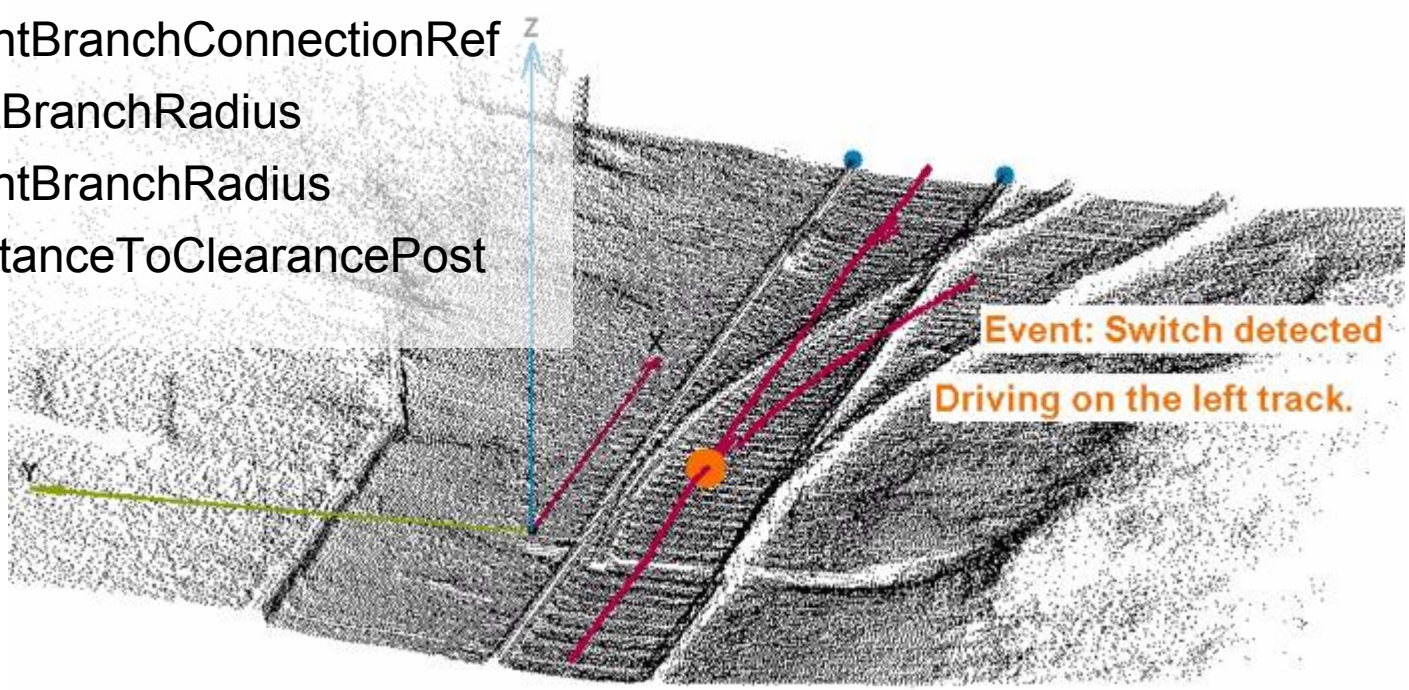
Extensions

- Example **SwitchLayer** for Map-matching purposes:
  - intersectionRef
  - leftBranchConnectionRef
  - rightBranchConnectionRef
  - leftBranchRadius
  - rightBranchRadius
  - distanceToClearancePost



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Thank you for your attention!

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