POSSIBILITIES OF HIGH-SPEED RAILWAY TURNOUT DATA DESCRIPTION

PRESENTATION OF THE CONFERENCE PAPER

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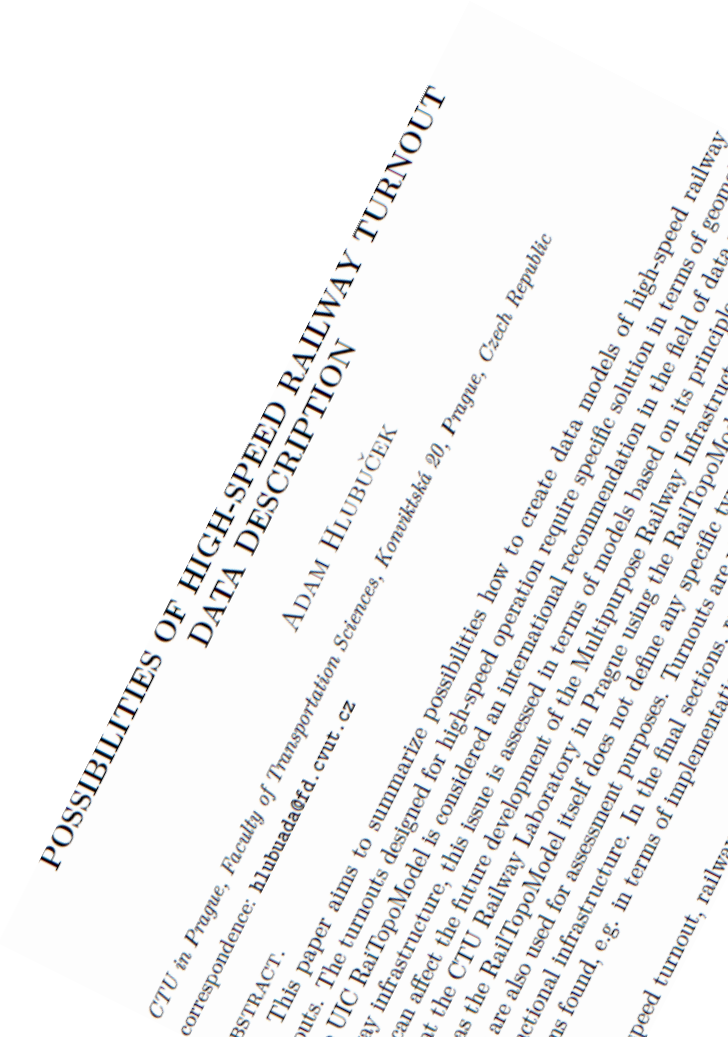
ABSTRACT

- paper aims to summarize possibilities how to create data models of high-speed railway turnouts
- turnouts designed for high-speed operation require specific solution in terms of geometry
- issue assessed in terms of models based on the RailTopoModel principles
- can affect the future development of the Multipurpose Railway Infrastructure Model
  - model gradually emerging at the CTU Railway Laboratory in Prague using the RailTopoModel principles
- railML® 3.1 specifications also used for assessment purposes (specific types of entities)
- turnouts viewed both in terms of topology and in terms of functional infrastructure
- recommendations on how to deal with the problems found (e.g. in terms of implementation)

- keywords: high-speed turnout, railway infrastructure, RailTopoModel, railML

CONTENT OF THE CONFERENCE PAPER

1. Introduction
2. Selected Specifics of High-Speed Turnouts
3. Railway Infrastructure Data Desription based on the UIC RailTopoModel
4. Multipurpose Railway Infrastructure Model Development
5. RailML® 3 Infrastructure Subschema
6. Possible Representatin of Turnouts the RailTopoModel and railML® 3.1 Principles
   - 6.1 Topological Approach
   - 6.2 Net Entity Approach
7. Assesment of the Usability of the RailTopoModel and railML® 3.1 Modeling Principles for the Needs of High-Speed Turnouts Description
8. Conclusions


POSSIBILITIES OF HIGH-SPEED RAILWAY TURNOUT DATA DESCRIPTION

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ABSTRACT.

This paper aims to summarize possibilities how to create data models of high-speed railway
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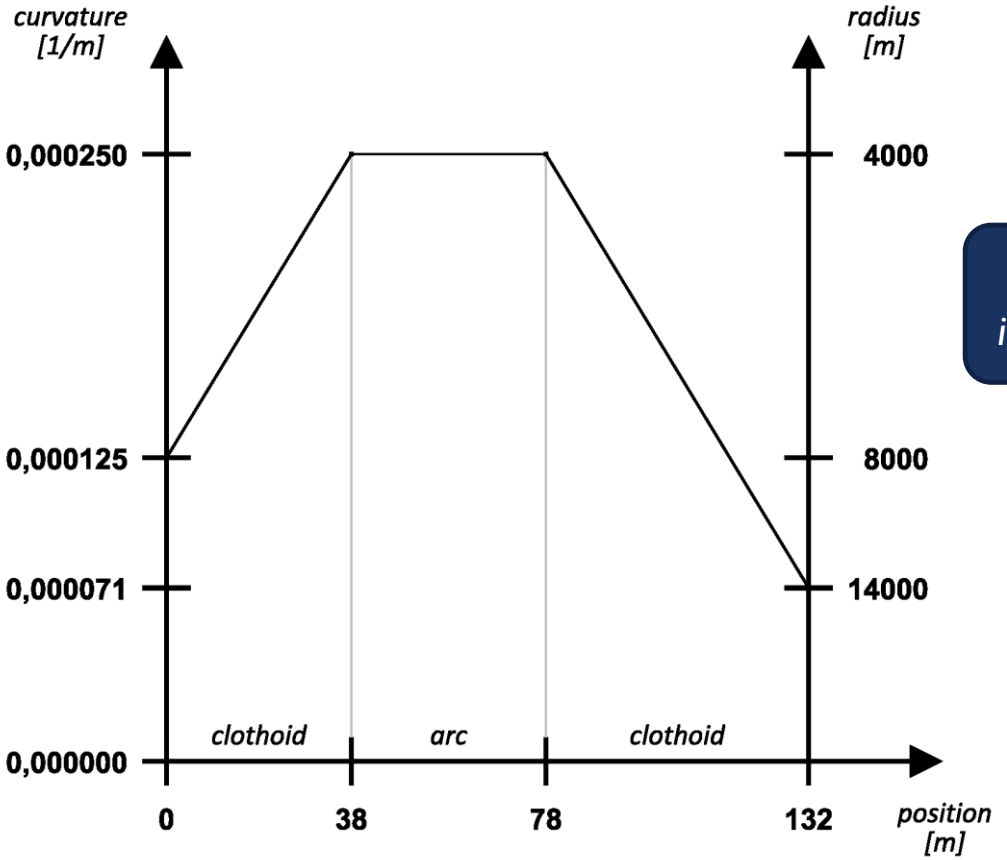
RAILWAY TURNOUT

- complex technical equipment consisting of many components
- allows the vehicle movement to be transferred between two tracks
- maximum allowed running speed of a railway vehicle limited by the value of unbalanced lateral acceleration caused by superelevation deficiency and its rate of change with respect to time
- conventional turnouts designed without using transition curves and superelevation (abrupt change of superelevation deficiency)
  - simple describable by not a very large set of parametres (radius of each of theirs branches has a constant value)
- high-speed turnouts designed in order to increase speed in the branching direction (more complex solution)
  - precise track geometry adapted to limit the large dynamic forces at high running speed required
  - high value of radius, slim turnouts, long switch rails, several point machines and movable parts of the frog possible
  - geometry optimized by the means of transition curves application, in some cases

EXAMPLE OF HIGH-SPEED TURNOUT GEOMETRY

- *J60-1:33,5-8000/4000/14000-PHS*
- *first turnout with unstable curvature developed in the Czech Republic*
- *total length of 132 m*
- *designed using two clothoid transition curves in the turning branch*
  - *clothoid 38 m*
    R = 8000 m → R = 4000 m
  - *circular arc 40 m*
    R = 4000 m
  - *clothoid 54 m*
    R = 4000 m → R = 14000 m

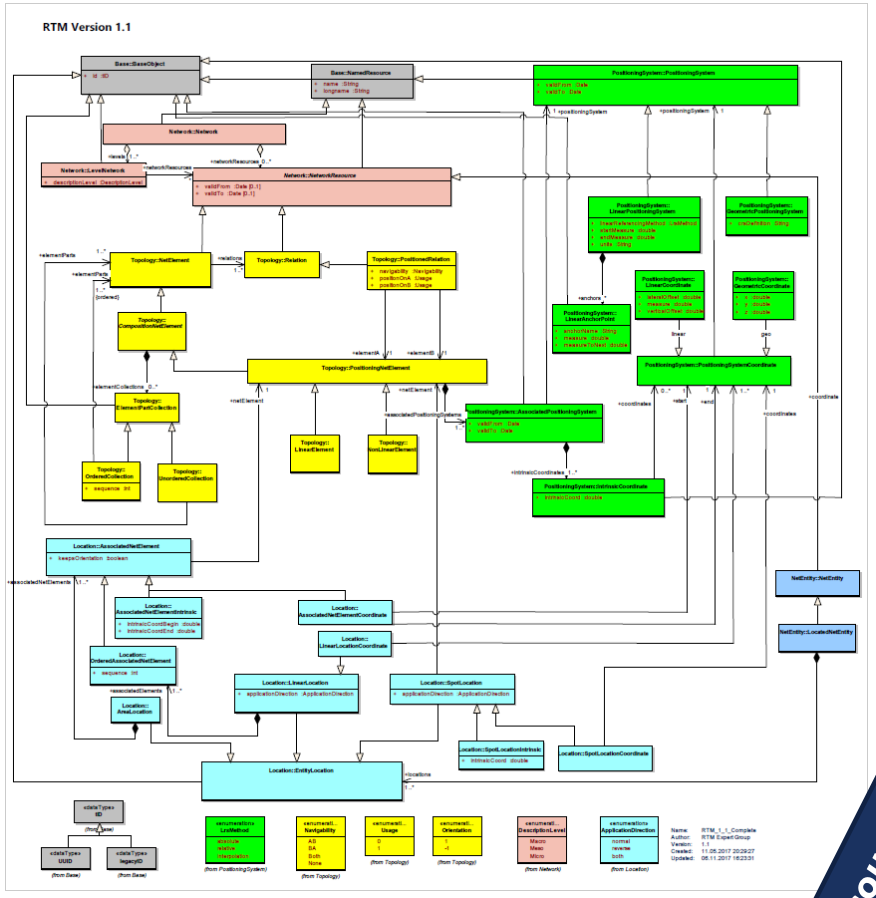


course of curvature in the turning branch

data source: [7]

UIC RAILTOPMODEL PRINCIPLES

- RailTopoModel initiative introduced in 2013 in order to create a common generic standard as regards the railway infrastructure data modeling
- released as UIC International Railway Standard 30100 in 2016
- topological core model of railway infrastructure based on a „connexity graph“
- subsystems: Base, Topology, Positioning, Net Entity, Location
- topology (net elements and net relations) allows to describe the railway infrastructure at several levels of detail
- spot, linear and area location of net entities based on intrinsic or external (linear or geometric) coordinates
- the most advanced use case is apparently railML® 3 data format



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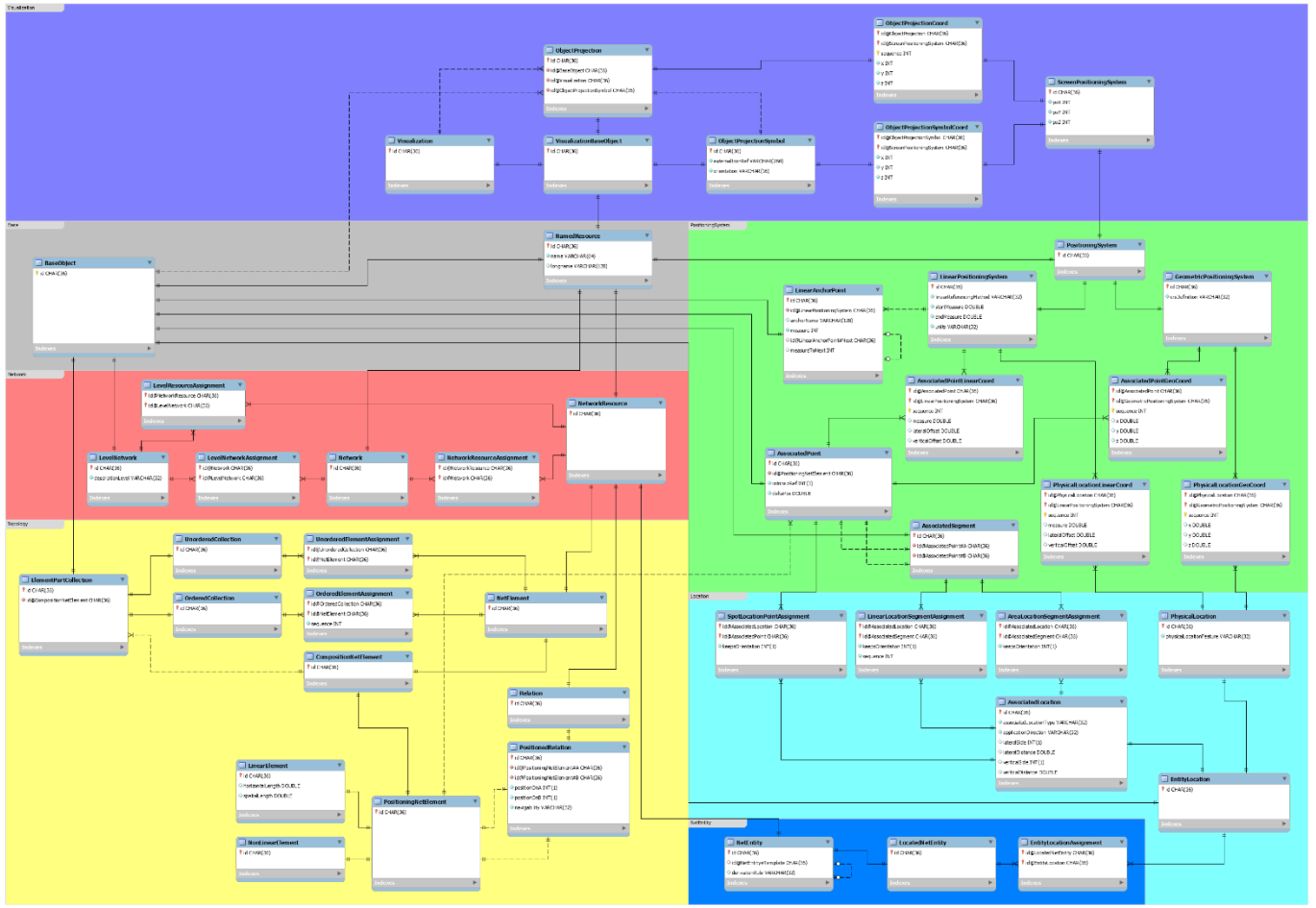
MULTIPURPOSE RAILWAY INFRASTRUCTURE MODEL

- CTU Railway Laboratory model of railway infrastructure data repository mainly based on the RTM principles
- relational data model (MySQL)
- also reflects an object-oriented approach to railway data modeling
- tables reflecting the RTM data classes
- some changes for more flexible use
- core model expandable by use case specific part
- use case specific part includes concrete types of net entities representing various objects and properties tobe localized



RAILML® 3 INFRASTRUCTURE SUBSCHEMA

- railML® is an open source XML-based data format consisting of several schemas
- railML® 3.1 released on 19 February 2019 respecting the use case-oriented approach
- railML® 3 infrastructure schema based on the RailTopoModel principles, consisting of following thematic views:
  - Topology
  - Geometry
  - Functional Infrastructure
  - Physical Infrastructure
  - Infrastructure States
  - Infrastructure Visualizations

```
        <switch name="W03" id="swi02" defaultCourse="left" type="ordinarySwitch">
          <spotLocation id="swi02_sloc01" netElementRef="ne_b03" intrinsicCoord="1">
            <linearCoordinate positioningSystemRef="lps01" measure="4.500"/>
          </spotLocation>
          <leftBranch netRelationRef="nr_b01b03" speedBranching="80" speedJoining="80"
radius="0"/>
          <rightBranch netRelationRef="nr_b03b04" speedBranching="40" speedJoining="40"
radius="300"/>
        </switch>
        <switch name="W04" id="swi03" defaultCourse="left" type="ordinarySwitch">
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            <linearCoordinate positioningSystemRef="lps01" measure="4.550"/>
          </spotLocation>
          <leftBranch netRelationRef="nr_b02b05" speedBranching="60" speedJoining="60"
radius="0"/>
          <rightBranch netRelationRef="nr_b02b04" speedBranching="40" speedJoining="40"
radius="300"/>
        </switch>
      </switches>
      ...
    </functionalInfrastructure>
```
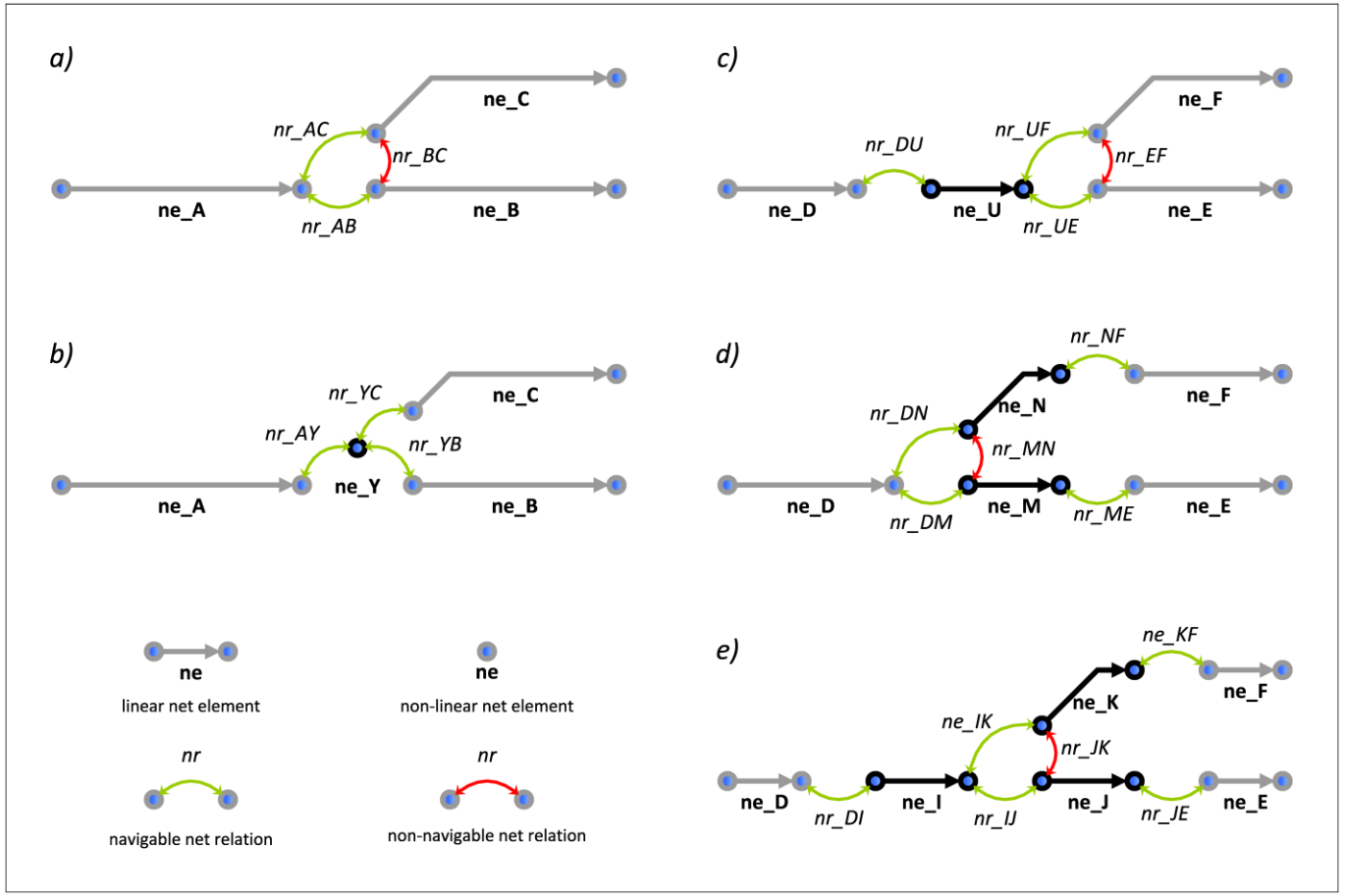

source: [12]

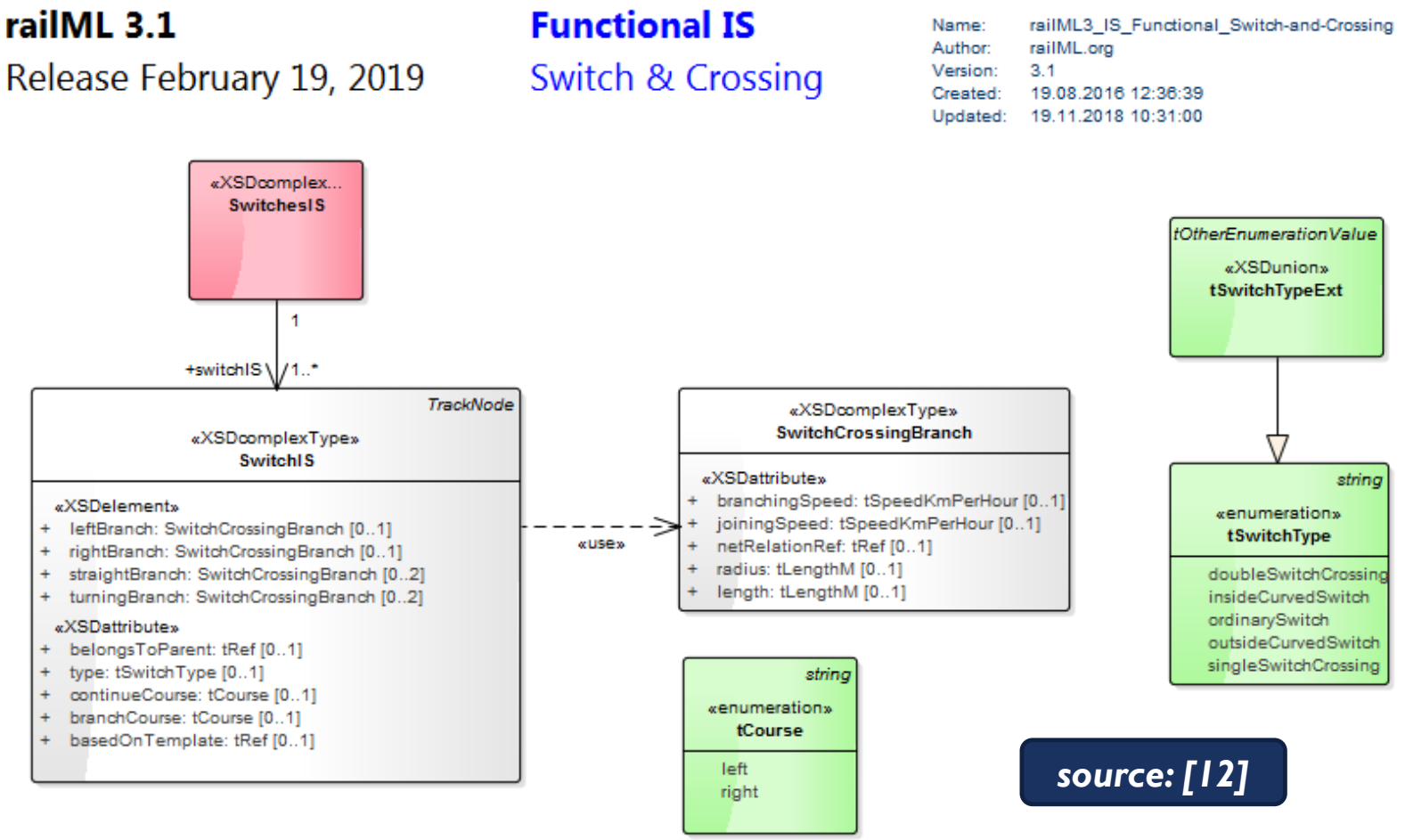
POSSIBLE REPRESENTATION OF RAILWAY TURNOUTS I.

- topological approach based on the RailTopoModel priciples
- possibility of more detailed levels
- a) adjacent tracks only
- b) turnout represented by non-linear net element
- c) turnout represented by one linear element
- d) turnout represented by two linear elements
- e) turnout represented by three linear elements



POSSIBLE REPRESENTATION OF RAILWAY TURNOUTS II.

- net entity approach not supported within the core RailTopoModel
- within the railML® 3.1 infrastructure schema a *SwitchIS* complex type defined (*SwitchIL* in the interlocking subschema)
- *switchIS* railML element can include the *leftBranch* and *rightBranch* elements
- turnout properties modeled using listed attributes



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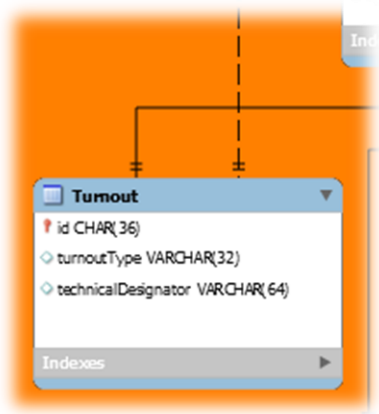
ASSESMENT OF THE USABILITY OF THE SPECIFICATIONS

- required properties compared with the current state of the RTM and railML® 3 specifications
- topological approach
  - no diference between high-speed turnout and conventional railway turnout, as regards the RTM and railML® 3 principles
  - if necessary, the branches of high-speed turnouts can be modeled in even more detailed level
  - new values of the *descriptionLevel* attribute should be introduced if the more detailed topological description needed
- net entity approach
  - RTM does not offer any concerte specifications, in the case of net entities
  - railML® 3 defines the *switchIS* and nested elements representing branches and related attributes
  - directional conditions can be expressed by the *horzintalCurve* elements, alternatively
  - *radius* attribute is far from sufficient to describe directional conditions of the high-speed turnouts
  - custom extensions need to be introduced within the Multipurpose Model of Railway Infrastructure



POSSIBILITIES OF IMPLEMENTATION TO THE MODEL

- possibility to define several new attributes to express required
  - parameterization of directional conditions is feasible but it is not able to cover to cover all possible geometric solutions
  - many of these parameters would be completely unnecessary when describing most other turnouts
- extension of the allowable internal structure of the *SwitchCrossingBranch* complex type by nested elements
  - these subsections could represent a segment describable by one horizontal curve type (e.g. *straight*, *arc* and *clothoid)*
  - it is not possible to assign the radius of the arc at different positions of the horizontal curve directly
    - replace the *radius* attribute with two similar attributes expressing the radius at the start point and end point of the described curve
- not to describe turnouts in terms of geometry within the *switchIS* elements at all and use the description of directional conditions exclusively through the *horizontalCurve* elements instead
  - it would be appropriate to provide the possibility to assign individual horizontal curve to a specific turnout branch
- turnout branch entity itself could only be described using an aggregated data item of minimal radius

CONCLUSIONS

- article provided insight into the specifics of high-speed railway turnouts and the possibilities of their data modeling
- when compared with the principles of the RailTopoModel and railML ® 3.1 data format, no significant difference between a conventional ordinary turnout topological data model and a possible high-speed turnout model found
- functional infrastructure interpretation of a turnout is insufficient, in this respect
- several possible ways how to implement high-speed turnouts description to the Multipurpose Railway Infrastructure Model outlined
- possible feedback for railML® 3 further development (use case-oriented approach)

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