Assessment of operational Feasibility

*Dutch Network, Timetable 2014 and 2017*

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Outline

1. Introduction
2. The Netherlands model (NL model)
3. Assessing operational feasibility of NL
4. Results
5. Next steps
6. Conclusion
Introduction

David Koopman MSc.
- Infrastructure and timetable planning

- Customers
  - ProRail (Dutch infrastructure manager)
  - NS (Dutch Railways) and other operators
  - Ministry of Infrastructure and Environment
  - Provinces
Growth of infrastructure Model

NL key facts (ProRail)
- 7030 km track
- 7151 Switches
- 11,944 signals
- 350 trains simultaneously

History
- Start 2005
- 2008 CoreNet
- 2009 Asd-Ehv
- 2012 North East
- 2013 NL Complete
## Facts and Numbers

### 7 infrastructure files

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
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<tbody>
<tr>
<td>Track Kilometers</td>
<td>8164 km</td>
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<tr>
<td>Switches</td>
<td>6410</td>
</tr>
<tr>
<td>Stations/Services</td>
<td>545</td>
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<td>Main Signals</td>
<td>9308</td>
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<td>Instruments</td>
<td>6093</td>
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<td>Edges</td>
<td>41277</td>
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<td>Routes</td>
<td>11151</td>
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<td>Paths</td>
<td>2752</td>
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<tr>
<td>Itineraries</td>
<td>707</td>
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Simulation: 06:00 - 13:00,
- step 2.0s, 2173 trains, 360 trains simultaneously
- 23 min timetable timetable statistics only
- 49 min with 46 train diagrams and output on.
Assessing operational feasibility

Why a microscopic model with OpenTrack?

- Current timetable planning tools limited
- Focus on planning without conflicts
- Significant timetable change in 2017 planned

- Complete NL model available
- Computation time has decreased
- Modeling time has decreased
Old timetable planning process

Old approach
- Local headway times according to rules
- Running times not accurate
- Feedback in planning process is limited. Real proof of the pudding is in the operation
Current planning process with OpenTrack

New ProRail/NS/RHDDHV approach
- Take into account all constraints from trains, infrastructure and timetable
- Check on nationwide feasibility and stability in every planning step
- Stable and safe base for operation
- Less start-up problems when timetable is implemented
Assessing operational feasibility of NL

How?

- Deterministic (First step)
- 2014 – Day
- 2017 – Hour pattern

- Modeling of running time variation with extra slack according to planning rules (passenger trains):
  - 7.5% running time slack compared to the 10th percentile train
  - +1 minute additional release time

- The output creates understanding of the conflicts in the timetable for planners
Results

Royal HaskoningDHV
- Planning issues
- Train diagrams
- Delay lists
- Conflicts
- Resulting secondary delays

ProRail/NS
- Asses the quality of the planned timetable based on these outputs and expert judgement.
- Uses the quality assessment for decision-making
- Improves all the weak spots in the timetable based on these outputs
Results

Planning issues

When modeling we encountered and solved these issues

- Track usage
- Route usage
- Shapeshifting trains
- Use of non existing routes
- Infrastructure constraints
Results

- 46 Train diagrams
## Results

- Conflict example

<table>
<thead>
<tr>
<th>Priority</th>
<th>Train 1</th>
<th>Train 2</th>
<th>Station/Junction</th>
<th>Type</th>
<th>Time</th>
<th>Delay train 1 [s]</th>
<th>Delay train 2 [s]</th>
<th>Headway norm [s]</th>
<th>Headway planned [s]</th>
<th>Headway measured simulation [s]</th>
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<tbody>
<tr>
<td>1</td>
<td>B1600-6</td>
<td>B11400-10</td>
<td>Amf</td>
<td>Stop at Signal</td>
<td>8:54:58</td>
<td>-86</td>
<td>-4</td>
<td>180</td>
<td>0</td>
<td>158</td>
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<td>2</td>
<td>AC6000-5</td>
<td>BD3200-12</td>
<td>Ht</td>
<td>Braking for Signal</td>
<td>9:54:42</td>
<td>82</td>
<td>52</td>
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<td>B2100-10</td>
<td>Ledn</td>
<td>Braking for Route</td>
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<td>144</td>
<td>16</td>
<td>180</td>
<td>0</td>
<td>138</td>
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</table>
Results

Stop at signal geographical example
Results

- Conflict scatterplot example
Next Steps

- Support implementation OpenTrack and model within ProRail
- More frequent checks on planned timetable
- Smaller area’s / direct feedback for planner
- Faster checks
- When planning is stable in deterministic version:
  - Prepare model for stochastic simulation
  - Setup a stochastic simulation with TrenoLab
Conclusion

- 10 Years of OpenTrack usage has lead to:
  - 10 years of experience in modeling and maintenance
  - A complete model of the Netherlands
  - 4 licenses (including 64-bit)
  - 10 OpenTrack users
  - Quality control
  - Data processing
- A micro simulation is feasible for a whole network
- Gives useful results
- Conflict detection is possible
- Data processing increases
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