Detailed feasibility assessment of timetables in the design phase

*With micro simulation*

David Koopman
06 October 2016
Outline

1. Introduction
2. The process of timetable planning
3. Benefits of Micro Simulation in timetable design
4. OpenTrack
5. Assessing operational feasibility of the Dutch timetable
6. Future forecast
Royal HaskoningDHV: Our Profile

_Independent international engineering and project management consultancy_

- Consultants, engineers, project managers, designers, environmental and technical professionals
- Expertise and experience of more than 6,000 colleagues in over 150 countries
- Top 50 engineering companies worldwide
- Turnover €667 million
- Leadership in sustainability and innovation
- Combining global expertise with local knowledge to deliver a multidisciplinary range of consultancy services for the entire living environment
Where we are in the world

Consultancy, Engineering & Project Management

Workforce of over 6,000 in more than 150 countries

One of the top independently owned engineering companies
Introduction

Advisory group Rail, Utrecht

- Infrastructure planning and timetable planning
- Engineering of:
  - Track
  - Traction and catenary
  - Signalling
  - Constructions
  - Project management

- Customers
  - ProRail (Dutch infrastructure manager)
  - NS (Dutch Railways)
  - Metro Amsterdam
  - Ministry of Infrastructure and Environment
  - Provinces
  - Contractors
OpenTrack: Railway traffic simulation

- Start mid 90’s
- First commercial version
- Spin-off ETH-Zurich (2006)
- +380: Licences
- +260: Companies and institutions
- 49 countries

Main characteristics:
- Microscopic simulation
- Time Based
- Synchronous
- API (SOAP over HTTP)

OpenTrack Railway Technology Ltd., Gubelstrasse 28, CH - 8050 Zurich Switzerland, info@opentrack.ch.
OpenTrack

Input

Rolling Stock

Infrastructure

Timetable

Simulation

Interactivity

Output

Diagrams

Train Graphs

Occupations

Statistics

<table>
<thead>
<tr>
<th>Course ID</th>
<th>Station</th>
<th>Initial Time</th>
<th>Duration</th>
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</table>

06 oktober 2016
Old timetable planning process

Old approach
- Local headway times and conflicts according to general rules, detailed calculation on request
- Running times not accurate
- Feedback in planning process is limited. Real proof of the pudding is in the operation
Current planning process with OpenTrack

Changes in transport

Changes in traffic

Changes in basic timetable

Changes in detailed timetable

Changes in railway operation

ProRail/NS/RHDHV 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
Micro-simulation

- Realistic running times
- Real headways
- Showing effect of conflicts
- Propagation of delays through the network
  - Primary and Secondary conflicts

- Full NL simulation
- One model for 2016, 2017, 2018 and 2023
Dutch OpenTrack Model
OpenTrack

Amsterdam Zuid
NL Model: Facts and Numbers

To make you feel impressed!

Track Kilometres 9164 km
Switches 6846
Stations/Services 676
Main Signals 10576 (NS’54 / ETCS / a.o.)
Double Vertices 44093
Edges 46876
Routes 13372

Single Simulation: 06:00 - 13:00,
- step 2.0s, 2900 trains, 400 trains simultaneously
- 6 min with minimal output
- 23 min with timetable statistics and speed distance
- 49 min with 46 train diagrams and output on.
Demo
Assessing operational feasibility of NL

Running time:

- Modelling of running time variation
  - Extra slack according to planning rules (passenger trains)
  - 7.5% running time slack compared to the 10th percentile train
  - +1 minute additional release time as buffer
Results

Output
- Planning issues solved in process
- Train diagrams
- Delay lists
- Conflicts

ProRail/NS incorporated simulation in the timetable development:
1. Asses the quality of the planned timetable based on the output and expert judgement.
2. Use of the quality assessment for re-design actions
3. Improve the weak spots in the timetable
Results: Planning issues

When modelling we encounter and solve the issues
- Track usage
- Route usage
- Shapeshifting trains
- Use of non existing routes
- Infrastructure constraints
Results: 46 Train diagrams
## Results: Conflicts

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<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>
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<td>B1600-6</td>
<td>B11400-10</td>
<td>Amf</td>
<td>Stop at Signal</td>
<td>8:54:58</td>
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<td>-4</td>
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<td>BD3200-12</td>
<td>Ht</td>
<td>Braking for Signal</td>
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<td>Ledn</td>
<td>Braking for Route</td>
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<td>144</td>
<td>16</td>
<td>180</td>
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</tbody>
</table>
Results: Geographical

Stop at signal
Results: Conflicts
Next Steps for improvement

- Implement OpenTrack in planning process
  - Direct feedback on planned timetable
  - Smaller area’s affected in early stage
- More efficient (faster) checks
- Improve the quality of stochastic simulation
- When planning is stable in deterministic version:
  - Run a stochastic simulation with TRENO
  - Assess stability
- Graphical representation
- Data analysis
- Improve the planning rules
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