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Detailed feasibility assessment of timetables in the design phase

With micro simulation

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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

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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

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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

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Introduction

Advisory group Rail, Utrecht

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

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- Customers
  - ProRail (Dutch infrastructure manger)
  - 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.

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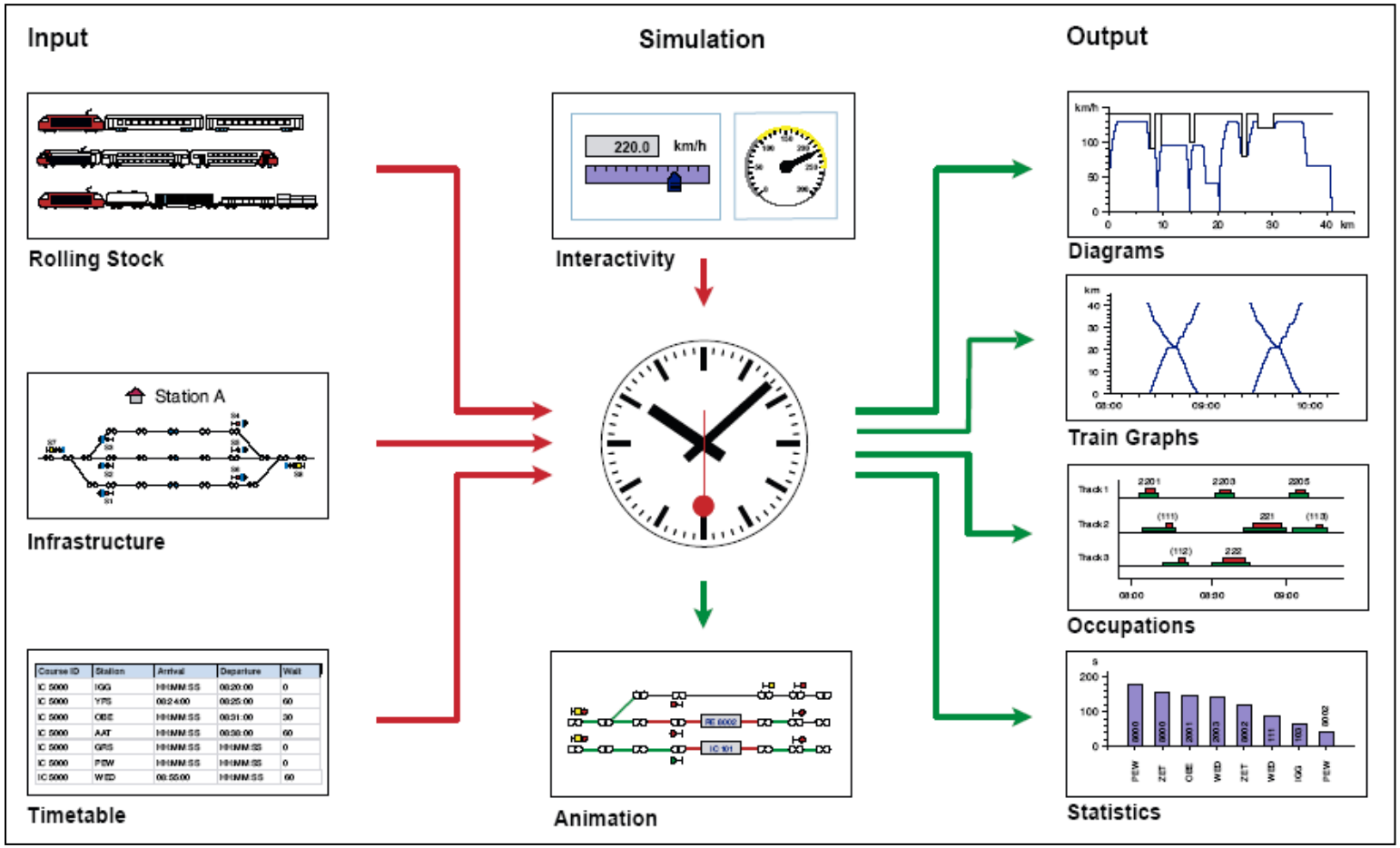
OpenTrack



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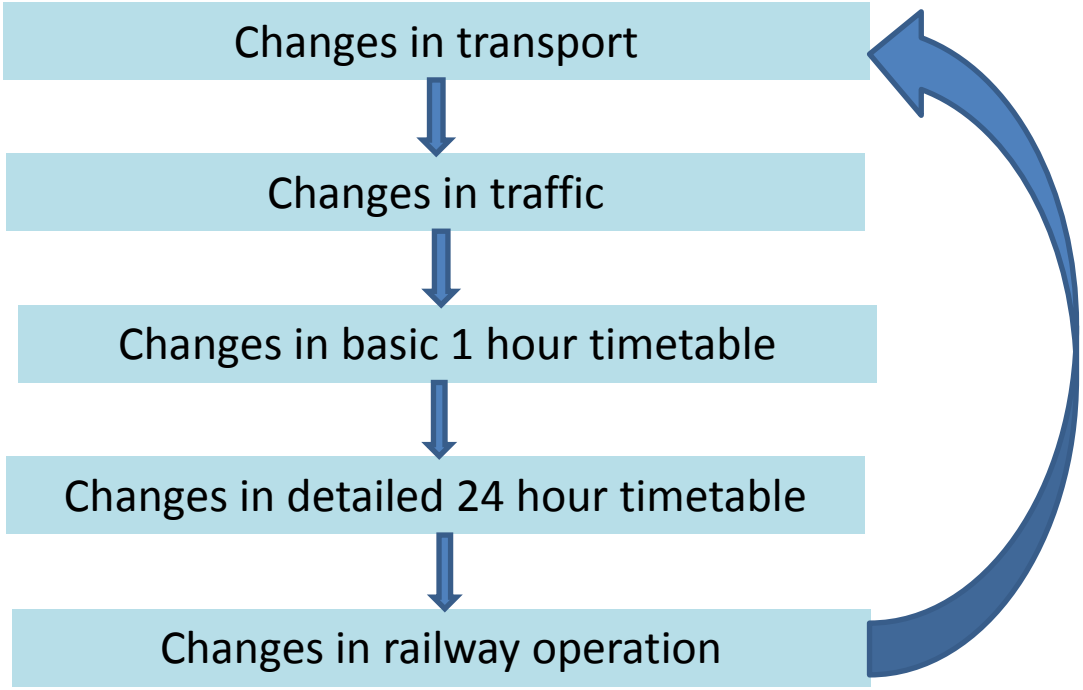
Old timetable planning process



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

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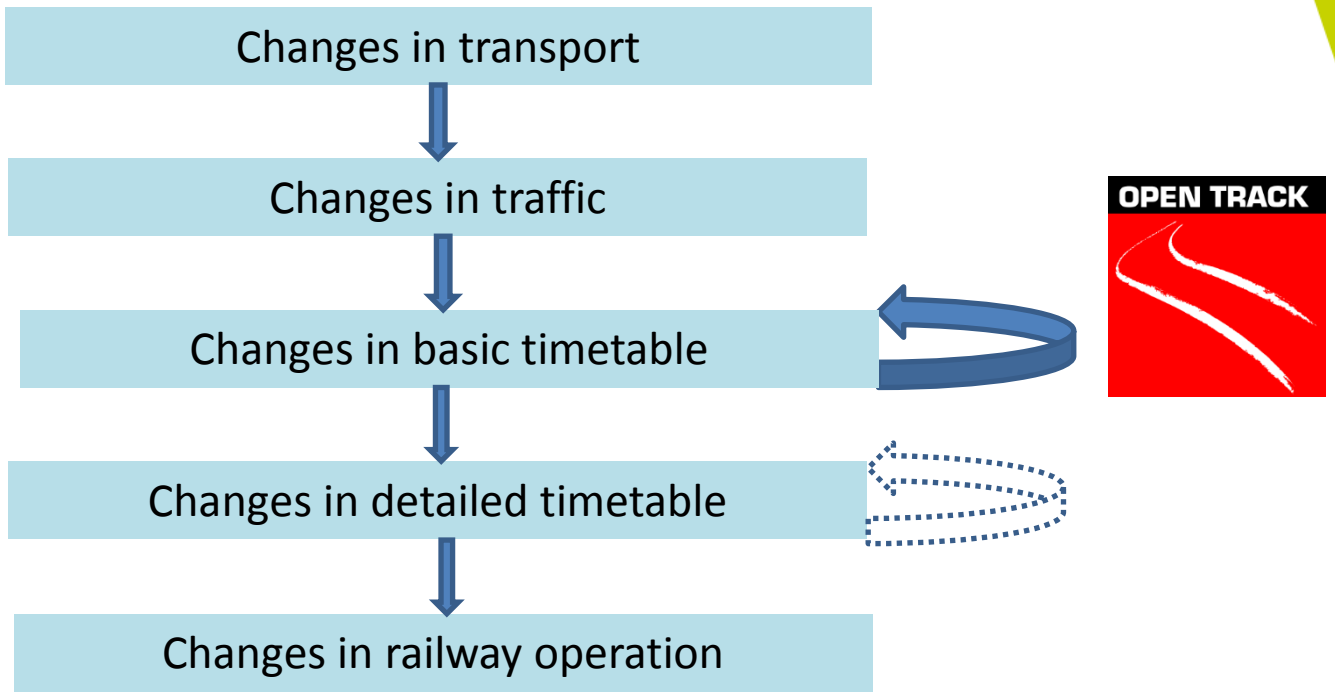
Current planning process with OpenTrack



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

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Micro-simulation

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

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

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Dutch OpenTrack Model

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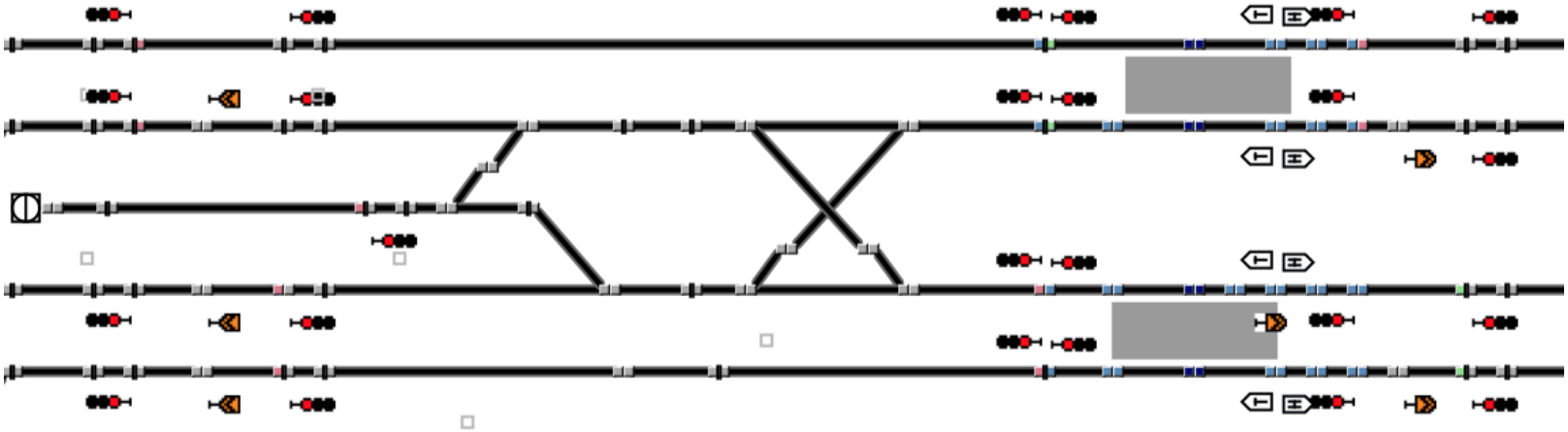
OpenTrack

Amsterdam Zuid



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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.

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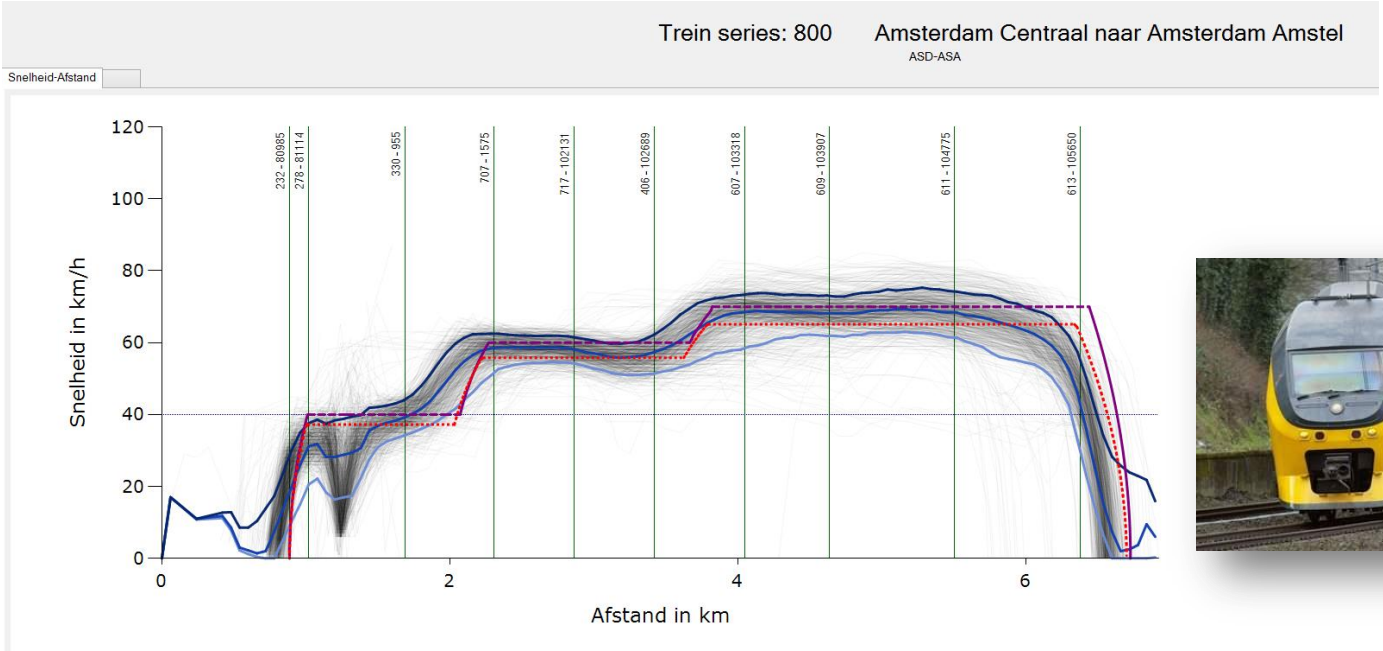
Demo

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



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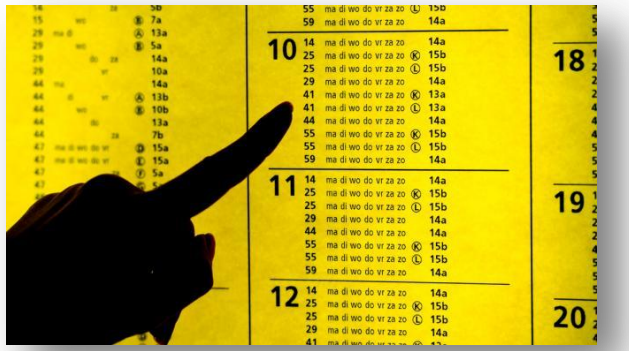
Results

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



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Results: Planning issues

When modelling we encounter and solve the issues

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

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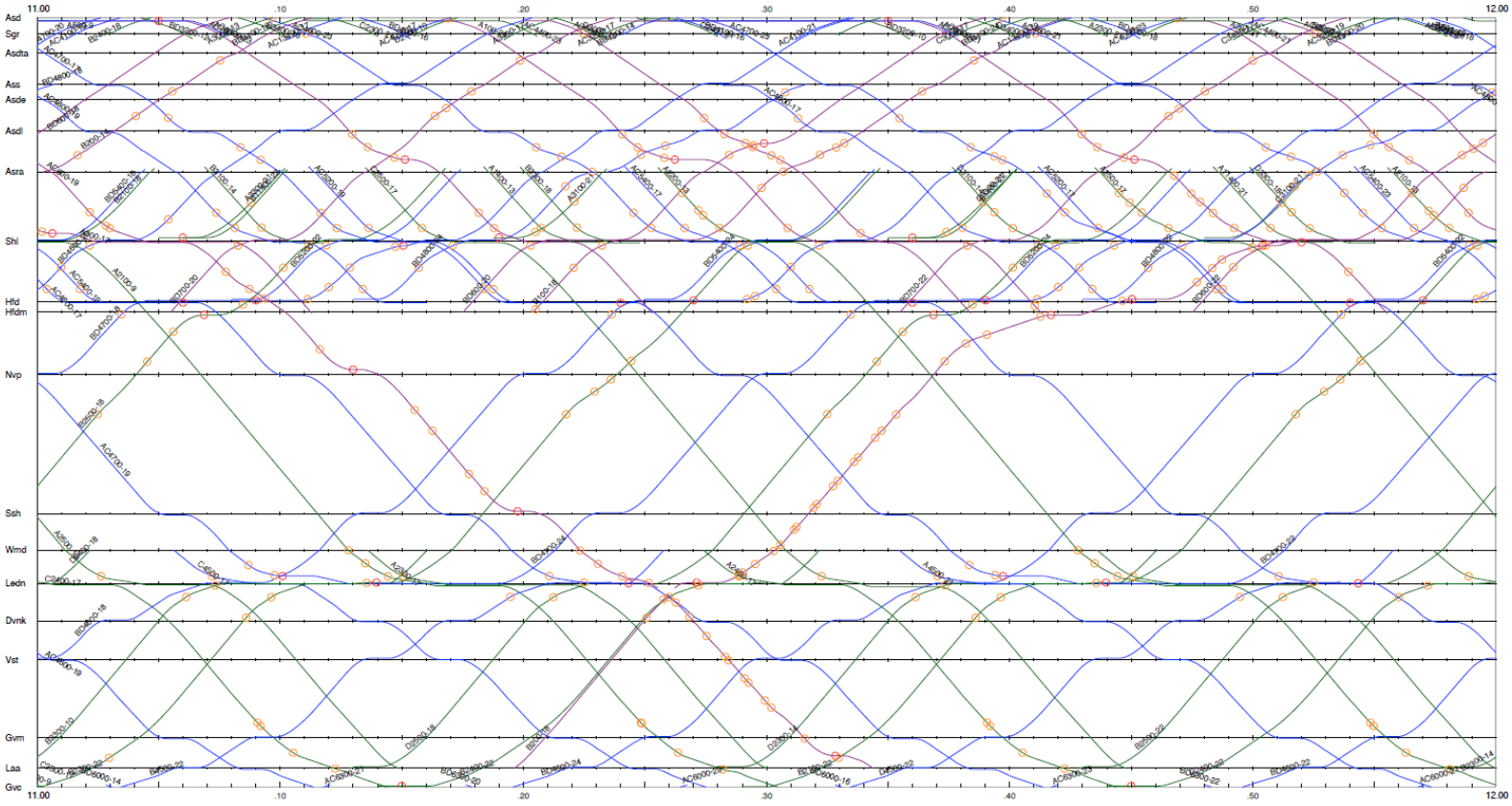
Results: 46 Train diagrams

Amsterdam Centraal - Den Haag Centraal



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Results: Conflicts

Priotrity	Train 1	Train 2	Station/Junction	Type	Time	Delay train 1 [s]	Delay train 2 [s]	Headway norm [s]	Headway planned [s]	Headway measured simulation [s]
1	B1600-6	B11400-10	Amf	Stop at Signal	8:54:58	-86	-4	180	0	158
2	AC6000-5	BD3200-12	Ht	Braking for Signal	9:54:42	82	52	180	0	154
3	AC4700-5	B2100-10	Ledn	Braking for Route	8:43:34	144	16	180	0	138

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Results: Geographical

Stop at signal

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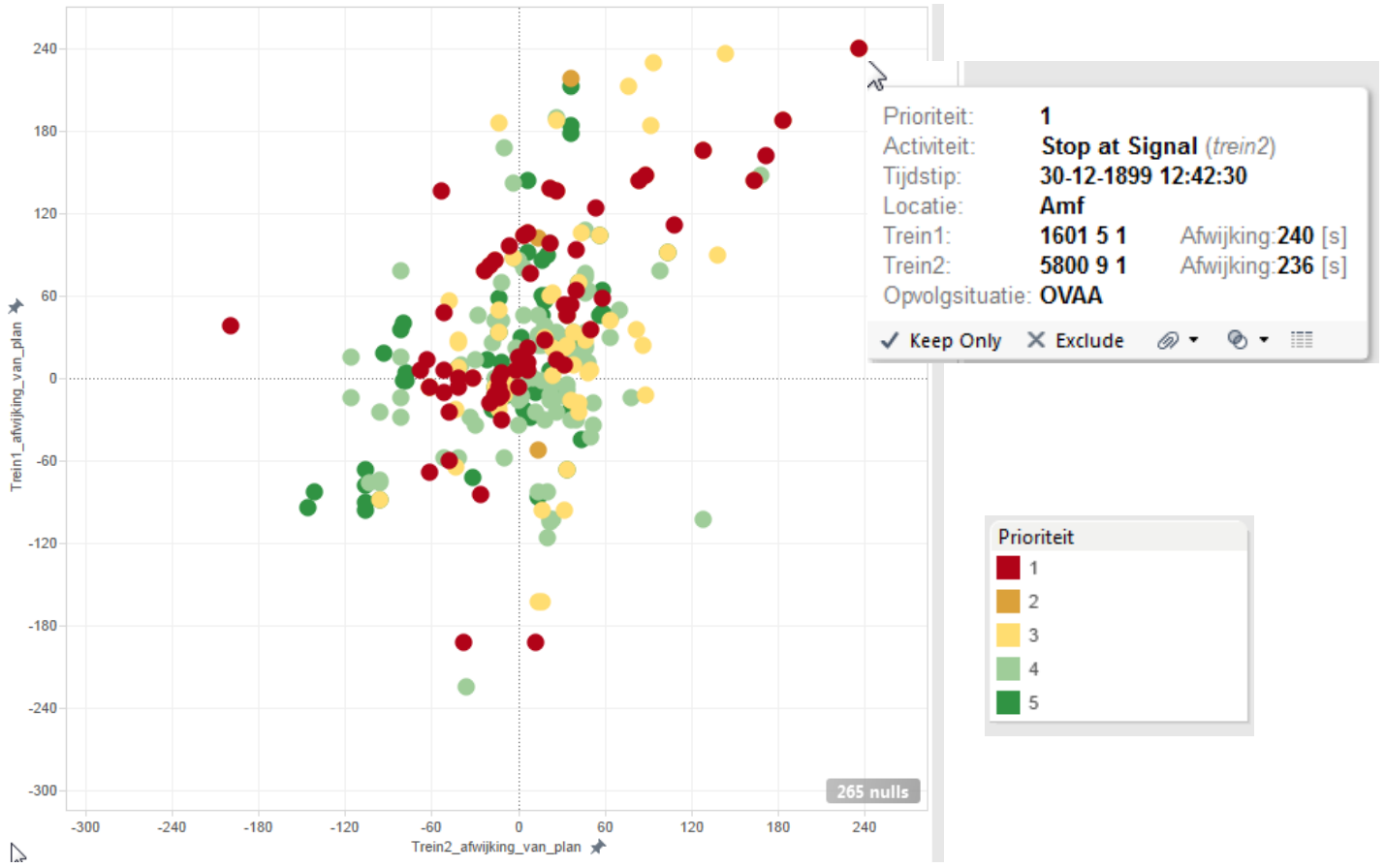
Results: Conflicts



Next Steps for improvement

- Implement OpenTrack in planning process
  - Direct feed back 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
  - Asses stability
- Graphical representation
- Data analysis
- Improve the planning rules

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