Simulation and models
FFE (Madrid, Spain) – 21 September 2017

Magnus Wahlborg
SP 3.2 WP leader
• Main focus research GAP tactical planning and operational traffic (digitalisation)

• Main partners
  • Infrastructure manager Trafikverket
  • System supplier Oltis – Traffic management systems
  • Research institute Linköping U - optimisation
Digitalisation and increased automation of tactical planning and operational process

• Ongoing trend tactical timetable planning process and operational traffic process is merging

• The limit between planning and operational traffic is 3 days to 8 hours before traffic starts

• A third process is to carry out maintenance and monitoring (status of infrastructure and vehicles)
Digitalisation and Automation – timetable planning/traffic management

Film new methods timetable planning
Trafikverket
https://www.youtube.com/watch?v=-AAiTASw7fs

RNE TTR project Redesign of the international timetabling process (TTR)
http://www.rne.eu/sales-timetabling/ttr/

Development of automation in timetable planning process Trafikverket

Shift2Rail
- 2016 start
- CCA Plasa
- IP5 ARCC WP2, WP3 (workshop IP2)
- 2017 start
- IP5 FR8Hub, OC Optiyard
- X2Rail-2

Capacity planning follow up – 1,5 years ahead
Capacity4Rail – framework modelling and simulation

- Simulation
  - Micro
  - Macro
- Optimisation
- Data management (analysis...)
- IT-systems and modules
The CAIN - LiU: Demonstrator
CAIN – CApacity of the INfrastructure

CAIN – Demonstrator

- IT tool developed by OLTIS Group
- Based on KADR (CZ & SK infra-managers)
- Real time software for:
  - input of ad-hoc train paths into the real timetable
  - optimisation of the timetable
  - simulation of different scenarios
- CAIN interacts with the model from Linköping University
CAIN – CApacity of the INfrastructure

CAIN – part I

- **Import** static data of Sweden:
  - Railway infrastructure
  - Timetable
  - Vehicles
- **Corridor Malmö – Hallsberg**
- Data in RailSys/railML format
- **Process** the data
- **Create** a virtual network
- **Display** the railway network
1. A request for a new train path sends to CAIN. (blue)
2. CAIN creates an allocated train path. (red)
3. An application (Bridge) fetches the allocated train path from CAIN via an Web-service. (green)
4. The bridge inserts the allocated train path into an adjusted timetable. (purple)
5. The LiU-model evaluates the adjusted timetable. (teal)
6. The Bridge sends the evaluation back to CAIN via the web-service
Numerical results - Specifications

Train path specification
- Type of train: Freight train
- Maximum speed: 90 Km/h
- Desired route: Mjölby – Nässjö
- Desired arrival time: 10:00

Simulation parameters
- Calibration dates for Bayesian network: 2016-02-11 – 2016-02-15
- Calibration dates for random deviation of departure time: 2015-12-13 – 2016-03-12
- Number of simulations: 200
**Numerical results - Cases**

Case 0 – Unchanged timetable
- Used as a benchmark for the different cases

Case 1 – Ad hoc train *(green)*
- Departing from Mjölby at 08:40
- Waits at Sommen and Flisby for passing passenger trains
- Arrives at Nässjö at 09:59

Case 2 – Ad hoc train alternative slot *(teal)*
- Departing from Mjölby at 09:17
- Arrives at Nässjö 10:17
Numerical results - Comparison

- Using the desired train path in case 1 more than double the estimated delay in the railroad network.

- Using the alternative train path in case 2 increases the estimated delay in the railroad network with 5%.

- The best choice from a robust time schedule point of view is case 2.

<table>
<thead>
<tr>
<th>Case</th>
<th>Arithmetic mean</th>
<th>Median</th>
<th>Difference to case 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>357.23</td>
<td>421.87</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>993.21</td>
<td>949.6</td>
<td>+ 125.09 %</td>
</tr>
<tr>
<td>2</td>
<td>429.7</td>
<td>444.14</td>
<td>+ 5.28 %</td>
</tr>
</tbody>
</table>
Main results

1. To define a framework strategic – tactical planning – operational traffic with micro-simulation, macro-simulation, data analysis, optimisation and IT system modules. By combining these methods tactical planning and operational traffic can be improved.

2. The LiU model have given us knowledge about a data analytic model to predict punctuality, when parameters in the timetable are changed.

3. The CAIN – LiU model interaction have given us new knowledge about interaction between IM timetable system and optimisation/data analysis model to predict timetable robustness and punctuality in the network due to changes in the timetable.

4. The CAIN demonstrator has given us knowledge about TAF/TSI, how to transfer data in Railsys/Rail ML standards and to interact between different data exchange standards. CAIN - Process the data, Create a virtual network and Display the network.
Publications and dissemination

D 32.1 Evaluation measures and selected scenarios, 2014-12-18
D32.2 Capacity impacts of innovations, 2017-03-31

Leaflet WP3.2 simulations and models, Innotrans 2017-09-20
Workshop Digital operations enhanced performance Olomuc 2017-04-27

Scientific publications arisen from the work in C4R, WP3.2:


Thank you for your kind attention

Magnus Wahlborg
Leader WP 3.2

Trafikverket
Magnus.Wahlborg@Trafikverket.se