Railway simulation using OpenTrack in Finland

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Contents:
• Overview of the Finnish railway scene
• All OpenTrack simulation studies done in Finland
• Previews of some OpenTrack studies
  • Helsinki main station study
  • Pasila–Riihimäki capacity increase study
• Summary
Track network in Finland

- Length of track network 5,700 kilometres
- Electrified track 2,600 kilometres
- Remote-controlled track 2,500 kilometres
- Railway service locations 480

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Single track
Double track
Four track

21.1.2008, Kosonen Tero, page 2
Traffic volumes – Freight

- Total amount of freight on rail is about 45 Mio tonnes / year
- Traffic is quite well distributed around the network
- Largest traffic volumes are in Eastern Finland (on some sections over 10 Mio tonnes / year)
- Russian import and transit traffic is about 30 % of the total volume (wood, oil, ore etc.)
Traffic volumes – Passenger long distance

- Total amount of long distance passenger trips is about 12 Mio / year
- The system and most of the traffic is Helsinki-based
- Northern mainline between Helsinki and Oulu has the largest volumes (about 5 Mio / year Helsinki–Riihimäki)
- Western and eastern main lines have over 1 Mio passengers
- Traffic to Russia is about 350 000 passengers / year
Current capacity problems

- Capacity totally in use
- Possibilities of adding new traffic limited
OpenTrack simulation studies in Finland

- Helsinki main station study 2004
- Ilmala passenger depot study 2005
- Turku–Toijala traffic analysis 2006
- Tampere area traffic study 2006
- New eastern high speed line study 2006
- New Vuosaari harbour study
- Master’s thesis of OpenTrack calibration 2007
- New airport line traffic study 2007
- New car-carrier terminal study 2007
- Master’s thesis of using OT in capacity allocation process 2008
- Helsinki–Riihimäki capacity increase 2008
- Kolari iron ore mine study 2008

Examples of finished studies

Helsinki main station study 2004

• Study was made for analyzing significant traffic increase planned for 2006 (from 967 trains/day to 1040 trains/day)
• Train amounts had increased in 1995–2003 over 70 % → would there be capacity left for additional increase?
• For initial data we had only preliminary future timetable structures, all the rostering and track usage had to be planned during the project
• Three different traffic scenarios were simulated
  • Existing production timetable 2003 (for comparison)
  • 2006 traffic planned with existing operation principles
  • 2006 traffic planned with alternative operation principles
• This combination made possible:
  • Analyzing the traffic increase without operation principle change
  • Would there be advantages in changing them
Examples of finished studies

Helsinki main station study 2004 – track usage schedule
Examples of finished studies

Helsinki main station study 2004 – simulation model

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line length</td>
<td>11.5 km</td>
</tr>
<tr>
<td>Total track length</td>
<td>85.0 km</td>
</tr>
<tr>
<td>Number of „stations“</td>
<td>13</td>
</tr>
<tr>
<td>Number of signals</td>
<td>225</td>
</tr>
<tr>
<td>Number of routes</td>
<td>680</td>
</tr>
<tr>
<td>Number of elements</td>
<td>1280</td>
</tr>
<tr>
<td>Number of train movements per simulation run</td>
<td></td>
</tr>
<tr>
<td>- timetable 2003</td>
<td>350</td>
</tr>
<tr>
<td>- timetable 2006</td>
<td>380</td>
</tr>
<tr>
<td>- timetable 2006 improved</td>
<td>370</td>
</tr>
<tr>
<td>Duration of a simulation (from 4 to 10 am)</td>
<td>~ 15 min</td>
</tr>
<tr>
<td>Number of output files per simulation run</td>
<td>~ 8200</td>
</tr>
</tbody>
</table>
Examples of finished studies

Helsinki main station study 2004 – results

21.1.2008, Kosonen Tero, page 10
Examples of finished studies

Helsinki–Riihimäki-line capacity increase 2008

• Objective of the study was to determine necessary infrastructure improvements in order to increase commuter traffic amount
• For initial data we had preliminary timetable structures and suggestions of the infrastructure improvements
• Rostering and track usage schedules for Riihimäki had to be planned during the project
• Helsinki main yard was left out from the model because of its complexity
• The simulation process was done in two different companies – VR-Track and Ramboll Finland
Examples of finished studies

Helsinki–Riihimäki-line capacity increase 2008 - model

Examples of finished studies

Helsinki–Riihimäki-line capacity increase 2008 - results

Occupations / morning peak hours to south

Limited recovery from perturbed situations

Occupation > 60 %

Examples of finished studies

Helsinki–Riihimäki-line capacity increase 2008 - results

Perturbated traffic - alternative A

Random generated delay at start
Delay at end
Examples of finished studies

Helsinki–Riihimäki-line capacity increase 2008 – results

• With simulation we were able to define following infrastructure improvements
  • By-pass sidings should be longer than first suggested
  • Tikkurila station proved to be a bottleneck → changes to layout should be made
  • Also minor changes to other station layouts should be carried out
  • Some additional improvements suggested before the simulation could be dropped out
• Certain improvement requests to OpenTrack were made during the project
  • Ability to define track occupation observing intervals → under way?
  • DelEnd-file observation point should be changed → done
Summary

Experiences from OpenTrack

- With OT we have been able to study and analyze wide variety of rail traffic problems starting from small travel time analysis ending to complex dead-end track yard studies
- After implementing OT our scope of simulation studies has widened quite much
- Simulation itself is still only a tool, the user has to know exactly what he/she is doing to get correct results
- Until now we have focused on double track studies → considering the situation in Finland, single track studies are inevitable

Future challenges

- Single track section modelling with heavy traffic?
- Construction works modelling with the machine movements?