EAG meeting
Hitchin, 25 June 2014

[Optimal Networks for Train Integration Management across Europe]
Collaborative Project
7th Framework Programme

Rob Goverde
WP3: Methods and algorithms for the development of robust and resilient timetables
Outline

• WP3 objectives
• Main reports so far
• Timetable KPIs
• WP3 timetabling approach
• WP3 demonstration
Objective 1
• Improved management of the flow of traffic through bottlenecks to minimize track occupancy times.

Objective 2
• To reduce overall delays through improved planning techniques that provide robust and resilient timetables capable of coping with normal statistical variations in operations and minor perturbations.

Objective 7
• To better understand, manage and optimize the dependencies between train paths in order to allocate more appropriate recovery allowances, at the locations they are needed, during timetable generation.
Main reports so far

1. **ONT-WP03-I-EPF-008-03** - Assessment of state of the art of train timetabling

2. **ONT-WP03-I-UDB-009-03** - Functional Design of robust and resilient timetable models

3. **ONT-WP03-D-TUT-034-01** - D3.1 Methods and algorithms for the development of robust and resilient timetables
Timetable KPIs

Stations, signals

Time

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FP7 - ON-TIME Collaborative Project

WP3 Presentation EAG meeting, Hitchin, 25 June 2014

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Timetable KPIs

1. Stable
2. Conflict-free
3. Robust
4. Resilient (Ad-hoc)

Macroscopic (Normative)

Deterministic

Stochastic

Microscopic

(Partial) unplanned
WP3 timetabling approach

- Modular approach with focus on timetable KPIs
- Set of exchangeable modules to prove concept
- Standardized RailML I/O data format (with extensions)
- Internal data structure with transformations between micro/macro models
- Three-level approach by team work of three partners
  - Microscopic models and data transformations
    - Detailed computations on local and corridor level
  - Macroscopic models
    - Network optimization and stochastic simulation
  - Fine-tuning model
    - Stochastic optimization on corridor level
Microscopic modules

Objectives

• Realizable train paths
• Conflict-free timetable
• Stable operations

Approach

• Running time and minimum headway calculations based on feasible speed profiles
• Operational speed profiles for given run time supplements
• Conflict detection using blocking times (rejection criteria)
• Infrastructure occupation/stability (rejection criteria)
• Input to other WP3 modules (aggregation, envelopes)
Macroscopic module

Objectives

- Robust optimal network timetable
- Minimization of running, dwell and transfer times
- Cancelling train path and connection requests

Approach

- Timetable precision 10 s
- Optimization model: ILP with weighted sum of cost terms
- Heuristic algorithm generating multiple solutions
- Robustness analysis by macroscopic stochastic simulation
- Selection of least robust cost timetable (incl. ILP cost)
Objectives

• Minimizing energy consumption

Approach

• Energy-efficient speed profiles using optimal control theory
• Optimized arrival and departure times on intermediate stops using dynamic programming with respect to stochastic dwell times
Overall approach

Timetabling Level 4

- Microscopic feasibility analysis
- Microscopic stability analysis
- Macroscopic stochastic robustness analysis
- Resilient multi-layer timetable by multi-speed freight path catalogue using (sufficient) residual capacity
- Output: RailML timetable with microscopic passing times and energy-efficient scheduled speed profiles

On-going research (D3.2 and Innotrans)

- Demonstration on Dutch case study
  - Scenario 1: scheduling passenger trains
  - Scenario 2: Insertion of freight path from multi-speed freight catalogue
Dutch case study

- Two intersecting corridors
  - Utrecht-Eindhoven and
  - Tilburg-Nijmegen
- Hourly timetable pattern with
  - 4 IC and 6 Local train lines
  - 2 trains/h each
- RailML data input prepared by Graffica based on input from NS and ProRail
Model sizes

- **Microscopic network**
  - 1500 nodes
- **Mesoscopic network**
  - 1000 nodes
- **Macroscopic network**
  - 16 nodes
Blocking time diagram for the train series 3500
Geldermalsen

- 16 trains/h
- Capacity occupation
  - 756 s = 12.6 min
- Unused capacity
  - 47.4 min
  - To be used for
    - Time allowances
    - Additional (freight) trains