[Optimal Networks for Train Integration Management across Europe]

Collaborative Project

7th Framework Programme

Contributions by Transrail Sweden AB

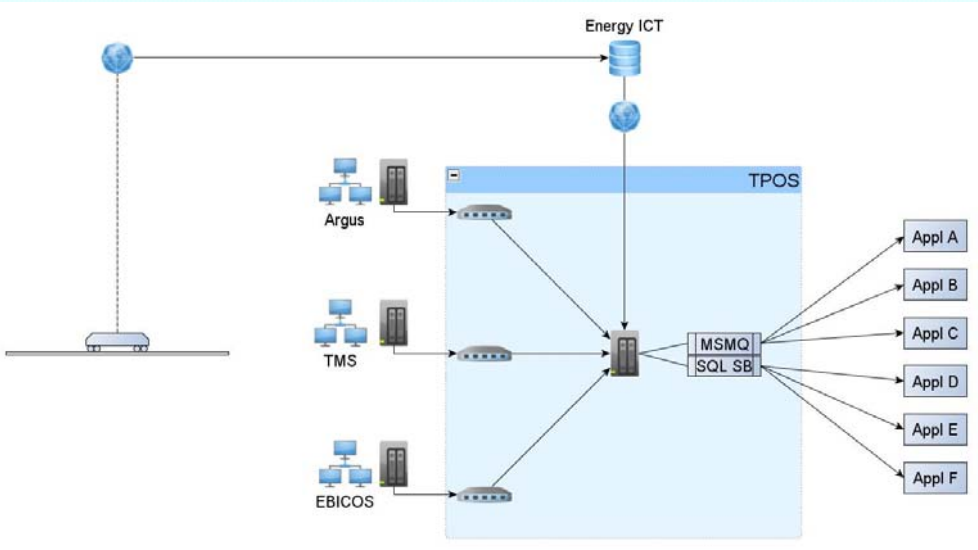
Dissemination seminar, Borlänge, 2014-10-16

Table of content

- Work in WP4
  - Monitoring of train traffic state (4.2)
  - Statistical prediction of train movements (4.2)
  - Optimal adjustment of scheduling times (4.5.3)
- Work in WP7
  - Integration with CATO & Transrail modules

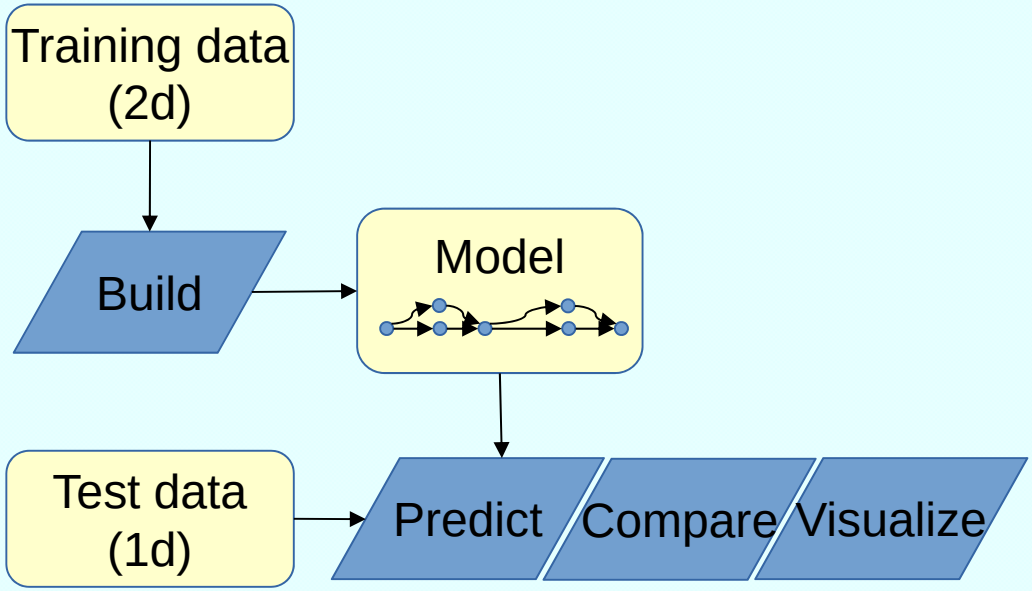
Monitoring traffic state

- Data source: TPOS
  - Train events
  - GPS positions
- Evaluation
  - Delays, time stamps
- Data set collection
  - Three days in Nov 2012
  - Malmbanan
  - Daily train graphs + logs and films from STEG, CATO, TPOS
  - Shared with all partners
  - Used in subsequent work
- Report



Predicting train movements

- Short term
- Training phase
  - Historical data, filtering
  - Building model (DAG)
    - Categories
    - Signals / Travel times
- On-line prediction
  - Event triggered
- Evaluation
  - Kiruna – Vassejaure
  - Error ~30 sec per 10 min (for stable characteristics)
- Report
  - Further enhancements



Operator	# predictions	Error [s/km]	Error [s/min]
All	2030	4.24	5.05
MTAB	1046	3.85	3.80
Green Cargo	451	14.04	14.65
CargoNet	200	1.94	2.82
SJ	224	2.50	3.81
Other	109	12.08	13.56

Figure 3: Prediction error grouped by operator

Adjusting scheduling times

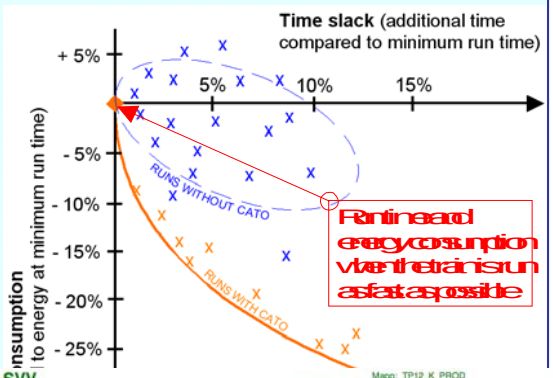
- Use case
  - Dispatcher/other method decide **ordering**
  - Algorithm decide **timing**
    - Global: all trains
    - Efficient: Oper. Cost vs robustness
- Optimization model
  - Variables: Scheduling times
  - Constraints: Schedule limits, separation, margins, ..
  - Objective: Oper. Cost (energy) & robustness (margin gain)

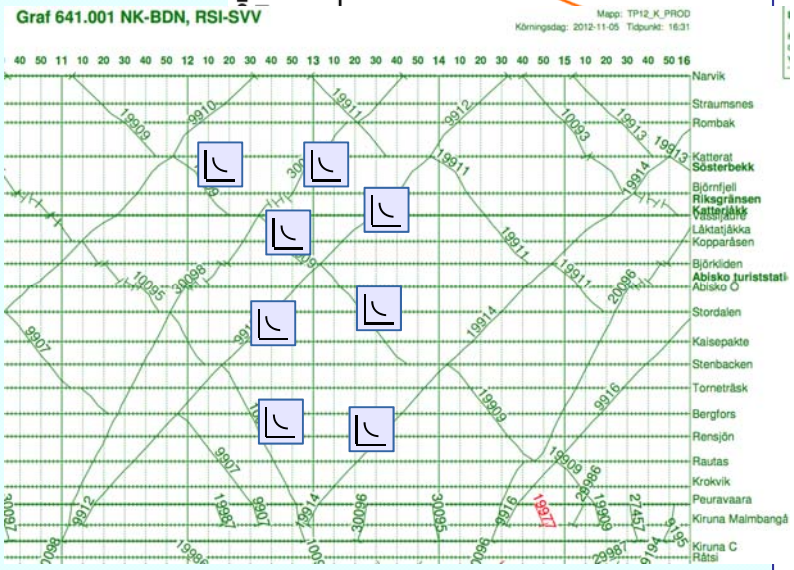
$$Min\ W^T + W^C - \sigma W^R$$

$$W^T = \sum_e \left(\omega_e^{T,min} t_e^{min} + \omega_e^{T,max} t_e^{max}\right)$$

$$W^C = \sum_p \sum_x \lambda_{xp} W_{xp}$$

$$W^R = R^C \sum_e \omega_e^k m_e$$





Evaluation

	Trip durations	Operating cost	Margins (min)	Margin gain
Original	1.00	1.00	X	1.00
Energy focus	1.12	0.91	X + 60	1.08
Robustness focus	1.11	0.93	X + 66	1.15

Normalised values

- Malmbanan, 4h plan, mixed traffic
- Schematic cost function, 5-10 min adjustment
- Both energy and robustness improve vs published plan
- Small margin additions give large robustness gain
- Very quick solutions (< 1s)
- Report, including modelling details

Highlights

- Monitoring
  - Technical platform in place
- Prediction
  - Good short term accuracy
  - Does not require detailed data about track and trains
- Adjusting scheduling times
  - Let dispatcher focus on major decisions
  - Assure correctness (separation, runtime limits, ..)
  - Save energy & improve stability
- Continuation in other projects
  - Ongoing, but open for more!!