Challenges in the development of computational decision support for railway traffic management: From a Swedish perspective

Johanna Törnquist Krasemann
Blekinge Institute of Technology & Linköping University

”FLOAT”

Flexible Re-scheduling of Railway Traffic

A research project funded by Trafikverket within the KAJT programme during 2013-2016. Experimental, comparative studies on how the traffic can be re-scheduled with the use of optimization in two very different contexts, are conducted within the project.

Project group members are Peter Hammarberg (Trafikverket), Johanna Törnquist Krasemann (BTH) and Håkan Grahn (BTH).

www.bth.se/float

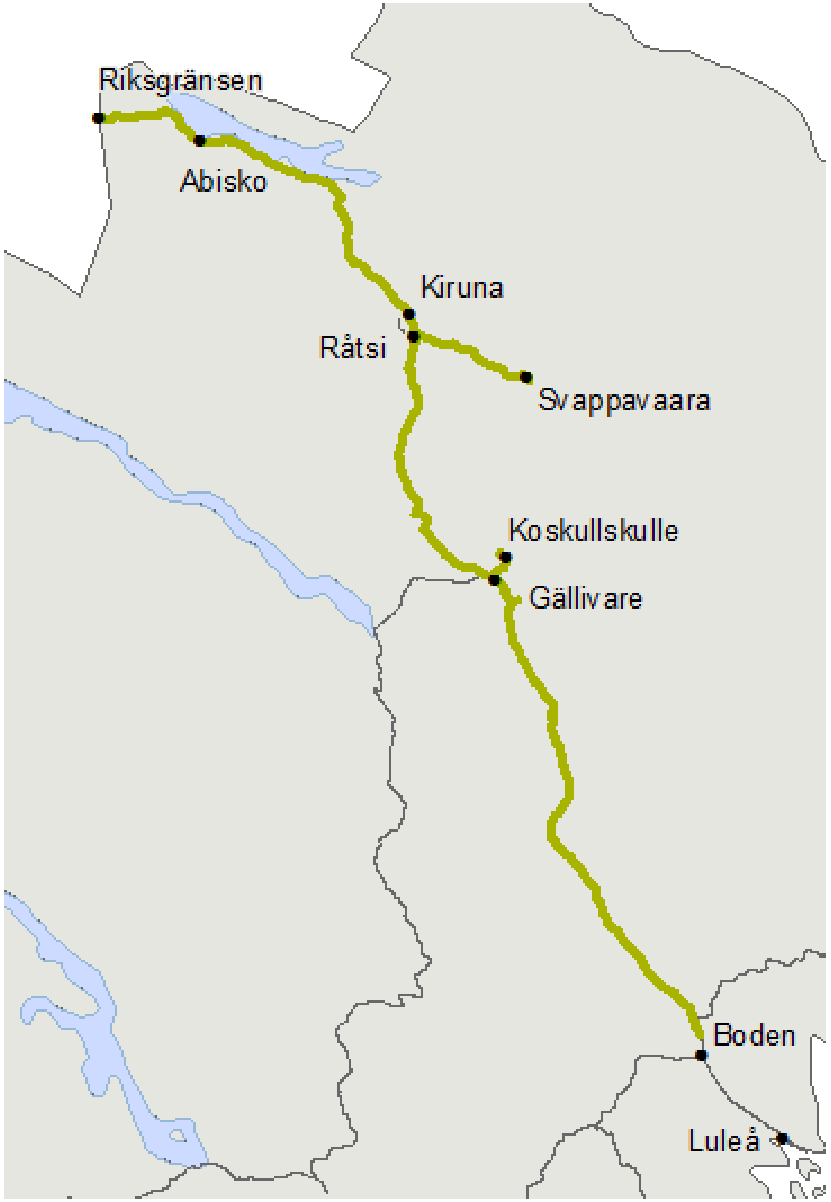
Three main challenges

1. *Prevent primary disturbances from occuring (e.g. signalling errors, rail failures, no-shows of staff etc)* *which may introduce ”knock-on” delays to other trains (referred to as ”secondary delays” sometimes)*

2. *Construct robust timetables* *which to some extent can absorb smaller delays and give the dispatcher good re-scheduling flexibility to reduce the domino effect.*

3. *Provide the dispatcher with optimizing re-scheduling support* *to enable an effective use of the flexibility in the timetable, to incorporate available information better in the decision-making process and to assess the effects of alternative actions.*

Case 1: The Iron Ore Line (”Malmbanan”)



Bildkälla: Trafikverket

500 km long single-tracked line between Narvik (Norway) -Riksgränsen-Kiruna-Boden.

In principal 4 classes of trains:

•Loaded iron ore trains (746m, 8160 tonnes, 60 km/h)

•Empty iron ore trains(746m, 1470 tonnes, 70km/h)

•Other freight trains (eg. 430m, 3400tonnes, 70 km/h)

•Passenger trains (160 km/h, 150m)

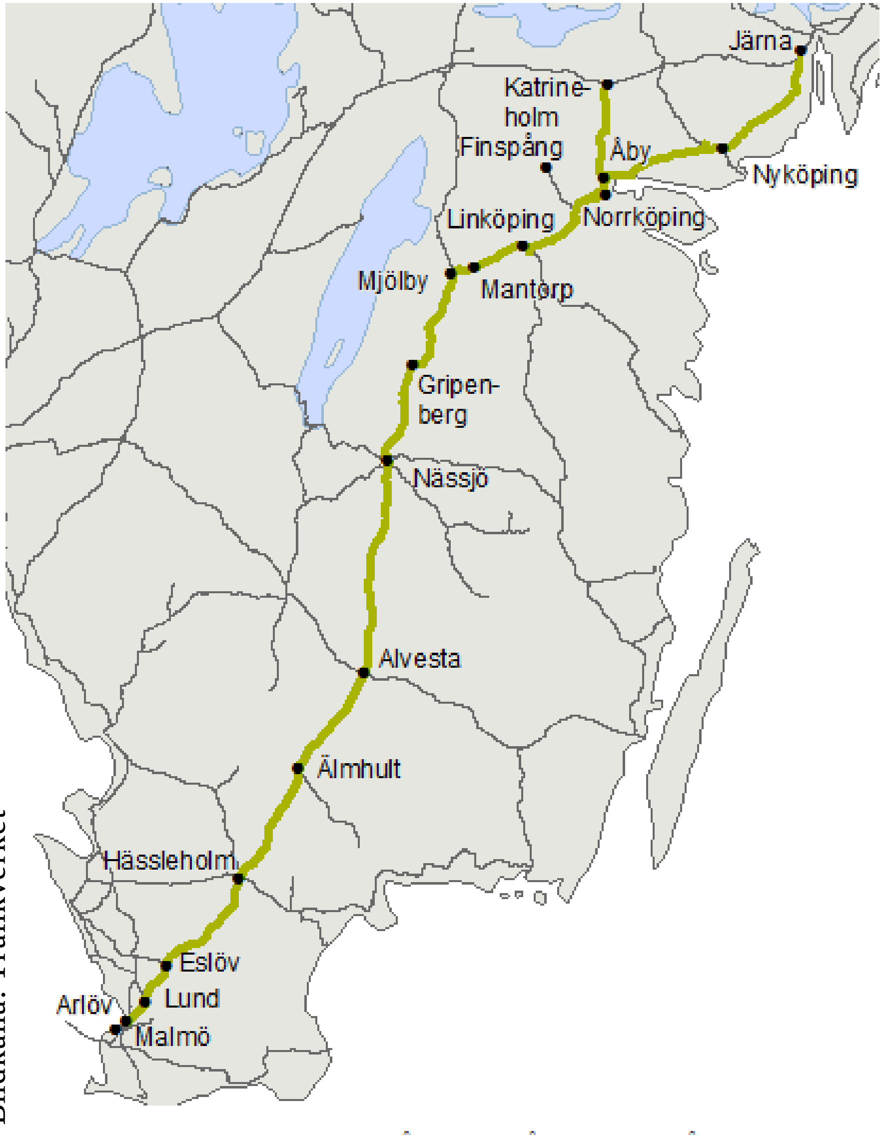
The infrastructure does not permit trains ≈750m to stop and meet at all stations.

The time distance between possible meeting locations for two iron ore trains is e.g.:

- •Stordalen-Stenbacken ca 25 min
- •Bergfors-Rautas 20 min

The stations do not permit simultaneous entrance and requires a time separation of 2-4 minutes.

Case 2: The Southern Main Line



Bildkälla: Trafikverket

A double-tracked core network line with several complex junctions where other lines merge. One part has even 4 parallel tracks.

Traffic intensity is very high and the line is shared by several regional train service systems, freight trains and long-distance fast trains, etc.

Many of the trains are handled by several dispatching areas (Malmö, Hallsberg, Norrköping and Stockholm).

Bi-directional traffic, where both tracks sometimes are allocated to trains in the same direction (planned, but also as a re-scheduling solution).

Some current and future challenges (1)

Interaction and Credibility

How can we combine the skills and knowhow of the dispatchers with the computational capabilities of the decision-support system (DSS) and configure a workload-effective interaction scheme?

How can we define, measure and communicate the underlying assumptions, approximations and consequential uncertainty of the proposed solutions to the dispatchers/users?

How do we handle the potential diversity of alternative solutions?

Computational challenges

Depending on the choice of time horizon and geographical cuts, the re-scheduling problem can easily become very large and complex. In the case of Malmbanan, previous experiments indicate that commercial solvers (e.g CPLEX) perform sufficiently well while in the case of Södra Stambanan (where the bi-directional tracks is a computational complication) an effective heuristic seems necessary.

Some current and future challenges (2)

Legislation and acceptance

DSS solutions should be harmonized with the current traffic management priority regulations (Sw. Operativa prioriteringskriterier) if such will continue to exist.

Knowledge development and best-practice in the rail domain

How do we together improve the compilation and dissemination of acquired knowledge and best-practice from research projects and from industry (publications about actual “lessons learned” are hard to find since most prefer to publish “success stories”)?