# Automated rail traffic dispatching and customer information

$$\max \quad f_{obj}(x, r)$$
$$\text{s.t.} \quad \sum_r a_r x_r \leq A$$
$$\sum_s b_s t_s \leq B$$
$$x_r \in \{0, 1\}$$
$$t_s \in \mathbb{R}^+$$

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## Aim of the project

This project fits in the broader research context of **automated railway**, which aims at increasing railway capacity and quality with IT-supporting tools. More precisely, this project focuses on algorithms for automated real-time rescheduling (or dispatching). With these algorithms it would be possible to cope with small disturbances such as small variations from the published timetable and failures of single technical components, and thus improve punctuality. As a consequence, infrastructure managers could schedule more trains with reduced buffer times, without loss of stability. Moreover, passenger information could be improved, thanks to the information provided by the new algorithms.

## Elements of the *automated railway*

Railway capacity and quality can be improved offline by constructing timetables that maximize network utilization and that are robust with respect to small disturbances. Another 15%-25% of capacity can be gained online. The main idea is to reduce or even to eliminate the time reserves at capacity critical points by improving precision during operations. In order to achieve this goal, the following elements are required:

*Automatic real-time rescheduling:* adapt the published timetable in real-time according to the current traffic situation automatically in order to avoid conflicts;

*Speed profiles optimization:* compute speed profiles that ensure optimal adhesion to the schedule in order to avoid unplanned stops;

*Automatic train operation:* drive train automatically in order to apply the given speed profile;

*Control loops for rescheduling and train driving:* combine the previous three points in a cascade control loops system, with an outer loop controlling the overarching traffic situation and an inner loop controlling the single train;

*Optimized time-reserves distribution:* recognise where buffer times are needed and tune them according to the actual needs of rail operations.

## Expected outcomes of this project

This project focuses on the first element of the automated railway and will cover the following topics:

- Elaborate a concept for the interconnection of the identification of disturbances, automatic scheduling, dispatching and passenger information.
- Review the international State-of-the-Art on automatic dispatching and select a suitable mathematical methodology.
- Develop the chosen algorithms for a series of small disturbances on the operating schedule in a short cadenza and in a limited region.
- Specify the spatial demarcation and identify the disturbances that are treatable with automatic preparation of solutions, evaluation and priorization.
- Determine the required forecast accuracy for the duration of operational problems for (partially) automated further processing.
- Proof-of-concept in a suitable simulation environment and, where appropriate, in practical applications.
- Assess the impact of dispatching semi-automations on the involved stakeholders and develop recommendations upon the automation level.

## Methods

Methods of Operations Research will be applied within this project. First, the problem of real-time rescheduling will be formulated as a mathematical optimization instance. Then, heuristics will be applied, in order to find a solution quickly, because exact methods would exeed the amount of time available. In fact, during real-time rail operations, dispatcher must react quickly, before a small local disturbance spreads to a wider network region.

## Summary

This project aims at developing a real-time rescheduling algorithm and a concept for its application in real operations. This will allow dispatchers to cope with small disturbances more quicky and to improve punctuality as well as customers information.

**Client**
SBB Infrastructure Division

**IVT Contributions**
Concept for rescheduling and connection with customers information, Algorithms, Proof-of-concept

**Applied Methods**
Mathematical modelling, Heuristics, Simulations

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