Thoughts on restoration of regular tram operation

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Introduction

Within the scope of our project "Computer Aided Traffic Scheduling" (CATS) we develop methods and applications to generate and evaluate robust time tables, which adhere to transport planning requirements. A detailed description of the project and its software modules can be found in [5, 6].

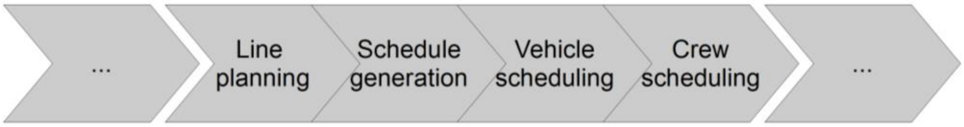

Figure 1: Shortened planning process of urban public transportation

The planning process of urban public transportation can be roughly divided into four different phases (see figure 1). Until now our research was focused on schedule generation with some necessary forays into the closely linked fields of line planning and vehicle scheduling. As described above, our research was until now concentrated on generating schedules which keep small delays at a local level, i.e. to minimize the impacts of delays on follow-up vehicles. Long lasting disturbances, whose impacts generally cannot be counteracted by schedule characteristics alone, were ignored until now. We now want to broaden the scope of our project and examine the applicability of rescheduling and re-routing measures during the daily operation of urban public transportation systems.

Rescheduling aims for the generation of transitional schedules in order to cope with the impacts of long lasting disturbances. Not only is the generation of those temporary schedules time-critical but the resulting time tables should also be robust and allow for reinstatement of the original schedule after the disturbance wore off/subsided.

Literature review

Research on rescheduling and re-routing is mainly applied to long distance transportation. Corman, D'Ariano, Pacciarelli and Pranzo in [1] develop a tabu search algorithm for re-routing trains during daily operation. In [2] they present a bi-objective optimization approach to minimize train delays as well as missed connections by dynamically switching the order of trains at common stations (therefore changing the underlying schedule).

Darmanin, Lim and Gan in [3] propose a new recovery strategy for Metro Train Melbourne, which employs existing bus lines for bypassing obstructed train tracks.

A similar approach for urban public transportation is proposed by Zeng, Durach and Fang in [7]. They examine the circumstances under which it is profitable for a tram company to cooperate with taxi companies in order to transport stranded passengers to the next regularly served station.

Ginkel and Schöbel in [4] propose an optimization approach for the bi-criteria delay management problem in public transportation, which minimizes vehicle delay as well as missed connections. Other than Corman, D'Ariano, Pacciarelli and Pranzo in [2] Schöbel and Ginkel focus on bus-to-train-delay.

Restoration of regular tram operation

In order to narrow the huge research field of rescheduling and re-routing we initially want to focus on one traffic system only, without consideration of replacement vehicles or standby personnel. Thus we may adapt part of our existing methods and applications, e.g. as a first step to generate temporary schedules we could apply the genetic algorithm described in [6].

Alongside the adaption of our existing methods we will also conduct an application-oriented comparison of existing rescheduling and re-routing strategies. In order to assess the applicability of these strategies we will develop a visualisation module that enables us to analyse the effects of small, incremental modifications to a schedule. Furthermore the existing optimization module should be modified in such a way that an existing schedule can be evaluated using the underlying objective function.

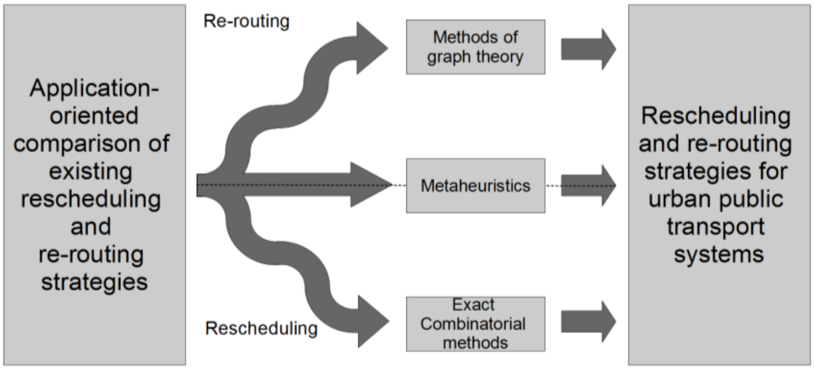

Figure 2: Road map to rescheduling and re-routing strategies for urban public transport systems

Independent of the results of the comparison we see at least three procedural paths (see figure 2): methods of graph theory (especially applicable for re-routing), metaheuristics like genetic algorithm, ant colony optimization or simulated annealing, and exact methods like branch and bound.

Based on the assessment of existing strategies and experiments using the aforementioned procedural paths, we will develop an (online-) optimization methodology and module to generate and evaluate special rescheduling and re-routing strategies for urban public transportation systems.

Pending questions/unresolved issues

There are still numerous questions that have to be addressed until the desired optimization approach is finished.

First of all, which kinds of disturbances are severe enough to justify rescheduling or re-routing? Especially re-routing entails excessive changes to the schedule of different lines and therefore should only be applied after serious/profound disturbances. Additionally, a clear definition of re-routing measures has to be formulated, i.e. which measures are summarized under the term re-routing.

Because rescheduling and re-routing takes place during daily operations, any application generating rescheduling/re-routing strategies is time-critical. This has to be taken into account while developing rescheduling/re-routing strategies and applications.

At last we have to decide how the generated, potential solutions should be evaluated, i.e. which criteria should be considered. It seems obvious to consider robustness, but other criteria like adherence to transport planning requirements or the number of omitted stations seem also promising.

Acknowledgements

This work was supported by Rhein Energie Stiftung Jugend Beruf Wissenschaft under grant number W-10-2-002.

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