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EVALUATION OF MULTI-MODAL TIMETABLE SYNCHRONIZATION IN THE RANDSTAD

A proposal for a multi-modal timetabling framework

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ABSTRACT

In this paper, the quality of multi-modal connections is evaluated within the Randstad. Although many trains, buses and trams operate all day with very high frequencies, we show that there is a low level of synchronization between services of different mode or different operator. Therefore the low-frequency services, such as regional buses or the night network, have a potential to improve door-to-door travel quality and attract more customers by a synchronized timetable, operational principles to keep connections even during disturbances and a real-time passenger information system. Therefore the design of an integrated multi-modal, operator-independent timetable model is proposed.

KEYWORDS

public transport, multi-modal, timetable, connections, night network

THE IMPORTANCE OF CONNECTIONS

As shown in (Rietveld, 1999), a transfer is uncomfortable for the passenger in two ways : (1) passengers perceive waiting time at stations longer than the same time spent in a vehicle, and (2) passengers are risk-averse regarding the journey time: even a longer journey time is preferable to a journey time with high variation.

Intermodal and inter-operator transfers

From the passengers' point of view, connections involving different modes (such as rail and bus) or different operators are just as important as uni-modal transfers within one operator. In practice, however, these connections are more difficult to implement due to physical, operational or organizational barriers and hence it is often only possible via the strong coordination of the public bodies ordering the services.

Layers of multi-modal integration

(1) **Spatial integration**: the vehicle access points (station platforms, bus stops) have to be in short walking distance of each other, not only for passenger comfort, but also for the visibility (advertising) of the connection possibility; as well as to keep not only absolute walking times but their variation at a minimum, which is essential for efficient synchronization.

(2) **Timing**:

(2a) **Off-line schedule synchronization**: The advertised schedule must include reasonably short waiting times between the arrival of the first and the departure of the second vehicle. A simple, but expensive way to achieve this is by operating both services at a high frequency. However, if the size of the demand does not justify short headways (such as maximum 10 minutes), the timings have to be synchronized. In case of the latter and very short waiting times, the existence of a guaranteed connection must be communicated to the customer in order to avoid stress because of too short perceived transfer time.

(2b) **Robust operational principles**: As some delays are unavoidable, without cooperation between the operators, a small delay of the first vehicle results in a missed connection and a substantially higher delay for the passenger. Communication channels, dispatching principles and decision supporting algorithms must be set up to safeguard connections as much as possible, even in case of disturbances.

(3) **Passenger information**: Both off-line and real-time travel information has to be provided to the passengers to inform them about delays and therefore about the feasibility of the planned connections to avoid both missed connections and stress due to uncertainty. Additionally, alternative travel advice is necessary in case of major disruptions.

The scope of the research

This paper assesses the synchronization of current schedules **(2a)** in the Randstad.

Spatial integration **(1)** is not in the direct focus of this research as we consider predefined lines and infrastructure; we can note, however, that in the Randstad, a very good geographical integration of air, rail, bus and water-borne travel has been provided in the form of multi-modal stations (OV-terminals).

Following research will extensively deal with assessing the stability and the robustness **(2b)** of different schedules and algorithms to generate optimal timetables in these aspects.

Passenger information **(3)** is not part of the research either at the current stage, but it has to be already stressed, that high quality, ubiquitous passenger information systems are required for the success of managed multi-modal transfers.

DATA

The official 2010 timetables in the Randstad are examined with special attention to stops where vehicles of different operators or different modes meet. Characteristic passenger waiting times are to be estimated for the valid timetable, as well as for proposed new times aiming at better synchronization without changing other parameters affecting operational costs.

As shared stops of two frequent services (such as headways no larger than 10 minutes) are considered good quality connections and the departure times of less frequent daytime services might be affected by constraints of other services (such as shared infrastructure), an emphasis is made on the evaluation of the night train and bus networks, where frequencies are low but departure times are not affected by other, more frequent services.

We focus on the overall efficiency of the network rather than isolated nodes; the network efficiency however is dependent on the key transfer nodes where most of the (potential) connections can be provided. The analysis shows that the number of attractive connections between the night train network and the urban night bus lines is low (see Figure 1).

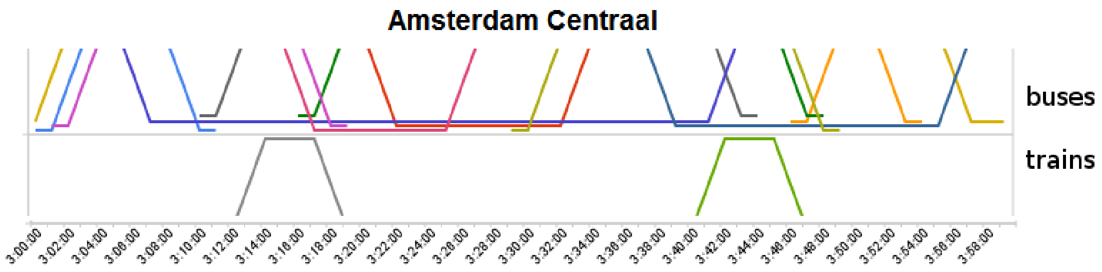

Figure 2: Bus and train arrivals and departures at Amsterdam Centraal on Monday-Wednesday nights between 3am and 4am

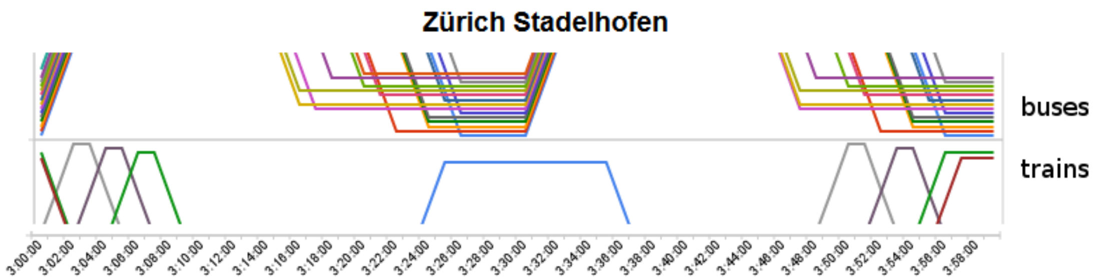

Figure 1: Bus and train arrivals and departures at Zürich Stadelhofen on Friday-Saturday nights between 3am and 4am

EVALUATION

Based on the analysis of the data described above, this paper answers the following 3 questions:

1. To what extent are the current schedules in the Randstad synchronized (with respect to inter-modal or inter-operator connections)? How many of the possible connections at a transfer point are possible with an attractive transfer time (such as max. 10-15 minutes)?
2. How big room for improvement exists in the current schedules (keeping the current lines and frequencies)? Is it possible to change the arrival and departure times without changing the frequencies (and therefore keeping the operational costs) to improve connections using the same resources?
3. What more substantial changes (possibly including investments or higher operational costs) might be efficient to provide synchronized schedules?

NEW MULTI-MODAL TIMETABLING FRAMEWORK

Given that it is shown that better intermodal timetable synchronization is necessary and the current modal and company structures do not always allow for simple hierarchical timetabling, a new model framework is needed which reflects the possibility of many different companies operating different modes and which facilitates the generation of one synchronized timetable system that does not favour one company or mode (such as only providing train-to-train transfers) but the sum of passenger benefits.

A multi-modal timetabling framework could have the following advantages:

1. Support for hybrid modes, such as light rail, tram-train, Bus Rapid Transit (such as the *Zuidtangent*).
2. Simpler modelling as a single model is sufficient for the scenarios of multiple nodes and operators.
3. Scenarios of services and connections can be evaluated using passenger-oriented criteria (such as door-to-door travel time and passenger delay) and more general societal benefits (including also e.g. costs and accessibility).

We believe that the 3rd advantage would be the main contribution of such a model.

CONCLUSIONS

This paper shows that a weakness of the public transport system in the Randstad is the low coordination of timetables between different modes and different operators. In order to attract more customers even outside hours of high frequencies, operators need to work together with each other and the public authorities to define an integrated, synchronized timetable.

Only in case of an integrated, synchronized timetable it becomes possible to develop methods to supervise these connections and guarantee transfers whenever possible even during disturbances; and real-time information systems displaying the connection statuses for the passengers.

To facilitate creating timetables spanning multiple modes and different operators, it is proposed to develop a multi-modal, multi-operator timetabling framework which does not favour one mode or operator, but can evaluate different connection scenarios according to passenger-oriented measures (such as passenger delay and door-to-door travel time) and can assess the stability and robustness of the timetable taking into account also multi-modal connections.

REFERENCES

Rietveld P., F.R. Bruinsma, D.J. van Vuuren (1999) *Coping with unreliability in public transport chains: A case study for Netherlands*, in: Transportation Research Part A 35 (2001) pp. 539-559.