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Dynamic Pricing of Track Capacity

Victoria Svedberg[ab]*, Martin Aronsson[a], Martin Joborn[ab], Jan Lundgren[b]

[a]RISE SICS, Box 1263, 164 29 Kista, Sweden
[b]Linköping University, Department of Science and Technology, SE-601 74 Norrköping, Sweden

Abstract

To reach a perfect competition on the tracks, new market based approaches to train timetabling needs to be investigated. In this paper, a process for dynamic pricing of track capacity is suggested. The process includes methods for calculating the supply of and demand for track capacity for an application for delivery commitments. These methods make it possible to apply techniques for dynamic pricing on the timetabling problem to find a market based price of a set of delivery commitments. Track capacity in high demand will thus get a higher price than capacity in less requested times and tracks, thus encouraging operators to avoid to request delivery commitments for trains to be operated during the most congested hours of the day. Subsequently, the congestion can be reduced and the timetabling process will be fair and flexible.

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Keywords: Dynamic Pricing; Railway Timetabling; Delivery Commitment

1. Introduction

Since the opening of the Swedish railway operator market in 2001, both the interest in transporting goods and travelling by trains have increased. Many new operators have since then competed for market shares. Today, there are multiple freight and passenger train operators operating on the Swedish railway network, some of which are SJ, MTR and Green Cargo. All of them are competing for customers and to get their train paths into the timetable. A train path is a specification of the route of a train and when that train should pass each geographic location on the route. Operators applying for train paths are actually applying for track capacity. To be assigned track capacity means to have the right to occupy some tracks at a certain time. Each year, the Swedish infrastructure manager, the

* Corresponding author. Tel.: +46 72-530 04 21.
E-mail address: Victoria.Svedberg@ri.se

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Swedish Transport Administration, coordinates the operators' train path applications into one timetable for the entire Swedish railway network. This is the train timetabling process. If two or more train paths cannot fit into the timetable without violating the security regulations, the train paths are in conflict and there is a dispute about track capacity. When a dispute arises, the Swedish Transport Administration must decide which operator that should win the conflict and as a result get its desired train path into the timetable. The principle is to let the train path, that provides the largest value to the society, win the conflict. The train timetable is published once a year when every train path application has been treated.

The Swedish Transport Administration's ambition is to have a perfect competition between the operators, which is also advocated by the European Union via the first railway directive. A perfect competition between operators also means that there should be equal rights to get a train path application into the timetable. According to Eliasson and Aronsson (2014), there are two reasons why the current train timetabling process never will fulfil this ambition. Firstly, the Swedish Transport Administration cannot transparently solve conflicts between operators attracting the same type of customers, for instance operators who both provides long distance high speed traffic. This is because the actual profit a train path could provide to the corresponding operator will never be revealed and cannot be estimated using models for economical investigations. Secondly, many freight operators do not have transport requests to operate before the application deadline and are therefore reliant on the possibility to hand in late train path applications. Late train path applications are train path applications handed in after the train path application deadline. These late train path applications are treated on a "first come, first served"-basis and are not allowed to change anything in the published timetable. Thus, these train path applications are not investigated by the Swedish Transport Administration in the same manner as the train path applications handed in before the application deadline. Therefore another process is requested, where train path applications can be compared whenever they are handed in to the Swedish Transport Administration.

In this paper we suggest to use dynamic pricing of track capacity in order to improve the train timetabling process. Dynamic pricing includes methods which set a price on a supply of wares based on the number of items in stock and the expected demand. Previously, little research has focused on revenue management methods applied to pricing of train paths. Gorman (2015) provides an overview of the recent research in dynamic pricing of train transports. The aim with using dynamic pricing of track capacity is to achieve that track capacity in high demand, where conflicts for track capacity usually arises, will be more expensive than track capacity during the less congested times of the day. The result will be a conflict regulation where the train operators' willingness-to-pay will solve the conflict. This is a more transparent and fair method for conflict regulation. In dynamic pricing, the future demand is considered in the price. The future demand is the train path applications using the same track capacity, which will be applied for later in the train timetabling process. If it is likely that an operator applies for track capacity in the future with a high willingness-to-pay, the infrastructure manager can account for that in the price today. Thus, the late train path applications can be justly compared to early train path applications.

We will use the notion of delivery commitments to define the agreement between the operator and the infrastructure manager, as introduced by Gestrelius et al. (2015). A delivery commitment includes a set of requirements on a train path, for example that the train should arrive to or depart from a station before a specific time. The difference between a train path and delivery commitments is visualized in Fig. 1. Instead of applying for a train path, operators apply for delivery commitments request, which means that operators only specify the important characteristics of a train path, which the infrastructure manager should consider when planning the train timetable.

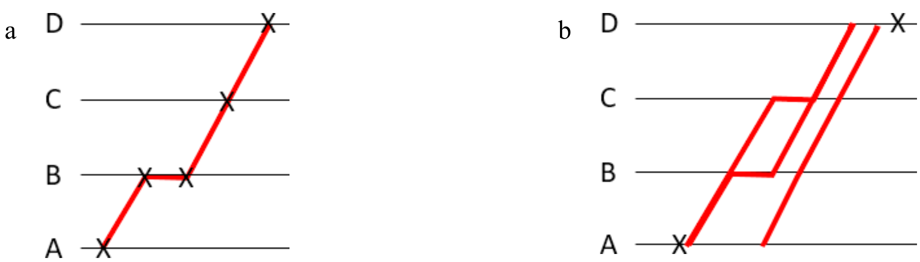

Fig. 1. (a) A train path is defined by the times the train should pass each geographic location through the route, i.e. the X:s in station A, B, C and D; (b) The delivery commitments is defined by the requirements on a train path. In the figure, the X in station A marks a delivery commitment for the earliest departure time and the X in station D marks a delivery commitment for latest arrival time. The delivery commitment must be fulfilled later on when the infrastructure manager plans the train path. Thus, there are several options on how the train path could be planned, allowing some flexibility for the infrastructure manger. Some examples of possible train paths are given in the figure.