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Real-time Management of Railway Traffic over a Complex Network

Railway is a transportation mode of central importance, potentially able to provide direct, fast and reliable connections between cities, industrial nodes, etc. Railway companies are actually facing a challenging target: improving the punctuality of trains, despite the expectation of a significant increase of traffic intensity and the limited budget available to build new rail infrastructure.
Such challenging target can only be achieved through intelligent use of the existing rail infrastructure and efficient exploitation of the available transport capacity.

Traffic Optimisation

The railway system is highly sensitive to delay propagation. Primary delays easily spread throughout the network and train traffic results in infeasibilities. Then dispatching actions are required in real-time, in order to solve those problems and return timely to planned operations.
Our contribution consists of an innovative **Traffic Management System (TMS)** which can be useful to improve the utilisation of the available resources and the punctuality of trains, by accurately monitoring the current train dynamics and the network operating conditions, and then predicting the potential conflicts and rescheduling trains in real-time.

Approach

Our TMS is based on an **alternative graph model**. The alternative graph is a powerful model, suitable for several real-world problems. It is fast and detailed at the same time, able to include in the optimisation model all the relevant features and constraints needed to produce efficient and realistic scheduling solutions. Powerful algorithms predict and solve potential conflicts, starting from the current situation of train positions, speeds, traffic and infrastructure status and constraints.
TMS provides a smooth and efficient traffic regulation, through a continuous updating of the current train schedule, in order to dynamically solve future conflicts and optimise the chosen cost function, and by communicating advisory speeds to trains when required. If profitable, alternative routes are explored in order to achieve a better solution.

Reference

Mazzarello, Ottaviani "A Traffic Management System for Real-Time Traffic optimization in Railways", Transportation Research Part B 41 (2), pp. 246-274 (2007).

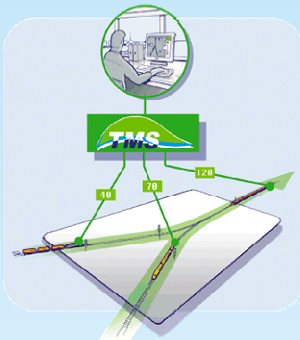
Applications and Results

The TMS was developed under two subsequent EU projects, named **COMBINE** and **COMBINE 2**, and it was enhanced during application studies by **ProRail (NL)**. Right now, the most important applications of TMS have been based on complex and densely occupied dispatching areas of the Dutch rail network. Very promising results were found in simulation studies and a pilot implementation of TMS, in the analysis of **punctuality** (increased from 89% to 95%)and **energy saving** (the number of non-commercial stops reduced of 80%).

The **pilot "The Green Wave"** (2004) showed the strength of the TMS in improving punctuality by preventing conflicts and guiding trains on the basis of recommended speeds.

A capacity study was carried out for **"The Schiphol bottleneck"** to verify if the use of a TMS could be effective to manage the forecasted increased traffic in 2007.

's-Hertogenbosch 2009 is a study executed for an area of reasonable size and complexity, where a real control challenge currently exists.
TMS results have been compared with success to common strategies (FCFS, VaVo).



ETMET 2013: "Each Ten Minutes a Train": TMS is applied to grant a frequency of one passenger train every 10 min. on a highly congested route.

We are currently exploiting the TMS model in other applications, like aircraft ground movements optimisation in airports.

On Advanced Industrial Research

2011, Traffic Management System