Timetable Planning and Information Quality

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Preface

This edition provides selected papers presented during the last three Conferences on Computer System Design and Operations in the Railway and other Transit Systems in 2004, 2006 and 2008. The papers, many of which have been updated for this edition, are divided into three parts, that is, Timetabling, Operations Analysis, and Rescheduling. The selection is made in order to emphasise the possibilities for closing the loop between computer-aided offline planning and design of scheduled railway services on one hand and online analysis of operations performance on the other. Feedback communication of deviations from service quality standards in real-time to customers combined with efficient information and decision support systems for railway staff enable a fast adaptation of traffic flows and schedules in case of disturbances and can increase customer satisfaction significantly.

Part A starts with a brief description by A. Nash *et al.* about the standard interface RailML for railroad applications. The current simulation programs of railway timetable and operations suffers from a lack of a suitable format of data input that require specific interface programs for data transfer between different applications. By using the web-based eXtensible Markup Language XML the description of timetable, infrastructure and rolling stock data RailML produces export files that can, in principle, be used by any other application. This means less costs and time would be required for the preparation of input data for different software, while comparative cross-border network studies will become easier. In the second paper J. Demitz *et al.* estimate timetable quality in a very large and densely occupied railway network of North Rhine-Westphalia/Germany. Timetable alterations of running and dwell times according to different rolling stock characteristics are simulated simultaneously in order to compute train delays and to compare with observed punctuality during real operations. K. Katsuta *et al.* present Crystal diagrams as technique for the design of high-density train diagrams, which enables to calculate minimum headway between trains and period of schedules at (terminal) stations as function of track layout, signalling, speed, train length, track occupation and clearance in order to optimise the circulation of trains.

The forth paper by I. Hansen gives an overview of the state-of-the-art of analytical and micro-simulation models for improving timetable and operations quality, capacity estimation and delay propagation. A precise estimation of blocking times based on realistic train running times is considered the key to model well railway traffic and to increase infrastructure capacity, as well as punctuality of train services. F. Barber *et al.* present in the fifth paper a decision support system for railway planners developed recently in Spain. It offers assistance in train scheduling, while automatically identifying bottlenecks and providing support for conflict resolution: The sixth paper by M. Klemenz & A. Radtke describes a comprehensive model and tool for optimised passenger connection management in a network using graph theory. The costs emerging from additional travel times of all involved passengers and train schedules are minimised by searching the shortest path in a given network timetable. In the last paper of this part A. Gille *et al.* discuss the benefits of different levels of accuracy of infrastructure models and propose a multi-scaling approach for capacity analysis, which allows switching between micro-, meso- and macroscopic models by means of timetable file conversion.

Part B comprises five papers with regard to analysis and simulation of train operations. In the first one A. Landex & O.A. Nielsen present an integrated analysis and simulation model for the estimation of trip times, rerouting of passenger flows and delays in case of disturbance in the suburban railway network of Copenhagen in order to evaluate the impact of infrastructure improvements. J. Yuan *et al.* evaluate the statistical fit of common probability distribution models for observed stochastic train process times in a major Dutch railway station. The best approximate models found are the log-normal distribution for arrival times and the Weibull distribution for non-negative arrival and departure delays, as well as dwell times of late arrivals of trains whose departure times are not connected to other lines.

S. Buchmueller *et al.* describe detailed models for the estimation of sub-process dwell times of different rolling stock based on automatic passenger counting data of suburban railway trains in Switzerland. O. Lindveldt introduces a simulation model for initial delays, run times and dwell times of different types of trains on the Western main railway line in Sweden, which demonstrates a rather good matching with recorded punctuality. S. de Fabris *et al.* introduce a new tool for detailed analysis and simulation of real-life train movements depending on synchronised position data via GPS, signal status messages via balises and train dynamics from speedometer that are recorded on-board of Italian trains and transmitted via radio continuously. A case study of the traffic on the main line from Trieste to Venice shows the good fit of recorded and simulated data after accurate calibration of the braking and acceleration parameters of the micro-simulation tool OpenTrack.

Part C compiles seven papers on recently developed rescheduling models of trains in Great Britain, Germany, Japan, France, Italy and the Netherlands. R. Takagi *et al.* present an optimisation routine embedded in an Object-Oriented Multi-Train Simulator, which uses a Genetic Algorithm for the order of route setting according to different weights of passenger and freight trains at a railway junction on the Birmingham to Bristol line in case of incidents. A. D'Ariano & T. Albrecht develop a model for the estimation of optimised running times in order to minimise train delays and energy consumption in case of disturbance on a Dutch railway line. The headway conflict recognition and resolution adopts blocking time theory and train schedules are modelled as alternative graphs. C. Hirai *et al.* propose an algorithm for automatic analysis and selection of rescheduling patterns in case of disturbances, where the rules are written in a specific language so that dispatchers can easily understand the instructions.

J. Rodriguez introduces a constraint-based scheduling model for the resolution of conflicts at railway junctions, where the individual train movements are described as jobs performing a sequence of activities that are linked by a set of precedence constraints. Optimal routes and corresponding track circuits for the resolution of conflicting train movements are assigned by means of a heuristic approach, which was validated on the infrastructure and scheduled trains of major railway junction North of Paris. S. Ricci & A. Tieri present a Petri net model for conflict forecasting and resolution, e.g. automatic overtaking of trains, which has been simulated in both un-perturbed and perturbed conditions on the high-density Italian railway line Roma-Formia. S. Wegele *et al.* compare the effectiveness of the two rescheduling tools ROMA developed in the Netherlands and GADis developed in Germany by testing their performance in simulated delay scenarios on a main Dutch railway corridor between Utrecht and Den Bosch. While ROMA solves the scheduling problem by means of a branch and bound algorithm and a train speed coordination procedure based on blocking time theory, the train paths in GADis are inserted heuristically one by one, reordered and varied by evolutionary genetic algorithms. The rescheduling performance of both models differs slightly, which is explained by different modelling of the signalling and automatic train protection system and its impact on train dynamics. Finally, K. Kumazawa *et al.* present a rescheduling system based on path search for train schedules by means of PERT, which are weighted by the estimated amount of passenger travel times, transfer passengers and passengers discomfort in trains due to overload, while the time needed for planning and execution of the rescheduling measures is considered in the model.

Further progress in research and development of innovative methods and tools to (re)design efficient timetables that enable high capacity consumption provides reliable train services according to transport demand and are robust against regular disturbances. Fast real-time data mining and monitoring tools that exploit standard train detection, signalling and track occupation/clearance data will become more and more available and improve the quality of timetabling, performance of operations and passenger information. Computer-aided dynamic traffic management systems and fast, accurate semi-automatic rescheduling tools are needed to alleviate traffic controllers and dispatchers from routine tasks and offer effective decision support in complex networks.