Appendix A

About RailSys 3.0

This appendix describes the software system for analysis RailSys used to carry out the different computational experiments and scenario designing required for the research done in this thesis. Information has been retrieved from RMCOM web page as well as the User Manual of RailSys 3.0 among others.

A.1 Introduction

To come up with a suitable decision-making, a simulation tool supporting the planning process in rail transport networks of any size would be certainly useful to optimize railway timetables and the capacity of tracks and stations to fulfil the demand of customers. Besides, it could serve as a support tool for real time dispatching.

The timetable and infrastructure management program RailSys is a computer-based software system for analysis, planning and optimization of operational procedures in railway networks developed for the German case by RMCON Rail Management Consultants. A detailed planning of both, infrastructure and timetable for several variants created, can be carried out by means of this microscopic simulation system. It includes tools for running time calculation, infrastructure mapping, timetable construction and evaluation and the planning of vehicle rosters (Bendfeldt, J-P et al., 2000).

All these characteristics make this tool suitable in different application fields like timetable construction and modelling, planning of capacities, infrastructure planning, scheduling and planning of different traffics, validation and investigation of timetables, disposition of strategies in case of delays or operational disturbances or checking of operational quality and punctuality.
A.2 System Components

Basically, RailSys consists of four basic parts where different tasks can be developed to carry out a suitable analysis. The following modules can be distinguished according to the different tasks to realize:

1. Infrastructure Manager
2. Timetable Manager
3. Simulation Manager
4. Evaluation Manager

![Figure A.1: System Components](image)

Various data can be managed in each module in independent variants to develop different tasks as running time calculation, conflict detection, route search or disposition among others. As shown in Figure A.1, all these outcomes are related through this simulation tool to allow the user to carry out a complete analysis. The following paragraphs give a short overview to the system architecture and different tasks that can be realized under the scope of each module previously presented.

**Infrastructure Manager**

Using the Infrastructure Manager module, infrastructure data (tracks, points, signals, etc.) can be entered and managed to map the rail network as a microscopic data basis. The terms “links” and “nodes” are used to symbolise tracks and connecting points or locations for different elements. Besides, protection systems are installed according to the German use and other predefined systems.
A.2. System components

Figure A.2: Infrastructure Manager Layout

Timetable Manager

The Timetable Manager module is one of the main modules in RailSys consisting on timetable construction (long term planning task). Both infrastructure and signalling system defined are used to calculate running times and track occupation times and additionally, to detect conflicts between trains throughout a network. It includes two sub-modules: it begins with the timetable, where trains can be entered into the network created in the previous module; another editor is the vehicle data and management. This module provides support in the static timetable compilation stage by means of conflict recognition tools and calculation of minimum running times to deliver a conflict free timetable (Radtke, A. et al., 2004). This enables fast checking of the timetable for conflicts and testing of the different routes and train patterns.

Figure A.3: Timetable Manager Layout (Simu++)

The exact calculation of running times is done by DYNAMIS, a tool to simulate train runs. This tool considers the traction force vs. speed diagram of the locomotives, weight and length of each vehicle. It includes an interactive tool to get an exact overview of the calculated train run and to modify all input data interactively. The results of running time calculations can be transferred into the timetable construction phase done by Simu++ that includes all necessary information on the infrastructure such as gradients, speed restrictions, block signals, platforms, points and stations (see Figure A.3). Then, Simu++ indicates inconsistencies such as overlapping of blocking times.

Figure A.4 shows the system architecture and data flow developed in this module.
Simulation Manager

Simulation of the timetable constructed in the previous module is carried out to evaluate the reliability and stability of the resulting timetable. So far simulation is the only way of optimizing proposed operations and facilities for railway systems as practical trials and experimentation are not possible. Carrying out a simulation of an operational program after development of a timetable through Simu++, train movements along the tracks are animated and displayed on the screen.

RailSys is based on the synchronous simulation along the previously defined network. This type of simulation is based on the fact that all trains are in the model running according to their timetable, thus it is possible that different trains influence other trains due to delays.

Simulation is divided in two parts. The first is the simulation of a timetable to check the effects of conflicts spreading over the network that remain unsolved. The second type is an operational simulation (stochastic), introducing randomly additional delays to trains. The aim of the operational simulation is to check and quantify the quality of the timetable planning (stability, robustness) and the resulting delay level of proposed measures.

Figure A.4: Architecture of the planning environment of RailSys (Bendfeldt, J-P. et al., 2000)

Figure A.5: Simulation Manager Layout
Evaluation Manager

The results of the simulation are statistically evaluated by means of the Evaluation Manager module in various graphical and tabular outputs. With only few settings it is possible to generate graphs according to the output to be evaluated (e.g. delay distribution over the network, additional delay).

![Evaluation Manager Layout](image)

**Figure A.6:** Evaluation Manager Layout

## A.3 System inconsistencies for application to Dutch system

As indicated before, RailSys is a system developed by German consultants and compiled to work in the German railway environment. With regard to German and Dutch operation, different signalling environments characterize both protection systems, making operation rather different. Whereas in the German case longer blocking distances are combined with specific approach distances, thus a train begins to stop when the distance to the preceding train becomes critical, in the Dutch case a three-aspect signalling system is applied indicating that when a train encounters a yellow signal it has to start braking until 40 km/h no matter the previous train is. A train protection system (ATP) controls the train to run at 40 km/h. This leads to completely different functioning of signalling aspects leading to different train movements.

![Speed profile across successive block sections aspects](image)

**Figure A.7:** Speed profile along a successive block sections aspects in the Dutch case (D’Ariano, A. et al., 2004)

Since the existing differences between train protection systems for Dutch and German railway networks, the presented simulation system is just applied in the scope of this thesis as a tool to calculate running times and blocking times on the basis of predefined running times derived on the
basis of tractive force-speed diagram. Hence, deterministic train path and blocking time graphs resulting from a use of characteristic acceleration and deceleration rates of the existing trains are calculated and used for external analysis. Purely simulation utility of RailSys referring to simulation of stochastically introduced delays to trains is based on defining perturbations by means of empirical or exponential distributions to develop a Monte Carlo Simulation leading to development of delays as well as propagation to other trains. Due to the previous constraints, this task is not developed, thus Simulation and Evaluation Manager modules are not applied due to the uncertainty that may arise from the results to be obtained.