Banverket capacity consumption, congested infrastructure and traffic simulation with Railsys

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Abstract

The capacity consumption in the Swedish network is high. Banverket (Swedish Rail Administration) declared Stockholm congested in April 2007. In October 2007 the lines Olskroken–Sävedalen and Iggesund–Sundsvall were declared congested due to conflicts between different traffic operators during the capacity allocation process. Each year since 2001 Banverket has been calculating the capacity consumption for the Swedish network. It has been done manually. For studying capacity measures timetable analysis with Trainplan or traffic simulations with Railsys are made. Capacity measures are normally infrastructure investments, timetable alternatives or punctuality. For traffic simulations with Railsys, Banverket and KTH (Royal Institute of Technology, Stockholm) have established a Swedish Railsys user-group. This user-group is working with standardisation for using Railsys in Sweden. There is a small consultant market for traffic simulations in Sweden. In Trainplan the running times are produced by the software tools Tigris – PcGTP.
Keywords: capacity analysis, capacity planning, capacity allocation, traffic simulation, Railsys.

1 Introduction

1.1 Banverket organisation

Banverket, the Swedish Rail Administration, has the overall responsibility for the rail transport system in Sweden.

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Banverket has undergone a major re-organization during 2007. The organization has one administrative part and one productive part. Banverket has 6500 employees of which two thirds work in the productive part. Banverket administration consists of the General directors staff, Operations division, Investment division and two supportive units: Expert support and Administration support. Capacity Planning is a unit in Operation Division and is responsible for the timetable planning and the capacity allocation. The unit has about 80 persons. Banverket's organization is nationwide and the main offices are in Borlänge, Stockholm, Luleå, Gävle, Göteborg and Malmö.

Banverket's productive part consists of Banverket Produktion, Banverket ICT, Banverket Consultant, Banverket Railway School and Banverket Material Services.

1.2 Banverket capacity analysis

Banverket, the Swedish Rail Administration, is working with capacity analysis for infrastructure investments, future traffic and timetables.

Today in Banverket there are about 30 persons working with capacity analysis. They are mainly in the Operation Division and in Expert support.

Banverket Consultant is a railway consultant. They have a smaller group working with traffic simulations and capacity analysis.

1.3 Methodology capacity analysis

For capacity analysis Banverket use different methods.

The methods are briefly:

- mathematical calculation of line capacity
- timetable analysis
- traffic simulation
- running time calculations

Mathematical calculation of line capacity is explained in chapter 2. Today mathematical calculation of line capacity is made manually. In the future we expect to use software tools to calculate capacity consumptions.

Timetable analysis is when a timetable is constructed while doing the analysis. The timetable can be constructed manually or by using the software tools Trainplan or Railsys.

Train traffic simulation means doing an analysis of infrastructure, timetable, rolling stock, disturbances, traffic control and punctuality. Bigger traffic simulation tasks should be done in projects with a group working with purpose, conditions and results. For traffic simulation Banverket use Railsys.

Running time calculations are made to study the running time for one train. The method is often followed by a timetable analysis or traffic simulation.

In the methods mentioned above the power supply is not limited. For studying power supply−train traffic Banverket use the software tool TracFeed Simulation.

2 Capacity situation in Sweden 2007

2.1 Capacity consumption and capacity restrictions

Banverket is reporting capacity consumption and capacity restrictions in Banverkets annual report.

Capacity consumption has been calculated since year 2001. Reference [1] describes the calculation for the year 2001. During the period 2001−2006 capacity consumption has only been calculated for the line sections where there has been a major change in traffic and/or infrastructure. Table 1a and 1b show the results for the years 2004−2006.

Table 1: (a) Capacity consumption max 2 hours, number of line sections.
(b) Capacity consumption 24 hours, number of line sections.

(a)

	2006	2005	2004
Number line sections Shortage (81−100%)	85	84	84
Number line sections Problem (61−80%)	65	69	64
Number line sections Balance (< 60%)	71	66	68
Total	221	219	216

(b)

	2006	2005	2004
Number line sections Shortage (81−100%)	16	13	13
Number line sections Problem (61−80%)	52	54	42
Number line sections Balance (< 60%)	153	152	161
Total	221	219	216

During 2007 a new calculation was made for the whole Swedish network. The calculation was made manually in the same manner as in 2001. The UIC 406 method was used for more information, see references [1] and [2]. 5 persons were involved. 3 persons did the calculations and 2 persons worked with analysis and the final report.

The capacity restrictions are estimated from the capacity consumption, the traffic demand and the importance of the traffic. In many parts of the network there is a high demand of train paths and there is little or no free capacity.

In Sweden we have major capacity restrictions in the big city areas Stockholm, Göteborg and Malmö and in bigger double track lines as Western Main line Stockholm - Göteborg, Southern Main line Katrineholm - Malmö and in single track lines such as Gävle–Sundsvall and Örebro–Mjölby.

Table 2a and 2b show the capacity consumption for the year 2007.

A report has been written, see [3], about the capacity consumption and the capacity restrictions in the Swedish network.

In the report the capacity restrictions are described national, in the big city areas, in double track lines and in single track lines. The capacity restrictions and capacity consumption are presented in maps and in tables for all line sections.

Table 2: (a) Capacity consumption max 2 hours, number of line sections. (b) Capacity consumption 24 hours, number of line sections.

(a)	2007
Number line sections Shortage (81−100%)	101
Number line sections Problem (61−80%)	35
Number line sections Balance (< 60%)	98
Total	234

(b)	2007
Number line sections Shortage (81−100%)	15
Number line sections Problem (61−80%)	45
Number line sections Balance (< 60%)	174
Total	234

2.2 Congested infrastructure

Banverket describes the conditions and rules for traffic operation in Sweden, in Banverket Network statement. The network statement is published annually.

Capacity allocation is a process between Banverket and the authorized applicants who apply for train paths.

In April 2007 Banverket declared the Stockholm area congested. The congestion is in the inner network Jakobsberg/Skavstaby–Älvsjö/Flemingsberg during peak time 06.30−09.00 and 15.30−18.00. The decision was taken because of lack of capacity and problem with punctuality. Banverket has made a capacity analysis and a capacity enhancement plan according to European legislation. The enhancement plan, see reference [4], is for the time period 2008−2010.

When the timetable for 2008 was decided in October 2007 we got more congested infrastructure. The congested infrastructure was Olskroken−Sävedalen and Iggesund–Sundsvall. Olskroken–Sävedalen is a part of the Western Main line Alingsås–Göteborg, and Iggesund–Sundsvall is a part of the East Coast line Gävle–Sundsvall. Banverket has made a capacity analysis according to European legislation. Banverket is currently working with capacity enhancement plans. The congestions are caused due to conflicts between different traffic operators. The time period is very short. In both congestions the major conflict is between a high speed train from SJ and a freight train from Green Cargo. Regional traffic is also involved in the conflicts.

The Network statement of Banverket gives more specific information about capacity analysis and capacity enhancement plan. The document is published at www.banverket.se.

3 Computer systems for capacity planning

3.1 Running time calculation

Banverket is using the information systems Tigris and PcGTP for running time calculations. The systems have about 30 users in Banverket.

Tigris contains infrastructure information and rolling stock information. The system has a user-interface for updating the information. Tigris calculates running times and running times are exported to Trainplan. Tigris is used to generate infrastructure information and running times to Trainplan for each annual timetable.

PcGTP has functions for editing infrastructure, editing rolling stock, running time calculation and graphical presentation. PcGTP import infrastructure data and rolling stock data from Tigris. PcGTP is used for analyzing running times or to estimate timetable times.

The Tigris user interface is developed by Banverket and the running time kernel is developed by ÅF Infrastruktur AB. PcGTP is developed by ÅF Infrastruktur AB. Tigris − PcGTP is used by Banverket.

3.2 Timetable planning

Banverket is using Trainplan for timetable planning. There are 190 Trainplan users in Banverket.

The main user categories are:

- Timetable planners, short period
- Timetable planners, annual timetable
- Planning of track maintenance
- The short period timetable planners use Trainplan for adding or canceling of trains. They work with the time periods 1 day and 1 week. There are strict demands on traffic security concerning the short period timetable planning.

The annual timetable planners work with the time period 1 year. They update the system with correct infrastructure information. They perform the running time calculations in Tigris and import running times in Trainplan. They get the applications for the trains from the traffic operators. They do the capacity allocation and construct the timetable.

The planners of the track maintenance work with the time periods 1 year, 8 weeks, 1 week and 1 day. The track maintenance is defined which part of the infrastructure, what time, information about the work and contact information. The work can be enclosed track or limited use of the track. Communication with the producers is via www.banportalen.se.

Trainplan has a common infrastructure model for each annual timetable. The infrastructure model is a macro model with points and track sections. The system is a multi-user system with a graphical interface and good possibilities to process train data. In the train graphs you can see block occupation and conflicts between different trains and track maintenance. The system imports running times from Tigris, exports timetable data to a common database and produces different kinds of tables and reports.

3.3 Traffic simulation

Banverket is using the information system Railsys for traffic simulations. Banverket and Banverket Projektering have 10 user-licenses. Banverket has 5−10 active Railsys users.

Banverket Projektering is using the information systems Railsys and Open-Track for traffic simulations.

4 Railsys at Banverket

4.1 Tender and acceptance test

Banverket has made a tender for a new traffic simulation program. The tender specification was published in autumn 2005. The evaluation process was from November 2005−March 2006. The winner of the tender was the Railsys program and the company RMCon. The acceptance test was made from April 2006−November 2006. During this period Banverket Railsys users got a 10 days course in using the program.

4.2 Traffic simulations at Banverket

Banverket do their own traffic simulations and buy traffic simulations from consultants. The consultant market is small.

Railsys is used/will be used in following areas:

- to study capacity consumption and capacity restrictions
- to plan timetables and study punctuality
- traffic planning and infrastructure investments 1−5 years a head
- dimensioning of infrastructure more than 5 years a head

During the first two years one bigger project and some smaller simulations have been made by Banverket on their own.

There are some traffic simulations made of consultants. The consultant simulations most often study infrastructure investments, but the number of traffic simulations for studying timetables and/or punctuality is increasing.

In the consultant projects the Railsys users of Banverket have different roles, which depend on the project. In some projects they are very active working with purpose, traffic and infrastructure conditions, methodology, analysis and final report. In other projects they have a quality function and just follow the simulation study and get the final report.

Banverket Railsys group stores all final reports. From January 2008 there is also a demand to get the Railsys model together with the final report.

When Banverket build new lines several simulation projects are made during the planning process. For the new Botnia line the first traffic simulation project was in 1998. About 5 bigger traffic simulation projects will be done before traffic start in 2010/2011. Railize and KTH (Royal Institute of Technology, Stockholm) have made some traffic simulations in Railsys for a new high speed line between Stockholm and Göteborg south of lake Vättern. This high speed line is under investigation.

4.3 Methodology and models

Banverket and KTH are working with developing a Railsys methodology for Sweden. During Autumn 2007 some first standard documents of Railsys infrastructure and traffic simulations were written.

During 2008 Banverket in co-operation with KTH have started creating a quality system for infrastructure models in Railsys.

Banverket has started to build an infrastructure model of today according to this quality system. The Banverket Railsys model is constructed mainly from consultant projects. In April 2008 Banverket quality marked Railsys infrastructure models for eastern Sweden and for western Sweden. These models are managed by one person.

Banverket has also started to building up a rolling stock database in Railsys.

4.4 Swedish user-group

In June 2007 Banverket and KTH, Royal Institute of Technology, in Stockholm established a Swedish user-group. Members of the user group are the Railsys users in Sweden. The members in the user group May 2008 are Banverket, KTH, Banverket Projektering, Railize and Atkins.

The plan is to have a big meeting each year for all users. In this meeting information is given about Railsys traffic simulations in Sweden. In the meeting in June 2007 contact persons from each organisation were decided.

The contact persons have had a couple of meetings during the first year. On the agenda there has been standardisation of Railsys infrastructure, handling of Railsys models and information about Railsys work in each organisation. An identified question to solve is how to exchange and update Railsys infrastructure models.

4.5 Banverket competence and Railsys work

There is a small group of people working with traffic simulations with Railsys in Banverket and in Sweden. There are current recruitments of more Railsys people in Banverket.

Banverket has research co-operation with KTH about Railsys and capacity analysis. KTH use Railsys in some railway courses for students. Some students are graduated each year with Railsys in their master thesis. Denmark Technical University in Copenhagen also educate students in Railsys.

There is a current process to develop the role of the Railsys user and to develop the Railsys organisation within Banverket.

Banverket develop their Railsys work step by step. Banverket has communication with the Railsys consultants in the Swedish Railsys group.

5 Conclusion

Banverket, Swedish Rail Administration, is working with capacity analysis for infrastructure investments, future traffic and timetables.

The used methods are mathematical calculation of line capacity, timetable analysis, traffic simulation and running time calculations.

The software tools for timetable analysis are Trainplan and Railsys. The software tool for traffic simulation is Railsys. The software tool for running time calculation is Tigris − PcGTP.

Banverket has started to use Railsys in 2006. Banverket do their own traffic simulations and buy traffic simulations from consultants. Banverket and KTH are developing a Railsys methodology for Sweden. Banverket and KTH have established a Swedish user-group in June 2007 for communication and co-operation concerning Railsys. Banverket develop their Railsys work step by step.

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