CATO

Computer aided Train Operation

Development of a standard and a system for remote controll and optimal driving of trains

transrail

CATO (Computer Aided Train Operation)

Background

The use of remote control of train driving is not new on the railways. It has been used specifically to assist the running of heavy freight trains. Normally verbal radio communication between the Traffic Control Centre dispatcher and the drivers has been used.

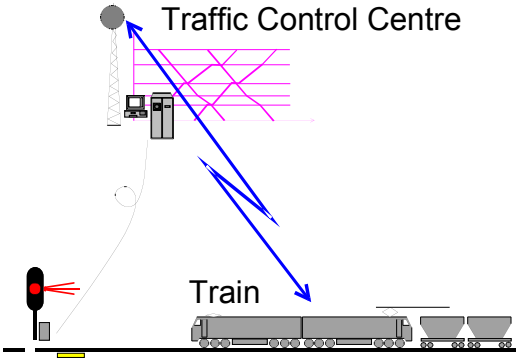
In Sweden a promising theoretical study on optimisation of train driving was carried out in the late 1980-ies. The results were never implemented in practical operation, partly there was no possibility for efficient data communication between TCCs and trains.

In recent years, the installation of a GSM-R radio communication in Sweden has brought new interest in this type of systems. Transrail made a proposal for the CATO project in 1998. A pre-study was financed by the Swedish National Railway Administration. The result was promising and a few similar development activities abroad were identified. A draft System Requirement Specification for the CATO system was developed. Today the project is in a phase of practical field tests. LKAB, operator of the Swedish heavy-haul iron-ore trains has entered for co-financing and provision of a suitable test site. At the same time CATO is well in line with LKAB's development strategy for improvement of their train operation.

The main idea

The main idea of the CATO system is to make trains run as optimally as possible, considering the daily traffic situation, minimum energy consumption etc. In short, this may be expressed as never to arrive to a red signal but to use available time to run with lowest possible energy consumption. This can be achieved by an integration of the TCC traffic control and the train driving systems, in principle as follows:

1. CATO-TRAIN sends position, speed and train performance data to the TCC.
2. CATO TCC calculates target points (time, position, speed) and maximum power for the trains, taking the current traffic situation into account. These data as well as the track data for the train paths are sent to each of the trains.
3. CATO TRAIN calculates the speed profile for the train in order to reach the target point requested by the TCC and utilising available time slack to minimise e.g. energy consumption.
4. The information is displayed to the driver to support him to drive the train in the best possible way. He may also switch over to an ATO mode, whereby the train is automatically run in accordance with the optimal speed profile.



CATO will give

The prospects of CATO are:

- More efficient train dispatching
- Better utilization of line capacity
- Reduced wear on vehicles (and track)
- Reduced energy consumption
- Reduced power consumption on electrified lines
- Improved working environment for dispatchers and train drivers
- Remote control/driving of trains (ATO, Automatic Train Operation)

The driver interface as used in a test run. The requested speed profile and traction/ braking controller positions are shown to the left

Objective of the CATO-project

The scope of the CATO-project is to develop a system for optimised traffic control and driving of trains, a traffic management layer on top of existing (or new) signal and safety systems. The main objective is to develop a standard that can be generally used by the railways to improve efficiency of the train operations. The standard is intended to become a platform giving possibility for various manufacturers to supply compatible CATO sub-systems.

Today we can find a number of international development projects in line with CATO. However, most of them are stand-alone on-board Driving Assistance Systems. Most interesting for the future is a system communicating with the TCCs, and thus enabling to take the daily traffic situation into consideration. This fact, in combination with a mixed traffic situation, makes standardisation important already at this stage of development.

The CATO Specification

You may download the CATO System Requirement Specification from the Transrail website:
http://www.transrail.se/new/transrailpapers.html

Application (LKAB iron-ore traffic)

Most freight railway services, so also the iron-ore trains of LKAB, are run to a fairly flexible time table. As an example a section of the graphical time table between Kiruna and Björkliden is shown in figure A below.

The actual, day-to-day, variation of running one of the trains (train 9903) is shown in the figure B. The diagram C shows the running and stand still times for these runs, indicating the daily variation of the operation as a consequence of both the traffic situation and the driving techniques of the drivers.'

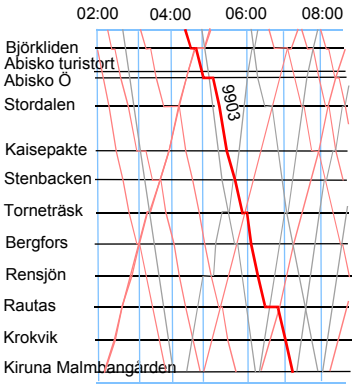


Figure A: A section of the graphical time table showing train 9903 and other trains on the line Kmb-Bln.

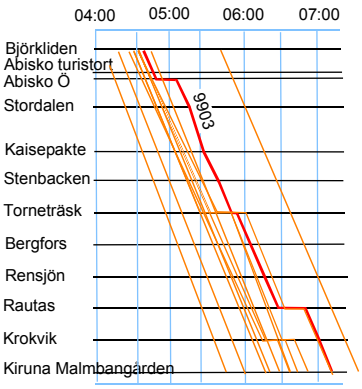


Fig B: The nominal graph of train 9903 and the actual graphs of the train various days.

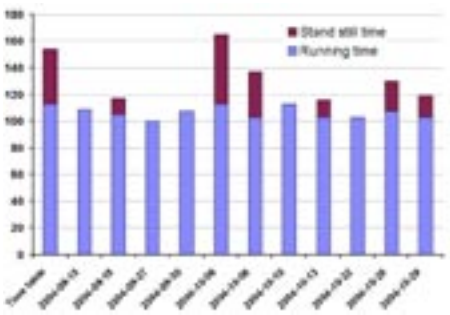
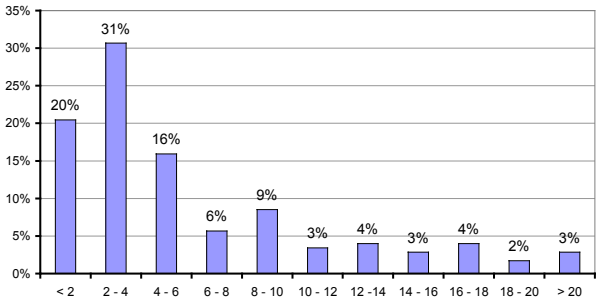
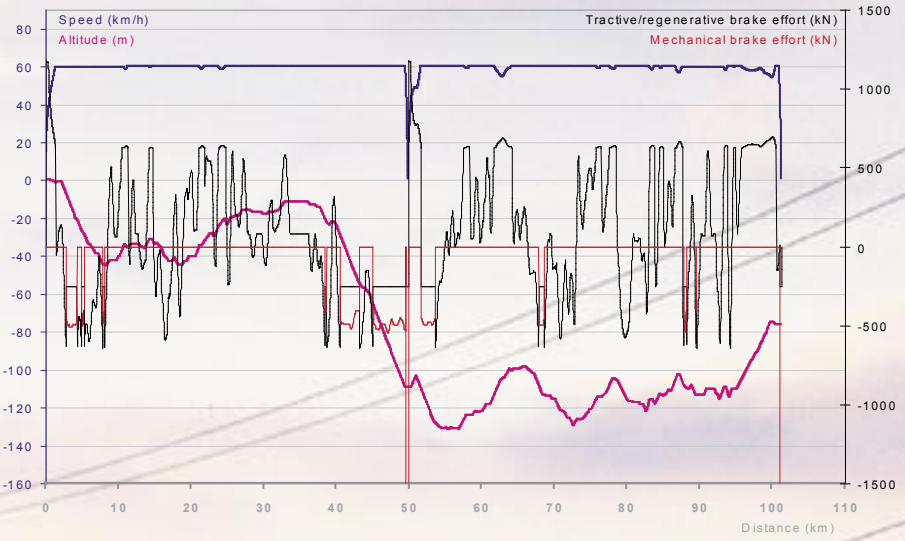


Fig C: Running and stand still times of train 9903 various days. Left bar shows times according to the time table.

The diagram to the right shows the typical slack distribution at train meetings. It shows the frequency of slack in various intervals (minutes) in the day-to-day traffic. Apart from just increasing the available time in the time table here are plenty of situations where optimised driving can be utilised.



Running of a loaded iron-ore train from Kiruna to Björkliden, with a stop at Torneträsk, at a minimum time is illustrated by this diagram, showing train speed, line altitude and tractive/ braking efforts.



The effect of a CATO energy optimising strategy on the two sections give the following promising results. The vertical profile of the line makes the result quite different on the two sections. Already a rather small slack makes it possible to optimise for a rather large energy reduction. In this case the reduction is measured as the net between the motoring and the regenerated energy. The value, depending on how regenerated energy is valued may be something different.