TOPIC

TRAFFIC MANAGEMENT OF THE FUTURE

THE TRAIN TRAFFIC MANAGEMENT SYSTEM CATO (COMPUTER AIDED TRAIN OPERATION) IS CURRENTLY UNDERGOING FINAL TESTING IN SWEDEN. THE TESTS SHOW VERY PROMISING RESULTS; CATO IMPROVES PUNCTUALITY, REDUCES ENERGY CONSUMPTION AND BOOSTS THE OVERALL OPERATIONAL EFFICIENCY. A NEW ERA FOR TRAIN OPERATIONS IS BORN. THE FUTURE IS ALREADY HERE.

Railway consulting and software specialist Transrail Sweden AB has developed CATO in R&D projects funded by the Swedish Transport Administration (Trafikverket) and the Swedish mining company LKAB.

Transrail drew the conceptual outlines of CATO long ago, before the necessary technologies were at hand. Today, development of computers, optimization algorithms and the GSM-R digital communication system make full scale implementations possible. After many years of development Transrail now see the start of a new era for train operations. Tests of CATO show very promising results.

Implementation of CATO, or systems interoperable with CATO, is foreseen on the Swedish railway network, not only the LKAB operation where the first implementation currently is on test.

CATO consists of two parts, the CATO-TCC module at the traffic control centre and the CATO-TRAIN module onboard each train. These units communicate over GSM-R digital radio. CATO-TCC is linked to the traffic dispatching system and sends running instructions, expressed as target points (positions to be reached at a given time and speed) to the trains. This makes it possible to run the trains according to the optimal operational scenario considering the overall traffic situation. Not only target points, but also the line profile and current speed restrictions of the train path will be downloaded to the train. This means that any variations of these parameters can be adhered to.

CATO-TRAIN continuously calculates the optimal speed profile for the train to reach its target points on time. The optimization may consider minimum energy consumption and/or any other optimization criteria. The optimal running speed profile is displayed as an advisory to a driver interface, but may also be used in an automatic train control mode. The driver interface is ergonomic and the driving advice is simple to follow. In fact, driver training has proved to be very easy.
Communication with the train operations centre allows the real-time traffic situation on a line to be assessed, rather than just the static planned timetable. This allows the trains to be run in accordance with the actual traffic situation.

The optimal speed profile on a line section will vary for different trains and depend on the available running time, which may change from day to day. The optimal speed profile may in fact be very different from the speed profile normally chosen by the driver. Furthermore, it ensures that the train will arrive just in time.

CATO makes it possible for the traffic dispatcher to control the motion of the trains and the drivers can trust that they will arrive to the target points on time and with the requested speed. Unnecessary braking and stops can be avoided.

The energy savings that can be achieved depends on a number of factors, e.g. the vertical profile of the line, type and weight of the train and the available time for the train to run the distance to the target point.

- **Improved capacity of the infrastructure**
- **Improved management of traffic disruptions**
- **Improved punctuality**
- **Reduced energy and power consumption**
- **Reduced operational costs**
- **Better working conditions for drivers and dispatchers**

"This type of system will be in our future plans."
Björn Östlund, Deputy Director General at Trafikverket.

"We look forward to install CATO, using new technology to further strengthen our environmentally friendly profile."
Martin Byström, Technical Director at Arlanda Express

"It takes a lot of energy and much wear and tear on brake pads, wheels and rails to slow down and then restart a train that weighs 8500 tons. With this system trains can get a "green wave" all the way from the mines in Kiruna to the port in Narvik, and that is of great benefit to us."

"CATO makes it possible to run without a fixed schedule. Trains can leave as soon as they are loaded, which means that the capacity of our system may be increased by 10–20 percent".
Thomas Nordmark, Head of logistics development at LKAB.

Calculations and tests indicate that CATO can reduce energy consumption by as much as 20–25 % even if the trains are operated at a higher than normal average speed. The optimization is a matter of efficient use of the time slacks which are built into the planned timetables and/or come up in the daily traffic operation. A time slack is the available running time for a train on a line section compared to its shortest possible running time.

CATO will reduce operational costs and improve punctuality and traffic capacity of the infrastructure. Costly infrastructure investments may be avoided, or reduced, by the use of CATO. The possibility to cope with traffic disruptions is heavily improved. Train drivers will always be informed about the current dispatching plan and dispatchers will know that trains will run according to the current plan. Reduced operational costs is not only a matter of minimized energy consumption, but also e.g. improved punctuality, better use of rolling stock and staff etc. There are big advantages to the railway mode in general, and to operators, infrastructure managers and customers in specific.

In the future there will be many suppliers of systems like CATO, and these systems will need to be interoperable. Together with European stakeholders in the EU R&D project Railenergy, Transrail has developed a draft interoperability standard named EETROP (Energy Efficient Train Operation). Transrail has chosen to be quite open regarding their development work. A System Requirement Specification has been available on their website for many years. CATO supports the various installation levels of the EETROP standard.

From the very start Transrail has designed CATO with consideration of realistic and sound interoperability aspects. Furthermore, CATO is designed to be operable as an add-on to ERTMS and other ATP safety systems.

When developing CATO, a clear advantage has been the use of the Transrail TRAINS-library. This is a modular software library being developed by Transrail during a long time and containing various very detailed and sophisticated algorithms for calculating train movements, traffic control and energy supply. It is used in many of Transrail's software products, not only CATO.

Compared to current traffic management systems, it's easy for suppliers to claim that they can provide an energy saving system. The question arises as regards how optimal it is in practice. The computer models and optimization algorithms may either be simplified or only applicable under certain conditions. The CATO solution allows any complexity for models of the traction unit, train running resistance, line profile etc. and can be handled by the optimizing algorithms. The optimization objective may be to minimize the cost for gross energy, net energy, regeneration, power consumption, fuel consumption, mechanical braking or any combination of these parameters. Still, the primary goal is to arrive to any target point on time.

Once CATO is implemented, there are many possibilities for further improvements of the traffic management routines, e.g. operation without fixed timetables, and to reduce adverse effects of various daily variations. Among other things, CATO is designed to be able to limit the total sub-station power loads, take the weather situation into consideration etc.

The market outlook for systems like CATO must be deemed very favorable. There is a continuous pressure on the railways to reduce the operational costs. Increasing railway traffic and the need to use infrastructure efficiently in combination with escalating energy costs and environmental awareness will drive the demand for this type of system■

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