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Assessing Stochastic Optimization for Rio Tinto Alcan's Hydropower System in Eastern Canada

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Rio Tinto Alcan (RTA) is a multinational aluminium producer with smelters in Quebec, Canada. RTA also owns and operates power houses on Péribonka and Saguenay Rivers. The system, which is run by RTA's Quebec Power Operations Division, consists of 6 generating stations and 3 major reservoirs, for an installed capacity of 2900 MW. One of the significant issues that had to be resolved for effective operation of this system was to determine the volume of water release per week for all generating stations. Several challenges had to be dealt with before a suitable solution could be found. Last year, RTA started a five year R&D project for improving the management of the hydropower system. This project includes data monitoring, Hydrological Ensemble Prediction (HEP) and stochastic optimization (SO) methods.

Development of SO methods is particularly interesting for RTA since, until now, the decision making process has been based on a deterministic solver even if it is impossible to predict naturally contributed volumes with any accuracy beyond a few days. Moreover, the production at the generating stations follows a non-linear, non-convex function of turbine flow rates and water head. Both of these factors have the effect of requiring that the decision should be based upon solving a non-linear and non-convex stochastic optimization problem. The following presentation describes the first part of the SO project and aims to assess the value of using a stochastic solver instead of a deterministic solver. Two different SO approaches were evaluated: lag-1 Stochastic Dynamic Programming (SDP) and Sampling Stochastic Dynamic Programming (SSDP) algorithms. HEP are used to capture the spatio-temporal variability of the inflows. Scenarios are generated using a hydrological model (HM) by initialising the HM with the same initial conditions (hydrologic state variables). These hydrologic variables are estimated using real-time observations available for the catchment area. Inter-scenario variability is provided by using different sequences of meteorological observations entered into the HM. The scenarios are used to estimate the parameters of the auto-regressive model utilized by SDP and the hydrologic state variables are used to estimate the probability transition between scenarios required by the SSDP algorithm.

The optimization methods were implemented in RTA's system and the results compared with the actual deterministic decision procedure. Methods were compared using a test bench into which were incorporated the characteristics of the facilities and the HEP database.