HELSINKI UNIVERSTY OF TECHNOLOGY
Department of Mathematics and Systems Analysis
Mat-2.4177 Seminar on Case Studies in Operations Research

Optimizing Energy Consumption in Mobile BitTorrent Networks

Midterm Report

3.3.2009

Client:
Nokia Research Center
Dr. Jukka Nurminen

Project Group:
Marko Kotilainen
Turkka Anttonen
Lars Kurkinen
Ilkka Mansikkamäki
Jukka Ylitalo
Jutta Ylitalo

Table of Contents

1. Overview

This is a midterm report for the course Mat-2.4177 Seminar on Case Studies in Operations Research. This report describes current status of the project and changes in the project after the project plan was written. The client of the project is Nokia Research Center.

The main objective of the project is to examine the behavior of BitTorrent like sharing in ideal world through energy consumption perspective. The examination is done by applying integer linear programming model. From the solutions of the model the project group derives conclusions and heuristic rules for optimal behavior.

2. Project status

The group has modeled the problem with MATLAB and tested it. As the model is an integer linear programming model, MATLAB is used to run Xpress, which is a more suitable program for solving this kind of problems. The main motive for doing this is that the solutions of the model are easier to interpret in MATLAB than in Xpress. There were no major problems with this coding task. However, the group identified restrictions related to the size of the problems that can be solved. The size of the problem and the integer linear programming approach results in a computationally very intense problem. With the current MATLAB model, e.g., a problem with the parameters 10 phones, 20 file parts, and 11 time steps can be solved in approximately two days with the PC the group uses. Further, the required computation time seems to increase quite dramatically as the size of the problem grows. The group has thus evaluated the benefits of using a more powerful PC to be quite marginal. Another limitation is related to the size of the matrixes that MATLAB can process. This is, however, partly dependent on how the problem is modeled in MATLAB. With the current model, the limit of what size of problems that can be solved using MATLAB are of the same order of magnitude as the problem in the example above.

The MATLAB model is continuously attempted to be made more efficient, thus increasing the maximum size of problems that can be solved and reducing the required computation time. It seems likely that the model can further be improved in the future after the group has identified some heuristic rules of the network's behavior. For example, if the same kind of behavior always occurs during the first time step, the first time step can be omitted and the problem can be considered as if it started from the second time step.

At the moment the group is acquiring solutions from the model. The group started with the minimum energy solutions that were the primary objective. The analysis task also started on time. It is obvious that the representation of the solutions requires a visual representation due to the size of the solutions. The analysis group has started by making a preliminary matrix representation (comprise of the solution) that helps with the visualization.

The size of problems we currently can solve is sufficiently smaller than what we initially expected. Dr. Nurminen does, however, evaluate that by even with the current size of the problem it should be possible to obtain relevant results by analyzing the obtained solutions.

3. Future actions

The acquiring solutions task continues alongside the analysis task. In the project plan, it was planned that it should have been done by week 10. As explained in the project status section, time consumption was underestimated. Overall, the task will continue as long as needed. Resource-wise there are no changes because of this. The workload of the task group will be reduced in the heuristic rule phase if necessary.

In addition to generating the minimum energy solutions, the group responsible of acquiring solutions begins to generate minimum time solutions. This enables the analysis group to compare the differences of these solutions. If possible, the size of the problem (i.e. the number of devices and the size of the file) will be increased as the project progresses further and the project group gains insight from solutions.

The analysis group continues to develop the visual representation. Alongside, the analysis group will analyze solutions. The analysis includes for example contemplating what happens at each time step and comparing the minimum time solutions with the minimum energy solutions. Other interesting objects for analysis are most likely discovered as analysis progresses and understanding of the solutions increases.

The project group should have a quite good understanding of the solutions when the derivation of heuristics task begins. Iteration of acquiring solutions, analysis of solutions and development of visual representation all should build understanding that helps with the derivation of heuristic rules.

The project manager will clarify, as soon as possible, the contents of the task reports. It is important to start the compilation of the final report as early as possible.

4. Risks

Below (Table 1) are represented updated risks. LP-Model works, so it was taken off the list. Also, it is not possible to obtain faster computer, if computing takes too much time, so it was taken off from the mitigation list.

Table 1 Most likely risks

Risk	Effect	Probability	Mitigation
Computing takes too much time			• Scale down the problem
Time consumption of tasks underestimated			• Closer monitoring • Reallocate resources • Redefine tasks
Outcome of the project is not satisfying			• Continuous communication with the client
Task report is not satisfying			• Clear communication about goals of task