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

Project Plan

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Nokia Research Center
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Table of Contents

Introduction

The BitTorrent protocol is a widely used peer-to-peer file sharing protocol that is used to distribute files in networks. It has been developed for the PC environment, but can also be used on mobile phones with a suitable client, such as SymTorrent. When BitTorrent clients are used in mobile phones energy consumption needs to be considered. There exists some research on this topic, but efficient solutions for minimizing energy consumption have not yet been developed.

The aim of our project is to optimize energy consumption in mobile BitTorrent networks. This project plan describes central objectives, characteristics, and the schedule of the study. In the project BitTorrent networks will be examined through an energy consumption perspective. We will apply a linear programming model to optimize the energy consumption of the participating devices. By studying the results we aim at developing heuristics rules that approximate the optimal behavior of the participating devices.

The study will be conducted during spring 2009 for the Seminar on Case Studies in Operations Research course (Mat-2.1477). The client of the project is Nokia Research Center.

Objectives

The main objective of this project is to examine the optimal behavior of BitTorrent like sharing in ideal world through energy consumption perspective. Here, ideal world refers to a situation where the following assumptions apply:

1. All devices are energy sensitive
2. Power consumption of a device is zero in idle phase
3. Power consumption of a device is constant in active phase.

The goal is not to concern with details of how the actual protocol works, but rather to investigate the best approaches to optimal energy consumption of the participating devices.

Based on the assumptions listed above, an appropriate integer linear programming model is built to minimize the total energy consumption of a BitTorrent like network. After the model has been approved, it is applied to several different networks with different sizes and other parameters. Based on the obtained results, conclusions and heuristic rules are derived to approximate the optimal behavior in BitTorrent like content sharing, in the terms of energy efficiency.

Approach

The starting point for the project was to familiarize the group with the subject. This was accomplished trough given literature.

The content sharing problem is solved with linear programming. The problem has already been formulated by Antti Punkka and Juuso Liesiö. The model has not been tested thoroughly. Next step for the project is coding and testing the model in a suitable optimization program. The problem is large linear integer problem, therefore the suitable program is Xpress. We have a single computer with Xpress installed. In addition, Matlab is used to initialize the problem and possibly for the analysis of solutions. Our group has already started coding the problem.

After coding the model, the next step is acquiring solutions with different initial states (e.g. number of devices and size of file). The goal is to produce enough different solutions so that possible dependencies can be identified in the analysis phase. It is also necessary to produce solutions with different objective function (i.e. minimizing time). This enables us to identify if there is difference between minimizing time compared to minimizing energy consumption. In addition, we examine effects of possible disturbance with the sensitivity analysis.

After obtaining conclusions from the analysis we can derive heuristics. Heuristic rules approximate the optimum behavior. Definition of heuristics in this context will be specified later with the client.

Each task produces a report or a document. The content of the report will be specified between the project manager and the person responsible for the report. The final report is compiled and edited from the task documents.

The project manager will communicate with the client trough out the project. Findings will be shared with the client during the project so that the client can give feedback. Trough feedback group can focus on relevant issues and gain insights. Continuous communication with the client also ensures that the final report is relevant for the client.

Resources

The project group members are Marko Kotilainen (project manager), Turkka Anttonen, Lars Kurkinen, Jutta Ylitalo, Ilkka Mansikkamäki and Jukka Ylitalo.

Jukka Nurminen from Nokia has knowledge on the subject and can be consulted. Nurminen also provides feedback trough out the project.

Course staff, Antti Punkka and Juuso Liesiö, has knowledge on optimization and can be consulted about it.

Group has access to the computer with Xpress installed. This computer is used to acquire solutions.

The primary means of communication for the project group is Yahoo groups. Yahoo groups is also used for sharing files between the group members.

Schedule

Below (Figure 1) is an initial schedule for the project. The initial schedule works as a guideline for the group. The schedule will be updated trough out the project as uncertainty about time consumption decreases.

There are hardly any parallel tasks, so it is critical that tasks do not go over deadlines. There is some parallelism, for example in preliminary decisions about initial states in acquiring solutions and in preliminary brainstorming in the analysis phase.

The most critical task is testing and coding of the model. The focus of this project is not in building the model but in the analysis. Project cannot proceed without solutions from the model. It is important to ensure early on that the model is functional.

	Week												
Task	5	6	7	8	9	10	11	12	13	14	15	16	17
Familirization with the subject													
The model, testing & coding													
Acquiring solutions													
Analysis of solutions and deriving conclusions													
Derive heuristic rules													
The compilation of the final report													

Figure 1 Project schedule

Milestones:

- Project plan presentation 13.2.2009 (week 7)
- Midterm report presentation 6.3.2009 (week 10)
- Final report presentation 24.4.2009 (week 17)

Resourcing

Below (Figure 2) is the rough presentation of the initial resourcing in terms of personal contribution for tasks. Blue background color indicates that the person is responsible for the task report.

	Contribution for the task (%)					
Task	Jukka	Ilkka	Jutta	Lars	Turkka	Marko
Familirization with the subject	16.7	16.7	16.7	16.7	16.7	16.7
The model, testing & coding		50	50			
Acquiring solutions	5	40	40	5	5	5
Analysis of solutions and deriving conclusions	25	5	5	25	30	10
Derive heuristic rules	20	16	16	16	16	16
The compilation of the final report						100

Figure 2 Project resourcing

In addition to above, the project manager is responsible for coordinating and monitoring the progress of tasks. The project manager also communicates with the client. The project manager is also responsible for the project plan and the midterm report.

Risks

Below (Table 1) is listed the most likely risks.

Table 1 The most likely risks

Risk	Effect	Probability	Mitigation
LP model does not function as expected			• Scale down the problem • Consult course staff
Computing takes too much time			• Scale down the problem • Request access to faster computer with Xpress
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