A real-time Streaming Protocol for large-scale P2P Networks

Bachelor Thesis

by

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Abstract

This thesis concentrates on implementing and evaluating different distribution algorithms for large data transfers in heterogenous peer-to-peer networks, especially for incremental transfers, which yields the possibillity for peer-to-peer video streaming. The main focus is on 1:N scenarios where only one peer has a given data set completely and N peers try to distribute this data set as fast as possible, though other scenarios are implemented and evaluated as well.

The main problem is the choice of the best distribution algorithm, which should be able to use most of the available network bandwidth of all participating peers. In a traditional client/server system the server uploads the data to all clients sequentially, which means that only the server upload bandwidth is used but none of the client upload bandwidths.

Peer-to-peer networks in combination with efficient distribution algorithms can help to solve this problem. Those algorithms are always based to the same technique where all participating peers load specific chunks from the peer with the whole data set and distribute those chunks among themselves. This way the upload bandwidths of the peers are not idle. The difficulty is the choice of the specific chunks the peers download and the tuning of parameters like chunk count and chunk size. Good algorithms are also flexible enough to adjust themselves to changing network conditions.

In the course of this thesis an application was developed which implements a variation of the BitTorrent protocol, I call this variation Chunked-Swarm-Distribution (CSD), which is better suited for the needs of this thesis in terms of performance and time, a logarithmic distribution algorithm and a sequential client/server disitribution algorithm for comparison. The application is implemented in Java using the Netty framework, a high performance network library. This framework offers the possibillity to run simulated network connections which is great for monitoring and evaluating different distribution algorithms since real networks add too much overhead for testing. The application implements a couple of comparing benchmarks to evaluate the quality of the algorithms used.

The benchmark results show that the CSD algorithm is able to almost fully load all participating peers which means that if a transfer from peer A to peer B takes T seconds, the time taken for the complete distribution for N peers also is about T seconds, in practice it is often a bit over T seconds, which is caused by meta data overhead. This means that the number of participating peers is, theoretically, of no importance. In practice more peers means more meta data, but with compression and efficient data formats those influences can be minimised.

Acknowledgments

A lot of people supported me during my work on this thesis to whom I wish to express my gratitude.

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Theory

WebRTC, Kurzform für *web real time communication*, ist ein offener Standard zur sicheren Echtzeitkommunikation zwischen Browsern. Die W3C (World Wide Web Consortium) ist für die API Standardisierung [BNBJ13] und die IETF (Internet Engineering Task Force) ist für die Standardisierung der Protokollebene [THT14] zuständig.

Chapter 4

Architecture

This chapter explains the architecture of the software in detail. From the very first beginning it was one of the main goals to achive high modularity so that individual parts can be enhanced or replaced easily. The software is seperated into the framework and the application part which in turn consist of multiple modules. Figure 4.1 shows the architecture in detail.

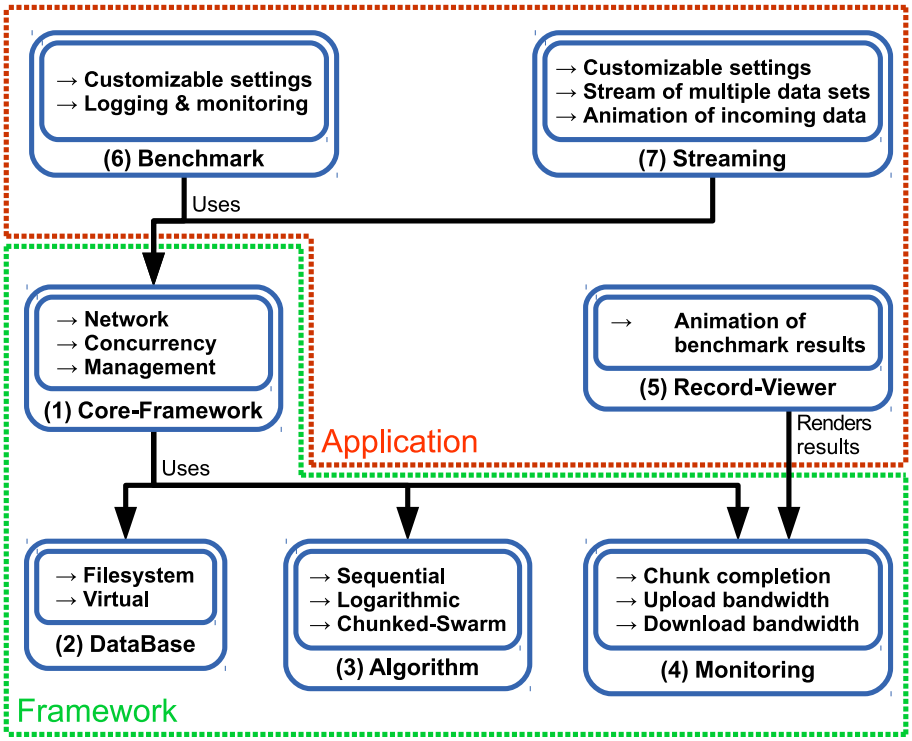


Figure 4.1: Software architecture

The application part depends on the Core-Framework and the Monitoring module. It contains three modules which are Benchmark, Streaming and Record-Viewer. The Benchmark module is the most important application part because it can help to create, monitor and evaluate different scenarios in terms of performance and efficiency. All measurements were done using this module. The Streaming module is related to future work and demonstrates the possibility for an incremental stream of data sets. The Record-Viewer module can render and animate results taken from the Monitoring module which is part of the framework part and thus only depends on it.

The framework part contains the Core-Framework, DataBase, Algorithm and Monitoring module. While the DataBase, Algorithm and Monitoring module can be replaced or even omitted the Core-Framework module is the most important module. It manages network, concurrency and the communication of the three other modules located in the framework part.

The DataBase module represents an interface for a generic data source which might be the filesystem or even completely virtual. This way the framework is able to transfer any kind of data.

The Algorithm module contains the most important part in terms of performance and efficiency. The concepts presented before are implemented in this module which include a sequential, logarithmic and chunked-swarm algorithm. To implement and test new distribution algorithms only this module has to be modified.

The Monitoring module records data like current bandwidth usage and chunk completion which are important data points for evaluating algorithms. This module creates csv files which can be plotted with tools like gnuplot and a special file which contains a chronological stream of events happend during the recording which can be rendered using the Record-Viewer module.

Chapter 5

Modules

Chapter 6

Evaluation

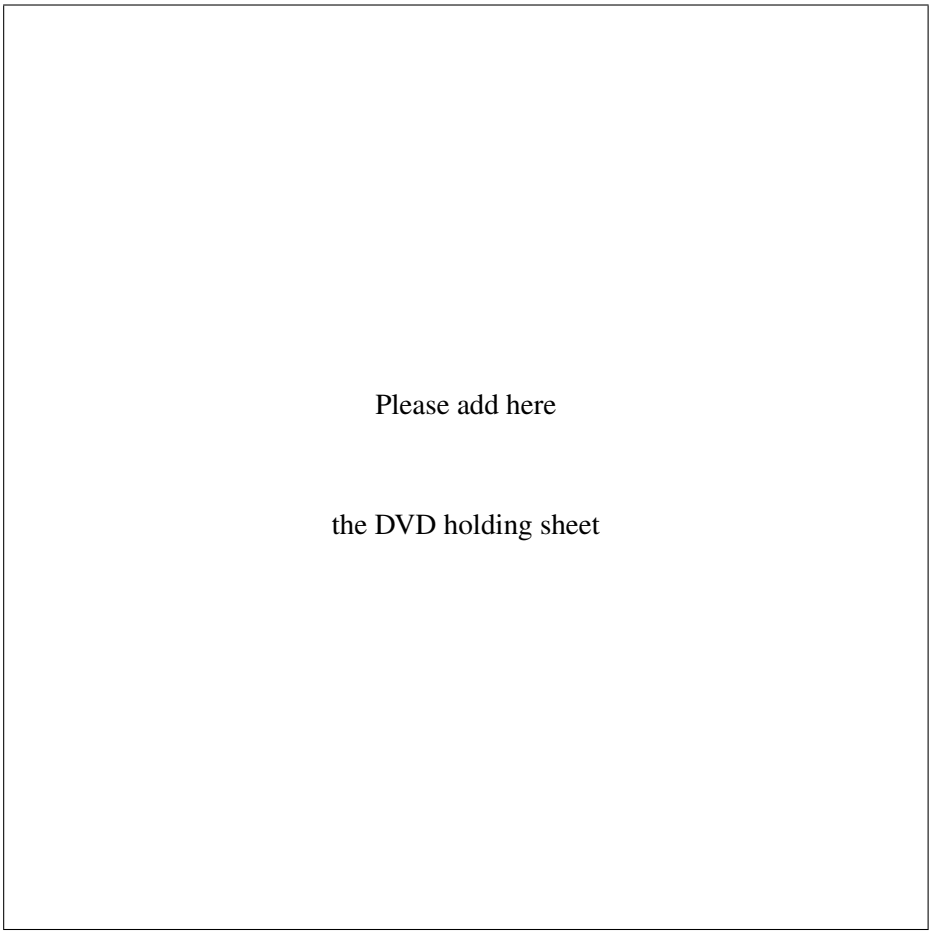
Bibliography

[GMHS07] GRAFFI, Kalman; MOGRE, Parag S.; HOLLICK, Matthias; SCHWINGENSCHLÖGL, Christian: *Detection of Colluding Misbehaving Nodes in Mobile Ad-Hoc and Wireless Mesh Networks, European Patent Office, Application No. /Patent No. 07022624.6 – 1249*. 2007.

Ehrenwörtliche Erklärung

Hiermit versichere ich, die vorliegende Bachelorarbeit selbstständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt zu haben. Alle Stellen, die aus den Quellen entnommen wurden, sind als solche kenntlich gemacht worden. Diese Arbeit hat in gleicher oder ähnlicher Form noch keiner Prüfungsbehörde vorgelegen.

Düsseldorf, 1.October 2014 Christopher Michael Probst



This DVD contains:

- A *pdf* Version of this bachelor thesis
- All LaTeXand grafic files that have been used, as well as the corresponding scripts
- **[adapt]** The source code of the software that was created during the bachelor thesis
- **[adapt]** The measurment data that was created during the evaluation
- The referenced websites and papers