

Getting the Most from Accountability in P2P

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ABSTRACT

An important concern for P2P developers is accountability. The few sources on P2P accountability define the term as a mechanism that makes the users accountable for their activity in the network. This general definition requires some refining to render it useful in the development of a P2P implementation. By 'accountability' we denote three general functions for the system. One is the system ability to detect and log any activity inside the system for future reference. Two is the system ability to convert this logged data into statistical information. Three is the response generated from this statistical information. Thus we have three foundational functions on which accountability is based. This paper suggests a low-overhead accountability scheme for content sharing.

1. INTRODUCTION

The first questions we address concern the kind of information to collect and how to use that information. The answer may be more straightforward if we first consider some the uses we want the information for. The character of the collected information is partly dependent on the P2P system architecture and protocols, on the functionality and services it provides, etc. To clarify these points we take as an example, a P2P file-sharing system, a subset of content sharing. We shall do this without specifying any particular existing implementation of a P2P file-sharing system.

Suppose we collect, store and use any information related to user activity and behavior, file migration, time events, etc. Some concrete examples of such information might be total size and number of stored files, number of downloaded versus uploaded files, percentage of successfully uploaded files, total online time and number of logins to the system, average transfer rate for uploads and downloads, average length and availability of the queue, etc. Such information is available to each peer in the P2P network community. This information can be useful in solving different organizational and functional problems, as well as for improving the quality of services delivered by the system. We do not raise here the issues that concern the content that is shared, i.e., the collection of information that actually carries semantics concerning the files that the peers exchange. This depends on the concrete system and its purpose. If we include in the accountability the content-specific information as well, that provides even more data for the statistics of system behavior. This implies more power and more flexibility

for improving the system functionality and the quality of delivered services.

2. USES FOR ACCOUNTABILITY

In our vision of the possible uses for accountability and the problems they can address and at least partially solve includes:

- A. Accountability as a basis for improving various organizational issues in the system.
 - As organizational issues we mention the peer behavior towards the others in the network and the fairness of contribution to the common good, eliminating free-riders (together these form a reputation system in the P2P network).
 - The possibility for any peer to see useful information about other peers so that appropriate decisions and actions are taken.
 - The organization of peers into virtual communities.

Good behavior of peers in the network is an important factor that can reduce the critical mass of peers required for optimal network functionality. Good behavior can be achieved by having a well-designed reputation system, which in turn can rely on the collected information about a peer's activity. The reputation system should be linked to the actual services a peer can get for a certain degree of reputation. It should be relatively hard to increase a given reputation index, and relatively easy to decrease it. This encourages the users to contribute to the network in order to use it. The more information we gather about the activity in the network, the easier it is to build a balanced and working reputation system. This, by itself, is a separate research topic.

- B. Accountability as valuable information for system developers.
 - In a P2P environment, it is much more difficult to analyze and control the functionality of the designed system than it is in a client/server model. This is due to the wide spread and variable connectivity of the network, with no central unit of control.
 - Having detailed information about different activities in the system can help developers in analyzing the closeness of the implemented model against the theoretical one. It also could

give quick insights into strong and weak points in the system.

C. Accountability as a basis for the improvement of communication protocols.

- Current implementations of P2P networks have simple communication protocols that use static algorithms or mechanisms to perform a certain task, e.g., peer discovery or message routing.
- The collected information about the activity in the network actually represents an accumulated experience over time, and could be useful for improving the protocols in the system, for building advanced routing or caching mechanisms.

D. Accountability as valuable information for service providers.

Taking advantage of P2P technology we can think of systems usable by service providers to deliver various services to subscribers (customers),.

- Accountability information can be used as a basis for charging the customers for the services they use. The more information that is available on network activities, the more flexible the business payment models can be (pay-for-service, get-paid, etc.)
- Accountability helps improve quality of service. The collected information can serve as a basis for personalization issues and user modeling that lead to a better quality of delivered user services.

E. Accountability as an information base for intelligent agents and services.

- As part of an intelligent P2P network one could see different intelligent agents that run and perform a variety of tasks.

For example, the user could specify to the system his wishes and needs, then leave further tasks to be performed automatically. This could involve time delays, search activities, computing and network activity, which are taken care of by intelligent software agents. The user is only informed about the results of his or her request. This leads to a new view on the services that the system provides, namely, seeing them as intelligent services.

F. Accountability as research data for P2P related projects.

- The continued success of any system depends on the system's capability to adapt to various changes in technology, new user requirements and needs, etc. For this to happen there should always be a tendency towards the analysis of the system functionality and corresponding changes

and improvements. Having a good base of accountability data facilitates research on the different issues that could arise.

The application areas of the collected information from the P2P network are not limited to the above cases. There could be many other cases of usefulness for accountability data, varying according to the characteristics of the system.

There are some barriers that make it difficult to implement a strong accountability mechanism in a P2P environment. This is mainly because of the characteristics special to P2P architectures. They represent a distributed, decentralized and highly dynamic network with unknown identity of peers. A hybrid P2P model could be a first step toward a fully distributed accountability mechanism in the future.

3. RESEARCH DIRECTIONS

As featured research directions towards powerful accountability in P2P network activities we see the following:

- Find suitable accountability models for different P2P architectures.
- Investigate the relationship between accountability and the services the system provides.
- Find and define the information needed for communication protocols improvement and support for intelligent protocols and agents.
- Investigate the correlation between accountability and privacy issues, and how a trade-off can be reached.

These research directions emphasize the usefulness for further work in accountability. We believe that in the current development of P2P more attention should be addressed toward accountability and how it may be implemented in the P2P architectures. This feature can have a strong effect on the improvement of P2P network services and raises useful research questions for the further improvement of P2P network development.

References

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