Influence of the Size of Swapping Entities in Mobile P2P File-Sharing Networks

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Abstract: The performance of an eDonkey-based mobile P2P file-sharing system is investigated by means of time-dynamic simulations. We show in detail that the sizes of the swapping entities, i.e. chunks and blocks, influence the time required for downloading a file. The performance depends on mobile P2P specific factors, like the access technology or the size of typical contents of mobile users.

1 Introduction

Peer-to-Peer (P2P) file-sharing has become the killer application in the wired Internet and might also be highly attractive for mobile networks. In particular since UMTS operators are searching for new applications which do both: *a)* exploit the potential of the UMTS technology and *b)* motivate the user to adopt the new technology.

Mobile networks differ from wireline networks mainly by the limited capacity of the radio link, the mobility of the users, and the anticipated content exchanged in these networks. P2P networks, in contrast, are overlays which run on top of a transport network. They consider the transport network only in an abstract way. P2P performance is typically considered on overlay level only. In a mobile environment, the question arises, whether the abstraction can be maintained for underlying mobile transport networks, too, and whether there will be a performance impact.

In this paper we investigate the performance of a *multiple source download* mechanism as used in the popular *eDonkey*[1] [Wea] file-sharing network. The performance of the proposed mobile P2P architecture has already been considered for several factors [HTA+04], like the capacity of the mobile access network, the mobility of the users, the application of the cache peer, and the size of typical contents of mobile users such as ring tones, images, and mp3 audio files. However, the performance may be increased by adapting the size of the *swapping entities* in dependence on these main influence factors. The swapping entities are the smallest units for uploading and downloading user data and are called *chunks* and *blocks*, respectively. In this work, we show if and how the swapping entities influence the entire system.

[1] In this paper, we subsume eDonkey 2000 and its derivatives, e.g. eMule, mlDonkey, by the single term "eDonkey".

2 Mobile P2P Architecture

The fundamental synchronization and control functions of P2P systems can be classified in two categories: *resource mediation* deals with locating resources while *resource control* grants and schedules priorities and access rights to shared resources.

The strength of pure P2P systems is its decentralization, which results from storing resources on end-user devices at the network edge. End-users of pure P2P systems gain full control on data resource access, which substantiates the high user-acceptance of these architectures. In contrast, the client/server approach offers high centralization in terms of resource control and mediation. Hybrid P2P applications like eDonkey utilize *weakly centralized* resource mediation with decentralized resource control.

In [AdMD^{+}04], we extended the hybrid eDonkey architecture in order to integrate it into mobile environments by introducing three system components: a modified index server for mediation, a cache peer for popular files, and a crawling peer which supports mobile peers searching the global community. The crawling peer searches files on behalf of mobile peers at any other peers and reduces in this way the amount of signaling traffic for mobile peers.

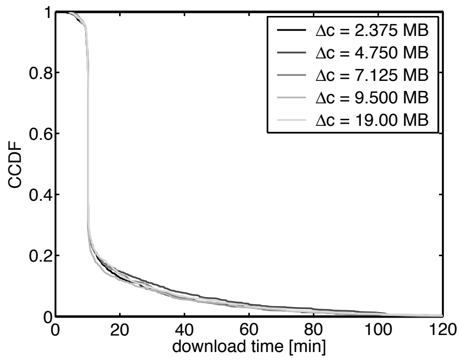
The proposed mobile architecture provides file caching in the network. The cache peer uses the same eDonkey mechanism as an arbitrary peer. After the download, the index server is informed about the newly shared file. This means that the existing eDonkey network can be extended seamlessly. At a source request by a peer, the index server returns the peer providing this file. It may favor the cache peer. Resources that are already cached can be downloaded from the cache peer first. In any other case, the index server returns the full list of mobile devices sharing the file.

3 Simulation Model

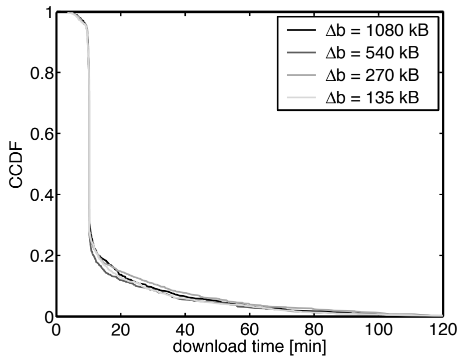
The mobile P2P simulation model consists of the peer model, the resource model, and the network model. The resource model describes the provided files and their popularity determining the file request arrival rate. For a file f the request arrivals follow a Poisson process with rate λ_f. This means the load of a system is determined by the request rates for all files. Since we are interested in the influence of the swapping entities on the mobile P2P system, it is sufficient to consider one very popular file which produces the entire load in the network. The simulation is initialized by a number N_0 of peers who initially share this file.

The peer model comprises the mobility of users and the upload/download behavior of a peer. In order to reflect the highly fluctuating connection status of mobile peers, we describe their participation in the overlay by an ON/OFF-process. The ON period and the OFF period are determined by exponential distributions. During the ON period, peers participate in the P2P network by providing their own files and requesting other files.

The eDonkey application maintains an *upload list*, reflecting the simultaneously served peers, and a *waiting list* containing all requesting peers. A newly arriving file request joins



(a) Chunk size Δc



(b) Block size Δb

Figure 1: Influence of the swapping entities on the download of a 10 MB file over UMTS

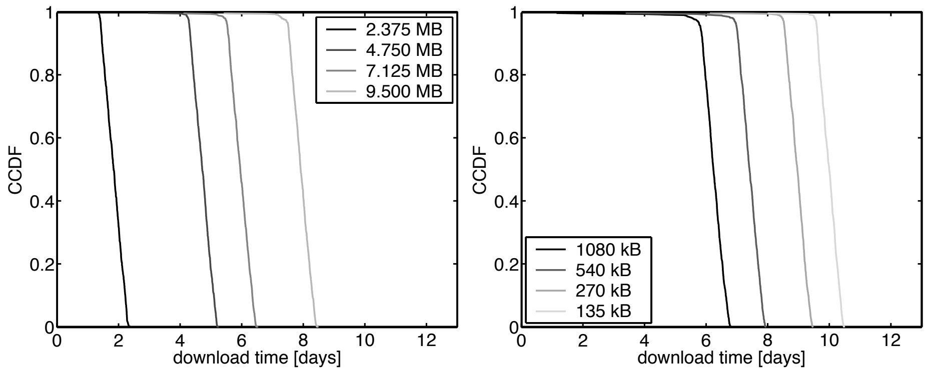
the end of the waiting list which is unlimited. In eDonkey, a file is structured into chunks of 9.5 MB and each chunk is downloaded in smaller pieces of 560 kB [emu04], denoted as blocks. After downloading a block, the peer also rejoins the end of the waiting list. Immediately after downloading a whole chunk, the peer is registered at source at the index server and the peer gets a provider of this chunk. The uplink bandwidth of a providing peer is equally split among the served peers in the upload list being limited to assure a minimal download bandwidth at a served peer. For the mobile peers, the maximal number of parallel upload connections is 4.

The network model describes the restrictions of the P2P system due to the access technology which is either GPRS or UMTS. In case of GPRS, a peer has an uplink bandwidth of 12 kbps and a downlink bandwidth of 48 kbps. A UMTS user has an uplink capacity of 128 kbps and a downlink capacity of 384 kbps. It is assumed that a mobile peer always utilized its full capacity for uploading and downloading. Since we are interested in the impact of the size of the swapping entities, it is not required to incorporate the cache peer in the simulation scenarios.

4 Results

Figure 1 shows the complementary cumulative distribution function (CCDF) for the download of a 10MB file over UMTS. The file is requested with a mean interarrival rate 45 requests/hour and we consider 1000 peers. Nearly 70% of the peers downloads the file within 10 minutes. This indicates that the system is barely loaded because of the large bandwidths of UMTS users. When a peer requests the file, this request is almost instantaneously served, since the waiting lists of the providing peers are nearly empty. Therefore the sizes of swapping entities do not affect the download performance, cf. Figure 1.

In order to study the influence of the swapping entities, a system with higher load has to be considered. This can be achieved by either increasing the file request rate or by reducing the bandwidth of the mobile peers. Figure 2 shows the same scenario as mentioned above for GPRS users. This results in a very large load which clearly demonstrates the influence



(a) Chunk size Δc

(b) Block size Δb

Figure 2: Influence of the swapping entities on the download of a 10 MB file over GPRS

of the swapping entities. The smaller the chunk size Δc is chosen the smaller the download time is, cf. Figure 2(a). In contrast, Figure 2(b) shows that the download time increases, if the block size Δb is decreased. Due to the fact that some overhead is associated with the transmission of a chunk, very small chunks are also useless and an optimal size for the swapping entities exists for a given network scenario.

5 Conclusion and Outlook

In this work, the performance of an eDonkey-based mobile P2P file-sharing system is investigated by means of time-dynamic simulations. The results show that the swapping entities have significant impact on the P2P file-sharing service in dependence of the current load in the system. The system load is influenced by the mobile access network, the popularities of files which determine the file request arrival rates, the sizes of the exchanged files, and the online/offline behavior of the mobile users. In order to optimize the chunk and block size for a given network scenario, overhead for the transmission of chunks has to be incorporated. This will be done in further studies.

References

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