Bandwidth and Storage Allocation for Operator-owned Content Management Systems

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Abstract

The demand for Internet-based visual content delivery has increased significantly in recent years, triggered mainly by the widespread use of Internet enabled smartphones and portable devices, and by the availability of super HD content. As a consequence, live and on-demand video content has become the most important source of network traffic in mobile and fixed networks alike. In order to be able to efficiently deliver the increasing amount of video traffic, network operators have started to deploy caches and operator-owned CDNs. These solutions do not only reduce the amount of transit traffic of the operators but they may also improve the customers' quality of experience, through bringing the video content closer to customers. Nevertheless, their efficiency is determined by the algorithms and protocols used to allocate their resources, both in terms of storage and bandwidth. The work in this thesis addresses the allocation of these two resources for operator-owned content management systems.

In the first part of the thesis we consider a cache maintained by a single network operator. We investigate how caching at a network operator affects the content distribution system as a whole, and consequently, the efficiency of content delivery. We propose a model of the decision process undertaken by a network operator that aims at optimizing the efficiency of a cache by actively managing its bandwidth. We design different algorithms that aim at approximating the optimal cache bandwidth allocation and we evaluate them through extensive simulations and experiments. We show that active cache bandwidth allocation can significantly increase traffic savings.

We then consider the potential interaction among caches maintained by different network operators. We consider the problem of selfish replication on a graph as a model of network operators that individually deploy replication systems, and try to leverage their peering agreements so as to minimize the traffic through their transit providers. We use game-theoretical tools to investigate the existence of stable and efficient allocations of content at the network operators. We show that selfish myopic updates of content allocations at different network operators lead the system to a stable state, and that the convergence speed depends on the underlying network topology. In addition, we show that interacting operator-owned caches can reach a stable content allocation without coordination, but coordination leads to more cost efficient content allocations.

References

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