

Abstract

The overlay topology of peer-to-peer (p2p) networks plays a crucial role in determining the performance of these systems. The main objective of this thesis is to enhance several topological properties of the overlay network so as to improve the performance of p2p systems. Since p2p networks are evolving systems with nodes continuously joining and leaving the system, the properties of the overlay need to be understood from an evolutionary perspective. This would then allow us to design effective topology enhancement schemes.

In this thesis, we initially analyze the p2p topologies that evolve due to bootstrapping of the peers following certain constraints in real p2p networks like limited bandwidth availabilities and limited cache sizes. These constraints lead to existence of cut-off degrees of the peers and limited availability of information about other peers in the network respectively. We derive models to characterize the degree distribution of the peers in the network and study the effects of other parameters like the minimum degree of the peers and the randomness in peer attachment, in presence of the cut-off degrees and the finite-sized caches.

Further, these derived topological characteristics also help to estimate the topological effects on other parameters like the volume of redundant messages generated in the network. The insights obtained from these models have been used to generate a mechanism that can successfully reduce the redundant messages with low overhead. We further use the insights to develop a bootstrapping mechanism for Gnutella-like networks to increase the network coverage of the peers and thus improve their search performance besides reducing message redundancy. Performance comparison with DCMP indicates better performance of the proposed mechanism, both in terms of the network coverage and overhead involved.

Finally, we show the effect of the overlay topology on the download performance of the peers in BitTorrent systems that have large heterogeneity in peer bandwidths. We derive the topological characteristics of these systems that minimizes average download latency of the peers. We show using simulations that the derived topologies improve the average download latency of the peers in the system by around 20% as compared to normal BitTorrent topologies.