Mathematical modeling of max–min fair bandwidth allocation in BitTorrent communities

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Data transfer in a BitTorrent community can be modeled as a network problem on a bipartite graph, where three types of nodes can be differentiated: the uploading peers (seeders and leechers), the downloading peers (leechers), and the content of the sharing sessions (torrents). The edges represent the peers' participation in the sessions, and bandwidth constraints are the weights of the edges.

The bandwidth allocation problem is setting feasible data flow values for every edge to achieve an optimal solution for a specific objective. In this case, we want to find a max–min fair bandwidth allocation. In other words, the minimum of the downloading data flows should be maximized. This type of allocation called "fair", because no one's resources are allowed to be increased at the expense of decreasing the resources of any "weaker" peer. Max–min fairness could be a reasonable objective in direct media sharing, for example.

Capotă et al. [1] have given an iterative procedure for computing max–min fair bandwidth allocation, however, they have used a complicated and computationally intensive filtering phase in their algorithm. Our aim was to give an intuitive, clear mathematical model for the same problem, to help better understanding of the problem, verify the results of the earlier algorithm, and conduce to the development of a more efficient algorithm, which would serve to analyze the effects of structural alterations in large-scale BitTorrent communities.

Acknowledgements

References

[1] M. Capotă, N. Andrade, T. Vinkó, F. Santos, J. Pouwelse, and D. Epema. Inter-swarm resource allocation in BitTorrent communities, *In Proceedings of IEEE International Conference on Peer-to-Peer Computing (P2P 2011)*, pp. 300–309, 2011