Towards Fair Sharing of Peer-to-Peer Resources

Tsuen-Wan "Johnny" Ngan, Dan S. Wallach, and Peter Druschel*
Department of Computer Science
Rice University

Cooperative peer-to-peer (p2p) applications require users to share their resources for the good of everyone. Recent studies [1], however, showed that open cooperative p2p applications are dominated by free riders. Users do not necessarily have *incentives* to share. In designing such systems, it is important to take fairness and economic incentives into account. We consider two such systems: archival networks and file sharing, and discuss mechanisms that give users incentives to share their disk space and bandwidth.

Archival networks usually store backups or data that are no longer in active use. They require large disk space, but not high bandwidth once the files are stored. A fair sharing policy could limit any given node to only consuming as much of the network's storage as it provides space for others on its local disk. To enforce this, we designed a system where nodes publish their resource usage and randomly audit other nodes [2]. Every node in the system maintains a *usage file*, digitally signed, which is available for any other node to read. The usage file contains lists of files it is storing for and has stored by the system, which together describe all the credit and debits to a node's account. To ensure that nodes to truthfully maintain their usage file, we designed an *auditing* mechanism for the nodes to audit each other periodically. As a result, the only way a node can consume more disk space is by providing more to others. We have shown that auditing has small overhead and scales well to large number of files and nodes.

The notion of fairness for file sharing applications is quite different. Unlike archival networks, files are usually of more general interest, and it is not uncommon to have multiple download requests made to the same node at the same time. The limiting resource is thus the upload link bandwidth. While there are many possible ways to define fairness (e.g. file "quality", upload bandwidth, stability of the bandwidth), we take a simpler and more objective approach by considering only the number of bytes sent and received. For a large network (say over 10,000 nodes), it would be impractical to maintain a global view of this information. Therefore, instead of auditing, we consider an audit-free *accounting* scheme, where each node maintains accounting information for nodes it has had direct connection with. Each node would maintain an estimate of how generous its neighbors are. The interesting question is how can this local information be used to arrive at global fairness in the presence of malicious nodes. Also, can this information be helpful to the p2p routing substrate (e.g., Pastry [3]) to allow generous nodes to cluster together and receive better service? Would the resulting system be more robust against selfish behavior and malicious attacks? We are currently implementing a simulator to answer these questions.

References

[1] E. Adar and B. Huberman. Free riding on Gnutella. *First Monday*, 5(10), October 2000.

[2] T.-W. J. Ngan, D. S. Wallach, and P. Druschel. Enforcing fair sharing of peer-to-peer resources. In *2nd International Workshop on Peer-to-Peer Systems (IPTPS)*, Berkeley, California, February 2003.

[3] A. Rowstron and P. Druschel. Pastry: Scalable, distributed object address and routing for large-scale peer-to-peer systems. In *Proc. IFIP/ACM Int'l Conf. on Distributed Systems Platforms*, Heidelberg, Germany, November 2001.

*Email: {twngan,dwallach,druschel}@cs.rice.edu