TDK - Team Distributed Koders
Distributed Systems I

Fairness in P2P Streaming Multicast

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Team Report I
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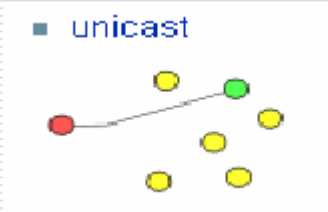
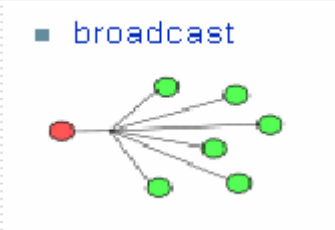
Introduction

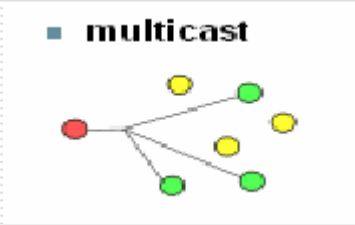
- Overview of P2P multicasting
- Fairness problem
- Approach
- Software to be implemented

Overview

- Unicast
  - Point-to-Point
- Broadcast
  - One-to-all
- Multicast
  - One-to-many



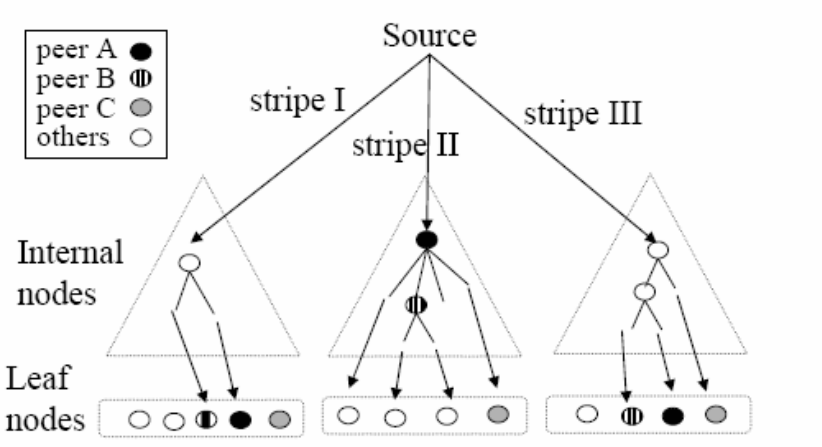




Overview (continued)

- Most often used for audio and video streaming (e.g. audio/video telecasting)
- An alternative to IP Multicast
- Peers act as both forwarders and receivers. Bandwidth is distributed from the root publisher.
- P2P architecture provides cooperative environment - enhances scalability, improves social welfare, fault tolerance

Overview (continued)



- Tree-based architecture often used; streaming content may be striped across multiple trees to balance forwarding load

- With the benefits of a cooperative environment come new problems - cannot assume peers will behave as expected

Problems

- Problem is enforcing fairness in resource sharing
- Example: Existence of selfish nodes/freeloader nodes
- Definition: selfish/freeloader nodes: nodes that benefit, usually deliberately, from others' information or effort but do not offer anything in return (Wikipedia)
  - Nodes may refuse to accept children
  - Nodes may refuse to forward content to children

Problems (continued)

- Asymmetrical bandwidth nodes
  - Many nodes on network can receive more information than they can send.
- Bit for Bit model does not maximize social welfare because these nodes are not receiving as much as they could

Approach

- Debt Maintenance
  - Each time a parent sends a packet, a debt is accumulated; if debt reaches a threshold, parent refuses service to this child
- Ancestor Rating
  - If expected packet not received, all ancestors assigned equal blame; similarly, if packet is received, they are all given equal credit

Approach (continued)

- Tree Reconstruction
  - periodically, forest trees are rebuilt to identify freeloaders
- Rebuilding allows reversing of parent-child roles so that debts may be paid off
- Falsely blamed nodes' ancestor ratings will average out
- Freeloaders' debt will only continue to accumulate

Approach (continued)

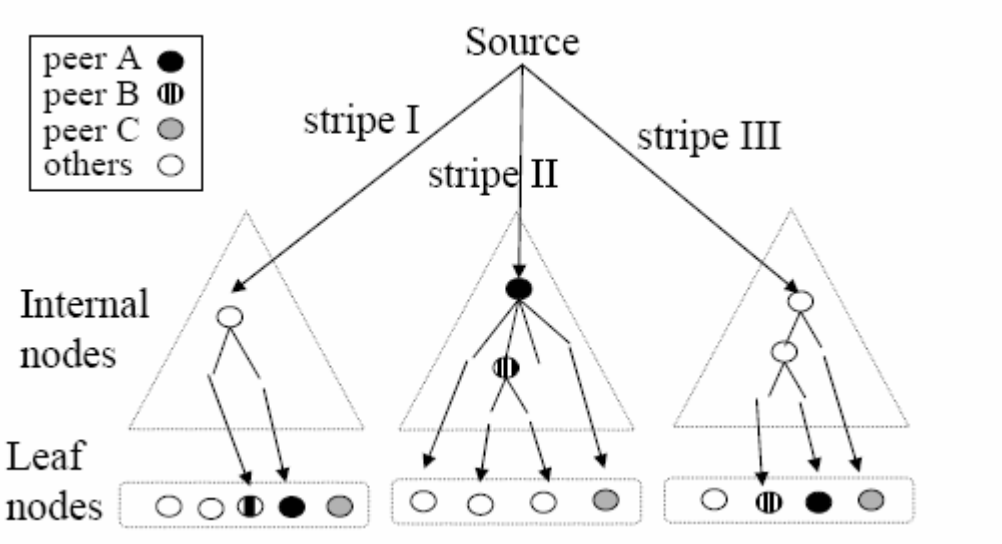
- Taxation to increase overall welfare
  - Number of streams a node wishes to receive determines the number of children it must accept
  - In order to receive a higher bitrate stream, a node needs to contribute more resources
    - Bandwidth rich nodes may end up forwarding more than they receive and bandwidth poor nodes may receive more than they forward.
- Publisher enforces taxation scheme

Software

- Simulate a multicast network following the SplitStream model using a discrete event simulation
- Implementation of Ancestor Rating, Debt Maintenance, and Tree Reconstruction
- Fairness algorithms will identify freeloaders and the results will allow a comparison of freeloader detection methods
- Taxation method will change bandwidth distribution

Software (continued)

- SplitStream splits the original content from the source into *k* stripes, which are multicast using 1 tree per stripe
- Each node is an interior node in at most 1 tree, and a leaf node in others
- This balances the forwarding load, so that not all the burden is placed on a small set of interior nodes; it also makes system more fault-tolerant



References

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2. T. W. J. Ngan, D. S. Wallach, and P. Druschel. Incentives-Compatible Peer-to-Peer Multicast. In The Second Workshop on the Economics of Peer-to-Peer Systems, July 2004. http://citeseer.ist.psu.edu/ngan04incentivescompatible.html
3. Chu, Y. 2004. A case for taxation in peer-to-peer streaming broadcast. In Proceedings of the ACM SIGCOMM Workshop on Practice and theory of incentives in Networked Systems (September 2004). ACM Press, New York, NY, 205-212. DOI= http://doi.acm.org/10.1145/1016527.1016535