Proposal and Evaluation of a Network Construction Method for a Scalable P2P Video Conferencing System

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Outline

- **Background**
- **Network Construction Method for a Scalable P2P Video Conferencing System**
- **Simulation Experiments**
- **Conclusion and Future Work**

Background

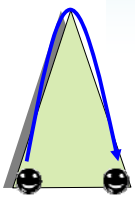
- **A variety of video conferencing systems are used on the Internet**
  - Using application level multicast
    - due to their ease of deployment and low cost of operation
- **It is required to support video conferencing with many users**
  - e.g. college lectures, business meetings of global company
- **Available on market:**
  - ONLY support of a few users (e.g. SmoothCom, WarpVision)
- **Topics of research:**
  - NO support of interactive communication (e.g. Borg, Sim)

Theme and Our Goal

- **Research group's theme**
  - Proposal for constructing and managing a distribution network
    - Support thousands of users
- **Research group's goal**
  - Low delay between active speakers for smooth conference
  - Low overhead for scalability
- **Considered aspects**
  - The fact that the number of simultaneous speakers is limited
  - Smooth communication requires small delays between speakers and listeners
  - ➢ Our method locate speaker to core of distribution network

Main Idea

- **Low delay**
  - Hierarchical distribution network
  - Dynamical Reorganization of distribution network
    - Considered with activity and the available bandwidths of peers



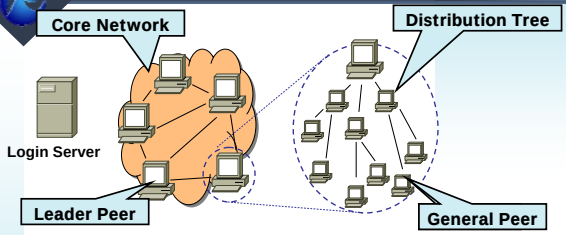
- **Low overhead**
  - Use ONLY local information
  - Messages are exchanged ONLY among neighboring participants

Mechanisms of Proposal

- **Network construction mechanism [5]**
  - Set up a hierarchical distribution network
- **Tree reorganization mechanism**
  - Reorganize distribution trees
    - Move speakers towards the root of distribution tree
    - Reduce the height of distribution tree
- **Failure recovery mechanism [5]**
  - Reconfigure the distribution network through local interactions among peers

[5] Suetsugu, S., Wakamiya, N., Murata, M.: A hybrid video streaming scheme on hierarchical P2P networks. In: Proceedings of Internet and Multimedia System and Applications 2005 (EuroIMSA2005). (2005) 240-245

Overview of Proposed System

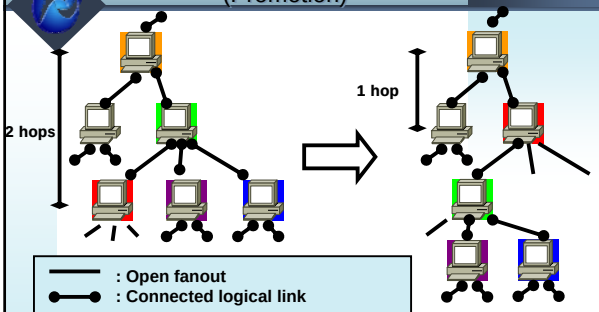


- Login server manages only information of leader peers
- Distribution trees are managed by a decentralized control algorithm
- Stream data is delivered to leader peer and to other distribution trees
- Peers have fanout
  - number of acceptable children
  - according to peer's available bandwidth

Tree Reorganization Mechanism

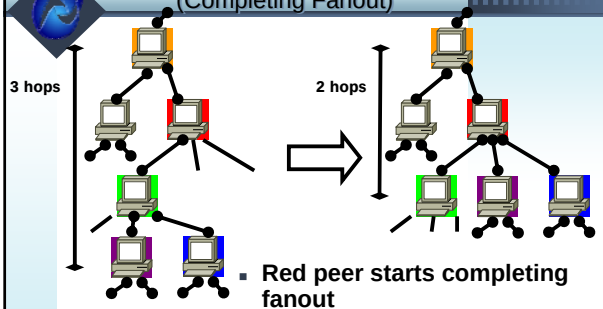
- **Promotion**
  - A peer moves to the root of the tree
    - speaking activity exceeds certain period of time
    - periodic comparison of its fanout with that of parents
  - For low delay and smooth conferencing
- **Completing fanout**
  - A peer with open fanout connects more children
    - periodic comparison of its fanout with number of children
  - Overcome tree unbalance caused by promotion

Tree Reorganization Mechanism (Promotion)



- Shortcoming: green, purple, blue peers move away from root

Tree Reorganization Mechanism (Completing Fanout)



- Red peer starts completing fanout
- After completing fanout, the height of tree is reduced

Simulation Conditions and Evaluation Metrics

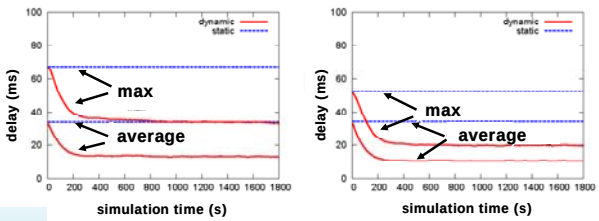
We evaluate tree reorganization mechanism with a single tree

Conditions
- Constant number of peers: 100
- Delay: physical hops × 1 ms
- Candidates (speaking peer): 10
- Period for promotion with speaking: 5 seconds
- Interval for promotion: every 24 seconds
- Interval for completion : every 7 seconds

Evaluation metrics
- Delay from leader peer to all peers and to candidates
- Number of messages received as overhead

Following results are the average over 1000 simulations

Delay between Leader and Peers

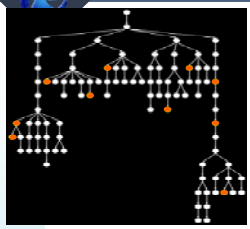


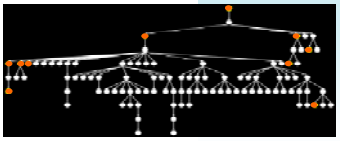
All Peers Candidates

- Our method can effectively reduce the delay
- Speakers experience better and smoother conversation
  - Smooth communication needs less than 100 ms end-to-end delay [9]

[9] ITU-T: Recommendation G.114 – one way transmission time. Switzerland (2003)

Change of Tree Topology with Tree Reorganization





Orange: Candidates
White: Other peers

Initial tree topology **Reorganized tree topology**

- **Our method reduces the height of the tree**
  - Hop distance from leader peer to all peers:
    7 → 4 (avg.), 14 → 10 (max)
  - Hop distance from leader peer to candidates:
    7 → 3 (avg.), 10 → 6 (max)

Overhead

- **Number of messages received per second at a single peer**
  - 0.0839 on average, 1.95 on maximum
  - Bandwidth: 22 (avg.) ,515 (max) bps
    - packet size: 33 Bytes
  - This is very small compared to the coding rate in video conferencing (64 kbps to 8 Mbps)

Conclusion and Future Work

- **Conclusion**
  - We proposed a network construction method for a scalable P2P video conferencing system
  - We evaluated tree reorganization mechanism:
    - reduces the delay among peers
    - causes very low overhead
- **Future work**
  - Evaluation of failure recovery mechanism
  - Evaluation with several distribution trees