Layered Peer-to-Peer Streaming

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Outline

- Introduction
- Problem Formulation
- Layered Peer-to-Peer Streaming Solution
- Performance Evaluation
- Conclusion and Discussion
Conclusion and Discussion

- This Layered Peer-to-Peer streaming solution addresses the asynchrony and heterogeneity issues in on demand media distribution.
- But large number of departing peer will make the quality bad!
Introduction

- Large-scale on-demand multimedia distribution has been shown as one of the killer applications in the Internet.
- Multicast has been extensively employed since it can effectively deliver media data to multiple receivers. (minimizing server and network overhead)
Introduction (cont’)

- Multicast is in conflict with two important features of media distribution
  - Asynchrony of user requests
  - Heterogeneity of client resource capabilities
- Layered Peer-to-Peer Streaming
Problem Formulation
Problem Formulation (cont’)

- Layer-encoded Stream\{l_0, l_1, \ldots, l_L\}
- Peers \{H_0, H_1, H_2, \ldots, H_N\}
- Streaming Quality Q_k
- Layer Availability A_k
- Buffer Length B_k
- Request Time t_k
- Supplying Peer Constraint C_k
Problem Formulation (cont’)

maximize \[ \sum_{k=1}^{N} (Q_k - Q_k^0) \]

subject to

1. \[ Q_k \leq I_k (1 \leq k \leq N) \]
2. \[ \sum_{H_k \to H_m} Q_m^k \leq O_k (1 \leq k \leq N) \]

NP-COMPLETE
Layered Peer-to-Peer Streaming Solution

- Basic algorithm
- Enhanced algorithm
- Node departure
Layered Peer-to-Peer Streaming Solution

Basic Algorithm

$Q_k$ at $H_k$ is 0
Layered Peer-to-Peer Streaming Solution
Basic Algorithm

- $H_1$ output two layers to $H_k$
- Increase $Q_k$ to 2
- $H_2$ output two layers to $H_k$
- Increase $Q_k$ to 4
Layered Peer-to-Peer Streaming Solution
Basic Algorithm

After H4 output three layers to $H_k$, $H_k$ ask the server to sane the missing layers to $H_k$.
Layered Peer-to-Peer Streaming Solution
Enhanced Algorithm

- $H_k$ can only stream from finite number of supplying peers. ($S=\{H_1, \ldots, H_m\}$)

- $Q_k^*(M, C_k) = \max [Q_k^*(m, C_k - 1) + Q_{\max}(H_{m+1} \ldots H_M)]$
  \[
  C_k - 1 \leq m < M
  \]

- $O(C_kM^2)$
Layered Peer-to-Peer Streaming Solution
Node Departure

- If Hm departs normally
  - Hm continues to stream data remained in its buffer to Hk as normal

- If Hm fails
  - A. server acts as Hm
  - B. Graceful Degradation of Streaming Quality
Layered Peer-to-Peer Streaming Solution
Node Departure
Performance Evaluation

average quality satisfaction

![Graph showing average quality satisfaction vs. average outbound/inbound bandwidth ratio. The graph compares 'layered' and 'versioned' models. The 'layered' model shows a smoother curve with higher satisfaction values across the bandwidth ratio range, while the 'versioned' model has a more abrupt change.]
Performance Evaluation

server bandwidth