Cooperative Video Streaming Mechanisms with Video Quality Adjustment

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Video streaming system with proxies

- To provide low-delay and high-quality streaming service
Issues

- Segmentation of video streams
- Video quality adjustment
- Locating the appropriate server
- Cache management
- Prefetching
• Each system entity communicates with each other
Video block transfer

**Cache Hit**
1. Read block from cache
2. Quality adjustment

**Prefetching**
1. Check cache
2. Request block transfer
3. Cache

**Cache Miss**
1. Determine helper server
2. Request block transfer
3. Quality adjustment & cache

- Video Server
- Neighboring Proxy
- Proxy Cache Server
- Client

**PLAY message with QoS**

**Initial buffering**

**Freeze time**

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Cache table

• Cache table is used to maintain information of locally cached blocks
  – block number $i$
  – quality of cached block $q(i)$
  – marker $M(i)$

• Marker is used to imply the possibility that the block will be required by the other proxies

• Range of marking is limited by inquiry window $I$

• QUERY and REPLY messages are exchanged to update markers
Remote table

- Remote table is used to maintain information of blocks cached at the other servers (video server, proxies)
  - estimated one way delay $d_k^S$
  - estimated throughput $r_k^S$
  - quality of offerable block $O_k (i)$
- Delay and throughput are estimated using measurement tools or TCP-friendly control mechanisms
- QUERY and REPLY messages are exchanged to update remote tables
Block retrieval algorithm

- The proxy determines the quality of block $i$ to offer to client $j$ based on:
  - Request $q_j(i)$
  - Cache and remote tables
  - Estimations $d_j^C, r_j^C$
  - The number of blocks in the client’s prefetch buffer $p_j$
  - Parameter $\beta_j$

- If the quality of block offerable using cache $q_j^P(i)$ satisfies $q_j^P(i) > \beta_j q_j(i)$, it is regarded as “cache hit”
The proxy retrieves the block preparing for the future cache miss.
Cache replacement algorithm

- Some blocks might be replaced with a newly retrieved block

Client 1

Client 2

Marker

Victim

Inquiry window

Start

End

Quality adjustment

Removal
Evaluation

- Measurements
  - average freeze time
  - required buffer size
  - degree of satisfaction ratio of provided quality to requested quality

- 1 sec block
- P=10, I=20
- initial wait 4 sec
- parameter $\beta_j = 0.6$
- 35 Gbit buffer
Comparison

- Four mechanisms are compared

**Graph 1:**
- Average Freeze Time [sec] vs. Client
- Independent w/o Prefetch
- Independent c/w Prefetch
- Cooperative w/o Prefetch
- Cooperative c/w Prefetch

**Graph 2:**
- Quality ratio vs. Client
- Independent w/o Prefetch
- Independent c/w Prefetch
- Cooperative w/o Prefetch
- Cooperative c/w Prefetch

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Conclusion

• The low-delay and high-quality video streaming service is accomplished
• Further efficient control is required
• We have to consider implementation issues