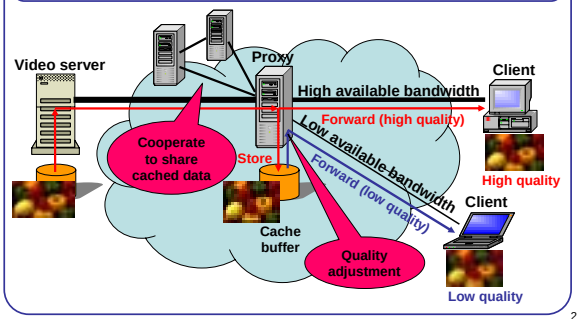
Video Streaming Service

- Considerable amount of video traffic
  - Causes network congestion
  - Longer transfer delay and higher packet loss probability

  →Proxy cache server
- Heterogeneity in clients
  - Available bandwidth: ADSL, FTTH, Dial-up
  - End-system performance: PC, PDA, Pocket PC

  →Video quality adjustment

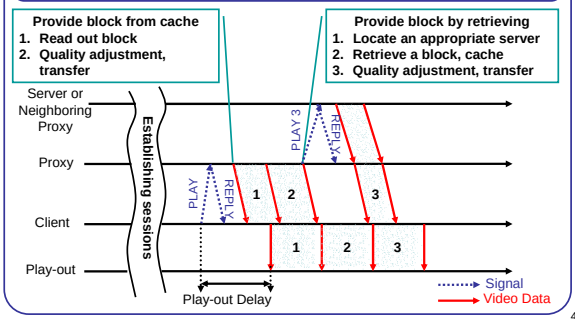
Video Streaming Service using Proxies with Video Quality Adjustment



Proxy Caching Mechanisms Considering on Video Characteristics

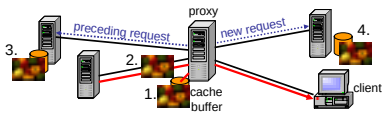
- Divide video data into blocks
  - Efficient use of a cache buffer and bandwidth
- Block Provisioning Mechanism
  - Provide blocks to clients considering network and cache condition for continuous and high-quality video distribution
- Block Prefetching Mechanism
  - Prefetch blocks of the appropriate quality to avoid future cache misses
- Cache Replacement Mechanism
  - Replace cached blocks with a newly retrieved block for efficient use of a cache buffer

Basic Behavior



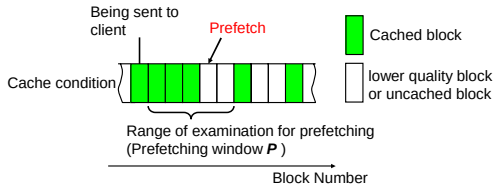
Block Provisioning Mechanism

- A proxy adopts the fastest way that can provide the client with a block of higher level of quality
  1. Read out and send a cached block, or
  2. Use a block being received, or
  3. Wait for the preceding request for the same block to be served, or
  4. Newly retrieve a block from the other server



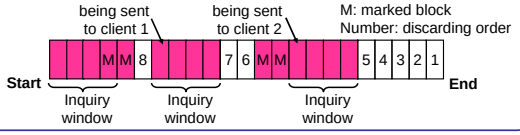
Block Prefetching Mechanism

- A proxy retrieves the block preparing for the future cache miss



Cache Replacement Mechanism

- Cached blocks are replaced with a new block
  - Candidates are chosen considering their importance
    - Blocks reside at the head are important
    - Blocks being sent to clients and their followings are important
    - Marked blocks are important since they will be needed soon
  - A candidate is first reduced its quality (if possible) and then removed from the cache



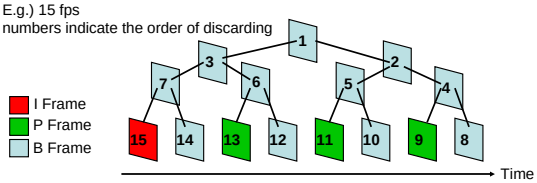
Sharing Information among Proxies

- A proxy has two tables
  - Cache Table
    - To maintain information of locally cached blocks
    - Consists of block number, bit rate (quality), marker
  - Remote Table
    - To maintain information of blocks cached at the other servers
    - Consists of estimated one-way delay, throughput, quality of offerable blocks
- RTSP messages are exchanged to update tables
  - QUERY: inquires quality of cached blocks at the other server
    Range of blocks to inquire is limited by inquiry window ***I***
  - REPLY: answers quality of cached blocks
    Those blocks in inquiry window ***I*** are marked not to be replaced

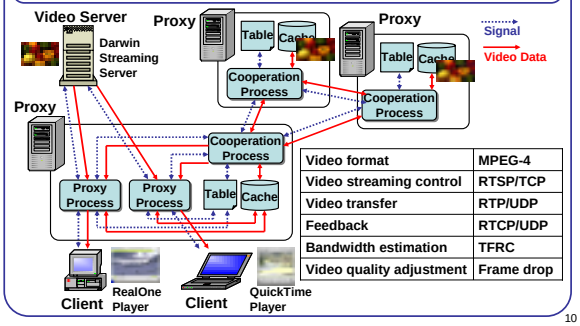
Video Quality Adjustment Mechanism

- Frame dropping filter
  - Buffer a series of frames of one second
  - The interdependency of video frame (*B, P, I* frame) is considered
  - Frames are prioritized for well-balanced discarding

E.g.) 15 fps
numbers indicate the order of discarding

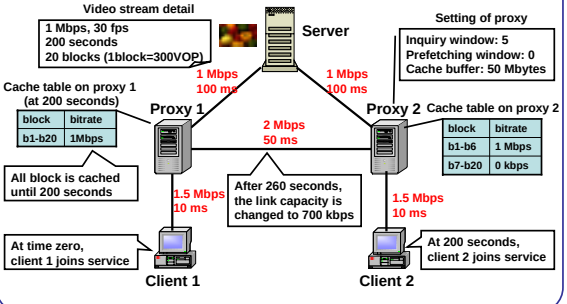


Outline of Implemented System

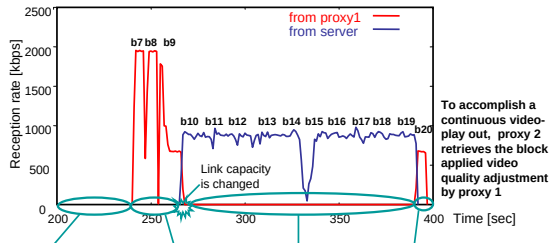


Video format	MPEG-4
Video streaming control	RTSP/TCP
Video transfer	RTP/UDP
Feedback	RTCP/UDP
Bandwidth estimation	TFRC
Video quality adjustment	Frame drop

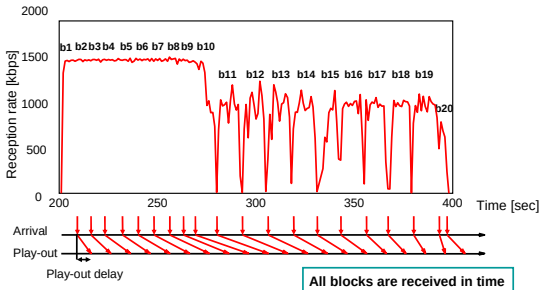
Configuration of Experimental System



Reception Rate Variation at Proxy 2



Reception Rate Variation at Client 2



All blocks are received in time

Conclusion and Future Work

- Conclusion
  - Our implemented system can provide users with a continuous and high quality video streaming service
- Future work
  - Additional experiments
  - Considering user interactions such as pauses, fast-forwarding, and rewinding