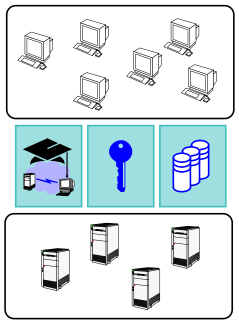
Community-of-Interest Multicast Cache Loading



Joe Touch

Large-Scale Active Middleware Project
USC/ISI Computer Networks Division

ISI Web Research

Transport for short transactions

- *Rate-based pacing (Heidemann/Visweswaraiah)*
- *TIME_WAIT avoidance (Touch/Faber/Yue)*
- *Control block sharing (Touch/Heidemann/Eggert)*
- *Support for satellite and asymmetric channels*
- *Support for partial order transport*

Middleware for cache support

- *Multicast push to client caches (Touch/Hughes/Oswal)*
- *Reducing cache hierarchy miss penalty*
- *Network adaptive caching*
- *Partial object caching*

Primary Focus

Response latency is the critical parameter

- *Netscape vs. Word?*
- *Interactive is much more useful than request/response*

All other parameters are resources

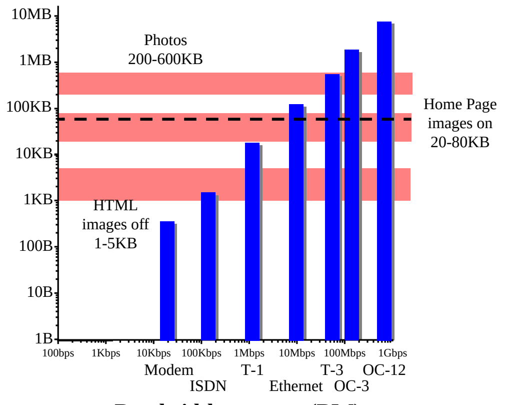
- *Processing (recompute)*
- *Storage (cache)*
- *Bandwidth (anticipate)*

Idle bandwidth is a wasted opportunity

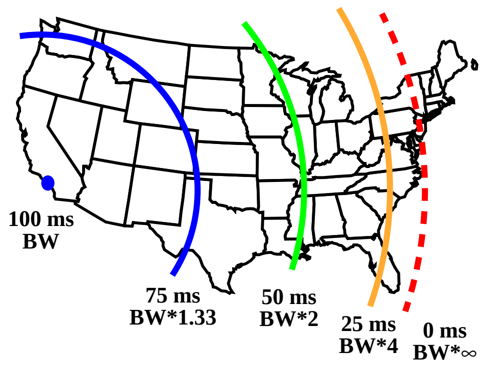
Cache Push Motivation

Bandwidth too high for interactive, or no interactive at all

Bytes sent in 100 ms



Bandwidth per user (BW)



Distance affects latency budget, which drives up BW cost of 'interactive'

Unicast Experiments

Preliminary results

- *FTP (Infocom '94)*
  - without proaction, per-item response averages 2.1 RTTs
  - with proaction 3x lower latency, 0.7 RTT avg. response, 7x higher BW
- *HTTP*
  - without proaction, 14% hit within 100 ms
  - with proaction, 83% hit within 100ms, 5-8x higher BW

Implications

- *Benefits*
  - Faster than speed-of-light response latency
  - Efficient multicast without requiring long server queues
- *Costs*
  - Resources - BW, CPU, storage
  - Complexity - contention avoidance for BW, CPU

Multicast Vision

Hot-spots are important

- *Significant traffic (conjecture)*
- *Important traffic, opportunity for interactive response*

HS's generate communities of interest (COI)

- *Groups of users associated with a group of data*

COI are dynamic

- *Time scale of hours-days-weeks (conjecture and goal)*
- *E.g., tell a few friends, they'll hit, etc.*

Content dictates COI

- *Predicted by URLs for now*

COI Components

Server

- *Creates COI page groups based on popularity*
- *Creates mcast channels for each COI group*
- *Advertises channels on index channel (per-server)*

Cache components

- *Partitioned, accepts remote loads*
- *COI channel per partition to receive mcast preloads*
- *Modified cache replacement*

Transport issues

- *"Lazy" reliable mcast transport*

Tuner Protocol

Publisher / subscriber relationship

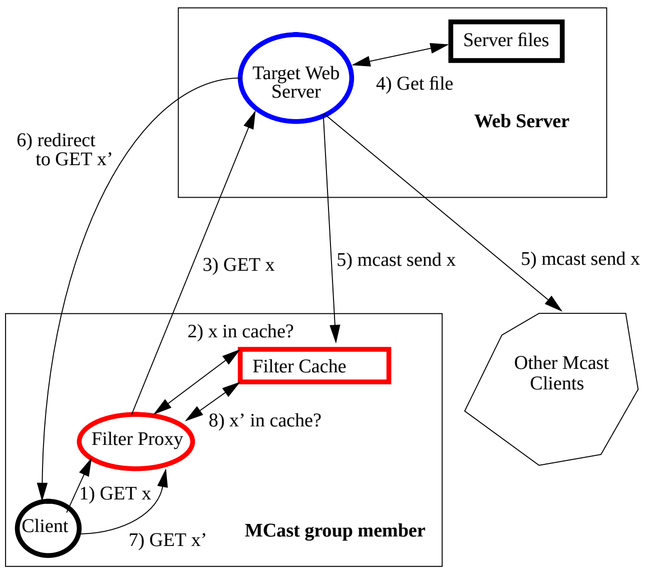
Server

- *"TV-Guide" per server*
- *Multiple channels per server dynamically 'topic of interest'*
- *Requests mcast if in a current 'topic of interest'*

Cache

- *Partitioned per channel*
- *Tune to TV-Guide of popular servers*
- *Allocate partition per popular 'topic of interest'*
- *(assumes within one server, or labelled)*
- ***Automatically converges at network aggregation points***

Multicast architecture



Issues

Cache partitioning

Item selection

- *Ordering / prioritization*
- *At server, and replacement at client*

Group selection

- *At server and client*

Transport issues

- *Lazy multicast reliable transport*
- *Background unicast reliable transport*
- *Multicast parameter tuning (TTL)*

Transport

Support mcast and unicast

Unicast selective NACKs

- *NACK triggered by cache hit, idle-ness, or API event*
- *NACK suppressed by new data*

Stateless servers

- *Retain partial transfers*

File and stream mode

Source or receiver controlled

- *Tag actions as silent/loud, optional/required, sync./async.*

Other Issues

Partial object caching

- *Variable-sized objects, variable cost complicates policy*
- *Need only enough to “prime the pipeline”*

Cache hierarchy overhead

- *Store-and-forward of tests increases MISS latency*
- *Use cut-through to root in parallel*

Network-adaptive caching

- *Use unicast preload, multicast, etc.*
- *Match cache mechanism to topology*

Environment Assumptions

Response latency is important

Idle bandwidth

- *Opportunistic use of ephemeral resources*
- *Can be used without affecting foreground traffic*

COIs aggregate

- *Content-based subset of pages of a single server*
- *Hours-days of 'hot-spot'*

Architecture supports mcast

- *Efficient mcast from server to caches*
- *Caches nearby to clients*

Management Issues

Server decides what to send

- *Creates COI groups based on "popularity"*

Client decides what to receive

- *Tunes partitions to COI channels based on "interest"*

Partitioning avoids contention

- *Background vs. foreground traffic*
- *Server processing queues*
- *Cache partitions*

Protocol Issues

“Lazy” reliable multicast

- *Currently using MFDP*
- *Prefer ‘lazy-NACK’ to avoid receiver overload*

Supports hierarchy

- *Mcast trees determine hierarchy automatically*
- *Avoiding transitivity also avoids store-and-forward costs*

Server, network driven

- *Server, proxies at network aggregation play*
- *Clients avoid extra individual load*

LSAM Status

http://www.isi.edu/lsam

Prototype mcast system in test

- *Uses MFDP*
- *Single, hard-wired group*

Future work

- *Server group selection*
- *Client group selection*
- *Cache replacement policy development*
- *Enforcing ‘backgrounding’ of mcast traffic*