CSc 461/561
Multimedia Systems
Peer-to-Peer Swarms

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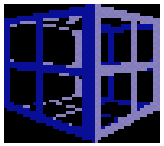
Review: going P2P

- Client-server
  - server is well-known and serves all client requests
  - scalability issue
- Peer-to-peer
  - structured or unstructured
  - every peer is a (potential) server
    - search is a challenge
  - one request is still served by one peer
    - until the peer fails, then try to use another peer

Napster and Gnutella

- Napster
  - centralized directory server
    - list uploading and query handling
  - peer-to-peer file download
- Gnutella
  - fully distributed
    - scoped flooding search
  - peer-to-peer file download
- Improving Gnutella
  - node hierarchy; non-flooding search



Q: more design space to explore?

More design choices

- If more than one peer can serve, why do they not serve the same request together?
- Benefit
  - more resilient to node dynamic
    - does not rely on any particular peer
  - fit better with the asymmetric access link
    - higher download bandwidth than upload
- Overhead
  - how to get served from multiple peers
    - work together constructively

The BitTorrent approach

- Chop a file into small, fixed-size pieces
  - e.g., pieces (usually 256 KB each)
  - and then into blocks (usually 16 KB each)
- .torrent
  - meta information about the file
  - out-of-band retrieval
- Tracker
  - return a list of peers may have some pieces
- Seed and leecher/downloader
  - peers have the complete/incomplete file

.torrent

- Tracker URL
- File info
  - name, length
- Piece info
  - length, hash
- Other info
  - date, comment, etc
- Bencoding
  - strings, integers, lists, directories
  - e.g., 4:*spam*, i3e, l*4:spam4:eggs*e, d4:spaml*1:a1:b*ee

Tracker protocol

- HTTP GET request
  - info_hash: to identify the file
  - peer_id: of the requesting peer
  - client address and port: to respond to incoming requests
  - bytes uploaded, downloaded, left, etc
  - numwant: the number of peers in the response list
- Tracker response
  - failure reason, if any
  - contact interval
  - peer list and stat (seed and leecher, etc)
- Tracker-less mode (on Kademlia DHT)

Tit-for-tat

- Download while upload: tit-for-tat
  - upload to whom from which download: trading pieces
  - prevent free-riding
    - fairness?
- Choking/unchoking
  - a limited number of uploads
    - default: 4+1
  - evaluate peers based on their recent download speed
    - 20-second average
  - upload to the peers with the fastest download speed
    - adjust every 10 seconds

Optimistic unchoking

- Stuck with poor peers?
- Optimistic unchoking
  - upload to other peers as well
    - rotate every 30 seconds
  - hope to get better download
  - also help bootstrap other peers
- Seed's unchoking
  - seed does not download from other peers
  - try to equally distribute its upload to leechers
  - or upload to the one downloads fastest

Peer wire protocol

- Messages over TCP
  - handshake
  - keep-alive
  - choke/unchoke
  - interested/not-interested
    - a block is downloaded if the client is interested and unchoked
    - a block is uploaded if the peer is interested and unchoked
  - have
    - advertise new pieces
  - request/piece
    - request blocks in a piece

Piece selection

- Initially, a few random pieces
  - anything is better than nothing
  - easy to find at the beginning
- Then, rarest-first in neighborhood
  - become less dependent on seed
  - more interested by peers
- Finally, “end game” mode
  - look for missing pieces aggressively
  - send requests to all peers
  - cancel requests after last pieces are collected

This lecture

- BitTorrent
  - P2P swarming
  - protocol overview
- Explore further
  - measurement-based modeling
  - measurement-based performance analysis
  - BitTorrent extensions
    - http://wiki.theory.org/BitTorrentSpecification

Liu, Y. and J. Pan, "The impact of NAT on BitTorrent-like P2P systems," in Proc 9th IEEE International Conference on Peer-to-Peer Computing (P2P'09), Seattle, WA, USA, Sept 8-11, 2009.