Content Distribution

CS 257/457
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Content Distribution

Files/News/Software Distribution on Demand

- Content distribution:
  - Popular web sites like Yahoo;
  - Breaking news from CNN;
  - Microsoft is distributing a new version of Windows online;
  - All downloading from a central content site creates performance problems.

- The main question:
  - How to get popular content to millions of users through the public Internet with limited bandwidth?

Your idea??

Means of Content Distribution

- By content providers, e.g. www.yahoo.com
  - replicated, distributed Internet sites
- By content consumers (or clients), e.g., UR
  - reduce bandwidth consumption of an organization through caching - Web caching
- By a third-party
  - content distribution network

Replicated Internet Sites

- Content providers build a set of distributed sites on the Internet.
- DNS answers the IP address of the site close to the client
- Is DNS caching a problem?
Web caches (proxy server)

- Cache is installed and shared by users (university, company, residential ISP)
- Goal: satisfy client requests without involving the original server.
- User sets browser: accesses via Web cache
- Browser sends all HTTP requests to Web cache
  - Object in cache: cache returns object
  - Otherwise cache requests object from the original server, then returns object to client

A Quantitative Study: the Base Case

Assumptions
- 1.5Mbps wide-area access link, 10Mbps local-area network
- Wide-area delay 2 seconds, local-area delay 10 milliseconds

Performance
- Effective bandwidth to wide-area content: 1.5Mbps
- Average access delay = Internet delay + LAN delay = 2.01 seconds

A Quantitative Study: Upgrading the Access Link

Upgrading the access link
- Increase bandwidth of access link to, say, 10Mbps

Performance
- Effective bandwidth to wide-area content = 10Mbps
- Average access delay = Internet delay + LAN delay = 2.01 seconds

A Quantitative Study: Web Caching

Install a Web cache
- Suppose hit rate is 50%

Performance
- Effective bandwidth to wide-area content = 3.0Mbps
- Average access delay = Cache miss delay * 50% + Cache hit delay * 50%
  = 2.02 * 50% + 0.01 * 50%
  = 1.015 seconds

Not bad! But it is costly to upgrade the access link.

Not only higher bandwidth without upgrading access link, but also shorter access delay.
More on Web Caching

- Advantages of Web caching:
  - reduce traffic on an institution's access link.
  - reduce average access delay for client requests.
  - very scalable
  - Internet dense with caches enables "poor" content providers to effectively deliver content
- Is the cached page up-to-date?
  - using If-modified-since HTTP header.
  - heuristics: remove pages that are too old.
- Any other problems brought by caching?

Cooperative Web Caching

- A number of nearby caches (each from a UR department) cooperate with each other.
- **Key**: maintaining up-to-date information about each other's cache content.
- How??

Distribution through a third party - Content Distribution Network

- Motivation: limited scale for replication by content providers; lose control of content by caching
- CDN is a service: content providers are the CDN customers.
- CDN company installs hundreds of CDN servers throughout Internet
- CDN replicates its customers' content in CDN servers. When provider updates content, CDN updates servers

CDN in Action

- HTTP request for www.yahoo.com with embedded image www.cdn.com/yahoo/sports.gif
- DNS query for www.cdn.com
- HTTP request for www.cdn.com/yahoo/sports.gif
- CDN's authoritative DNS server
- CDN company replicates content at CDN servers
- uses its authoritative DNS server to redirect requests to a nearby CDN server
Determining Nearby CDN Server

- CDN creates a "map", indicating distances between ISPs and CDN nodes
- When a DNS query arrives at authoritative DNS server:
  - server determines ISP from which query originates
  - uses "map" to determine a nearby CDN server
- How to build the map?

Summary

- Three means:
  - By content providers - replicated, distributed Internet sites
  - By content consumers (or clients) - Web caching
  - By a third-party - content distribution network
- Rank them on the following:
  - Scalability
  - Content staleness
  - Transparency to clients
  - Reliance on the Domain Name System