Web Performance Acceleration

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Web Performance

- Web performance problems with popular content at a central site:
  - Limited bandwidth at the central site;
  - Many users are far away from the central site.

Means of Web Acceleration

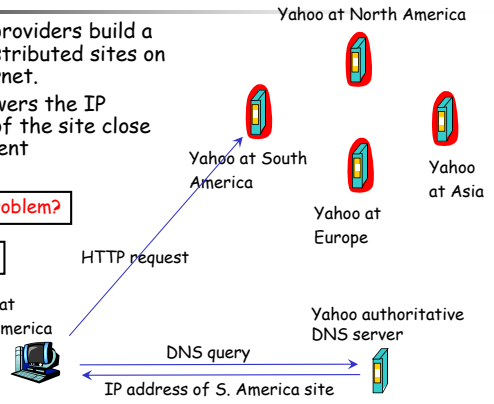
- By content providers, e.g., www.yahoo.com
  - replicated, distributed Internet sites
- By content consumers (or clients)
  - Web caching
  - Web prefetching
- By a third-party
  - content distribution network

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?

limited scale!



Determining Nearby Content Server

- We create a "map", indicating distances between Internet machines (or networks) and content servers
- When a DNS query arrives at authoritative DNS server:
  - server determines network from which query originates
  - uses "map" to determine a nearby content server
- How to build the map?
  - offline pings from content servers to all networks
  - just-in-time pings from content servers to the source
- What if the source does not respond to pings?

A Related Question

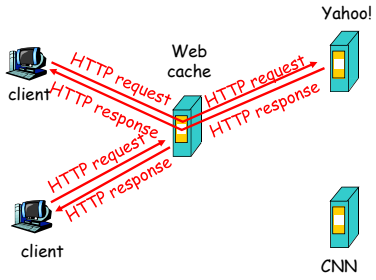
- Scalable estimation of node-to-node relative proximity
  - A specific problem: given any node X, find a few nearby nodes in a group of 10,000 nodes (N_1, …, N_{10000}).
  - Too costly to measure the distance from X to 10,000 nodes.
- Use a landmark L:
  - Measure the distances from N_1, …, N_{10000} to L offline.
  - Given node X, we measure the distance from X to L.
    - For node N, if distance(X,L) differs significantly from distance(N,L), X and N are likely far apart.
    - If distance(X,L) is similar to distance(N,L), does it mean X and N are nearby?
- Use multiple landmarks

Another Related Question

- How to build a map indicating the geographical location of machines or local networks?

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

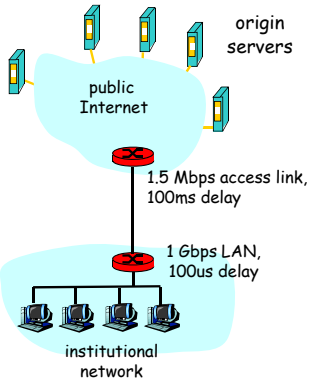
Assumptions

- 1.5Mbps wide-area access link, 1Gbps local-area network
- wide-area delay 100 millisecs, local-area delay 100 microsecs

Performance

- bandwidth to wide-area content – 1.5Mbps
- average access delay
  = Internet delay + LAN delay
  = 100.1 millisecs

Upgrade the access link is costly, doesn't help the access delay.



A Quantitative Study: Web Caching

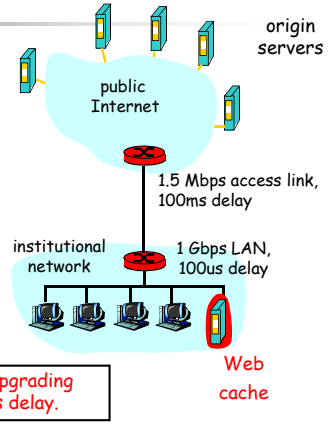
Install a Web cache

- 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%
  = 100.2 * 50% + 0.1 * 50%
  = 50.15 millisecs

Not only higher bandwidth without upgrading access link, but also shorter access delay.



Cooperating Web Caching

- Caching cooperation
  - Several caches (often nearby) cooperate with each other
  - Benefits: more cache hits; less load on original servers
- Probing all caches at each access is too costly
- Challenge: knowing (roughly) each other's cache content
  - Each cache periodically broadcast its content to other caches

Cache Content Staleness

- Content providers lose direct control of cache content
  - retain some control through cached content staleness
- Is the cached page up-to-date?
  - using `If-modified-since` HTTP header.
  - removing pages that are too old.

Mining of Cache Logs

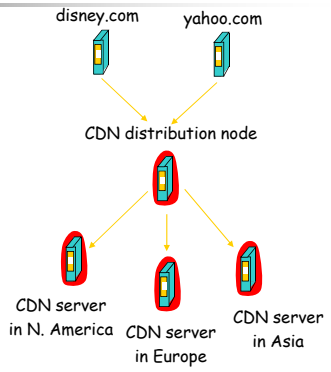
- Web cache logs contain a wealth of information
  - List of who accessed what at when
- User privacy
- Aggregate statistics
  - Most popular web objects, distribution of web object popularity
  - General user access models (think time between accesses, pattern of page browsing sequence, …)
  - …

Web Prefetching

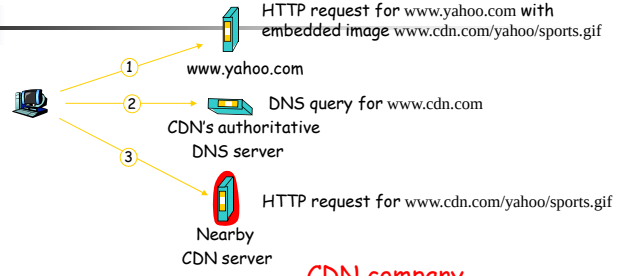
- Prefetch a web page before client makes access
  - Save latency, but not bandwidth
- Prefetching heuristics?
  - Hyperlinks in the current page (assume client may click some of them)
  - Predict future accesses based on past browsing history
- Benefit vs. cost

Content Distribution Network

- Motivation:
  - limited scale for replication by content providers
  - lose control of content by caching
- Content distribution network:
  - hundreds of CDN servers throughout Internet
  - content providers' content replicated on CDN servers
- Goals:
  - transparent to clients
  - content providers retain primary control



CDN in Action

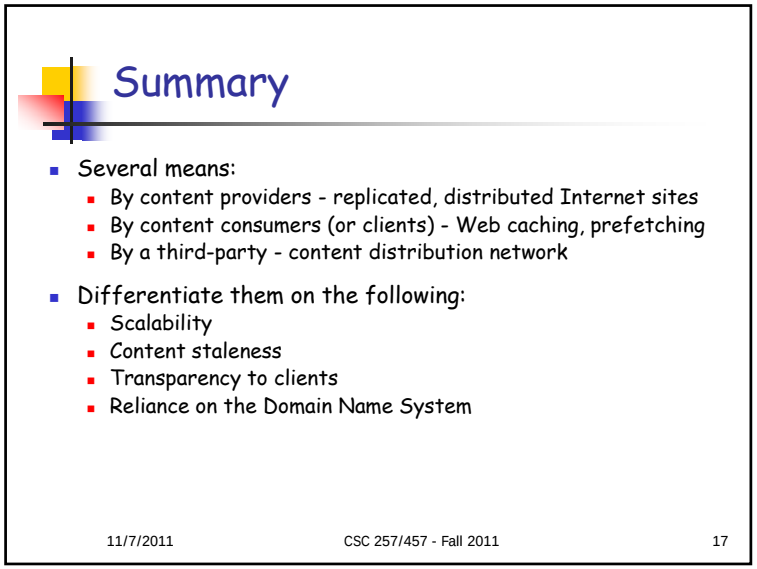


Content provider

- www.yahoo.com
- Replaces www.yahoo.com/sports.gif with www.cdn.com/yahoo/sports.gif

CDN company

- replicates content at CDN servers
- uses its authoritative DNS server to redirect requests to a nearby CND server


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