

# Content Distribution

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# 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:
  - Limited bandwidth at the central site;
  - Many users are far away from the central site.

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# Means of Content Distribution

- By content providers, e.g., [www.yahoo.com](http://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

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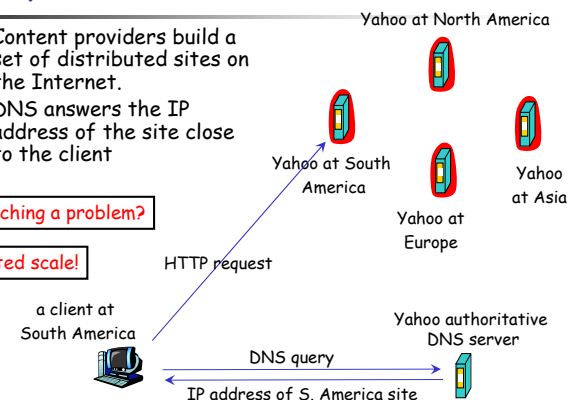
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# Replicated Internet Sites

- 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!



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## Determining Nearby Content Server

- We create a "map", indicating distances between machines (or local 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 potential sources
  - just-in-time pings from content servers to the source
- What if the source does not respond to pings?

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## 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 ( $N_1, \dots, N_{10000}$ ).
  - Too costly to measure the distance from X to 10,000 nodes.
- Use a landmark L:
  - Measure the distance from  $N_1, \dots, N_{10000}$  to L offline.
  - Given node X, we measure the distance from X to L.
    - For node N, if  $\text{distance}(X,L)$  differs significantly from  $\text{distance}(N,L)$ , X and N are likely far apart.
    - So we prefer nodes whose distances to L are similar to  $\text{distance}(X,L)$ .
- Use multiple landmarks

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## Another Related Question

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

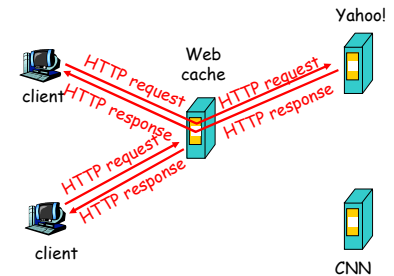
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## Web caches (proxy server)

- 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



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## A Quantitative Study: the Base Case

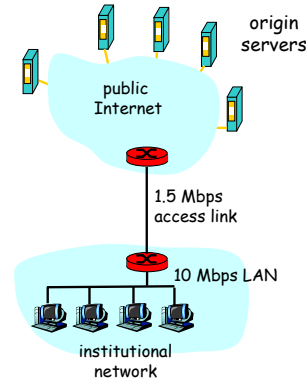
### Assumptions

- 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

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



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## A Quantitative Study: Web Caching

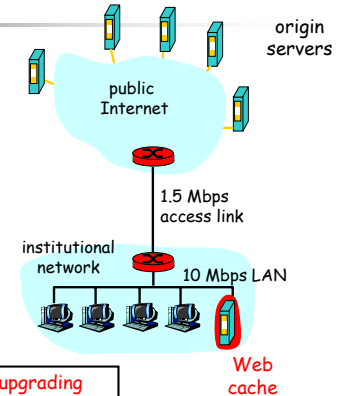
### Install a Web cache

- 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 only higher bandwidth without upgrading access link, but also shorter access delay.



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## More on Web Caching

- Content providers lose direct control of content
- Is the cached page up-to-date?
  - using If-modified-since HTTP header.
  - removing pages that are too old.
- Cooperative web caching
  - A number of nearby caches (each from a UR department) cooperate with each other.
  - Key:** knowing each other's cache content.

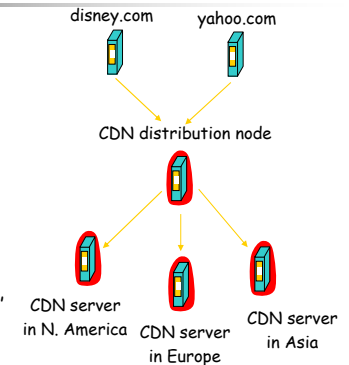
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## Content Distribution Network

- 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

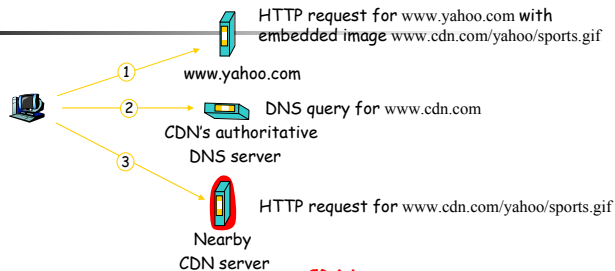


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## CDN in Action



### 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 CDN server

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## Summary

- Three means:
  - By content providers - replicated, distributed Internet sites
  - By content consumers (or clients) - Web caching
  - 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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