Internet and Intranet Protocols and Applications

# Lecture 8a: WWW Proxy Servers and Cookies

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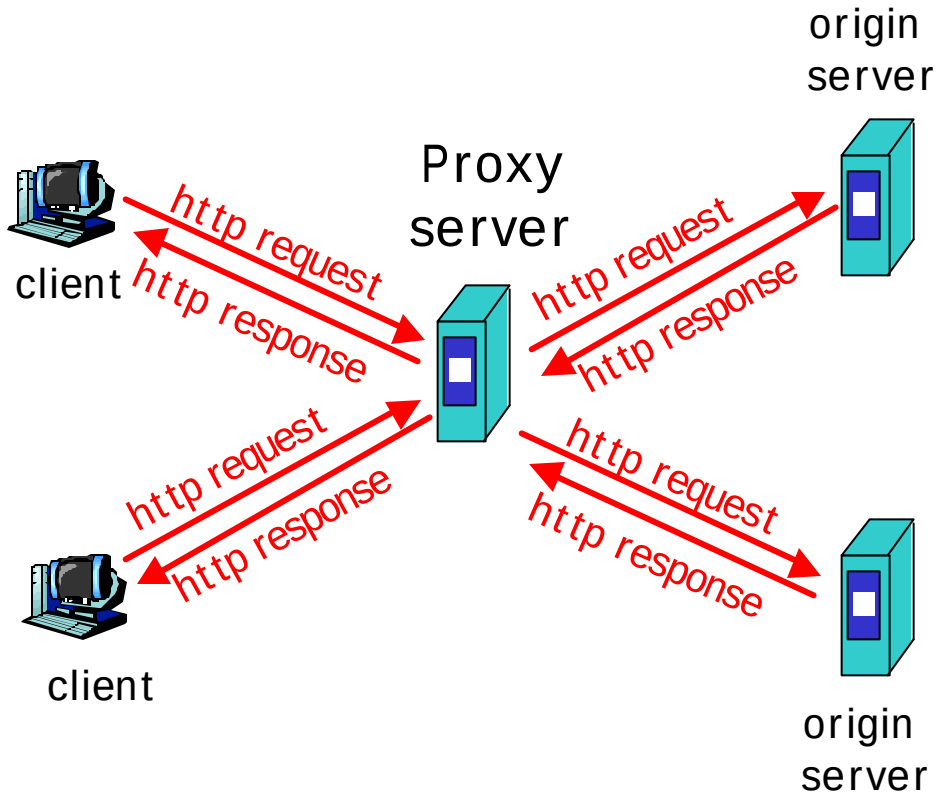
# Terminology

- **Origin Server**
  - The Web server that hosts the resource
- **Proxy Server**
  - Intermediate server that accepts requests from clients and forwards them to (towards) origin servers, to other proxy servers, or services request from its cache.
  - Acts as server to requesting client, and as client to origin server

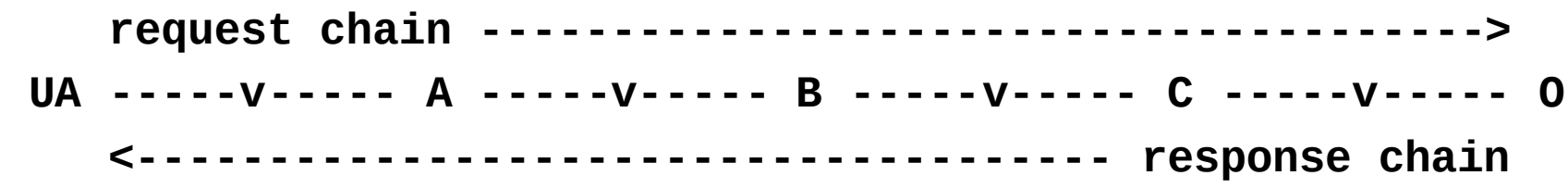
# Web Caches (proxy server)

Goal: satisfy client request without involving origin server

- configure browser: Web accesses via web cache
- client sends all http requests to web cache
  - if object at web cache, web cache immediately returns object in http response
  - else requests object from origin server, then returns http response to client



# Figure from RFC 2616

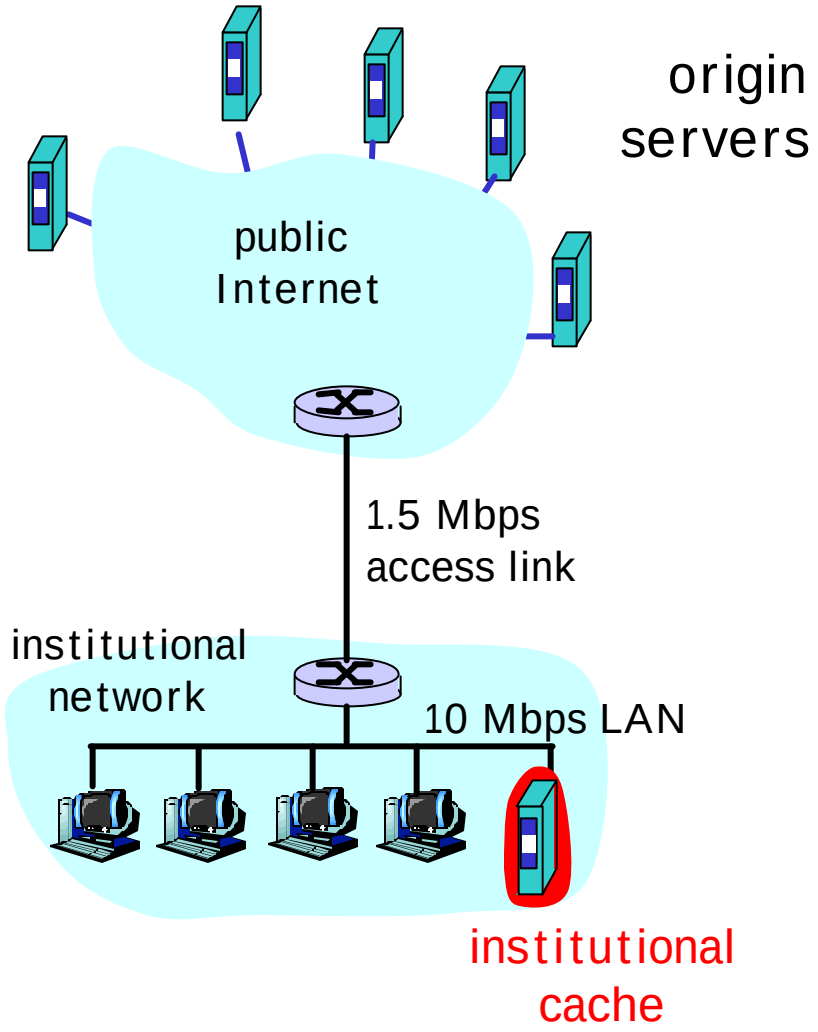



The figure above shows three intermediaries (A, B, and C) between the user agent (UA) and origin server (O).

# Why Web Caching?

Assume: cache is "close" to client

- smaller response time
- decrease traffic to distant servers
  - link out of institutional/local ISP network is often a bottleneck



# Web Caching Summary

- Web proxy Servers store copies of documents retrieved from origin servers
- Advantages
  - **Improve performance** (latency reduction, bandwidth conservation)
  - **Advanced access control** (intermediate requester in firewalled DMZ, authentication & authorization)
  - **Advanced filtering** (e.g. detect espionage!)
  - **Logging and auditing**
- Disadvantages
  - Recognizing and avoiding stale (out of date) data

# **Proxy Server:** *Basic Operation*

- Accept connection request from client
  - establishes new Socket client_sock
- Read HTTP request
- Parse HTTP request
  - reject invalid requests with appropriate response code
  - Request is REQUIRED to be in absoluteURI form
    - (see RFC 2396)
- Connect to (towards) requested server
  - establishes new socket serv_sock
- Send original HTTP request to server
  - or to next proxy on path to server

# **Proxy Server:** *Basic Operation (continued)*

- Read response from Server
  - If time-out server connection, then issue
  - `504 Gateway Timeout`
- Copy object in response to cache, if allowed
- Send response to client
- If **`Connection: close`** header received, close client connection (client_sock)
- What about server connection (serv_sock)?

# HTTP 1.1 Cache Control Directives

- Control an object's "cacheability"
  - RFC 2616 Section 14.9
- Examples
  - ***Cache-Control:*** general header is used to specify directives that **MUST** be obeyed by **ALL** proxy servers handling the request or response.
  - Directives used in Requests

    ***no-cache*** an end-to-end revalidation should be preformed

    ***no-store*** sensitive information: do not store any part of request or response on disk

    ***max-age=<delta-seconds>*** max age acceptable to client

# Cache Control Directives (cont.)

- Directives used in responses

  ***public*** response is cacheable by any cache (proxy or client)

  ***private*** response is cacheable by client only

  ***no-cache*** cache MUST NOT use the response to satisfy a subsequent request (for example, dynamic pages)

  ***no-store*** response may not be written to disk

# **Proxy Server:** *Using Cached Objects*

```
Parse HTTP request
look for the URL in the cache
if (object is found) then
   if (fresh) then
      send response to client with the object
   else
      // validation, see below
   end_if
 end_if
```

# **Proxy Server:** *Validate a Stale Object*

Proxy:

```
Forward ‘conditional’ request towards server with
an “If-Modified-Since” header with the object’s
modification date
```

Server:

```
If (the object has been modified since the If-
Modified-Since date) then
   return the object in the response
Else (the object has not been modified)
  return a 304 (Not Modified) response
```

Proxy:

```
If( receives 304) then send object from cache
If( receives new object) then cache and send it,
```

Avoids

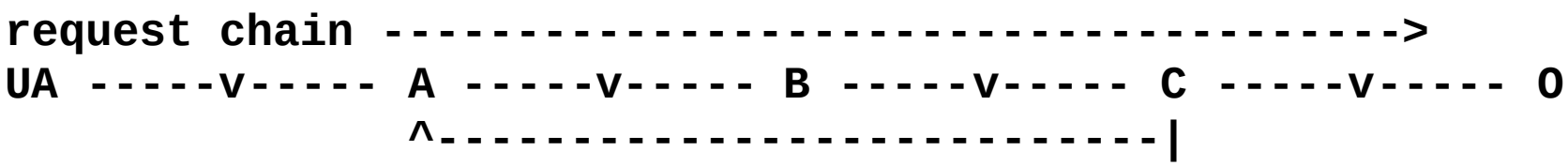
– transmitting the full response if the object is current

– an extra round trip if the object is stale

## **Proxy Server:** *Validate a Stale Object, cont.*

- Validation
  - More general that ‘creation date’ and ‘If-Modified-Mince’
- Includes
  - Expires date
  - Age allowed
  - Heuristic expiration times
- Quite complex—see 13.2 of 2616

# Request Loops




- ... to avoid request loops, a proxy MUST be able to recognize all of its server names, including any aliases, local variations, and the numeric IP address.

# Cache Architectures

- Components of a Web proxy cache
  - Network communications
  - Storage mechanism for storing the cache data
  - Mapping mechanism to establish relationship between URLs and their cached copies
  - Format for cached object content and its metadata

# **Cache Architecture**: mapping

- Direct mapping
  - e.g, map URL to a file system path
  - direct mappings are reversible
- Hash mapping
  - compute some unique ID
  - could be file name or index to table
  - not reversible

# Existing Mapping Mechanisms

- Directly mapping URLs to filesystem
  - Original CERN httpd used a tree map
  - Easy to implement, but not a good performer
    - long pathnames = long inode search
    - garbage collection requires complete traversal of tree

# Existing Mapping Mechanisms

- Hashing URLs
  - Netscape Proxy server
- Object location (on disk) based on MD5 hash
  - very fast
  - good distribution of different object types (image, text) across cache
  - disadvantage: cannot compute URLs from hash

# Alternative Cache Protocols

- **On-Demand**
  - document does not exist in cache unless it has been requested (at least once) by some client
- **On-Command, or Pre-Fetch**
  - proxy server automatically retrieves documents (or even entire web sites!) at regular intervals

# General Purpose Proxy Servers

- **Transparency**
  - users get same response whether connection was direct or to proxy (a non-transparent proxy modifies content in some way)
- **Use is client controlled**
  - client programs (e.g., browsers) can be configured to use (or not use) proxy servers.
- **Origin Server is unaware of proxy server**
  - Origin Server does not have to process request from proxy differently than from other client
- **Example protocols**
  - Ftp, ssh, socks, telnet, SMTP
- **Typical Location**
  - Firewalled DMZ

# Other Intermediate Systems

- **Firewall**
  - General term for hardware, software, or combination used to protect internal network from intruders.
  - Uses packet filtering to enforce generic security policies
  - Uses application level proxy servers to enforce protocol-specific polices
- **Packet filter**
  - Control based on something in packet headers (e.g., IP addresses or port numbers)
- **Application level proxy**
  - Control based on knowledge of application level protocol (.e.g, SMTP headers or HTTP methods)

# HTTP State Management: Cookies

- We said earlier that HTTP is a stateless protocol
- We also said that stateful protocols can provide improved performance. This feature is usually established by the idea of a “session” between client and server.
- So, cookies enable HTTP sessions

# Cookies

- Cookie protocol - RFC 2109
- A cookie is a token given to a client by a server
  - Server sends *Set-cookie:* <*cookie*> header in a response
  - Client associates <*cookie*> with the server that sent it
- The *cookie* a sequence of name/value pairs
- Each cookie has a unique name

# Cookie Fields

- NAME=VALUE
  - REQUIRED. The name of the "cookie" is NAME, and its value is VALUE.
- Domain=value
  - OPTIONAL. The Domain attribute specifies the domain for which the cookie is valid.
- Path=value OPTIONAL.
  - The Path attribute specifies the subset of URLs on the origin server to which this cookie applies.
- Secure
  - OPTIONAL. The Secure attribute directs the user agent to use only secure means to contact the origin server whenever it sends back this cookie.
- Version=value
  - REQUIRED. The Version attribute identifies the version of the state management specification to which the cookie conforms.

# Example Cookies

| Origin server domain name | Path | Secure | Name | Value |
|---|---|---|---|---|
| .google.com | / | FALSE | PREF | ID=3e9b22dc195e9901:LD=en:NR=50:<br>TM=1027083506:LM=1061947174<br>:S=SOI90sazZHxYdFy4 |
| .intellicast.com | / | FALSE | RMID | 426cdd9b3ed8ad10 |
| smallbusiness.yahoo.com | /webhosting/ | FALSE | bmcPromoCode | 1 |
| 12.46.120.19 | / | FALSE | HASBRO_ID | 66.108.222.128-70824240.29582435:<br>:863790A4DC04E40567FF2D0CF4145723 |

# Client-server Interaction: Cookies

- server sends “cookie” to client in response message

  **`Set-cookie: 1678453`**
- client presents cookie in later requests

  **`Cookie: 1678453`**
- server matches presented-cookie with server-stored info
  - authentication
  - remembering user preferences, previous choices