The Hyper-Text Transfer Protocol (HTTP)

Lecture given by Emmanuel Lochin

ISAE-SUPAERO

Original slides from A. Carzaniga (Univ. Lugano)
Extended/modified by E. Lochin (ISAE-SUPAERO) with author permission

Textbook Chap. #2 Sections 2.2.4 to 2.2.6

Outline

Anatomy of a Request

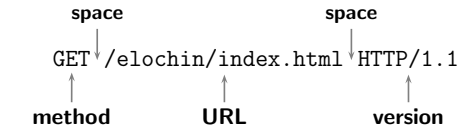
`GET /elochin/index.html HTTP/1.1`	request line

`Host: www.isae.fr`
`Connection: close`
`User-agent: Mozilla/4.0`
`Accept-Language: fr`
	zero or more header lines

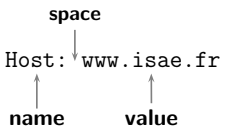
	empty line
	object body (possibly empty)

Anatomy of a Request (2)

- Request line



- Header line



- Line terminator : **CRLF** ("carriage return" and "line feed")
  - two bytes : numeric values 13 and 10

Methods

GET retrieve the object identified by the URL

OPTIONS requests the available communication options for the given object

HEAD like `GET`, but without the body
- useful for testing the validity of links

POST allows one to submit data to the server
- e.g., a mail message in a web mail system, a form in an e-commerce site...
- the given URL is the object that **handles** the posting

PUT requests that the enclosed object be stored under the given URL

DELETE deletes the given object

TRACE see RFC 2616, Section 9.8

CONNECT see RFC 2616, Section 9.8

Anatomy of a Response

`HTTP/1.1 200 Document Follows`	status line

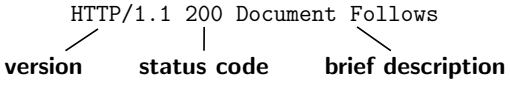
`Date: Fri, 18 Mar 2005 01:18:04 GMT`
`Server: Apache/2.0.46 (Red Hat)`
`Allow: GET,HEAD,POST,OPTIONS,TRACE`
`Content-Length: 329`
`Connection: close`
`Content-Type: text/html`
	zero or more header lines

	empty line

`<html><head>`
`<title>Emmanuel Lochin</title>`
`</head><body>`
`...`
	object body (possibly empty)

Anatomy of a Response

- Status line



- The **status code** is a 3-digit value (e.g., 200 or 401)
- The rest has exactly the same structure as a request

Status Codes

1*xx* "informational" (see Section 10.1 of RFC 2616)

2*xx* successful operation (see Section 10.2 of RFC 2616)

3*xx* redirection. E.g., indicates that the object has moved, either temporarily or permanently

4*xx* client error. E.g., malformed request (400), object not found (404), method not allowed (405), unauthorized (401).

5*xx* server error. E.g., internal server error (500), service overloaded (503)

Headers

- Object characterization
  - e.g., `Content-Type`, `Content-Length`, `Content-Encoding`
- Content negotiation
  - e.g., `Accept-Charset`, `Accept-Encoding`
- Object properties useful for cache management
  - e.g., `Expires`, `Last-Modified`, `ETag`
- Explicit cache control
  - e.g., `Cache-Control`
- Method-specific responses
  - e.g., `Allow` as a response to `OPTIONS`
- Authorization/identification
  - e.g., `Authorization`

Web Caching

- Same idea as caching in a memory hierarchy

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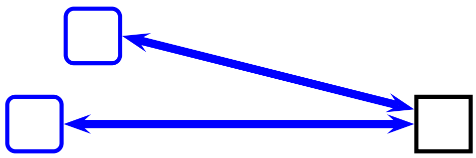

Web Caching

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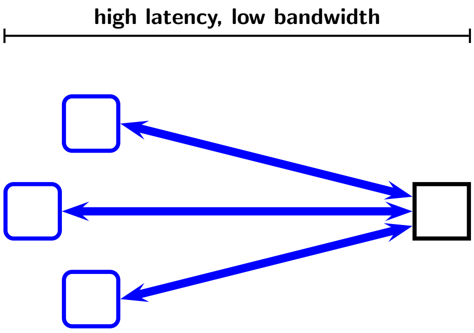

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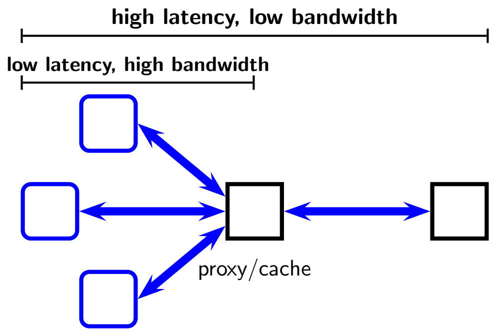

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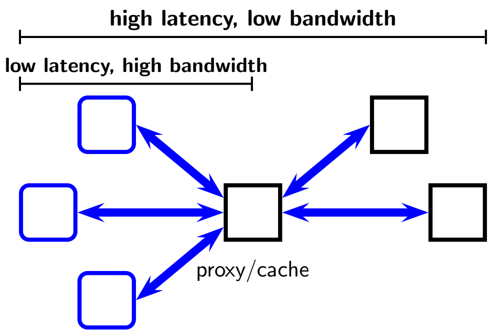

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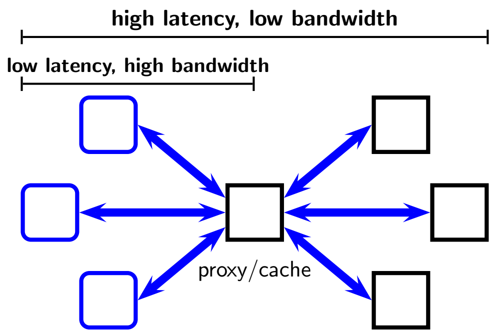

Example

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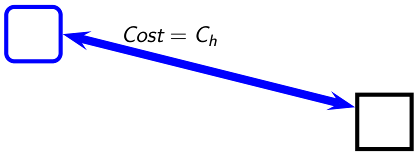

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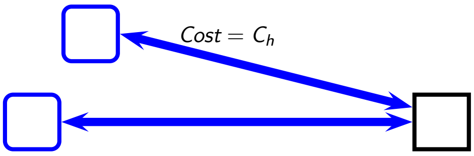

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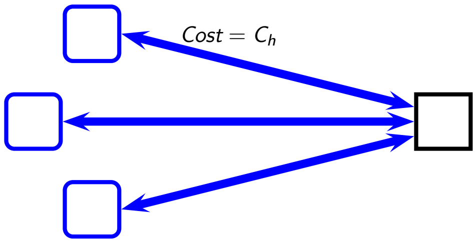
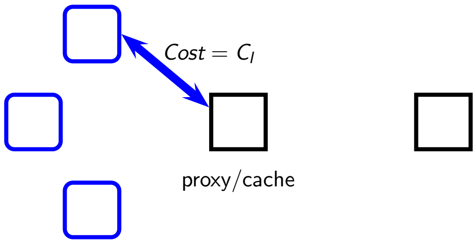


Example

- Without proxy/cache : *total cost* $= 3C_h$

Example



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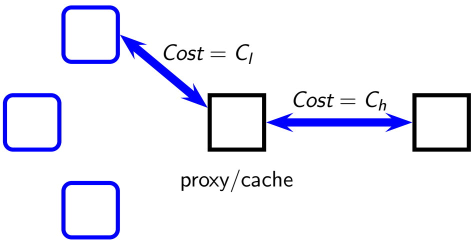

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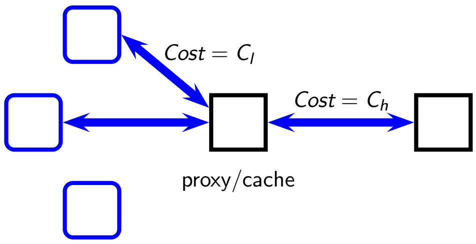

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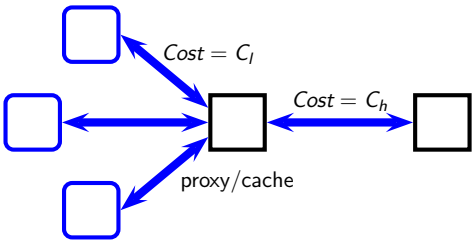

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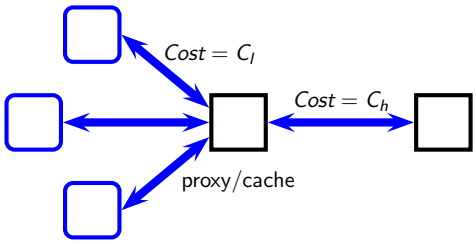

- Without proxy/cache : *total cost* = $3C_h$
- With proxy/cache : *total cost* = $C_h + 3C_l$

Web Caching (2)

- A client request goes to a **proxy** (cache) server
- The proxy may
  1. forward the request to the **origin** server, thereby acting as a client
  2. get the response from the origin server
  3. possibly store (cache) the object
  4. forward the response back to the client
- The proxy may
  1. respond immediately to the client, possibly using a cached object

Web Caching (3)

- Benefits of the proxy/cache architecture
  - performance : reduced latency
  - performance : reduced network traffic
  - security : privacy, the server sees the proxy as a client
  - security : protection from intrusions, in combination with a firewall
- Problems
  - latency (just like any other caching system)
  - complexity

HTTP and Caching

- The proxy/cache architecture is central to several features of HTTP—in fact, **it affects its overall design**
- HTTP is defined as a request/response protocol, where requests and responses are explicitly passed through a request chain

HTTP and Caching (2)

- HTTP is defined as a request/response protocol, where requests and responses are explicitly passed through a request chain

- HTTP defines
  - how protocol versions are handled on the request chain
  - how each method must be handled w.r.t. the request chain
    - ⋆ e.g., responses to `OPTIONS` requests are not cacheable ; 302 responses are only cacheable if indicated by a `Cache-Control` or `Expires` header field
  - specific authentication mechanisms for proxies
  - a lot of headers to control caching along the request chain

HTTP and Caching (3)

- Cached pages may become obsolete
- A `HEAD` request could be used to see if an object has been updated, in which case the cache can be invalidated
  - but how does a proxy decide that it is okay to respond to a client with a cached object ?
- Servers specify explicit expiration times using either the `Expires` header, or the `max-age` directive of the `Cache-Control` header
- A client or proxy can use a **conditional** `GET` by including a `If-Modified-Since` header

`Cache-Control` in Requests

- ```
  GET /elochin/index.html HTTP/1.1
  Host: www.isae.fr
  Cache-Control: no-cache
  ```

  "Please, do not use cached objects !"
  - proxies must go to the origin server
- ```
  GET /elochin/index.html HTTP/1.1
  Host: www.isae.fr
  Cache-Control: max-age=20
  ```

  "Please, give me a cached object only if it is less than 20 seconds old"

`Cache-Control` in Replies

- ```
  HTTP/1.1 200 Ok
  Cache-Control: no-cache

  ...
  ```

  "Please, do not cache this objects !"

- ```
  HTTP/1.1 200 Ok
  Cache-Control: maxage=100; must-revalidate

  ...
  ```

  "You **may** use this object up to 100 seconds from now. After that, you **must** revalidate the object."

  - without the `must-revalidate` directive, a client may use a stale object

Sessions in HTTP

- HTTP is a stateless protocol
  - so how do you implement a "shopping cart" ?
- HTTP provides the means for higher-level applications to maintain **stateful sessions** (see RFC 2109)
- `Set-Cookie` header
  - sent within an HTTP response, from the server to the client
  - tells the client to store the given "cookie" as a session identifier for that site
- `Cookie` header
  - sent within an HTTP request, from the client to the server
  - tells the server that the request belongs to the given session

Example

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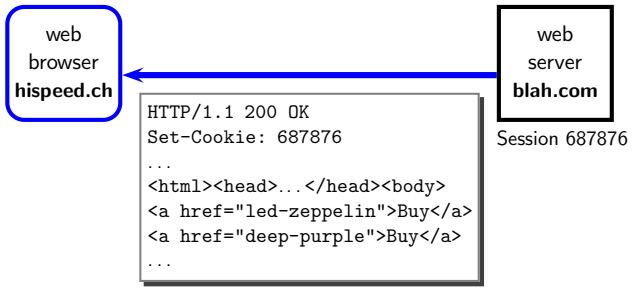

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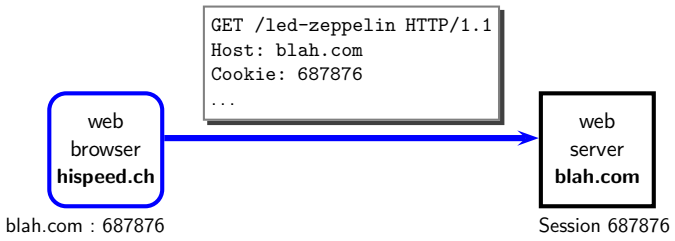

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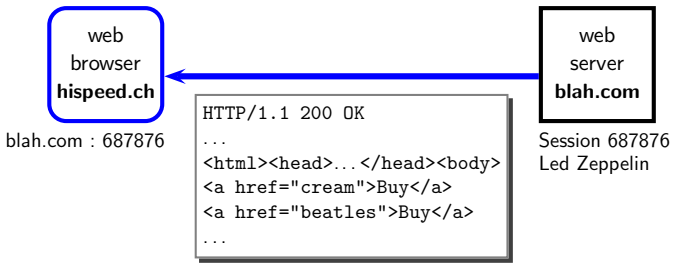

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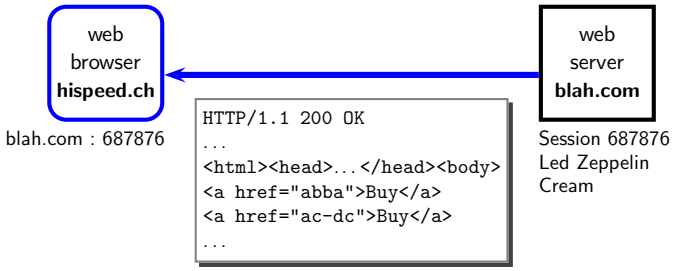

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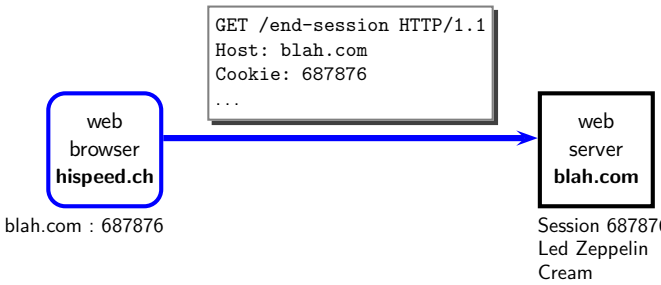

Example

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Cookies and User Privacy

- A "session" identifies the actions of a user
- Web sites may use cookies to compile and collect user profiles
  - and obviously they do exactly that !
- In our example, we can infer that user n. 687876...
  - likes rock-blues music from the sixties and seventies
  - lives in Switzerland
  - ...
- If user n. 687876 buys something on line with a credit card, then he or she would also be immediately indentified