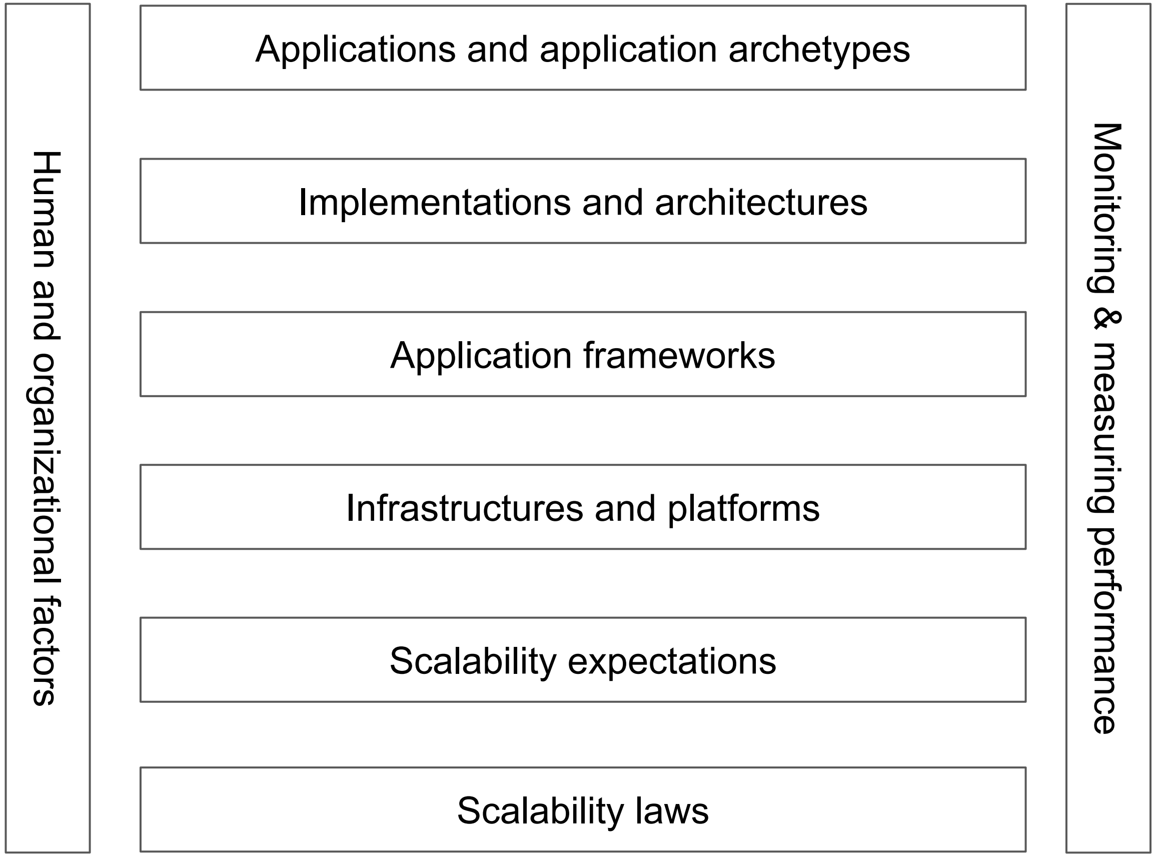
Designing and Building Scalable Web Applications

Lecture 2 / 31.10.2022

The Big Picture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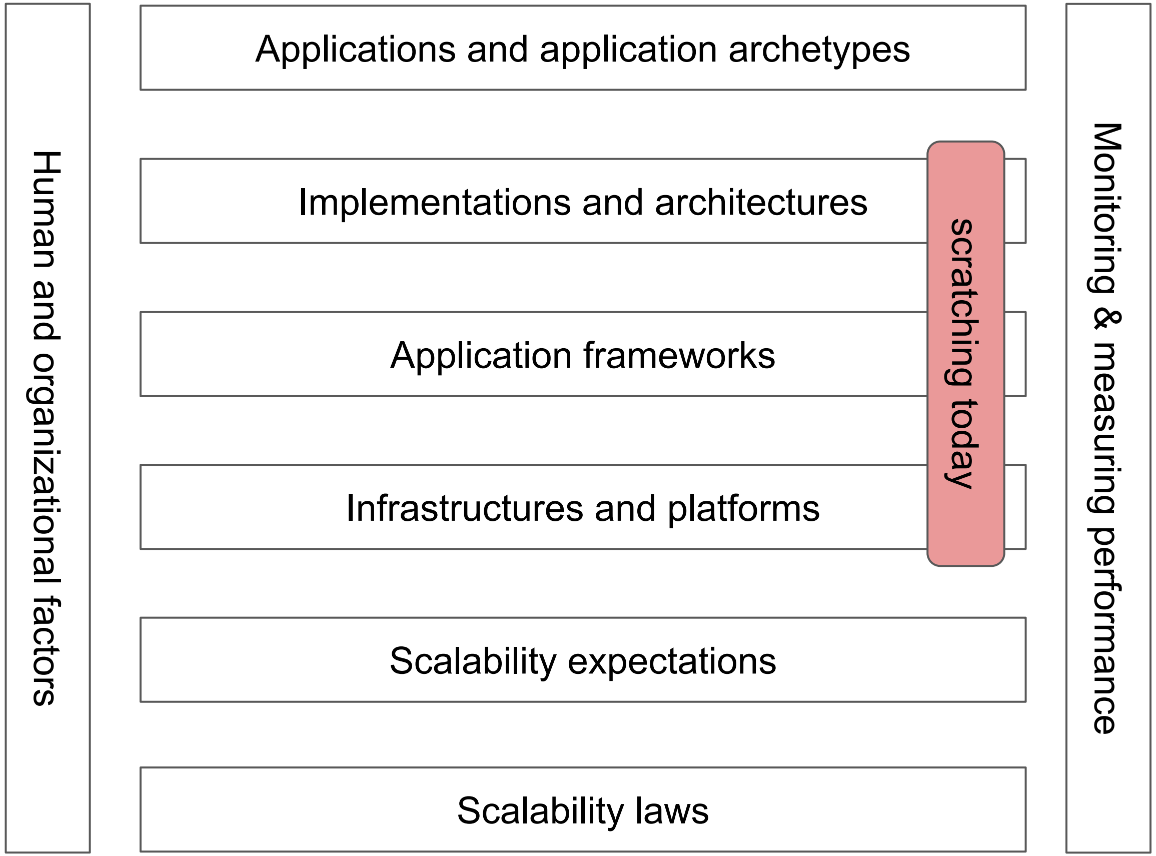
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Agenda

- Brief HTTP Refresher
- Caching and Content Delivery Networks
- Starting with Client-side Web Development

HTTP Refresher

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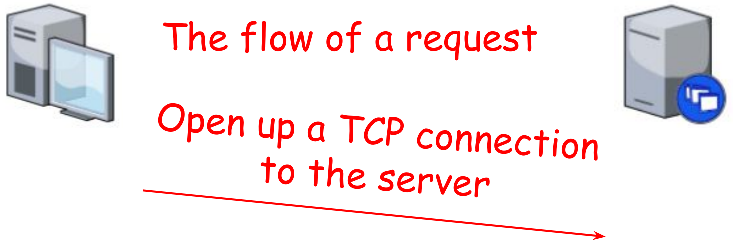

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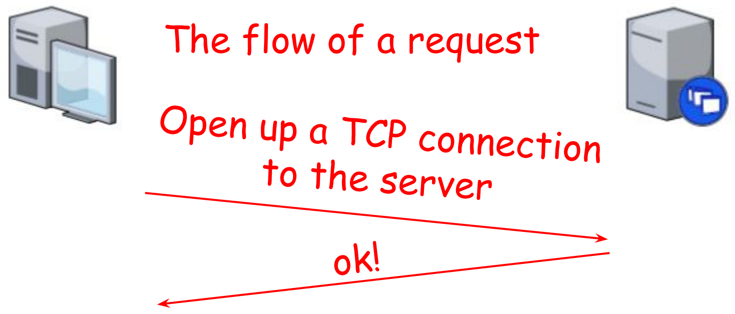

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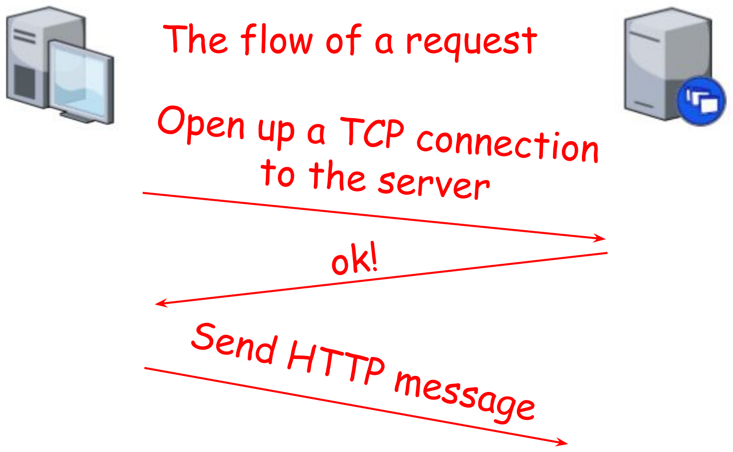

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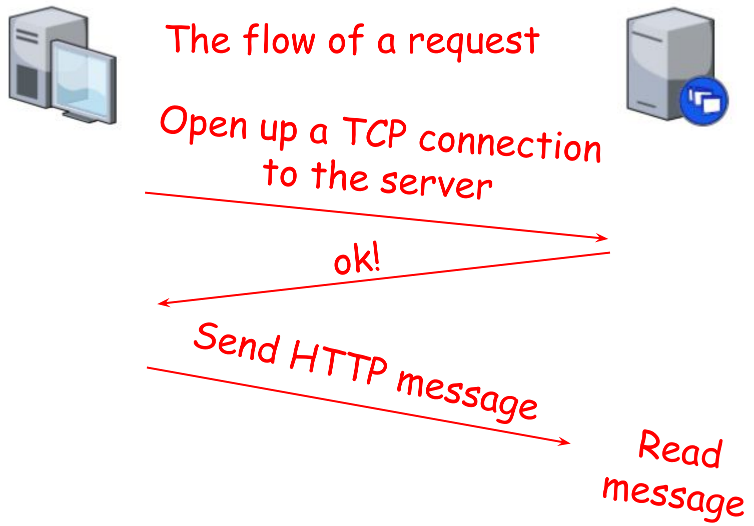

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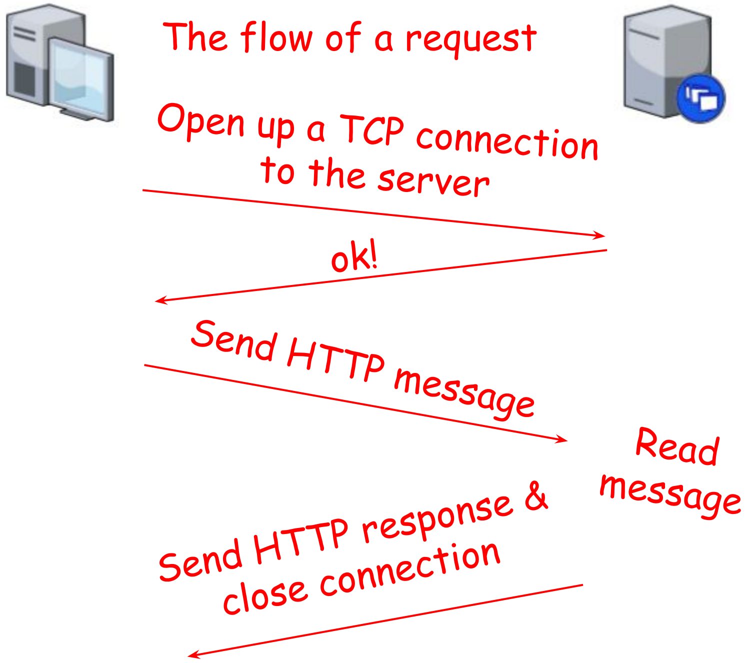

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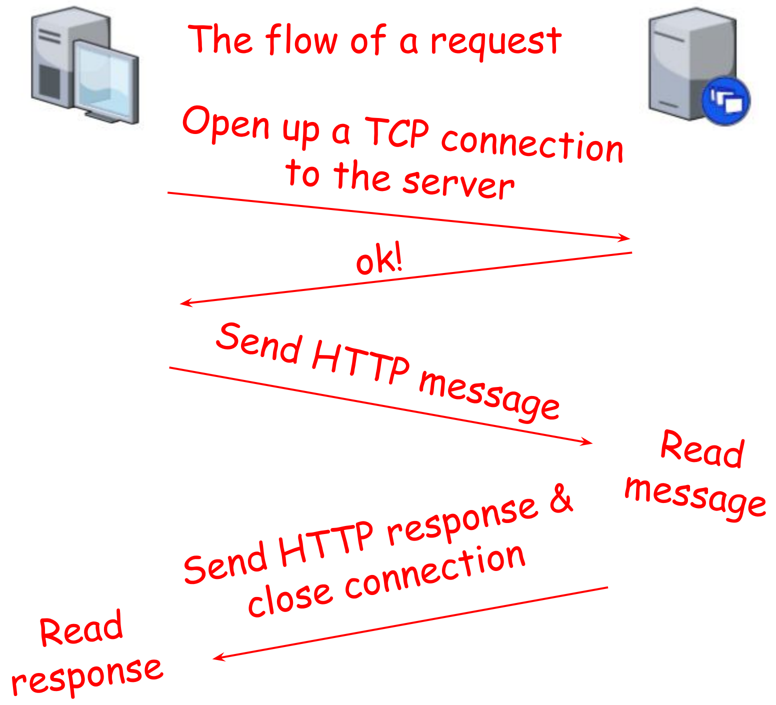

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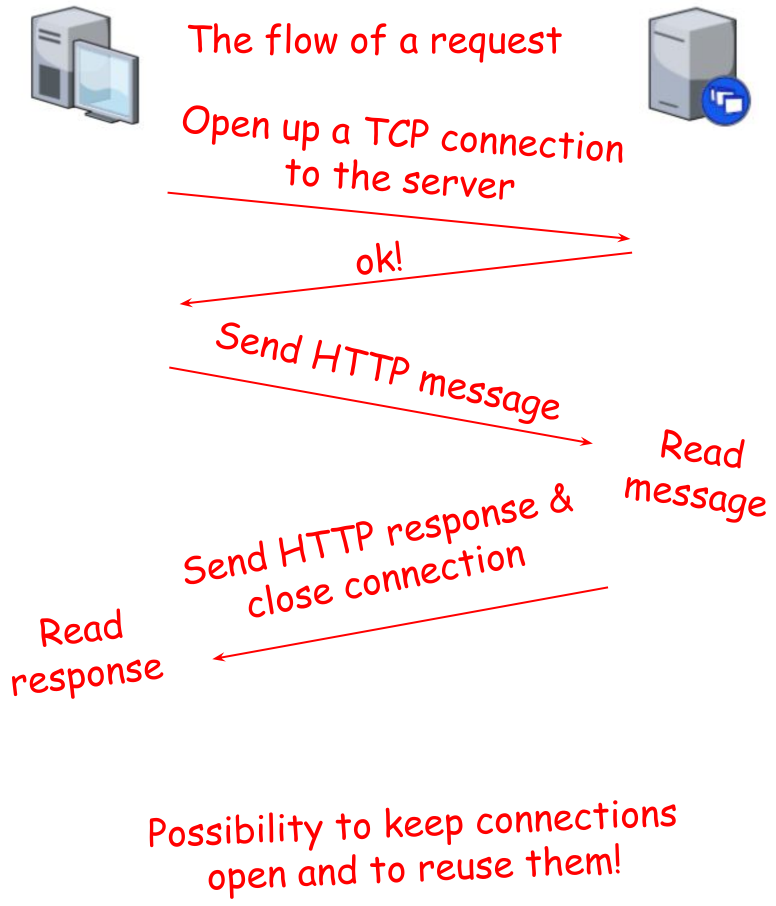
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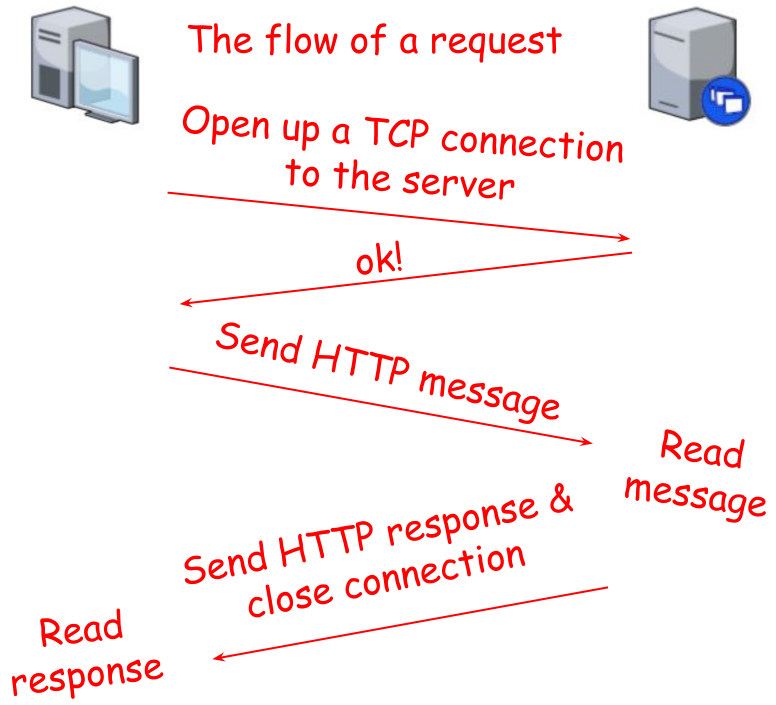
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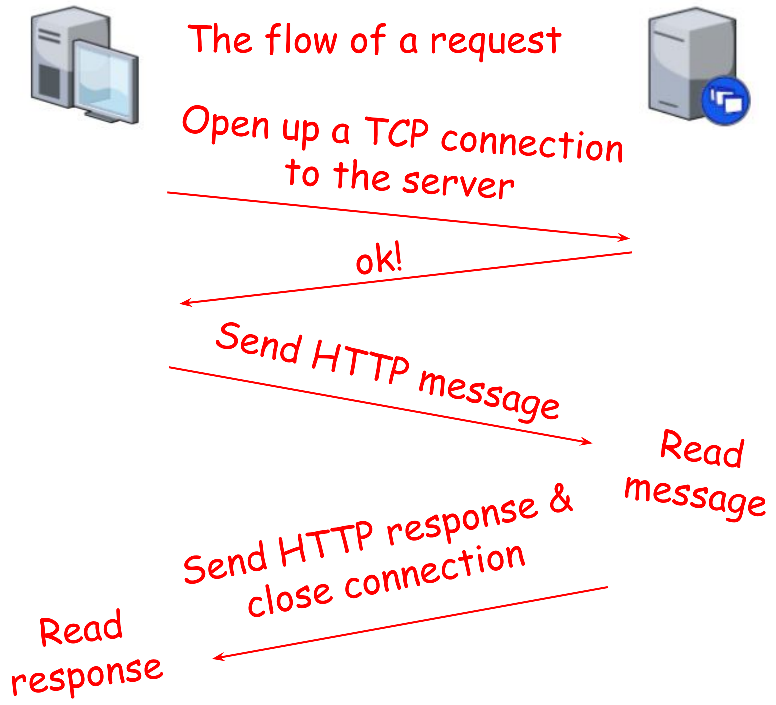
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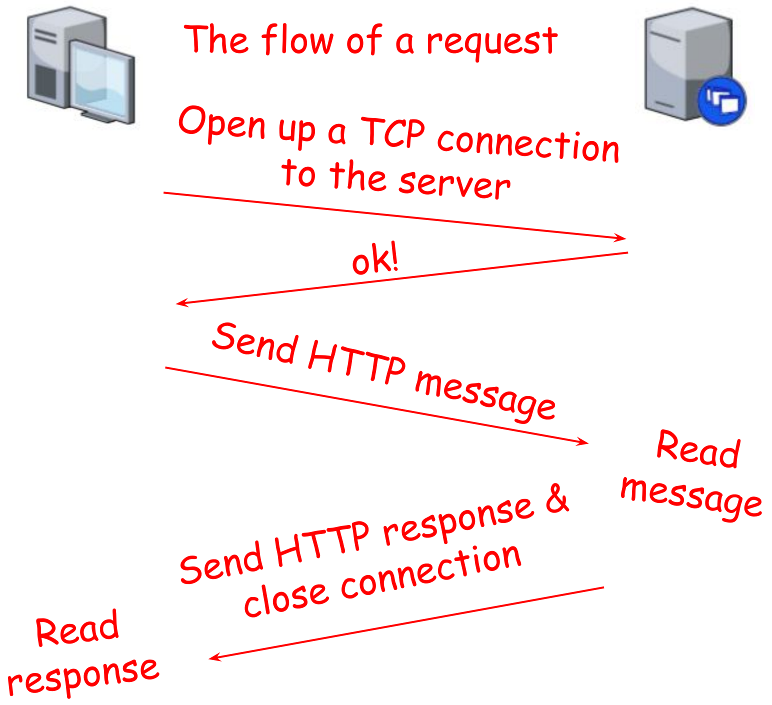
- Older RFC: Persistent connections to the server should be limited (no more than 2 connections per server).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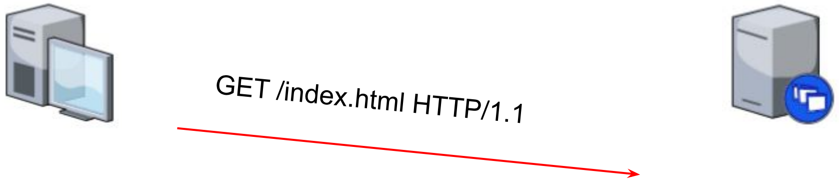

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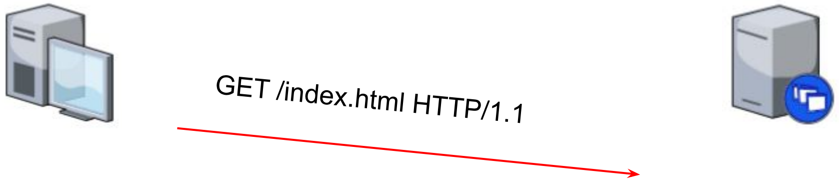

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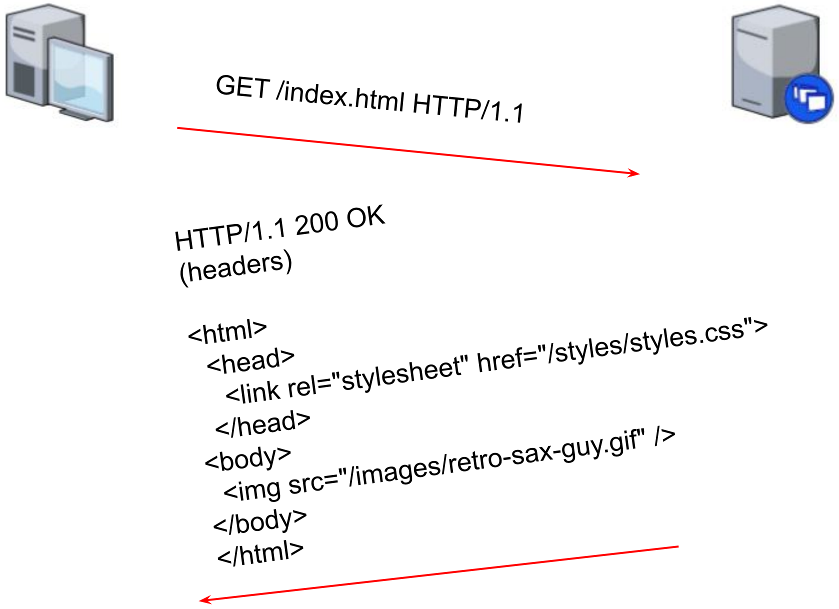

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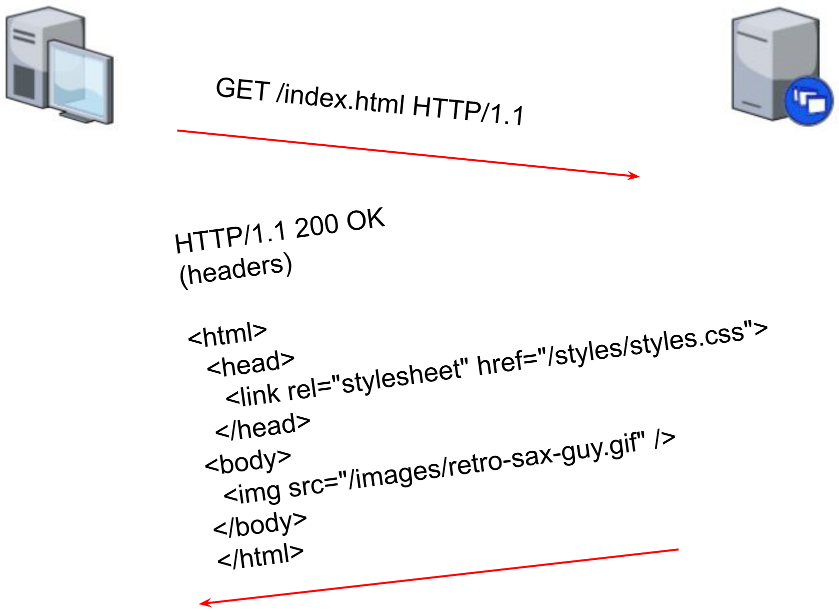

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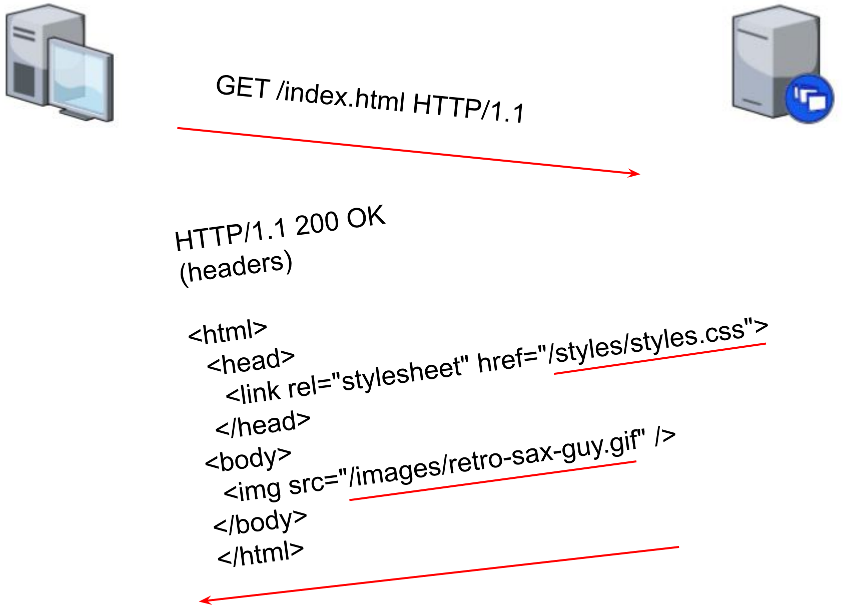

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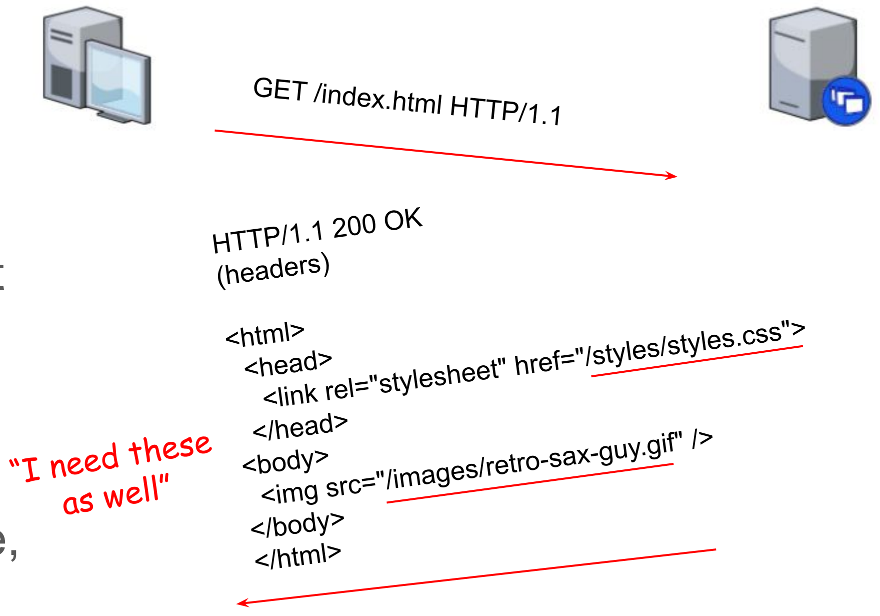

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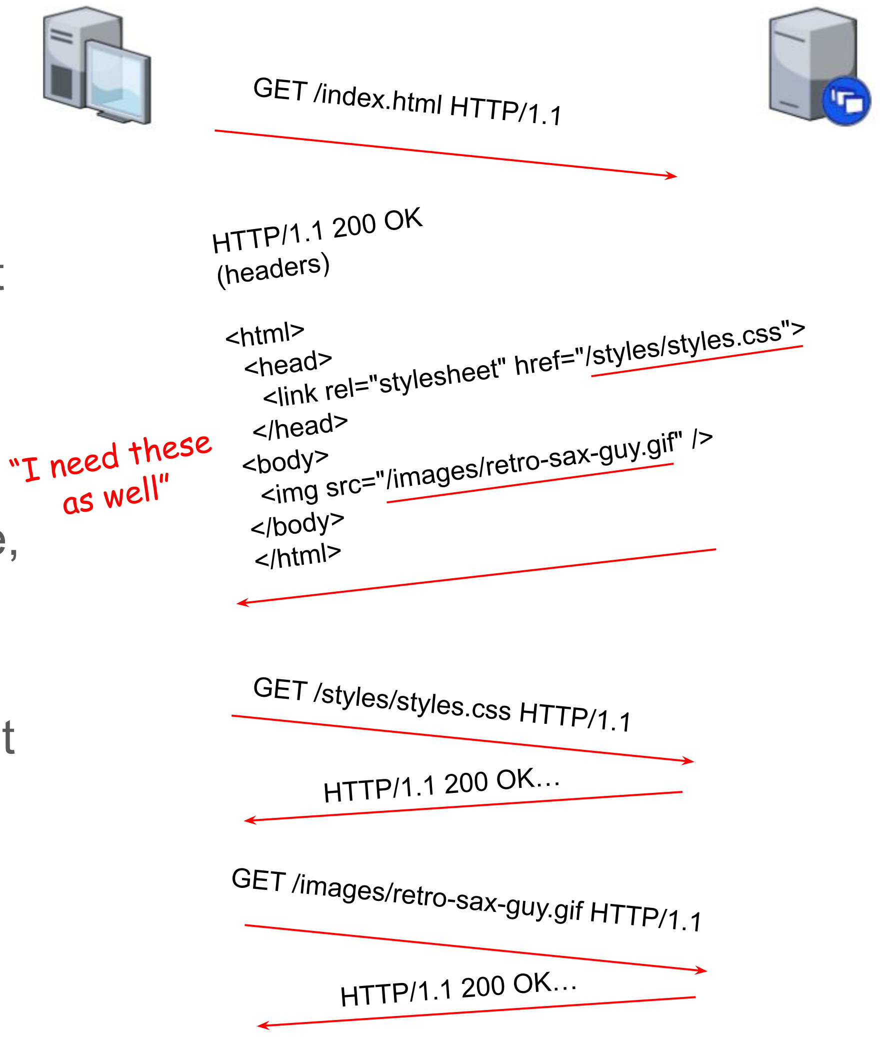
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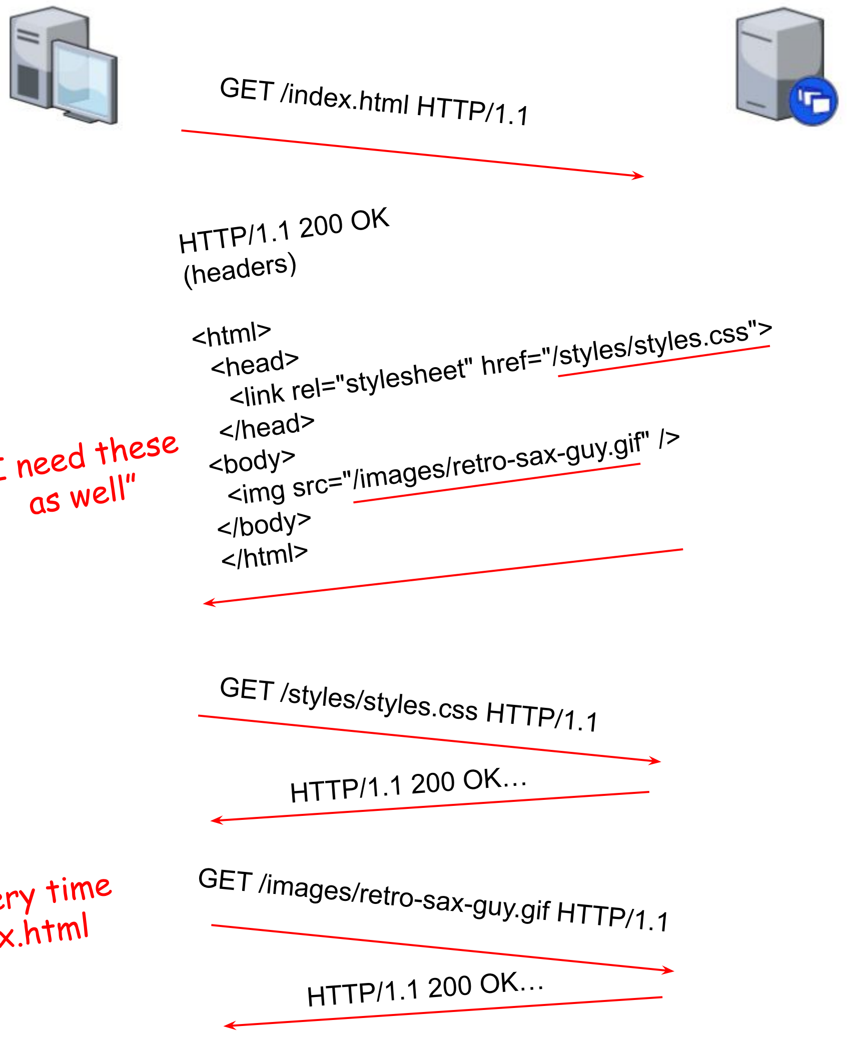

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By default, this happens every time the client retrieves /index.html

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- There may be multiple resources that need to be fetched.
- The number of concurrent connections from a client is limited.
- We may have to wait to load some of the resources.
- How to get around this?
    - Use caches to limit unnecessary loading.
    - Distribute resources over servers.

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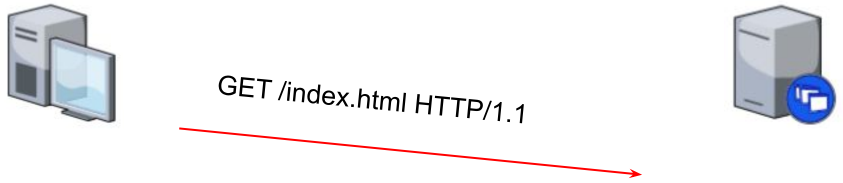

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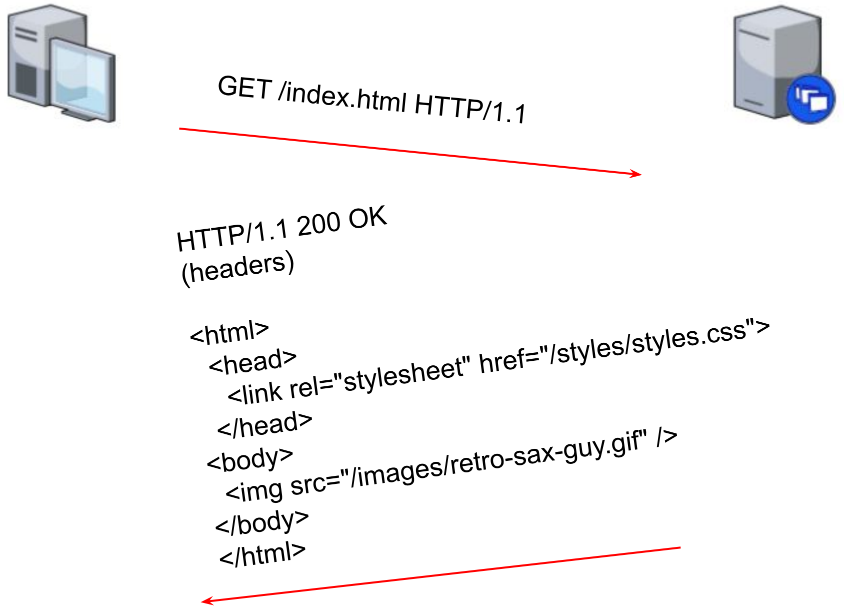

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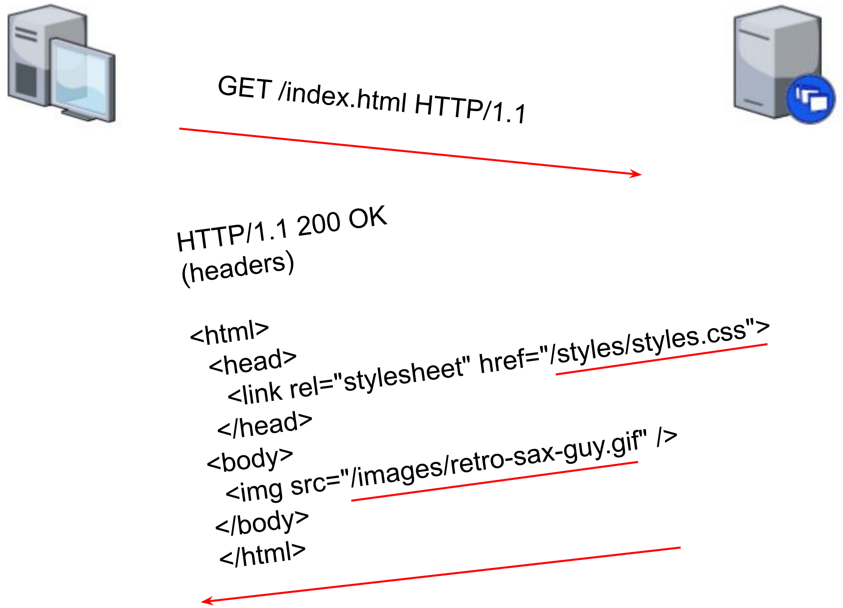

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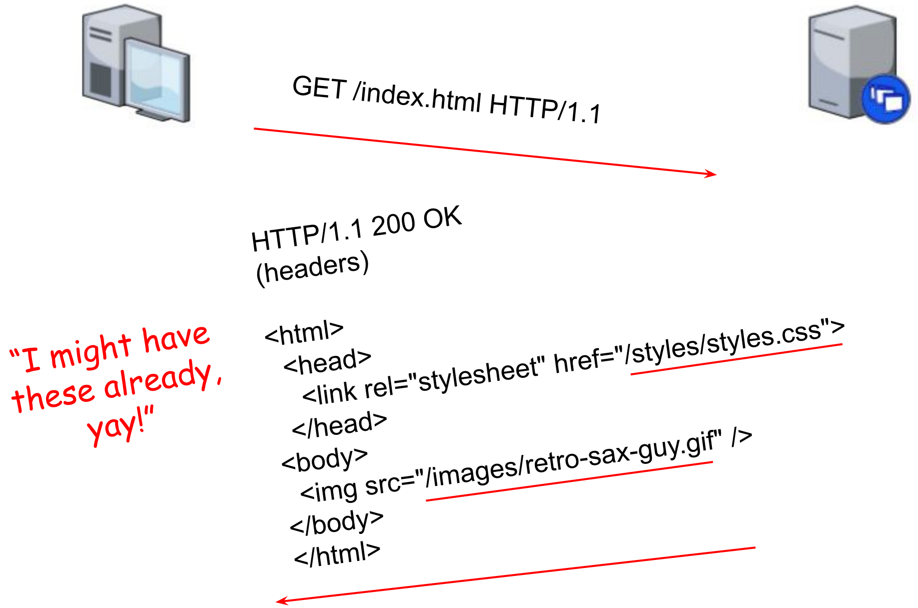

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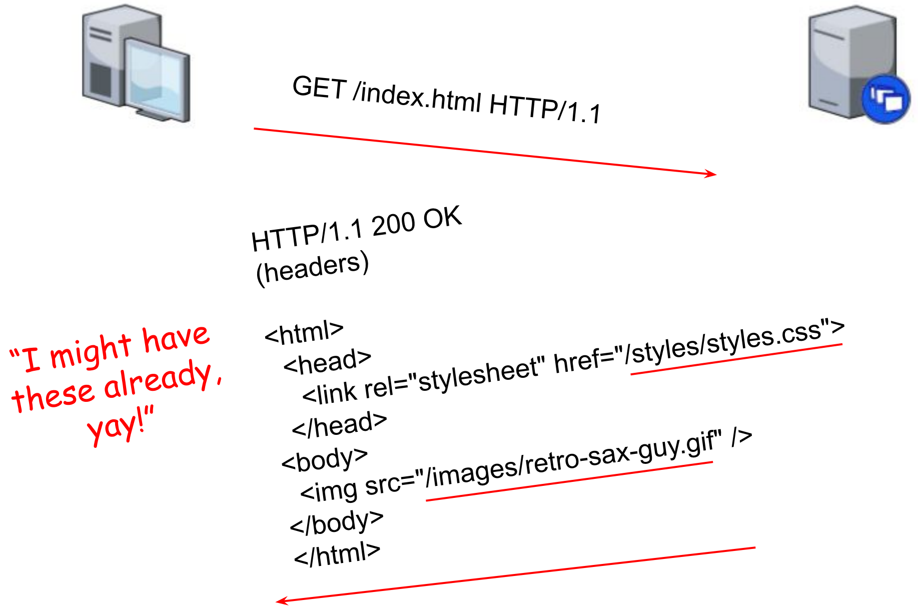

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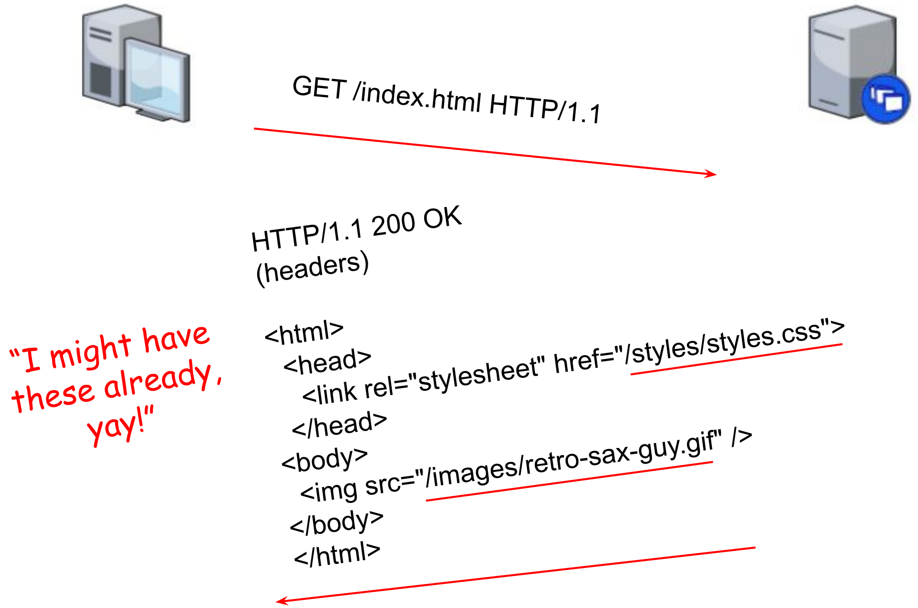

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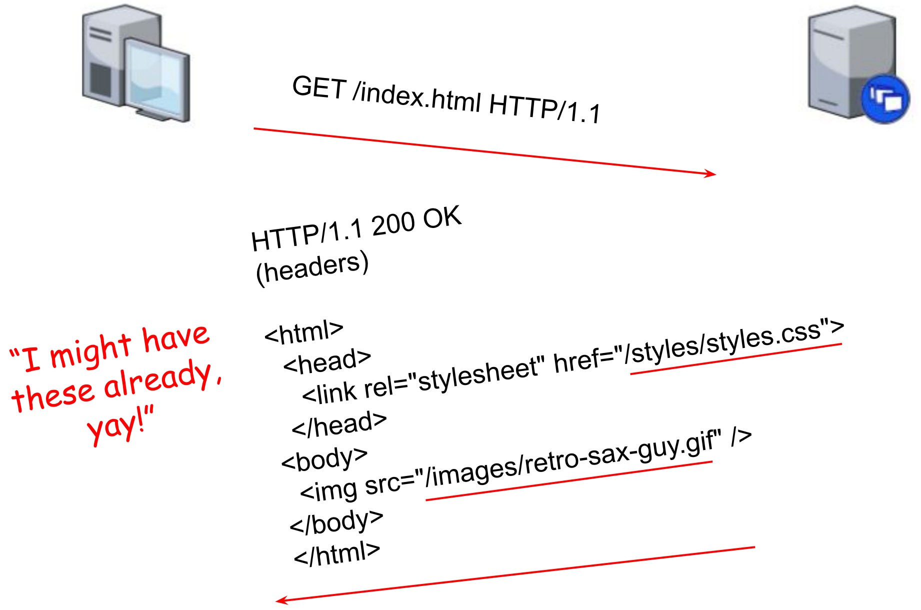
- Multiple shared (server-side) cache implementations / approaches



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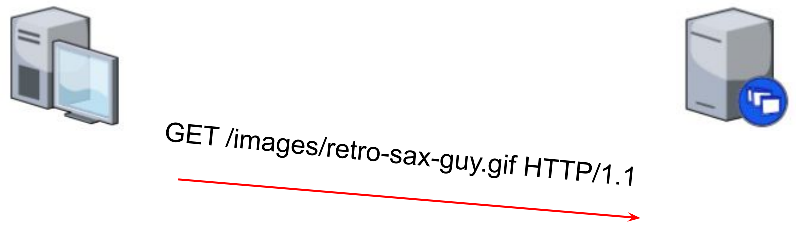

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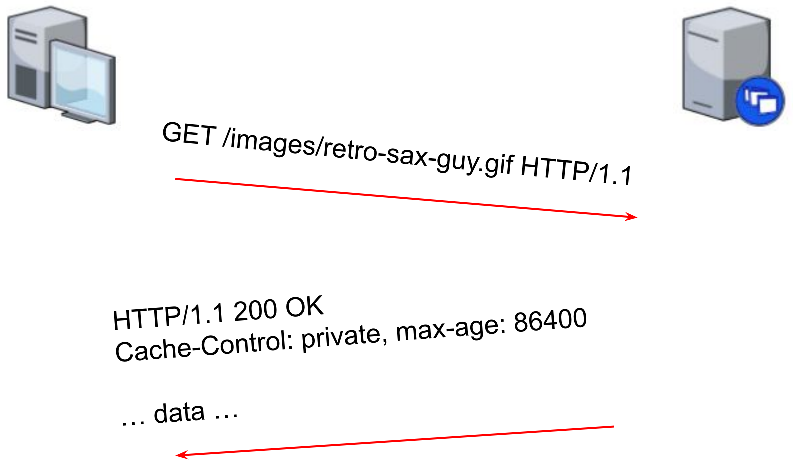
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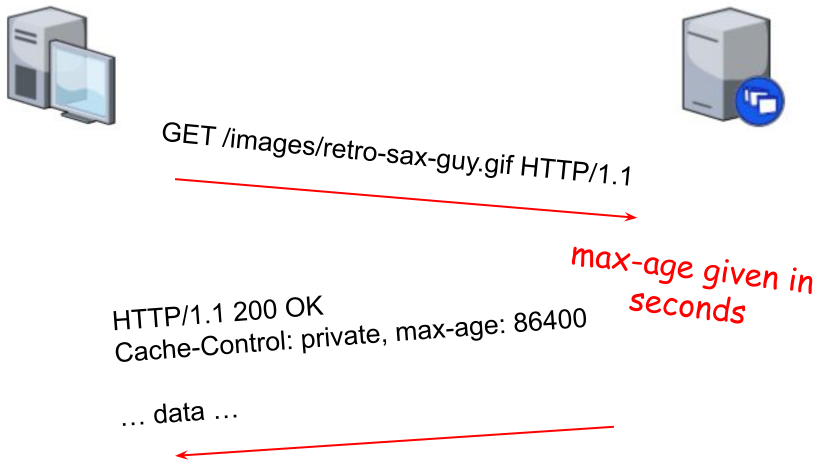

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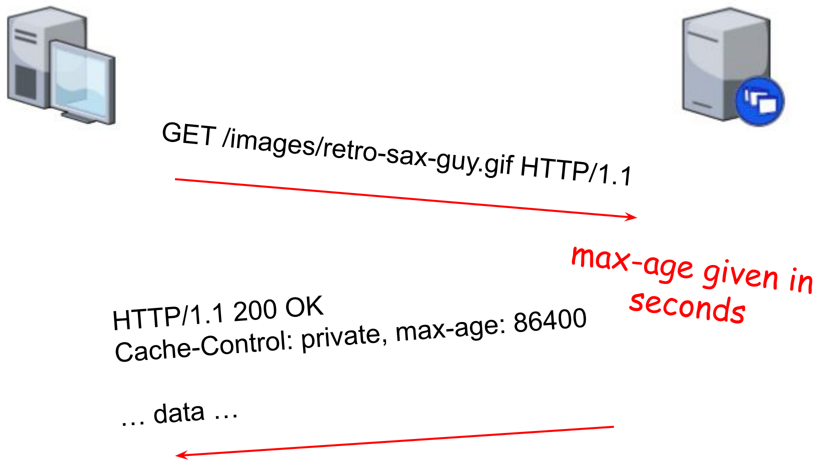

```
GET /images/retro-sax-guy.gif HTTP/1.1
```

```
HTTP/1.1 200 OK
Cache-Control: private, max-age: 86400

... data ...
```

max-age given in seconds

Now, there's no need to re-retrieve the resource in 60 * 60 * 24 = 86400 seconds.

https://www.rfc-editor.org/rfc/rfc9111.html

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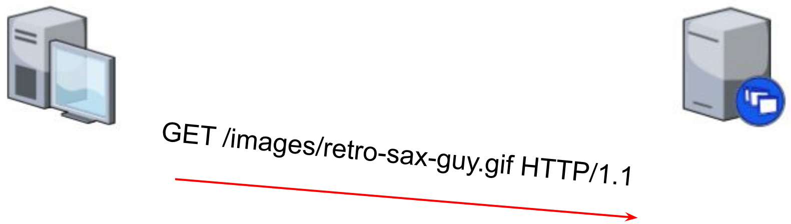

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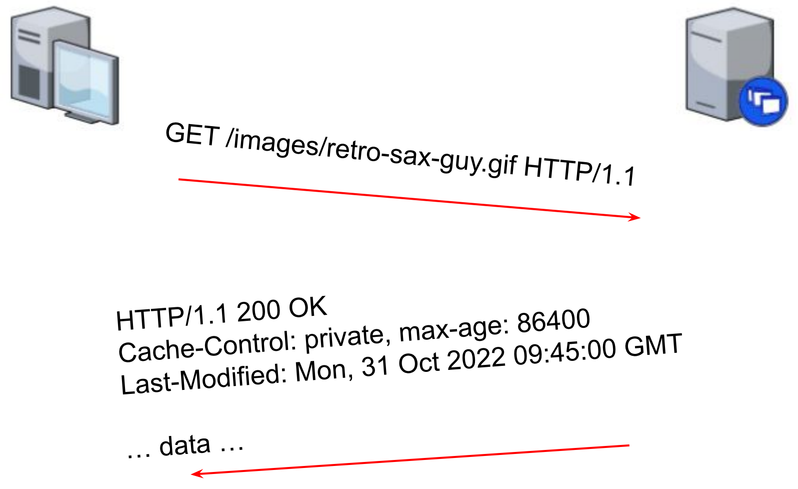

```
GET /images/retro-sax-guy.gif HTTP/1.1
```

```
HTTP/1.1 200 OK
Cache-Control: private, max-age: 86400
Last-Modified: Mon, 31 Oct 2022 09:45:00 GMT

… data …
```

https://www.rfc-editor.org/rfc/rfc9111.html

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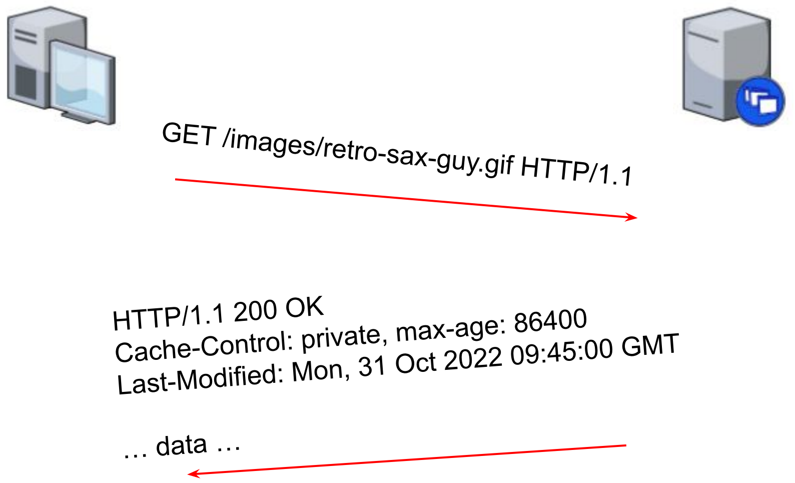

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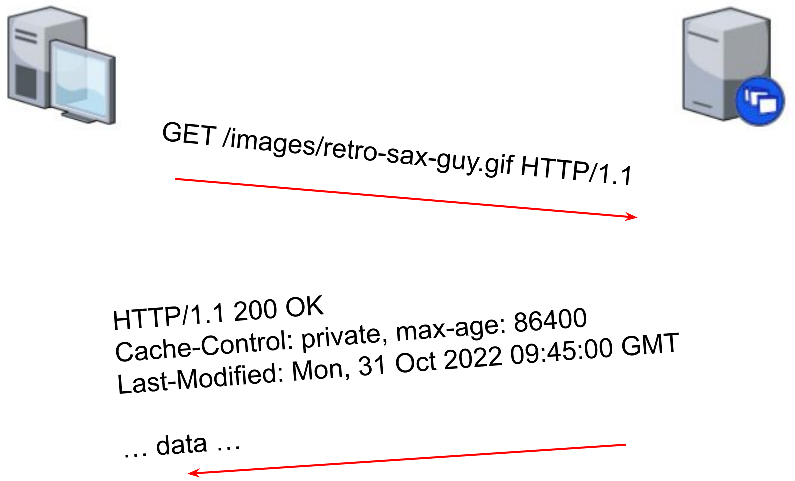

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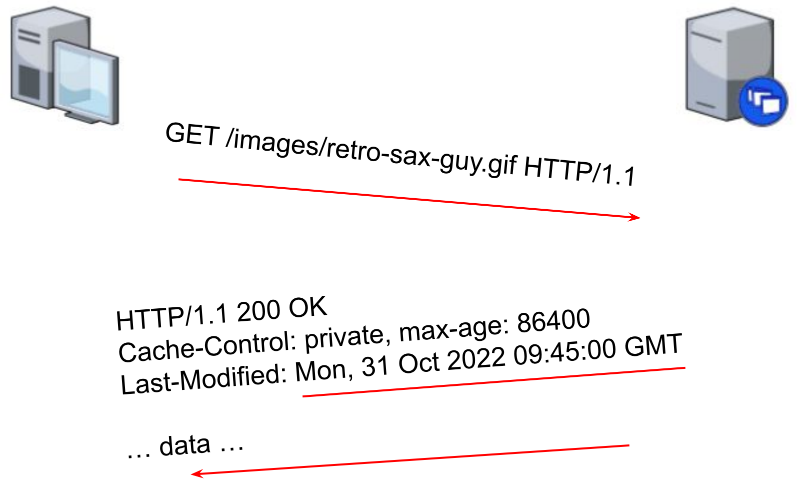

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```

```
… data …
```

Now, there's no need to re-retrieve the resource in 60 * 60 * 24 = 86400 seconds.

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Ask for a new version of the resource only if it has not been modified since Last-Modified.

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Used to enable caching for resource and, optionally, to set an age for a resource

Time-based caching

Now, there's no need to re-retrieve the resource in 60 * 60 * 24 = 86400 seconds.

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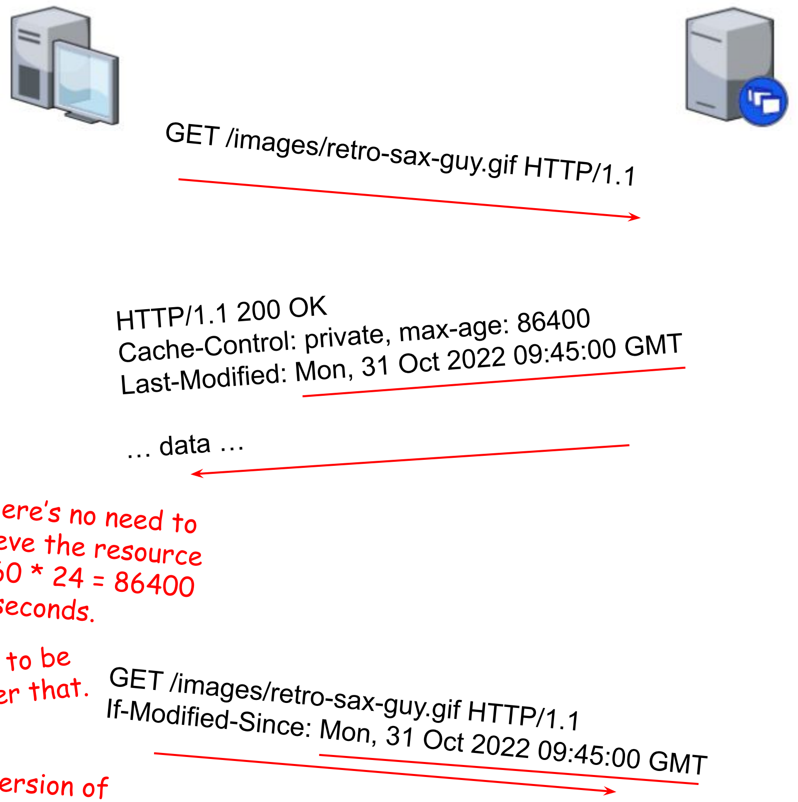

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HTTP/1.1 200 OK
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… data …
```

```
GET /images/retro-sax-guy.gif HTTP/1.1
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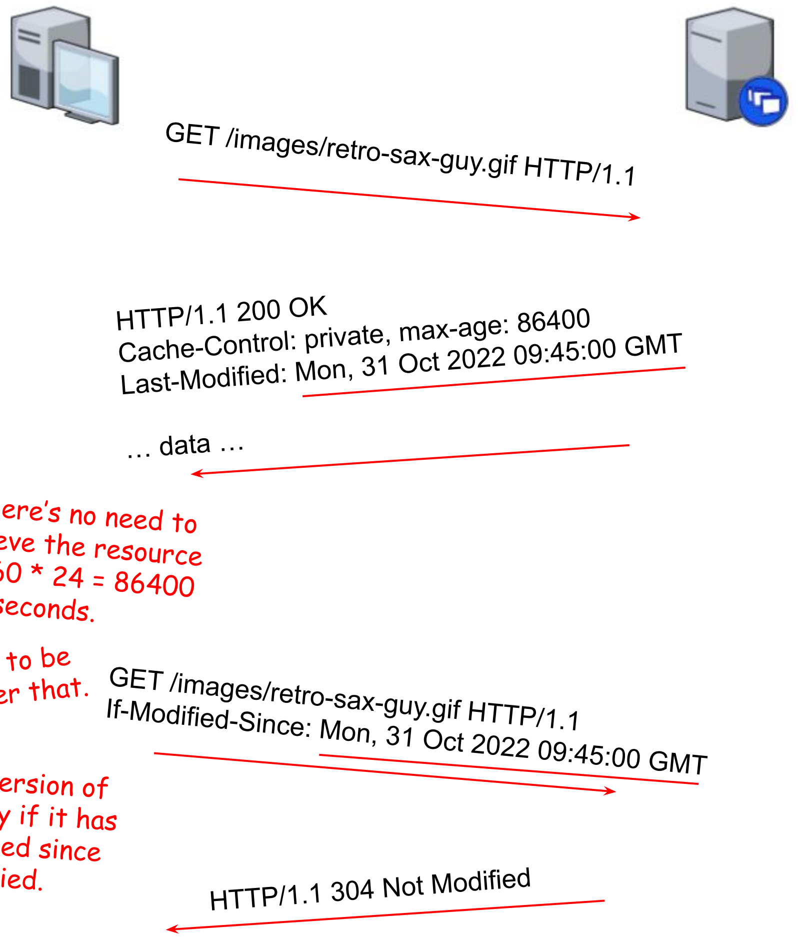

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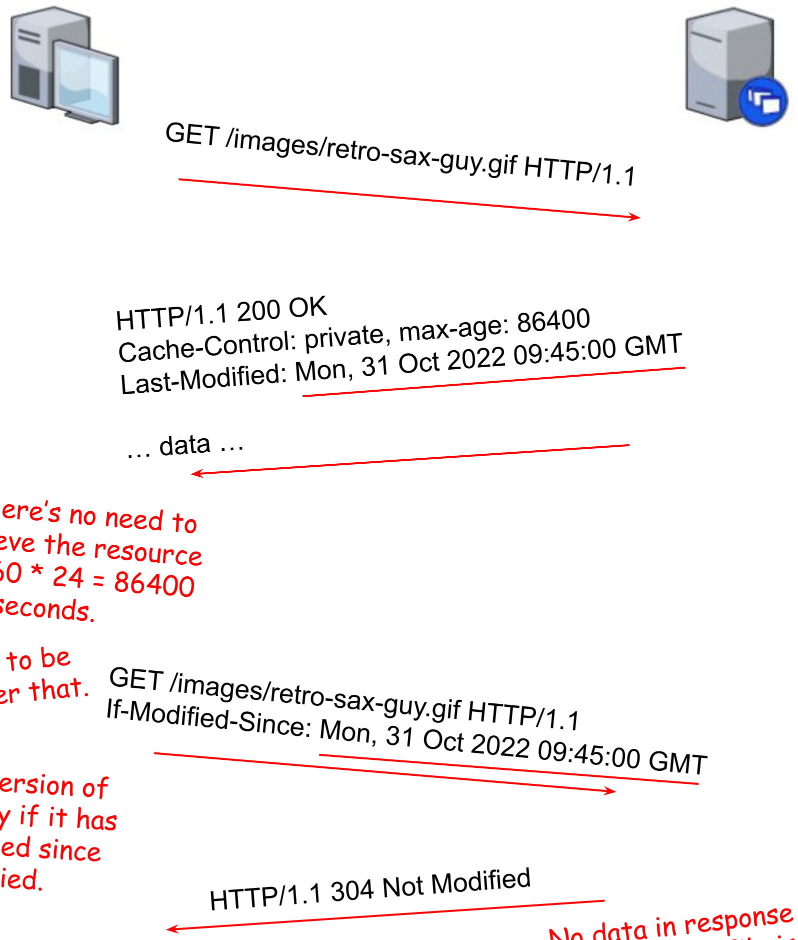

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If-Modified-Since: Mon, 31 Oct 2022 09:45:00 GMT
```

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```
HTTP/1.1 304 Not Modified
```

No data in response if the cached file is still valid.

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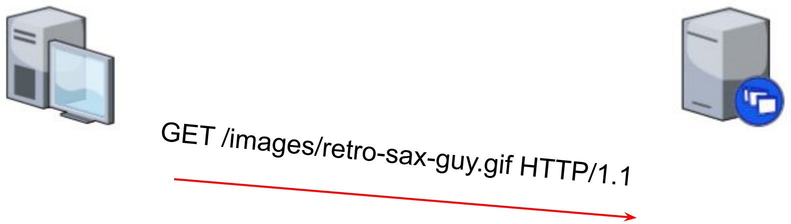

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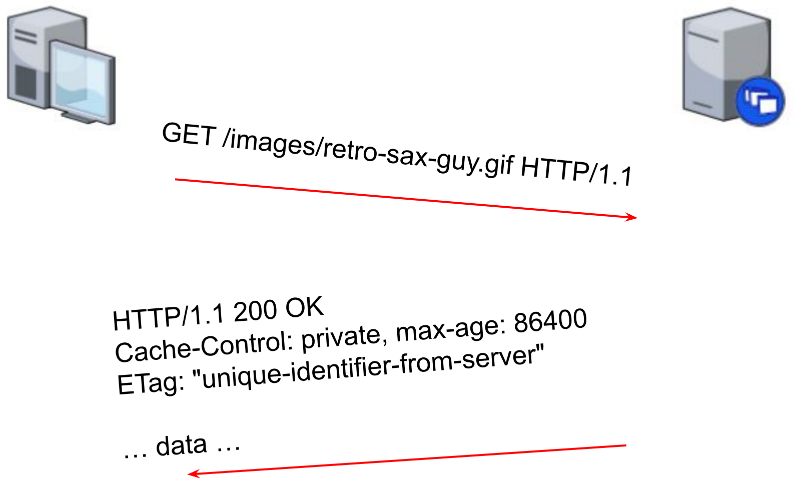

```
GET /images/retro-sax-guy.gif HTTP/1.1
```

```
HTTP/1.1 200 OK
Cache-Control: private, max-age: 86400
ETag: "unique-identifier-from-server"

… data …
```

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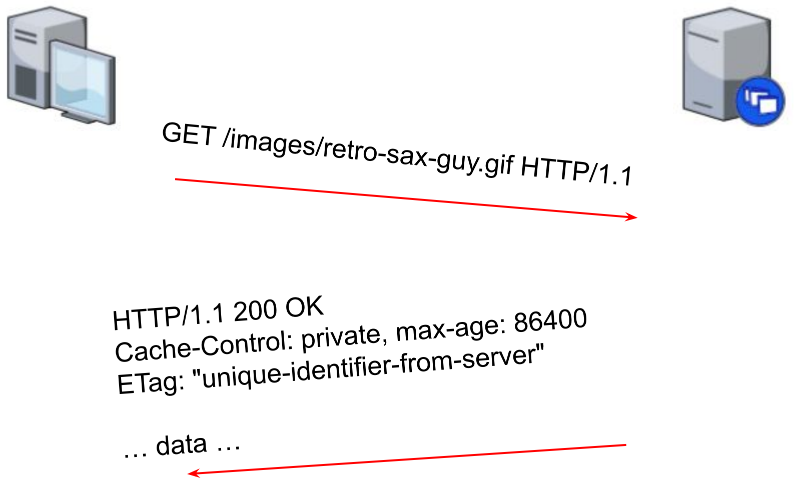
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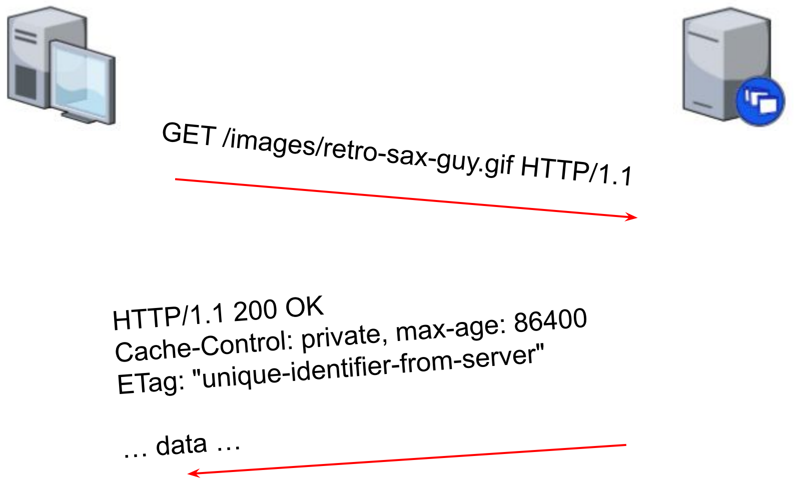

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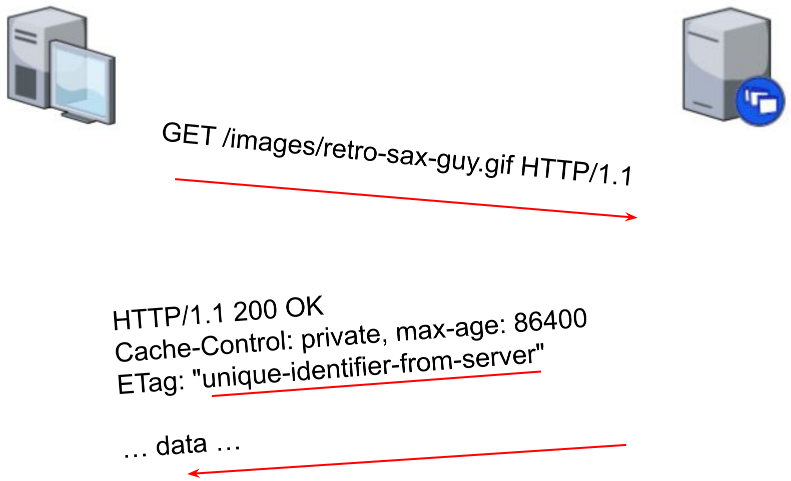
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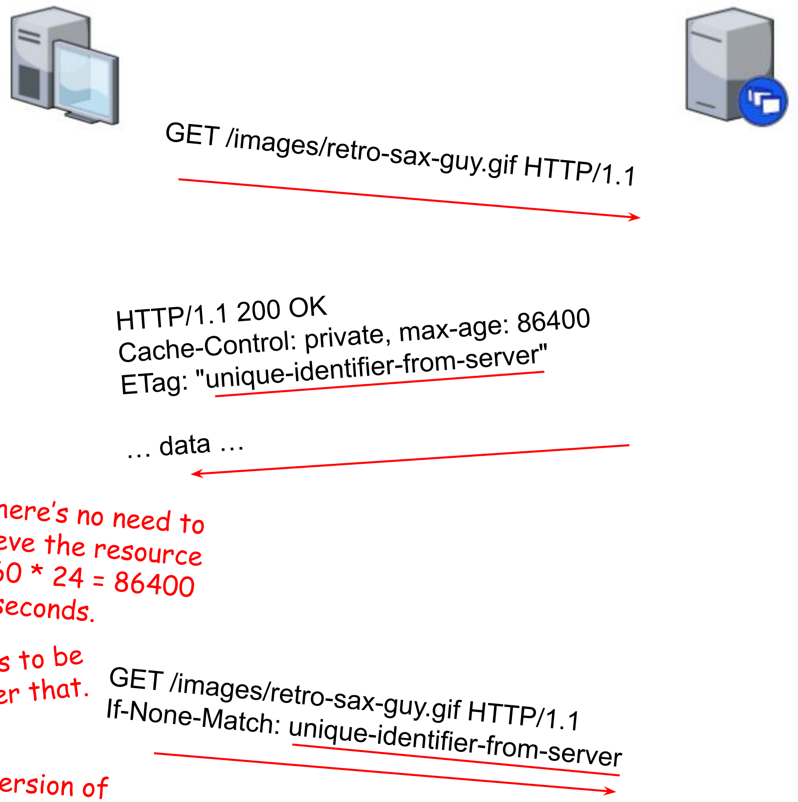

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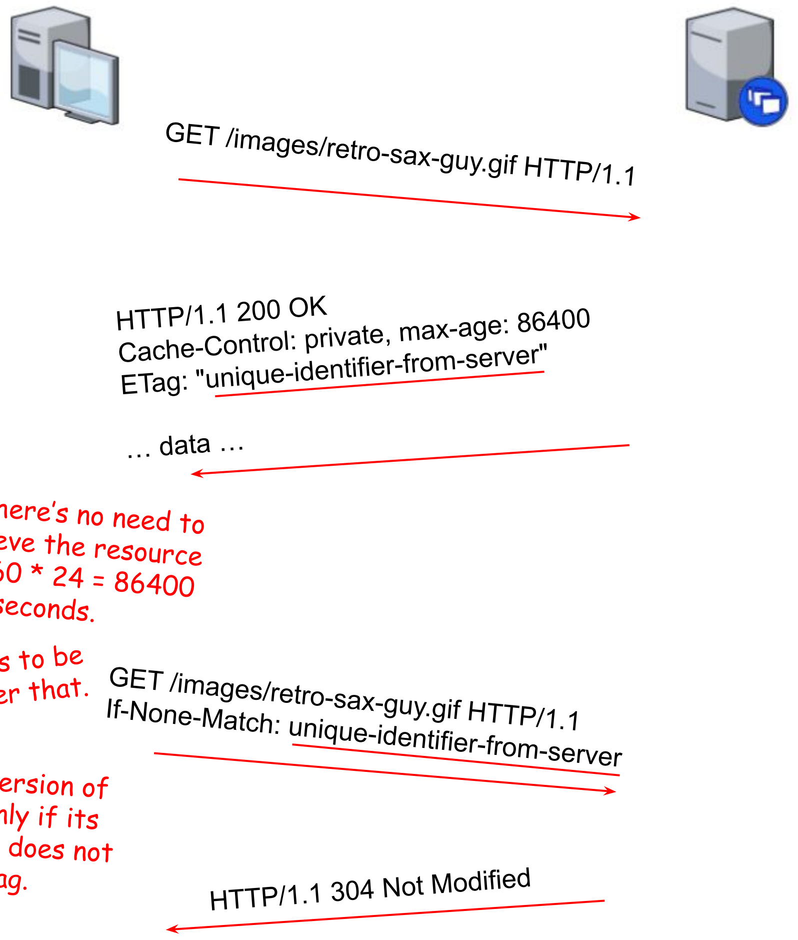

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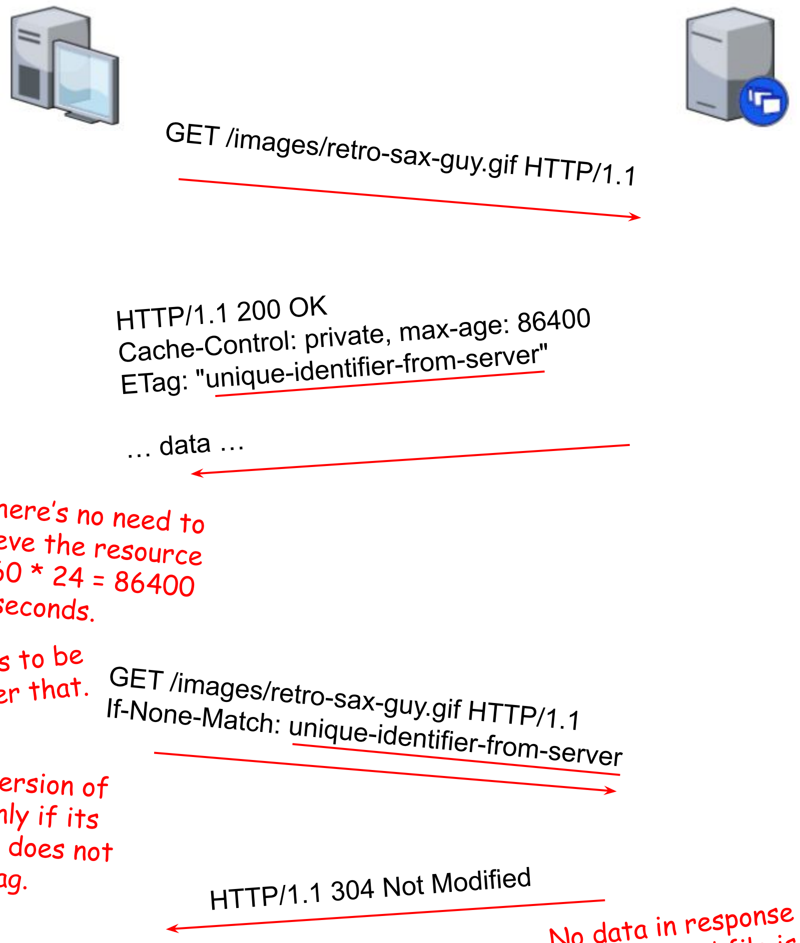

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No data in response if the cached file is still valid.

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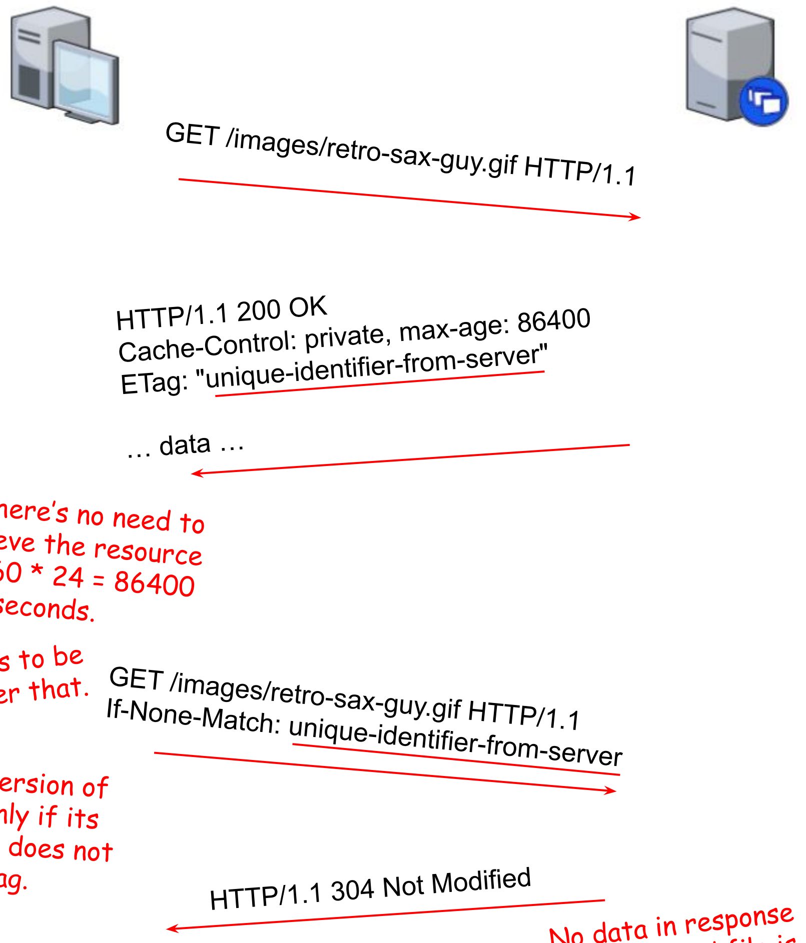
Time-based caching

Content-based caching

- Headers received in HTTP responses and sent in HTTP requests.
- Recently also Web Cache API that can, e.g., be used to cache JavaScript request responses. See RFC9111.



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Client-side Caching: Example

Server-side Caching

Server-side Caching

- Many approaches, many ways to implement – typically on a need basis:
  - Caching static resources from disk
  - Caching resources retrieved from database
  - Caching dynamic content
  - Caching resources on the server
  - Caching resources on a separate server, e.g. a dedicated cache server, load balancer, reverse proxy, …

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Note: proxy servers and reverse proxy are different

- Previously also caching on proxy servers. With increasing use of HTTPS, this is used less often (and is less often useful).

Less often used, well.. except for..

Content-Delivery Networks

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- A specific shared cache; cacheable data (e.g. static content) is distributed across a body of servers – a Content-Delivery Network (CDN).

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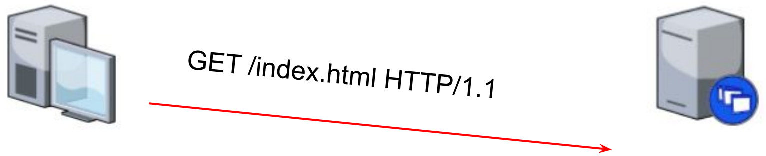

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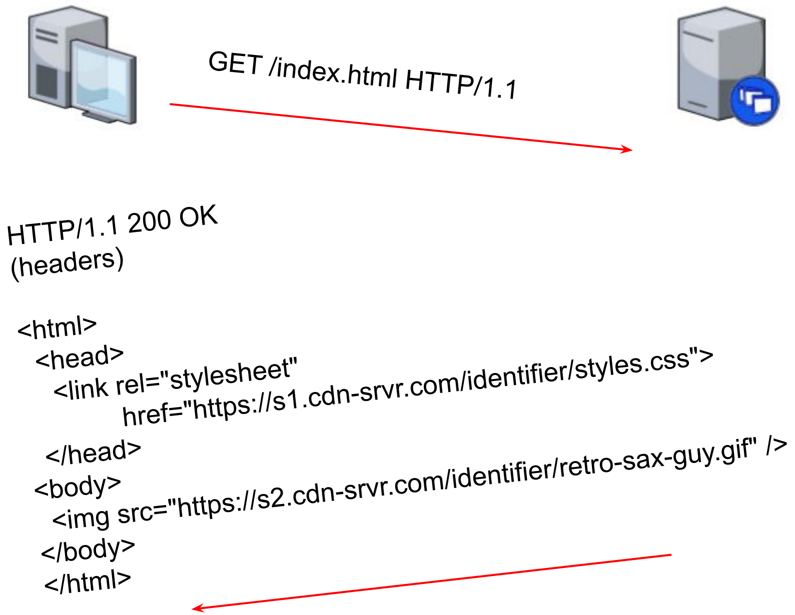


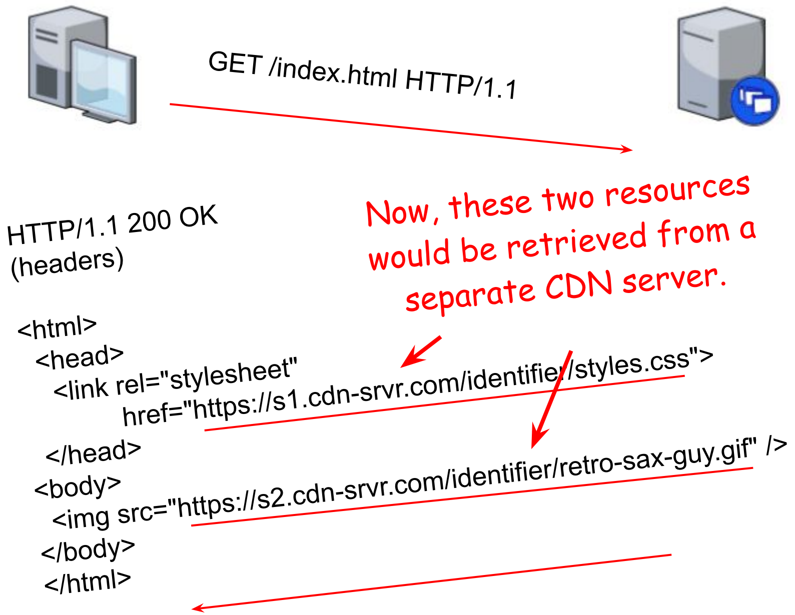
```
GET /index.html HTTP/1.1
```

```
HTTP/1.1 200 OK
(headers)

<html>
  <head>
    <link rel="stylesheet"
          href="https://s1.cdn-srvr.com/identifier/styles.css">
  </head>
  <body>
    <img src="https://s2.cdn-srvr.com/identifier/retro-sax-guy.gif" />
  </body>
</html>
```

Content-Delivery Networks

- A specific shared cache; cacheable data (e.g. static content) is distributed across a body of servers – a Content-Delivery Network (CDN).



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</html>
```

Now, these two resources would be retrieved from a separate CDN server.

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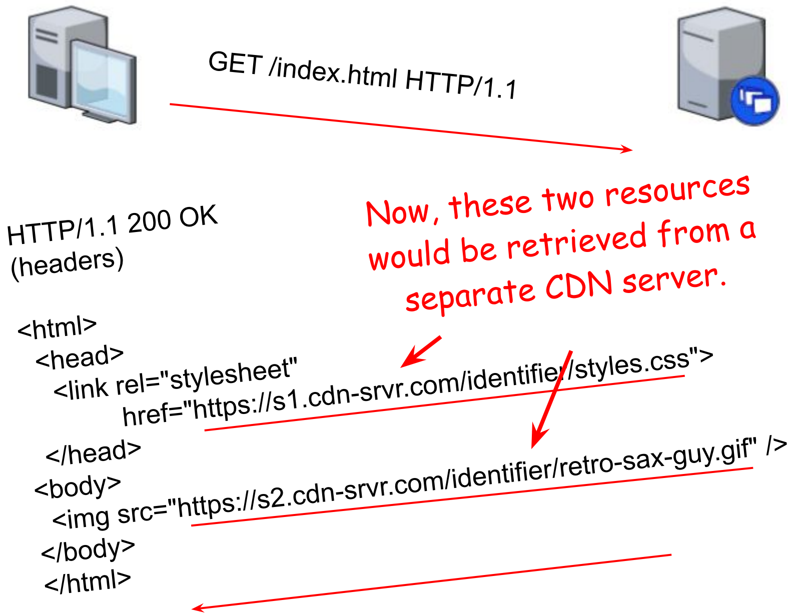

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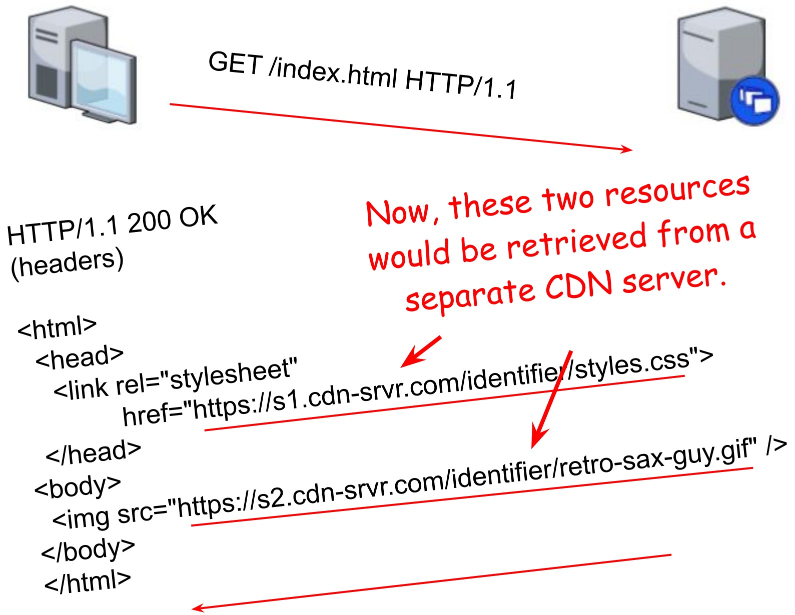
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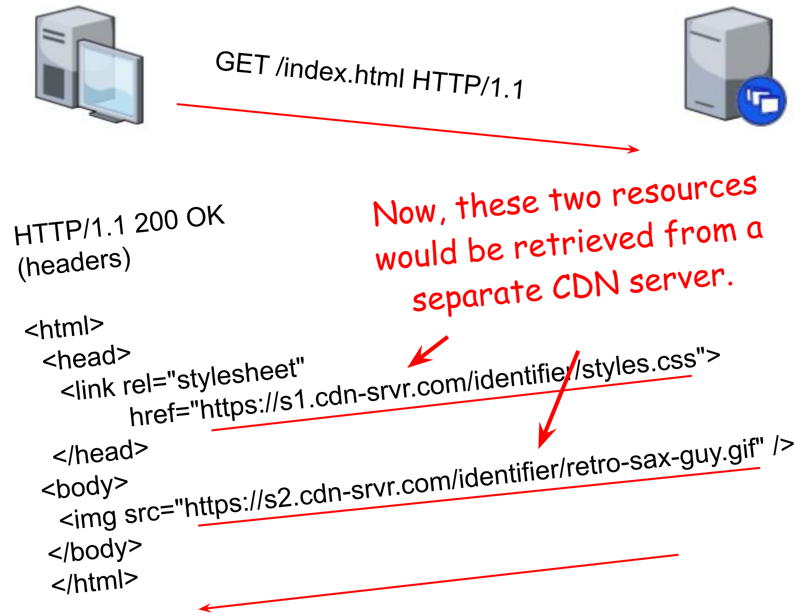

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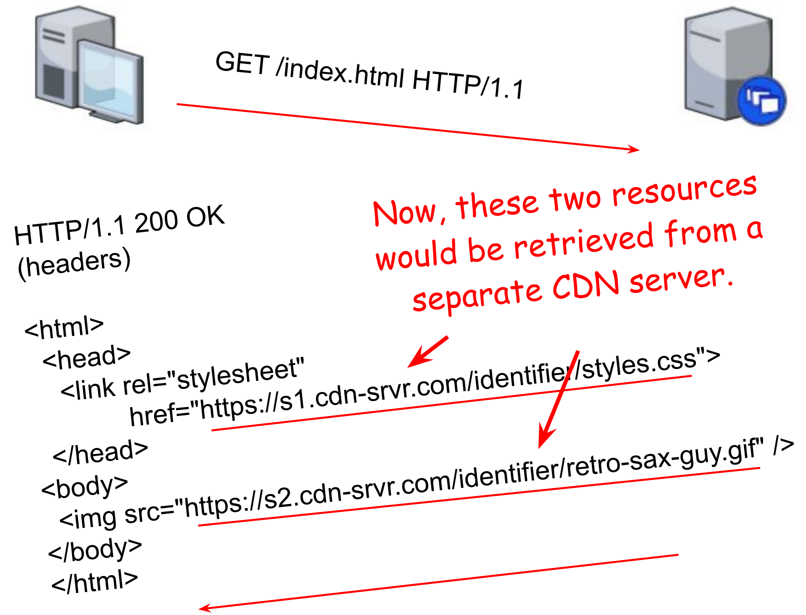

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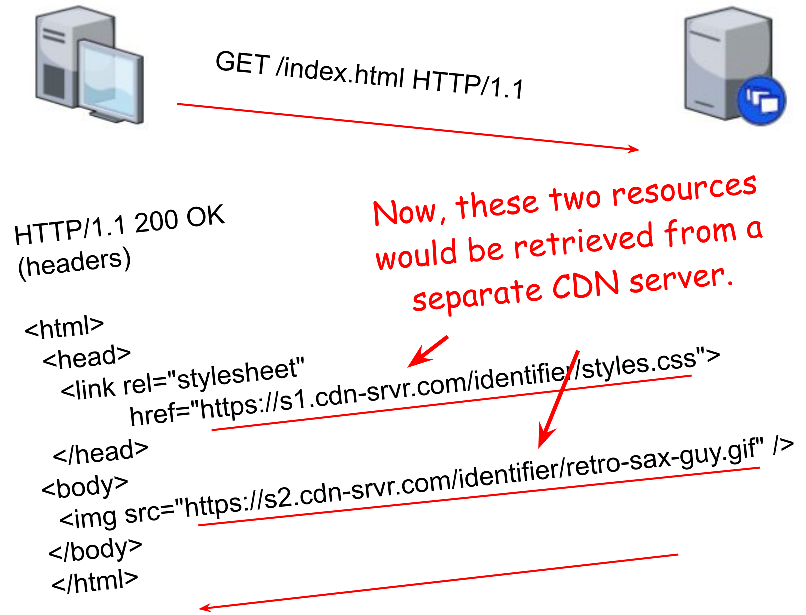

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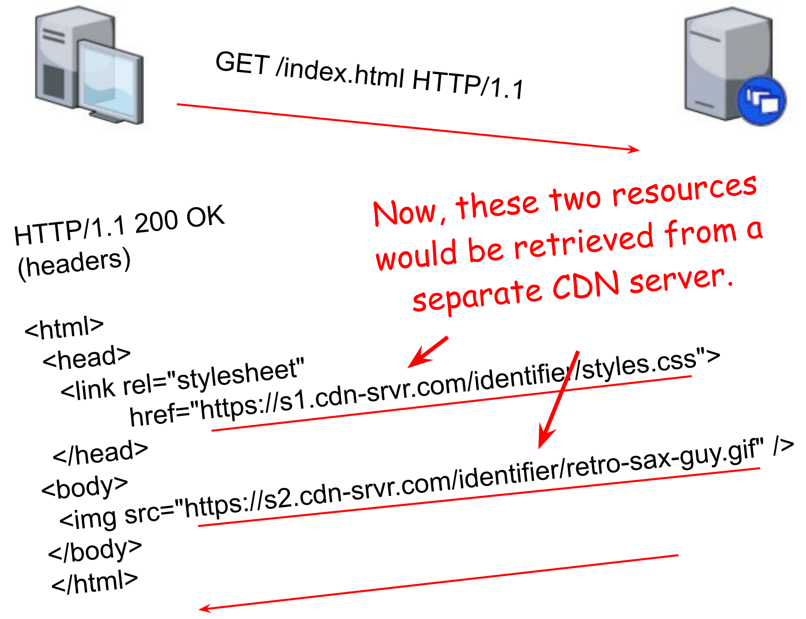

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Can also be used like a proxy server

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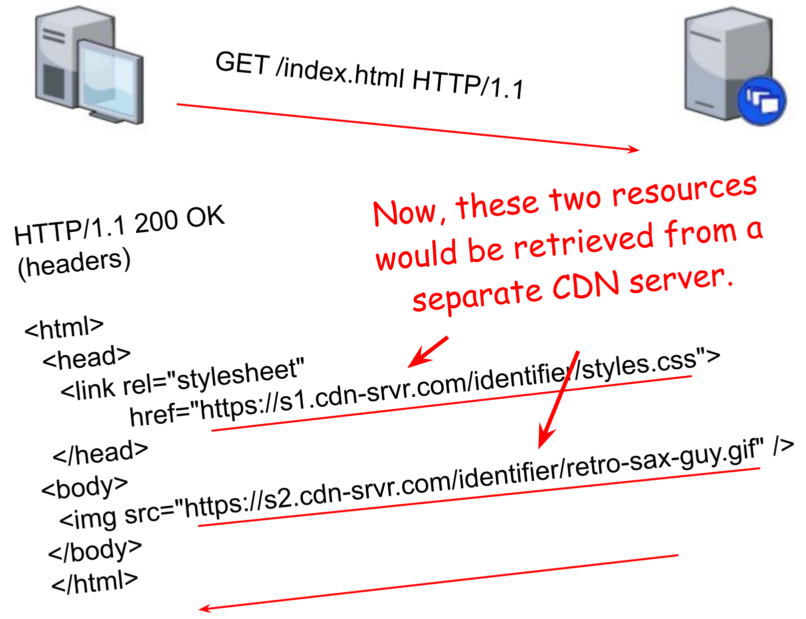

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https://dmsec.io/hacking-thousands-of-websites-via-third-party-javascript-libraries/

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Example: Cloudflare CDN

https://cloudflare.com

Starting with Client-Side Web Development

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- The field has evolved significantly during the last decade and seems to still be evolving.

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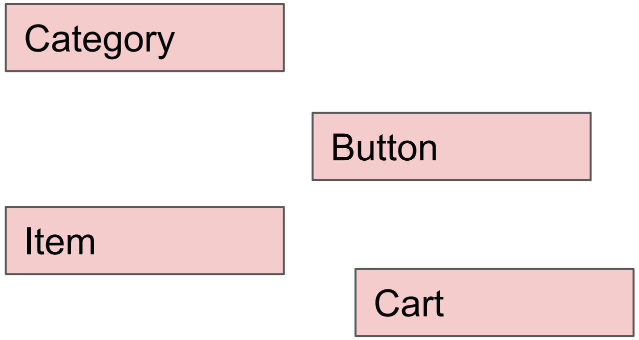

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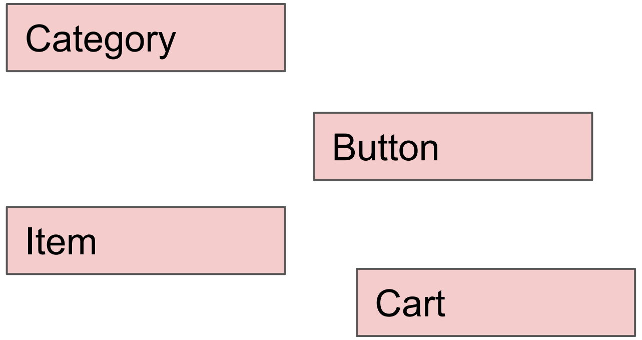

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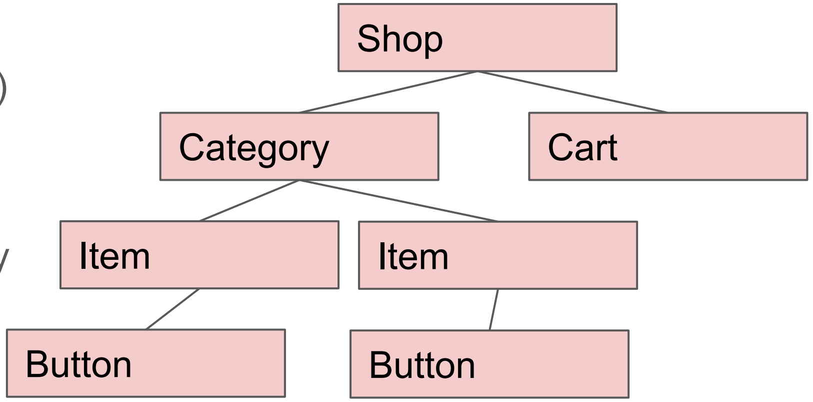

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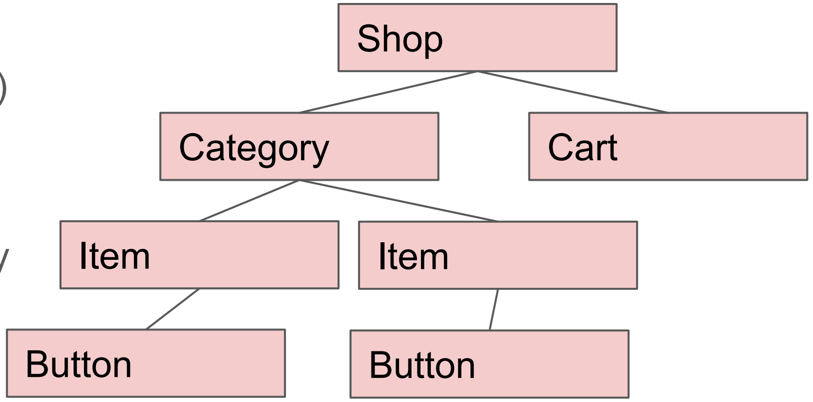

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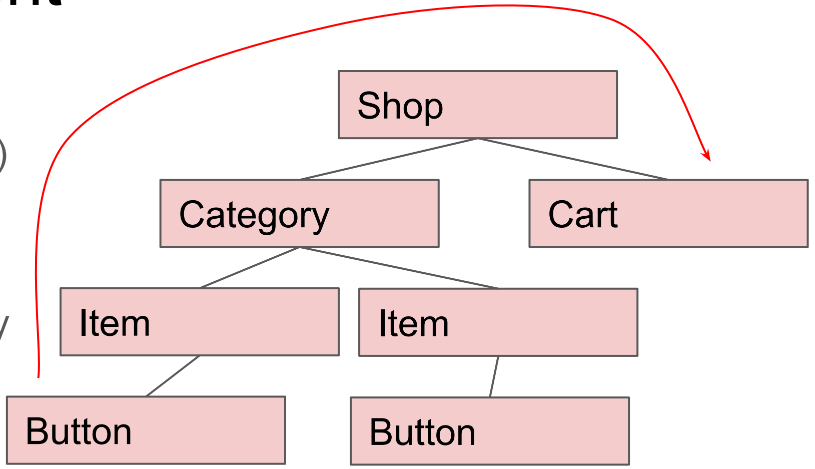

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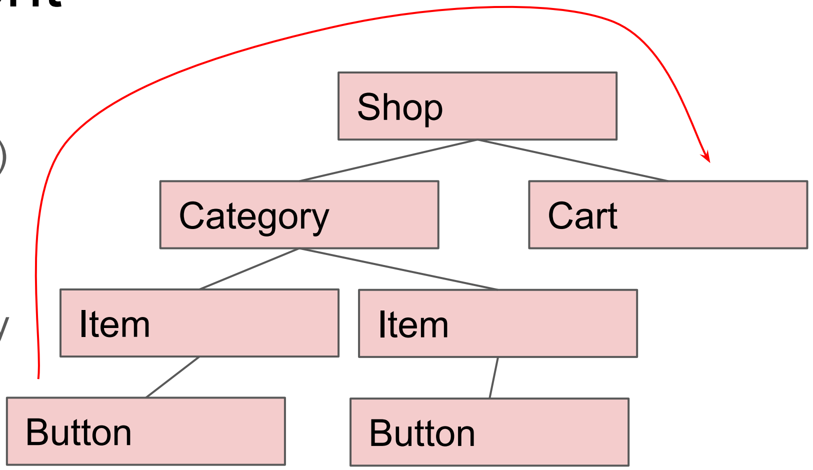

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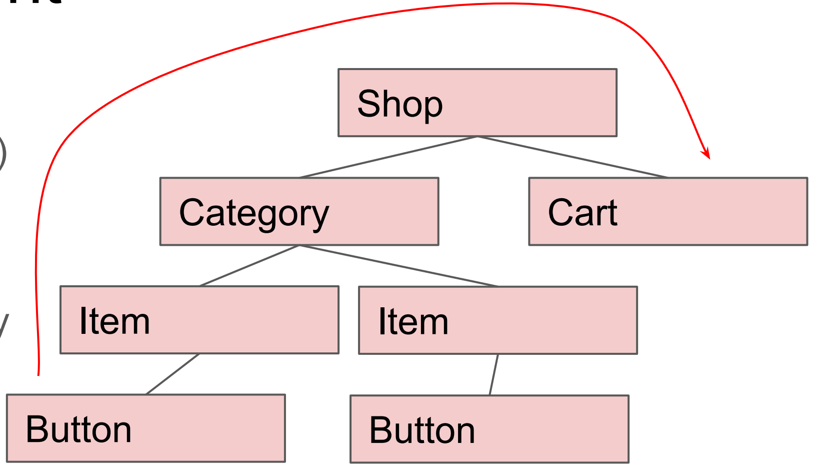

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A Brief Peek at Svelte

https://kit.svelte.dev/