The Web (part 2)

Lecture 7

http://www.cs.rutgers.edu/~sn624/352-F24

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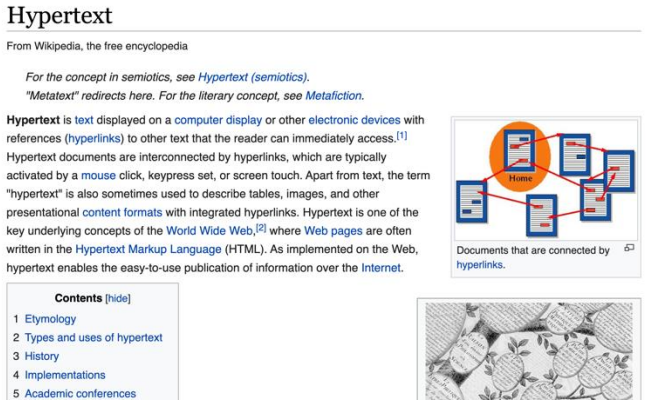
Review of concepts



Hypertext

From Wikipedia, the free encyclopedia

For the concept in semiotics, see Hypertext (semiotics).
"Metatext" redirects here. For the literary concept, see Metafiction.

Hypertext is text displayed on a computer display or other electronic devices with references (hyperlinks) to other text that the reader can immediately access.[1] Hypertext documents are interconnected by hyperlinks, which are typically activated by a mouse click, keypress set, or screen touch. Apart from text, the term "hypertext" is also sometimes used to describe tables, images, and other presentational content formats with integrated hyperlinks. Hypertext is one of the key underlying concepts of the World Wide Web,[2] where Web pages are often written in the Hypertext Markup Language (HTML). As implemented on the Web, hypertext enables the easy-to-use publication of information over the Internet.

Documents that are connected by hyperlinks.

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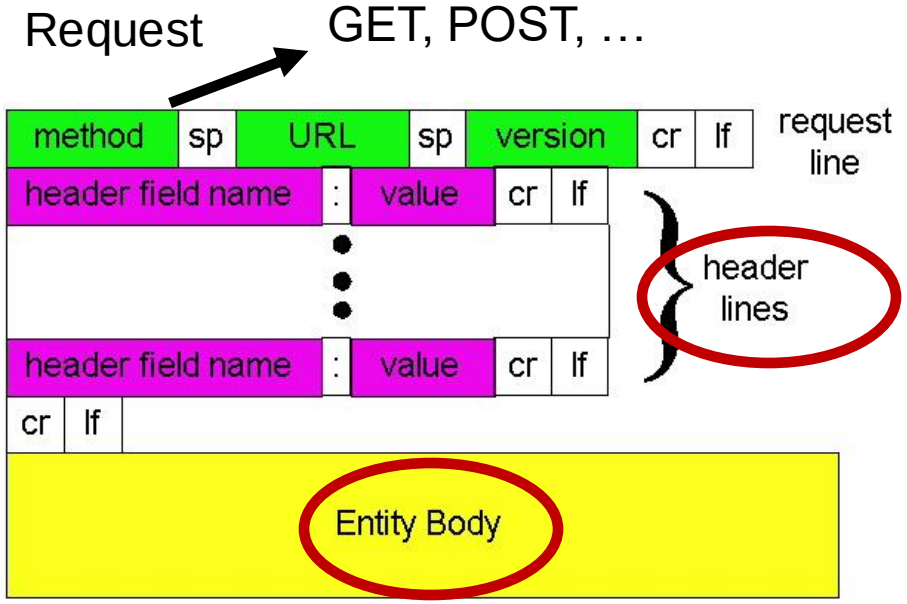
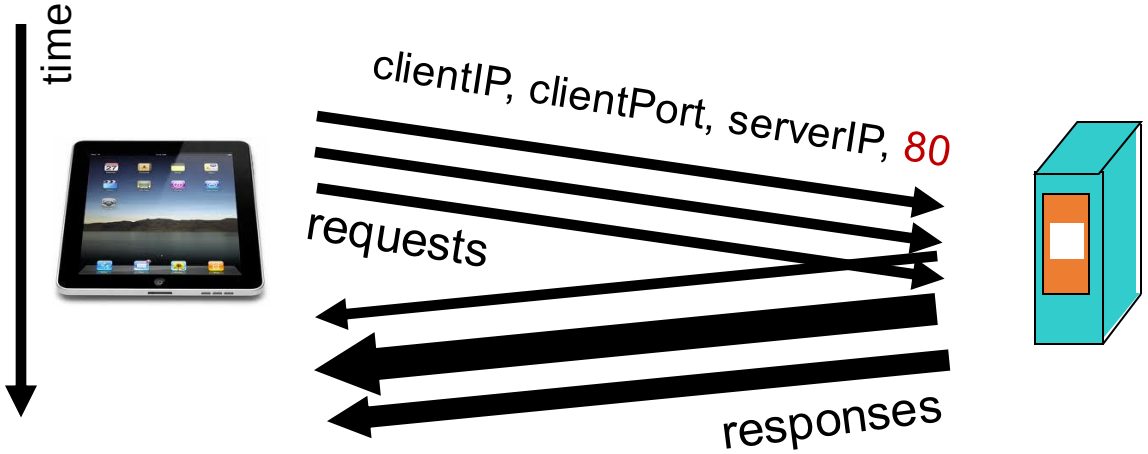
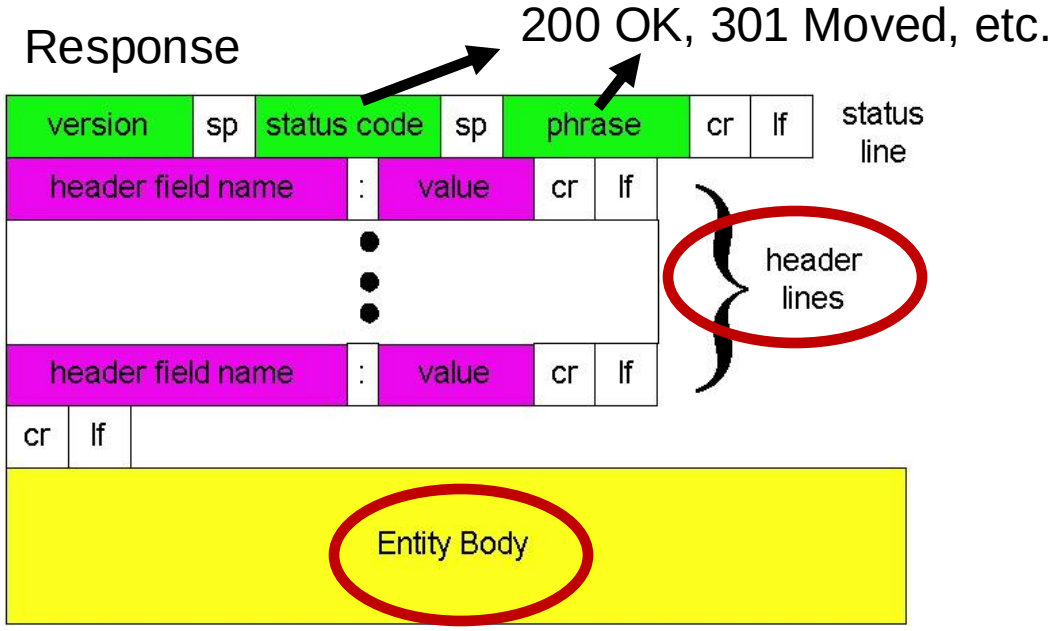
1 Etymology
2 Types and uses of hypertext
3 History
4 Implementations
5 Academic conferences



HyperText Transfer Protocol (HTTP)

Client-Server Protocol





HTTP Persistence

Two types of HTTP connectivity

Non-persistent HTTP

- At most one object is sent over a TCP connection.
- HTTP/1.0 uses non-persistent connections

Persistent HTTP

- Multiple objects can be sent over single TCP connection between client and server.
- HTTP/1.1 uses persistent connections in default mode

TCP is a reliable communication protocol provided by the transport layer. It requires setting up some resources (e.g., memory regions) for the connection to be set up at the endpoints before data communication.

Non-persistent HTTP (HTTP/1.0)

1a. HTTP client initiates TCP connection to HTTP server

1b. HTTP server at host “accepts” connection, notifying client

Suppose a user visits a page with text and 10 embedded images.

2. HTTP client sends HTTP request message

3. HTTP server receives request message, replies with response message containing requested object

time

Non-persistent HTTP (HTTP/1.0)

4. HTTP server closes TCP connection.

5. HTTP client receives response message containing HTML file, displays HTML. Parsing HTML file, finds 10 referenced image objects

time

6. Steps 1-5 repeated for each of 10 image objects

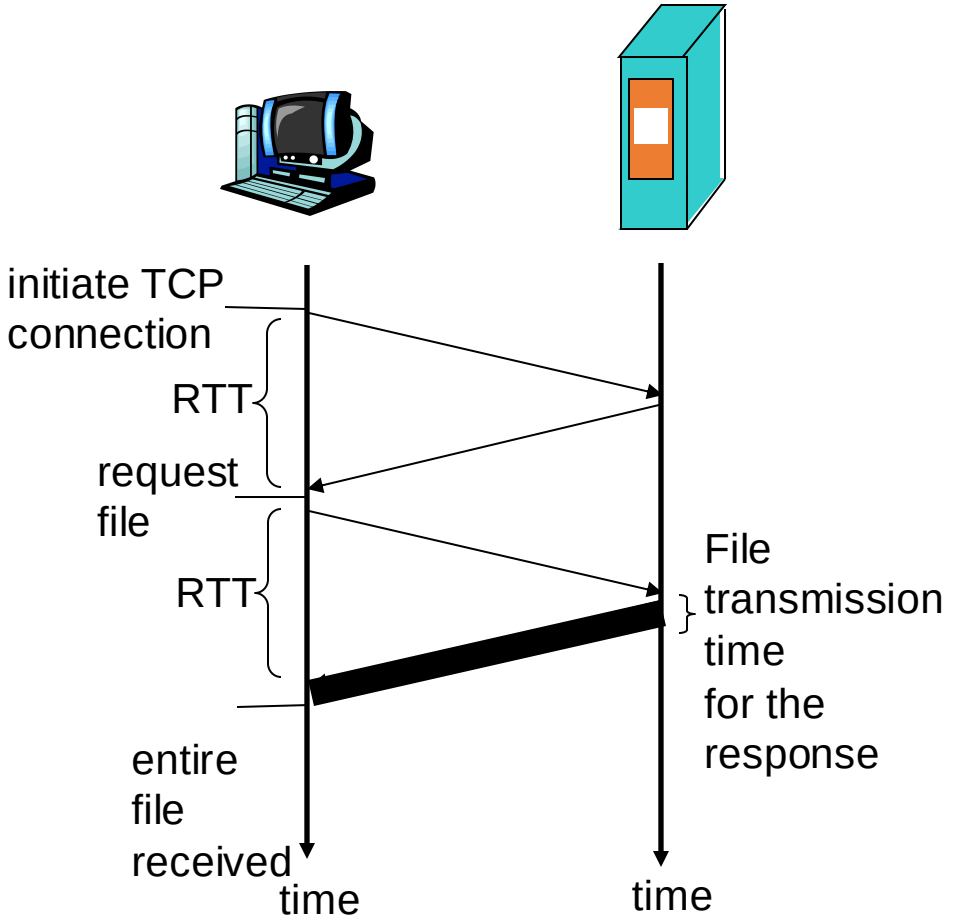
Single connection per object

Useful at a time when web pages contained 1 object: the base HTML file.

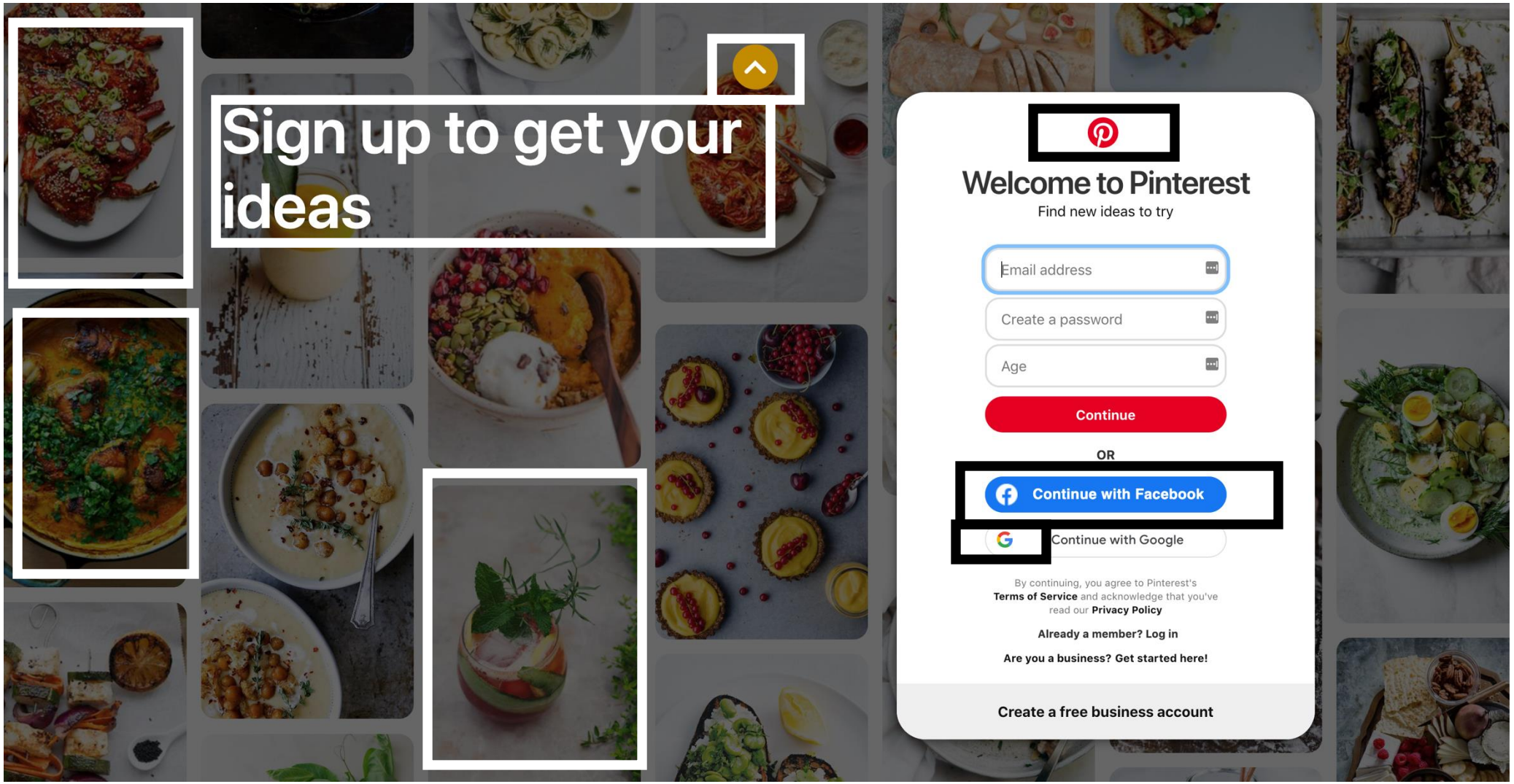
How long does it take to download an entire web page with non-persistent HTTP?
i.e.: before your browser can load the (entire) web page?

Non-persistent HTTP user response time

- Total delay = propagation + queueing + transmission
- Response time for the user
  - = sum of forward and backward total delays
- Round-Trip Time (RTT): total forward + backward delay for a “small” packet
  - Zero transmission delay
- Assumptions:
  - TCP initiation packet, response, HTTP requests are all “small” packets
  - No processing delays at the server
  - RTT is stable over time
- (2RTT + file transmission time) * #objects



Per-object overheads quickly add up



Modern web pages have 100s of objects in them.

Objects (e.g. images) may not be small.

Persistent HTTP (HTTP/1.1)

Suppose user visits a page with text and 10 images.

Web Server

1a. HTTP client initiates TCP connection to HTTP server

1b. HTTP server at host "accepts" connection, notifying client

2. HTTP client sends HTTP request message

3. HTTP server receives request message, replies with response message containing requested object

`Connection: keep-alive`

HTTP header introduced in HTTP/1.1

time

Persistent HTTP (HTTP/1.1)

4. HTTP server sends a response.

5. HTTP client receives response message containing HTML file, displays HTML. Parsing HTML file, finds 10 referenced image objects

Server keeps the TCP connection alive.

time

The 10 objects can be requested over the same TCP connection.

i.e., save an RTT per object (otherwise spent opening a new TCP connection in HTTP/1.0)

Persistent HTTP user response time

- Assume requests made one at a time (separate RTT per req)
- RTT + (RTT + file transmission time) * #objects
- Pipelining: send more than one HTTP request at a time
  - Extreme case: all requests in one (small) packet
  - 2RTT + (file transmission time) * #objects
  - In practice, dependencies between objects
- Compare with non-persistent:
  - (2RTT + file transmission time) * #objects
- Persistence (& pipelining) can save significant time, especially on high-RTT connections
- Other advantages of persistence: CPU savings, reduced network congestion, less memory (fewer connections)

Persistence vs. # of connections

- Persistence is distinct from the number of concurrent connections made by a client

- Your browser has the choice to open multiple connections to a server
  - HTTP spec suggests to limit this to a small number (2)

- Further, a single connection can have multiple HTTP requests in flight (pipelining) with persistent HTTP

> Clients that use persistent connections SHOULD limit the number of simultaneous connections that they maintain to a given server. A single-user client SHOULD NOT maintain more than 2 connections with any server or proxy. A proxy SHOULD use up to 2*N connections to another server or proxy, where N is the number of simultaneously active users. These guidelines are intended to improve HTTP response times and avoid congestion.
>
> **8.2 Message Transmission Requirements**

Remembering Users On the Web

HTTP: Remembering users

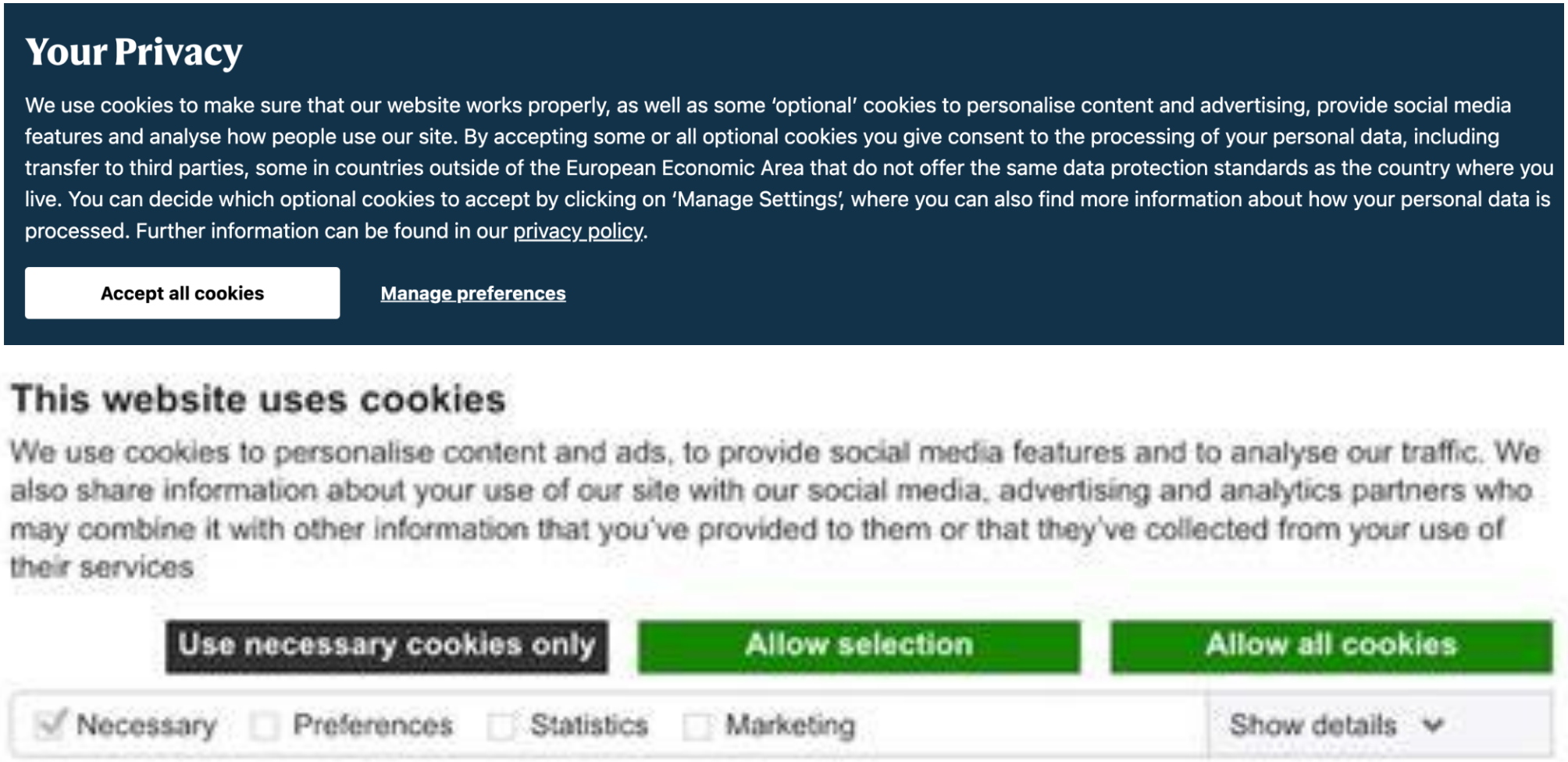
So far, HTTP mechanisms considered stateless

- Each request processed independently at the server
- The server maintains no memory about past client requests

However, state, i.e., memory, about the user at the server, is very useful!

- User authentication (e.g., gmail)
- Shopping carts (e.g., Amazon)
- Video recommendations (e.g., Netflix)
- Any user session state in general

Familiar with these?



Cookies: Keeping user memory

Cookie is typically opaque to client.