

Web and HTTP

Application layer: overview

- Principles of network applications
- **Web and HTTP**
- E-mail, SMTP, IMAP
- The Domain Name System
DNS
- P2P applications
- video streaming and content distribution networks
- socket programming with UDP and TCP



Web and HTTP

First, a quick review...

- web page consists of *objects*, each of which can be stored on different Web servers
- object can be HTML file, JPEG image, Java applet, audio file,...
- web page consists of *base HTML-file* which includes *several referenced objects, each* addressable by a *URL*, e.g.,

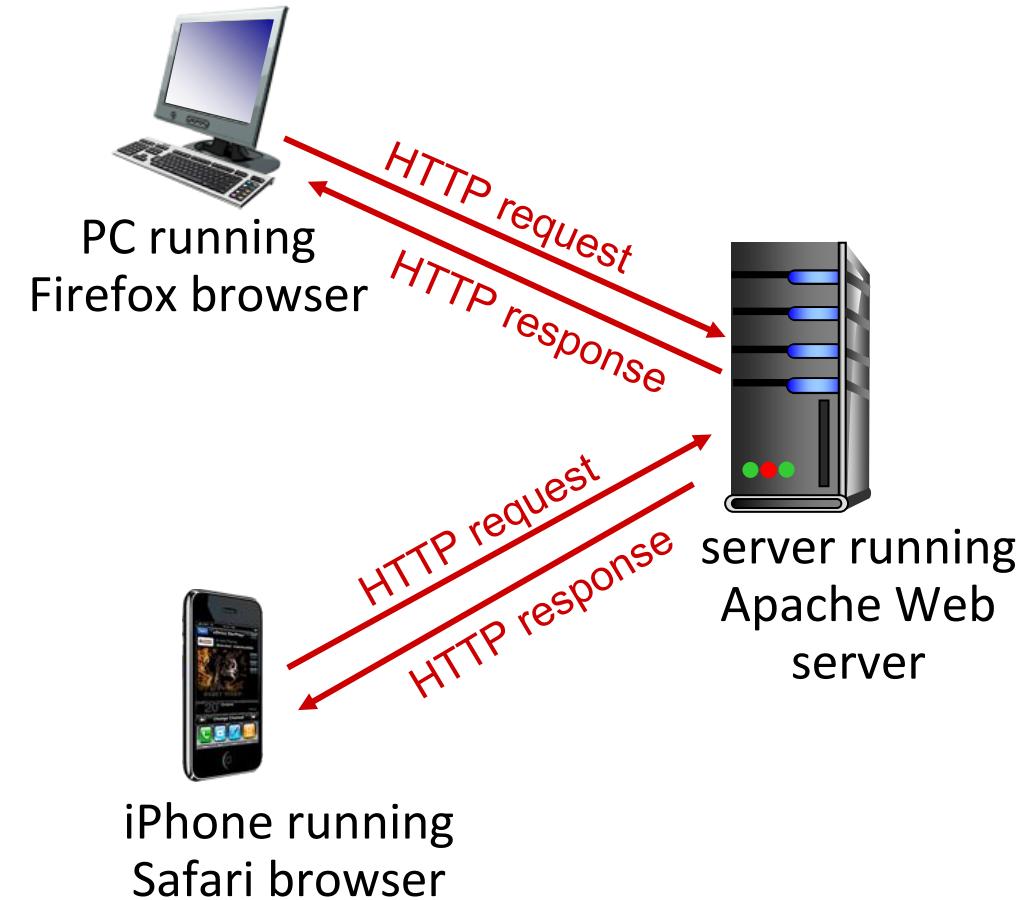
www.someschool.edu/someDept/pic.gif

The URL 'www.someschool.edu/someDept/pic.gif' is shown. A horizontal brace is positioned below the first part of the URL, 'www.someschool.edu', with the label 'host name' centered below it. Another horizontal brace is positioned below the remaining part of the URL, '/someDept/pic.gif', with the label 'path name' centered below it.

HTTP overview

HTTP: hypertext transfer protocol

- Web's application-layer protocol
- client/server model:
 - *client*: browser that requests, receives, (using HTTP protocol) and “displays” Web objects
 - *server*: Web server sends (using HTTP protocol) objects in response to requests



HTTP overview (continued)

HTTP uses TCP:

- client initiates TCP connection (creates socket) to server, port 80
- server accepts TCP connection from client
- HTTP messages (application-layer protocol messages) exchanged between browser (HTTP client) and Web server (HTTP server)
- TCP connection closed

HTTP is “stateless”

- server maintains *no* information about past client requests

aside
protocols that maintain “state” are complex!

- past history (state) must be maintained
- if server/client crashes, their views of “state” may be inconsistent, must be reconciled

HTTP connections: two types

Non-persistent HTTP

1. TCP connection opened
2. at most one object sent over TCP connection
3. TCP connection closed

downloading multiple objects required multiple connections

Persistent HTTP

- TCP connection opened to a server
- multiple objects can be sent over *single* TCP connection between client, and that server
- TCP connection closed

Non-persistent HTTP: example

User enters URL: `www.someSchool.edu/someDepartment/home.index`
(containing text, references to 10 jpeg images)



time ↓

1a. HTTP client initiates TCP connection to HTTP server (process) at `www.someSchool.edu` on port 80

2. HTTP client sends HTTP *request message* (containing URL) into TCP connection socket. Message indicates that client wants object `someDepartment/home.index`



1b. HTTP server at host `www.someSchool.edu` waiting for TCP connection at port 80 “accepts” connection, notifying client

3. HTTP server receives request message, forms *response message* containing requested object, and sends message into its socket

Non-persistent HTTP: example (cont.)

User enters URL: `www.someSchool.edu/someDepartment/home.index`
(containing text, references to 10 jpeg images)



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

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



4. HTTP server closes TCP connection.

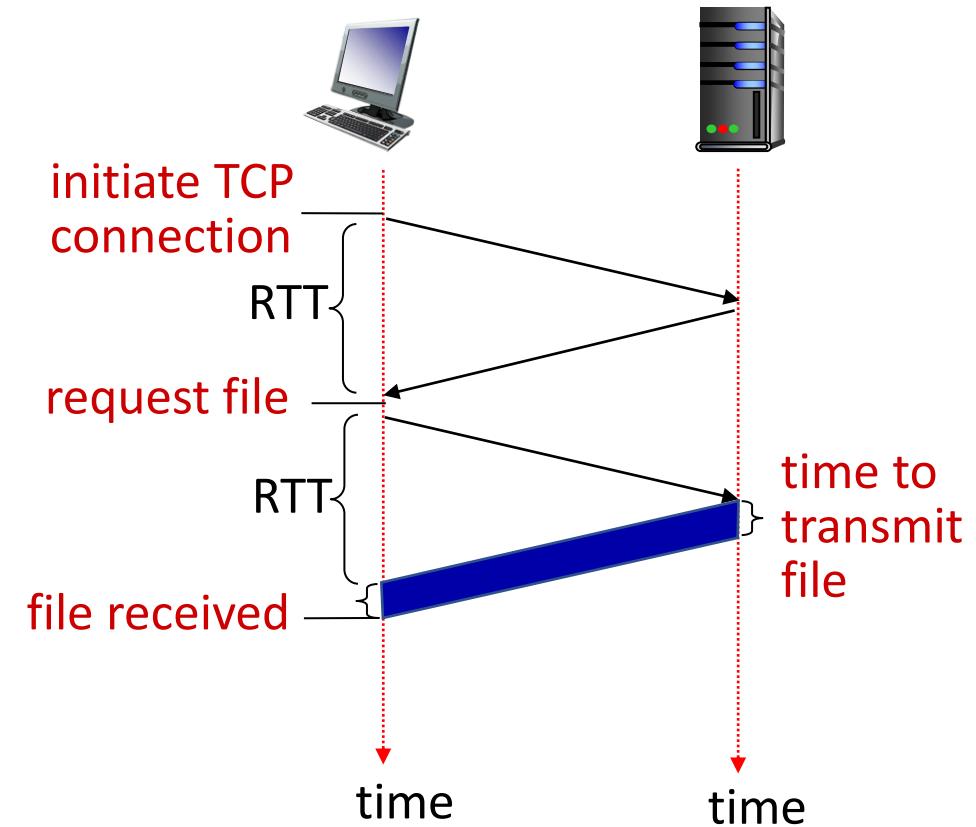
time

Non-persistent HTTP: response time

RTT (definition): time for a small packet to travel from client to server and back

HTTP response time (per object):

- one RTT to initiate TCP connection
- one RTT for HTTP request and first few bytes of HTTP response to return
- object/file transmission time



$$\text{Non-persistent HTTP response time} = 2\text{RTT} + \text{file transmission time}$$

Persistent HTTP (HTTP 1.1)

Non-persistent HTTP issues:

- requires 2 RTTs per object
- OS overhead for *each* TCP connection
- browsers often open multiple parallel TCP connections to fetch referenced objects in parallel

Persistent HTTP (HTTP1.1):

- server leaves connection open after sending response
- subsequent HTTP messages between same client/server sent over open connection
- client sends requests as soon as it encounters a referenced object
- as little as one RTT for all the referenced objects (cutting response time in half)

HTTP request message

- two types of HTTP messages: *request, response*
- **HTTP request message:**

- ASCII (human-readable format)

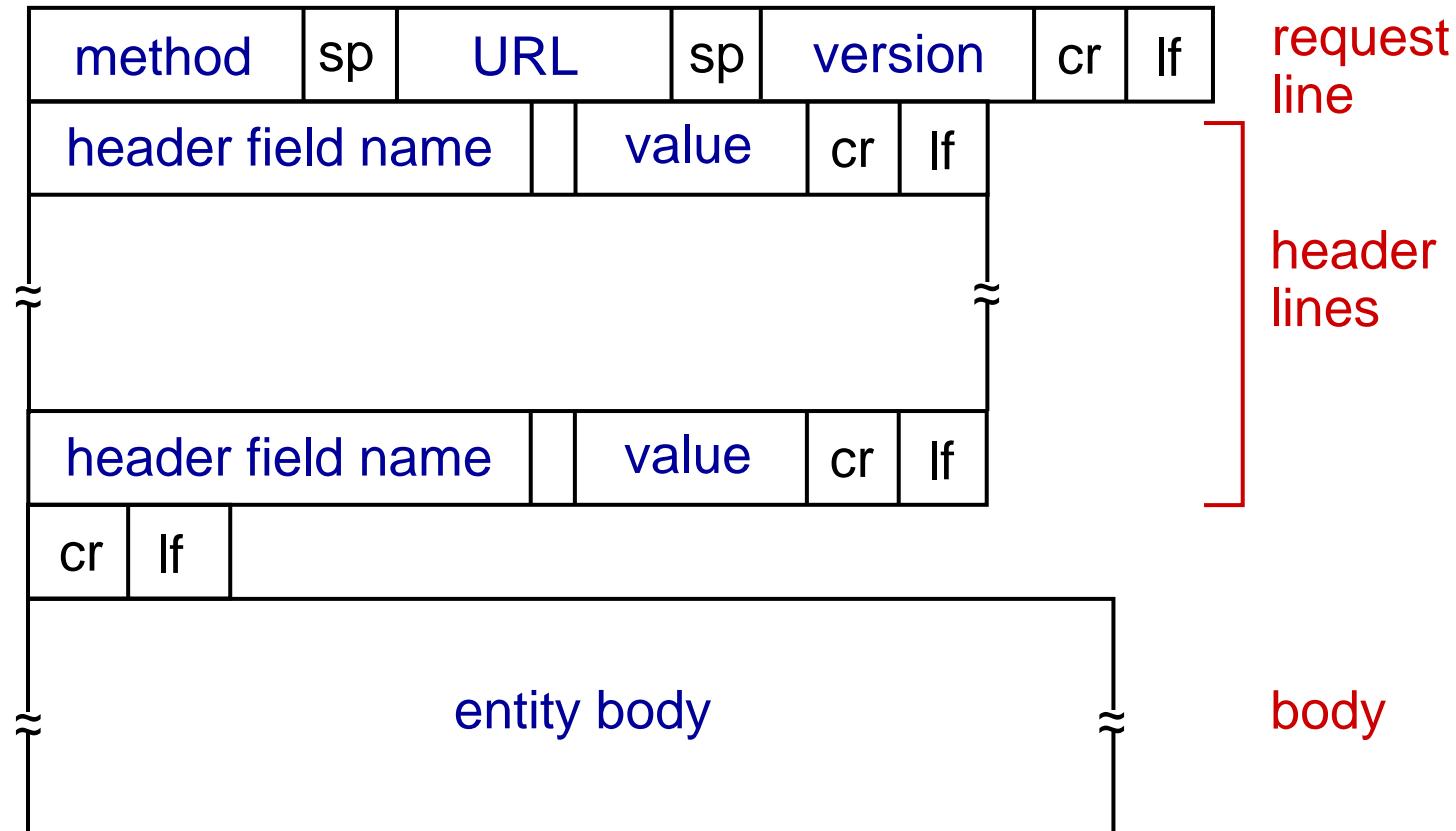
request line (GET, POST,
HEAD commands) →

carriage return character
line-feed character

carriage return, line feed →
at start of line indicates
end of header lines

* Check out the online interactive exercises for more
examples: http://gaia.cs.umass.edu/kurose_ross/interactive/

HTTP request message: general format



Other HTTP request messages

POST method:

- web page often includes form input
- user input sent from client to server in entity body of HTTP POST request message

GET method (for sending data to server):

- include user data in URL field of HTTP GET request message (following a '?'):

`www.somesite.com/animalsearch?monkeys&banana`

HEAD method:

- requests headers (only) that would be returned *if* specified URL were requested with an HTTP GET method.

PUT method:

- uploads new file (object) to server
- completely replaces file that exists at specified URL with content in entity body of POST HTTP request message

HTTP response message

status line (protocol → **HTTP/1.1 200 OK**
status code status phrase)

HTTP response status codes

- status code appears in 1st line in server-to-client response message.
- some sample codes:

200 OK

- request succeeded, requested object later in this message

301 Moved Permanently

- requested object moved, new location specified later in this message (in Location: field)

400 Bad Request

- request msg not understood by server

404 Not Found

- requested document not found on this server

505 HTTP Version Not Supported

Trying out HTTP (client side) for yourself

1. netcat to your favorite Web server:

```
% nc -c -v gaia.cs.umass.edu 80
```

- opens TCP connection to port 80 (default HTTP server port) at gaia.cs.umass.edu.
- anything typed in will be sent to port 80 at gaia.cs.umass.edu

2. type in a GET HTTP request:

```
GET /kurose_ross/interactive/index.php HTTP/1.1  
Host: gaia.cs.umass.edu
```

- by typing this in (hit carriage return twice), you send this minimal (but complete) GET request to HTTP server

3. look at response message sent by HTTP server!

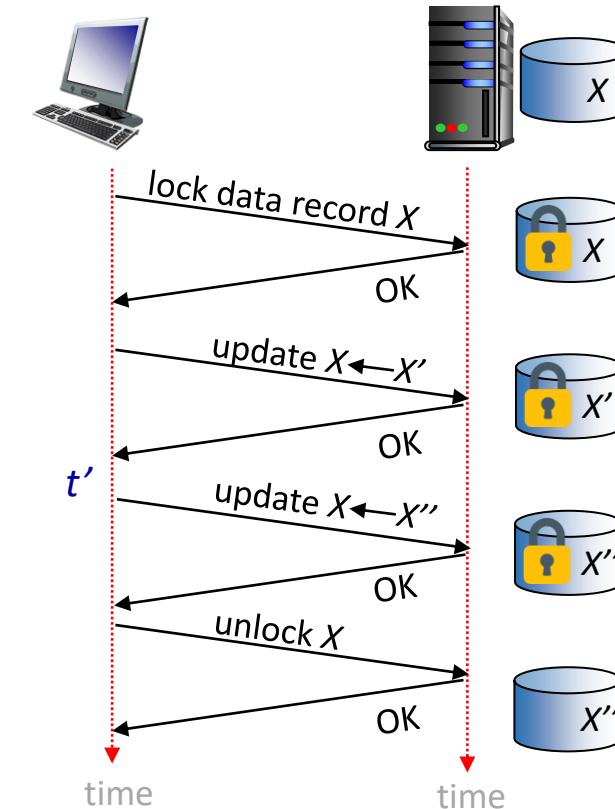
(or use Wireshark to look at captured HTTP request/response)

Maintaining user/server state: cookies

Recall: HTTP GET/response interaction is *stateless*

- no notion of multi-step exchanges of HTTP messages to complete a Web “transaction”
 - no need for client/server to track “state” of multi-step exchange
 - all HTTP requests are independent of each other
 - no need for client/server to “recover” from a partially-completed-but-never-completely-completed transaction

a stateful protocol: client makes two changes to X, or none at all



Q: what happens if network connection or client crashes at t' ?

Maintaining user/server state: cookies

Web sites and client browser use ***cookies*** to maintain some state between transactions

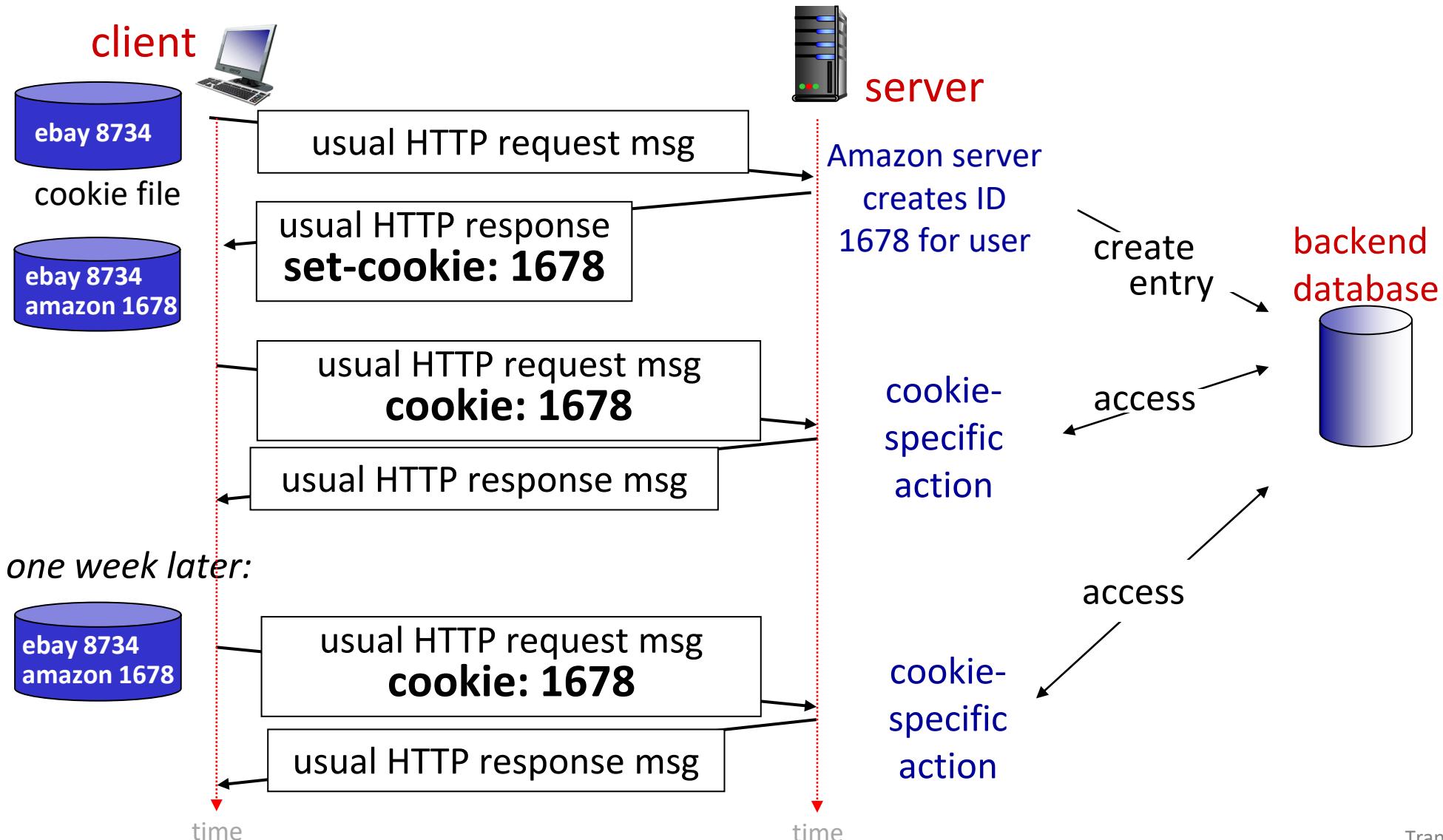
four components:

- 1) cookie header line of HTTP *response* message
- 2) cookie header line in next HTTP *request* message
- 3) cookie file kept on user's host, managed by user's browser
- 4) back-end database at Web site

Example:

- Susan uses browser on laptop, visits specific e-commerce site for first time
- when initial HTTP requests arrives at site, site creates:
 - unique ID (aka "cookie")
 - entry in backend database for ID
 - subsequent HTTP requests from Susan to this site will contain cookie ID value, allowing site to "identify" Susan

Maintaining user/server state: cookies



HTTP cookies: comments

What cookies can be used for:

- authorization
- shopping carts
- recommendations
- user session state (Web e-mail)

Challenge: How to keep state?

- *at protocol endpoints:* maintain state at sender/receiver over multiple transactions
- *in messages:* cookies in HTTP messages carry state

aside
cookies and privacy:

- cookies permit sites to *learn* a lot about you on their site.
- third party persistent cookies (tracking cookies) allow common identity (cookie value) to be tracked across multiple web sites

Questions

Thank you