

The World Wide Web

- what it is
- a brief history
- how it works
- how advertising works
- cookies, other tracking
- technical issues
- political / legal / social / economic / jurisdictional issues

(World Wide) Web

- a way to connect computers that provide information (servers) with computers that ask for it (clients like you and me)
 - uses the Internet, but it's not the same as the Internet
- URL (uniform resource locator, e.g., <http://www.amazon.com>)
 - a way to specify what information to find, and where
- HTTP (hypertext transfer protocol)
 - a way to request specific information from a server and get it back
- HTML (hypertext markup language)
 - a language for describing information for display
- browser (Firefox, Safari, Internet Explorer, Opera, Chrome, ...)
 - a program for making requests, and displaying results
- embellishments
 - pictures, sounds, movies, ...
 - loadable software
- the set of everything this provides

HTTP: Hypertext transfer protocol

- What happens when you click on a URL?
- client opens TCP/IP connection to host, sends request

```
GET /filename HTTP/1.0
```

- server returns
 - header info
 - HTML



- since server returns the text, it can be created as needed
 - can contain encoded material of many different types (MIME)

- URL format

```
service://hostname/filename?other_stuff
```

- *filename?other_stuff* part can encode
 - data values from client (forms)
 - request to run a program on server (cgi-bin)
 - anything else

Embellishments

- **original design of HTTP just returns text to be displayed**
- **now includes pictures, sound, video, ...**
 - need helpers or plug-ins to display non-text content
e.g., GIF, JPEG graphics; sound; movies
- **forms filled in by user**
 - need a program on the server to interpret the information (cgi-bin)
- **cookies to remember information on client**
 - HTTP is stateless: server doesn't save anything from one request to next
 - cookies are a way to remember information at the client
- **active content: download code to run on the client**
 - Javascript
 - plug-ins

Forms and CGI programs

- **"common gateway interface"**
 - standard way to request the server to run a program
 - using information provided by the client via a form
- **if the target file on server is an executable program**
- **and it has the right properties and permissions**
 - e.g., in /cgi-bin directory and executable
- **then run it on server to produce HTML to send back to client**
 - using the contents of the form as input
 - output depends on client request: created on the fly, not just a file
- **CGI programs can be written in any programming language**
 - Perl, Python, PHP, Java, Ruby, ...

Cookies

- HTTP is stateless: doesn't remember from one request to next
- cookies intended to deal with stateless nature of HTTP
 - remember preferences, manage "shopping cart", etc.
- **cookie: one chunk of text sent by server to be stored on client**
 - stored in browser while it is running (transient)
 - stored in client file system when browser terminates (persistent)
- **when client reconnects to same domain,**
 - browser sends the cookie back to the server**
 - sent back verbatim; nothing added
 - sent back only to the same domain that sent it originally
 - contains no information that didn't originate with the server
- in principle, pretty benign
- but heavily used to monitor browsing habits, for commercial purposes

Advertising

- **advertising exchanges**
 - Doubleclick Ad Exchange, ...
- **a person uses a browser to request a web page**
- **the web page "publisher" notifies exchange that advertising space on that page is available**
 - publishers are typically portals or entertainment and news sites
 - publisher provides information about the person: past online activity, viewing and shopping habits, geographic location, demographics
probably not actual identity (?)
- **advertisers bid on the ad space**
 - amount depends on person's attributes and location, advertiser's budget, etc.
- **winner's advertisement is inserted into the page**
- **elapsed time: 10-100 milliseconds**
- **this happens for multiple advertisements on one page**

Cookies are not the only tracking mechanism

- **web bugs, web beacons, single-pixel gifs**
 - tiny images that report the use of a particular page
 - these can be used in mail messages, not just browsers
- **"super cookies"**
 - e.g., Verizon's X-UIDH HTTP header on cellphones
 - cookie respawning
- **HTML canvas fingerprinting**
 - uses subtle differences in browser behavior to distinguish users
- **defenses:**
addons like AdBlock, uMatrix, Ghostery, NoScript

Plug-ins, add-ons, extensions, etc.

- **programs that extend capabilities of browser (and other programs)**
 - browser provides an API and a protocol for data exchange
 - extension focuses on specific application area
 - e.g., documents, pictures, sound, movies, scripting language, ...
 - may exist standalone as well as in plug-in form
 - e.g., Acrobat Reader, Flash, Quicktime, Windows Media Player, ...
- **scripting languages interpret downloaded programs**
 - Javascript
 - compiled into instructions for a virtual machine
 - (like the Toy machine on steroids)
 - instructions are interpreted by virtual machine in browser

Potential security & privacy problems

- **attacks against client**

- release of client information

- cookies: client remembers info for subsequent visits to same server

- adware, phishing, spyware, viruses, ...

- spyware: client sends info to server upon connection (Sony, ...)

- often from unwise downloading

- buggy/misconfigured browsers, etc., permit vandalism, theft, hijacking, ...

- **attacks against server**

- client asks server to run a programs when using cgi-bin

- server-side programming has to be careful

- buggy code on server permits break-in, theft, vandalism, hijacking, ...

- denial of service attacks

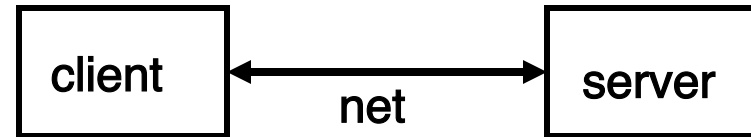
- **attacks against information in transit**

- eavesdropping

- encryption helps

- masquerading

- needs authentication in both directions



Privacy on the Web

- **what does a browser send with a web request?**
 - IP address, browser type, operating system type
 - referrer (URL of the page you were on)
 - cookies
- **what do "they" know about you?**
 - whatever you tell them, implicitly or explicitly (e.g., Facebook)
 - public records are really public
 - lots of big databases like phone books
 - log files everywhere
 - aggregators collect a lot of information for advertising
 - spyware, key loggers and similar tools collect for nefarious purposes
 - government spying is everywhere
- **who owns your information?**
 - in the USA, they do
 - less so in the EU

Defenses

- use strong passwords; don't share them across important accounts
- use 2-factor identification when available (e.g., Duo)
- cookies off, spam filter on, Javascript limited
- turn off previewers and HTML mail readers
- anti-virus software on and up to date
 - turn on macro virus protection in Word, etc.
- run spyware detectors
- use a firewall
- try less-often targeted software
- be careful and suspicious all the time
 - don't view attachments from strangers
 - don't view unexpected attachments from friends
 - don't just read/accept/click/install when requested
 - don't install file-sharing programs
 - be wary when downloading software

