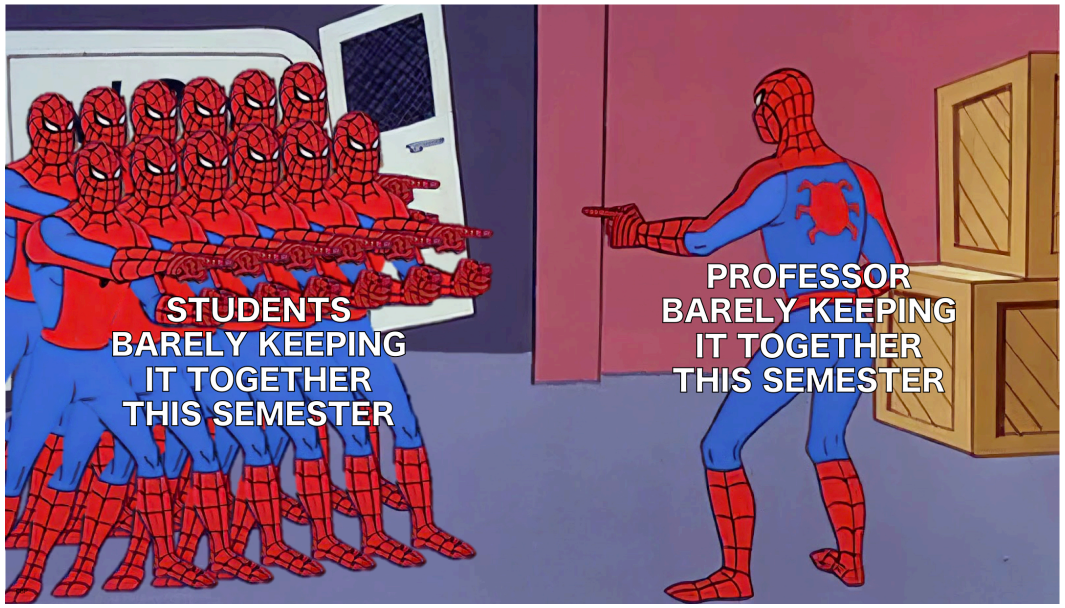
The Web...


STUDENTS
BARELY KEEPING
IT TOGETHER
THIS SEMESTER
PROFESSOR
BARELY KEEPING
IT TOGETHER
THIS SEMESTER

Bug of the Day: VMWare V-Sphere

- Guess what, ***not a buffer overflow!***
- Instead, vSphere runs a web server
  - Because well everything is a web server...
- Unauthenticated user could upload an archive file
  - That would be extracted in /tmp using standard utilities...
- But you can have ../../ in a tar archive
  - Go up in the directory... tar doesn't check
- So have a tar archive that is ../../.ssh/authorized_keys...
  - And can now log in to the server!

Critical VMware vSphere Vulnerability Is a Must-Patch

"It's really the highest possible risk we have, and exploitation is very simple."

Maria Korolov | Feb 26, 2021

About Project 2...

- Not only is it to teach you the difficulty of implementing crypto systems
  - Real-world cruel grading would be "1 security bug -> 0 credit!"
  - This is the "Kobyashi Maru" project: I don't want anybody to get 100%!
    But I want everyone to get >80%. You learn from failure too, not just success
    - I really don't want you building crypto-systems outside this class!
      When I've had students go on and do it, they've failed!
- But to also test/teach by doing some important software engineering skills
  - Using a safe language (Go)
  - Developing good tests
    - Go has an excellent testing infrastructure
  - Design ***first!***
  - Serialization & Deserialization of Data
    - How to go from program internal representations to blobs-of-data and back...

Don't write code first, ***design*** first!

- Read all parts...
- Write your design document ***first***
  - When you ask the TAs for help, they are instructed to start with your design document!
- Good design makes the project easy (ish)
  - My 100% solution for the slightly simpler version last year is <400 LOC...
  - But of course my initial 100% solution actually had a bug!
- Couple more hints on the design...
  - What do HMAC and Argon2 do?
  - When in doubt there is the universal CS solution:
    add another layer of indirection!

The Data Storage Problem:

- You have some ugly internal data structures...
  - It doesn't really matter what it is, but lots of pointers, arrays, and other ugly things...
- You need to convert it to a single string of bits
  - For storage, encryption, transmission, whatever
  - And go the other way, turn it back into the data structure
- This is called ***serialization*** and ***deserialization***: Turning your data into a sequence of bits

Paradigm #1:
Do It Manually...

- The C/C++ traditional world
  - Also very common in network programming
  - Python's **`struct`** module as well
- Define a byte order
  - If you need to go between different instruction sets!
- Pack/unpack data into bytes
  - If you may have endianness, use **`ntoh`** and **`hton`**
- Generally safe when adversaries hand you data...
  - Assuming you don't do classic memory screwups that is
- Generally a PitA!

Paradigm #2:
Java `serialize` & python `pickle`...

- Nice and convenient:
  - Allows you to dump and restore arbitrary objects
- But ***horribly dangerous!***
  - If an adversary provides an object, it can deserialize to ***basically anything they want***!
- Never, ***ever ever ever*** use these if you are communicating outside your own program!
  - They are not suitable for a malicious environment!
- Common programmer F-up: Use serialize or pickle ***thinking*** it will only have trusted input...
  - And then another programmer creates a path where the function is reachable from untrusted input
- So add these to your "search" list for 'you just got handed a new project'
  - Along with `system()` and direct calls to SQL databases, along with unsafe C string operations:
    If you see `serialize` or `pickle`: worry if you need to worry about untrusted input!

Paradigm #3:
Google Protocol Buffers

- Provides a compiler to compile code to pack/unpack structures
  - Highly efficient binary encoding
  - Available for C++, python, java, go, ruby, Objective-C, C#
- Safe, but requires using an external compiler to create code to pack/unpack structures
  - And its not human readable in the slightest

Paradigm #4: XML and JSON

- Text based formats
  - Human readable-ish:
    Don't underestimate the value in being able to read your computer data directly!
- JSON is small and simple
  - Just a few types in key/value pair structures
- XML is grody and complex...
  - XML parsers tend to have bugs.
- Both are less compact
  - Lots of useless text as they are ASCII format, not binary
- So we provide you with Json **`marshal`**/**`unmarshal`**!
  - Hint: You can coerce the bytes to a string if you want to print what is being written!

Personal Preference:
When in doubt, use json.

- It is cross platform like Google Protocol Buffers
  - But doesn't require any external compiler support
- It is simple
- It is "geek readable"
  - Especially if you turn on pretty-printing to add newlines
- It is really easy for web applications to use
  - JavaScript directly recognizes it! "JavaScript Object Notation"
- Space overhead pretty much goes away with compression
  - ASCII text is "less efficient" than binary, but gzip() of ASCII text becomes effectively the same in the limit:
    - Compression gets pretty close to the Shannon's limit these days
  - And the web compresses everything pretty much by default

Web Security: Web History...

- Often one needs to start with history to realize why present day is so incredibly **`fsck`**'ed...
  - And the web, is indeed, strongly **`fsck`**'ed up
- We saw that on the back end on Thursday...
  - **`system`** and SQL were designed for non-secure environments

The Prehistory Idea: Memex...

- Observation from 1945:
  We need a conceptual way to organize data
  - A reference library may have a ton of stuff, but how do you find something?
  - Microfilm is even more compact
  - E.g. a single microfiche card is a 105mm x 148mm piece of film
    - That can hold photos of 100 ***pages*** of text!
- But how do we find and understand things?
  - Idea from Vannevar Bush:
    WW2 head of the primary military R&D office
- https://en.wikipedia.org/wiki/Memex

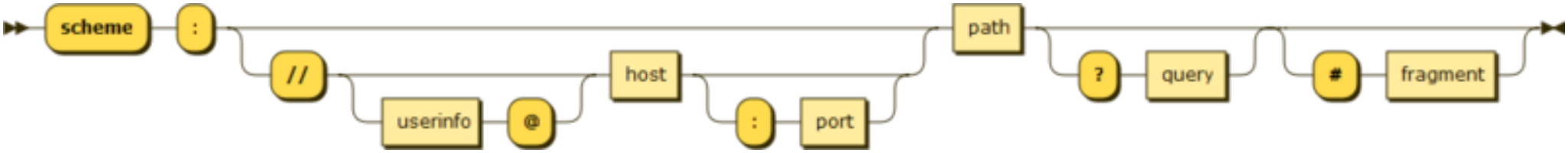
The Memex...

- A big integrated desk that can store and access microfilm...
  - The most compact storage available at the time
- Idea #1: "Trails"
  - Rather than just view pages of data linearly...
  - You could follow a "trail": A linear path through an arbitrary sequence of actual film
    - This is what we'd now call a "hyperlink":
      Refer to another piece of data by location
  - You could also create "personal trails": your own custom path for
- Idea #2: "Upload data"
  - It would also include a photographic hood:
    You could then add it to the collection in the Memex
- Never actually ***built*** but conceptually very important
- Note that it was ***only*** about accessing data, not code!

HTML, HTTP, and URLs

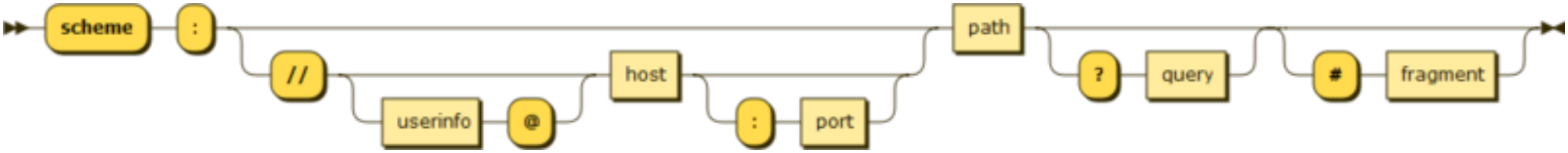
- HTML: Hyper Text Markup Language
  - A text-based representation with "tags" (e.g. <TITLE>this is a title</TITLE>, <A HREF="....">, <IMG SRC="...">)
- HTTP: Hyper Text Transfer Protocol
  - A (cleartext) protocol used to fetch HTML and other documents from a remote server (the "Web server")
- URLs: Uniform Resource Locators
  - A text format for identifying where a piece of data is in the world...

The URL, which is a URI (Uniform Resource Identifier



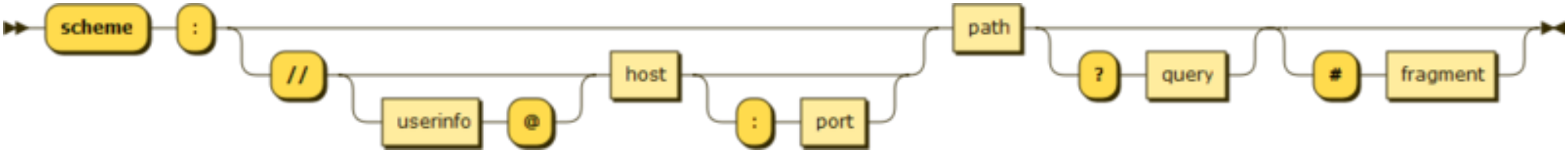
- https://en.wikipedia.org/wiki/Uniform_Resource_Identifier
- Scheme: What protocol to use, e.g.
  - "ftp" File Transfer Protocol
  - "http" Hyper Text Transfer Protocol
  - "https" Encrypted HTTP
  - "file" A local file on the network
  - "git+ssh" a SSH tunneled git fetch

The URL Continued: Location



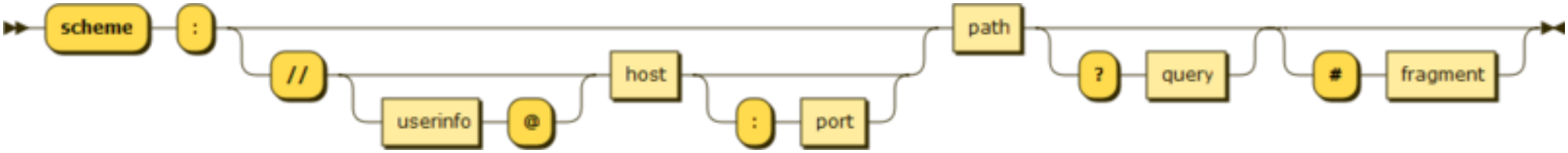
- Remote location: "//.."
  - Username followed by @ if there is one (optional)
  - Host, the remote computer (mandatory if remote)
    - Either a hostname or an IP (Internet Protocol) address
  - Remote port (if different from the default, optional)
    - Networking speaks in terms of remote computers and ports
- This is "where to find the remote computer"

The URL Continued: Path



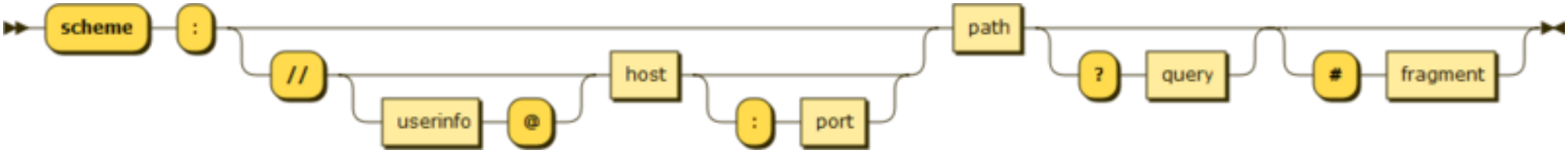
- Path is mandatory and starts with /
  - "/" alone is the "root" of the directory tree, and must appear
- Directory entries are separated with /
  - Unix style rather than Window's style \
- Sent to the remote computer to tell it where to look for the file starting at its own root directory for data that it is sharing

The URL Continued: Query



- Query is optional and starts with ?
  - Need to encode ? as %3f if elsewhere in the URI
- This is sent to the remote server
  - Commonly designed as a set of key/value pairs... EG, Name=Nick&Role=SuperGenius
  - Remote server will then interpret the data appropriately

The URL Continued: Fragment



- Fragment is optional and starts with #
- This is ***not sent*** to the remote server!
  - Only available to the local content
  - Initially intended just to tell the web browser where to jump to in a document...
  - But now used for JavaScript to have local content in the URL that isn't sent over to the server

URIs are ASCII text

- It is an ASCII (plain text) format: Only 7 bits with "printable" characters
- To encode non-printable characters, spaces, special characters (e.g. ?, #, /) you must "URL encode" as %xx with xx being the hexadecimal value
  - %20 = ' '
  - %35 = '#'
- Can optionally encode normal ASCII characters too!
  - %50 = '2'
- Can make it hard to detect particular problems...
  - EG, /%46%46/etc/password converts to: /../etc/password
    - Will go "above the root" if the web server is misconfigured to grab the password file!

HTTP
(Hypertext Transfer Protocol)

A common data communication protocol on the web

HTTP

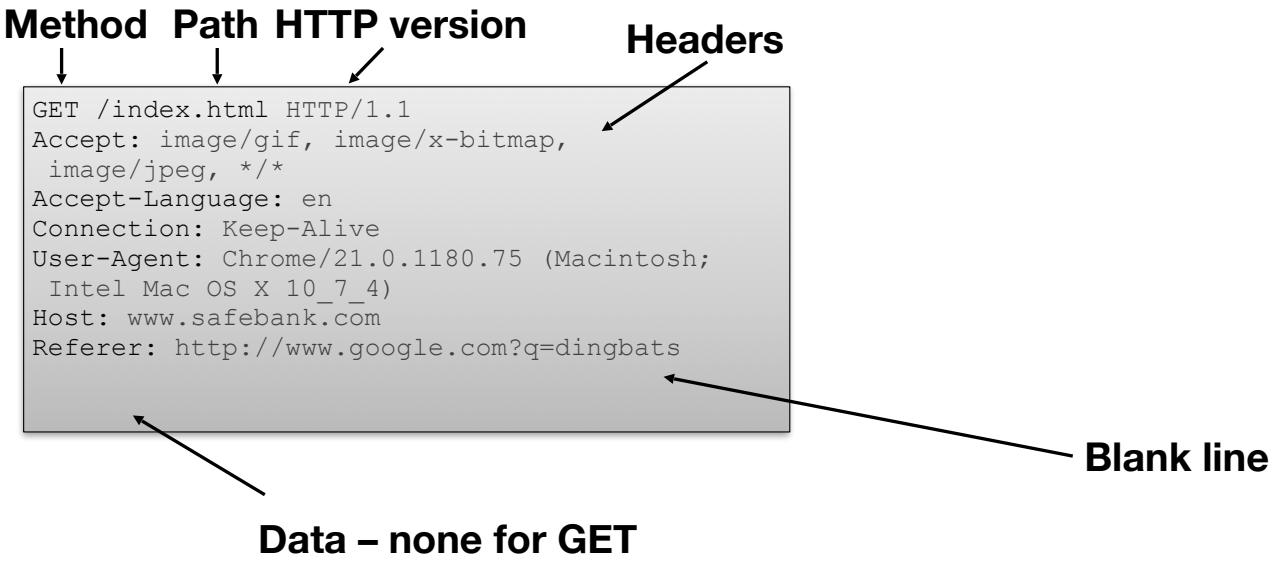

CLIENT BROWSER
WEB SERVER
safebank.com
safebank.com/account.html
SAFEBANK
Alice
Smith
Accounts
Bill Pay
Mail
Transfers
HTTP REQUEST:
GET /account.html HTTP/1.1
Host: www.safebank.com
HTTP RESPONSE:
HTTP/1.0 200 OK
<HTML> . . . </HTML>

HTTP Request

GET: no side effect (supposedly, HA)

POST: possible side effect, includes additional data

HEAD: only the first part of the content



HTTP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WEB SERVER
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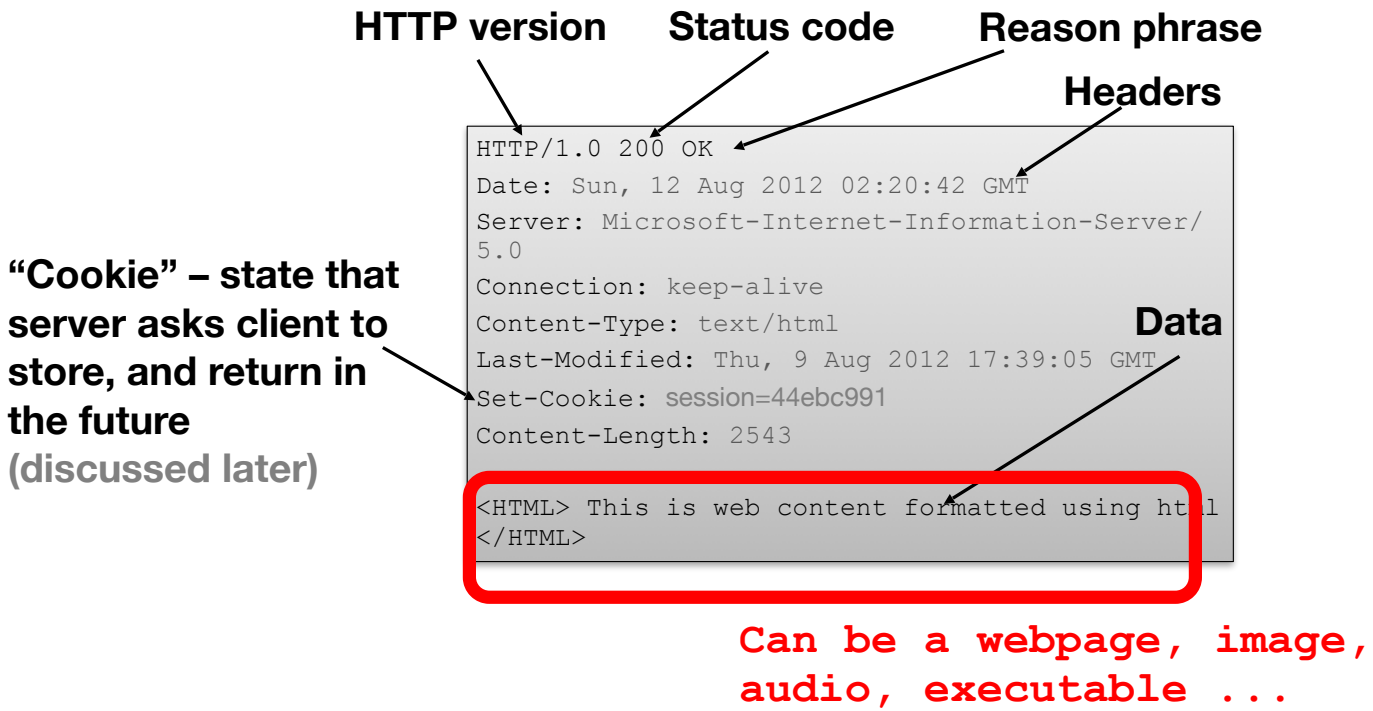
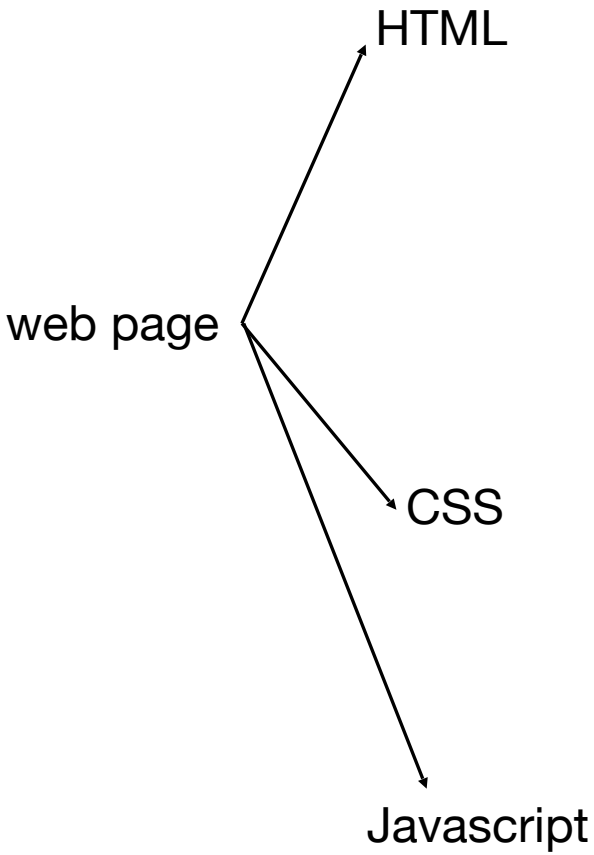
Alice Smith
Accounts
Bill Pay
Mail
Transfers
HTTP REQUEST:
GET /account.html HTTP/1.1
Host: www.safebank.com
HTTP RESPONSE:
HTTP/1.0 200 OK
<HTML> . . . </HTML>

HTTP Response



Web page



HTML

A language to create structured documents
One can embed images, objects, or create interactive forms

index.html

```
<html>
    <body>
        <div>
            foo
            <a href="http://google.com">Go to Google!</a>
        </div>
        <form>
            <input type="text" />
            <input type="radio" />
            <input type="checkbox" />
        </form>
    </body>
</html>
```

CSS (Cascading Style Sheets)

Language used for describing the presentation of a document

index.css

```
p.serif {
font-family: "Times New Roman", Times, serif;
}
p.sansserif {
font-family: Arial, Helvetica, sans-serif;
}
```

Originally There Was Only HTTP...

- It was a way of expressing the text of the documents
  - With other embedded content like images...
- And it was good, but...
- Sun had a programming language called "Java"
  - Designed to compile to an intermediate representation and run on a lot of systems
- They built a web browser that could also fetch and execute Java...
  - But Java was too powerful: It was designed to do everything a host program could do
- So they created a language called "JavaScript"
  - Only thing in common with "Java" is the name and bits of the syntax

Javascript

Programming language used to manipulate web pages. It is a high-level, dynamically typed and interpreted language with support for objects. It is why web sites are now programs running in the browser

Supported by all web browsers

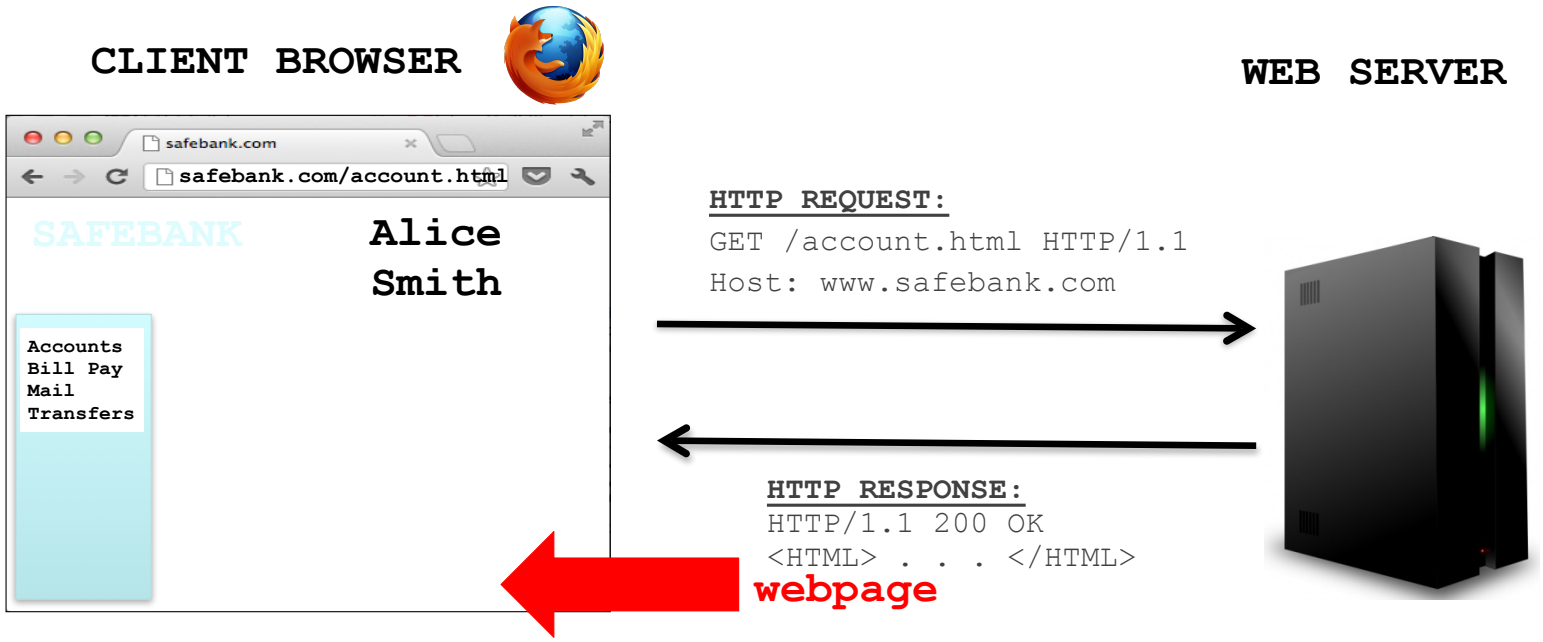
```
<script>
function myFunction()
{    document.getElementById("demo").innerHTML = ”Text
changed.";
}
</script>
```

Very powerful!

Lots Of Work To Make This Fast...

- These days JavaScript is used just about everywhere
  - So a lot of work goes into making this execute quickly
- Common technique: "Just In Time Compiler"
- Initially interprets JavaScript
- After a function is interpreted enough, convert the function into native machine code
  - So need some memory that is both executable AND writeable...
- Which is why vulnerabilities in the JavaScript interpreter/compiler are so dangerous
  - Attacker is already running code, its just "sandboxed" to limit what it can do
  - Gain an arbitrary read/write primitive:
    EG "use after free" on a JavaScript object
  - Now can have the JavaScript program inspect memory!
  - Breaks ASLR: The attacker's program can examine memory to derandomize things
  - Breaks W^X: Find something in the W&X space to overwrite with the attacker's code...
    - No need to do those silly ROP chains...

HTTP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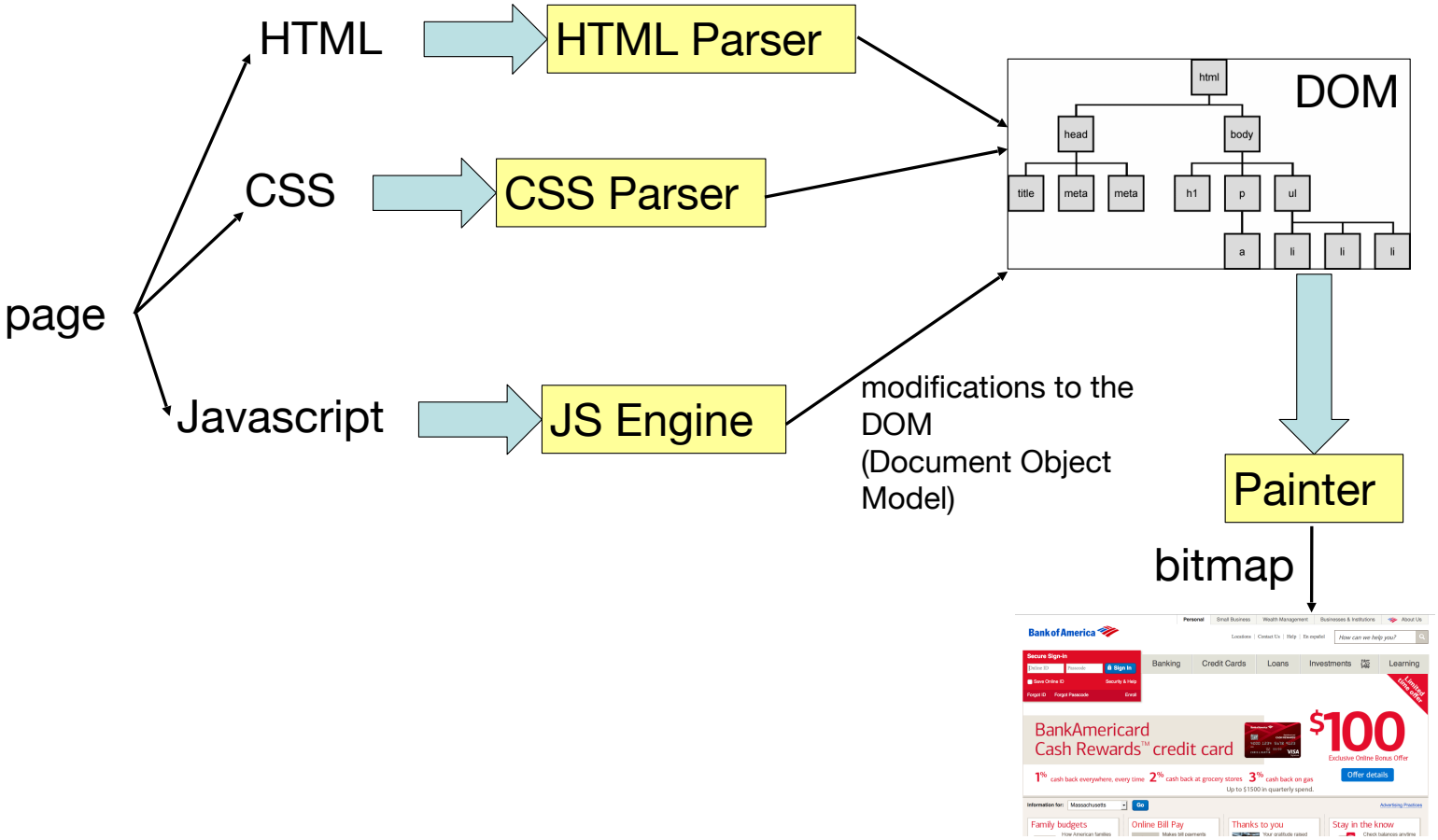
Accounts
Bill Pay
Mail
Transfers
HTTP REQUEST:
GET /account.html HTTP/1.1
Host: www.safebank.com
HTTP RESPONSE:
HTTP/1.1 200 OK
<HTML> . . . </HTML>
webpage

Page rendering

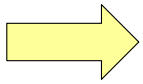


DOM (Document Object Model)

Cross-platform model for representing and interacting with objects in HTML

HTML

```
<html>
    <body>
        <div>
            foo
        </div>
        <form>
            <input type="text" />
            <input type="radio" />
            <input type="checkbox" />
        </form>
    </body>
</html>
```



DOM Tree

```
|-> Document
   |-> Element (<html>)
     |-> Element (<body>)
       |-> Element (<div>)
         |-> text node
       |-> Form
            |-> Text-box
            |-> Radio Button
            |-> Check Box
```

The power of Javascript

Get familiarized with it so that you can think of all the attacks one can do with it.

What can you do with Javascript?

Almost anything you want to the DOM!

A JS script embedded on a page can modify in almost arbitrary ways the DOM of the page.

The same happens if an attacker manages to get you load a script into your page.

w3schools.com has nice interactive tutorials

Example of what Javascript can do…

Can change HTML content:

```
<p id="demo">JavaScript can change HTML content.</p>

<button type="button"
onclick="document.getElementById('demo').innerHTML =
'Hello JavaScript!'">
   Click Me!</button>
```

DEMO from
http://www.w3schools.com/js/js_examples.asp

Other examples

Can change images
Can chance style of elements
Can hide elements
Can unhide elements
Can change cursor...

Basically, can do ***anything it wants*** to the DOM

Another example: can access cookies (Access control tokens)

Read cookie with JS:

```
var x = document.cookie;
```

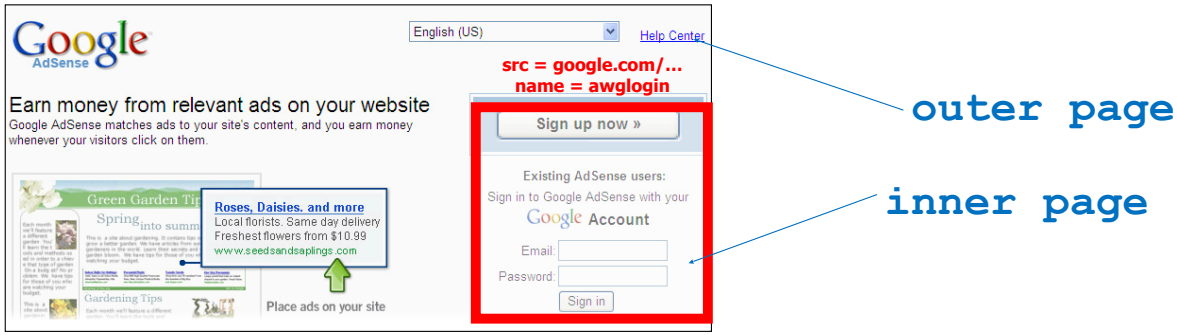
Change cookie with JS:

```
document.cookie = "username=John Smith; expires=Thu, 18
Dec 2013 12:00:00 UTC; path=/";
```

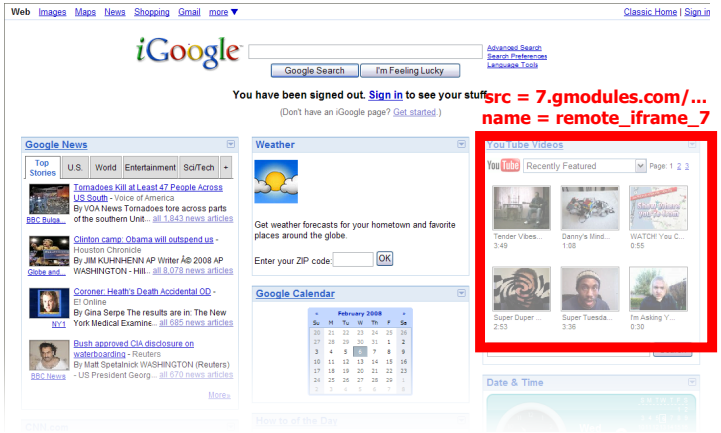
Frames

- Enable embedding a page within a page

```
<iframe src="URL"></iframe>
```



Frames



- Modularity
  - Brings together content from multiple sources
  - Client-side aggregation
- Delegation
  - Frame can draw only inside its own rectangle

Frames

- Outer page can specify only sizing and placement of the frame in the outer page
- Frame isolation: Outer page cannot change contents of inner page; inner page cannot change contents of outer page

Desirable security goals

- ***Integrity***: malicious web sites should not be able to tamper with integrity of our computers or our information on other web sites
- ***Confidentiality***: malicious web sites should not be able to learn confidential information from our computers or other web sites
- ***Privacy***: malicious web sites should not be able to spy on us or our online activities
- ***Availability***: malicious parties should not be able to keep us from accessing our web resources

Security on the web

- Risk #1: we don't want a malicious site to be able to trash files/programs on our computers
  - Browsing to **`awesomevids.com`** (or **`evil.com`**) should not infect our computers with malware, read or write files on our computers, etc...
  - We generally assume an adversary can cause our browser to go to a web page of the attacker's choosing
- Mitigation strategy
  - Javascript is sandboxed: it is ***not allowed*** to access files etc...
  - Browser code tries to avoid bugs:
    - Privilege separation, automatic updates
    - Reworking into safe languages (rust)

Security on the web

- Risk #2: we don't want a malicious site to be able to spy on or tamper with our information or interactions with other websites
  - Browsing to **`evil.com`** should not let **`evil.com`** spy on our emails in Gmail or buy stuff with our Amazon accounts
- Defense: Same Origin Policy
  - An ***after the fact*** isolation mechanism enforced by the web browser

Security on the web

- Risk #3: we want data stored on a web server to be protected from unauthorized access
- Defense: server-side security

Major Property:
"Same Origin Policy"

- Basic idea:
  - A web page runs from an 'origin': A remote domain/protocol/port tuple.
- Within that origin, the web page runs code in the browser
  - But is ***only*** supposed to affect things within the same origin
- The web browser ***must*** enforce this isolation
  - Otherwise, a malicious web site can cause behaviors on other web sites
- Matching is exact
  - **`http://www.example.com`**,
    `https://www.example.com`,
    `http://example.com` are ***all*** different origins

Same Origin Controls
What A Page Can Do...

- Can ***fetch*** images and content ***regardless of origin***
  - But can ***not*** determine detailed properties:
    Images are blank squares when loaded cross-origin
  - Remote scripts run within the origin of the page, not the origin where they are fetched from
- Can create frames
  - Each frame can be in its own origin...
  - Can only ***communicate*** with frames from the same origin or with origin crossing options
- Can ***only*** do certain calls (e.g. xml-http-request) to the origin
- Summary here:
  https://developer.mozilla.org/en-US/docs/Web/Security/Same-origin_policy
- There is an option for the ***other*** origin to specifically allow sharing
  - Cross Origin Resource Sharing (CORS):
    https://developer.mozilla.org/en-US/docs/Web/HTTP/CORS

Can change origin ***up...***

- **`www.example.com`** can change its origin to be **`example.com`**
  - But once it does so, it is no longer in the origin of **`www.example.com`**
- But can't change origin down

But Cookies Are Different

- Cookies can be set by a remote website
  - With the **`set-cookie:`** header
- And can also be set by JavaScript
- Common usage: user authentication
  - EG, set a "magic value" to identify the user
  - The server can then check that value on subsequent fetches
- If someone or another web-site can get this cookie...
  - They can impersonate that user
  - Attacker goal is to often get cookies of other web-sites

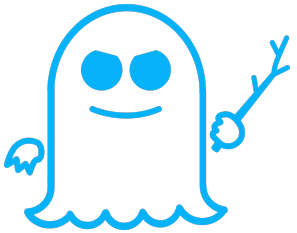
Cookie Origin Rules != JavaScript Same Origin

- Cookies are generally described as key/value pairs
  - `username=nick`
  - `authcookie=nSFCOAusrr97097y03`
- Cookies are set with an associated hostname/path binding
  - EG, `example.com/foo`
- It will be sent to all websites who's suffix fully matches:
  - `www.example.com/foo` will get it
  - `example.com/bar` won't get it
- Further complicating things:
  - Although set using name/domain/path/value...
  - They are read (in ***unspecified order***) as just name/value
  - There is ***no way to know*** if you have two copies of the username cookie which one is legit!
  - Leads to fun "Cookie stuffing" attacks
- https://developer.mozilla.org/en-US/docs/Web/HTTP/Cookies

Secure and http-only

- Cookies, by default, will be sent over both http and https
  - Designed so you can have a "secure" login page but "insecure" main pages...
  - From back when the security of HTTPS was considered "expensive"
  - Which means that anyone listening in can capture the cookies
    - "Firesheep": A browser plug-in designed to make it easy to steal login cookies
- "Fix": the "**`secure`**" flag
  - Cookie will only be sent over encrypted connections
    - But you could set it with an insecure connection (now fixed)
- **`http-only`**: Only set in the cookie header
  - Not accessible to JavaScript: Designed to protect (a bit) from rogue scripts

Example of Cookie Failures: Spectre...



- It used to be Chrome isolated different tabs in different Unix processes
  - Both for security sandboxing (you'd need to both exploit the browser AND escape the sandbox to compromise a user) and so if a tab crashed, the browser wouldn't
- Spectre: A hardware sidechannel attack
  - Observation: There are many cases where a program may want to keep data safe from other parts of the same program...
- The big one in this case is JavaScript
  - If you have multiple origins running in the same tab... and one script could read another origin's cookies...
  - It is game over

Real World Spectre: How It Works

- **`evil.com`** gets the user to visit its web page
  - Starts running in a browser tab
- **`evil.com`** then opens a frame to **`victim.com`**
  - Now under the isolation rules:
    JavaScript in **`evil.com`** must not be able to read any memory from **`victim.com`**...
    In particular the cookies
- But they are running in the same operating system process
  - So the only memory protection is enforced by the JavaScript JIT
- Goal: break the isolation, read memory from victim...

Modern Processors: Insanely Complex Beasts...

- In order to get good IPC (Instructions per cycle), modern processors are insanely aggressive
  - Branch prediction: guess which way a program is going to go and do it
  - Aggressive caches: cache everything possible
  - Speculative execution: uh, think I'm going to need this, do it anyway
- Spectre's key idea
  - We can detect the results of failed speculative execution:
    A side-channel attack such as timing, cache state, etc...
    - Allows us to see what the input to the speculative execution was
  - We can ***force*** speculative execution by making the processor guess wrong
  - We can then ***read*** the side channel to know the results of the execution

So Spectre-JS

- **`evil.com`** loads **`victim.com`** in a frame
- And **`evil.com`** javascript then executes this loop
  - **`for (lots) do {...}`**
- All executions are allowed
  - Don't want to get terminated
- But this also trains the branch predictor
  - So the processor will attempt to run the loop one ***more*** time
  - This last time does computation on memory **`evil.com`** is not supposed to see
    - EG **`victim.com`**'s cookies
  - Then checks how long it took which tells some bits about what was being read
    - Lather, rinse, repeat

Countering Spectre:
EAT RAM! NOM NOM NOM

- Chrome & Firefox now runs every ***origin*** as its own process: "Site Isolation"
  - Which means process level isolation from the operating system
- Defeats spectre-type attacks
  - Now you can't even attempt to speculate across processes...
    since they have different page-tables they would load different data
    - If you could read across this barrier you've broken OS level isolation
  - No such thing as a "Lightweight" isolation barrier
- But OS processes are expensive
  - Lots of memory overhead
  - Context-switching between processes is expensive:
    wipes out most processor state

Cookies & Web Authentication

- One very widespread use of cookies is for web sites to track users who have authenticated
- E.g., once browser fetched **`http://mybank.com/login.html?user=alice&pass=bigsecret`** with a correct password, server associates value of "session" cookie with logged-in user's info
  - An "authenticator"
- Now server subsequently can tell: "I'm talking to same browser that authenticated as Alice earlier"
  - An attacker who can get a copy of Alice's cookie can access the server ***impersonating Alice! Cookie thief!***

Cross-Site Request Forgery (CSRF) (aka XSRF)

- A way of taking advantage of a web server's cookie-based authentication to do an action as the user
  - Remember, an origin is allowed to fetch things from other origins
    - Just with very limited information about what is done…
  - E.g. have some javascript add an IMG to the DOM that is: **`https://www.exifltratedataplease.com/?{datatoexfiltrate}`** that returns a 1x1 transparent GIF
    - Basically a nearly unlimited bandwidth channel for exfiltrating data to something outside the current origin
    - Google Analytics uses this method to record information about visitors to any site using

Rank	Score	ID	Name
[1]	93.8	CWE-89	Improper Neutralization of Special Elements used in an SQL Command ('SQL Injection')
[2]	83.3	CWE-78	Improper Neutralization of Special Elements used in an OS Command ('OS Command Injection')
[3]	79.0	CWE-120	Buffer Copy without Checking Size of Input ('Classic Buffer Overflow')
[4]	77.7	CWE-79	Improper Neutralization of Input During Web Page Generation ('Cross-site Scripting')
[5]	76.9	CWE-306	Missing Authentication for Critical Function
[6]	76.8	CWE-862	Missing Authorization
[7]	75.0	CWE-798	Use of Hard-coded Credentials
[8]	75.0	CWE-311	Missing Encryption of Sensitive Data
[9]	74.0	CWE-434	Unrestricted Upload of File with Dangerous Type
[10]	73.8	CWE-807	Reliance on Untrusted Inputs in a Security Decision
[11]	73.1	CWE-250	Execution with Unnecessary Privileges
[12]	70.1	CWE-352	Cross-Site Request Forgery (CSRF)
[13]	69.3	CWE-22	Improper Limitation of a Pathname to a Restricted Directory ('Path Traversal')
[14]	68.5	CWE-494	Download of Code Without Integrity Check
[15]	67.8	CWE-863	Incorrect Authorization
[16]	66.0	CWE-829	Inclusion of Functionality from Untrusted Control Sphere

Static Web Content


```
<HTML>
  <HEAD>
    <TITLE>Test Page</TITLE>
  </HEAD>
  <BODY>
    <H1>Test Page</H1>
    <P> This is a test!</P>

  </BODY>
</HTML>
```

Visiting this boring web page will just display a bit of content.

Automatic Web Accesses


```
<HTML>
  <HEAD>
    <TITLE>Test Page</TITLE>
  </HEAD>
  <BODY>
    <H1>Test Page</H1>
    <P> This is a test!</P>
    <IMG SRC="http://anywhere.com/logo.jpg">
  </BODY>
</HTML>
```

Visiting *this* page will cause our browser to **automatically** fetch the given URL.

Automatic Web Accesses


```
<HTML>
  <HEAD>
    <TITLE>Evil!</TITLE>
  </HEAD>
  <BODY>
    <H1>Test Page</H1>  <!-- haha! -->
    <P> This is a test!</P>
    <IMG SRC="http://xyz.com/do=thing.php...">
  </BODY>
</HTML>
```

So if we visit a *page under an attacker's control*, they can have us visit other URLs

Automatic Web Accesses


```
<HTML>
  <HEA
    <T
  </HE
  <BOD
    <H1>Test Page</H1>  <!-- haha! -->
    <P> This is a test!</P>
    <IMG SRC="http://xyz.com/do=thing.php...">
  </BODY>
</HTML>
```

When doing so, our browser will happily send along cookies associated with the visited URL! (any `xyz.com` cookies in this example) 😟

Automatic Web Accesses

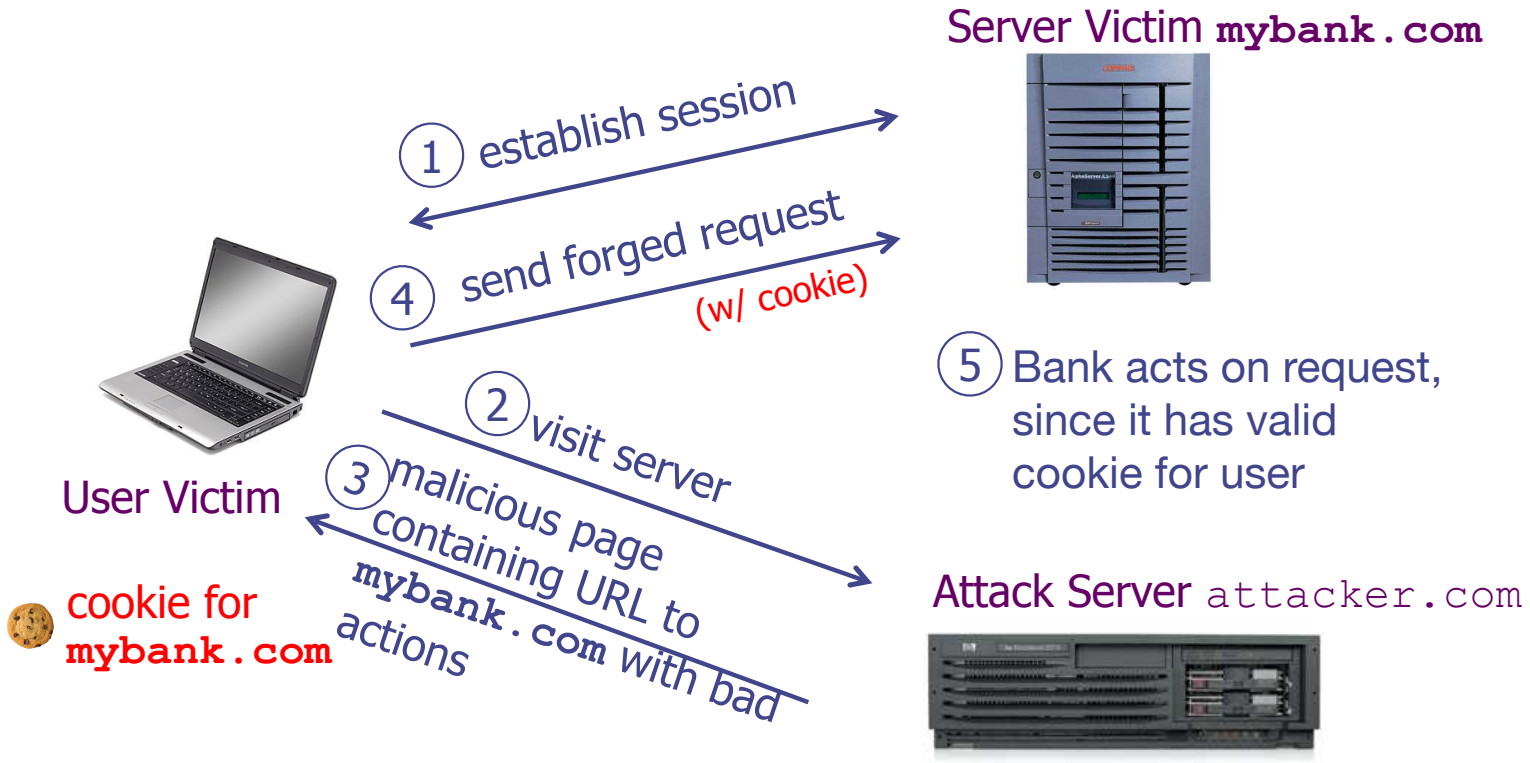

```
<HTML>
  <HEAD>
    <TITLE>Evil!</TITLE>
  </HEAD>
  <BODY>
    <H1>Test Page</H1>  <!-- haha! -->
    <P> This is a test!</P>
    <IMG SRC="http://xyz.com/do=thing.php...">
  </BODY>
</HTML>
```

(Note, Javascript provides many *other* ways for a page returned by an attacker to force our browser to load a particular URL)

Web Accesses w/ Side Effects

- Take a banking URL:
  - `http://mybank.com/moneyxfer.cgi?account=alice&amt=50&to=bob`
- So what happens if we visit evilsite.com, which includes:
  - `<img width="1" height="1" src="http://mybank.com/moneyxfer.cgi?Account=alice&amt=500000&to=DrEvil">`
  - Our browser issues the request … To get what will render as a 1x1 pixel block
  - … and dutifully includes authentication cookie! 😟
- Cross-Site Request Forgery (CSRF) attack
  - Web server ***happily accepts the cookie***

CSRF Scenario



URL fetch for posting a *squig*

```
GET /do_squig?redirect=%2Fuserpage%3Fuser%3Ddilbert
    &squig=squigs+speak+a+deep+truth
COOKIE: "session_id=5321506"
```

Authenticated with cookie that browser automatically sends along

Web action with *predictable structure*

CSRF and the Internet of Shit...

- Stupid IoT device has a default password
  - `http://10.0.1.1/login?user=admin&password=admin`
  - Sets the session cookie for future requests to authenticate the user
- Stupid IoT device also has remote commands
  - `http://10.0.1.1/set-dns-server?server=8.8.8.8`
  - Changes state in a way beneficial to the attacks
- Stupid IoT device doesn't implement CSRF defenses...
  - Attackers can do ***mass malvertized*** drive-by attacks:
    Publish a JavaScript advertisement that does these two requests

CSRF and Malvertizing…

- You have some evil JavaScript:
  - **`http://www.eviljavascript.com/pwnitall.js`**
- This JavaScript does the following:
  - Opens a 1x1 frame pointing to **`http://www.eviljavascript.com/frame`**
- The frame then…
  - Opens a gazillion different internal frames all to launch candidate xsrf attacks!
- Then get it to run by just paying for it!
  - Or hacking sites to include **`<script src="http://...">`**