CSE 484 / CSE M 584: Web Security: CSRF and Browser Security Model

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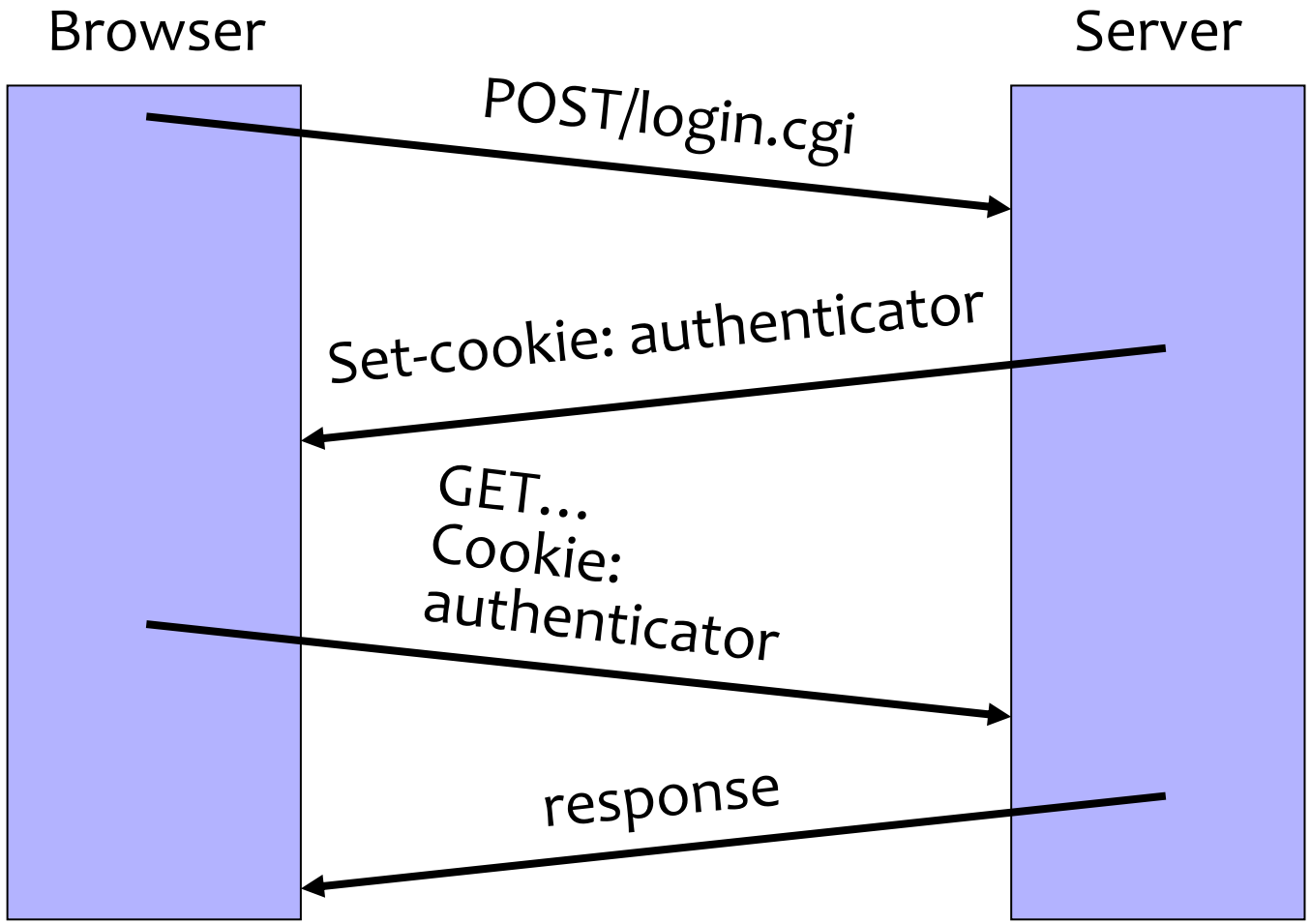
Announcements

- **Lab 2:** Now out!
- **Final Project checkpoint #1:** Due Friday
- Friday is a holiday! (Veterans' Day)

Cross-Site Request Forgery (CSRF/XSRF)

Cookie-Based Authentication Review



Same Origin Policy Review

- SOP prevents cross-origin requests, DOM accesses, etc.
- **But:** Active content (scripts) can **send** anywhere!
  - For example, can submit a POST request
  - Some ports inaccessible -- e.g., SMTP (email)
- Can only *read* response from the *same origin*
  - … but you can do a lot with just sending!

Cross-Site Request Forgery

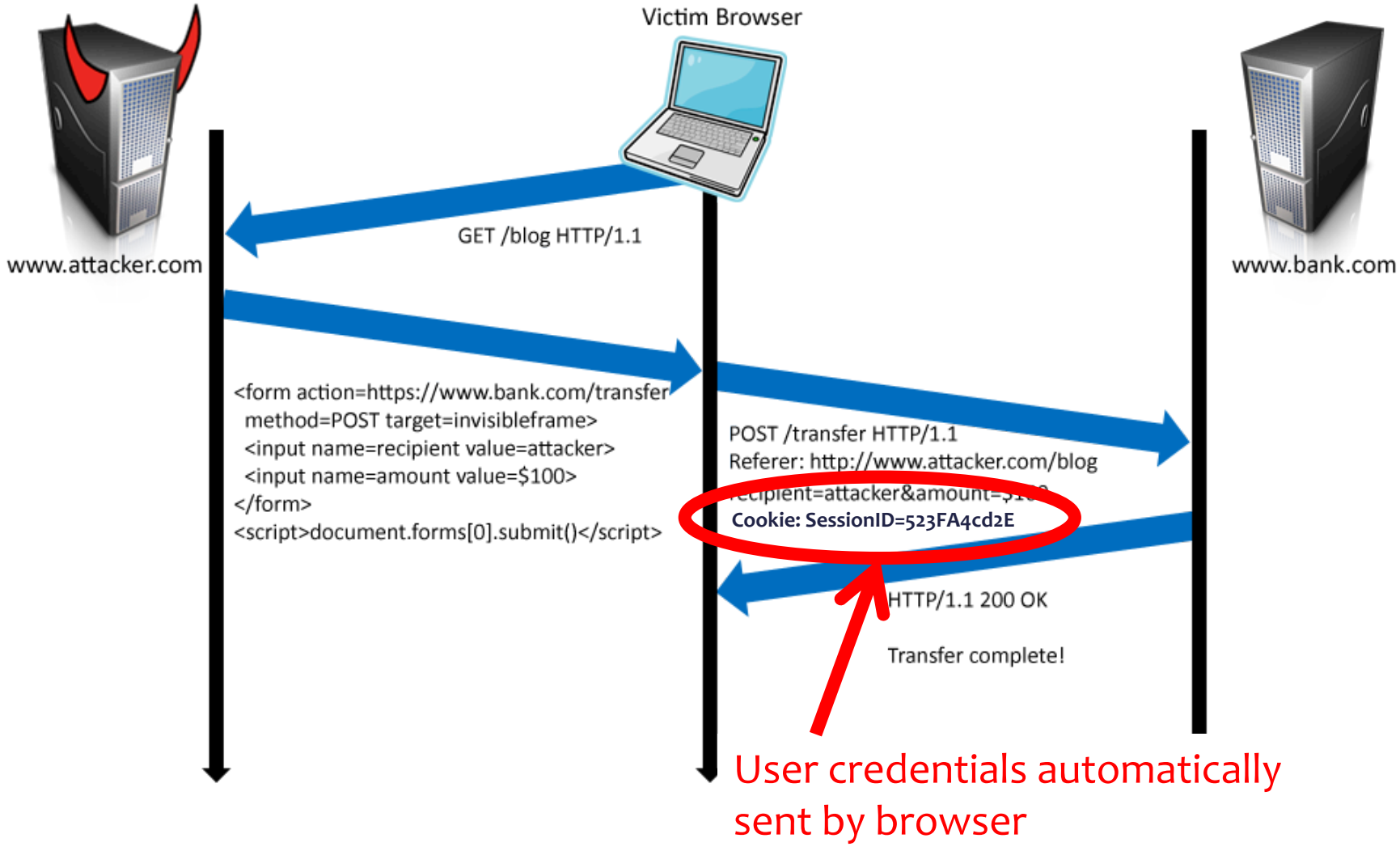
- Users logs into bank.com, forgets to sign off
  - Session cookie remains in browser state
- User then visits a malicious website containing

```
<form  name=BillPayForm
action=http://bank.com/BillPay.php>
<input  name=recipient  value=attacker> …

<script> document.BillPayForm.submit(); </script>
```

- Browser sends cookie, payment request fulfilled!
- Lesson: cookie authentication is not sufficient when side effects can happen

Cookies in Forged Requests



Sending a Cross-Domain POST

```
<form method="POST" action=http://othersite.com/action >
...
</form>
<script>document.forms[0].submit()</script>
```

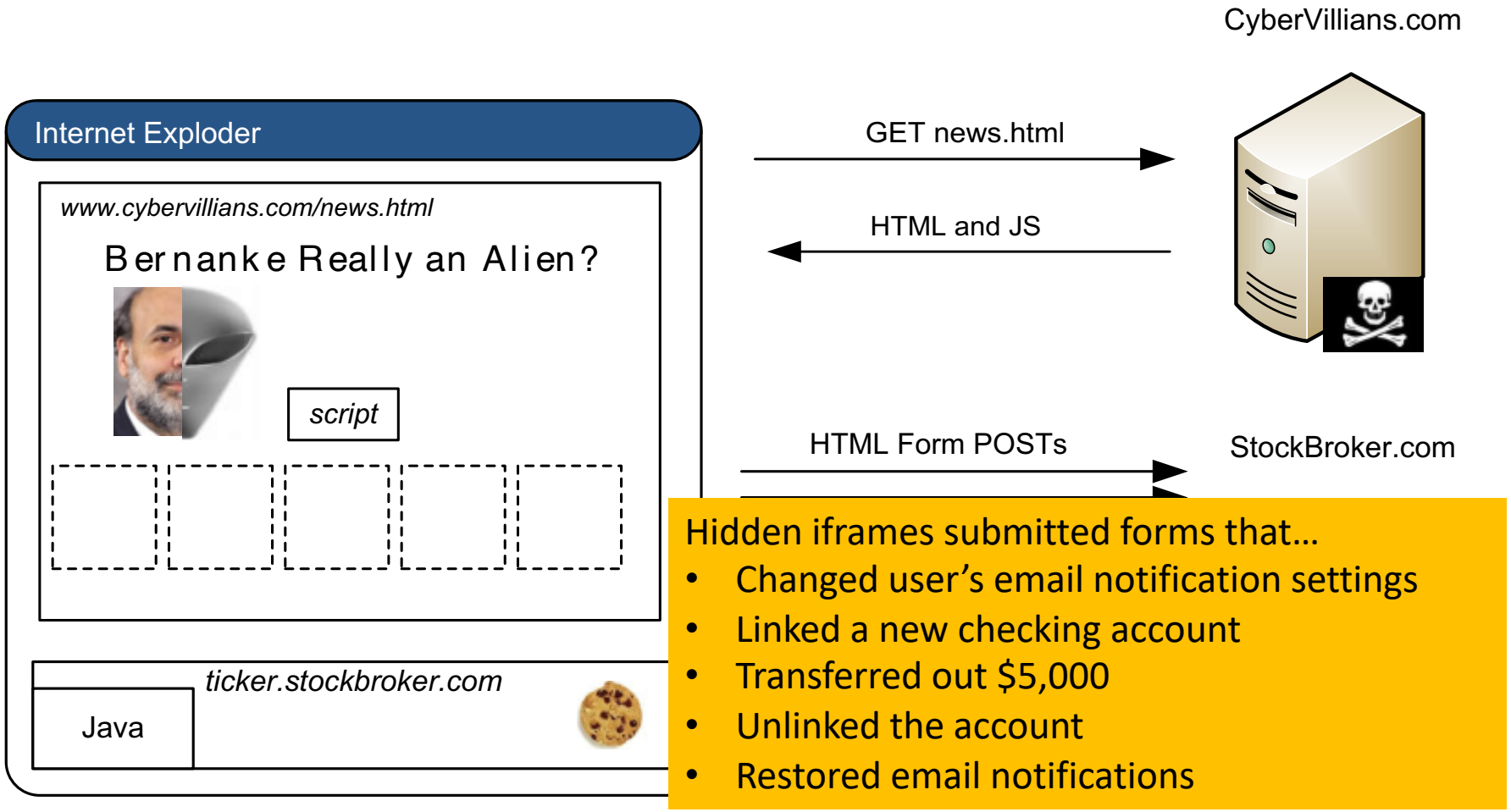
← submit post

- Hidden iframe can do this in the background
- User visits a malicious page, browser submits form on behalf of user
  - Hijack any ongoing session (**if no protection**)
    - Netflix: change account settings, Gmail: steal contacts, Amazon: one-click purchase
  - Reprogram the user's home router
  - Many other attacks possible

Impact

- Hijack any ongoing session (if no protection)
  - Netflix: change account settings, Gmail: steal contacts, Amazon: one-click purchase
- Reprogram the user's home router
- Login to the *attacker's* account
  - Why might an attacker want this?

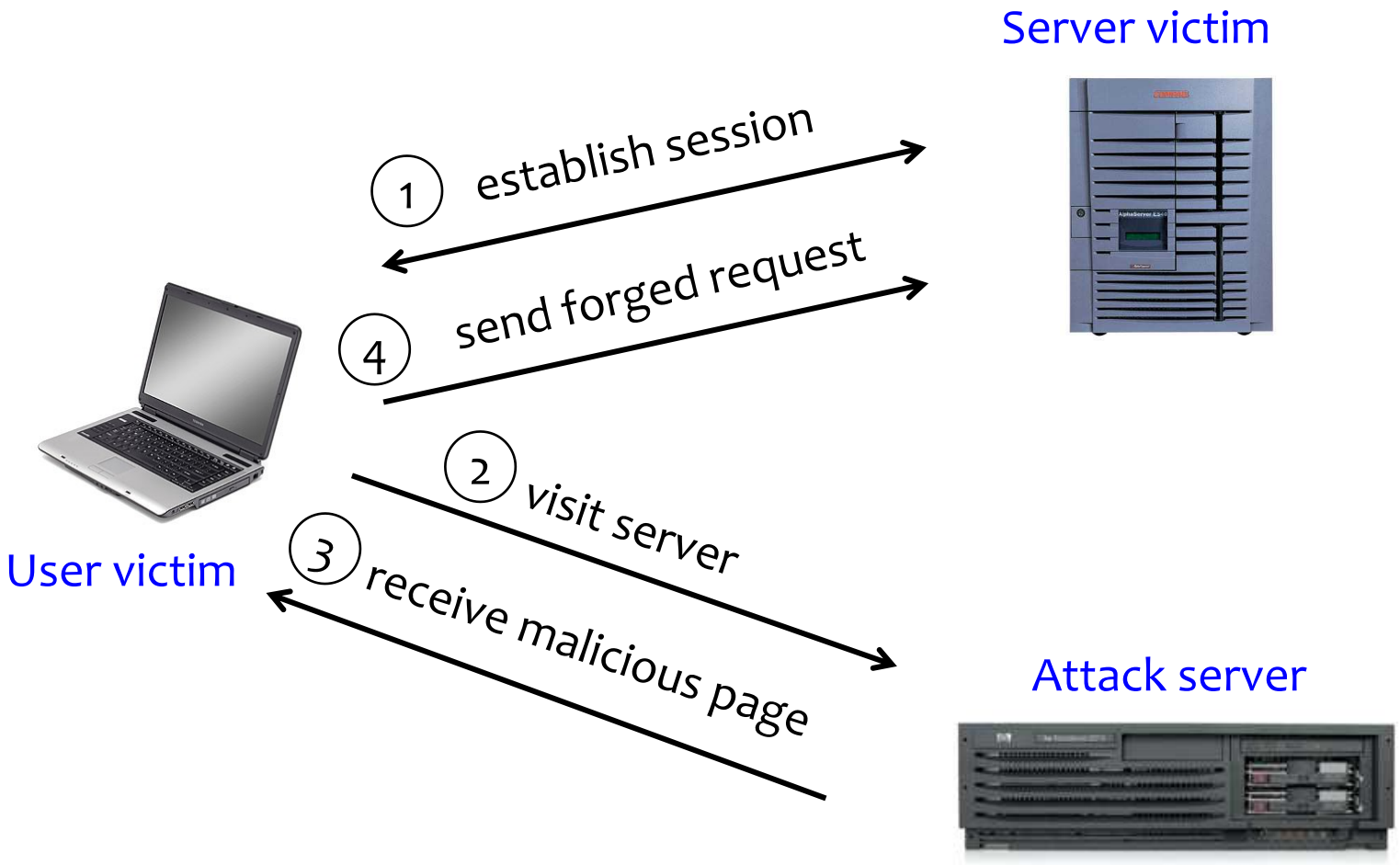
XSRF True Story [Alex Stamos]



Hidden iframes submitted forms that…

- Changed user's email notification settings
- Linked a new checking account
- Transferred out $5,000
- Unlinked the account
- Restored email notifications

XSRF (aka CSRF): Summary



Q: how long do you stay logged on to Gmail? Financial sites?

Broader View of XSRF

- Abuse of cross-site data export
  - SOP does not control data export
  - Malicious webpage can initiates requests from the user's browser to an honest server
  - Server thinks requests are part of the established session between the browser and the server (automatically sends cookies)

Canvas Activity

How might a web application defend itself against CSRF?

XSRF Defenses

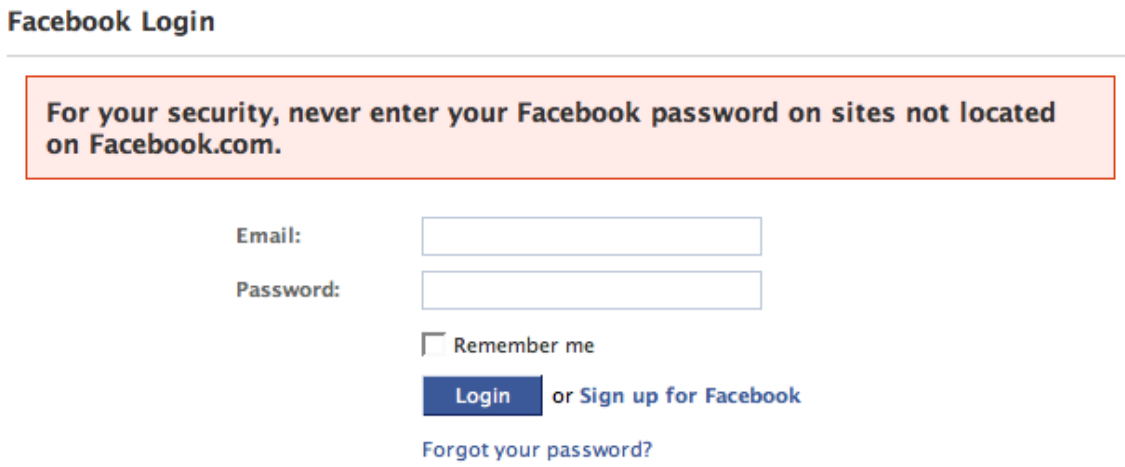
- Secret validation token


```
<input type=hidden value=23a3af01b>
```

- Referer validation


```
Referer:
http://www.facebook.com/home.php
```

Referer Validation



✓ `Referer: http://www.facebook.com/home.php`

✗ `Referer: http://www.evil.com/attack.html`

? `Referer:`

- Lenient referer checking – header is optional
- Strict referer checking – header is required

Why Not Always Strict Checking?

- Why might the referer header be suppressed?
  - Stripped by the organization's network filter
  - Stripped by the local machine
  - Stripped by the browser for HTTPS → HTTP transitions
  - User preference in browser
  - Buggy browser
- Web applications can't afford to block these users
- **Many web application frameworks include CSRF defenses today**

Better Idea: Add Secret Token to Forms

```
<input type=hidden value=23a3af01b>
```

- "Synchronizer Token Pattern"
- Include a secret challenge token as a hidden input in forms
  - Token often based on user's session ID
  - Server must verify correctness of token before executing sensitive operations
- Why does this work?
  - **Same-origin policy:** attacker can't read token out of legitimate forms loaded in user's browser!
  - So: can't create fake forms with correct token!

Stepping Back: Two Sides of Web Security

(1) Web browser

- Responsible for securely confining content presented by visited websites

(2) Web applications

- Online merchants, banks, blogs, Google Apps …
- Mix of server-side and client-side code
  - Server-side code written in PHP, JavaScript, C++ etc.
  - Client-side code written in JavaScript (… sort of)
- Many potential bugs: XSS, XSRF, SQL injection

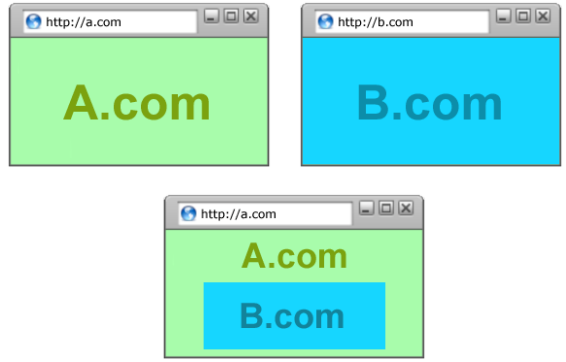
Review: Browser Security Model

Goal 1: Protect local system from web attacker

→ Browser Sandbox

Goal 2: Protect/isolate web content from other web content

→ Same Origin Policy



Browser Sandbox

Goals: (1) Protect local system from web attacker;
(2) Protect websites from each other

- E.g., safely execute JavaScript provided by a website
- No direct file access, limited access to OS, network, browser data, content from other websites
- Tabs **(new: also iframes!)** in their own processes
- Implementation is browser and OS specific*

*For example, see: https://chromium.googlesource.com/chromium/src/+/master/docs/design/sandbox.md

	High-quality report with functional exploit
Sandbox escape / Memory corruption in a non-sandboxed process	$30,000

From Chrome Bug Bounty Program

Cross-Origin Communication

- Sometimes you want to do it…
- Cross-origin Resource Sharing (CORS)
  - Access-Control-Allow-Origin: <list of domains>
    - Unfortunately, often:

      Access-Control-Allow-Origin: *
- Cross-origin client side communication
  - HTML5 postMessage between frames
    - Unfortunately, many bugs in how frames check sender's origin

What about Browser Plugins?

- **Examples:** Flash, Silverlight, Java, PDF reader
- **Goal:** enable functionality that requires transcending the browser sandbox
- Increases browser's attack surface

Java and Flash both vulnerable—again—to new 0-day attacks

Java bug is actively exploited. Flash flaws will likely be targeted soon.

by **Dan Goodin** (US) - Jul 13, 2015 9:11am PDT

- Good news: plugin sandboxing improving, and need for plugins decreasing (due to HTML5 and extensions)

Goodbye Flash

"As of mid-October 2020, users started being prompted by Adobe to uninstall Flash Player on their machines since Flash-based content will be blocked from running in Adobe Flash Player after the EOL Date."
https://www.adobe.com/products/flashplayer/end-of-life.html

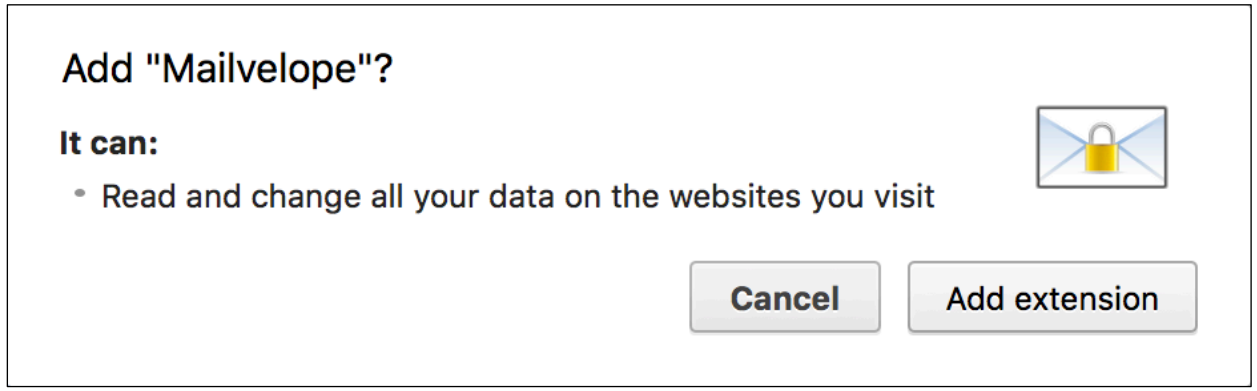
What about Browser Extensions?

- Most things you use today are probably extensions
- **Examples:** AdBlock, Ghostery, Mailvelope
- **Goal:** Extend the functionality of the browser

- (Chrome:) Carefully designed security model to **protect from malicious websites**
  - Privilege separation: extensions consist of multiple components with well-defined communication
  - Least privilege: extensions request permissions

What about Browser Extensions?

- But be wary of malicious extensions: **not subject to the same-origin policy** – can inject code into any webpage!



- Today: Extensions in flux – new "Manifest v3" specification from Google, trying to make things safer.

Web Security Summary

- Browser security model
  - Browser sandbox: isolate web from local machine
  - Same origin policy: isolate web content from different domains
  - Also: Isolation for plugins and extensions
- Web application security
  - How (not) to build a secure website