CSE 484 / CSE M 584: Computer Security and Privacy

Web Security: Web Application Security [continued]

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Admin

- Reminder: Friday is a holiday
  - No class or office hours
- Lab 2
  - Sign up if you haven't!
  - Check forum post for whether you should have access (let us know if having trouble)
  - FYI: Running your sites on **homes.cs.washington.edu** is not a web security things but a restriction of the lab itself

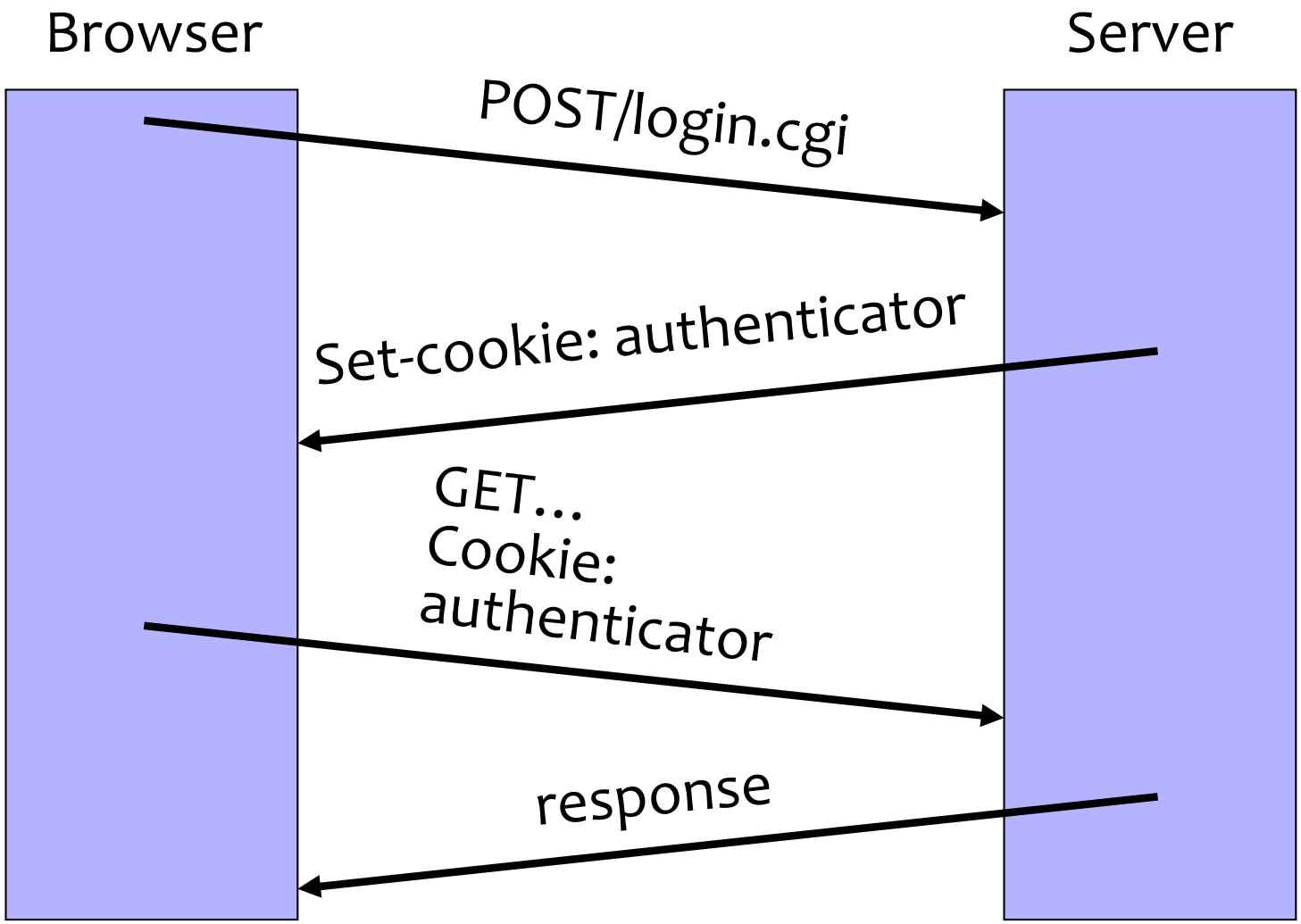
http://www.owasp.org

OWASP Top 10 Web Vulnerabilities

1. Injection
2. Broken Authentication & Session Management
3. Cross-Site Scripting
4. Insecure Direct Object References
5. Security Misconfiguration
6. Sensitive Data Exposure
7. Missing Function Level Access Control
8. Cross-Site Request Forgery
9. Using Known Vulnerable Components
10. Unvalidated Redirects and Forwards

Cross-Site Request Forgery (CSRF/XSRF)

Cookie-Based Authentication Redux



Browser Sandbox Redux

- Based on the same origin policy (SOP)
- 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

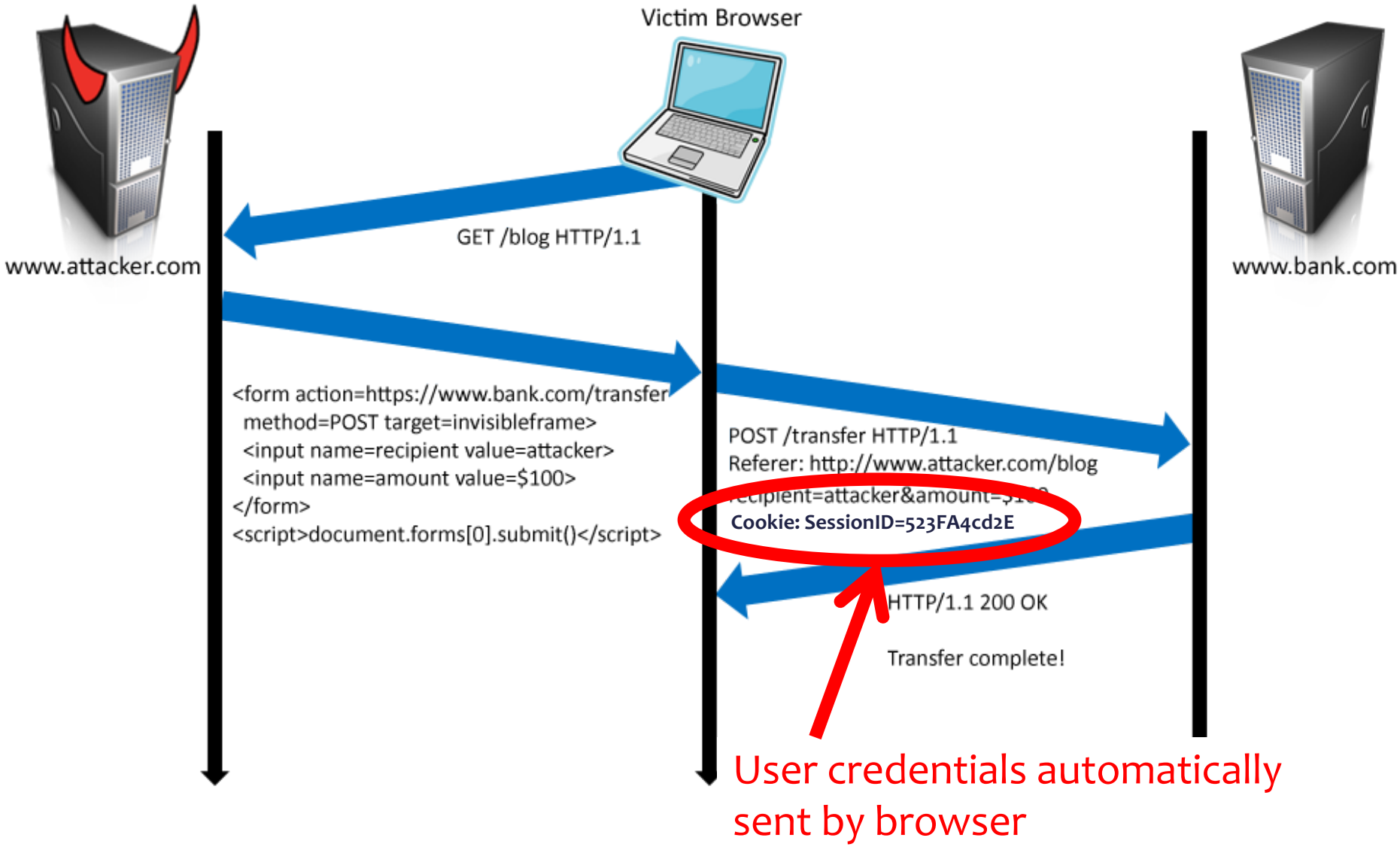
- Users logs into bank.com, forgets to sign off
  - Session cookie remains in browser state
- User then visits a malicious website containing

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

 <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



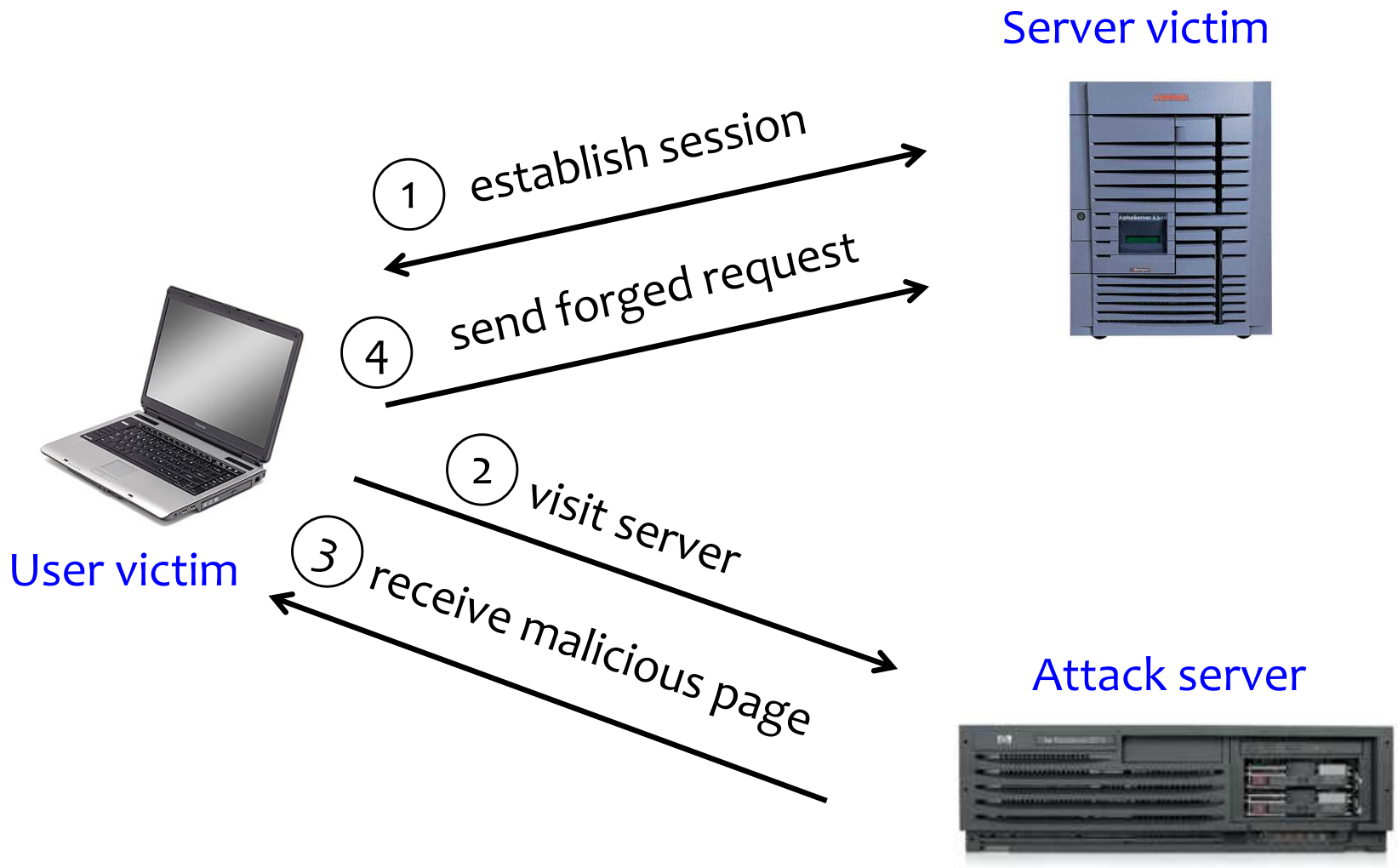
Sending a Cross-Domain POST

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

submit post

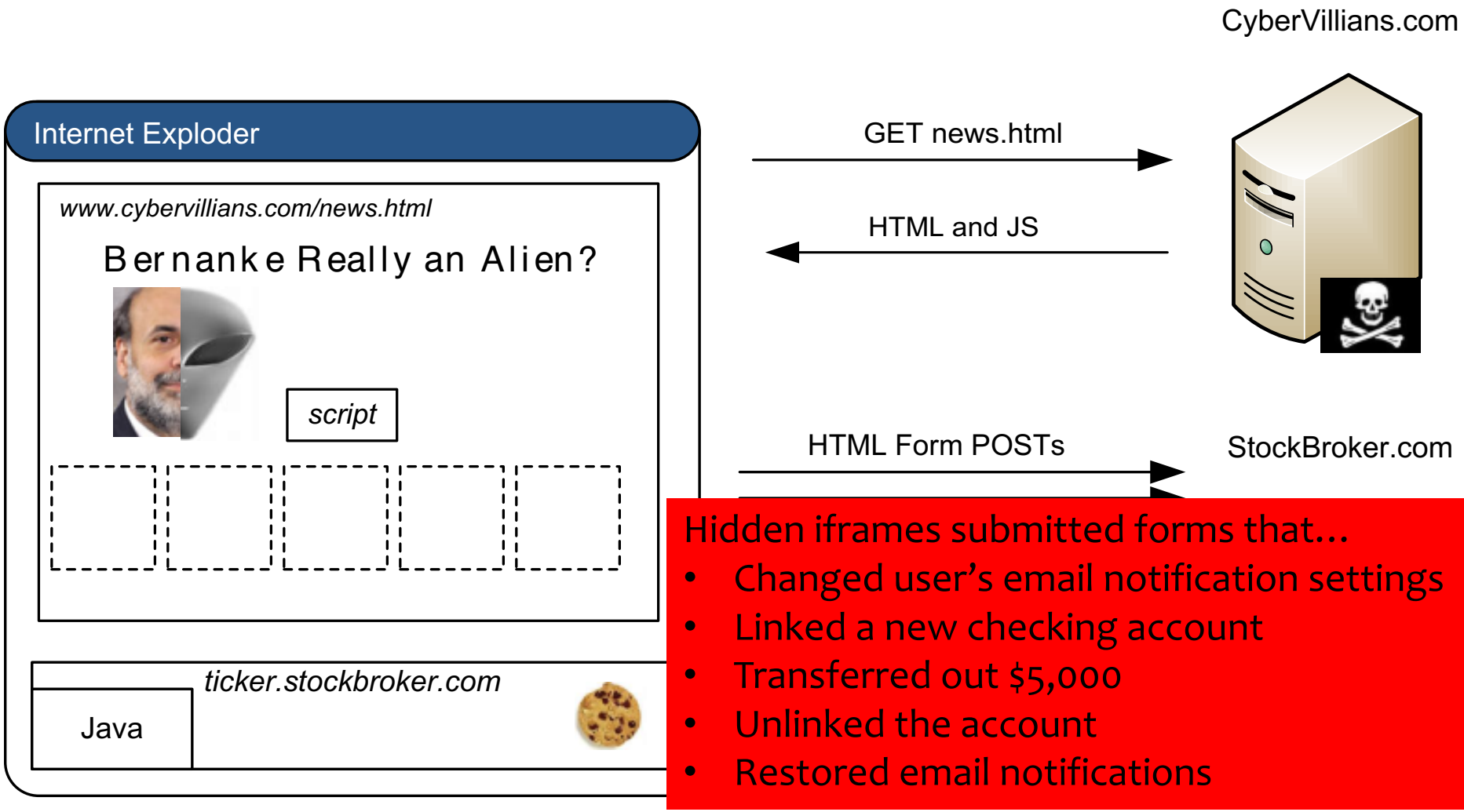
- Hidden iframe can do this in the background
- User visits a malicious page, browser submits form on behalf of the user
  - Hijack any ongoing session (if no protection)
    - Netflix: change account settings, Gmail: steal contacts, Amazon: one-click purchase
  - Reprogram the user's home router
  -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

XSRF (aka CSRF): Summary



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

XSRF True Story [Alex Stamos]



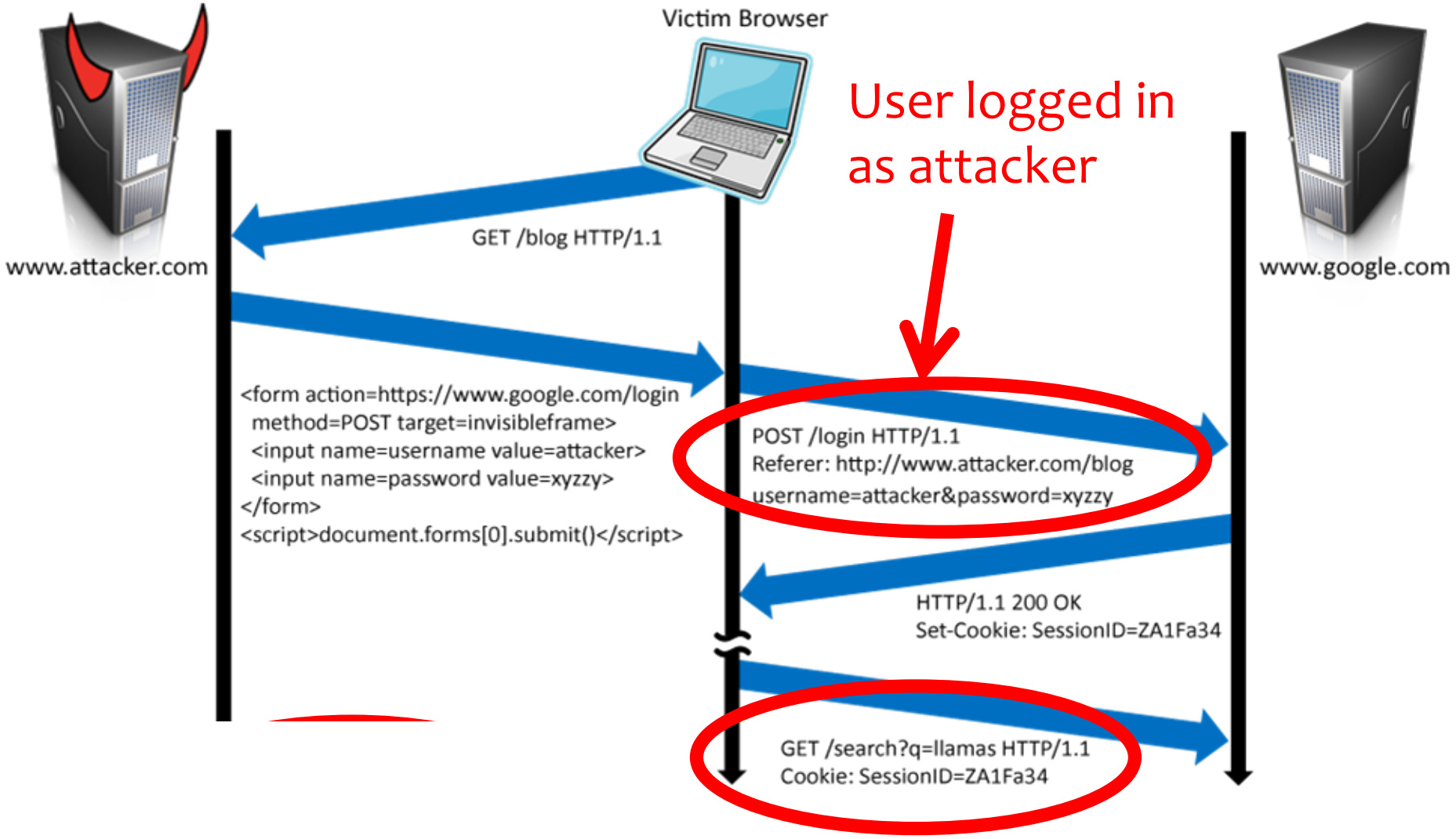
Hidden iframes submitted forms that…

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

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)

Login XSRF: Attacker logs you in as them!



XSRF Defenses

- Secret validation token


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

- Referer validation

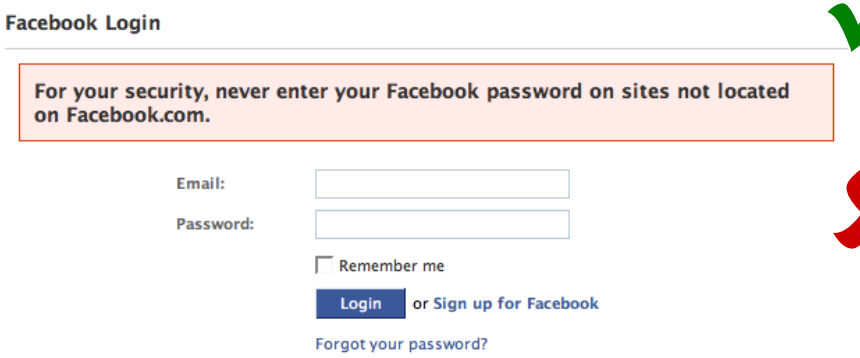

```
Referer:
http://www.facebook.com/home.php
```

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

Referer Validation



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

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

? `Referer:`

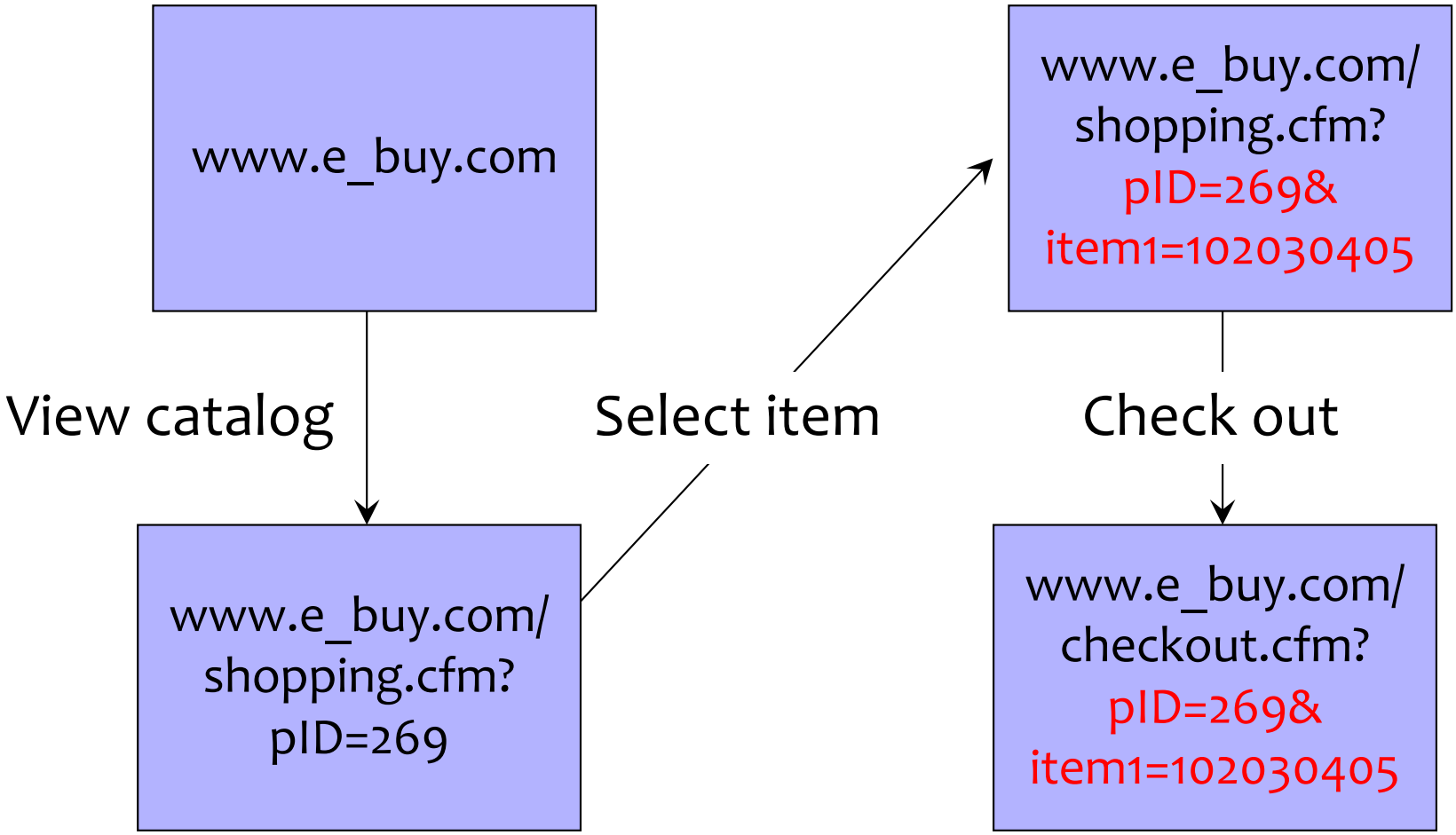
- Lenient referer checking – header is optional
- Strict referer checking – header is required

Why Not Always Strict Checking?

- Why might the referer header be suppressed?
  - Stripped by the organization's network filter
    - For example, http://intranet.corp.apple.com/projects/iphone/competitors.html
  - 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

Web Session Management

Primitive Browser Session



Store session information in URL; easily read on network

Bad Idea: Encoding State in URL

- Unstable, frequently changing URLs
- Vulnerable to eavesdropping and modification
- There is no guarantee that URL is private

FatBrain.com circa 1999

- User logs into website with his password, authenticator is generated, user is given special URL containing the authenticator

  https://www.fatbrain.com/HelpAccount.asp?t=0&p1=me@me.com&p2=540555758

  - With special URL, user doesn't need to re-authenticate
    - Reasoning: user could not have not known the special URL without authenticating first. That's true, BUT…
- Authenticators are global sequence numbers
  - It's easy to guess sequence number for another user

    https://www.fatbrain.com/HelpAccount.asp?t=0&p1=SomeoneElse&p2=540555752
  - Partial fix: use random authenticators

Typical Solution: Web Authentication via Cookies

- Servers can use cookies to store state on client
  - When session starts, server computes an authenticator and gives it back to browser in the form of a cookie
    - Authenticators must be **unforgeable** and **tamper-proof**
      - Malicious client shouldn't be able to compute his own or modify an existing authenticator
    - Example: **MAC(server's secret key, session id)**
  - With each request, browser presents the cookie
  - Server **recomputes** and verifies the authenticator
    - Server does not need to remember the authenticator

Storing State in Hidden Forms

- Dansie Shopping Cart (2006)
  - "A premium, comprehensive, Perl shopping cart. Increase your web sales by making it easier for your web store customers to order."

```
<FORM METHOD=POST
 ACTION="http://www.dansie.net/cgi-bin/scripts/cart.pl">

  Black Leather purse with leather straps<

  <INPUT TYPE=HIDDEN NAME=name     VALUE="Black leather purse">
  <INPUT TYPE=HIDDEN NAME=price    VALUE="20.00">
  <INPUT TYPE=HIDDEN NAME=sh       VALUE="1">
  <INPUT TYPE=HIDDEN NAME=img      VALUE="p
  <INPUT TYPE=HIDDEN NAME=custom1  VALUE="B
    with leather straps">

  <INPUT TYPE=SUBMIT NAME="add" VALUE="Put in Shopping Cart">

</FORM>
```

Change this to 2.00

Bargain shopping!

Fix: MAC client-side data, or, more likely, keep on server.

Top Web Vulnerabilities: Summary

- XSS (CSS) – cross-site scripting
  - Malicious code injected into a trusted context (e.g., malicious data presented by an honest website interpreted as code by the user's browser)
- SQL injection
  - Malicious data sent to a website is interpreted as code in a query to the website's back-end database
- XSRF (CSRF) – cross-site request forgery
  - Bad website forces the user's browser to send a request to a good website
- Broken authentication and session management