

CS4221: Database Applications Design and Tuning

Week 12: Security of Web Applications

7 April 2016





Client-Side Security

Introduction

Security Issues

Abuse of Trust

Capture of Information

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- Anyone can create a Web site and make it referenced by search engines... including **malevolent** individuals
- No *a priori* reason to trust the creators of a visited Web site
- Browsers are supposed to provide a protected environment (**sandbox**) in which HTML/CSS layout is performed, JavaScript scripts are executed, etc.
- But this protection is not always perfect





- General interaction principle across JavaScript execution contexts: two scripts (in different windows or frames of the browser) can interact only if the context URLs have the same **protocol**, **port**, and **domain name**
- In practice, numerous subtleties
- Possible to communicate across scripts collaborating with the **postMessage** API
- AJAX restricted in a similar fashion





- No origin restriction for:
 - loading images, videos, applets
 - loading CSS stylesheets
 - HTML `<iframe>`'s
 - JavaScript loading using the `<script>` tag
- Cookies function in a more liberal manner (the notion of domain is extended, no port or protocol control) for reading/writing, but can be restricted to a path
- Flash, Silverlight, Java plugins implement a similar interaction policy... but sometimes dangerous differences in behavior





- **Erroneous behaviors** in software
 - **Disclosure** of confidential data (passwords, credit card numbers, email addresses, etc.)
 - **Loss** of local data (vandalism, ransomware)
 - Reuse **user credentials** on other Web sites to send fraudulent emails, make bank transfers, order items, etc.
 - Participation of a local computer to a **botnet**:
 - Storage of illegal data
 - Relay for other forms of attacks
 - Spam sending





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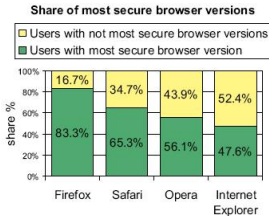


Problem

A **software** **programming** error in the Web browser allows unplanned behavior (from erroneous behavior or crashes to distant takeover of the computer).

Solution

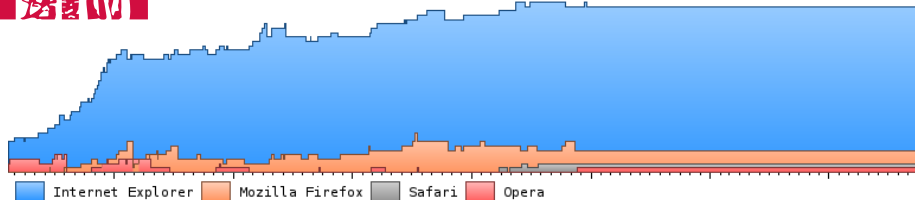
Update one's browser very regularly (e.g., through automatic update mechanisms).



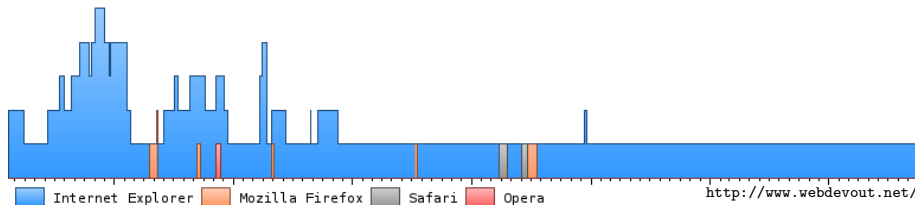
<http://www.techzoom.net/publications/insecurity-iceberg/index.en>



Number of open high severity advisories versus time (2004-02-09 to 2011-09-26). Peak: 39



Number of open high severity advisories versus time (2004-02-09 to 2011-09-26). Peak: 5



<http://www.webdevout.net/>





A **programming error** in an extension of a Web browser (ad blocker, Java, Flash or PDF plug-in, localization package, multimedia player, etc.) allows unplanned behavior.

Solution

Update all such software as regularly as possible (may be tricky). Remove unused extensions. Get informed about most important known issues. Prefer extensions whose update mechanisms are integrated within that of the operating system (or of the browser).





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Problem

A user launches an executable, a Java applet without a sandbox, an ActiveX control, etc., linked from a Web page; arbitrary code can be run.

Solution

Take heed of browser warnings! And **think it over!**





A user visiting a malicious Web site is led to **click at a dangerous location** (browser warning, zone within a frame belonging to a trustworthy Web site, etc.) by masking the area where the click is going to happen until the last minute.

Solution

Timing between display and click on an important action within browsers; be careful of weird behaviors of the mouse pointer within a site.



Problem

If a user clicks on a link (in an email, on the Web, etc.), a user is led to a Web page he thinks is that of a site he trusts (online banking, electronic commerce, etc.) and is asked for his connection identifiers. The site is only an **imitation** of the official site, and these identifiers are disclosed to malevolent individuals.

Solution

Always **carefully** check the URL of a site one reaches through a link. In case a site handles sensitive information, or allows dangerous operations, only use it with HTTPS, and check the **SSL certificate** (browsers display the validated identity of the site owner in the address bar). Use your common sense!





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Problem

Data on a wired network, on an unencrypted WiFi network (or with an easy-to-crack WEP encryption), an attacker can **monitor IP packet exchanges** that contain all communication between a browser and a Web server, including all HTTP parameters, etc. This problem also exists, but less dramatically, on the Internet at large.

Solution

Do not use HTTP to transmit sensitive information through the Internet, even more so when on a shared wired network or unencrypted WiFi network. **HTTPS**, another protocol allowing encryption of every message on the Web, must be used.





Using one of the techniques presented in this lecture (e.g., XSS or IP packet capture) to retrieve the **session identifier** of a user (usually stored within a cookie) to usurp her identity.

Solution

Solve other issues! On the server side, allow disconnecting (in PHP, with **session_destroy**) as soon as the session is not useful anymore.





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- Web : **hostile** environment
- Unless one controls access to the Web server, anyone can access a Web site... including **malevolent** individuals
- Some things are the responsibility of the system administrator (e.g., having up-to-date Web server software), others are that of the Web master





- **Disclosure** of confidential data (passwords, credit card numbers, email addresses, etc.) **of your users**
- **Jeopardize the safety** of your users
- **Loss** of local data (vandalism, ransomware)
- Participation of a local computer to a **botnet**:
 - Storage of illegal data
 - Relay for other forms of attacks
 - Spam sending



One can impose a number of restrictions on data that can be put in a

Web form on the client side:

- `maxlength` on a `<input type="text">` for a maximal length on text fields
- `<select>`'s, radio buttons, checkboxes forcing to choose one (or several) proposed values
- A `<input type="hidden">` hidden field or a `readonly` field sets a parameter's value
- JavaScript validation code runs arbitrary verifications



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But all of this is only true if the Web client plays nice. Very easy to overcome (turning JavaScript off, modifying the page).

Never ever trust data sent by a Web client! Always (re)do the verifications on the server side.





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A user can put, within an HTTP parameter that will be displayed in the page, HTML code (and therefore CSS styling or JavaScript code). He thus modifies the code of the produced HTML page. If this parameter is stored to be displayed again (e.g., blog comments), the code can influence the content of the site for other users.

Example

Assume an HTTP parameter login contains:

```
<div style='color: red'> within the PHP code:  
echo "Bonjour ".$_REQUEST["login"]." !";
```

Solution

Use functions for escaping HTML special characters (in PHP, `htmlspecialchars`).



Special case of the previous attack: inserting JavaScript code inside an HTML page, which will be displayed to other users; the JavaScript code “steals” information typed by a user to transfer them to another server.

Solution

As before, use `htmlspecialchars`, in particular when some text filled in by a user will be displayed to another.



Problem

A third party site loads (e.g., in an `<iframe>`) a page of the attacked site. The browser accesses this page, logged in as the original user, which may allow the attacker to accomplish an action instead of the user (e.g., ordering something) or infer information about the user.

Solution

- Use the HTTP POST method for every behavior that has side effects.
- Avoid inclusion of a page within another. (with the X-Frame-Options HTTP header).
- Make sure access to this page is controlled by non-guessable unique tokens.



Problem

Assume we can modify a SQL query by an appropriate choice of special characters in SQL in a variable used to construct the query.

Example

Assume \$passwd contains “’ OR 1=1 --” in the PHP code:

```
$result=mysql_query("SELECT * FROM T WHERE  
passwd='$passwd'");
```

Solution

Use escaping functions for SQL characters (e.g., `mysql_real_escape_string` in PHP). Better, never construct a query like this and use **prepared queries**.



Problem

Assume that `passthru` modify calls to external programs on the server side (e.g., in PHP, called with `system`, `exec`, `passthru`, etc.).

Example

Assume `$rep` contains “`&& cat /etc/password`” in the PHP code:
`passthru("ls $rep");`

Solution

Avoid calling external programs from the Web server. Carefully check the content of command line. In PHP, use `escapeshellcmd` or `escapeshellarg` to protect the special characters of the shell.





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Problem

Assuming the possibility, when accessing files on a server (e.g., in PHP, with `fopen`, `readfile`), using `'/'`, `'..'`, to gain access he is not supposed to have.

Example

Assume `$file` contains `"../../../../../../etc/passwd"` in the PHP code:

```
readfile($fichier);
```

Solution

Check that arguments of functions that access files do not point to files that are not supposed to be accessible (e.g., check there is no `'/'` inside).





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An attacker can induce unplanned behavior on the server side by exploiting a programming error that assumes one block of instructions to be **executed as one**, with no **concurrency** from other instructions.

Example

A PHP script retrieves the largest integer stored in a MySQL table, increments it, saves a file with name this integer. Concurrency if two scripts run simultaneously, and both look up the table to know the largest integer, before adding a line.

Solution

Think about race conditions cases. Use **transactions** of the DBMS (e.g., InnoDB in MySQL 5), use **locks** on files.





Attack a Web site (or whatever Internet service) by requesting from the server **more than it can handle** (very large number of connections, costly computation, etc.).

Solution

Essentially the responsibility of the administrator, but the Web master can prevent some attacks by 1) avoiding files that are too heavy to download 2) avoid useless computation on the server side.





Weak passwords (common or proper nouns without or with little variation, very short) can be cracked by brute force, by exploring one by one a list of all possible words; even less costly if a (crypted) password file can be retrieved locally.

Solution

Impose **strong** passwords to users (and oneself). Never make available a password file, even crypted. Monitor accesses to a Web site that try out various passwords, and block them.





Likely the most used form of attack: exploit a **fault** not in software, but in **human reasoning**! Force a honest user to give confidential information, etc.

Solution

Keep a critical mind in every thing, use common sense, and never get abused by technical ignored!



To prevent attacks or to limit their consequences:

- Use known **cryptology algorithms**, not home-made cyphers
- Never store passwords in a database, only store non-reversible **cryptographic hashes**
- Add **salt** in hashed passwords, to avoid attacks through precomputation of hashes
- Never store credit card numbers or other **sensitive information** in a database
- Make sure the Web server software has **limited access rights** on the computer it runs on
- Do not **blindly trust** third-party code
- **Think it over** and **put oneself in an attacker's shoes**





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The Tangled Web: A Guide to Securing Modern Web Applications, Michael Zalewski, to understand how Web technologies interact security-wise

- *The Art of Deception*, Kevin Mitnick, to get familiar with the dangers of social engineering
- *Hacking, the Next Generation*, Nitesh Dhanjani, Billy Rios, Brett Hardi (O'Reilly) for concrete examples of modern attacks
- Firebug for Firefox, or other browser features and extensions, to study and analyse sites from the client side
- Hacking challenge sites like <http://www.hackthissite.org/> to put oneself in an attacker's shoes



Article 3 (1)&(2)

Any person who knowingly causes a computer to perform any function for the purpose of securing access without authority to any program or data held in any computer shall be guilty of an offence and shall be liable on conviction to a fine not exceeding \$5,000 or to imprisonment for a term not exceeding 2 years or to both and, in the case of a second or subsequent conviction, to a fine not exceeding \$10,000 or to imprisonment for a term not exceeding 3 years or to both.

(2) If any damage is caused as a result of an offence under this section, a person convicted of the offence shall be liable to a fine not exceeding \$50,000 or to imprisonment for a term not exceeding 7 years or to both.

Article 10 (1)

Any person who abets the commission of or who attempts to commit or does any act preparatory to or in furtherance of the commission of any offence under this Act shall be guilty of that offence and shall be liable on conviction to the punishment provided for the offence.





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