Securing PHP Applications

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What is Security?

- Security is a measurement, not a characteristic.
- It's is also an growing problem that requires an continually evolving solution.
  - A good measure of secure application is it's ability to predict and prevent future security problems, before someone devises an exploit.
- As far as application design goes, security must be considered at all times; initial spec, implementation, testing and even maintenance.

PHP & Security

- PHP keeps on growing as a language, making headway into enterprise and corporate markets.

- Consequently PHP applications often end up working with sensitive data.
  - Unauthorized access to this data is unacceptable.
  - To prevent problems a secure design is needed.

Accessing Input Data

- As of PHP 4.1, there are a series of super-globals that offer very simple access to the input data.
  - $_GET – data from get requests.
  - $_POST – post request data.
  - $_COOKIE – cookie information.
  - $_FILES – uploaded file data.
  - $_SERVER – server data
  - $_ENV – environment variables
  - $_REQUEST – combination of GET/POST/COOKIE

Register Globals

- Arguably the most common source of vulnerabilities in PHP applications.
  - Any input parameters are translated to variables.
    - ?foo=bar >> $foo = “bar”;
  - No way to determine the input source.
    - Prioritized sources like cookies can overwrite GET values.
  - Un-initialized variables can be “injected” via user inputs.

Register Globals

```
if (authenticated_user()) {
   $authorized = true;
}
if ($authorized) {
   include '/highly/sensitive/data.php';
}
```

- Because `$authorized` is left un-initialized if user authentication fails, an attacker could access privileged data by simply passing the value via GET.

  http://example.com/script.php?authorized=1

Solutions To Register Globals

- Disable `register_globals` in PHP.ini.
  - Already done by default as of PHP 4.2.0
- Code with `error_reporting` set to `E_ALL`.
  - Allows you to see warnings about the use of un-initialized variables.
- Type sensitive validation conditions.
  - Because input is always a string, type sensitive compare to a Boolean or an integer will always fail.

```
if ($authorized === TRUE) {
```

Hidden Register Globals Problems

```
$var[] = "123";
foreach ($var as $entry) {
   make_admin($entry);
}
```

script.php?var[]=1&var[]=2

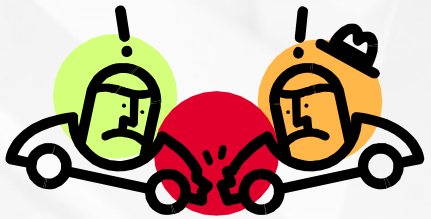
The link above will allow the attacker to inject two values into the $var array. Worse yet PHP provides no tools to detect such injections.

$_REQUEST

- The `$_REQUEST` super-global merges data from different input methods, like `register_globals` it is vulnerable to value collisions.

```
PHP.ini: variables_order = GPCS
```

```
echo $_GET['id']; // 1
echo $_COOKIE['id']; // 2
echo $_REQUEST['id']; // 2
```



$_SERVER

- Even though the $_SERVER super-global is populated based on data supplied by the web-server it should not be trusted.
  - User may inject data via headers

    ```
    Host: <script> ...
    ```

  - Some parameters contain data based on user input

    ```
    REQUEST_URI, PATH_INFO, QUERY_STRING
    ```

  - Can be fakes

    Spoofed IP address via the use of anonymous proxies.

Numeric Value Validation

- All data passed to PHP (GET/POST/COOKIE) ends up being a string. Using strings where integers are needed is not only slow but also dangerous.

```
// integer validation
if (!empty($_GET['id'])) {
        $id = (int) $_GET['id'];
} else
        $id = 0;
// floating point number validation
if (!empty($_GET['price'])) {
        $price = (float) $_GET['price'];
} else
        $price = 0;
```

- Casting is a simple and very efficient way to ensure variables do in fact contain numeric values.

Validating Strings

- PHP comes with a `ctype`, extension that offers a very quick mechanism for validating string content.

```
if (!ctype_alnum($_GET['login'])) {
        echo "Only A-Za-z0-9 are allowed.";
}
if (!ctype_alpha($_GET['captcha'])) {
        echo "Only A-Za-z are allowed.";
}
if (!ctype_xdigit($_GET['color'])) {
        echo "Only hexadecimal values are allowed";
}
```

Path Validation

- Values passed to PHP applications are often used to specify what file to open. This too needs to be validated to prevent arbitrary file access.

```
http://example.com/script.php?path=../../etc/passwd
```

```
<?php
$fp = fopen("/home/dir/{$_GET['path']}", "r");
?>
```

Path Validation

- PHP includes a `basename()` function that will process a path and remove everything other then the last component of the path, usually a file name.

```
<?php
$_GET['path'] = basename($_GET['path']);

// only open a file if it exists.
if (file_exists("/home/dir/{$_GET['path']}")) {
   $fp = fopen("/home/dir/{$_GET['path']}", "r");
}
?>
```

Better Path Validation

- An even better solution would hide file names from the user all together and work with a white-list of acceptable values.

```
// make white-list of templates
$tmpl = array();
foreach(glob("templates/*.tmpl") as $v) {
        $tmpl[md5($v)] = $v;
}
if (isset($tmpl[$_GET['path']]))
        $fp = fopen($tmpl[$_GET['path']], "r");

http://example.com/script.php?path=57fb06d7...
```

magic_quotes_gpc

- PHP tries to protect you from attacks, by automatically escaping all special characters inside user input. (`'`, `"`, `\`, `\0 (NULL)`)
  - Slows down input processing.
    - We can do better using casting for integers.
    - Requires 2x memory for each input element.
  - May not always be available.
    - Could be disabled in PHP configuration.
  - Generic solution.
    - Other characters may require escaping.

Magic Quotes Normalization

```
if (get_magic_quotes_gpc()) { // check magic_quotes_gpc state
        function strip_quotes(&$var) {
                if (is_array($var)
                        array_walk($var, 'strip_quotes');
                else
                        $var = stripslashes($var);
        }

        // Handle GPC
        foreach (array('GET','POST','COOKIE') as $v)
                if (!empty(${"_".$v}))
                        array_walk(${"_".$v}, 'strip_quotes');

       // Original file names may contain escaped data as well
        if (!empty($_FILES))
                foreach ($_FILES as $k => $v) {
                  $_FILES[$k]['name'] = stripslashes($v['name']);
}
```

Recursive Functions == Crash

- While the code on the previous slide works, it can be easily exploited, due to its reliance on recursive functions!

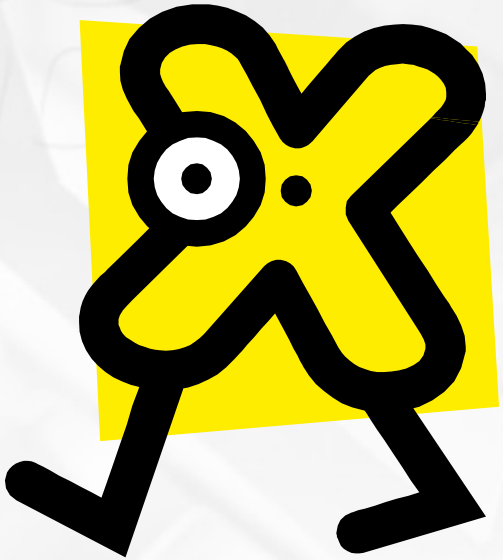
```
<?php
$qry = str_repeat("[]", 1024);
$url = "http://site.com/script.php?a{$qry}=1";
file_get_contents($url);

// run up in memory usage, followed by a prompt
   crash
?>
```

More Reliable & Faster Solution

```
if (get_magic_quotes_gpc()) {
    $in = array(&$_GET, &$_POST, &$_COOKIE);
    while (list($k,$v) = each($in)) {
        foreach ($v as $key => $val) {
            if (!is_array($val)) {
                $in[$k][$key] = stripslashes($val);
                continue;
            }
            $in[] =& $in[$k][$key];
        }
    }
    unset($in);
}
```

XSS

- Cross Site Scripting (XSS) is a situation where by attacker injects HTML code, which is then displayed on the page without further validation.
  - Can lead to embarrassment.
  - Session take-over.
  - Password theft.
  - User tracking by 3rd parties.



XSSOOPS Demo

- As you'll see in a moment that XSS is arguably the most common vulnerability you'll find on the web.
- Nearly every single web site in vulnerable to XSS attacks.

Preventing XSS

- Prevention of XSS is as simple as filtering input data via one of the following:
  - `htmlspecialchars()`
    - Encodes ‘, “, <, >, &
  - `htmlentities()`
    - Convert anything that there is HTML entity for.
  - `strip_tags()`
    - Strips anything that resembles HTML tag.

Preventing XSS

```
$str = strip_tags($_POST['message']);
// encode any foreign & special chars
$str = htmlentities($str);
// maintain new lines, by converting them to <br />
echo nl2br($str);

// strip tags can be told to "keep" certain tags
$str = strip_tags($_POST['message'], '<b><p><i><u>');
$str = htmlentities($str);
echo nl2br($str);
```

- Tag allowances in `strip_tags()` are dangerous, because attributes of those tags are not being validated in any way.

Tag Allowance Problems

```
<b style="font-size: 500px">
TAKE UP ENTIRE SCREEN
</b>

<u onError="alert(document.cookie);">
supposedly harmless text
</u>

<p style="background:
   url(http://tracker.com/image.gif)">
Let's track users
</p>
```

SQL Injection

- SQL injection is similar to XSS, in the fact that not validated data is being used. But in this case this data is passed to the database.
  - Arbitrary query execution
    - Removal of data.
    - Modification of existing values.
    - Denial of service.
    - Arbitrary data injection.

SQL Escaping

- If database interface extension offers dedicated escaping functions, USE THEM!
  - MySQL
    - `mysql_escape_string()`
    - `mysql_real_escape_string()`
  - PostgreSQL
    - `pg_escape_string()`
    - `pg_escape_bytea()`
  - SQLite
    - `sqlite_escape_string()`

SQL Escaping in Practice

```
// undo magic_quotes_gpc to avoid double escaping
if (get_magic_quotes_gpc()) {
  $_GET['name'] = stripslashes($_GET['name'];
  $_GET['binary'] = stripslashes($_GET['binary']);
}
```

```
$name = pg_escape_string($_GET['name']);
$binary = pg_escape_bytea($_GET['binary']);
```

```
pg_query($db, "INSERT INTO tbl (name,image)
               VALUES('{$name}', '{$image}')");
```

Escaping Shortfall

- When un-quoted integers are passed to SQL queries, escaping functions won't save you, since there are no special chars to escape.

```
http://example.com/db.php?id=0;DELETE%20FROM%20users
<?php
$id = sqlite_escape_string($_GET['id']);
// $id is still 0;DELETE FROM users

sqlite_query($db,
      "SELECT * FROM users WHERE id={$id}");
// Bye Bye user data...
?>
```

Prepared Statements

- Prepared statements are a mechanism to secure and optimize execution of repeated queries.
- Works by making SQL “compile” the query and then substitute in the changing values for each execution.
  - Increased performance, 1 compile vs 1 per query.
  - Better security, data is “type set” will never be evaluated as separate query.
  - Supported by most database systems.
  - MySQL users will need to use version 4.1 or higher.
  - SQLite extension does not support this either.

Prepared Statements

```
<?php
$data = "Here is some text to index";

pg_query($db, "PREPARE my_stmt (text) AS
               INSERT INTO search_idx (word) VALUES($1)");
foreach (explode(" ", $data) as $word) {
        // no is escaping needed
        pg_query($db, "EXECUTE my_stmt({$word})");
}

// de-allocte the prepared statement
pg_query($sb, "DEALLOCATE my_stmt");
?>
```

- Unless explicitly removed, prepared statements “stay alive” between persistent connections.

Error Reporting

- By default PHP will print all errors to screen, startling your users and in some cases disclosing privileged information.
  - File paths.
  - Un-initialized variables.
  - Sensitive function arguments such as passwords.
- At the same time, disabling error reporting would make bug tracking near impossible.

Solution?

- This problem can be solved by disabling displaying of error messages to screen

```
ini_set("display_errors", FALSE);
```

- And enabling logging of errors

```
ini_set("log_errors", TRUE);
```

- to a file

```
ini_set("error_log", "/var/log/php.log");
```

- or to system central error tracking facility

```
ini_set("error_log", "syslog");
```

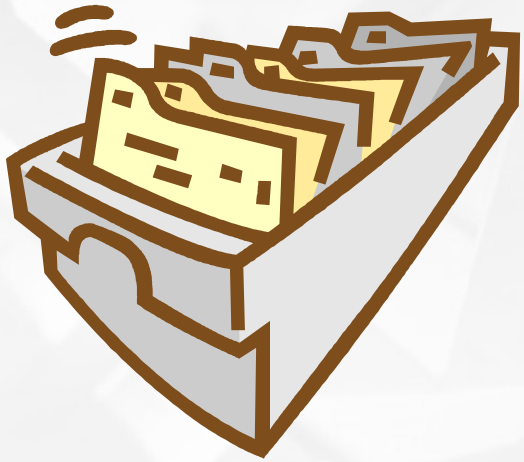
File Security

- Many PHP applications often require various utility and configuration files to operate.
- Because those files are used within the application, they end up being world-readable.
- This means that if those files are in web directories, users could download & view their contents.

External (web) Access

- Do not place files in web root that do not have to be there.
- If nothing is being output by the file, give it a .php extension.
- Use .htaccess to block access to files/directories

```
<Files ~ "\.tpl$">
Order allow,deny
Deny from all
</Files>
```



Securing Configuration Files

- Configuration scripts, usually contain sensitive data that should be kept private.
- Just denying web access, still leaves is readable to all users on the system.
  - Ideally configuration files would only be readable by the owner.

Solution #1

- If the configuration file only stores database connection settings, you can set them via ini directives that will then be loaded by httpd.conf via `Include` directive.

mysql.cnf

```
mysql.default_host=localhost
mysql.default_user=forum
mysql.default_password=secret
```

httpd.conf

```
<VirtualHost 1.2.3.4>
Include "/site_12/mysql.cnf"
</VirtualHost>
```

- Apache parses configuration files as "root", so your SQL settings file can have restricted permissions (0600) and still work.

Solution #2

- For all other settings, Apache environment variables can be used to “hide” data.

misc_config.cnf

```
SetEnv NNTP_LOGIN   "login"
SetEnv NNTP_PASS    "passwd"
SetEnv NNTP_SERVER "1.2.3.4”
```

httpd.conf

```
<VirtualHost 1.2.3.4>
Include “misc_config.cnf”
</VirtualHost>
```

```
echo $_SERVER['NNTP_LOGIN']; // login
echo $_SERVER['NNTP_PASS']; // passwd
echo $_SERVER['NNTP_SERVER']; // 1.2.3.4
```

Session Security

- Sessions are a common tool for user tracking across a web site.
- For the duration of a visit, the session is effectively the user's identity.
- If an active session can be obtained by 3rd party, it can assume the identify of the user who's session was compromised.

Securing Session ID

- To prevent session id theft, the id can be altered on every request, invalidating old values.

```
<?php
session_start();
if (!empty($_SESSION)) { // not a new session
 session_regenerate_id(TRUE); // make new session id
}
?>
```

- Because the session changes on every request, the “back” button in a browser will no longer work, as it will make a request with the old session id.

Session Validation

- Another session security technique is to compare the browser signature headers.

```
session_start();
$chk = @md5(
        $_SERVER['HTTP_ACCEPT_CHARSET'] .
        $_SERVER['HTTP_ACCEPT_ENCODING'] .
        $_SERVER['HTTP_ACCEPT_LANGUAGE'] .
        $_SERVER['HTTP_USER_AGENT']);


if (empty($_SESSION))
        $_SESSION['key'] = $chk;
else if ($_SESSION['key'] != $chk)
        session_destroy();
```

Safer Session Storage

- By default PHP sessions are stored as files inside the common `/tmp` directory.
- This often means any user on the system could see active sessions and “acquire” them or even modify their content.
- Solutions?
  - Separate session storage directory via `session.save_path`
  - Database storage mechanism, mysql, pgsql, oci.
  - Shared memory “mm” session storage.
  - Custom session handler allowing data storage anywhere.

Shared Hosting

- Most PHP applications run in shared environments where all users “share” the same web server instances.
- This means that all files that are involved in serving content must be accessible to the web server (world readable).
- Consequently it means that any user could read the content of files of all other users.

The PHP Solution

- PHP's solution to this problem are 2 INI directives.
  - `open_basedir` – limits file access to one or more specified directories.
    - Relatively Efficient.
    - Uncomplicated.
  - `safe_mode` – limits file access based on uid/gid of running script and file to be accessed.
    - Slow and complex approach.
    - Can be bypassed with little effort.

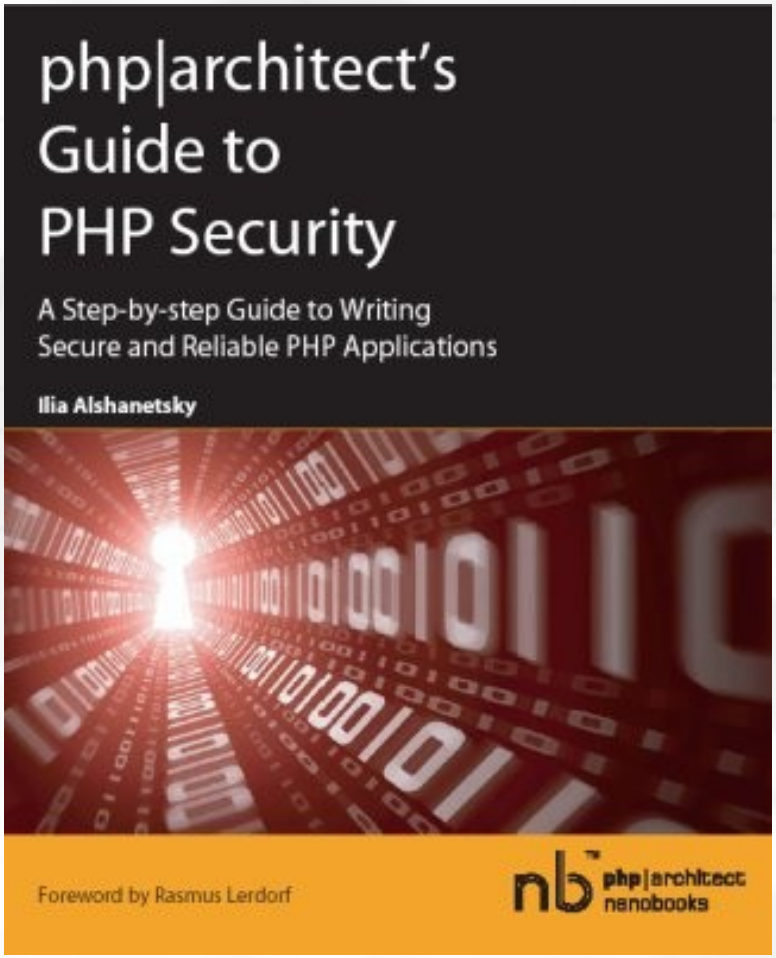
Security Through Obscurity

- While by itself is not a good approach to security, as an addition to existing measures, obscurity can be a powerful tool.
  - Disable PHP identification header

    ```
    expose_php=off
    ```
  - Disable Apache identification header

    ```
    ServerSignature=off
    ```
  - Avoid obvious names for restricted control panels.

<?php include “/book/plug.inc”; ?>



Questions Resources

- http://ilia.ws/
  (These Slides)
- http://www.modsecurity.org/
  (mod_security Apache module)
- http://www.hardened-php.net/
  (PHP Security Patches)
- http://www.xssoops.com/
  (Security Scanner)