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Why File Upload Forms are a Major Security Threat

To allow an end user to upload files to your website, is like opening another door for a malicious user to compromise your server. Even though, in today's modern internet web applications, it is a common requirement, because it helps in increasing your business efficiency. File uploads are allowed in social network web applications, such as Facebook and Twitter. They are also allowed in blogs, forums, e-banking sites, YouTube and also in corporate support portals, to give the opportunity to the end user to efficiently share files with corporate employees. Users are allowed to upload images, videos, avatars and many other types of files.

The more functionality provided to the end user, the greater is the risk of having a vulnerable web application and the chance that such functionality will be abused from malicious users, to gain access to a specific website, or to compromise a server is very high.

While testing several web applications, we noticed that a good number of well known web applications, do not have secure file upload forms. Some of these vulnerabilities were easily exploited, and we could gain access to the file system of the server hosting these web applications. In this whitepaper, we present you with 8 common ways we encountered of securing file upload forms. We also show how a malicious user, can easily bypass such security measures.

Case 1: Simple file upload form with no validation.

A simple file upload form usually consists of a HTML form and a PHP script. The HTML form, is the form presented to the user, while the PHP script contains the code that takes care of the file upload. Below is an example of such form and PHP script:

HTML form:

```
<form enctype="multipart/form-data" action="uploader.php" method="POST">
<input type="hidden" name="MAX_FILE_SIZE" value="100000" />
Choose a file to upload: <input name="uploadedfile" type="file" /><br />
<input type="submit" value="Upload File" />
</form>
```

PHP code (uploader.php):

```
<?php
$target_path = "uploads/";
$target_path = $target_path . basename( $_FILES['uploadedfile']['name']);
if(move_uploaded_file($_FILES['uploadedfile']['tmp_name'], $target_path)) {
    echo "The file ".  basename( $_FILES['uploadedfile']['name']).
    " has been uploaded";
} else{
    echo "There was an error uploading the file, please try again!";
}
?>
```

When PHP receives a **POST** request with encoding type **multipart/form-data**, it will create a temporary file with a random name in a temp directory (e.g. /var/tmp/php6yXOVs). PHP will also populate the global array **$_FILES** with information about the uploaded file:

- $_FILES['uploadedfile']['name']: The original name of the file on the client machine
- $_FILES['uploadedfile']['type']: The mime type of the file
- $_FILES['uploadedfile']['size']: The size of the file in bytes

- $_FILES['uploadedfile']['tmp_name']: The temporary filename in which the uploaded file was stored on the server.

The PHP function **move_uploaded_file** will move the temporary file to a location provided by the user. In this case, the destination is below the server root. Therefore the files can be accessed using a URL like: http://www.domain.tld/uploads/uploadedfile.ext. In this simple example, there are no restrictions about the type of files allowed for upload and therefore an attacker can upload a PHP or .NET file with malicious code that can lead to a server compromise.

This might look like a naïve example, but we did encounter such code and other similar code in a number of web applications.

Case 2: Mime Type validation

Another common mistake web developers do when securing file upload forms, is to only check for mime type returned from PHP. When a file is uploaded to the server, PHP will set the variable $_FILES['uploadedfile']['**type**'] to the mime-type provided by the web browser the client is using. However, a file upload form validation cannot depend on this value only. A malicious user can easily upload files using a script or some other automated application that allows sending of **HTTP POST** requests, which allow him to send a fake mime-type.

Case 3: Block dangerous extensions

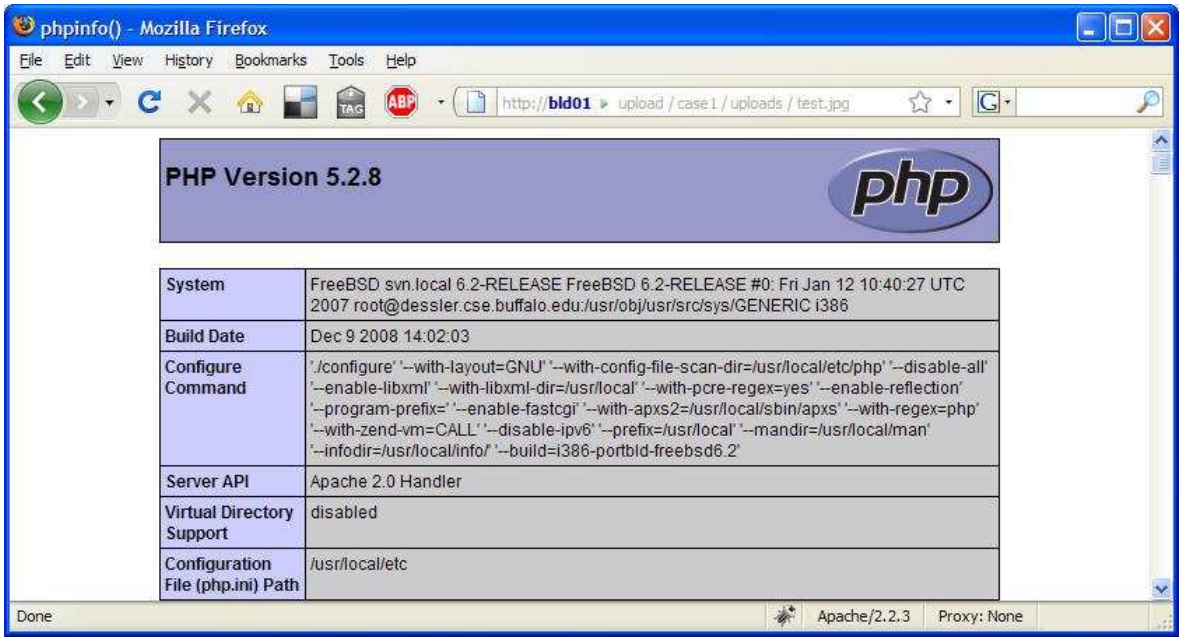
In other cases, we encountered file upload forms using a blacklist approach, as a security measure. A list of dangerous extensions is compiled from the developer, and the access is denied if the extension of the file being uploaded is on the compiled list.

One main disadvantage of using black listing of file extensions, is that it is almost impossible to compile a list that includes all possible extensions that an attacker can use. E.g. If the code is running in a hosted environment, usually such environments allow a large number of scripting languages, such as Perl, Python, Ruby etc, and the list can be endless.

A malicious user can easily bypass such check by uploading a file called ".htaccess", which contains a line of code similar to the below:

AddType application/x-httpd-php .jpg

The above line of code, instructs Apache web server to execute jpg images as if they were PHP scripts. The attacker can now upload a file with a jpg extension, which contains PHP code. As seen in the screen shot below, requesting a jpg file which includes the PHP command phpinfo() from a web browser, it is still executed from the web server:



Case 4: Double extensions (Part 1)

This case's security measures, as a concept are very similar to that one used in case 3. Though instead of simply checking the extension string present in the filename, the developer is extracting the file extension by looking for the '.' character in the filename, and extracting the string after the dot character.

The method used to bypass this approach is a bit more complicated, but still realistic. First, let's have a look at how Apache handles files with multiple extensions. A quote from the Apache manual states:

"Files can have more than one extension, and the order of the extensions is normally irrelevant. For example, if the file welcome.html.fr maps onto content type text/html and language French then the file welcome.fr.html will map onto exactly the same information. If more than one extension is given which maps onto the same type of meta-information, then the one to the right will be used, except for languages and content encodings. For example, if .gif maps to the MIME-type image/gif and .html maps to the MIME-type text/html, then the file welcome.gif.html will be associated with the MIME-type text/html."

Therefore a file named 'filename.php.123', will be interpreted as a PHP file and will be executed. This only works if the last extension (in our case .123), is not specified in the list of mime-types known to the web server. Web developers, usually are not aware of such 'feature' in Apache, which can be very dangerous for a number of reasons. Knowing this, an attacker can upload a file named shell.php.123 and bypass the file upload form protection. The script will compute the last extension (.123), and concludes that this extension is not in the list of dangerous extension. Having said that, it is impossible to predict all the possible random extensions a malicious user will use to be able to upload a file on your web server.

Case 5: Double Extensions (Part 2)

A better approach to securing file upload forms is the white list approach. In this case, the developer defines a list of known/accepted extensions and does not allow extensions that are not specified in the list.

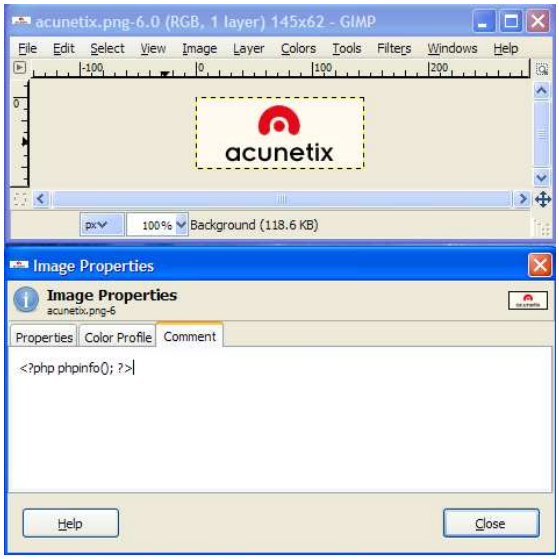
However, in some cases this approach will not work as expected. When Apache is configured to execute PHP code, there are 2 ways one can specify this: to use the **AddHandler** directive, or to use the **AddType** directive. If **AddHandler** directive is used, all filenames containing the '.php' extension (e.g. '.php', '.php.jpg') will be executed as a PHP script. Therefore, if your Apache configuration file contains the following line, you may be vulnerable:

AddHandler php5-script .php

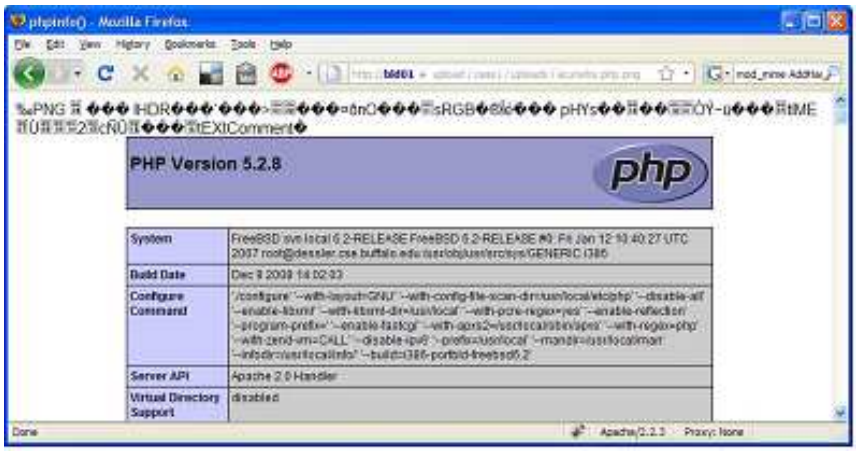
An attacker can upload a file named 'filename.php.jpg' and bypass the protection, and will be able to execute the code.

Case 6: Check the image header

When images only are allowed to be uploaded, developers usually validate the image header by using the PHP function called **getimagesize**. When called, this function will return the size of an image. If the image validation is invalid, which means that the header is incorrect, the function will return a false. Therefore a developer typically checks if the function returns a true or false, and validate the uploaded file using this information. So, if a malicious user tries to upload a simple PHP shell embedded in a jpg file, the function will return false and he won't be allowed to upload the file. However, even this approach can be easily bypassed. If a picture is opened in an image editor, like Gimp, one can edit the image comment, where PHP code is inserted, as shown below.



The image will still have a valid header; therefore it bypasses the **getimagesize** PHP check. As seen in the screen shot below, the PHP code inserted in the image comments still gets executed when the image is requested from a normal web browser:



Case 7: Protecting the upload folder with .htaccess

Another popular way of securing file upload forms, is to protect the folder where the files are uploaded using .htaccess file. The idea is to restrict execution of script files in this folder. A .htaccess file typically contains the below code when used in this kind of scenario:

AddHandler cgi-script .php .php3 .php4 .phtml .pl .py .jsp .asp .htm .shtml .sh .cgi
Options –ExecCGI

The above is another type of blacklist approach, which in itself is not very secure. In the PHP manual, in the **move_uploaded_file** section, there is a warning which states '*If the destination file already exists, it will be overwritten*.'

Because uploaded files can and will overwrite the existing ones, a malicious user can easily replace the .htaccess file with his own modified version. This will allows him to execute specific scripts which can help him compromise the server.

Case 8. Client-side validation

Another common type of security used in file upload forms, is client-side validation of files to be uploaded. Typically, such approach is more common in ASP.NET applications, since ASP.NET offers easy to use validation controls.

These types of validation controls, allow a developer to do regular-expression checks upon the file that is being uploaded, to check that the extension of the file being uploaded is specified in the list of allowed extensions. Below is a sample code, taken from the Microsoft's website:

```
<asp:FileUpload ID="FileUpload1" runat="server" /><br />
<br />
<asp:Button ID="Button1" runat="server" OnClick="Button1_Click" Text="Upload File" /> <br />
<br />
<asp:Label ID="Label1" runat="server"></asp:Label>
<asp:RegularExpressionValidator id="RegularExpressionValidator1" runat="server"
ErrorMessage="Only mp3, m3u or mpeg files are allowed!"
ValidationExpression="^(([a-zA-Z]:)|(\\{2}\w+)\$?)(\\(\w[\w].*))
+(.mp3|.MP3|.mpeg|.MPEG|.m3u|.M3U)$"
ControlToValidate="FileUpload1"></asp:RegularExpressionValidator>
<br />
<asp:RequiredFieldValidator id="RequiredFieldValidator1" runat="server"
ErrorMessage="This is a required field!"
ControlToValidate="FileUpload1"></asp:RequiredFieldValidator>
```

This ASP.NET code uses validation controls, so the end user is only allowed to upload .mp3, .mpeg or .m3u files to the web server. If the file type does not match any of the 3 specified extensions, the validation control throws an exception and the file won't be uploaded.

Because this type of validation is done on the client side, a malicious user can easily bypass this type of validation. It is possible to write a short client side script that will do the validation instead of the script provided by the web application. Without using a web browser, the attacker can use an application that allows sending of HTTP POST requests to be able to upload the file.

Suggested Solutions

Below is a list of best practices that should be enforced when file uploads are allowed on websites and web applications. These practices will help you securing file upload forms used in web applications;

- Define a .htaccess file that will only allow access to files with allowed extensions.
- Do not place the .htaccess file in the same directory where the uploaded files will be stored. It should be placed in the parent directory.
- A typical .htaccess which allows only gif, jpg, jpeg and png files should include the following (adapt it for your own need). This will also prevent double extension attacks.

  ```
  deny from all
  <Files ~ "^\w+\.(gif|jpe?g|png)$">
  order deny,allow
  allow from all
  </Files>
  ```

- If possible, upload the files in a directory outside the server root.
- Prevent overwriting of existing files (to prevent the .htaccess overwrite attack).
- Create a list of accepted mime-types (map extensions from these mime types).
- Generate a random file name and add the previously generated extension.
- Don't rely on client-side validation only, since it is not enough. Ideally one should have both server-side and client-side validation implemented.

Conclusion

As seen above, there are many ways how a malicious user can bypass file upload form security. For this reason, when implementing a file upload form in a web application, one should make sure to follow correct security guidelines and test them properly. Unfortunately, to perform the number of tests required, can take a lot of time and require a good amount of web security expertise.

Though with Acunetix WVS, one can automatically perform file upload forms vulnerability tests without the need of web security expertise. Acunetix WVS provides the developer with extensive amount of information to be able to trace and fix the problem in the least possible time.

Visit http://www.acunetix.com/vulnerability-scanner/ for more information on Acunetix Web Vulnerability Scanner.

Bogdan Calin, May 2009