“Http Parameter Contamination”

Research paper

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**Introduction to Http Parameter Contamination (HPP)**

In software engineering, multi-tier architecture is a client–server architecture in which the presentation, the application processing, and the data management are logically separate processes. Multi-tier application architecture provides a model for developers to create a flexible and reusable application. By breaking up an application into tiers, developers only have to modify or add a specific layer, rather than have to rewrite the entire application over. Differences in handling the same data on variety of platforms can lead to a potential logical error or security vulnerability.

Let’s examine Web Service deployment tiers:

![Diagram of Web Service deployment tiers]

Picture 1 / Owasp09 Poland / Http parameter polluting

Adding more flexible layers may potentially open doors to many new forms of abuse and attack vectors. Rapid application development and technology growth makes security development lifecycle almost impossible to apply. After some time all bugs gets fixed.

But, what with weaknesses that exist for many years in the most popular protocol on the web like HTTP? Two years ago we have witnessed new approach that exploits logic weakness in HTTP by manipulating query string delimiters (&): HTTP PARAMETER POLLUTION.

In a nutshell, Http Parameter Pollution inserts additional query string delimiters or additional parameters with the same name in HTTP request to bypass some security restrictions as a result of platform specific behavior or application error.
HTTP PARAMETER CONTAMINATION (HPC) original idea comes from the innovative approach found in HPP research by exploring deeper and exploiting strange behaviors in Web Server components, Web Applications and Browsers as a result of query string parameter contamination with reserved or non expected characters.

Some facts:

- The term Query String is commonly used to refer to the part between the “?” and the end of the URI
- As defined in the RFC 3986, it is a series of field-value pairs
- Pairs are separated by “&” or “;”
- RFC 2396 defines two classes of characters:
  Unreserved: a-z, A-Z, 0-9 and _ . ! ~ * ' ( )
  Reserved: ; / ? : @ & = + $ ,
  Unwise: { } | \ ^ [ ]

Web Servers Enumeration

HTTP back-ends behave in several ways in the case of multiple parameters sent with the same name:

<table>
<thead>
<tr>
<th>Technology/HTTP back-end</th>
<th>Overall Parsing Result</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASP.NET/IIS</td>
<td>All occurrences of the specific parameter</td>
<td>par1=val1, par2=1</td>
</tr>
<tr>
<td>ASP.NET</td>
<td>All occurrences of the specific parameter</td>
<td>par1=val1, val2</td>
</tr>
<tr>
<td>PHP/Apache</td>
<td>Last occurrence</td>
<td>par1=val2</td>
</tr>
<tr>
<td>PHP/Zend</td>
<td>Last occurrence</td>
<td>par1=val2</td>
</tr>
<tr>
<td>JSP, Servlet/Apache Tomcat</td>
<td>First occurrence</td>
<td>par1=val1</td>
</tr>
<tr>
<td>JSP, Servlet/Oracle Application Server 10g</td>
<td>First occurrence</td>
<td>par1=val1</td>
</tr>
<tr>
<td>JSP, Servlet/Jetty</td>
<td>First occurrence</td>
<td>par1=val1</td>
</tr>
<tr>
<td>IBM Lotus Domino</td>
<td>Last occurrence</td>
<td>par1=val2</td>
</tr>
<tr>
<td>IBM HTTP Server</td>
<td>First occurrence</td>
<td>par1=val1</td>
</tr>
<tr>
<td>mod_peri, libapreq2/Apache</td>
<td>First occurrence</td>
<td>par1=val1</td>
</tr>
<tr>
<td>Perl CGI/Apache</td>
<td>First occurrence</td>
<td>par1=val1</td>
</tr>
<tr>
<td>mod_peri, lib???/Apache</td>
<td>Becomes an array</td>
<td>ARRAY(val1, val2)</td>
</tr>
<tr>
<td>mod_wsgi (Python)/Apache</td>
<td>First occurrence</td>
<td>par1=val1</td>
</tr>
<tr>
<td>Python/Zope</td>
<td>Becomes an array</td>
<td>[&quot;val1&quot;, &quot;val2&quot;]</td>
</tr>
<tr>
<td>J2K Wrap</td>
<td>Last occurrence</td>
<td>par1=1, par2=2</td>
</tr>
<tr>
<td>AXIS 2400</td>
<td>All occurrences of the specific parameter</td>
<td>par1=val1, val2</td>
</tr>
<tr>
<td>Linksys Wireless-G PTZ Internet Camera</td>
<td>Last occurrence</td>
<td>par1=val2</td>
</tr>
<tr>
<td>Ricoh Aficio 1022 Printer</td>
<td>First occurrence</td>
<td>par1=val1</td>
</tr>
<tr>
<td>webcamXP PRO</td>
<td>First occurrence</td>
<td>par1=val1</td>
</tr>
<tr>
<td>DEE Man</td>
<td>All occurrences of the specific parameter</td>
<td>par1=val1=~1+val2</td>
</tr>
</tbody>
</table>
If we apply HPC idea to an HTTP backend, we get results like this:

<table>
<thead>
<tr>
<th>Query string</th>
<th>Web Servers response / GET values</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>?test=1=2</td>
<td>test_1=2</td>
<td>Curly bracket changed with underscore</td>
</tr>
<tr>
<td>?test_1=2</td>
<td>test_1=2</td>
<td>Curly bracket changed with underscore</td>
</tr>
<tr>
<td>?1&amp;d=2</td>
<td>d=2</td>
<td>First is ignored whole param, second query delimiter</td>
</tr>
<tr>
<td>?1&amp;xx=2</td>
<td>1={key}</td>
<td>Characters between array and equal sign are ignored</td>
</tr>
<tr>
<td>?test_d=1+2</td>
<td>test_d=12</td>
<td>First sign plus converted to underscore, second to space</td>
</tr>
<tr>
<td>?test%=</td>
<td>test%</td>
<td>JSP ignore param, ASP ignore value</td>
</tr>
<tr>
<td>?test%x=1</td>
<td>test%=NULL</td>
<td>JSP ignore param, ASP ignore percent sign</td>
</tr>
<tr>
<td>?test%0=1</td>
<td>test%=1</td>
<td>JSP include NULL value in param key</td>
</tr>
<tr>
<td>?test%0=1</td>
<td>test%=1=1</td>
<td>JSP include NULL value in param key, others ignore after</td>
</tr>
<tr>
<td>?test%0=1</td>
<td>NULL</td>
<td>Apache ignore param, JSP include NULL, ASP ignore after</td>
</tr>
<tr>
<td>?%0=1</td>
<td>NULL</td>
<td>JSP have strange behavior, doesn’t print key</td>
</tr>
</tbody>
</table>

And if we take a close look to the results in table, different web servers have different logic for processing special created requests. There are more web server, backend platform and special character combinations, but we will stop here this time.

Code Snippets we use in our research:

**PHP:**

```php
<?php
print_r($_SERVER['QUERY_STRING']);
echo '<br />';
print_r($_GET);
?>
```

**JSP:**

```jsp
<%
java.util.Enumeration names = request.getParameterNames();
while(names.hasMoreElements()){
String keyx = names.nextElement().toString();
out.println(keyx + '=' + request.getParameter(keyx));
}
%
```
**ASP:**

```asp
<%
dim item
For Each item In Request.QueryString
  Response.Write(item & " = " & Request.QueryString(item) & "<br />")
Next
%>
```

**Web Application Firewall (WAF) Bypass POC**

This attack vector can be used against Web Application Firewalls (WAF), an application which combines data from the QUERY_STRING raw and GET variables, or an application which use special characters for some further inspection.

* for \$_SERVER[‘argv’] variables in Apache/PHP we need "register_argc_argv” set to On.

dummy1;variable overflow: http://localhost/?a=1+b=2+c=3

```php
$varArrTemp = array(); // max 2 params
if(count($_GET) < 2)  {
    foreach($_SERVER[‘argv’] as $k=> $v)  {
        $varArrTemp[] = $v
    }
}
```

dummy2;waf bypass: http://localhost/? x[y =a

```php
if(strpos("_",$_SERVER[‘query_string’]) === false)  {
    system(key($_GET));
}
```

dummy3;security check bypass: http://localhost/?a[];some_evil_command;=111

```php
if(strpos("some_evil_command",$_GET[‘a’]) === false AND count($_GET) = 1)  {
    system([$_SERVER[‘argv’][0]);
}
```
Real world examples

{1} Bypass Mod_Security SQL Injection rule (modsecurity_crs_41_sql_injection_attacks.conf)

Forbidden: http://localhost/?xp_cmdshell
Bypassed ([ => _): http://localhost/?x[p]cmdshell


{2} Bypass URLScan 3.1 DenyQueryStringSequences rule


Conclusion and further research

These types of hacking techniques are always interesting because they reveal new perspectives on security problems. Many applications are found to be vulnerable to this kind of abuse because there are no defined rules for strange web server behaviors (for many years).

HPC can be used to extend HPP attack with spoofing real parameter name in the QUERY_STRING with “%” character on an IIS/ASP platform, if there is WAF who blocks this kind of an attack.

We will continue with in-depth research regarding this problem. Please feel free to contact us if you have any interesting comment, remark or idea.

Credits

RSnake (http://ha.ckers.org/)
j0rgan (http://www.remote-exploit.org/?page_id=2)
lightos (http://sla.ckers.org/forum/read.php?3,36640)