Sandboxing is (the) shit !

Jonathan Brossard (Toucan System)

5/10/2013

Who am I ?

- Security researcher, publishing since 2005.

- Past research : vulnerabilities in BIOSes, Microsoft Bitlocker, Truecrypt, McAfee Endpoint (Defcon 2008), PMCMA debugger (Blackhat USA 2011), « Rakshasa » supply chain backdoor PoC (Blackhat 2012), 2 SAP notes (2013).

- Speaker/trainer at HITB, CCC, Ruxcon...

- Co-founder of the Hackito Ergo Sum and NoSuchCon research conferences (France).

Disclaimer : contains research

This was supposed to be a short research on finding/exploiting a few cool low level bugs in sandboxes.

It ended up leading to more questions than answers on my understanding of what the industry is doing in the AV/sandbox space.

If you have better understanding, I'd really like if you took the time to explain me

(endrazine@gmail.com,+PGP).

Disclaimer (rephrased)

WTF is the AV industry doing ? Well, I'm not so sure I understand anymore ...

What's hot in the AV industry in 2013 ?

AV industry : 2013 trends

- Desktop AV is essentially a thing of the past

- Focus moves technologies hopefully able to « detect 0days »[1] like sandboxing.

=> The new cool thing is emulation and sandboxing.

[1] Don't laugh yet.

How it all started... (/story telling)

CVE-2013-0640
(Adobe Sandbox bypass)

Adobe Reader and Acrobat 9.x before 9.5.4, 10.x before 10.1.6, and 11.x before 11.0.02 allow remote attackers to execute arbitrary code or cause a denial of service (memory corruption) via a crafted PDF document, as exploited in the wild in February 2013.

CVE-2013-0640
(Adobe Sandbox bypass)

Their « analysis » :

Here is the sequence of the ROP shellcode:

msvcr100!fsopen()

msvcr100!write()

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kernel32!LoadLibraryA()

kernel32!Sleep()

Upon loading the malicious library, it will enter a long sleep and ensure that the thread has not crashed because the whole stack in the thread is already manipulated for creating a ROP chain.

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=> In trivial english, this is called bullshitting. They clearly have no idea what the exploit is trying to do here.

What I believe really happens in this case (wild guess)

Sleep 5 minutes to attempt bypass sanboxing detection :)

After all, it's a hardened exploit, found in the wild and the first of its kind to bypass Adobe sandboxing technology...

Limits of such technologies (imho)

- Good at finding artefacts (it's still « something »).

- Pretty bad at understanding what is actually happening inside the exploit.

That being said...

The raise of sandboxes...

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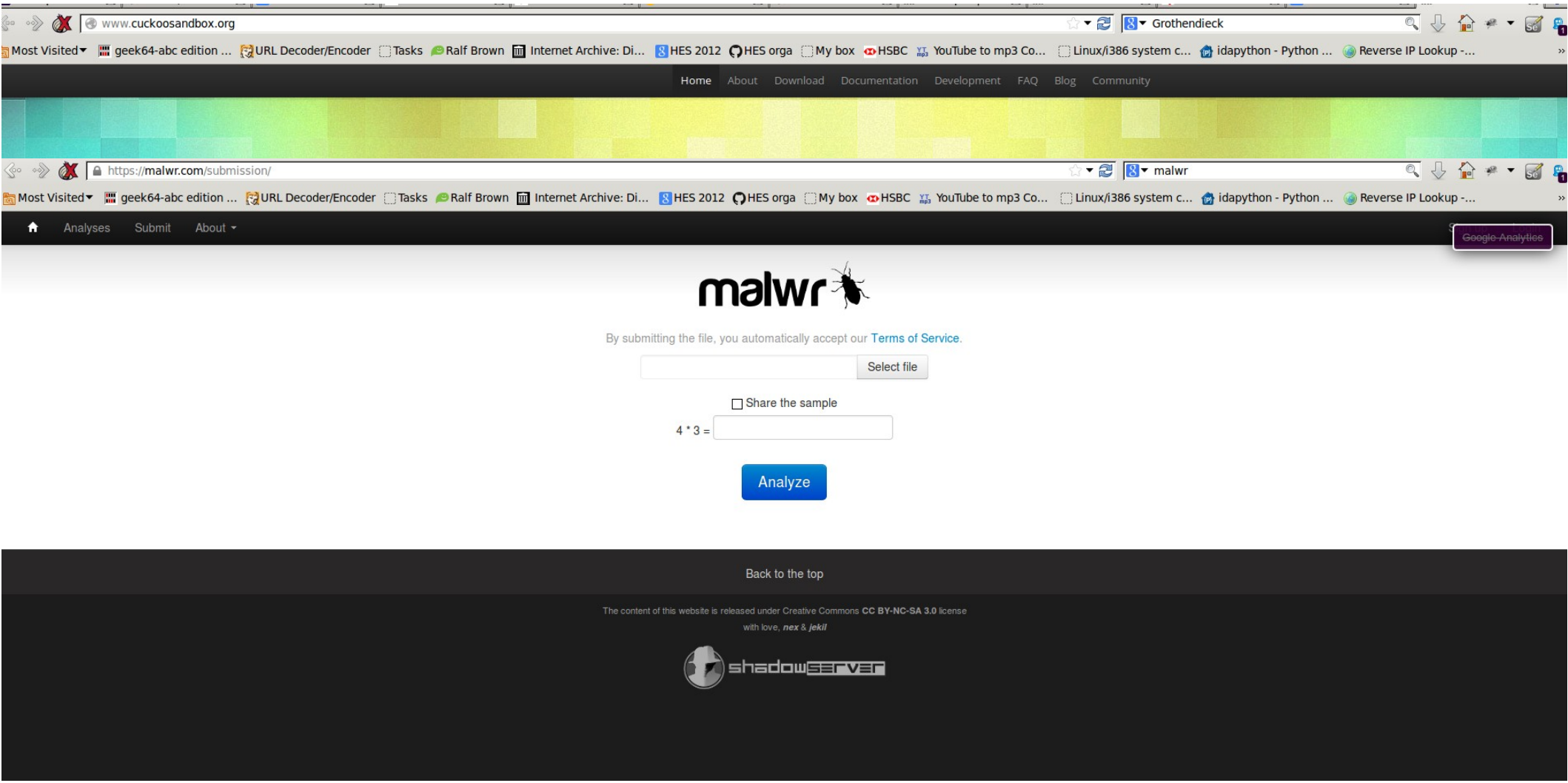
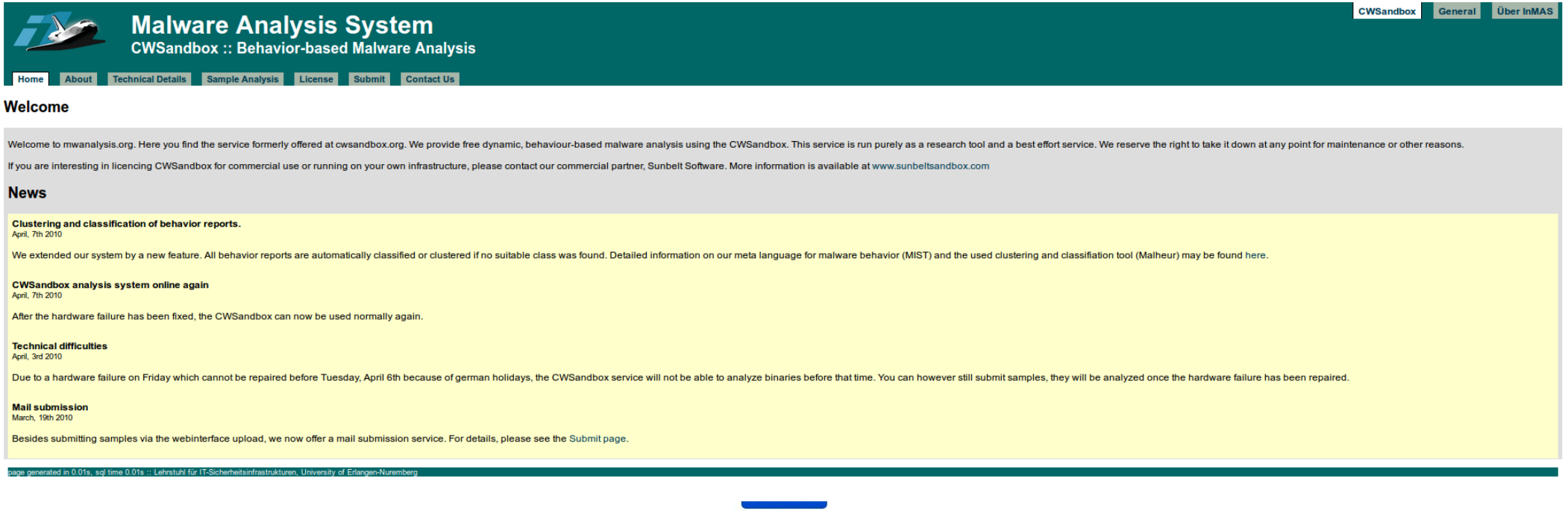


The raise of sandboxes...



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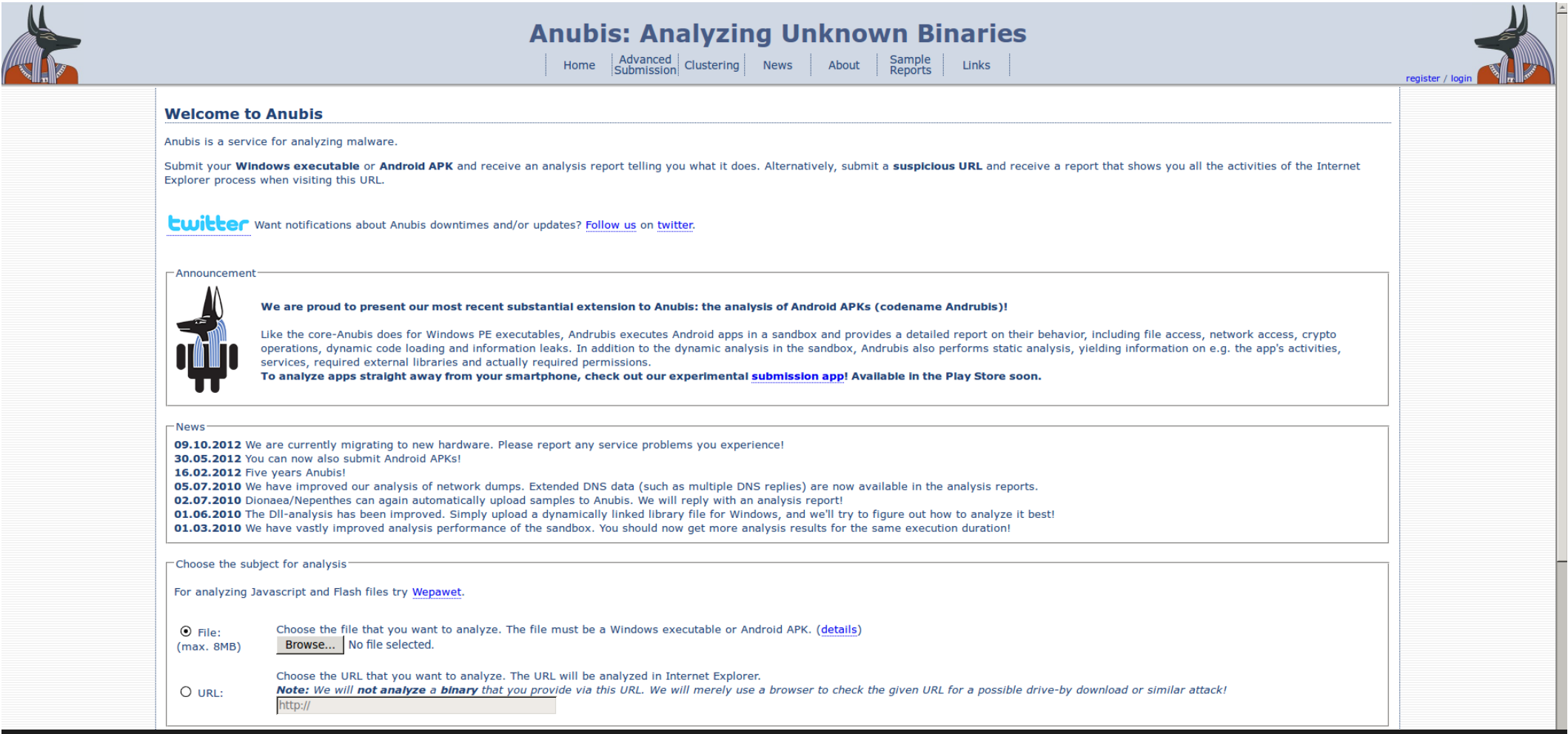

Anubis: Analyzing Unknown Binaries

Home | Advanced Submission | Clustering | News | About | Sample Reports | Links

register / login

Welcome to Anubis

Anubis is a service for analyzing malware.

Submit your **Windows executable** or **Android APK** and receive an analysis report telling you what it does. Alternatively, submit a **suspicious URL** and receive a report that shows you all the activities of the Internet Explorer process when visiting this URL.

twitter Want notifications about Anubis downtimes and/or updates? Follow us on twitter.

Announcement

We are proud to present our most recent substantial extension to Anubis: the analysis of Android APKs (codename Andrubis)!

Like the core-Anubis does for Windows PE executables, Andrubis executes Android apps in a sandbox and provides a detailed report on their behavior, including file access, network access, crypto operations, dynamic code loading and information leaks. In addition to the dynamic analysis in the sandbox, Andrubis also performs static analysis, yielding information on e.g. the app's activities, services, required external libraries and actually required permissions.
To analyze apps straight away from your smartphone, check out our experimental submission app! Available in the Play Store soon.

News

09.10.2012 We are currently migrating to new hardware. Please report any service problems you experience!
30.05.2012 You can now also submit Android APKs!
16.02.2012 Five years Anubis!
05.07.2010 We have improved our analysis of network dumps. Extended DNS data (such as multiple DNS replies) are now available in the analysis reports.
02.07.2010 Dionaea/Nepenthes can again automatically upload samples to Anubis. We will reply with an analysis report!
01.06.2010 The Dll-analysis has been improved. Simply upload a dynamically linked library file for Windows, and we'll try to figure out how to analyze it best!
01.03.2010 We have vastly improved analysis performance of the sandbox. You should now get more analysis results for the same execution duration!

Choose the subject for analysis

For analyzing Javascript and Flash files try Wepawet.

File: (max. 8MB) — Choose the file that you want to analyze. The file must be a Windows executable or Android APK. (details)
Browse... No file selected.

URL: — Choose the URL that you want to analyze. The URL will be analyzed in Internet Explorer.
Note: *We will **not analyze** a **binary** that you provide via this URL. We will merely use a browser to check the given URL for a possible drive-by download or similar attack!*
http://

Note to self : I don't find quite reasonable to add to your corporate network something nobody really understands.

Note : lack of third party assessment

Jonathan Brossard
@endrazine

Dear @FireEye , is there a chance you will let independant researchers look at your appliance ? Lack of transparency=not good :) /cc @taviso

Reply Delete Favorite More

Note : lack of third party assessment

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The whole concept of sandboxing vendors is to not have the perceived enemy take a look at the technology. Ok, agreed.

Note : lack of third party assessment

It also means no third party assessment has been done by the security community...

In real life, having software due dilligence done by the community has proved to be a good thing for the quality of the said software.

See similar requests from Tavis Ormandi and Pipacs to have a look at Bromium's technology...

Note : well, they're not Bromium clients, so we have a problem... as an industry, really.

Note 2 : Afaik, Bromium has researchers like Nergal and Jarred Demott. Who of this caliber works for FireEye really ?

grsecurity
@grsecurity

Following

A petition to get a Bromium demo for @taviso and Pipacs. Pipacs has agreed to use a 10 year old copy of IDA to handicap his breaking it.

Reply Retweet Favorited More

31 RETWEETS | **6** FAVORITES

8:40 PM - 6 Aug 13

Reply to @grsecurity @taviso

Kostya Kortchinsky @crypt0ad 6 Aug
@grsecurity @taviso can I play too??
Details

Room for problems (research leads)

Room for problems part I : general design/architecture

What's the trend, perceived objective like

Current « genious » idea :

- Correlate/share more data to create information asymetry.

- To do that, most (all I've seen allow it, at least in non default mode) solutions now allow a malware to connect back to the internet[*].

[*] Idea being to correlate DNS/binary checksum informations over « campaigns » of attacks in the time.

A few facts on this...

- The whole corporate strategy over the past 15 years has been to segregate LANS, DMZs and the internet.

- Now you give a temporary shell to the attacker at network perimeter (proxies, mail gateways, wherever such sandboxing solutions exist)...

- … and what happens to your DNS ? To your http proxy cache ?

The Katsuni-Kaminsky attack (having it both ways)

- Attacker can run a malware inside a sandbox.
- Sandbox allows attacker to connect back to the internet.
- Corporate DNS server is used as a recursive DNS server.
- Attacker has it both ways and can synchronize arbitrary spoofed packets emission from both inside and outside the network.

=> That's gonna be very « safe » for sure...

Not to mention...

- What happens if the malware, from inside the sandbox manages to attack other networks (say crowdstrike !) ?

- What happens if the malware can send back a modified copy of itself to the same network (smtp?) for more analysis, and more sandbox cpu time ?

=> It's all about implementation details really.

Is this « wormable » (yet) ?

- FireEye claims to work with 30 % of the TOP 100 Companies. That makes it not so hard to find...

- Their strategy is to synchronize malware information sharing... (allow exploits to drop exes on the sandboxes... ?!?)

- They cover you « 360 », from mail gateways to http proxy file downloads, etc.

- Ok, so how exactly do you prevent one malware to get endless free execution time inside your different sandboxes around the world ?

Room for problems part II : Turning lame bugs into sandbox Oracles

The problem

- Many online malware scanning engines run qemu (+ some various instrumentation and automation custom software)

- User doesn't get to see anything from the scanning process.

- Now, what if an attacker has a qemu lame DoS or endless loop PoC ?

Turning lame bugs into sandbox Oracles

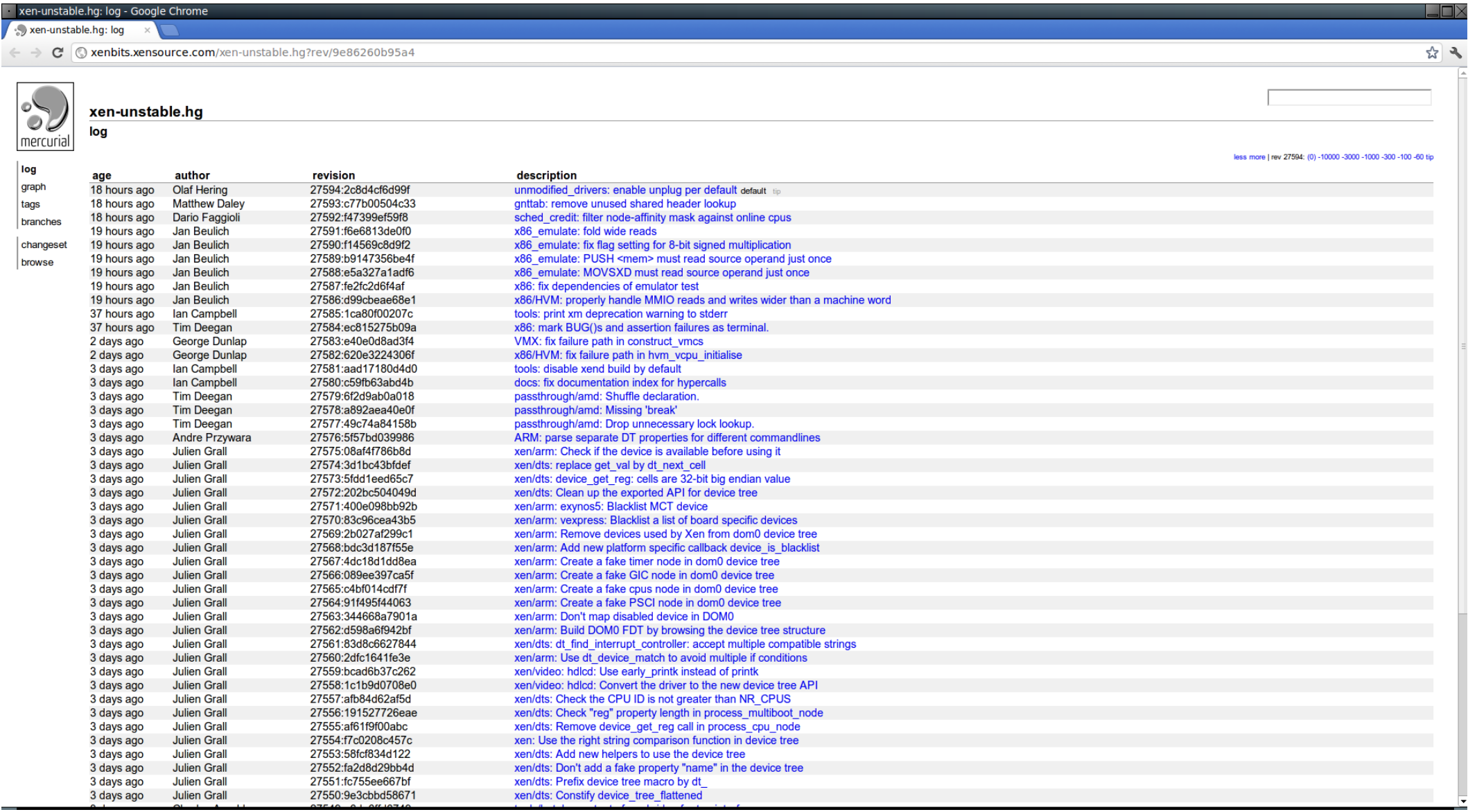
(aka : hacking online malware analysis tools... hrm)

Room for problems part III : Such bugs do happen...

What degrees do projects like Xen or qemu really have in terms of security ?

A fair question is the relative maturity of such technology, not when it comes to support legacy Oses or current Oses, but hostile malware trying to hurt them.

Exempli gratia : typical bugs reported (complexity, software maturity : format strings/symlinks or complex overflows ?)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mercurial
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log
log
graph
tags
branches
changeset
browse
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age author revision description
18 hours ago Olaf Hering 27594:2c8d4cf6d99f unmodified_drivers: enable unplug per default default tip
18 hours ago Matthew Daley 27593:c77b00504c33 gnttab: remove unused shared header lookup
18 hours ago Dario Faggioli 27592:f47399ef59f8 sched_credit: filter node-affinity mask against online cpus
19 hours ago Jan Beulich 27591:f6e6813de0f0 x86_emulate: fold wide reads
19 hours ago Jan Beulich 27590:f14569c8d9f2 x86_emulate: fix flag setting for 8-bit signed multiplication
19 hours ago Jan Beulich 27589:b9147356be4f x86_emulate: PUSH <mem> must read source operand just once
19 hours ago Jan Beulich 27588:e5a327a1adf6 x86_emulate: MOVSXD must read source operand just once
19 hours ago Jan Beulich 27587:fe2fc2d6f4af x86: fix dependencies of emulator test
19 hours ago Jan Beulich 27586:d99cbeae68e1 x86/HVM: properly handle MMIO reads and writes wider than a machine word
37 hours ago Ian Campbell 27585:1ca80f00207c tools: print xm deprecation warning to stderr
37 hours ago Tim Deegan 27584:ec815275b09a x86: mark BUG()s and assertion failures as terminal.
2 days ago George Dunlap 27583:e40e0d8ad3f4 VMX: fix failure path in construct_vmcs
2 days ago George Dunlap 27582:620e3224306f x86/HVM: fix failure path in hvm_vcpu_initialise
3 days ago Ian Campbell 27581:aad17180d4d0 tools: disable xend build by default
3 days ago Ian Campbell 27580:c59fb63abd4b docs: fix documentation index for hypercalls
3 days ago Tim Deegan 27579:6f2d9ab0a018 passthrough/amd: Shuffle declaration.
3 days ago Tim Deegan 27578:a892aea40e0f passthrough/amd: Missing 'break'
3 days ago Tim Deegan 27577:49c74a84158b passthrough/amd: Drop unnecessary lock lookup.
3 days ago Andre Przywara 27576:5f57bd039986 ARM: parse separate DT properties for different commandlines
3 days ago Julien Grall 27575:08af4f786b8d xen/arm: Check if the device is available before using it
3 days ago Julien Grall 27574:3d1bc43bfdef xen/dts: replace get_val by dt_next_cell
3 days ago Julien Grall 27573:5fdd1eed65c7 xen/dts: device_get_reg: cells are 32-bit big endian value
3 days ago Julien Grall 27572:202bc504049d xen/dts: Clean up the exported API for device tree
3 days ago Julien Grall 27571:400e098bb92b xen/arm: exynos5: Blacklist MCT device
3 days ago Julien Grall 27570:83c96cea43b5 xen/arm: vexpress: Blacklist a list of board specific devices
3 days ago Julien Grall 27569:2b027af299c1 xen/arm: Remove devices used by Xen from dom0 device tree
3 days ago Julien Grall 27568:bdc3d187f55e xen/arm: Add new platform specific callback device_is_blacklist
3 days ago Julien Grall 27567:4dc18d1dd8ea xen/arm: Create a fake timer node in dom0 device tree
3 days ago Julien Grall 27566:089ee397ca5f xen/arm: Create a fake GIC node in dom0 device tree
3 days ago Julien Grall 27565:c4bf014cdf7f xen/arm: Create a fake cpus node in dom0 device tree
3 days ago Julien Grall 27564:91f495f44063 xen/arm: Create a fake PSCI node in dom0 device tree
3 days ago Julien Grall 27563:344668a7901a xen/arm: Don't map disabled device in DOM0
3 days ago Julien Grall 27562:d598a6f942bf xen/arm: Build DOM0 FDT by browsing the device tree structure
3 days ago Julien Grall 27561:83d8c6627844 xen/dts: dt_find_interrupt_controller: accept multiple compatible strings
3 days ago Julien Grall 27560:2dfc1641fe3e xen/arm: Use dt_device_match to avoid multiple if conditions
3 days ago Julien Grall 27559:bcad6b37c262 xen/video: hdlcd: Use early_printk instead of printk
3 days ago Julien Grall 27558:1c1b9d0708e0 xen/video: hdlcd: Convert the driver to the new device tree API
3 days ago Julien Grall 27557:afb84d62af5d xen/dts: Check the CPU ID is not greater than NR_CPUS
3 days ago Julien Grall 27556:191527726eae xen/dts: Check "reg" property length in process_multiboot_node
3 days ago Julien Grall 27555:af61f9f00abc xen/dts: Remove device_get_reg call in process_cpu_node
3 days ago Julien Grall 27554:f7c0208c457c xen: Use the right string comparison function in device tree
3 days ago Julien Grall 27553:58fcf834d122 xen/dts: Add new helpers to use the device tree
3 days ago Julien Grall 27552:fa2d8d29bb4d xen/dts: Don't add a fake property "name" in the device tree
3 days ago Julien Grall 27551:fc755ee667bf xen/dts: Prefix device tree macro by dt_
3 days ago Julien Grall 27550:9e3cbbd58671 xen/dts: Constify device_tree_flattened

x86_emulate: MOVSXD must read source operand just once (Xen Unstable, 21/09/2013)

```
1.109       if ( (rc != X86EMUL_OKAY) ||
1.110            (regs.eax != 0x0000ffff) ||
1.111            ((regs.eflags&0x240) != 0x200) ||
1.112 -          (regs.eip != (unsigned long)&instr[2]) )
1.113 +          (regs.eip != (unsigned long)&instr[2 + (ctxt.addr_size
1.114            goto fail;
1.115       printf("okay\n");
1.116
1.117 @@ -821,6 +877,8 @@ int main(int argc, char **argv)
1.118            if ( j == 2 ) break;
1.119            memcpy(res, blowfish32_code, sizeof(blowfish32_code));
```

Ok, so you're at miscomputing EIP on basic instructions such as MOVSXD on 32b...

Note : this is totally exploitable imho btw.

How does that rank compared to real cpu bugs ?

Intel® Pentium® Processor

Invalid Instruction Erratum Overview

Invalid Instruction Errata Home

Software Backgrounder
Updated Nov. 20 1997

Software Vendor Statements

Erratum Technical Description
Updated Nov. 20 1997

Intel Identifies Workaround for the "Invalid Operand with Locked Compare Exchange 8Byte (CMPXCHG8B) Instruction" Erratum

Erratum Overview

On Friday, November 7th 1997, a number of reports were posted to the Internet implying the possibility of a new erratum on the Pentium® processors and Pentium® processors with MMX™ technology. An erratum is a design defect or error which may cause a product to deviate from published specifications. Based on the Internet reports our engineering team quickly jumped on this issue. Once we were able to reproduce the behavior we confirmed that an erratum does exist which is now named the "Invalid Operand with Locked CMPXCHG8B instruction" erratum. We were also able to identify the following:

That was in 1997... The instruction is far less used (CMPXCHG8B)

Qemu internals

Qemu goals

- (Fast) binary translation

- Binary code is translated into an IR, which is then executed by a virtual cpu, independently of host OS/arch.

- Super generic, super fast, super portable, super cool. Truely impressive.

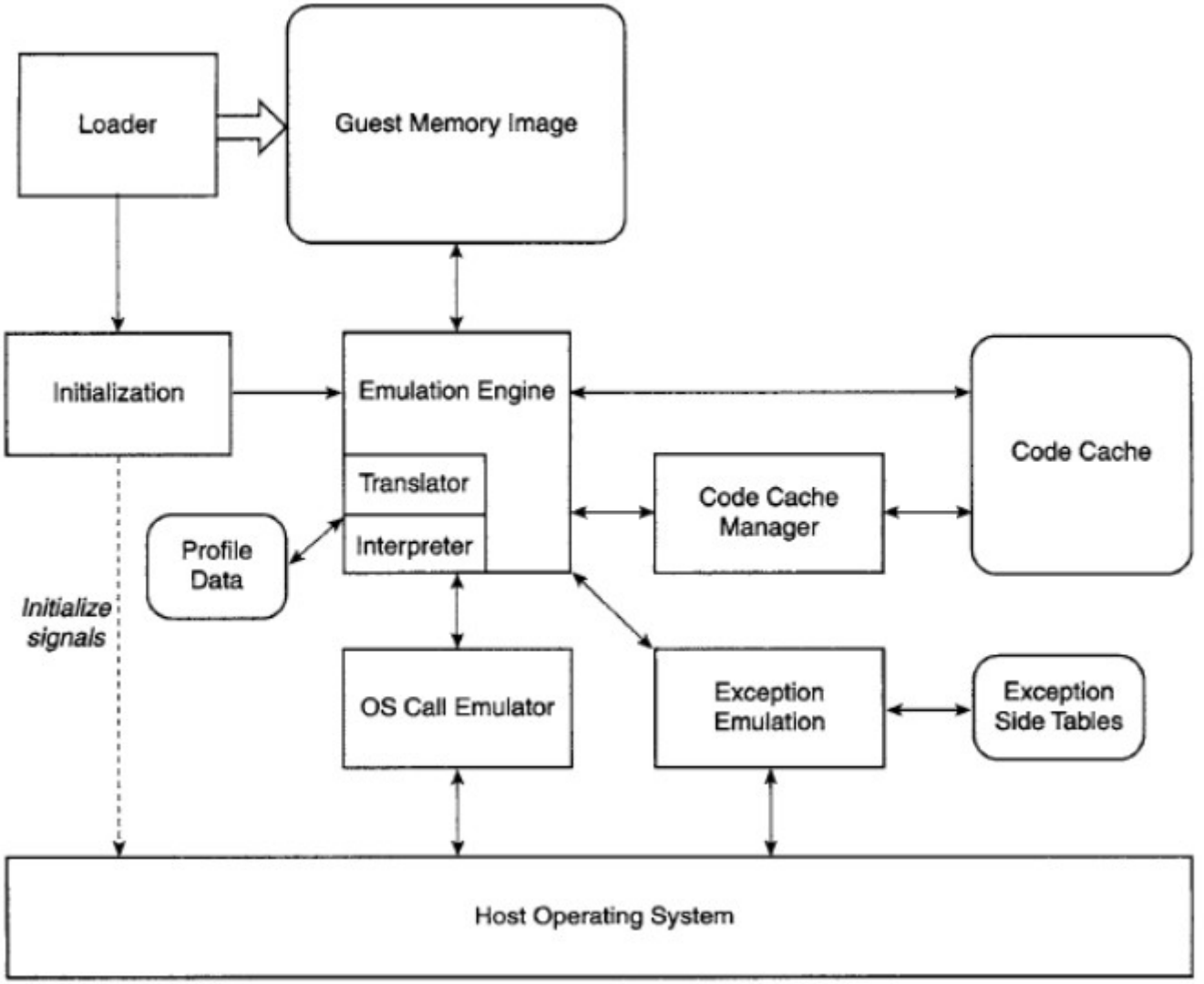
- Super secure for the purpose of malware analysis though ?

Qemu supports two modes

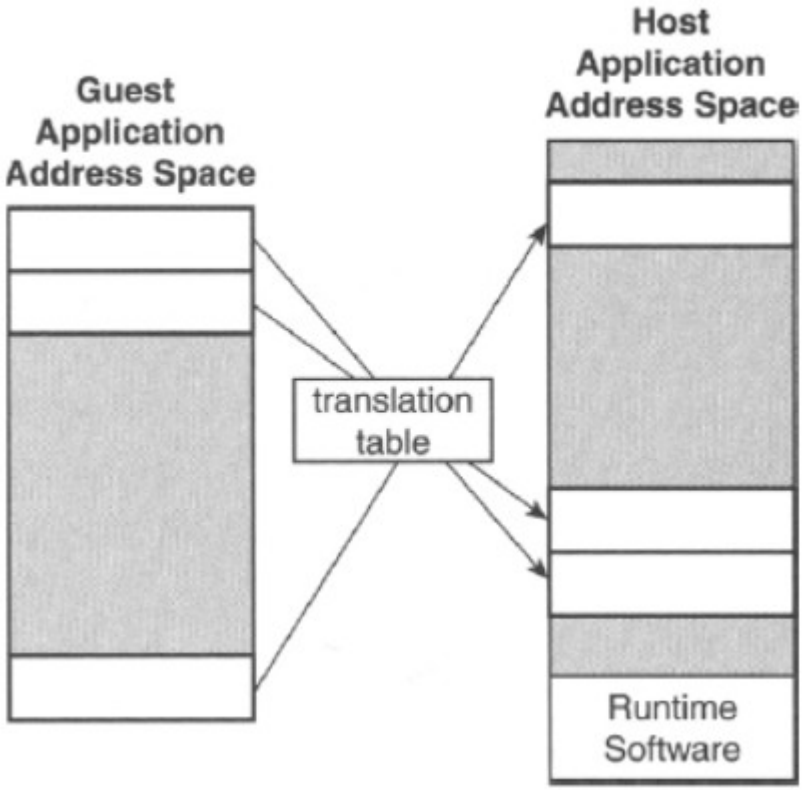
- System (full) virtualization
- Kernel emulation (wine/Windows, linux).

While many of current implementations are likely to be using the first flavour, we'll focus on the later one, which promises great speed enhancements, and a much greater attack surface... ;)

Qemu architecture



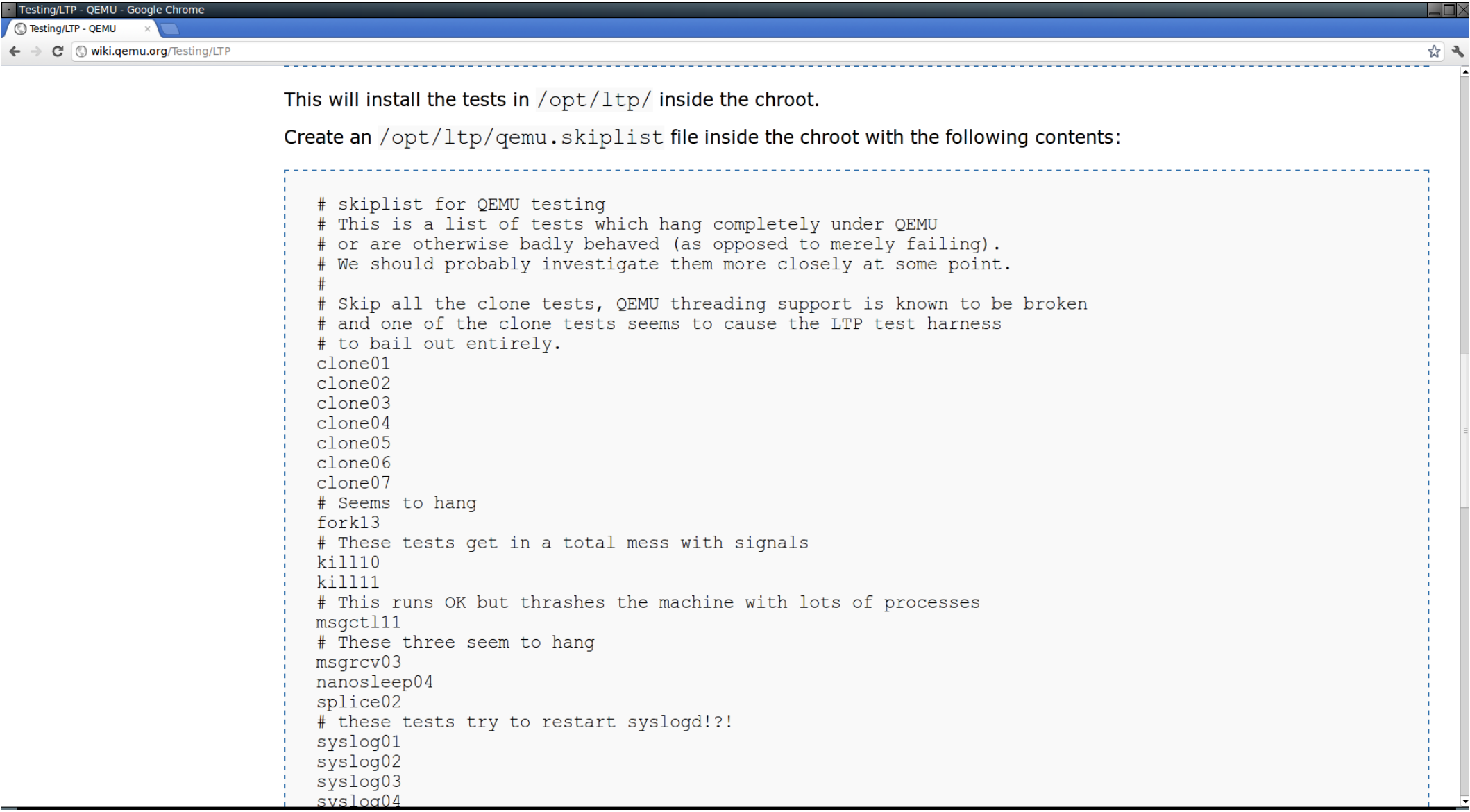
Understanding binary translation & memory sharing



Party time !!


toucan system
IT serenity
H2HC
Hackers to Hackers Conference

Qemu regression tests...



Demos


toucan system
IT serenity
H2HC
Hackers to Hackers Conference

Conclusion

Interresting technologies. Cool hacking tools, usefull for researchers.

There is room for massive security problems, the devil being in the details. Imho, not ready for Enterprise grade deployment.

No such a thing as third party assessment afaict.

From a strict game theory pov, your best interrest is probably to have others use that, but stay away from such technologies...

The Katsuni-Grothendieck theorem applied to silver bullet 0day sandboxing :

« You can't have it both ways ! »

Thanks for inviting me.

Questions ?