DC/4
DAYCONFOUR//DAYTONSECURITYSUMMIT 2010

Supply Chain (In-) Security

Graeme Neilson & Enno Rey

Contact us: graeme@aurasoftwaresecurity.co.nz, erey@ernw.de

Graeme & Enno

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- **Graeme Neilson**
  - Security Consultant & Researcher
  - Networking, Reverse engineering, appliances

Graeme & Enno

- **Enno Rey**
  - Old-school network guy & founder of ERNW
  - Blogs at www.insinuator.net
  - Regularly rants at **Day-Con**
  - Hosts **TROOPERS**

Why this talk

- **Most cons have "some specific characteristic"…**
- **So does Day-Con**
  - Angus loves talks about "potential future attack paths"
  - … sometimes with a "spooky element" in them
  - This talk is our contribution to this space ;-)

- **What *we* love about Day-Con: Pretty much all talks make you *think*.**
  - Not just sit around: "cool demo, next one"…

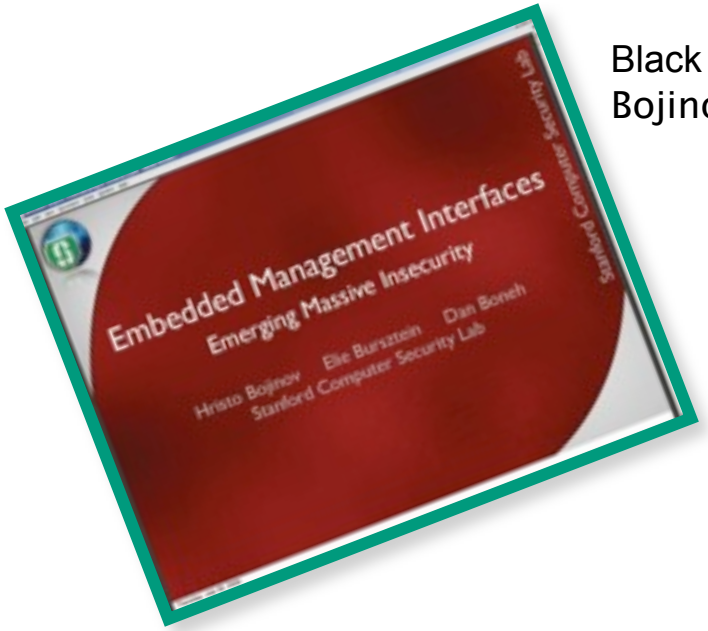
Agenda

- **Supply Chain – Overview**
- **Threats … & Vulnerabilities**
- **Some common appliances' internal architecture**
- **… and how to attack those**

- **Mitigation & Conclusion**

Device Compromise is a well-known threat…

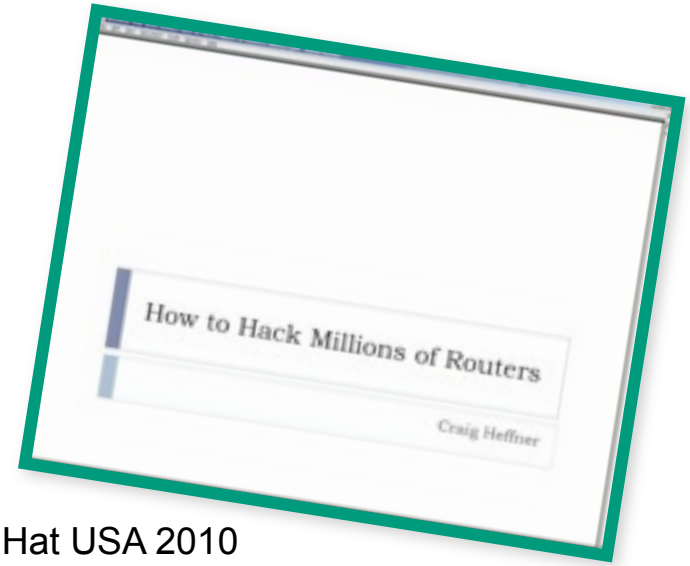
Device Compromise is a well-known threat…



Black Hat USA 2010
Bojinov

Device Compromise is a well-known threat…

Black Hat USA 2010
Bojinov

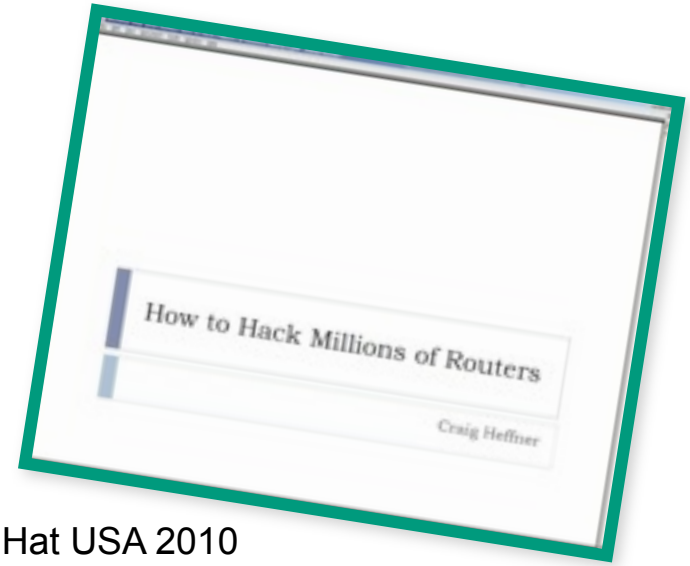


Black Hat USA 2010
Heffner

Device Compromise is a well-known threat…

Black Hat Europe 2006
Jack

Black Hat USA 2010
Bojinov



Black Hat USA 2010
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Device Compromise is a well-known threat…

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Black Hat USA 2010
Heffner

Black Hat Europe 2010
Mende, Rey

… and there's well known controls for this one

ERNW providing security.

Kaeo Informational [Page 1]

RFC 4778 OPSEC Practices January 2007

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… and there's well known controls for this one

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ISO_IEC_24762.pdf (SECURED) - Adobe Reader

File Edit View Document Tools Window Help

26 / 78 137% access control

Thus service providers should ensure that physical access control facilities, policies and established, documented and implemented, commensurate with the assessed risks and the s to organizations, to control and monitor physical access into and out of, and within, service pro

6.3.2 Personnel security categorization

A formal system of security categorization for personnel should be established. The categ cater for the following personnel categories:

a) service provider staff;

b) organization employees;

c) vendors and contractors;

d) visitors.

6.3.3 Security zones

Separate physical security zones should be identified and established in service provider prem

a) restricted facilities – areas/rooms housing key equipment and facilities such as se computer equipment, communications switches and other related equipment and cabl archives, air conditioning facilities, and main distribution frames for the power supply;

… at least for some attack vectors

- **Remote Compromise**

- **Physical access to device (on organization's premise)**

But…

... some thing may be overlooked here

Ask yourselves

- **Who touches a device BEFORE it enters an organization's premises?**

Overview Supply Chain

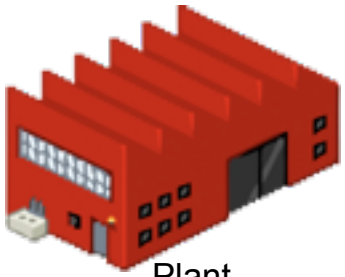
Do you ***trust*** the _____ ?

Overview Supply Chain

Manufacturer

Do you ***trust*** the _____ ?

Overview Supply Chain



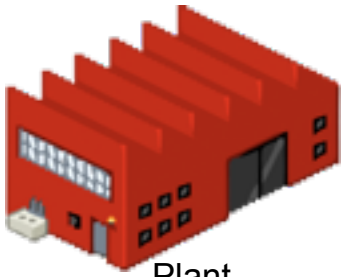
Plant

Manufacturer

Do you ***trust*** the _____ ?

Overview Supply Chain

Manufacturer

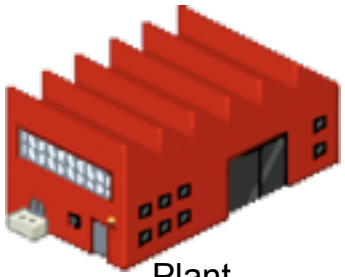


Plant

Distributor

Do you ***trust*** the _____ ?

Overview Supply Chain



Plant

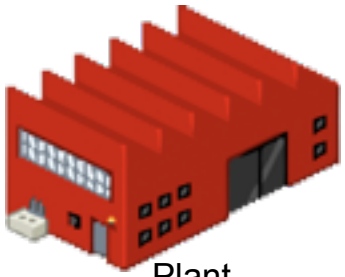
Manufacturer

Do you ***trust*** the _____ ?

Distributor

Reseller

Overview Supply Chain

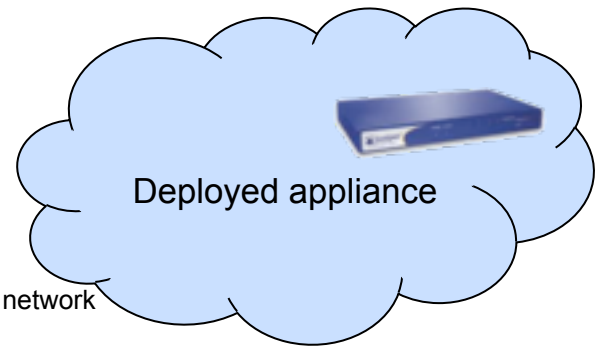


Plant

Manufacturer

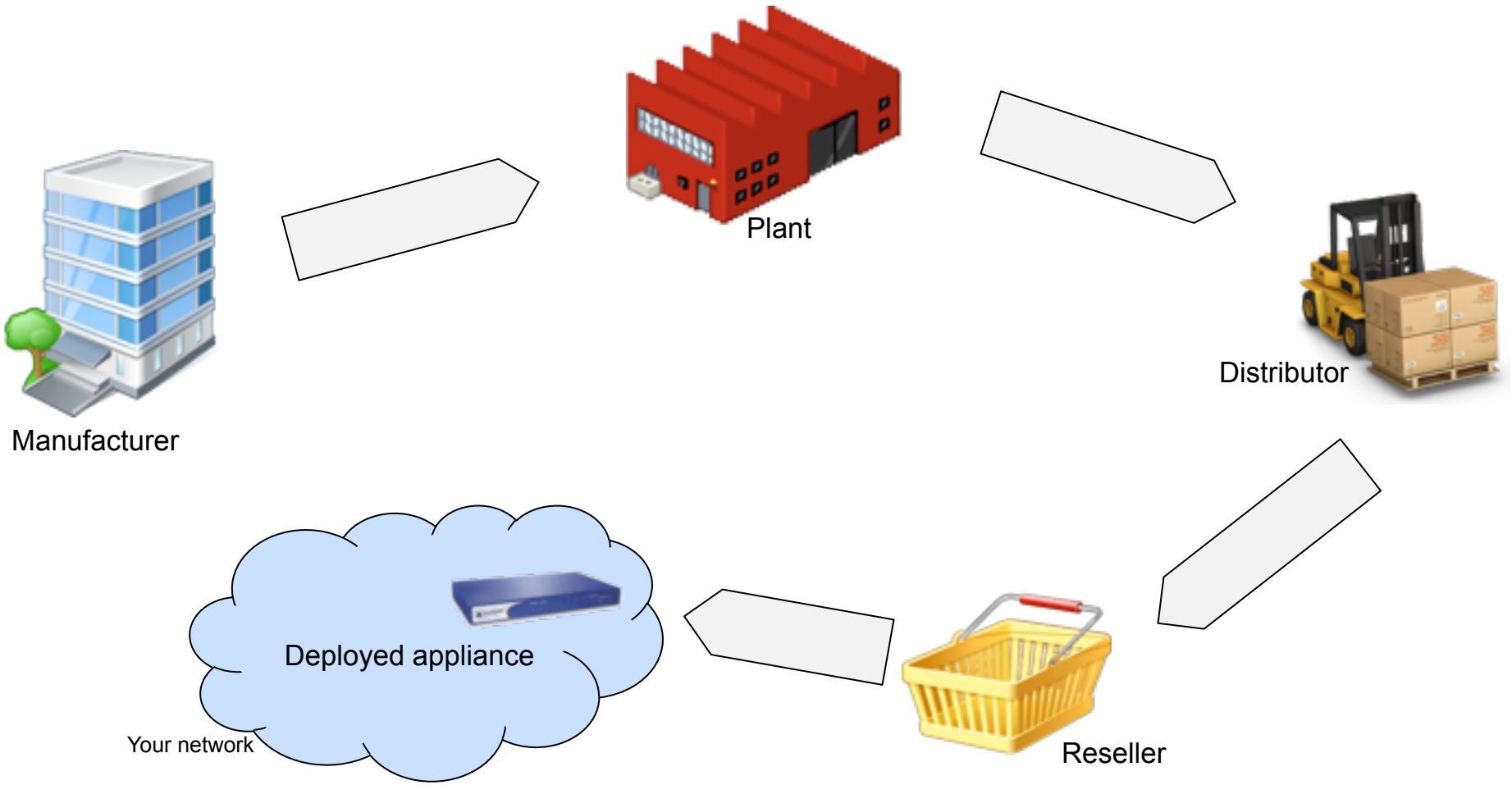
Distributor

Do you ***trust*** the _____ ?



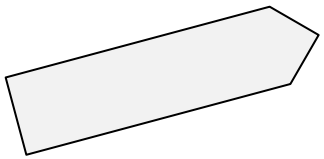
Reseller

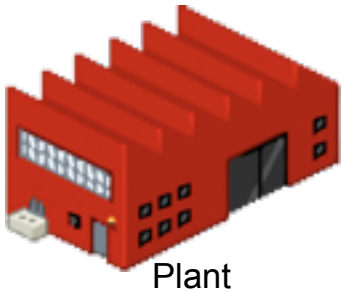
Overview Supply Chain



Overview Supply Chain

Manufacturer





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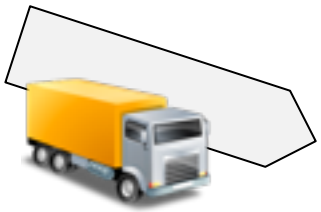
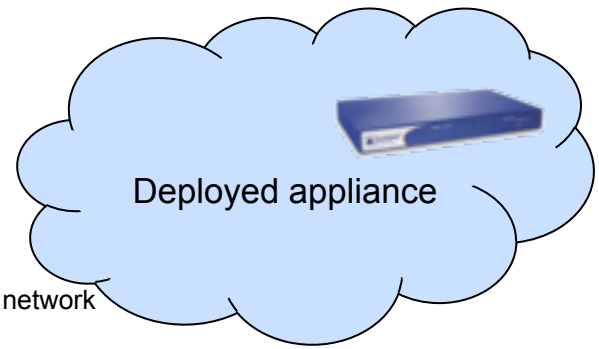


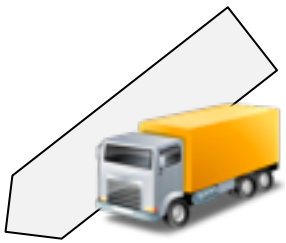
Distributor

And what's about the ***carrier processes***?

e.g.: FedEx UPS DHL



Reseller



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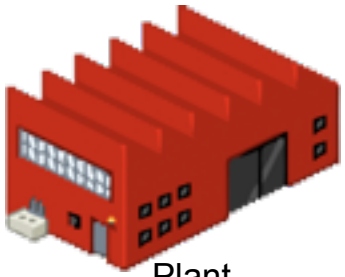

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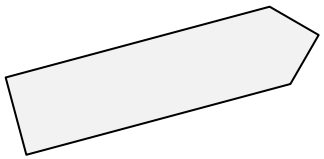
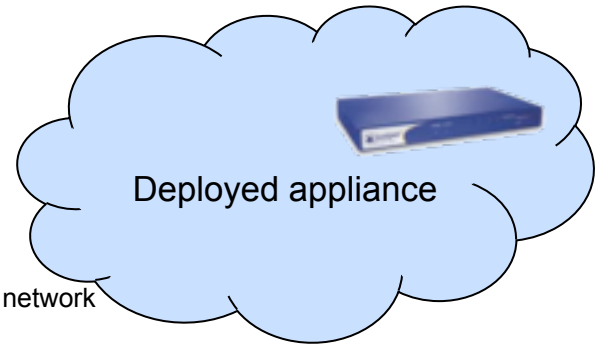


And what's about the ***carrier processes***?
Or ***customs***, if borders are crossed?

Distributor



Deployed appliance

Your network

Reseller

We won't discuss "the malicious manfacturer scenario" here

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Home / News & Blogs / Zero Day

Scammers caught backdooring chip and PIN terminals

By Dancho Danchev | August 19, 2008, 1:51pm PDT

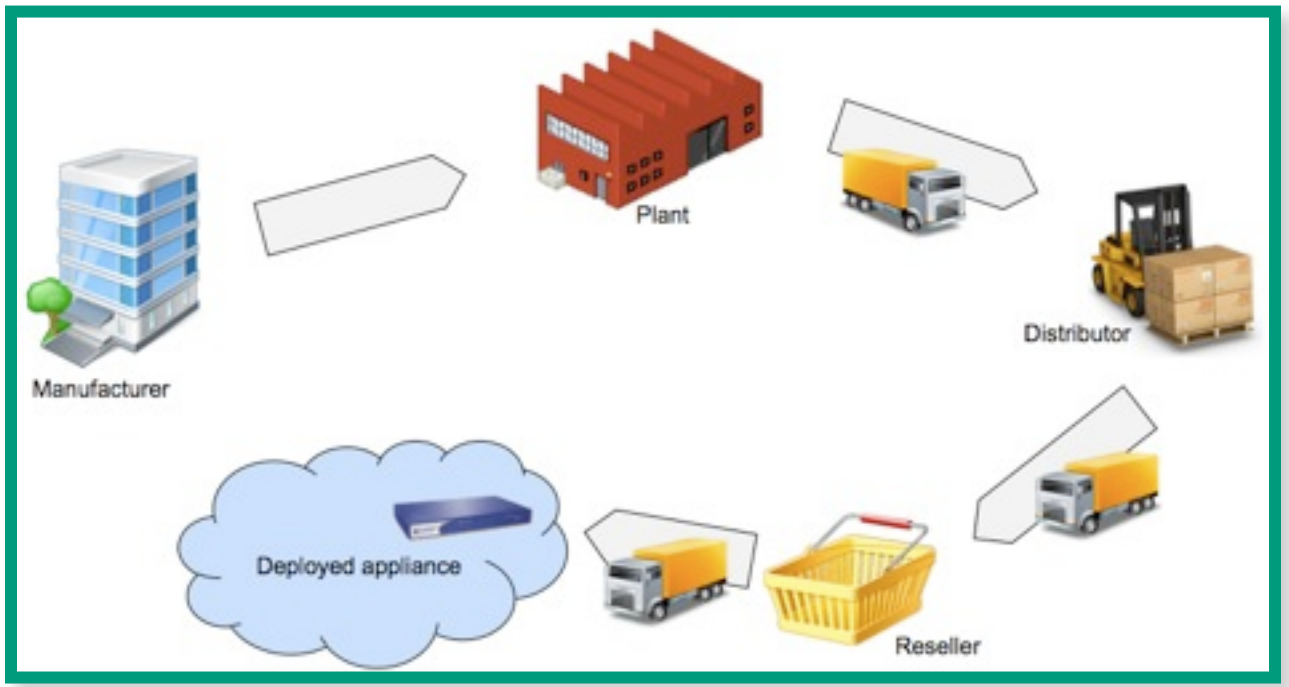
Summary

The U.K's Dedicated Cheque and Plastic Crime Unit (DCPU) have recently uncovered state of the art social engineering scheme, where once backdoored, chip and PIN terminals were installed at retailers

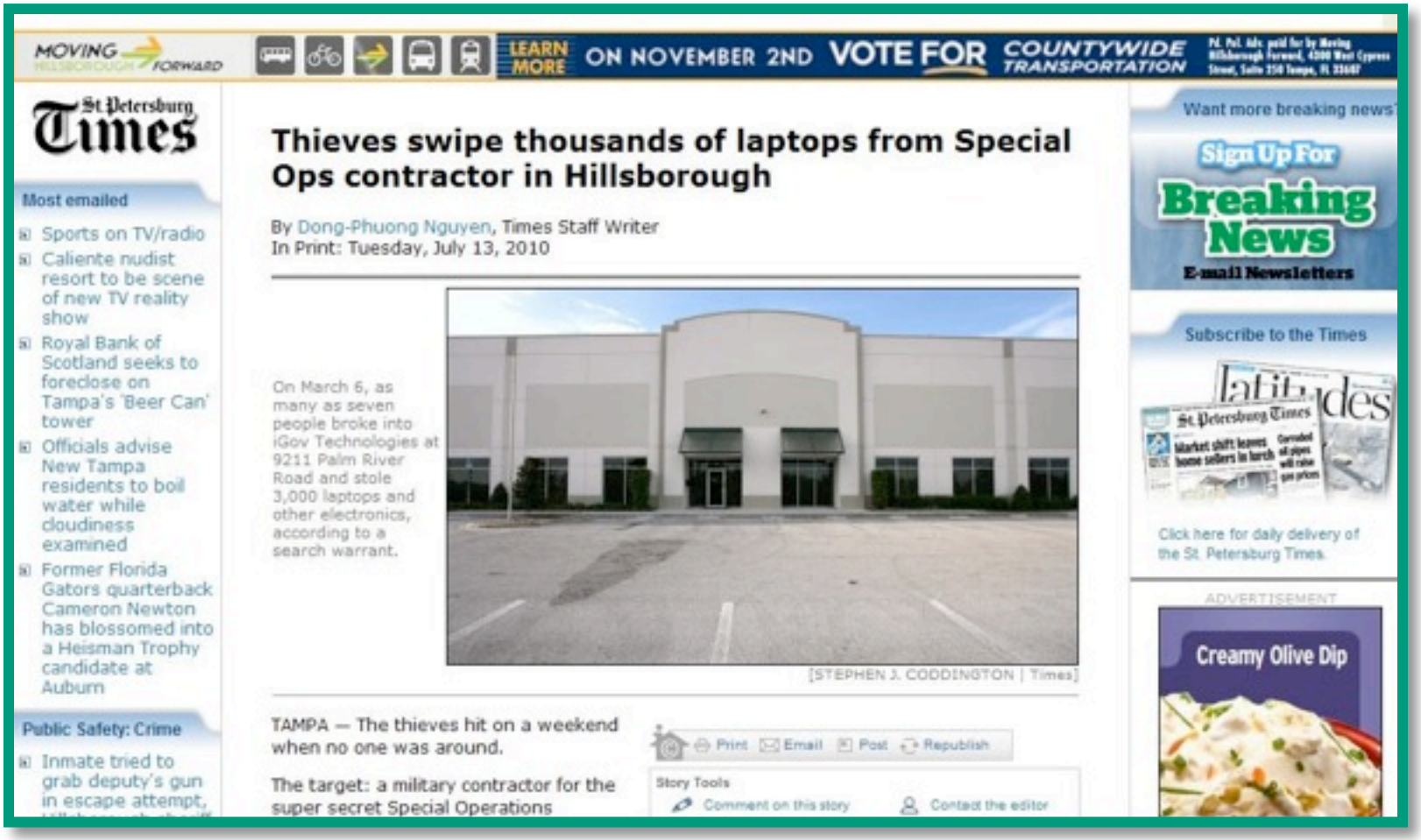
The U.K's Dedicated Cheque and Plastic Crime Unit (DCPU) have recently uncovered state of the art social engineering scheme, where once backdoored, chip and PIN terminals were installed at retailers and petrol stations in an attempt to steal the credit card details passing through. Originally, before online banking took place proportionally with the developments on the banker malware front, scammers used to take advantage of old-fashioned ATM skimming and fake

So what does this mean?

- **Potentially every party in this chain might be able to touch "sensitive parts" of the device.**



And maybe not only authorized parties



What do you mean by “sensitive parts”?

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- **Bootloader**

- **Firmware / Image**

- **Configuration Files**

“At a device’s going-into-production,

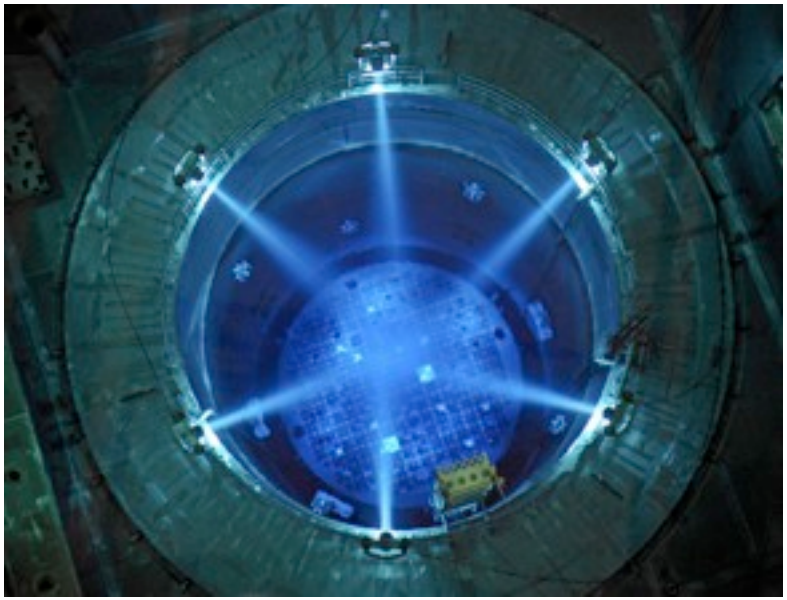
- **Are you sure?**
- **For the bootloader??**
- **Would you notice (and delete) a user “sysupdate” in the administrators group of $SOME_SECURITY_APPLIANCE?**

“Isn’t firmware protected against

- **… by cryptographic means (checksums, digital signatures etc.) …**
- **Well, that’s what you might expect.**
- **Reality proves otherwise…**

So why would somebody want to do that?

- **Blowing up something, some time**
- **Deployment of backdoors (to devices or your network)**



Blowing up something, some time

Siberian pipeline sabotage

From Wikipedia, the free encyclopedia

The **Siberian pipeline sabotage** refers to the alleged 1982 sabotage of the Soviet *Urengoy - Surguf - Chelyabins* theft of American technology.

Contents [hide]

1 Background
2 Hoax Theory
3 References
4 See also
5 External links

Background

The pipeline, as planned, would have a level of complexity that would require advanced automated control software, Supervisory Control And Data Acquisition (SCADA). The pipe utilized plans for a sophisticated control system and its software that had been stolen from a Canadian firm by the KGB. The CIA allegedly had the company insert a logic bomb program for sabotage purposes, eventually resulting in an explosion with the power of three kilotons of TNT [1].

The CIA was tipped off to the Soviet intentions to steal the control system plans in documents in the Farewell Dossier and, seeking to derail their efforts, CIA director William J. followed the counsel of economist Gus Weiss and a disinformation strategy was initiated to sell the Soviets deliberately flawed designs for stealth technology and space defense operation proceeded to deny the Soviets the technology they desired to purchase to automate the pipeline management, then, a KGB operation to steal the software from a Can company was anticipated, and, in June 1982, flaws in the stolen software led to a massive explosion of part of the pipeline.

http://en.wikipedia.org/wiki/Siberian_pipeline_sabotage

Blowing up something, some time

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http://en.wikipedia.org/wiki/Siberian_pipeline_sabota

Backdoors

- **[PAXSON00]:**

- **“A backdoor is a mechanism surreptitiously introduced into a computer system to facilitate unauthorized access to the system.”**

More on this

- **This brings up some interesting questions.**

- **Is enabled SNMP with public/private a backdoor?**
  - Based on deliberate decision (= “surreptitiously”?).
  - Means to provide access.
  - Well, yes, maybe not intended for *unauthorized* access.
  - But used for such in many cases…

Types of backdoors

- **Buffer Overflow vulnerabilities**
- **Hidden configuration options (“allowHiddenAccountLogin=YES”)**
- **Unsecure cryptographic properties**
  - Weak initialization vectors
  - Manipulated S-Boxes (e.g. in AES)
  - Deterministic PRNGs
- **Master password (“lkwpeter”)**
- **Hidden credentials (user/pass)**
- **Port knocking**
- **Data leakage/logging second channel (external system, …)**
- **Additional access mechanism (SSH, telnet, …)** ← ***most common rootkit behavior***

Typical vulnerabilities in supply

- **Lack of standards**
  - ISO 28001 much lesser known than ISO 27001
- **Lack of visibility**
- **Lack of tools for verification**

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Architecture details of some popular security appliances

Disclaimer

- **All this stuff is not too well documented. We did our best when assembling the information displayed in the following slides. Still, it might be inaccurate here + there.**

Cisco ASA

- **Based on (mostly) standard PC hardware, x86 architecture**
- **Image is based on Linux kernel and can be extracted, see e.g.[1]**
- **Presumably the BIOS can be modified/replaced, although this voids the warranty ;-), see [2]**
- **“Verify” command for verifying the MD5 checksum present [3]**
  - … but does not inhibit firmware execution if checksum fails

Juniper routers

- **Routing engine is commodity hardware with Intel CPU, harddrive, flashdrive etc.**
- **Parts can be exchanged easily**
- **JunOS based on FreeBSD kernel**

- **Usually new image released every 90 days**
  - One can “predict new image” ;-)
- **REs have CF card slot**
  - Which, by default, is booted from first

Juniper Netscreen devices

- **ScreenOS proprietary RTOS on PowerPC**
- **Previous research "Netscreen of the Dead" Blackhat 2009**

  See http://www.troopers.de/content/e728/e897/e938/TROOPERS10_Netscreen_of_the_Dead_Graeme_Neilson.pdf
- **Weakness in the firmware protection & verification**
- **Developed fully trojaned ScreenOS firmware image with**
  - backdoor
  - custom code execution
  - firmware update prevention

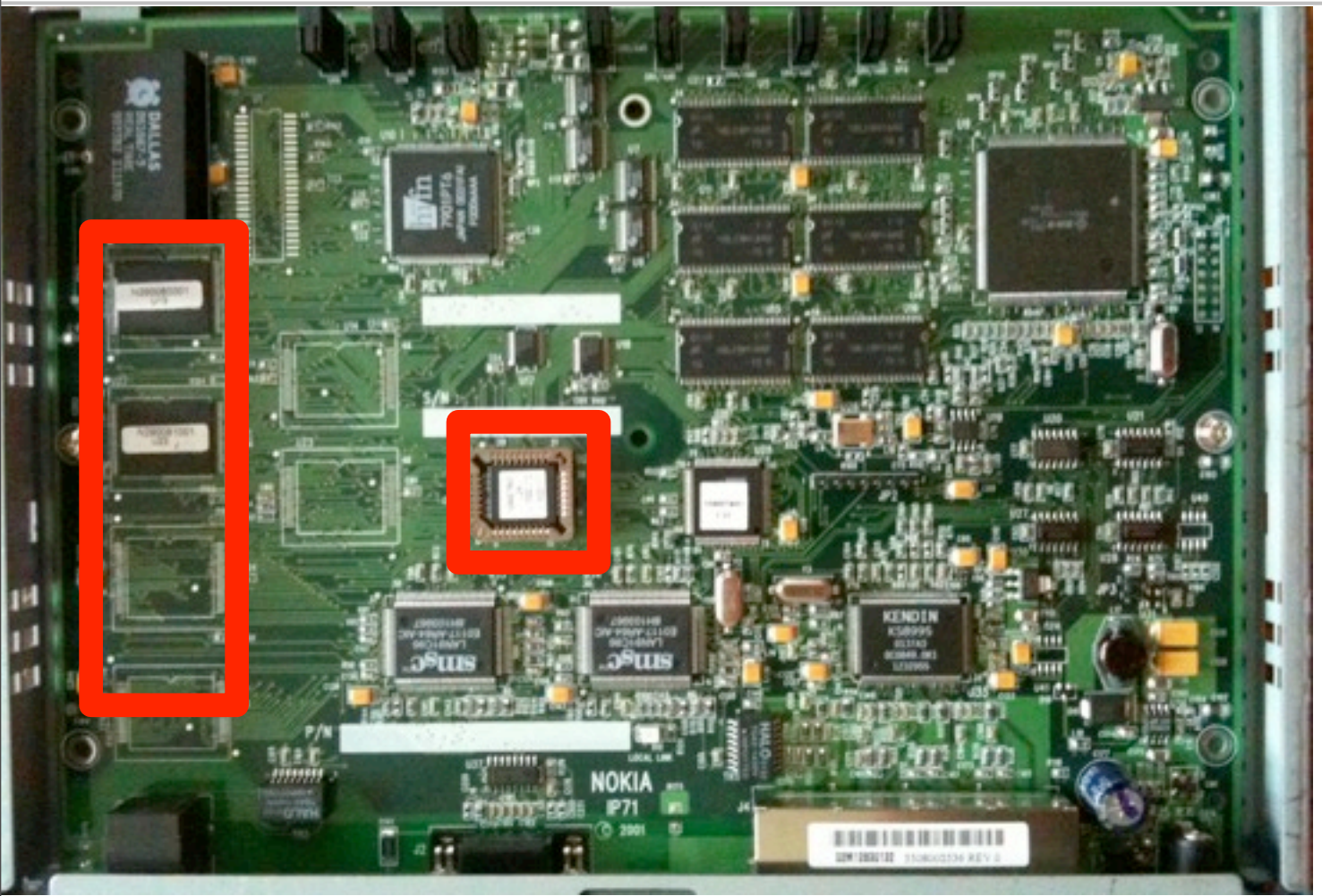
Nokia & Check Point

- **Check Point supply Firewall-1/VPN-1 software which can run on top of other operating systems**
- **Appliances Linux/FreeBSD based**

Example Appliance (admittedly an old one, newer behave differently)

- **Nokia IP71 series with SuperH RISC processor**
- **System is stored in on-board flash with no option to download flash :(**
- **Restricted shell with a custom menu console application running**
- **Attack vectors are:**
  - break out of app and restricted shell
  - customise or overwrite BIOS to gain control of flash memory

Nokia IP71

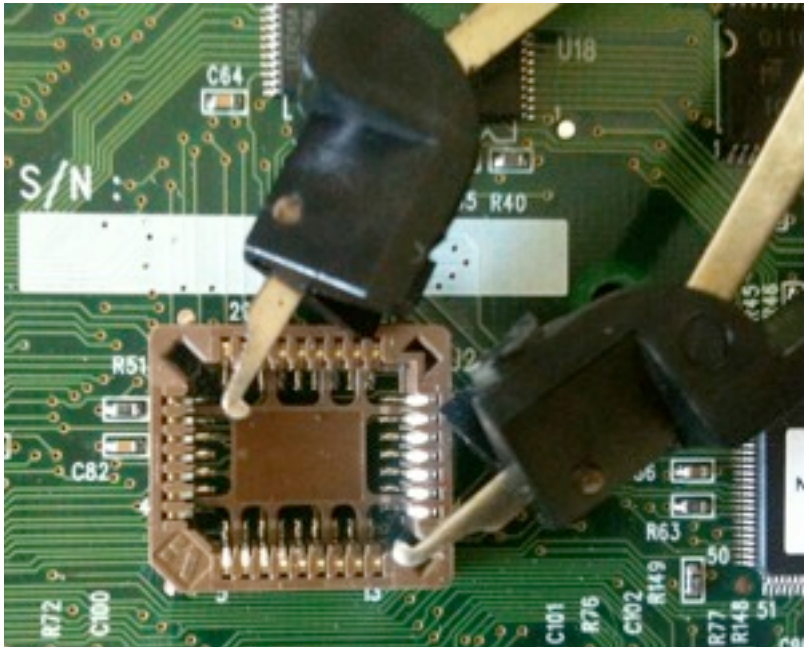


Flash

BIOS

Nokia (IP71) BIOS

- **Removable BIOS chip running Nokia boot loader**
- **Remove chip, dump code, reverse engineer, modify, reflash chip**
- **BIOS rootkit or "BootKit"**



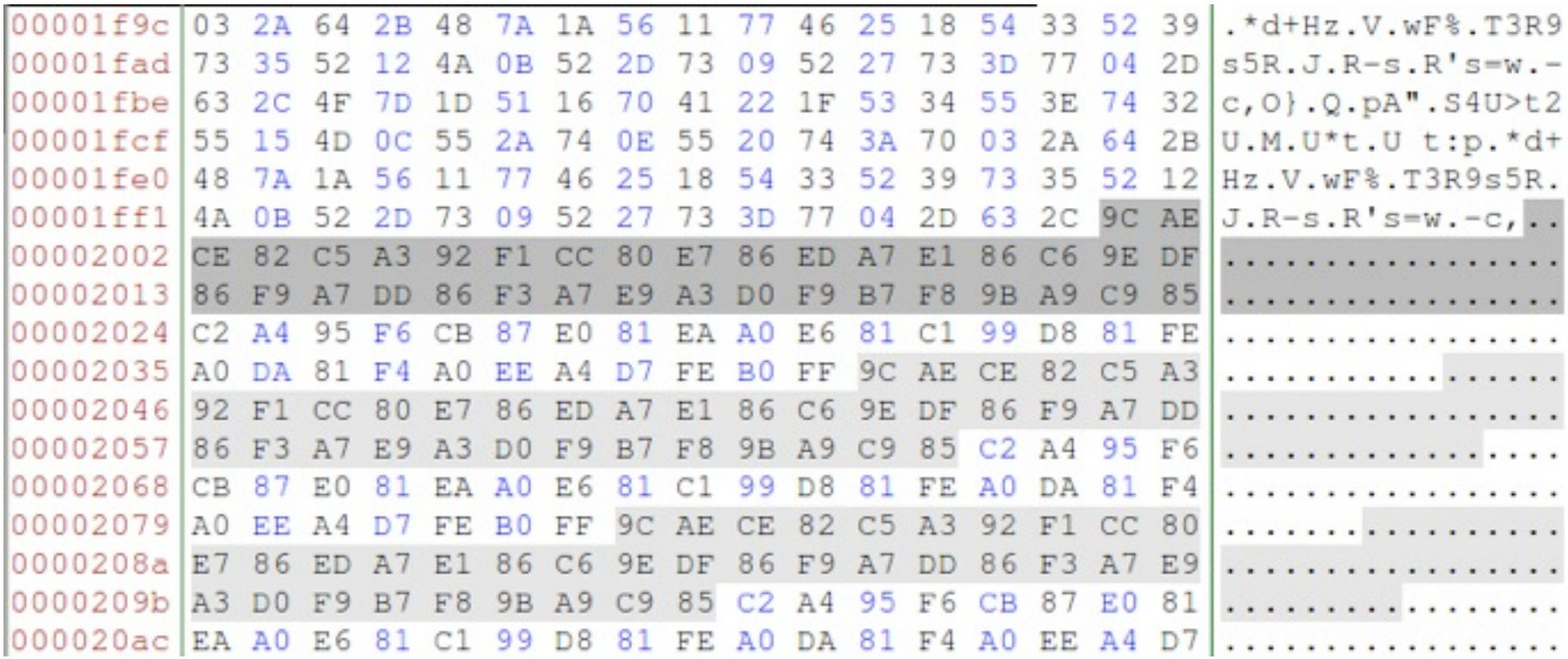
Demo : ZomBIOS

- **BIOS level control**

Fortigate

- **Fortinet make Fortigate appliances (x86 platform).**
- **Runs FortiOS - based on Linux.**
- **Supplied as standard gzip file with certificate and hash appended.**
- **Decompress gives an encrypted blob of data.**
- **The encryption used has weaknesses:**
  - Watermarks (patterns in the data) looks like a disk image.
  - Location of MBR, kernel, root file system can be seen.
  - This allows known plain text attacks

Watermarks



```
00001f9c 03 2A 64 2B 48 7A 1A 56 11 77 46 25 18 54 33 52 39 .*d+Hz.V.wF%.T3R9
00001fad 73 35 52 12 4A 0B 52 2D 73 09 52 27 73 3D 77 04 2D s5R.J.R-s.R's=w.-
00001fbe 63 2C 4F 7D 1D 51 16 70 41 22 1F 53 34 55 3E 74 32 c,O}.Q.pA".S4U>t2
00001fcf 55 15 4D 0C 55 2A 74 0E 55 20 74 3A 70 03 2A 64 2B U.M.U*t.U t:p.*d+
00001fe0 48 7A 1A 56 11 77 46 25 18 54 33 52 39 73 35 52 12 Hz.V.wF%.T3R9s5R.
00001ff1 4A 0B 52 2D 73 09 52 27 73 3D 77 04 2D 63 2C 9C AE J.R-s.R's=w.-c,..
00002002 CE 82 C5 A3 92 F1 CC 80 E7 86 ED A7 E1 86 C6 9E DF ..................
00002013 86 F9 A7 DD 86 F3 A7 E9 A3 D0 F9 B7 F8 9B A9 C9 85 ..................
00002024 C2 A4 95 F6 CB 87 E0 81 EA A0 E6 81 C1 99 D8 81 FE ..................
00002035 A0 DA 81 F4 A0 EE A4 D7 FE B0 FF 9C AE CE 82 C5 A3 ..................
00002046 92 F1 CC 80 E7 86 ED A7 E1 86 C6 9E DF 86 F9 A7 DD ..................
00002057 86 F3 A7 E9 A3 D0 F9 B7 F8 9B A9 C9 85 C2 A4 95 F6 ..................
00002068 CB 87 E0 81 EA A0 E6 81 C1 99 D8 81 FE A0 DA 81 F4 ..................
00002079 A0 EE A4 D7 FE B0 FF 9C AE CE 82 C5 A3 92 F1 CC 80 ..................
0000208a E7 86 ED A7 E1 86 C6 9E DF 86 F9 A7 DD 86 F3 A7 E9 ..................
0000209b A3 D0 F9 B7 F8 9B A9 C9 85 C2 A4 95 F6 CB 87 E0 81 ..................
000020ac EA A0 E6 81 C1 99 D8 81 FE A0 DA 81 F4 A0 EE A4 D7 ..................
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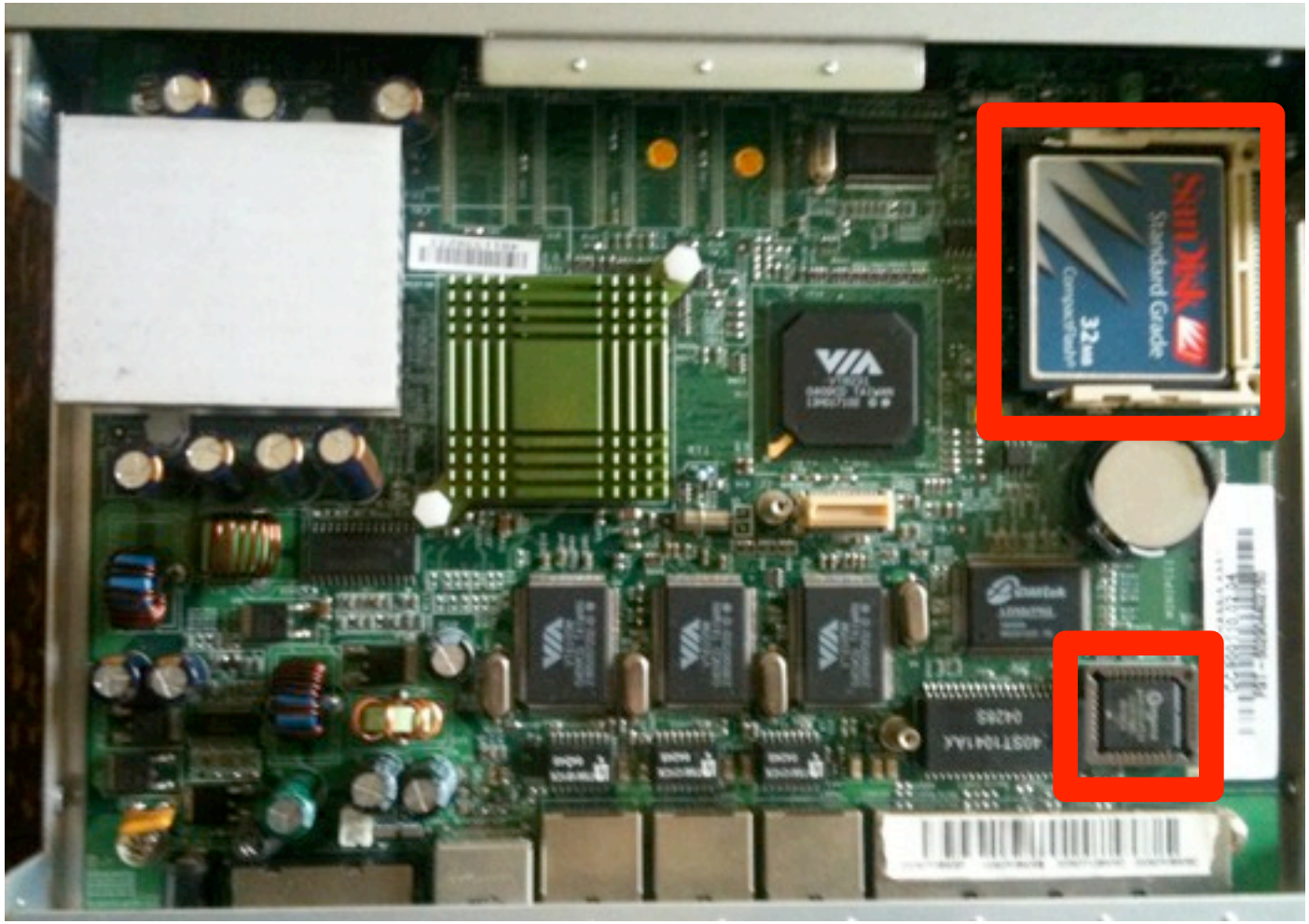
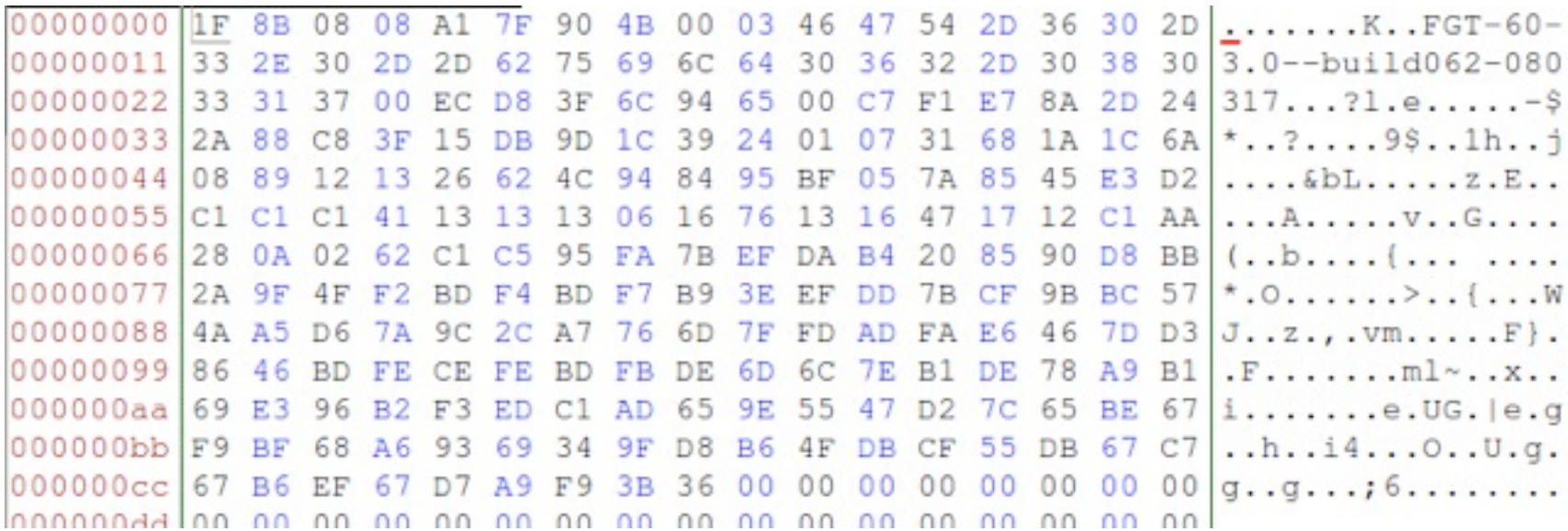
Fortigate



Fortigate

- **Fortigate will load firmware even if it has no certificate, no hash and is unencrypted.**
- **The verification is of filenames contained within the gzips**
  - Start of MBR must contain a filename matching a device & version ID
  - Kernel must be called “fortikernel.out”



Fortigate

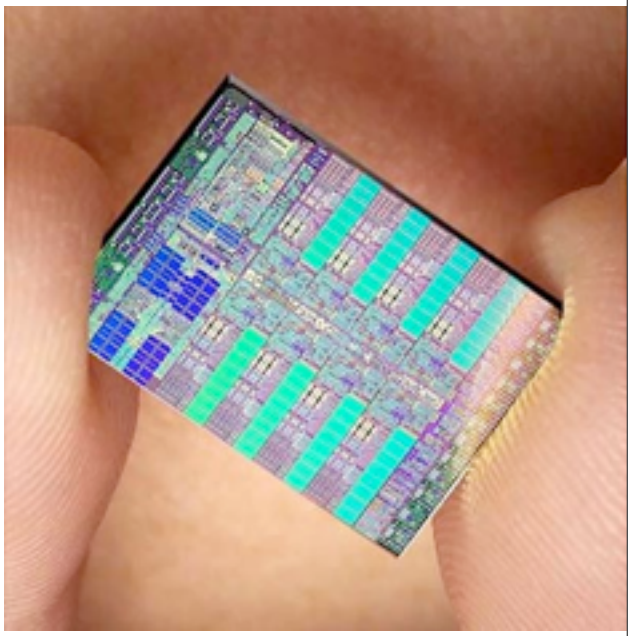
- **Can modify existing system or replace kernel and file system.**
- **Automated firmware upgrade on reboot from USB stick is a feature.**
- **Boot into custom linux and dd memory**
  - to Compact Flash data is encrypted
  - to serial console there is no encryption

Demo : ZombiOS

- **Operating system level control**

As a point of comparison…

- **Playstation 3 NOT a firewall, NOT protecting your data, designed to protect Sony's intellectual property and investment in game development.**



- **IBM Cell architecture – chip designed with security at the hardware level**
  - Secure processing vault
  - Runtime secure boot
  - Hardware root of secrecy

- **Signed code necessary at multiple levels: boot time, hypervisor, gameOS, game.**

As a point of comparison…

- **Full hard disk encryption**
- **Recently a flaw in the USB stack allows running unsigned code BUT this is not persistent across reboots because of the signed boot code and signed hypervisor.**

→ A gaming console is a more secure platform than most security appliances!

PlayStation 3 cluster

Some (kind-of-checklist) questions

- **What are the motivations/incentives of the involved parties?**
- **Do you think they're capable (of providing a secure supply chain)?**
- **What do you know about your organization's (security device) supply chain?**

Conclusions

- **(Most) security appliances are not designed to withstand "unauthorized physical access".**
- **The supply chain may not be as secure as you expect.**
  - **This might lead to "interesting scenarios" ;-)**
- **Think about it!**

There's never enough time…

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THANK YOU…

...for yours!

TROOPERS II,
03/28-04/01/2011 Heidelberg, Germany

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and meet with experts from around the world at TROOPERS11 at Heidelberg, Germany.

References

- **Specific to Cisco ASA**
  - [1] “Simulation [of] Cisco ASA with QEMU and GNS3”: http://kizwan.blogspot.com/2010/01/simulatio-cisco-asa-with-qemu-and-gns3.html
  - [2] Cisco ASA 5580 Adaptive Security Appliance Hardware Installation Guide: http://www.cisco.com/en/US/docs/security/asa/hw/maintenance/5580guide/procedures.html
  - [3] Cisco ASA “verify” command http://www.cisco.com/en/US/docs/security/asa/asa80/command/reference/uz.html#wp1569565

- **Specific to Cisco routers**
  - http://www.cisco.com/web/about/security/intelligence/iosimage.html