

#### **Open Source Firmware**

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# Disclaimer: No shaming, no mocking!





## Agenda

- Introduction
- Motivation
- Inspecting Hardware
- Building Firmware
- User/Developer Experience





# Introduction





#### Firmware is everywhere



#### Embedded devices

SoC

#### Aptio Setup Utility - Copyright (C) 2012 American Hegatrends, Inc and Advanced Chipset Boot Security Save & Exit

BIOS Information Project Name	XMG 0404	Set the Date. Use Tab to switch between Date element
BIOS FW Version		
Build Date and Time		
EC FN Version		
Processor Information		
Haswell		
Intel(R) Core(TM) 17-4710H0 CPU	0 2.50GHz	
Number of Processors	4Core(s) / SThread(s)	
ME FW Version		
		HH: Select Screen
		14: Select Item
ustem Time	IO1:23:241	Enter: Select
		+/-! Change Opt.
		F1: General Help
		F8: Previous Values
		F9: Optimized Defaults
		F10: Save & Exit
		ESC: Exit
	. Copyright (C) 2012 America	n Megatrends, Inc.

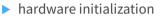
#### Laptops

- BIOS/UEFI (host CPU)
- ME (coprocessor)
- GbE
- ► EC





### What Firmware Does



- specific to SoC, mainboard, some peripherals
- user interaction
  - UI, settings, boot selection
- OS interfacing
  - updates, feedback, power management





## Open Source Firmware Origins

1994

- IEEE 1275-1994
- Open Firmware
- OpenBIOS

#### 1999

- Das U-Boot
- LinuxBIOS, later renamed to coreboot

#### 2004

TianoCore





# Motivation







Vendor firmware may have issues, but isn't fixed for various reasons.

→ C 🌔 https://lists.freebsd.org/pipermail/freebsd-acpi/2006-February/002571.html

#### How can I fix these problems of the asl of my computer?

Moore, Robert robert.moore at intel.com

Wed Feb 15 14:39:53 PST 2006

- Previous message: <u>kern/80815: ACPI(pci\_link) problem in 5.4-STABLE: TIMEOUT WRITE\_DMA retrying</u>
- Next message: How can I fix these problems of the asl of my computer?
- Messages sorted by: [ date ] [ thread ] [ subject ] [ author ]

ze2205au.as 2243: Return (UPRS) Error 1022 -Object does not exist ^ (UPRS) ze2205au.asl 2253: Store (UPRS, Local0) 1022 -Object does not exist ^ (UPRS) Error ze2205au.asl 4138: Name ( WDG, Buffer (0x50) Warning 2033 -Unknown reserved name ^ ( WDG) 702205au as] 4699. Method ( WED, 1, NotSerialized) Unknown reserved name ^ (WED) Warning 2033 -1) Add "External (UPRS)" after the definition block is opened: DefinitionBlock ("DSDT.aml", "DSDT", 1, "HP ", "3091 ", 537137673) External (UPRS)

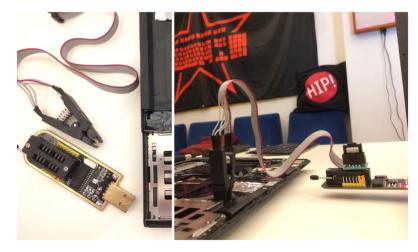
 Ignore the warnings. Your BIOS writers did not read the ACPI spec or became blind sometime in the middle of it, highly probable. :-)





## Recovery

#### Updates can brick an existing system, so recovery options should be known.







#### Malware

Malware can be hidden in firmware, so it has to be auditable.

Breaking Through Another Side: Bypassing Firmware Security Boundaries from Embedded Controller

MAY 8, 2019 - HUCKTECH



Alex Matrosov

A

Our REsearch "Breaking Through Another Side: Bypassing Firmware Security Boundaries from Embedded Controller" with Alexandre Gazet accepted for @BlackHatEvents! Tons of interesting stuff: Lenovo BIOS Guard bypass, gaining persistence on EC (blindspot for any type of AV) and more

🔿 118 1:58 AM - May 8, 2019

 $\bigcirc$  35 people are talking about this



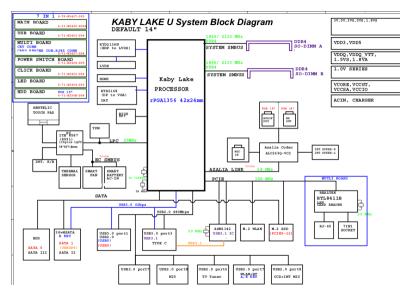


# Hardware Inspection





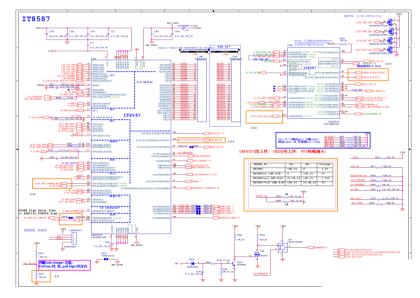
#### System Block Diagram







## Embedded Controller Schematic







# Hardware Inspection Software Utilities

- igt-gpu-tools
- i2c-tools
- dmesg
- Ispci
- acpidump (part of iasl, util/acpi/acpidump-all script in coreboot)
- dmidecode
- Istopo (part of hwloc) to list PCI device topology

#### from coreboot:

- autoport (-make\_logs uses tools below + lspci, acpidump, dmidecode)
- ectool
- inteltool
- superiotool





# **Building Firmware**





## **Build Process**

- toolchain for target architecture (x86, ARM, ...)
- firmware source code ;)

\$ EDK\_TOOLS\_PATH=`pwd`/../BaseTools ./build.sh
Initializing workspace

FV Space Information

SECFV [10%Full] 212992 total, 22192 used, 190800 free
PEIFV [20%Full] 917504 total, 189992 used, 727512 free
DXEFV [36%Full] 11534336 total, 4216648 used, 7317688 free
FVMAIN\_COMPACT [35%Full] 3440640 total, 1222080 used, 2218560 free









### **Developers Wanted**

TUXEDO Computers is hiring a coreboot developer

#### **UXEDO** COMPUTERS

Software Developers for Coreboot BIOS (m/f/d)

We're hiring:

To increase our team in Königsbrunn (Germany) we are looking for **Software Developers for Coreboot BIOS (m/f/d)** in a permanent position. **German language skills required - level B2 or higher!** 

Are you a software developer with heart and soul?

C is for you not only a letter and kernel you find not only in avocados totally exciting? If you also know how to solve a ticket for the dbus and have both feet firmly on the socket, you've come to the right place!





# Thunderbolt

- System76 makes open source Thunderbolt controller firmware
  - USB4 based on Thunderbolt

#### OPEN FIRMWARE



System76 has been granted a Thunderbolt license, meaning that we can now integrate Thunderbolt compatibility into our open firmware. This is a huge development in the open firmware project, as we can now achieve full functionality of Thunderbolt in our machines once the firmware is implemented.





# Privacy

Qubes OS certified Insurgo Privacy Beast X230







# coreboot

coreboot 4.10	has	been	released
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Release	Date	Source	Source GPG	Blobs	Blobs GPG	Release Notes
coreboot 4.0	8. Feb 2010	Ŧ	Ŧ			
coreboot 4.1	13. July 2015		Ŧ	Ŧ	Ŧ	Ŧ
coreboot 4.2	30. October 2015	.t.	Ŧ	Ŧ	Ŧ	Ŧ
coreboot 4.3	29. January 2016	. T	Ŧ	Ŧ	Ŧ	Ŧ
coreboot 4.4	01. May 2016	Ł	Ŧ	Ŧ	Ŧ	Ŧ
coreboot 4.5	18. October 2016	Ł	Ŧ	Ŧ	Ŧ	Ŧ
coreboot 4.6	30. April 2017	Ł	Ŧ	Ŧ	Ŧ	Ŧ
coreboot 4.7	14. January 2018	Ł	Ŧ	Ŧ	Ŧ	Ŧ
coreboot 4.8.1	16. May 2018	Ł	Ŧ	Ŧ	Ŧ	Ŧ
coreboot 4.9	20. December 2018	Ł	Ŧ	Ŧ	Ŧ	Ŧ
coreboot 4.10	22. July 2019	<u>ال</u>	Ŧ	Ŧ	Ŧ	Ŧ





### Servers

> 9elements Cyber Security ported coreboot to modern server board







# User/Developer Experience





#### **Prebuilt Binaries**

easy peasy: download, flash and run



@CvReVolt@mastodon.social

M Edit profile

Today we flashed another two #laptops with #coreboot in our #workshop at @daslabor during our spring(); break; event. first time we had a non-Thinkpad device: a HP #EliteBook 2570p. There were still #blobs for the EC to be extracted though. Thanks to all participants!

We're getting closer to #opensource #firmware. 🙂







## Emulation in QEMU



SeaBIOS (version rel-1.12.0-19-g2cb654b)

iPXE (http://ipxe.org) 00:03.0 C980 PCI2.10 PnP PMM+07F2BAF0+07E8BAF0 C980

Press ESC for boot menu.





#### Supported Devices

	easy	peasy:	downloa	ad, build,	flash	and	run
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Name		Offset	Туре	Size	Comp
cbfs master header		0×0	cbfs header	32	none
fallback/romsta	ge	0×80	stage	62708	none
cpu_microcode_b	lob.bin	0xf600	microcode	122880	none
fallback/ramsta	ge	0x2d680	stage	76715	none
vgaroms/seavgab	ios.bin	0×40280	raw	28160	none
config		0×47100	raw	183	none
revision		0×47200	raw	579	none
cmos_layout.bin		0×47480	cmos_layout	1804	none
fallback/dsdt.a	ml	0x47c00	raw	14078	none
fallback/payloa	d	0x4b380	simple elf	68150	none
payload_config		0x5be00	raw	1682	none
payload_revisio	n	0x5c500	raw	273	none
etc/ps2-keyboar	d-spinup	0x5c680	raw	8	none
(empty)		0x5c6c0	null	1716952	none
bootblock		0x1ff9c0	bootblock	976	none
HOSTCC	cbfstool/ifw	itool.o			
HOSTCC	cbfstool/ifw	itool (link)			

Built lenovo/t400 (ThinkPad T400)





# Porting

- a lot of time, knowledge and effort required
- can be frustrating because of "intellectual property"
- luck and fortune help, and of course the coreboot IRC channel :)

	iuwati
Soullill (version rol-1.12.0-0-gaddbodd) Pruss ESC for boot nom.	
Desting from Hard Blah	
Attempting to decrypt master bay Enter passphrase for bd0.gpt2 (S2077480=fo2tibba8c8b286asc802364): _	
്തെ തെട്ട്രീണ്ടെ പ്രഹിം —	





#### Announcement





# Open Source Firmware Conference 2019

- San Francisco
- https://osfc.io
- tracks: general, security, BMC







# Thanks! :)

