

## It's the right time to switch computing to Open Hardware Power Architecture

**OpenPOWER devroom** 

FOSDEM'21



#### **Power Progress Community**



#### Our goals



Design Open Hardware, accessible to the widest range of people.



Facilitate the re-use of dismissed or low-cost hardware by means of open source software.



Encourage people to use open source software.



Promote innovation and libre scientific progress supporting multiplicity and variety in order to avoid

- or at least reduce - monopolies.







#### **Our DNA**



- The association is run by hobbyists that work for fun on the project on their spare time, no one is getting paid, only the funded electronic engineers
- We have a very flexible business plan, no tight time-to-market strategy
- We can afford to run a donations campaign for an unlimited amount of time, and that is not allowed by any crowdfunding platform.







## History of CPU



#### Cpu Architectures in time



Instruction set	Bits	Introduced
Alpha	64	1992
ARM	32	1983
ARMv8-A	64/32	2011[2]
AVR32	32	2006
Blackfin	32	2000
DLX	32	1990
eSi-RISC	16/32	2009
Itanium (IA-64)	64	2001
M32R	32	1997
Motorola 68k	32	1979
Mico32	32	2006
MIPS	64 (32 → 64)	1981
MMIX	64	1999
6502	8	1975
65k	64 (8 → 64)[8]	2006?
NS320xx	32	1982
PA-RISC (HP/PA)	64 (32 → 64)	1986
PowerPC	32/64 (32 → 64)	1991
S+core	16/32	2005
SPARC	64 (32 → 64)	1985
SuperH (SH)	32	1990s
System/360 / System/370 / z/	64 (32 → 64)	1964
VAX	32	1977
x86	32 (16 → 32)	1978
x86-64	64 (32 → 64)	2003
Z80	8	1976
Xilinx	4 → 48 → 56	2005
Crusoe	32	2000



## Closed Source Software Limit CPU innovation



- 1993 Windows 25 million licenses (X86)
- 1993 PowerPC 601 released
- 1994 first Apple computer with PowerPC

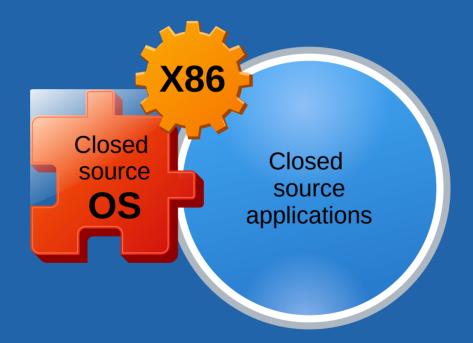
PowerPC is released without software compiled for it: OS and previous applications was running on 386 or Motorola 68000.

When Apple created PowerPC they were running parts of Mac OS written for 68k, under emulation on the PowerPC.



## Closed source close CPU Architecture options





CPU with many (proprietary) applications force to compatibility into new CPUs, limits innovation.



#### Proprietary OS? NO PARTY



1995 Windows NT 3.51/4.0
 PowerPC dropped in 1996

- 1995 Os/2 Warp, PowerPC edition
- 1995 Solaris 2.51 for PowerPC









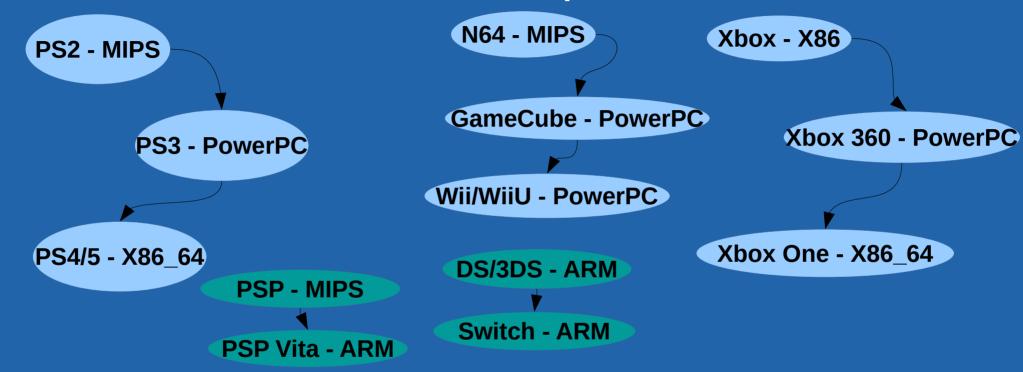


#### PowerPC games console

Name	Image	Manufact urer	Gen erati on	CPU	Clock	RAM	On the market	No. sold
<u>Pippin</u>		Apple Bandai Katz Media	<u>5:th</u>	PowerPC 603	66 MHz	6 MB	1995 - 1997	42.000
<u>M2</u>		3DO Panasonic	<u>5:th</u>	2× PowerPC 602	2× 66 MHz	8 MB	1997 Never marketed	none
<u>GameCub</u> <u>e</u>	POR SOL	<u>Nintendo</u>	<u>6:th</u>	<u>Gekko</u>	486 MHz	24 MB	2001 - 2007	21.74 million
<u>Xbox 360</u>		Microsoft	<u>7:th</u>	XCPU (Xbox 360) XCGPU (Xbox 360 S)	3.2 GHz	512 MB	2005 - present	77.2 million <i>March</i> 2013
Wii		<u>Nintendo</u>	<u>7:th</u>	Broadway	729 MHz	64 MB	2006 - present	99.8 million <i>March</i> 2013
PlayStatio n 3		Sony	<u>7:th</u>	Cell B.E.	3.2 GHz	256 MB	2006 - present	78.4 million <i>May 201</i> 3
Wii U		<u>Nintendo</u>	<u>8:th</u>	Espresso	1.24 GH z	2 GB	2012 - present	3.45 million <i>March</i> <i>2013</i>

#### Game Consoles processors



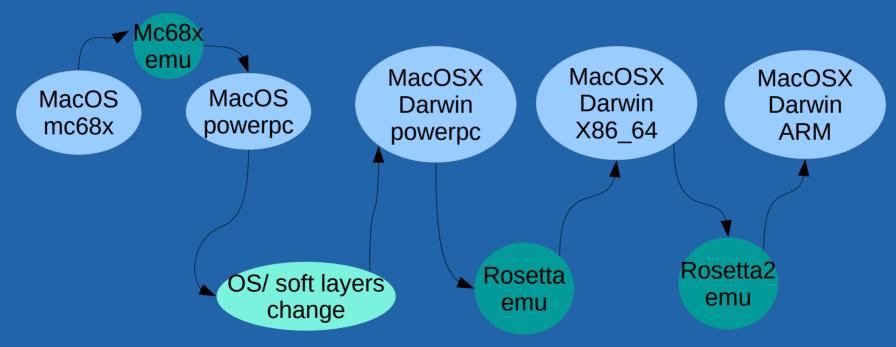




Consoles have a tiny OS with few embedded applications Games are written from scratch or are developed on cross-architecture engines. CPU change affects them less.



## CPU architecture change with Closed source applications and soft layers







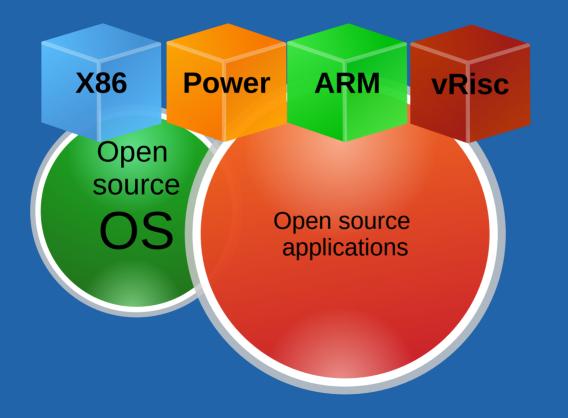
## Switch to new CPU with Closed Source

- Need Emulators Layes ( as mc68x and Rosetta/Rosetta2 )
- Titanic Resources to develop emulators and tests all apps
- Slowdown applications
- Create incompatibilities
- depends from companies that own closed source application



## FOSS software open to CPU Architecture Flavour









## Switch to new CPU Architecture with FOSS

- Hardware to test new CPU Architecture
- Endianess Code and with no machine code





## Open Source code should be truly CPU agnostic



 We commonly encounter open source software tight to Little Endian CPUs nd that cannot be compiled on Big Endian CPUs.

When a library or a framework cannot be compiled, it causes troubles to all software depending on it, and that compromise the usability of the entire system.

Our volunteers works to fix endianess issues to source codes, but it's a huge task for a very few people: we need help!

 We are trying to concentrate on those packages and libraries that solve the dependencies to a multitude of others packages.





#### **Why Power Architecture**

It is a modern, **up to date** and innovative architecture.

Interesting power efficiency for laptops\*

Is used in **every sector**.



- → Open architecture
- → Open ISA
- no royalty

































Micron



## POWER ISA: Open Contribution Timeline



- August 20, 2019 Open ISA Announcement at NA OpenPOWER
   Summit
- **February 13, 2020** Final Draft of the End User License Released by OPF:
  - https://openpowerfoundation.org/final-draft-of-the-power-isa-eula-released/
- April 2020 POWER ISA 3.0c contribution to OPF
  - Same as POWER ISA 3.0b except for
    - Compliancy Subsets
    - Custom Extension Space (Sandbox)
    - SMF Feature
- May 2020 POWER ISA 3.1 contribution to OPF
- May 2020 POWER ISA Workgroup Chartered in OPF





#### **Power ISA Timeline**

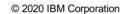
- Abbreviated Lineage of the Power ISA
  - Greater than 30 years of innovation and a developed ecosystem
  - Instruction heritage shown for Power ISA 3.1

Instruction Heritage	Note	# Instr.	Cum Instr.	Open ISA
POWER (P1)	Base	218	218	Contributing
POWER (P2)		6	224	Contributing
PowerPC (P3)	64b	119	343	Contributing
PowerPC 2.00 (P4)		7	350	Contributing
PowerPC 2.01		2	352	Contributing
PowerPC 2.02 (P5)		14	366	Contributing
Power ISA 2.03	SIMD-VMX	171	537	Contributing
Power ISA 2.05 (P6)		105	642	Contributing
Power ISA 2.06 (P7)	SIMD-VSX	189	831	Contributing
Power ISA 2.07 (P8)		111	942	Contributing
<b>Power ISA 3.0</b> (P9)		231	1173	Compliance
<b>Power ISA 3.1</b> (P10)	Prefix	246	1419	Compliance

America **IBM Server PowerPC** POWER 1990 **POWER PC** POWER 2 **PowerPC Embedded** POWER PC 1997 PPC-E PPC 64 PPC 2.00 2003 Power.org PPC-E PPC 2.02 **Power ISA** 2006 2.03 Embedded Features 2006 2.07 2.07B 3.0 2017 **Open Power ISA** Custom 3.0C 3.1 Extensions

1985







#### Final Draft of the Power ISA EULA Released



#### 1. Grant of Rights

- 1.1 OPF grants to Recipient a nonexclusive, worldwide, perpetual, **royalty-free**, non-transferable license under all copyrights licensable by OPF and contained in the Power ISA to a) develop technology products compatible with the Power ISA, and b) create, use, reproduce, perform, display, and distribute Power ISA Cores.
- 1.2 OPF grants to Recipient the right to license Recipient Power ISA Cores under the **Creative Commons**Attribution 4.0 license.

1.5 OPF grants to Recipient a nonexclusive, worldwide, perpetual, royalty-free, non-transferable license under Licensed Patent Claims to make, use, import, export, sell, offer for sale, and distribute Power Compliant Chips.
[...]

Estracted from: https://openpowerfoundation.org/final-draft-of-the-power-isa-eula-released/





## Open Power ISA test FOSS on FPGA softcore



- No need wait "real production hardware"
- Test FOSS software compiled for Power on FPGA





#### Software/IP Cores

Microwatt A proof of concept FPGA core written in VHDL

https://github.com/antonblanchard/microwatt

Chiselwatt proof of concept FPGA core but written in Chisel

https://github.com/antonblanchard/chiselwatt

**Libre-SoC** Project A project to build an entirely Libre(free) SoC

https://libre-soc.org/





#### Open POWER ISA soft core FPGA

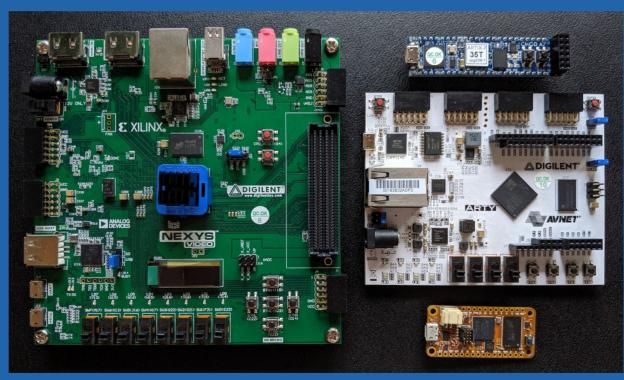
https://github.com/antonblanchard/microwatt

The Power ISA instruction set is royalty-free.

There is an Open POWER ISA softcore written in VHDL 2008 that also runs on very cheap FPGAs such

as Cmod A7-35T





### libreSOC



#### Why a Libre 3D CPU / GPU / VPU?

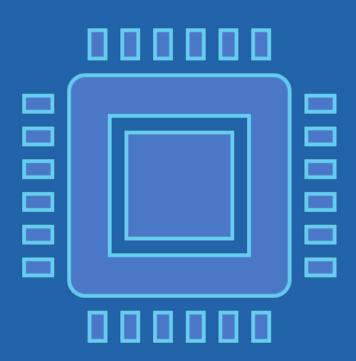
- Study of SoCs (Allwinner, Rockchip, NXP) shows none are fully Libre
  - Either GPU driver firmware is proprietary, or VPU firmware, or bootloader
- This causes customer product development issues
- "adapting games to proprietary drivers (on all platforms) is much more complicated" https://tinyurl.com/valve-steam-intel
- Businesses are waking up to lack of transparency
  - Intel Management Engine (spying backdoor co-processor)
  - Spectre, Meltdown, CSME (Chain-of-Trust) issues



Solution: full transparency. All source available for everything.



#### A2 Power Processors



In Open Source ecosystem from 2020 with Creative Commons 4.0 licenses







#### A2 processor family

- Configurable and modular microprocessor cores, memory subsystem, and auxiliary execution units
- Can be used for routers, edge computing devices, autonomous driving
- > A2I (used in BlueGene) -
  - 4-threaded per core, In-order, Throughput optimized core

https://github.com/openpower-cores/a2i

- A2O (never released) -
  - Dual threaded per core, Out of order, single threaded performance optimized core

https://github.com/openpower-cores/a2o



## The Open Hardware GNU/Linux PowerPC Notebook Project

www.powerpc-notebook.org





#### **Brief history**

2014	powerpc-notebook.org first published
2015	Becomes Open Source Hardware
2016	Established PowerProgressCommunity association
2017	List of hardware requirements
2017-2018	Donation campaign for Electrical Schematics
2019-2020	Donation campaign for Printed Circuit Board design
2020	Donation campaign for Fast SI bus simulations

#### **Technical specifications**



**CPU**: NXP T208x, e6500 64-bit Power Architecture with Altivec technology

4 x e6500 dual-threaded cores, low-latency backside 2MB L2 cache, 16GFLOPS x

core - 64-bit PowerISA v2.07

**RAM:** 2 x RAM slots for DDR3L SO-DIMM

**VIDEO:** MXM 3 mobile video card interface

**AUDIO:** cmedia sound chip, audio in and audio out jacks

**USB:** 3.0 and 2.0 ports

**STORAGE:** 

NVM Express (NVMe), M.2 2280 connector

2 x SATA

1 x SDHC card reader

#### **NETWORK:**

1 x ethernet RJ-45 connector

WiFi connectivity

Bluetooth connectivity

**POWER:** on-board battery charger and power-management

CHASSIS: Slimbook Eclipse notebook case 15,6"





#### Who make the PCB design?



- association counts around 50 volunteers
- few are electronic expert
  - electronic expert volunteer no spare time
- donation campaign to pay engineers





#### Our Open Source Hardware Path

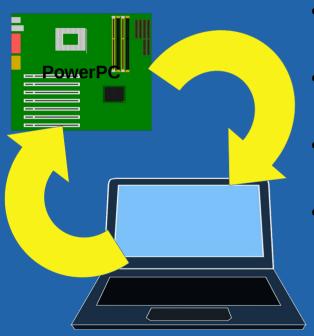
Goal: Oshwa Certification - https://certification.oshwa.org/

#### **Steps**

- Support from the NYU Technology Law and Policy Clinic to make the project as Open Hardware as possible.
- Contacts with Chip manufacturers for authorizations to distribute the finalized project as Open Hardware
- Publication of the electrical schematic (Orcad source)
   with the Open Hardware CERN license v1.2

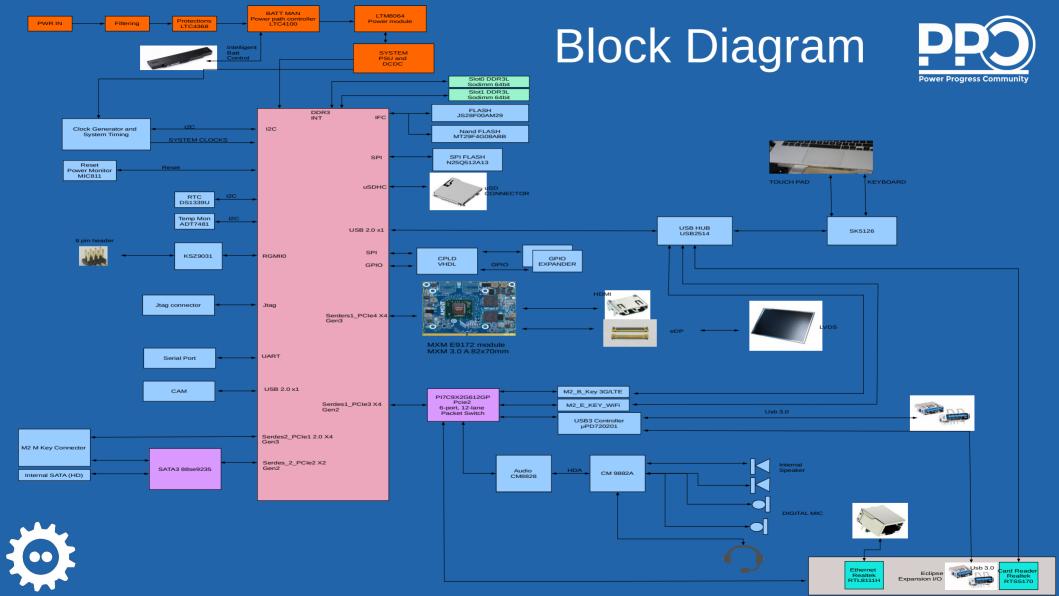


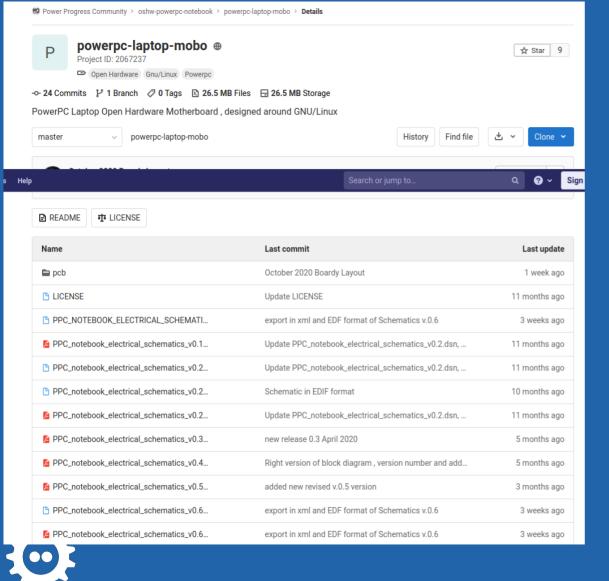
### It's born before the Laptop Chassis or the motherboard?



- Creating a brand new notebook chassis from scratch in small numbers was not financially feasible.
- Find a supplier that provide us few hundreds of notebook body without the motherboard was very difficult.
- After a couple of years (!) we finally found a viable solution thanks to the Slimbook support.
- We are now designing a PowerPC motherboard targeting the Slimbook "Eclipse" chassis.







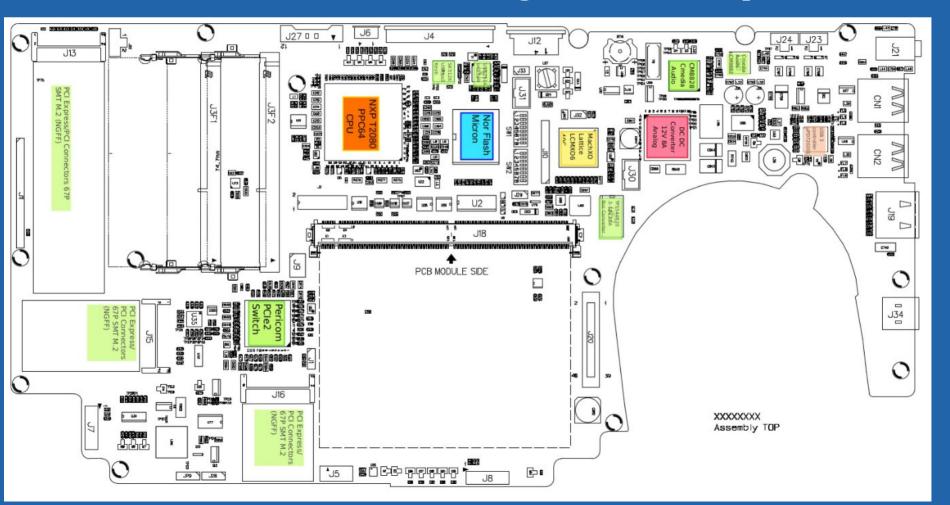
## **Eletrical Schematics**



- 6 revisions of the wiring diagrams have been made
- PCB design from version 0.6 August 2020
- Published on our Gitlab repo

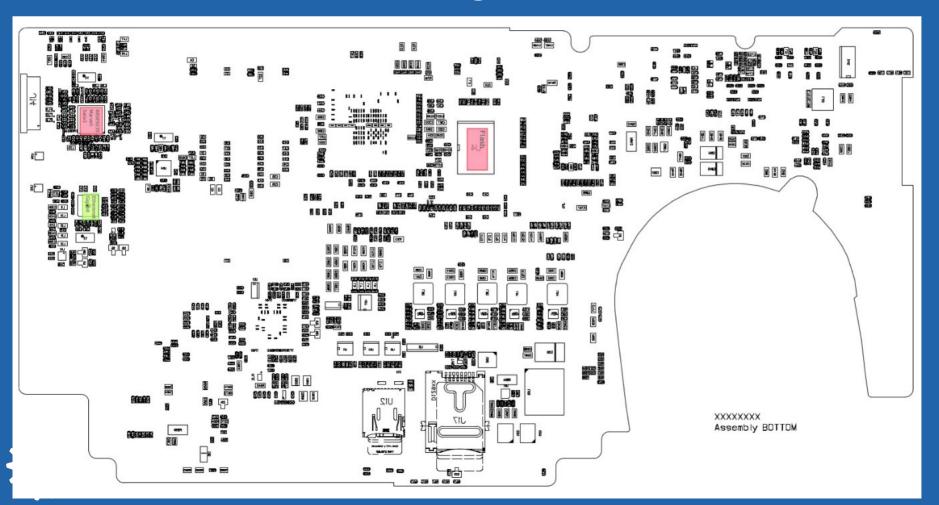
#### **Board Layout - Top**

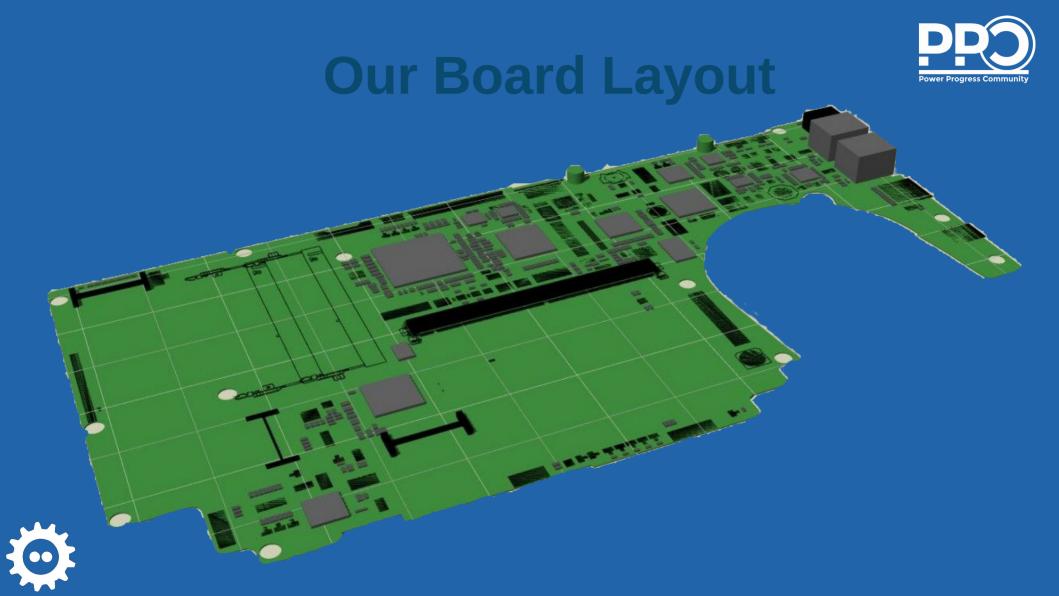




#### **Board Layout - Bottom**









#### Slimbook Eclipse body



Gaming Oriented
Allows us to use MXM
graphics

The body of the laptop is actually the entire case, the cooling system, the screen, the keyboard, the backlight, the webcam, the speakers and the battery.









1	Electrical schematics 2 July 2017 - 7 June 2018	€ 12.600
2	PCB Printed Circuit Board 12 October 2019 - 8 September 2020	€ 19.000
3	Fast SI bus simulations 9 September 2020 -12 December 2020	€ 5.000
1	3 prototypes	C 12 000



6 CE Certification

12 December 2020 -

Hardware Tests

€ 12.500

€ 14.000



#### Join Open our Hardware team

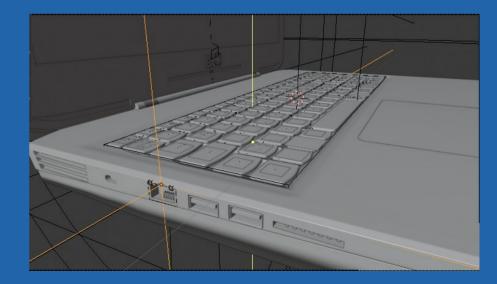
### **Open Source Laptop Chassis Designs**

FreeCad/Blender 3D chassis design

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#### **Open Hardware Designs**

PCB review, PCB/Schematic forks







#### Join us with Your Creativity on



- Creation of multimedia design to advertise (video, animations, images, articles, etc...).
  - Translations of the websites, social networks and software
- Spreading the project on blogs, forums, socials
  - Law Assistance to support the Open Source Hardware License
  - Maintain, update, manage our software tools and services
- Outreach, seminars in High Schools and Universities



#### **Future Plans**





- Reach the goals of the Donation Campaigns phases
- Involve additional volunteers, especially hardware expert and anyone able to fix endianess issues
- Support forks of our design to the newer Power
   Architecture processors based on the Power Open ISA
  - Libre-SOC CPU/GPU
  - A2I POWER Processor Core
  - New OpenISA chips
- In-source new Hardware designs with Open Hardware engineers
- Seminars in Tech High Schools and Universities to encourage study and improvement on our Open Hardware designs and Power Open ISA CPU/GPU





Thank you!

and now QA

**Power Progress Community** 

www.powerprogress.org

