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.
Power Progress
Community founders and the core team
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

<table>
<thead>
<tr>
<th>Instruction set</th>
<th>Bits</th>
<th>Introduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>64</td>
<td>1992</td>
</tr>
<tr>
<td>ARM</td>
<td>32</td>
<td>1983</td>
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<tr>
<td>ARMv8-A</td>
<td>64/32</td>
<td>2011[2]</td>
</tr>
<tr>
<td>AVR32</td>
<td>32</td>
<td>2006</td>
</tr>
<tr>
<td>Blackfin</td>
<td>32</td>
<td>2000</td>
</tr>
<tr>
<td>DLX</td>
<td>32</td>
<td>1990</td>
</tr>
<tr>
<td>eSi-RISC</td>
<td>16/32</td>
<td>2009</td>
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<td>Itanium (IA-64)</td>
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<tr>
<td>M32R</td>
<td>32</td>
<td>1997</td>
</tr>
<tr>
<td>Motorola 68k</td>
<td>32</td>
<td>1979</td>
</tr>
<tr>
<td>Mico32</td>
<td>32</td>
<td>2006</td>
</tr>
<tr>
<td>MIPS</td>
<td>64 (32 → 64)</td>
<td>1981</td>
</tr>
<tr>
<td>MMIX</td>
<td>64</td>
<td>1999</td>
</tr>
<tr>
<td>6502</td>
<td>8</td>
<td>1975</td>
</tr>
<tr>
<td>65k</td>
<td>64 (8 → 64)[8]</td>
<td>2006?</td>
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<tr>
<td>NS320xx</td>
<td>32</td>
<td>1982</td>
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<td>PA-RISC (HP/PA)</td>
<td>64 (32 → 64)</td>
<td>1986</td>
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<td>PowerPC</td>
<td>32/64 (32 → 64)</td>
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<tr>
<td>S+core</td>
<td>16/32</td>
<td>2005</td>
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<tr>
<td>SPARC</td>
<td>64 (32 → 64)</td>
<td>1985</td>
</tr>
<tr>
<td>SuperH (SH)</td>
<td>32</td>
<td>1990s</td>
</tr>
<tr>
<td>System/360 / System/370 / z/</td>
<td>64 (32 → 64)</td>
<td>1964</td>
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<td>VAX</td>
<td>32</td>
<td>1977</td>
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<tr>
<td>x86</td>
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<tr>
<td>Z80</td>
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<tr>
<td>Xilinx</td>
<td>4 → 48 → 56</td>
<td>2005</td>
</tr>
<tr>
<td>Crusoe</td>
<td>32</td>
<td>2000</td>
</tr>
</tbody>
</table>
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.
CPU with many (proprietary) applications force to compatibility into new CPUs, limits innovation.

Closed source close CPU
Architecture options
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

<table>
<thead>
<tr>
<th>Name</th>
<th>Image</th>
<th>Manufacturer</th>
<th>Generation</th>
<th>CPU</th>
<th>Clock</th>
<th>RAM</th>
<th>On the market</th>
<th>No. sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pippin</td>
<td><img src="image" alt="Pippin" /></td>
<td>Apple Bandai Katz Media</td>
<td>5:th</td>
<td>PowerPC 603</td>
<td>66 MHz</td>
<td>6 MB</td>
<td>1995 - 1997</td>
<td>42,000</td>
</tr>
<tr>
<td>M2</td>
<td><img src="image" alt="M2" /></td>
<td>3DO Panasonic</td>
<td>5:th</td>
<td>2× PowerPC 602</td>
<td>2× 66 MHz</td>
<td>8 MB</td>
<td>1997 Never marketed</td>
<td>none</td>
</tr>
<tr>
<td>GameCube</td>
<td><img src="image" alt="GameCube" /></td>
<td>Nintendo</td>
<td>6:th</td>
<td>Gekko</td>
<td>486 MHz</td>
<td>24 MB</td>
<td>2001 - 2007</td>
<td>21.74 million</td>
</tr>
<tr>
<td>Xbox 360</td>
<td><img src="image" alt="Xbox 360" /></td>
<td>Microsoft</td>
<td>7:th</td>
<td>XCPU (Xbox 360)</td>
<td>3.2 GHz</td>
<td>512 MB</td>
<td>2005 - present</td>
<td>77.2 million March 2013</td>
</tr>
<tr>
<td>Wii</td>
<td><img src="image" alt="Wii" /></td>
<td>Nintendo</td>
<td>7:th</td>
<td>Broadway</td>
<td>729 MHz</td>
<td>64 MB</td>
<td>2006 - present</td>
<td>99.8 million March 2013</td>
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<tr>
<td>PlayStation 3</td>
<td><img src="image" alt="PS3" /></td>
<td>Sony</td>
<td>7:th</td>
<td>Cell B.E.</td>
<td>3.2 GHz</td>
<td>256 MB</td>
<td>2006 - present</td>
<td>78.4 million May 2013</td>
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<tr>
<td>Wii U</td>
<td><img src="image" alt="Wii U" /></td>
<td>Nintendo</td>
<td>8:th</td>
<td>Espresso</td>
<td>1.24 GHz</td>
<td>2 GB</td>
<td>2012 - present</td>
<td>3.45 million March 2013</td>
</tr>
</tbody>
</table>
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

- MacOS mc68x
- MacOS powerpc
- MacOSX Darwin powerpc
- MacOSX Darwin X86_64
- MacOSX Darwin ARM

- Mc68x emu
- Rosetta emu
- Rosetta2 emu

- OS/ soft layers change
Switch to new CPU with Closed Source

- Need Emulators Layers (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

Open source OS

Open source applications
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 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**.

OpenPOWER™

→ Open architecture
→ Open ISA
→ no royalty
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/](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
### Abbreviated Lineage of the Power ISA
- Greater than 30 years of innovation and a developed ecosystem
- Instruction heritage shown for **Power ISA 3.1**

<table>
<thead>
<tr>
<th>Instruction Heritage</th>
<th>Note</th>
<th># Instr.</th>
<th>Cum Instr.</th>
<th>Open ISA</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER (P1)</td>
<td>Base</td>
<td>218</td>
<td>218</td>
<td>Contributing</td>
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<td>POWER (P2)</td>
<td></td>
<td>6</td>
<td>224</td>
<td>Contributing</td>
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<tr>
<td>PowerPC (P3)</td>
<td>64b</td>
<td>119</td>
<td>343</td>
<td>Contributing</td>
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<tr>
<td>PowerPC 2.00 (P4)</td>
<td></td>
<td>7</td>
<td>350</td>
<td>Contributing</td>
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<tr>
<td>PowerPC 2.01</td>
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<td>2</td>
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<td>Contributing</td>
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<tr>
<td>PowerPC 2.02 (P5)</td>
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<td>14</td>
<td>366</td>
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<tr>
<td>Power ISA 2.03</td>
<td>SIMD-VMX</td>
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<td>537</td>
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<tr>
<td>Power ISA 2.06 (P7)</td>
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<td>Power ISA 2.07 (P8)</td>
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<td><strong>Compliance</strong></td>
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<td><strong>Power ISA 3.1</strong> (P10)</td>
<td>Prefix</td>
<td>246</td>
<td>1419</td>
<td><strong>Compliance</strong></td>
</tr>
</tbody>
</table>
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**.

[...]

*Extracted 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**
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

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>powerpc-notebook.org first published</td>
</tr>
<tr>
<td>2015</td>
<td>Becomes Open Source Hardware</td>
</tr>
<tr>
<td>2016</td>
<td>Established PowerProgressCommunity association</td>
</tr>
<tr>
<td>2017</td>
<td>List of hardware requirements</td>
</tr>
<tr>
<td>2017-2018</td>
<td>Donation campaign for Electrical Schematics</td>
</tr>
<tr>
<td>2019-2020</td>
<td>Donation campaign for Printed Circuit Board design</td>
</tr>
<tr>
<td>2020</td>
<td>Donation campaign for Fast SI bus simulations</td>
</tr>
</tbody>
</table>
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.
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
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.
<table>
<thead>
<tr>
<th></th>
<th>Project Description</th>
<th>Start Date</th>
<th>End Date</th>
<th>Amount</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Electrical schematics</td>
<td>2 July 2017</td>
<td>7 June 2018</td>
<td>€ 12,600</td>
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<td>2</td>
<td>PCB Printed Circuit Board</td>
<td>12 October 2019</td>
<td>8 September 2020</td>
<td>€ 19,000</td>
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<tr>
<td>3</td>
<td>Fast SI bus simulations</td>
<td>9 September 2020</td>
<td>12 December 2020</td>
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<tr>
<td>4</td>
<td>3 prototypes</td>
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<td>5</td>
<td>Hardware Tests</td>
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<tr>
<td>6</td>
<td>CE Certification</td>
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<td>€ 12,500</td>
</tr>
</tbody>
</table>
Join Open our Hardware team

Open Source
Laptop Chassis Designs
FreeCad/Blender 3D chassis design

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