

**SBC, PCBA, SoC, PMIC, LDO,
GIC, eMMC, SPI, TCON,
ARM, AArch64, MaskROM,
BROM, TF-A, U-Boot, DT,
PSCI, SMC, PINE64...**

Is it confusing enough?

Dragan Simic
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Talk outline

- What is this all about?
- Not all computers are made equal
- “Traditional” embedded systems
- ARM and RISC-V architectures
- Single-board computers
- Not all software is made equal
- PINE64 products and community
- Free PINE64 hardware!
- Questions?



What is this all about?

- Do you want to really know how the modern computers work? Down to the schematics?
- There are various CS textbooks, but they usually present an idealised picture.
- The reality is quite different, it is surprisingly hard to get down to the bits and resistors.
- Modern PCs, smartphones and embedded appliances have become real black boxes.
- Not everyone cares or needs to care directly.

What is this all about? (cont.)

- Even if you do not care directly, you are most probably entangled enough in real life.
- Convenience trumps everything...
- ... so nearly everyone carries a true spy box everywhere they go, including the restroom.
- Can we do something about it? Really?
- As-open-as-possible hardware platforms do exist, but they are often not known very well, and even more often not understood well.

Not all computers are made equal

- All computers compute, but only for some of them is really known how they do that.
- Implementations of the popular x86 and x86_64 architectures are not made to be open.
- Moreover, they contain some secure parts that are specifically made to be inaccessible.
- ARM and RISC-V architectures are much more open, but it is still a very long way from the architecture to a real computer built upon it.

“Traditional” embedded systems

- Embedded systems mostly used to remain nearly invisible in the “good old days”.
- Somebody made them, and nobody cared.
- This still pertains to the modern era, but the increased connectivity made them more visible.
- Unfortunately, embedded systems are still very often obscure throwaway projects.
- Made to “just work” and often made to actually be unmaintainable, even for the OEM.

ARM and RISC-V architectures

- In general, they break the old mold and offer a modular approach to building an SoC.
- Building an SoC becomes like filling a shopping cart with the desired CPU cores, glue logic, and IP blocks from different suppliers.
- One of the results is a custom-tailored SoC.
- Another unfortunate result is a huge variety of different SoCs, which makes the system design and low-level software support hard.

Single-board computers

- By definition, a complete computer made of a single PCBA. This has become inaccurate.
- In practice, a compact computer based on ARM or RISC-V architecture, for which is known how it actually works, more or less.
- Can be seen as inexpensive, small things that “just get the job done”. That is fine.
- But it is also wrong. Some of them offer much more, if you look closely enough.

Single-board computers (cont.)

- The talk title on the first slide is a bit misleading on purpose. It is impossible to describe all those abbreviations well on a few slides.
- However, they hopefully portray the underlying complexity rather well.
- Not all SBCs are designed and made to be open and understandable, either as complete units, or as sums of their parts.
- Understanding is hard. No pain, no gain.

Not all software is made equal

- Software often needs to “just get the job done”. Well, that is only one way to see it.
- As a result, embedded systems are often just obscure, throwaway projects. Nobody cares.
- Well, do you care? Do you want to throw away hardware you own, or to keep using it for the next 10 or 15 years, while always running the latest versions of low-level software?
- If the answer is yes, be prepared for some pain.

Not all software is made equal (cont.)

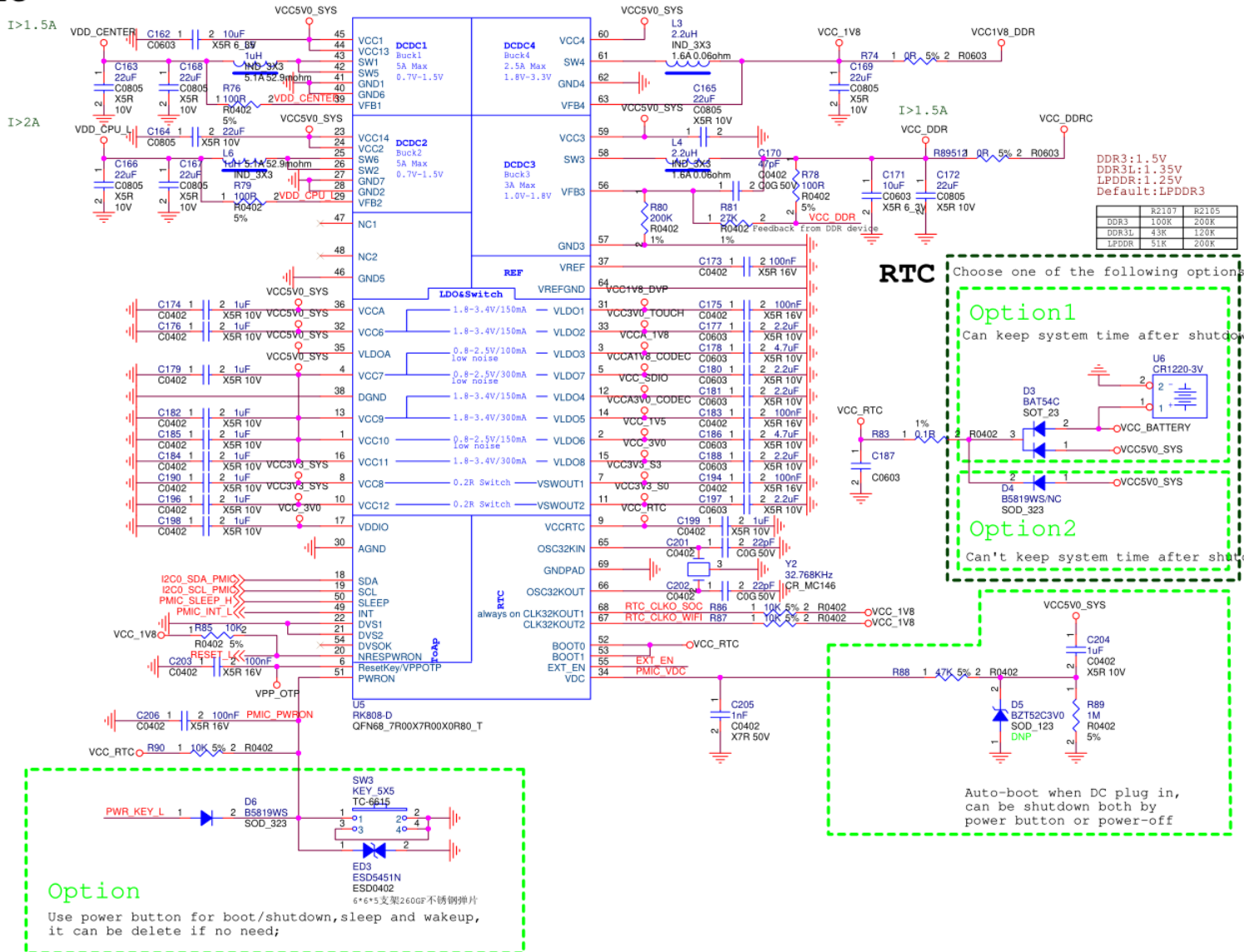
- There should be no need to buy new hardware just to be able to run latest low-level software.
- Unfortunately, that has gradually become needed, because software “gets the job done”, which is to make money for the manufacturers.
- Making sure that latest software runs is hard.
- The only real solution is to run the upstream versions, and to upstream all the required changes for a specific board or device.

PINE64 products

- PINE64 is one of the SBC manufacturers that make their designs as open as possible.
- The goal is not to make money, but to make inexpensive, open SBCs and devices available to the people, for everyone's benefit.
- Started as a single SBC model, and has grown to multiple SBC models, smartphones, laptops, and SoMs. Even a smart soldering iron.
- As open as possible, down to the schematics.

PINE64 products (cont.)

PMIC

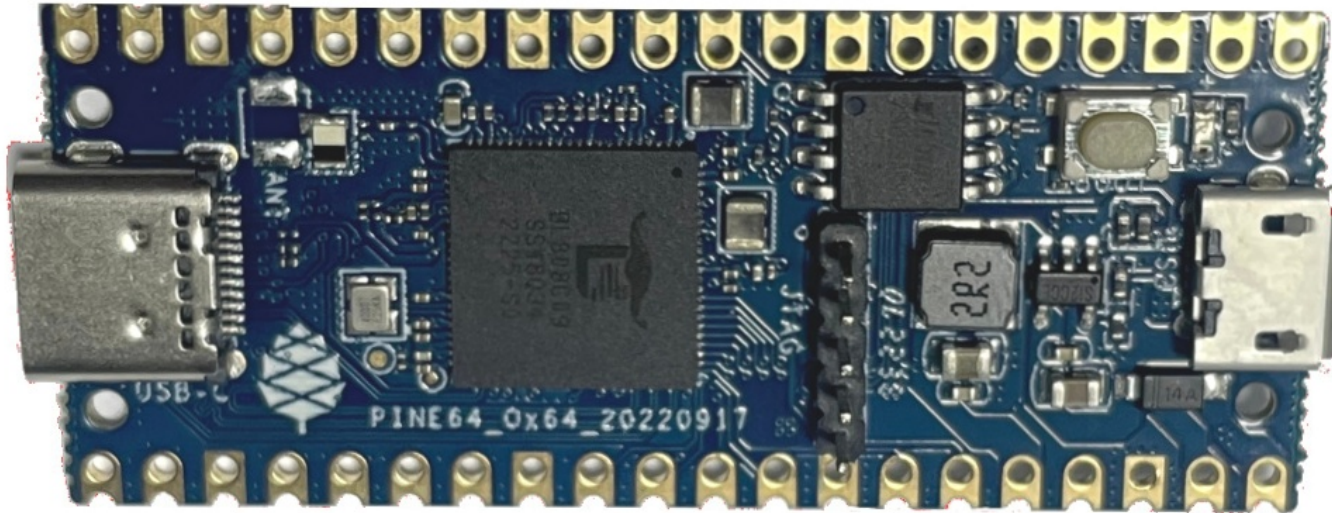


- An excerpt from the ROCKPro64 schematic, showing the PMIC

PINE64 community

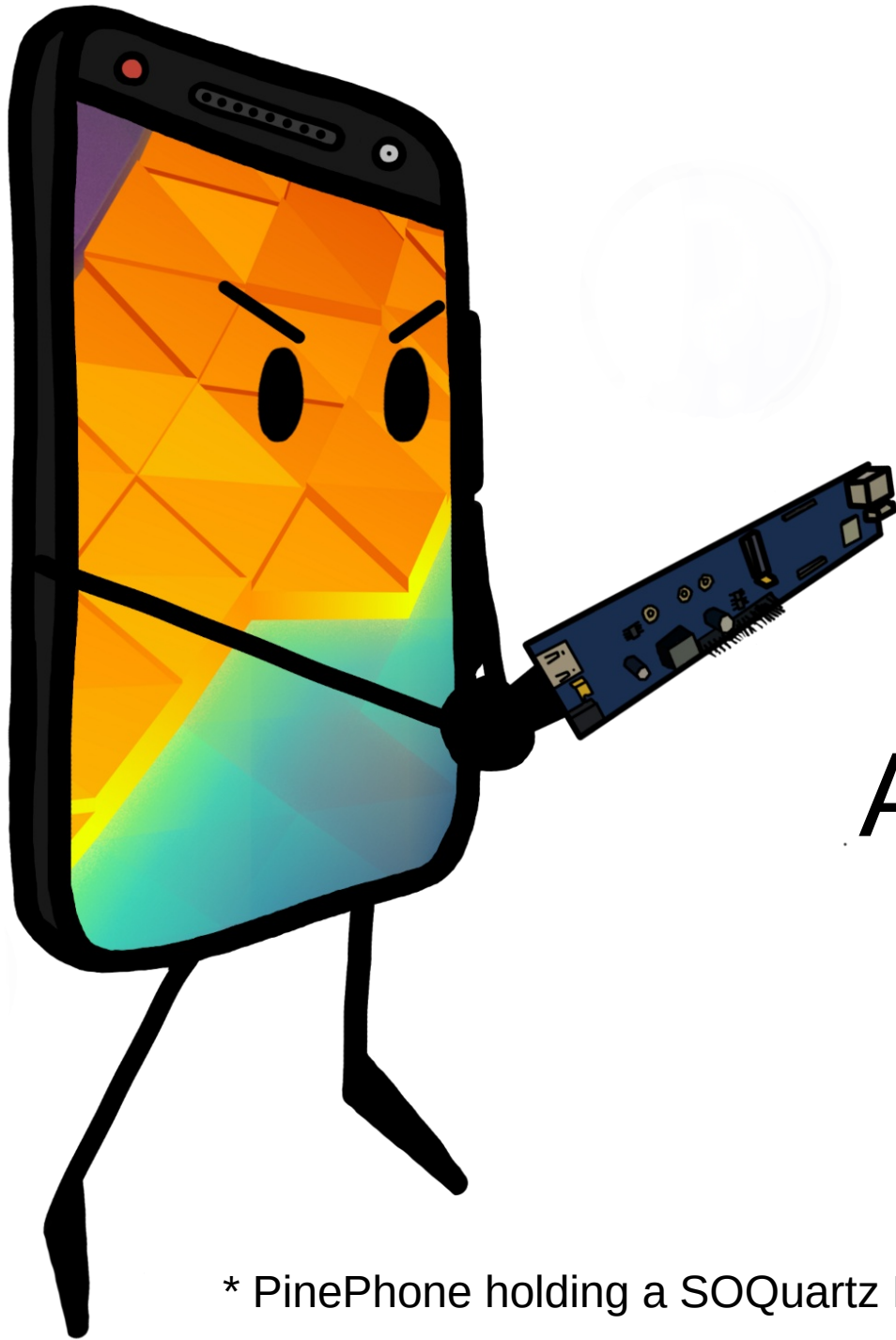
- PINE64 makes hardware, while the broader community makes software. All software, but the focus here is on low-level software.
- This involves various upstream projects, including the Linux kernel, U-Boot and TF-A.
- Some members of the community are also contributors to various upstream projects.
- Highly active members of the community even receive hardware donations from PINE64.

Free PINE64 hardware!



BL808 RISC-V SoC
Three CPU cores
64 MB of PSRAM
16 MB of SPI flash
microSD card slot
2.4 GHz WiFi
Bluetooth LE 5.0
Zigbee radio
USB 2.0 dual-role
Fast Ethernet
UART, I²C, I²S

- Thanks to a hardware donation from PINE64, five BarCamp attendees will receive one free Ox64 128 Mbit board each. It runs Linux, but is still in early stages of development.
- It is simple. All you need is to propose one of the five best ideas for how you would use one of these tiny beauties.



Thank you!

Any questions?

* PinePhone holding a SOQuartz Blade