Building an aarch64 Linux Laptop

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Why would anyone want to do this?

- ARM processors are no longer just low-power low-performance CPUs for embedded devices -- a single-core Cortex-A72 can beat a single-core Core M in some benchmarks (falling not too far behind in others).

While it won’t do too well at “make -j”, an aarch64 laptop can do what a regular person needs.
Why would anyone want to do this?

- Power consumption is significantly lower - battery life time should be much better, avoiding my default mode of travel...
Why would anyone not want to do this.

- More cores… Who doesn’t want a power efficient Deca-Core Laptop?
- No need for fans (saving even more power, and a potential thing to break)
- Weight (fans add to it - the current prototype is lighter than an eeePC)
- Doesn’t burn your legs while running “make -j” in the kernel tree
- No viruses or other malware (yet), and makers of such code are unlikely to be familiar with the architecture (so far)
Why would anyone not want to do this.

- Development platform - avoiding crosscompiling to those aarch64 devboards, mobile devices, and servers
- Enable some more real world testing of aarch64 ports -- stuff that is neither mobile centric nor server centric currently gets very little testing.
- A possibility to be more open - no secret BIOS, no Intel Management Engine
Where is it?

- We couldn’t possibly be the only ones seeing the need… So why aren’t there any aarch64 laptops out there? Or are there?
Chromebooks...

- There’s this and a few more like it... A good start, but no (e)SATA connectors inside, and a maximum of 64 GB eMMC storage (16 GB in smaller models) is nowhere near enough for needs beyond a web browser and email client.

- Also, a 12” screen with a keyboard that has only a bare minimum of keys is great for mobility, but not that great to do development on even if you attach big storage on USB.
Pi-Top

- Another rather interesting device - not exactly what we wanted (small, low resolution screen, powered by a Raspberry Pi (great device for embedded systems, but not quite a desktop replacement for serious users...))
So can we just “fix” an x86 laptop?

Putting old hardware to good use...

But this doesn’t scale… And no 2 laptops are the same on the inside...
Let’s take another look at the Pi-Top...

- At least it is open and not bolted shut… On the inside, it connects the display to the Pi’s HDMI port and the keyboard and touchpad to the Pi’s USB port…
- Can we just replace the Pi with a more powerful board for a prototype?
We can! (Just have to modify the power supply…) 

Probably the world’s first 10-core laptop.

Powered by the MediaTek X20 devboard.

But still no proper storage, too little RAM, …
So what would we want to have in it?

- Fast aarch64 CPU (at least 4-core A72)
- GPU that doesn’t need binary-only drivers (No Mali, no PowerVR!), at least 1920x1080
- (e)SATA or M.2 port that can handle decent storage
- USB ports to be exposed to the outside
- As much RAM as possible
- Board affordable and available to the public so we don’t end up building just 1 unit
- Nice to have, but not 100% required: HDMI port to be exposed to the outside (for projectors)
But it’s just not out there...

- (Currently) 96boards don’t have storage options (unless we use usb storage, but most boards don’t even have USB 3), the only one that has an open graphics driver is the DragonBoard 410c, which also lacks on the RAM and CPU power sides
- Tegra boards are very expensive and NVIDIA has a bad track record with Open Source
- Raspberry Pi/Banana Pi/ODROID etc. are lacking on the performance side
- i.MX8 may well be interesting (Vivante GPU, etnaviv driver exists), but isn’t available yet
Can we (ab)use a networking board?

**MACCHIATObin**

- Quad-Core A72, up to 2 GHz
- DDR4 DIMM slot (better than hardwired 2 GB...)
- 3x SATA 3.0 connectors
- PCIE port (drop in a Radeon, driver problems solved...)

Close, but no...

The PCIe bridge doesn’t seem to have a sufficient aperture for the framebuffer.
OpenQ 820 seems to be the best choice for now

- 4-Core Kryo CPU, 2.2 GHz
- Adreno 530 GPU, (mostly) supported by Freedreno
- 3 GB RAM (would be nice to have more, but…)
- 32 GB UFS 2.0 storage (good enough for the OS - let’s put /home on a separate disk…)
- 2x PCIe 1x mini PCIe v1.2, 1x PCIe X1 slot v2.1 (which we can use for SSDs - already working)
... but it doesn’t support Linux

The OpenQ 820 is being sold as an Android only board - no support for normal Linux.

But Android runs on a Linux kernel, and we weren’t planning to use any supplied binary-only graphics drivers in the first place… So is that really a problem?
Getting it to boot...

The bootloader likes android-ish “Sparse filesystem images” to install an operating system -- essentially what you get when building AOSP (system.img, userdata.img, …)

“fastboot flash system system.img” won’t accept a regular ext4 image, and the ext2simg tool that is supposed to turn an ext4 image into a sparse image doesn’t work properly
Getting it to boot...

But AOSP is open source… So we can just use the same tools Android uses to generate our root filesystem image. A little non-standard in the Linux world, but workable.

The `make_ext4fs` tool that can be found in AOSP is easy enough to use - works quite a bit like `tar` - and just needs a few patches to handle non-Androidish users properly, and a few more patches to build outside the AOSP environment.

https://github.com/OpenMandrivaAssociation/android-tools
Already using the components

We’re already using the OpenQ 820 board present in the Laptop as part of our build system -- aarch64 and armv7 packages that need native builds get compiled on this board.

At the time of creation of these slides, it has been up and running without reboot (and without a fan!) for 50 days and 14 hours.

It currently runs kernel 4.11.6 - newer kernels are already available, but not yet tested.
Current status...

- Basic functions (booting, networking, WiFi, PCI, USB)  WORKING
- Graphics: freedreno crashes a lot, but works overall  MOSTLY WORKING
- OS: All packages have been ported to aarch64  WORKING
- Display:
  We’d like to get away from using the Pi-Top’s HDMI interface - by using the board’s MIPI interface, we’d use less power and have the HDMI interface available for exposing externally (e.g. for projectors).
  Also want to go for a higher resolution.
  Sadly, MIPI displays only come in small sizes - but MIPI to eDP converters exist.  MOSTLY WORKING
Current status...

- Input devices  WORKING
- Case (we’d like to go bigger)  TO BE DONE
- Battery  ALMOST DONE
Questions? Comments?

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