

SmolPhone

a smartphone with energy limits

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14th International Green and Sustainable Computing
Toronto, October 28. 2023

SmartPhone evolution



Nokia 3310 (2000)

16 MB storage
100 MHz ARM7
13 kg eq.CO2



Iphone 3GS (2009)

32 GB storage
600 MHz ARM8 + GPU
55 kg eq.CO2



Iphone 14 Pro (2022)

Up to 1TB storage
6 cores + 5GPU + NN+Img
116 kg eq.CO2

- ▶ **Battery life:** only feature to steadily decrease, despite tripled capacity

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SmolPhone project

- ▶ A device offering some smartphone-like features but lasting days on a charge
- ▶ Aim of **increased battery life**, possibly at the cost of a **reduced set of features**

Energy trade-offs

Typical smartphone consumption (from literature)

- ▶ CPU: 3000 mW
- ▶ Screen: OLED 800 mW
- ▶ Cellular: 600 mW idle / 1200 mW TX (4G – LTE Cat4)
- ▶ Wifi: 80 mW idle / 120 mW TX

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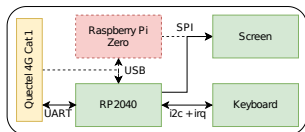
Smolphone envisioned hardware

- ▶ Energy-efficient **computing**: micro-controllers
 - ▶ RP2040 (Cortex M0): 100 mW / core @133MHz; Fast sleep mode at 0.4 mW
 - ▶ Speed comparable to Pentium II (1997 – \approx 50W) but 264kB RAM, 2MB flash
- ▶ Energy-efficient **screen**
 - ▶ **OLED**: 3 mW/cm² (black) to 20 mW/cm² (bright white)
 - ▶ **elnk** is bi-stable, but inefficient updates (10 mW/cm² at 2 Hz)
 - ▶ **Memory LCDs**: no refresh \rightsquigarrow 2 μ W/cm² (monochrome, fast)
- ▶ Energy-efficient **cellular network**
 - ▶ **LTE Cat M1**: 200 mW (TX 10kbps) / 5G: 3000 mW (TX 100Mbps)

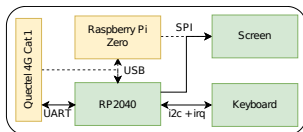
The SmolPhone vision: advanced low-techs

On-board computation offloading

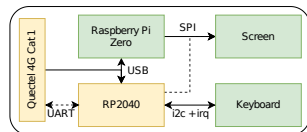
- ▶ **Tiny-small design:** most operations on a RP2040 microcontroller;
 - ▶ Offload heavy computations to a Raspberry Pi Zero on board
 - ▶ Pass full control to Pi Zero for legacy application



Main operating mode



Offloading computations



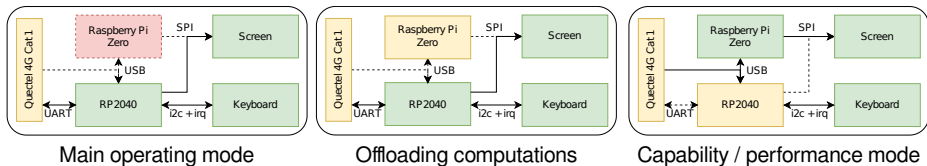
Capability / performance mode

- ▶ **Multikernel:** Harness compute power; offload TCP, filesystem to other chips
- ▶ **Compile-time verif** with Rust to alleviate lack of MMU & runtime safety

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Online proxying in cloud

- ▶ **Remote renderer** of HTML5, before download
 - ▶ Do not offload anything to the cloud (extra work hardly efficient)
- ▶ **Online point of presence**: turn off data plan aggressively
 - ▶ Online proxy sends text messages when a message arrives

Conclusion

Designing a smartphone with energy limits

- ▶ A device offering some smartphone-like features but lasting days on a charge
 - ▶ **Tiny-small** design on board + **multi-kernel** to spread OS functions on chips
 - ▶ Cloud-assisted: Rendering in **smart proxy** + online **point of presence**

Prospective applications

- ▶ Phone, Text messaging, DAV calendar, todo notes, podcasts: **RP2040**
- ▶ MyAndroidApp: **Pi Zero** with WayDroid; Passkey instead of banking app
- ▶ GPS navigation: Tile rendering on **Pi Zero**, navigation on **RP2040**
- ▶ Instant messaging: Matrix proxy server in **cloud**, interactions on **RP2040**
- ▶ HTML pages: Rendering in **cloud**, interactions on **RP2040**

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- ▶ **Redefining smartphones**: features removed (video), but offline OSM / WP

Current state: prototyping / exploration

