

SmolPhone

a smartphone with energy limits

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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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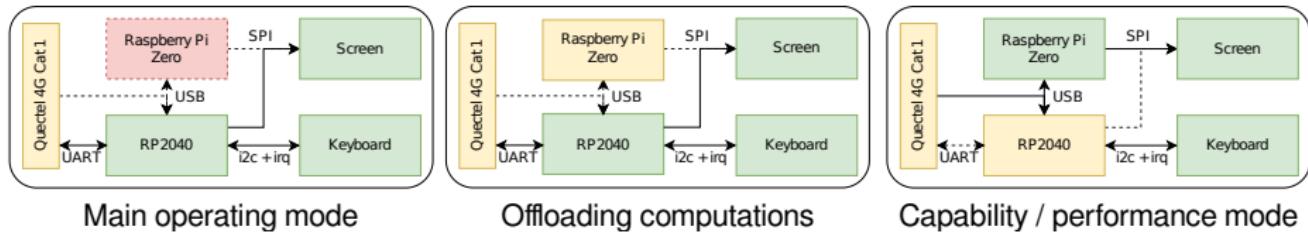
Smolphone envisioned hardware

- ▶ 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)
 - ▶ eInk is bi-stable, but inefficient updates (10 mW/cm² at 2 Hz)
 - ▶ Memory LCDs: no refresh \sim 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

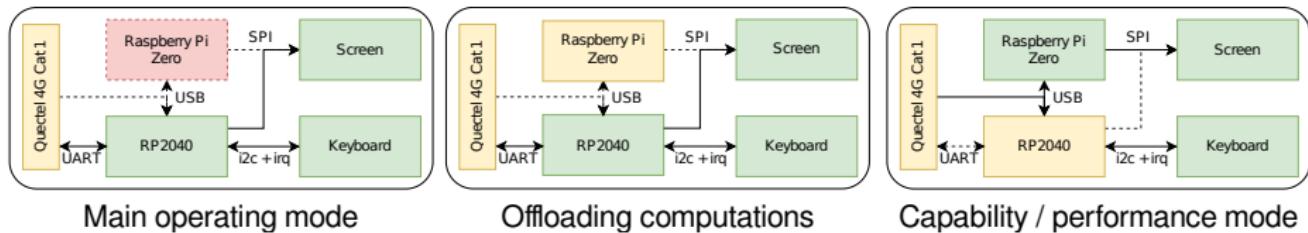


- ▶ Multikernel: Harness compute power; offload TCP, filesystem to other chips
- ▶ Compile-time **verif** with Rust to alleviate lack of MMU & runtime safety

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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

