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
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Up to 1TB storage
6 cores + 5GPU + NN+Img
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- Modern smartphone outperform recent laptops
- Battery life: only feature to steadily decrease, despite tripled capacity

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Exponential growth vs. Finite resources and finite needs

- How could we do otherwise? Do we really need all this?
- Can we go for low-tech mobile computing?

What are the low-techs? (1/2)

Definition by Valérie Laforest (DR in Environmental and Organizational Eng.)

- Low pressure on resources: Resource efficient and recycling/reuse
- Avoid sophistication: simplify, accessible by non-knowledgeable people
- Foster social links: collaborative, participative, locally adapted
- Target non-superfluous needs: As defined by Manfred Max-Neef
  Needs are limited; satisfiers vary a lot but shouldn't be the focus

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Definition by ADEME

- Maximize social utility; Reduce complexity; Maintenance over replacement
- Reduce environmental impact to not overpass local and planetary limits
- Question needs toward essential ones.
- Accessible solutions: empowers broader audience w/ understanding and usage

What are the low-techs? (2/2)

Definition by the Low-tech Lab

- Accessible: buildable and repairable with no advanced tooling/knowledge
- Useful: not futile. Addressing fundamental needs.
- Durable: ecological (efficient, reuse), reparable.

Low-tech inspired by a vast literature

- Illich: *Tools for Conviviality*, 1973.
- Schumacher: *Small is beautiful*, 1973.
- Bookchin: *Toward a Liberatory Technology*, 1965.
- ...

Some initiatives toward practical applications

- Some fablabs, Low-tech lab, L'atelier paysan, etc.

Low-tech computing?

Previous definitions are not adapted to computing

- Are computers doomed as a large technosystem? cf. "Héritage et Fermeture"
- Resilient systems (efficient, durable, reusable, easy-to-use, fault tolerent)?
- Can we avoid rebound effects and expert's dictatorship?

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ESOS project (lead by Insa Rennes)

- Sustainable, Open and Sovereign Electronic
- Bottom-up approach to the problems induced by the computing technosystem

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- Attempt toward a useful, durable and accessible mobile computing
- Top-down: Simplify hardware to the point where capabilities must be reduced
- A device offering some smartphone-like features but lasting days on a charge
  - Increase battery life of a reduced set of features
- Long term goals (unrealistic now): lasting 10 years; hackable by non-specialists
- Non-goals: cheaper device; sell devices or services

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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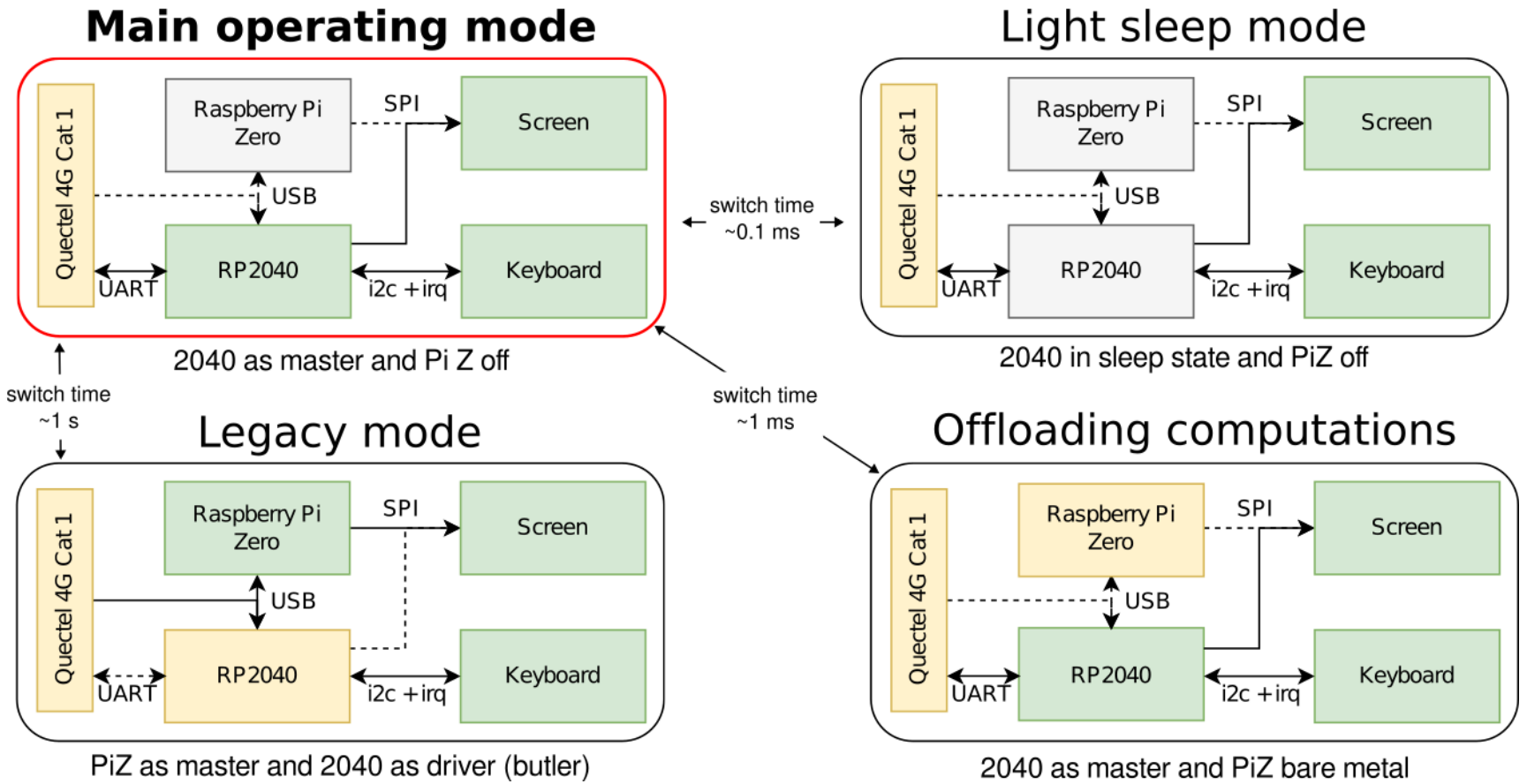
Smolphone envisioned hardware

- 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/cm^2 (black) to 20 mW/cm^2 (bright white)
  - eInk is bi-stable, but inefficient updates (10 mW/cm^2 at 2 Hz)
  - Memory LCDs: no refresh $\rightsquigarrow$ 2 μW/cm^2 (monochrome, fast)
- Energy-efficient cellular network
  - LTE Cat M1: 200 mW (TX 10kbps) / 5G: 3000 mW (TX 100Mbps)

On-board computation offloading

- Tiny-small design: most operations on a RP2040 microcontroler;
  - Offload heavy computations to a Raspberry Pi Zero on board (bare metal)
  - Pass full control to Linux on 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

Online infrastructure

Remote rendering

- HTML5 cannot be rendered on 2040
- Render in the cloud before download, to not start the PiZ
- 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
- Maybe useless with LTE M1 hardware?

Junkyard computing

- Reuse existing hardware (e.g. your old phone)
- Reduce carbon impact
- Data self-hosting improves privacy

Designing a smartphone with energy limits

Low-power mobile device

- Memory LCD + keyboard: 0.5mW monochrome (from 800mW OLED)
- LTE M1 cellular: 200mW @10kbps (from 1200mW 4G or 3000mW 5G)
- Processing: RP2040 100mW per busy core + 600mW Pi Zero (from 3000mW)

Device with smartphone-like features but lasting days on a charge

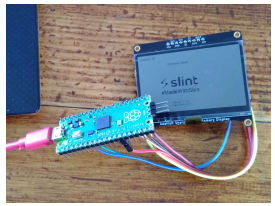
- Tiny-small design on board + multi-kernel to spread OS functions on chips
- Cloud-assisted: Rendering in smart proxy + online point of presence

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

SmolPhone current state

Prototyping and exploration since maybe one year



Ongoing internship: on-board offloading

- GPS navigation as a target application (with mepo)
- Goal: first-hand metering of the different modes' consumption + SW prototype

Proposed internship: SmolNet

- Cloud rendering, deported asynch graphical interface and simplified HTML
- No student yet, so we are slowly exploring by ourselves

Inria Action Exploratoire (accepted on 02/14)

- HW engineer for 2 years: Puzzle prototype + A5 devboard + better form factor
- Embedded software engineer for 2 years:
  - Base software (phone, Text messaging, DAV calendar, todo notes, podcasts)
  - Online infrastructure toward self-hosting and junkyard computing

Conclusion

Low-techs as an appealing future

- Resource efficient, accessible by novices, participative, non-superfluous needs
- Social utility, low complexity, long maintenance, essential needs, accessible
- Accessible, useful and durable.

Special challenges to low-tech computing

- Rebound effect, expert dictatorship, technosystem as a ruinous ruin

SmolPhone vision & research programs

- Low power hardware limiting the applications by design
- Architecture ideas: Tiny-small and onboard offloading, multi-kernel
- Cloud ideas: smart proxy & online presence w/ junkyard computing
- Other HW ideas: intermitent computing, energy harvesting
- Other empowering ideas: computing in the small (WP), simpler systems
- Other design ideas: foster local interactions and participative communities
- (insert your dream here)