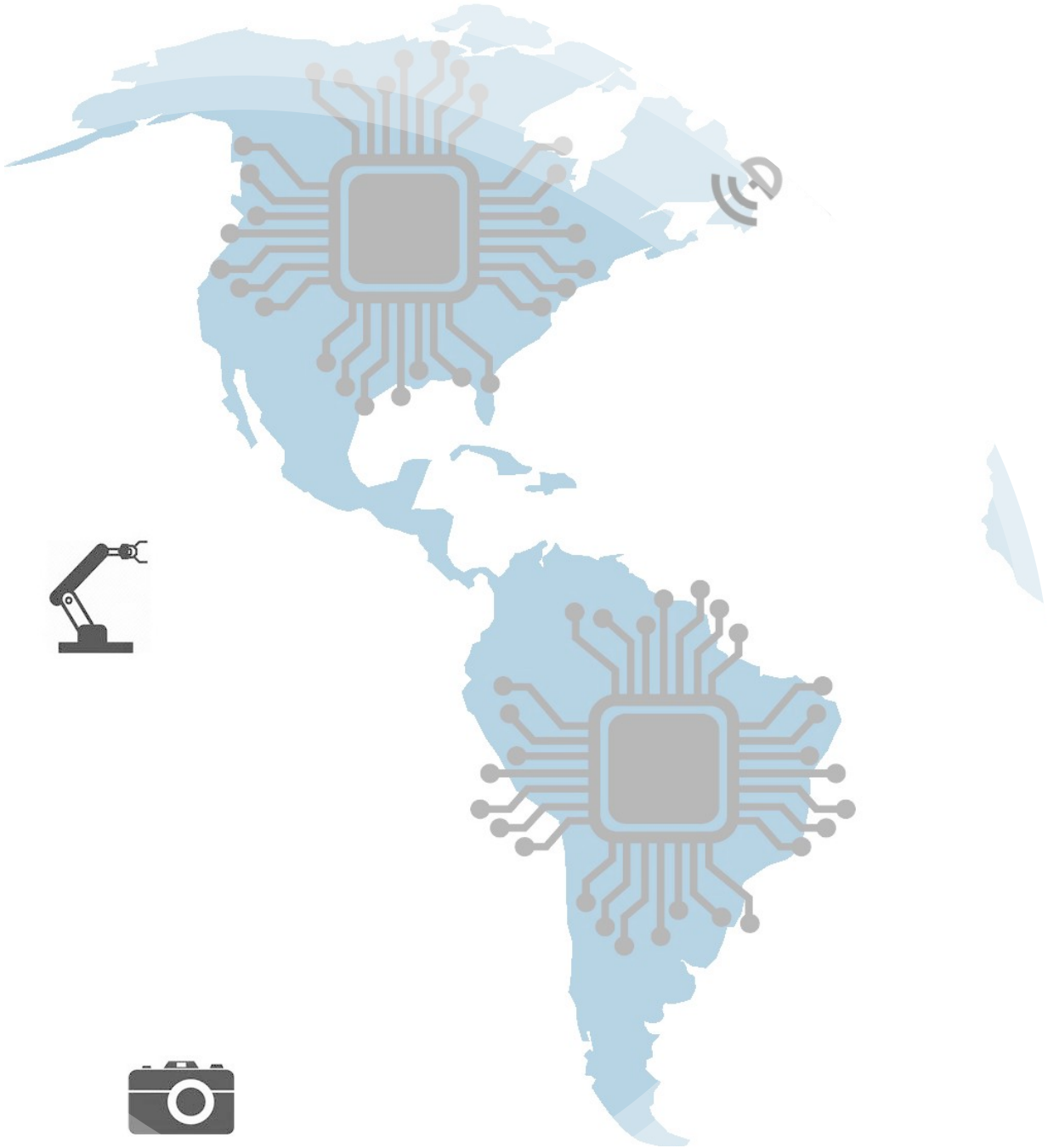


BicycleCompanion

An open-source low-power
bicycle-computer based on NuttX

Matias Nitsche

August 15-16 2020

NuttX Online Workshop

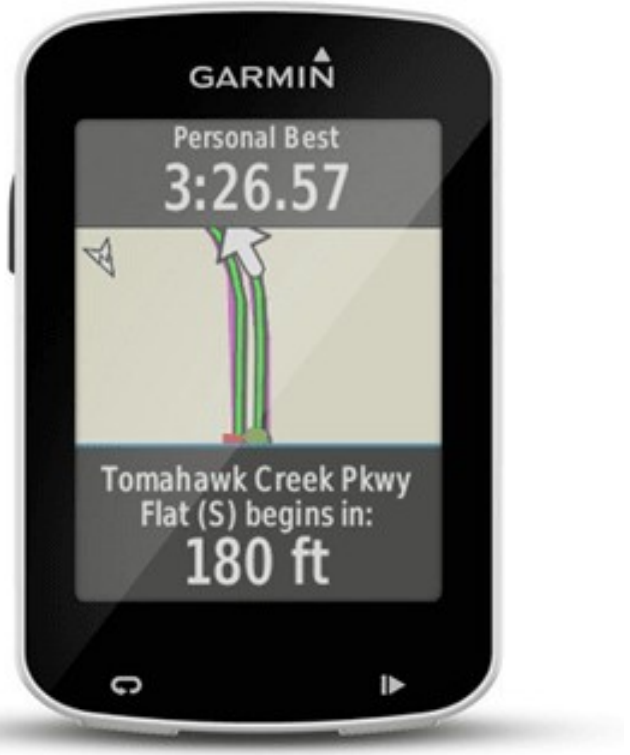
What?

Why?

- I like Bicycle Touring

Why?

- I don’t like typical bicycle “computers” (too dumb, closed / too expensive, GPS based)



Also...

- I like OSHW
- Gain experience:
  - Low-power hardware/software
  - PCB + case design
- ☠ Hackaday Prize
  - Won the community award!

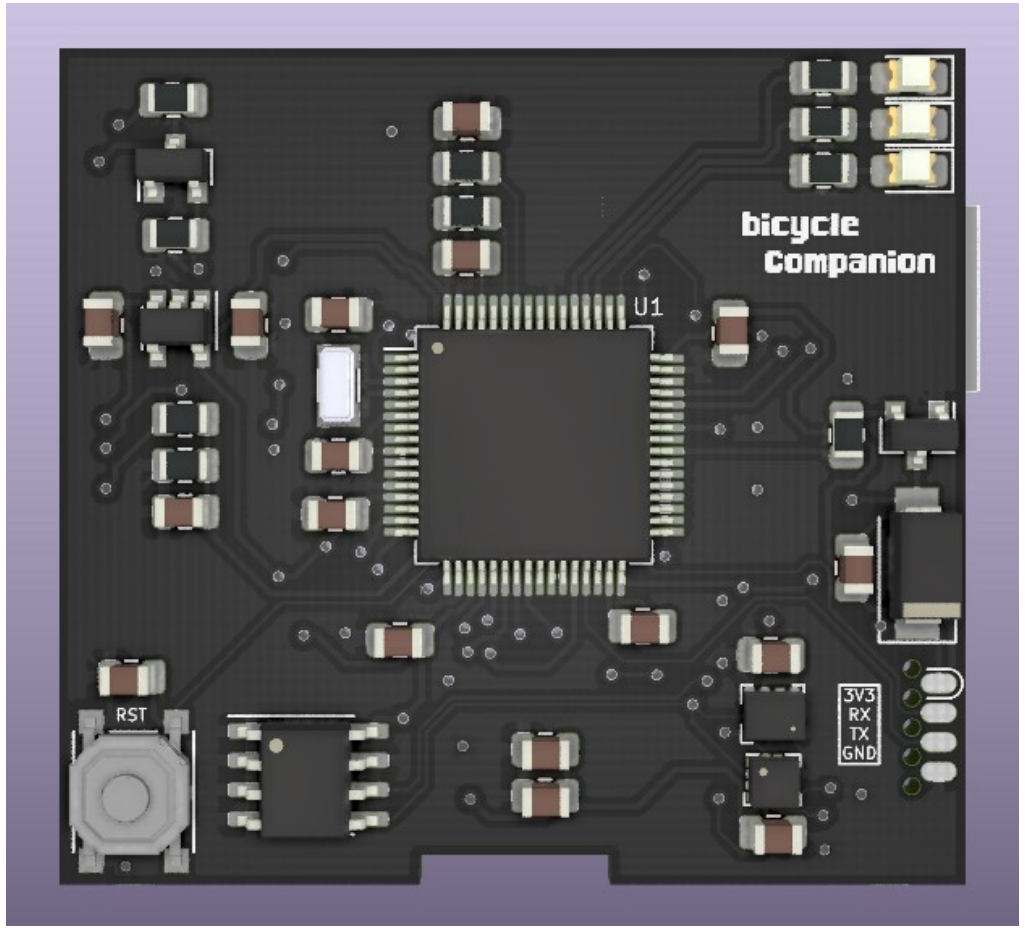
Goals

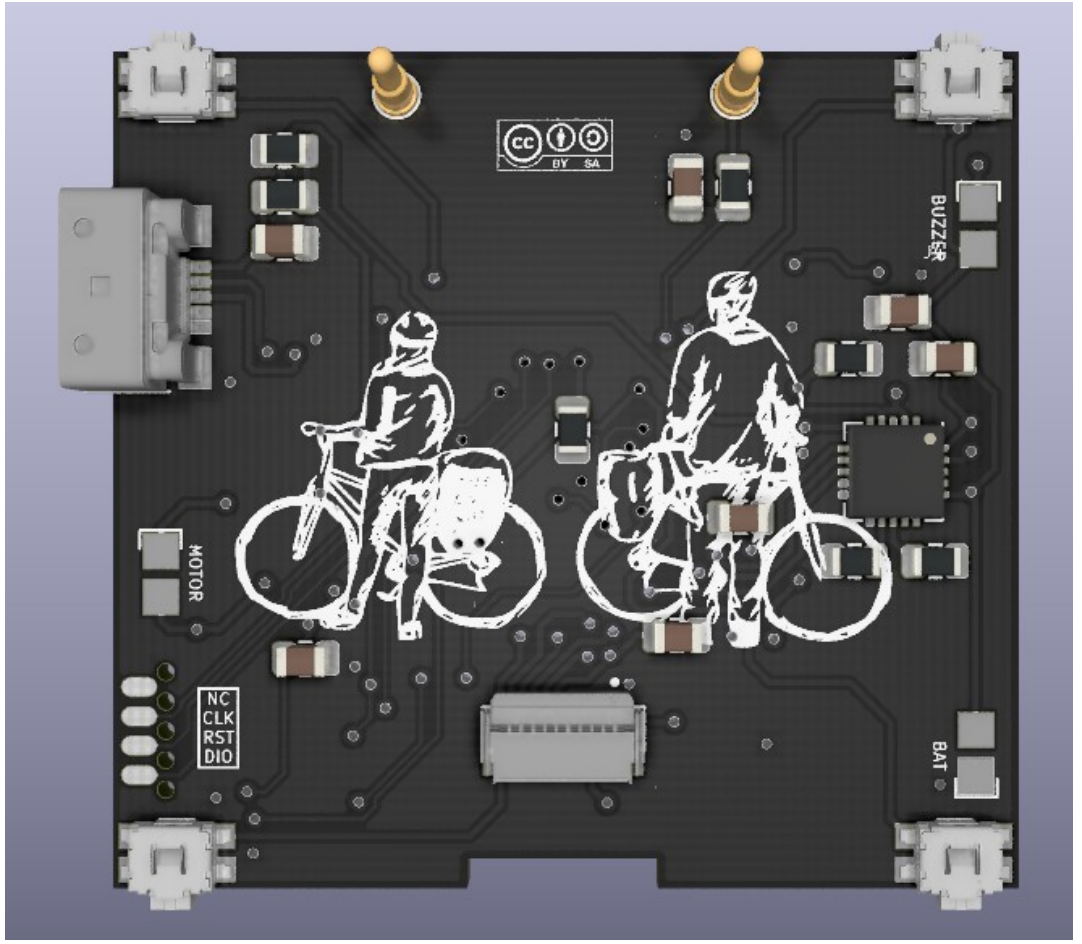
- Low-power: ~ month, daily used 6-8hs
- Daylight readable display
- Wheel sensor (reed)
- Mag. + acc. + baro. + temp. + ~~lightning~~
- Sound/vibraton feedback
- Rechargeable
- Non-volatile memory (settings/stats)

Hardware Design

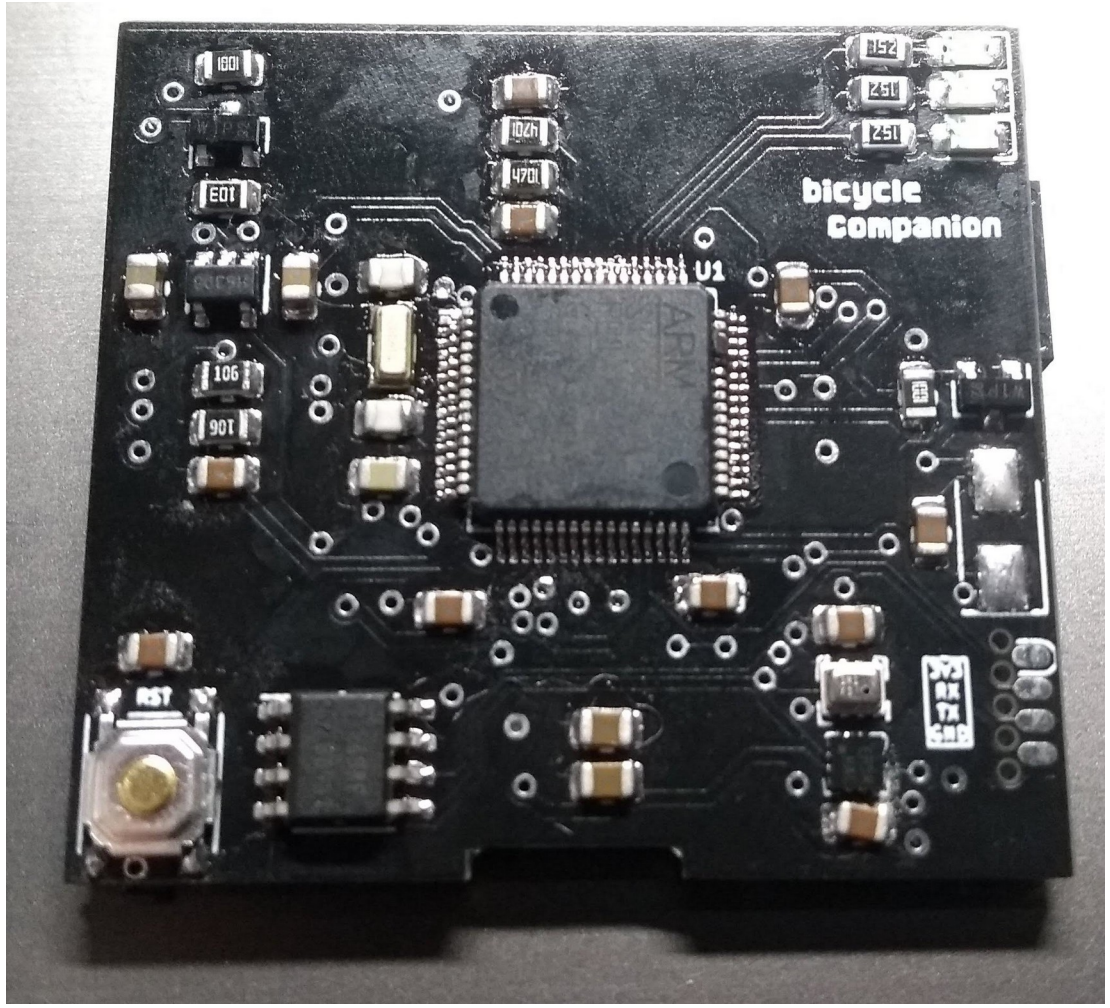
- Low-Power:
  - STM32L4: nice low-power features
  - Sharp Memory LCD: high refresh rate, low-power
  - Low Iq components
  - Tact buttons (no touchscreen, capacitive)

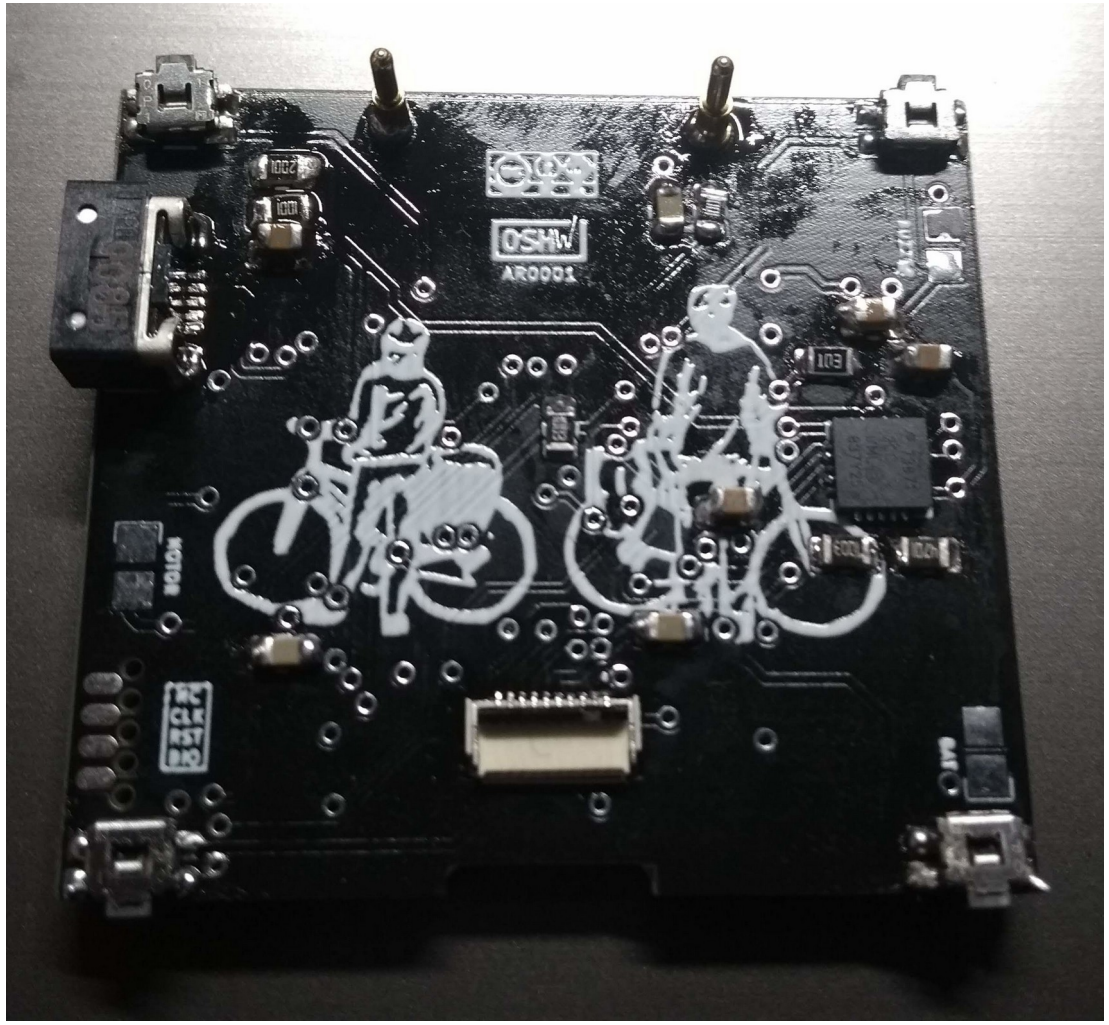
Hardware Design



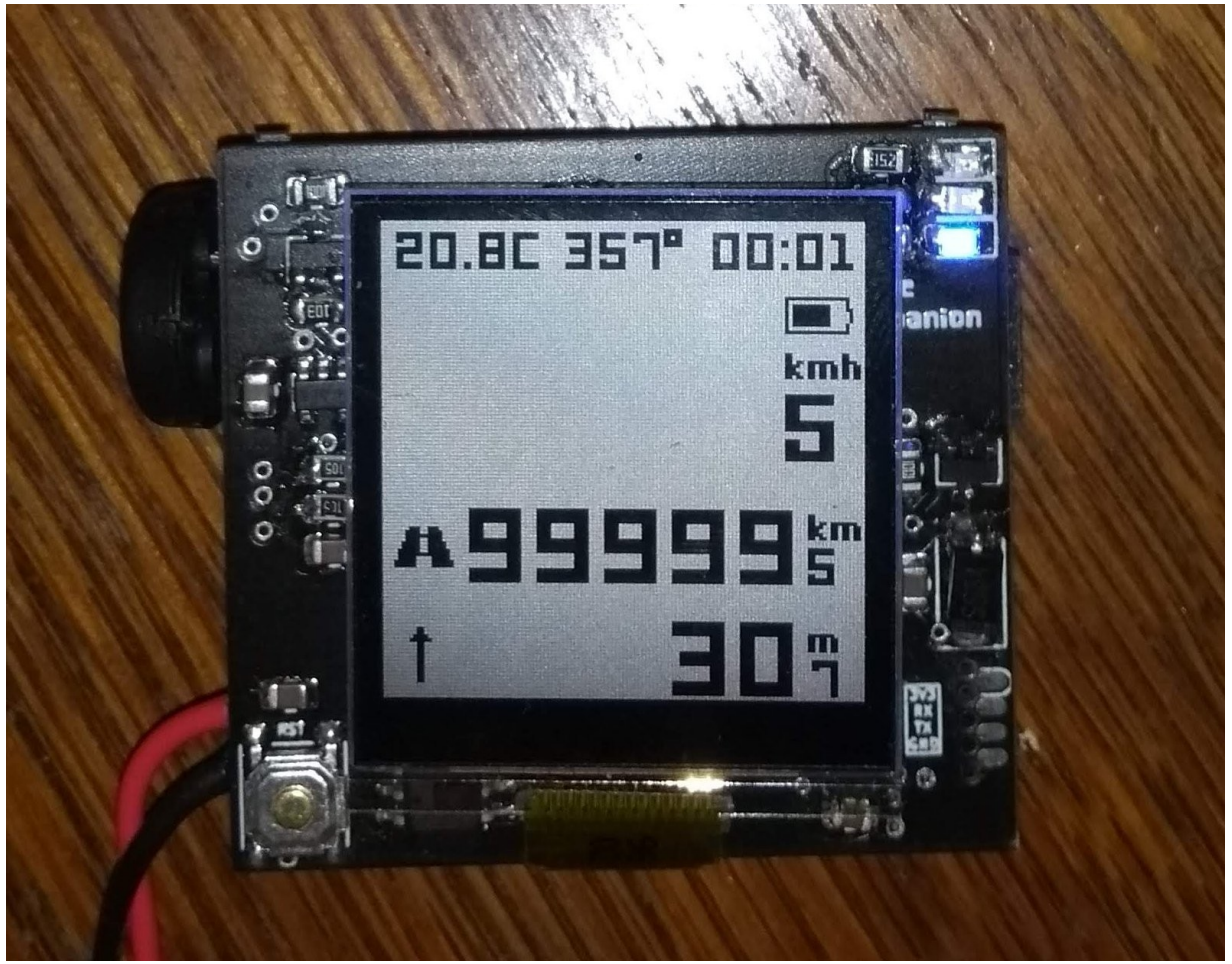


Hardware Design





Hardware Design

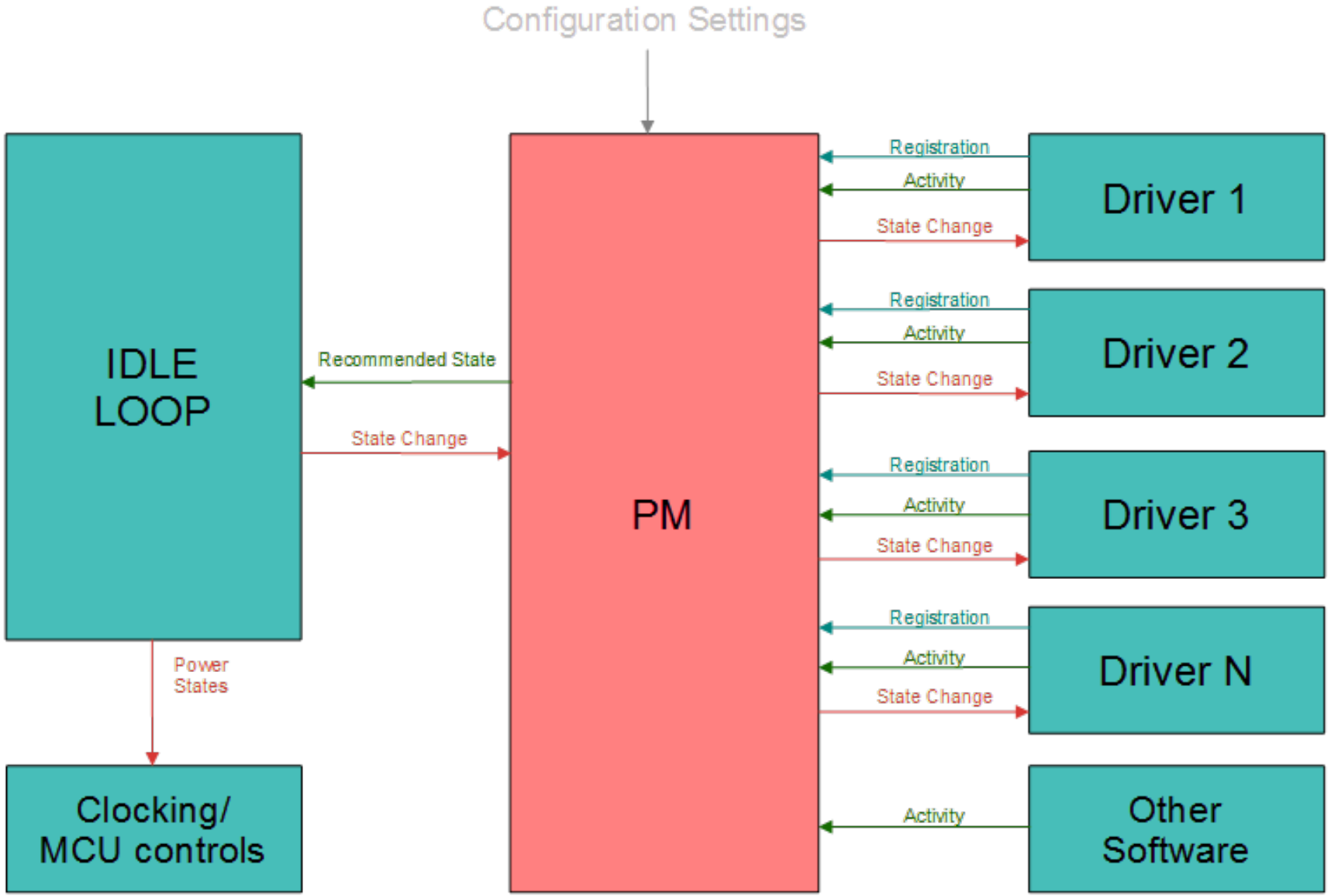


Firmware Design

- Sleep most of the time
  - App controlled power-management
  - Maximize sleep levels
- Turn off unneeded resources
- Transparent to user: fast wake up
- Nice UI

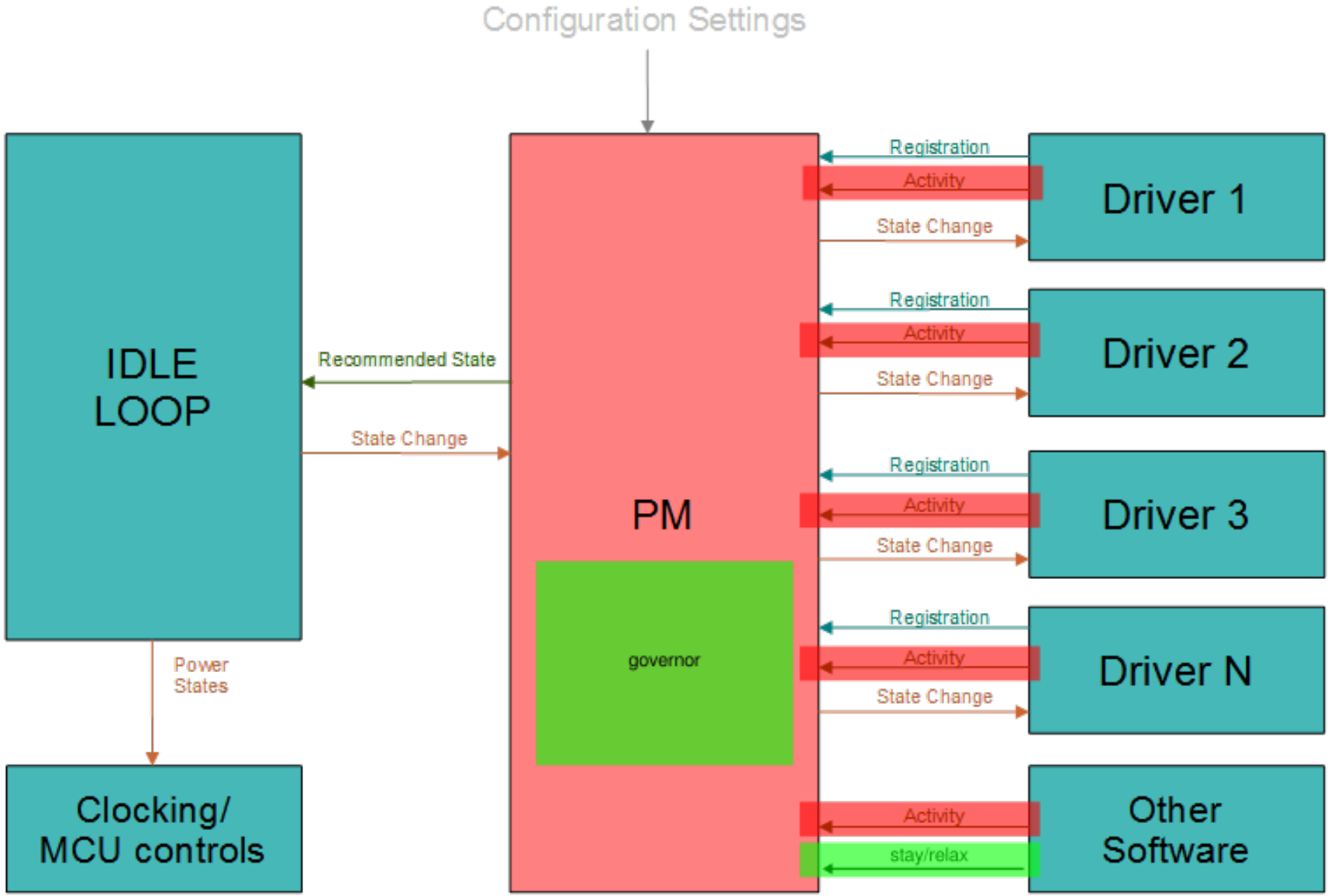
NuttX Power Management

- States: NORMAL, IDLE, STANDBY, SLEEP
  - idle loop maps this to HW sleep-states
- Before: activity based governor (pm_activity)
  - Driver controlled sleep/wakeup (eg: UART activity)
  - States chosen (proposed) by activity threshold
  - Unaware of app. state / logic


Configuration Settings
IDLE LOOP
Recommended State
State Change
Power States
Clocking/ MCU controls
PM
Registration
Activity
State Change
Driver 1
Registration
Activity
State Change
Driver 2
Registration
Activity
State Change
Driver 3
Registration
Activity
State Change
Driver N
Activity
Other Software

NuttX Power Management

- Now: selectable governor, new greedy governor
  - Always go into lowest possible level
  - pm_stay/pm_relax (boardctl)
  - pause() → idle loop → sleep
  - Wakeup: 1 Hz refresh / button / ext. int.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State Change
Driver N
Activity
stay/relax
Other Software

STM32L4 Features

- Clock sources: HSE, HSI, **MSI**, **LSE**
  - **MSI@48MHz**: fast refresh, sleep sooner, USB
  - **LSE**: RTC, LPTIM
  - No PLL!
- Sleep levels: STOP1, STOP2, STANDBY
- LPTIM1: odometer, LPTIM2: 60 Hz LCD EXTCOMM
- RTC periodic wakeup + daily alarm
- NuttX: various contributions / bugfixes

Nice UI

- L(ittle)VGL: very nice widget / redraw system
  - Integrated via custom LCD chardev: draw many rows at once (less time → less power)
  - NuttX sim + X11 FB


NuttShell (NSH) NuttX-9.0.0
nsh>
NuttX

For more information

- Hardware: gitlab.com/bicycle-companion/hardware
- Firmware: gitlab.com/bicycle-companion/firmware
- Project Logs: hackaday.io/project/24907-bicyclecompanion

Appendix: my workflow

- QtCreator: clang-backend, compilation database
- NuttX Workspace Manager:
  - Makefile based, on top of NuttX
  - Git submodule based (versioned)
  - Out-of-tree app + OS code (avoid forking)
  - Useful make targets

gitlab.com/nuttx_projects/

Contact

- Twitter: @protobits
- E-mail: matias@protobits.dev
- Hackaday: hackaday.io/protobits
  - Checkout thumbMouse! https://hackaday.io/project/167075-thumbmouse


NuttX Online
Workshop
Thank you!
APACHE
SOFTWARE FOUNDATION