

OpenSWISS: A Reliable, Modular, Low-Cost Platform for Air Quality Crowdsensing

Emmanuel Droz¹, Julien Eberle², Karl Aberer², Alcherio Martinoli¹

¹Distributed Intelligent Systems and Algorithms Laboratory (ENAC), ²Distributed Information Systems Laboratory (IC)

OpenSWISS is an hardware and software platform built around an autonomous data logger.

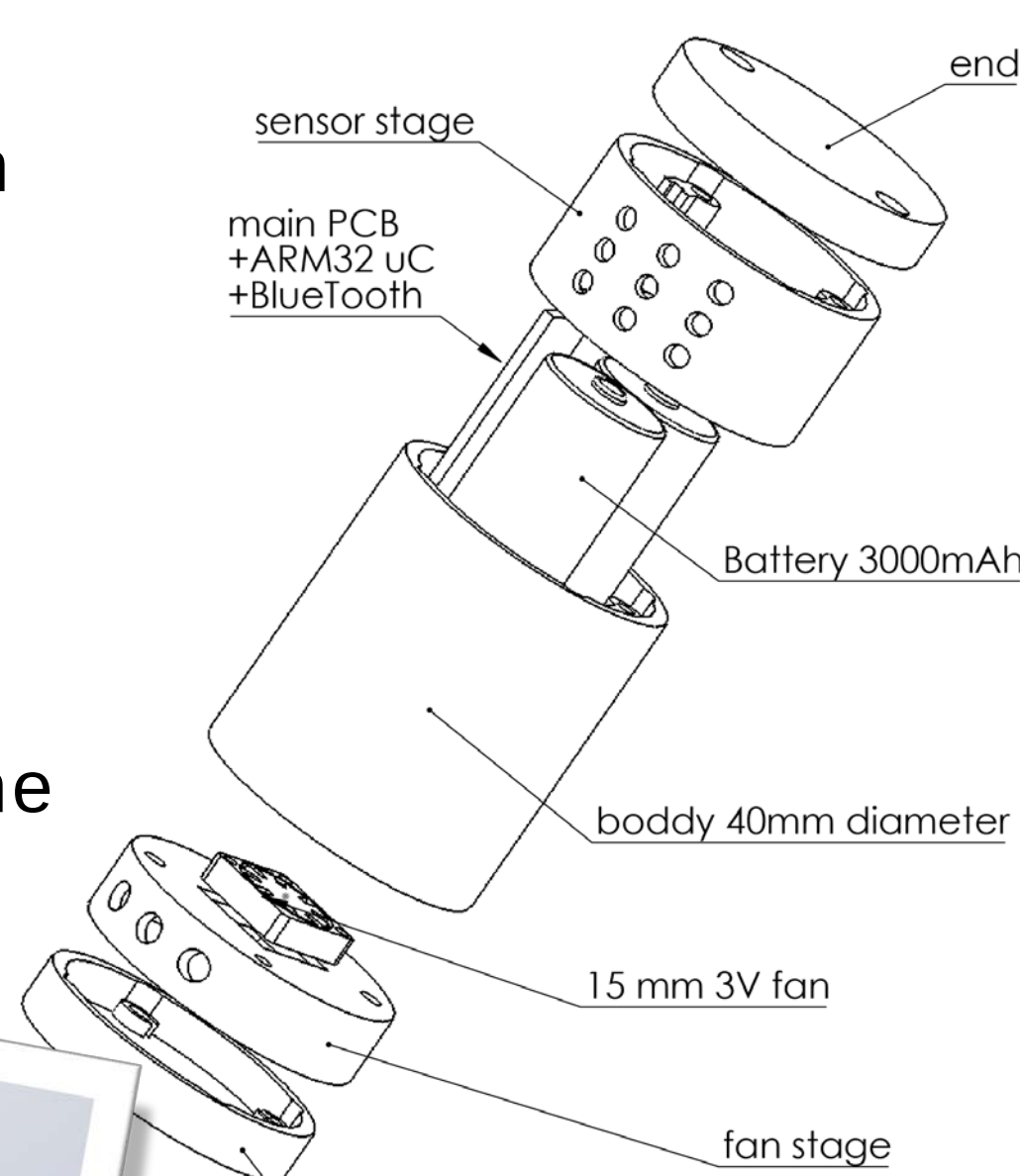
Built-in or home-made extensions can be plugged on it and provide it with sensing modalities and other capabilities.

Measured parameters are stored on the device and transmitted opportunistically to a streaming backend for visualization and analysis.

Hardware

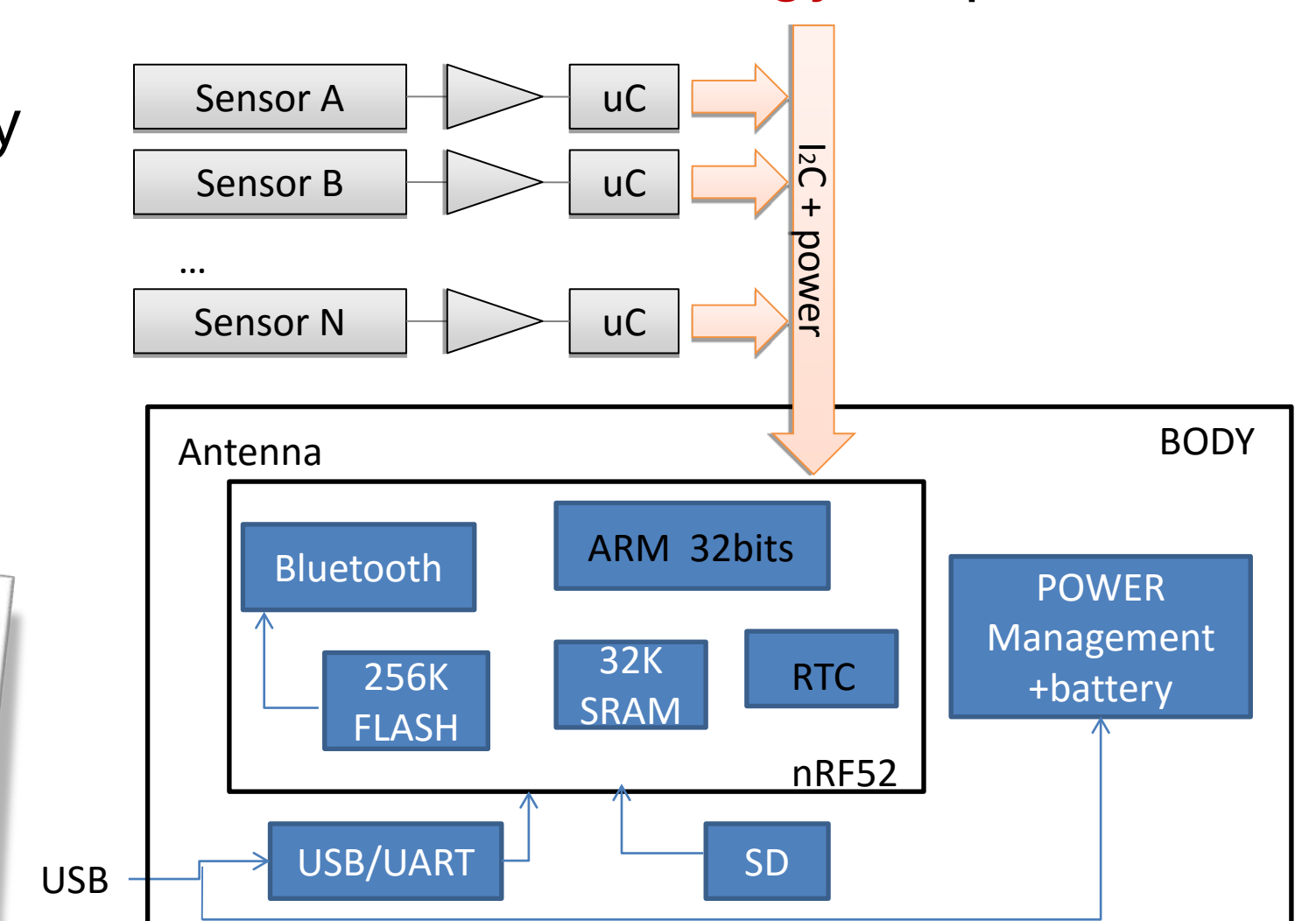
Mechanical parts

- Battery and main controller contained in the body.
- Connectors on **both sides** for attaching extensions.
- The extensions can be **stacked**.
- Examples of extensions:
 - air quality sensors
 - fan module for pushing air through the sensor.



Electronic parts

- Controller to extensions communication through **I2C**.
- Each extension has its **own micro-controller** for translating the measurements or the commands of the main controller.
- Main controller running on a nrf52 **Bluetooth Low Energy** chip, with minimal footprint.
- All measurements stored locally on **SD card**.
- Long-lasting battery, charged over USB.



Software

Embedded

- Data logger based on command-response protocol for receiving data and sending commands from, resp. to, the extensions.
- **Circular buffer** on the SD card for all measurements, allowing to collect data while being offline.
- Bluetooth data gateway (smartphone) opportunistically querying any new data available in the buffer.

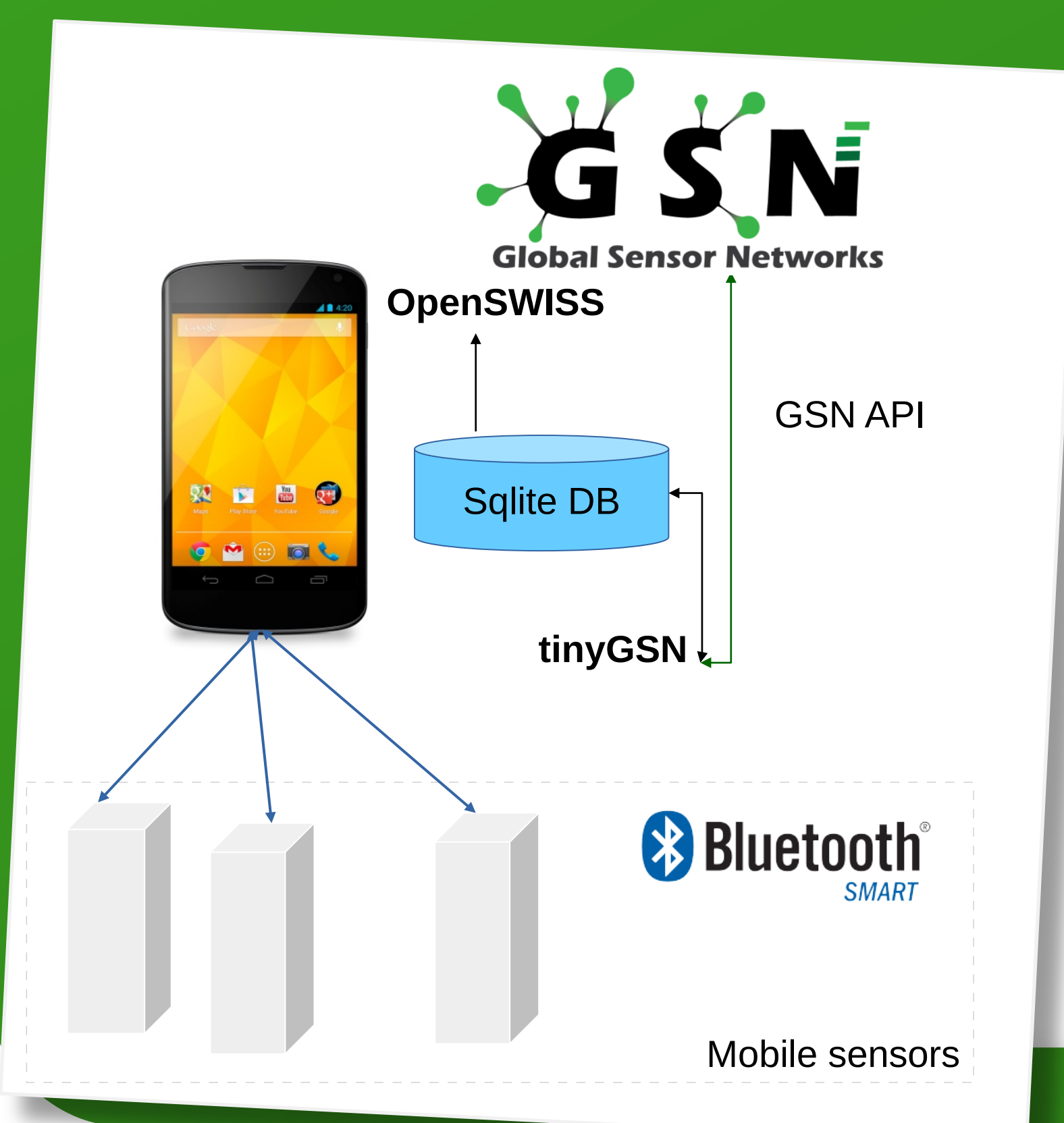
User Interface

- Dedicated **OpenSWISS Android application** for showing to the user an overview of the currently measured values.
- Data provided directly from **tinyGSN**, running in the background.
- Various **visualizations** such as a map or a detailed graph allowing the user to explore the measurements directly from the smartphone.



Middleware

- Global Sensor Networks (GSN) middleware used for aggregating data from the OpenSWISS platforms.
- A mobile version, tinyGSN, as **gateway** on the smartphone:
 - Based on the same architecture as GSN and able to process locally the data before forwarding it
 - Responsible for **geo-tagging** the data and applying a **privacy** preserving mechanism to prevent leaking sensitive user information
- Data collected whenever the phone can connect to the OpenSWISS platform and then uploaded to the server when WiFi available.
- Common GSN back-end with OpenSense II deployment, allowing for **merging the data** from those two sources.



References:

Global Sensor Networks (GSN) and tinyGSN, on Github: <https://github.com/LSIR/gsn>
Nordic Semiconductor nRF52: <https://www.nordicsemi.com/Products/nRF52-Series-SoC>