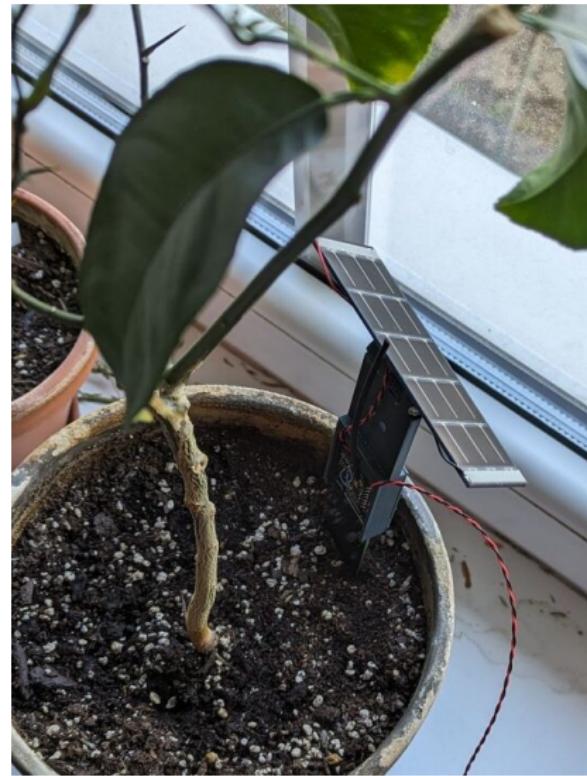
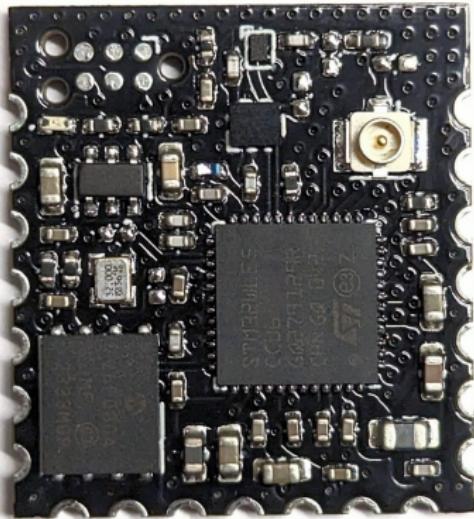


Sensor Network for Smart Agriculture

Jiří Maňák

June 5, 2024



Goals

Custom soil moisture sensor network

- ▶ Able to cover large-enough area
- ▶ Zero-maintenance, no external dependency
- ▶ Potentially extensible with more sensor types

Cover large-enough area with no external dependency

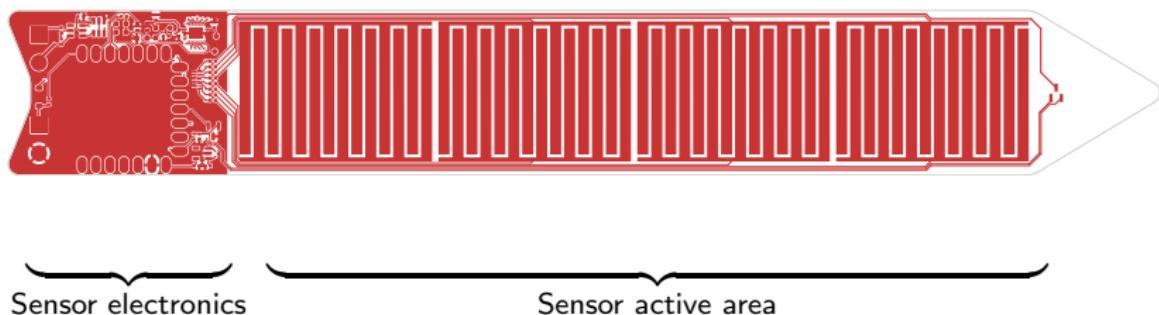
- ▶ LoRa
- ▶ Custom protocol

Zero-maintenance and extensible

- ▶ Solar power
- ▶ OTA updates

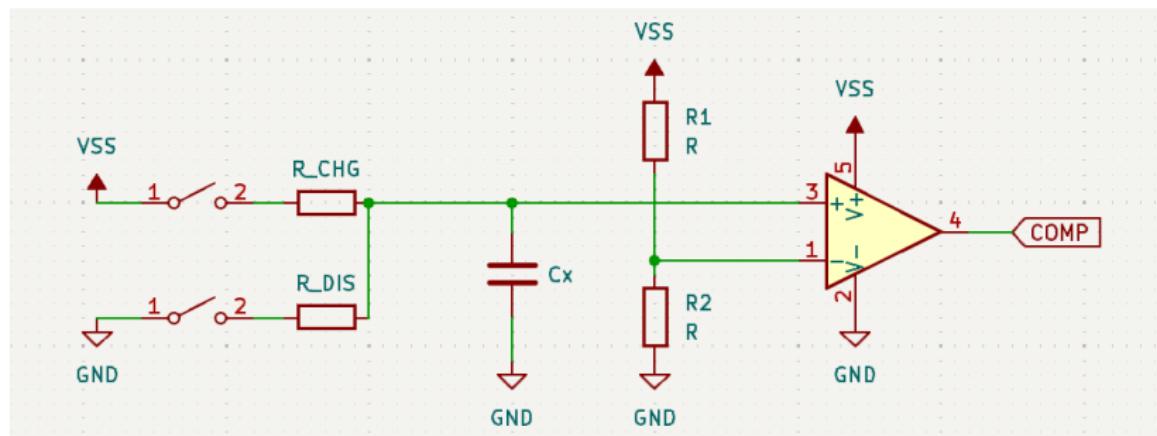
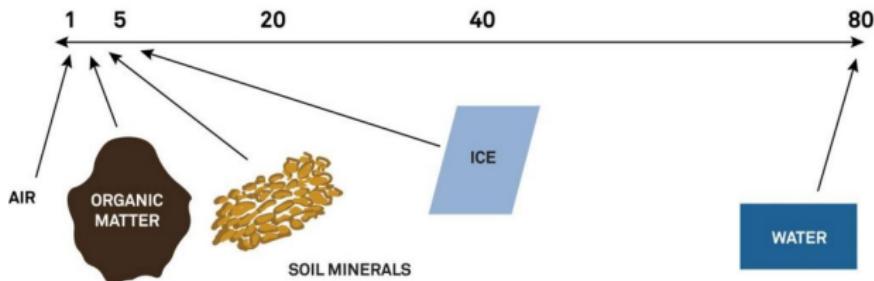
Soil Moisture Sensor

- ▶ PCB construction
- ▶ 4 capacitive zones (15 cm total depth)
- ▶ 330 mAh lithium cell, 150 mWp solar panel

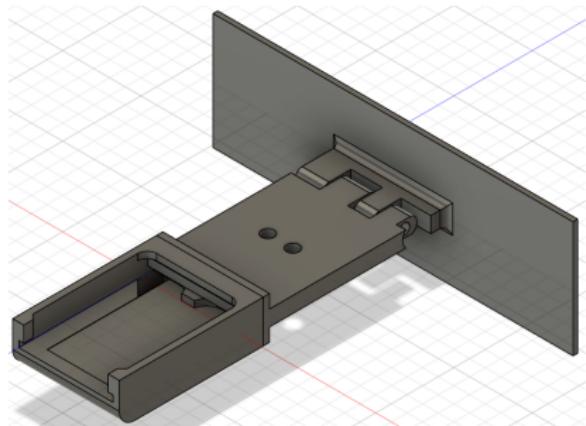


Soil Moisture Sensor

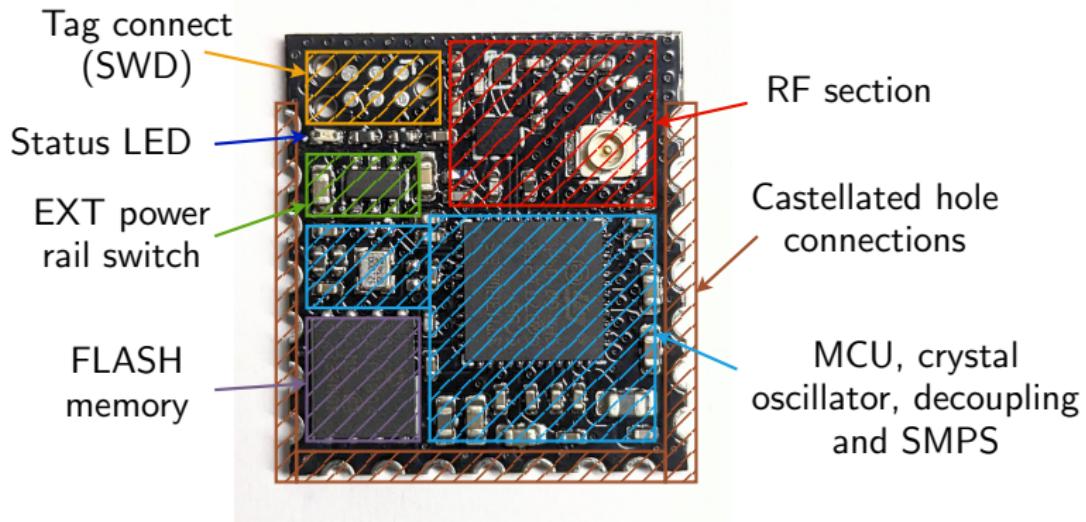
Dielectric constant
of materials found in soil



Soil Moisture Sensor

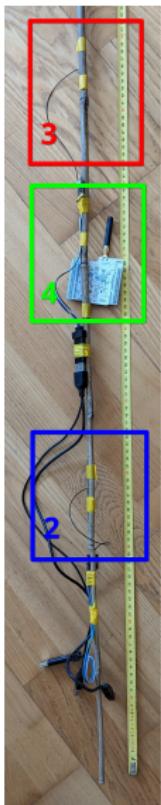


LoRa Module



- ▶ **STM32WLE5CC**
- ▶ 868 MHz, 15 dBm
- ▶ **20.32×22.48 mm**
- ▶ 1 MB FLASH
- ▶ 2.3–3.5 V
- ▶ 16 IO pins

LoRa Module Range Test

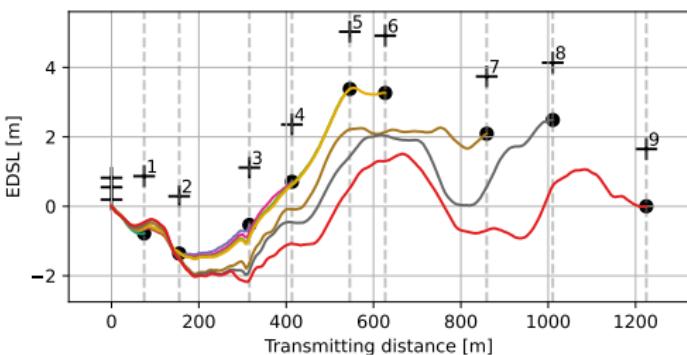
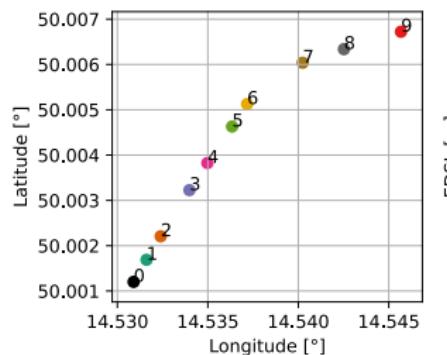
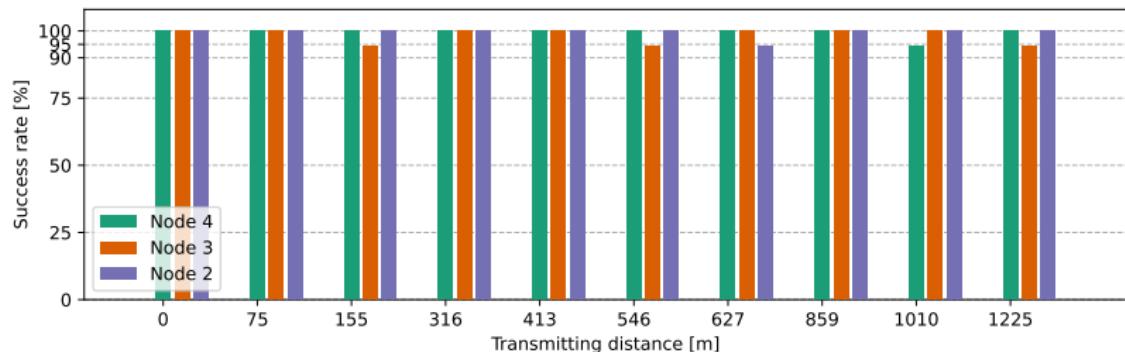


Node 2



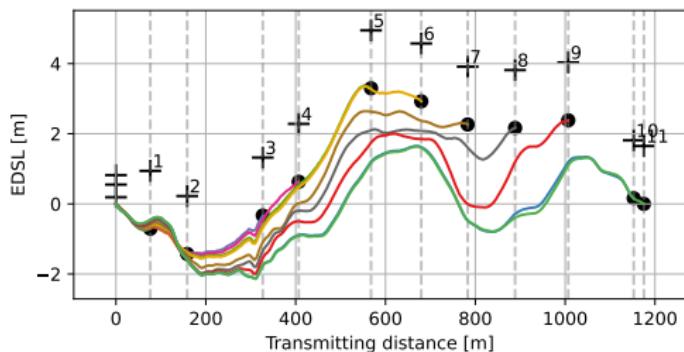
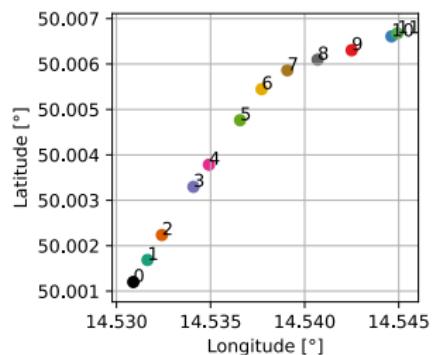
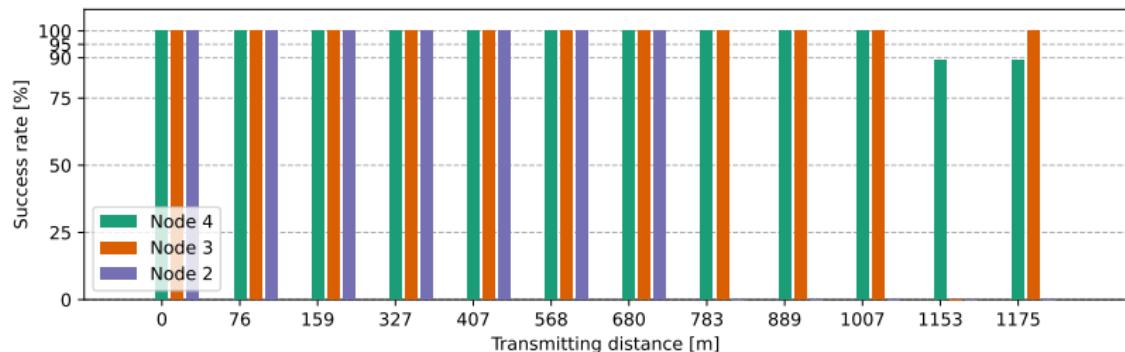
Node 3

LoRa Module Range Test - SF11



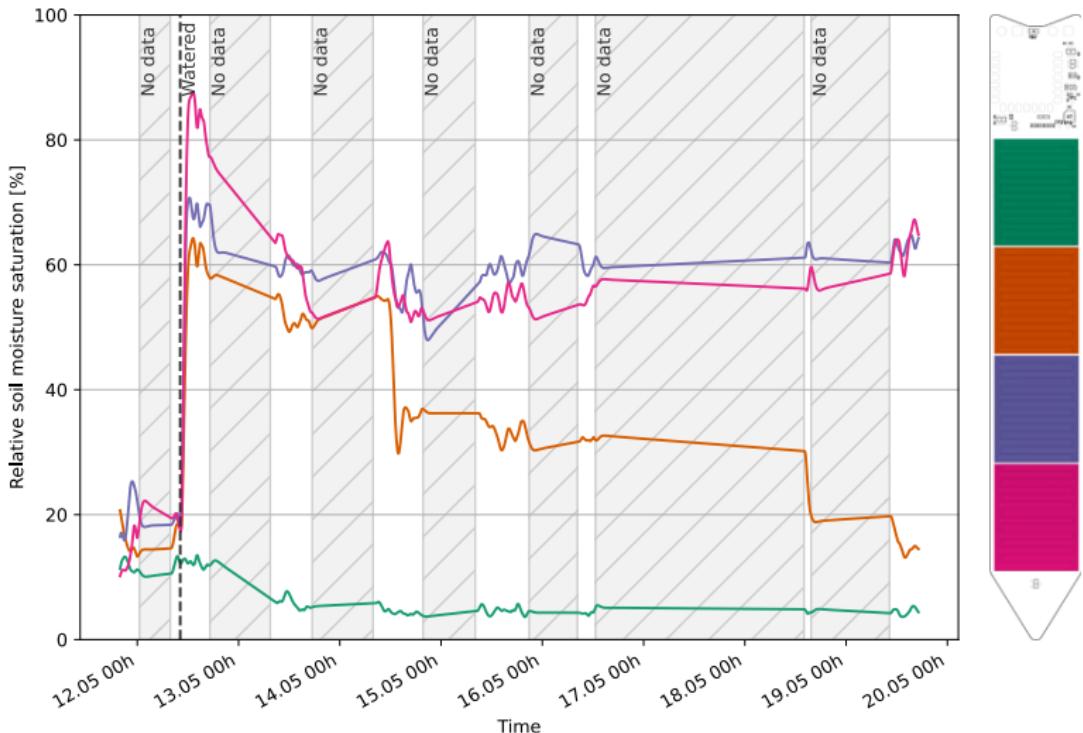
Node 2 - 20 cm, Node 3 - 80 cm, Node 4 (Nucleo) - 50 cm, 1.125 s round-trip, 300 bps, Page 41, Section 4.4.4

LoRa Module Range Test - SF5



Node 2 - 20 cm, Node 3 - 80 cm, Node 4 (Nucleo) - 50 cm, 0.125 s round-trip, 3 kbps, Page 41, Section 4.4.4

Soil Moisture Sensor Validation



Live Demo



(or visit the link)

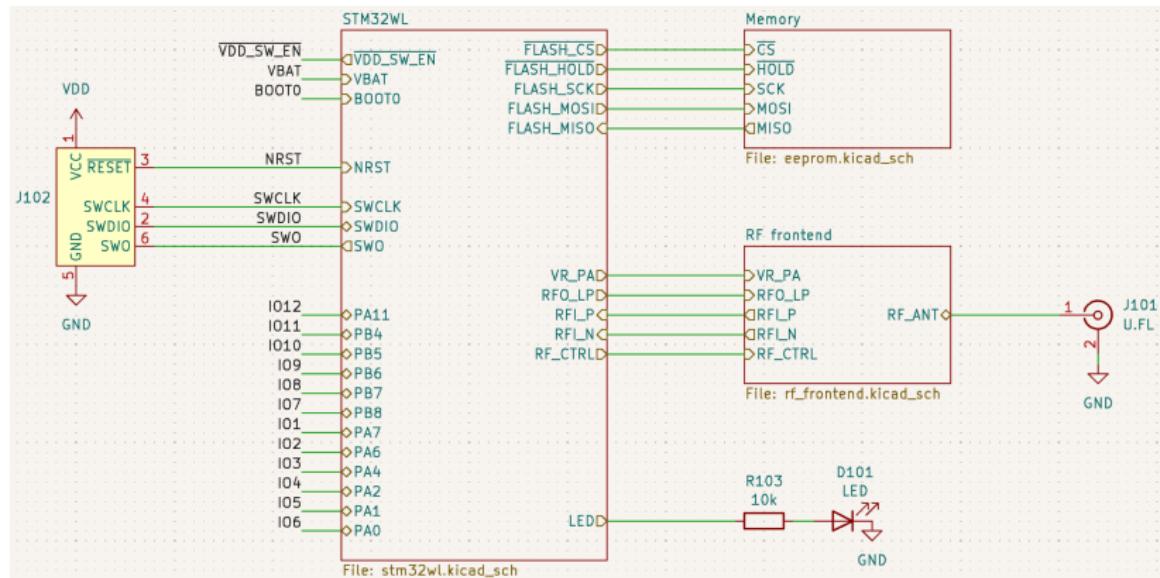
Conclusion

This thesis brought

- ▶ **STM32 LoRa Module - a platform for connected sensors**
- ▶ **Soil moisture sensor - an application of the module**
- ▶ Backend service which processes the sensor data
- ▶ module-runtime Rust package - HAL, OTA, async

All publicly available at <https://github.com/manakjiri>

LoRa Module



LoRa Module



STDES-WL5U4ILH



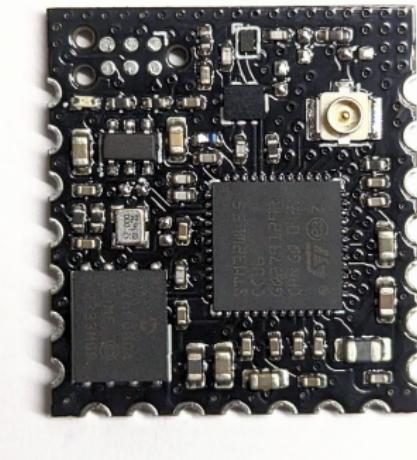
Nucleo-WL55JC

Existing solution?



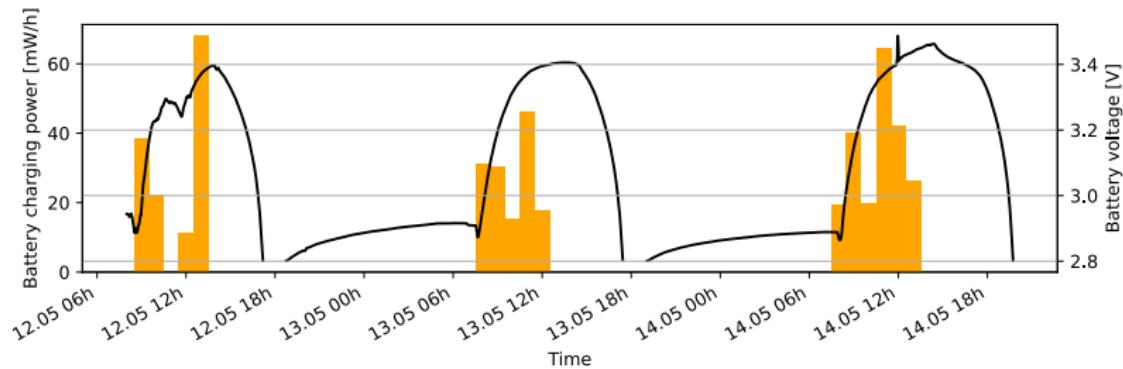
Seeed Studio Wio-E5

>
?
<

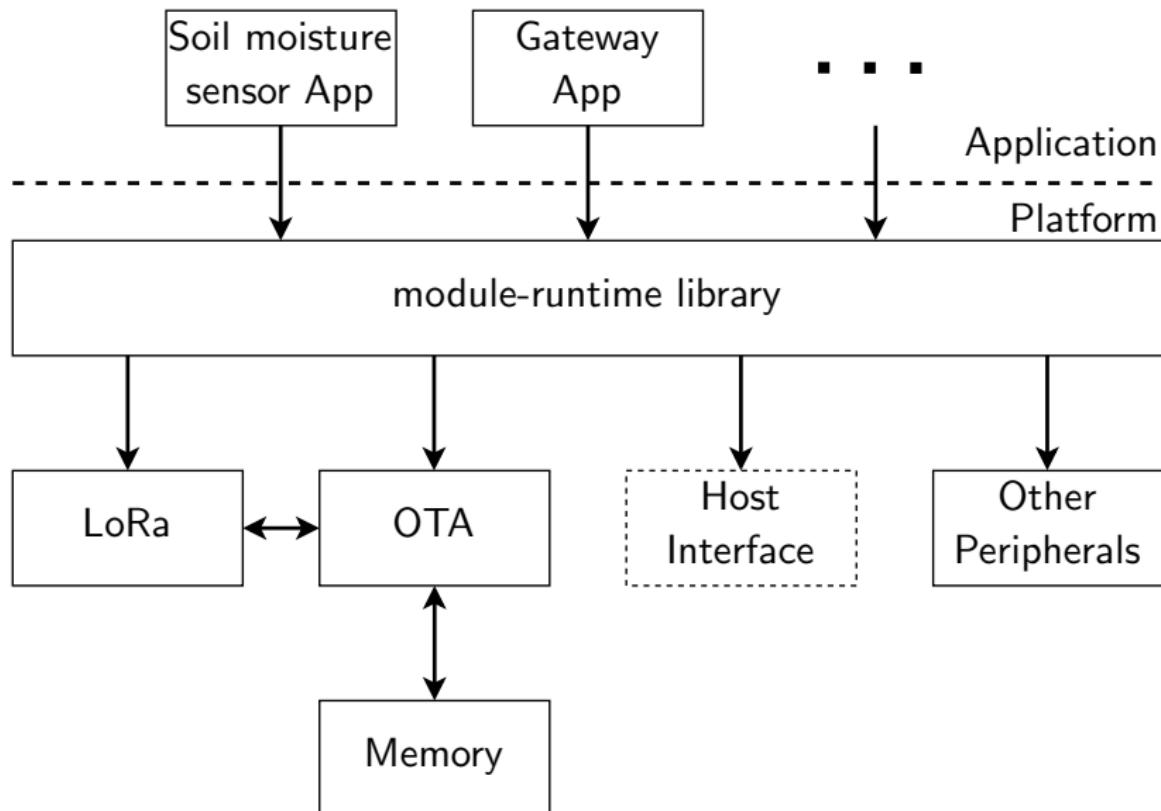


My LoRa Module

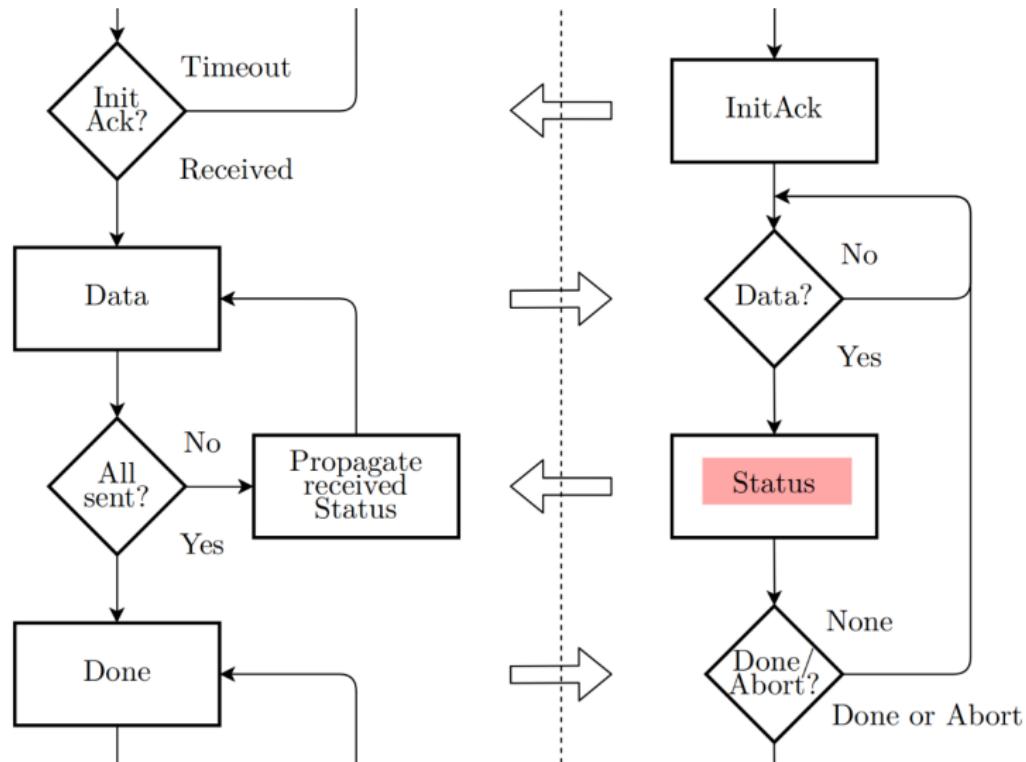
Solar Power



Firmware



Over The Air Update



Page 36, Figure 4.9

LoRa Module

- ▶ 2.8–3.3 V nominal voltage range,
- ▶ low power design - support for switchable power rails,
- ▶ target the EU868,
- ▶ wide temperature range
- ▶ minimize the amount of specialized hardware,
- ▶ support for OTA updates,
- ▶ integrated RF,
- ▶ host communication interface,
- ▶ minimal footprint,
- ▶ low cost.

Page 15, Section 3.2.3