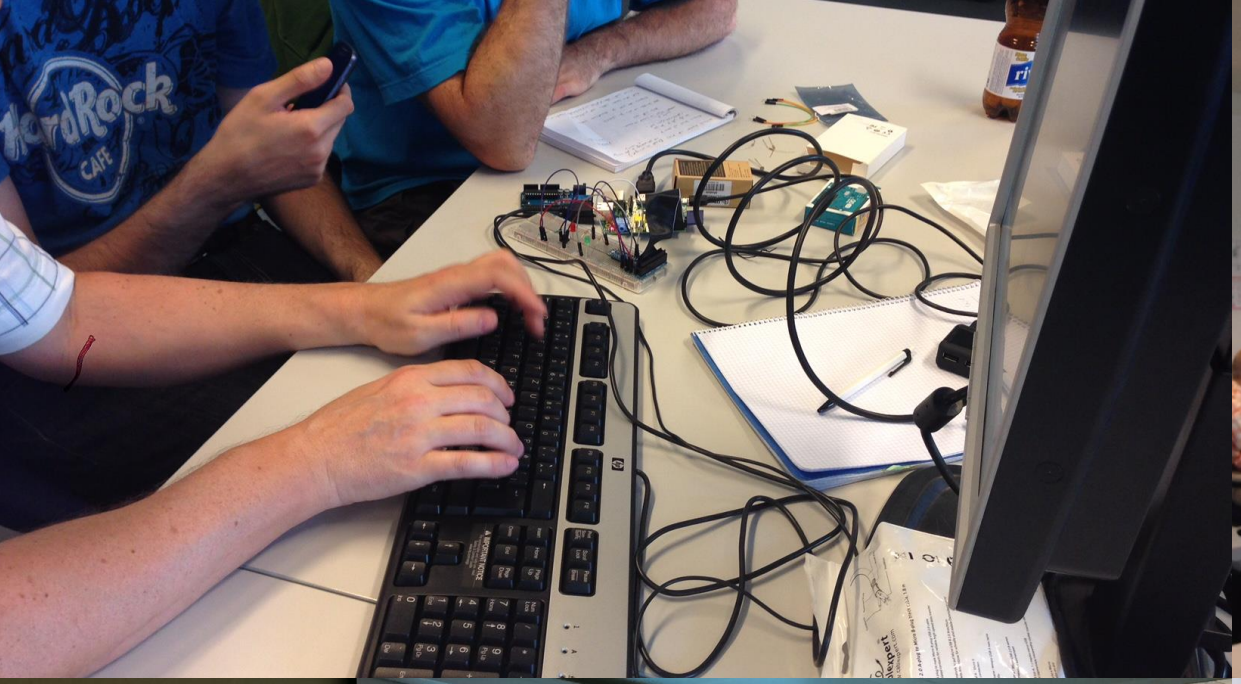
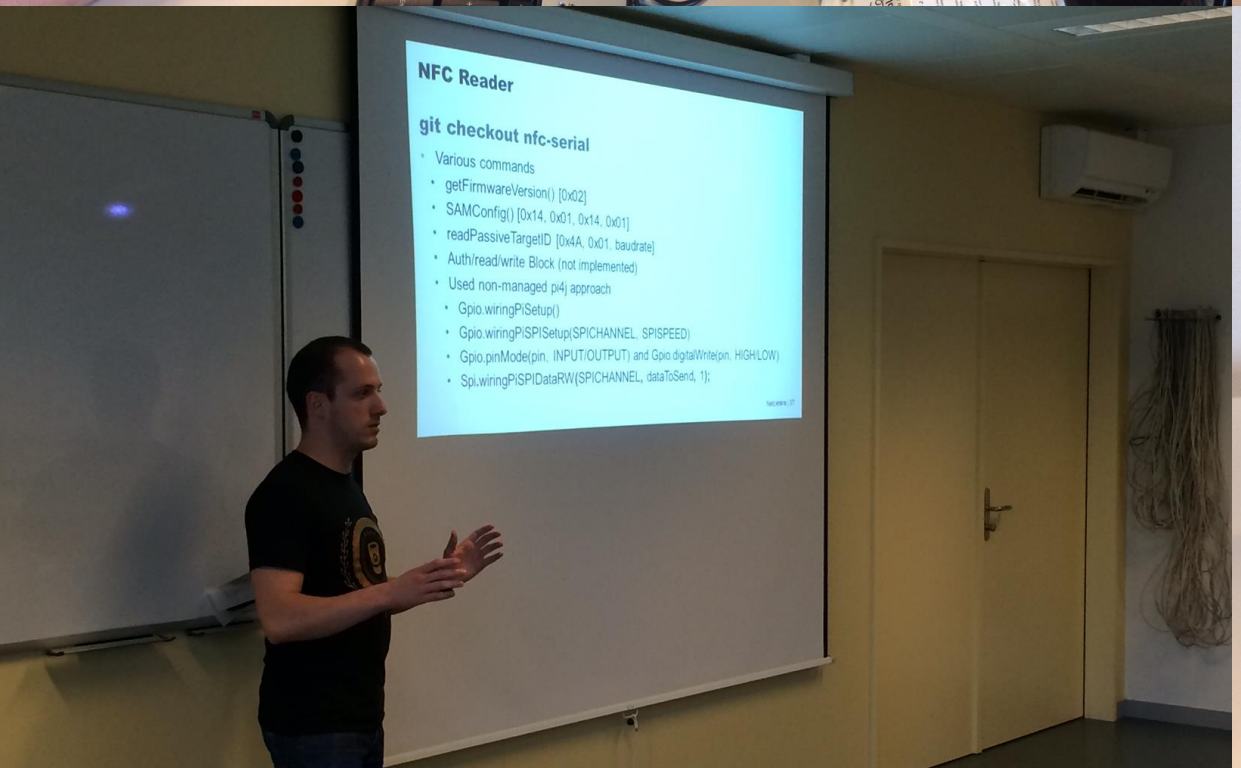
Gluing the IoT world with Java and LoRaWAN

Pance Cavkovski, Netcetera, jug.ch 12.09.2017




NFC Reader
git checkout nfc-serial
Various commands
getFirmwareVersion() [0x02]
SAMConfig() [0x14, 0x01, 0x14, 0x01]
readPassiveTargetID [0x4A, 0x01, baudrate]
Auth/read/write Block (not implemented)
Used non-managed pi4j approach
Gpio.wiringPiSetup()
Gpio.wiringPiSPISetup(SPICHANNEL, SPISPEED)
Gpio.pinMode(pin, INPUT/OUTPUT) and Gpio.digitalWrite(pin, HIGH/LOW)
Spi.wiringPiSPIDataRW(SPICHANNEL, dataToSend, 1);

June 2014

whoami

senior software engineer @ Netcetera

jug.mk Leader

codefu.mk admin

hardware & IoT enthusiast

TTN SK initiator

http://pance.mk/ and @hsilomedus

JUGMK
JAVASKOP
Hall 6
Hall 5
09:10 Managers and Customers – The missing manual — Corsin Decurtins, Netcetera
09:50 Coffee Break
10:10 Do not make the Monolith great again! — Dimitar Siljanovski, Cuponation
10:50 Break
11:10 How reactive do we need to be — Jana Karcheska, Netcetera
11:30 Break
11:40 How to deploy Dockerized apps to AWS ElasticBeanstalk — Pavel Bely, Seavus
12:00 Lunch break
12:50 Flux your App via Redux — Petar Blazhevski, Polarcape
12:50
13:00 How I learned to stop worrying and love the Monolith — Nikola Zhivkov, Seavus
13:40 Coffee & Energy Break
14:00 From Zero to Production in 1 conference talk time — Milen Dyankov, Liferay
14:40 Break
15:00 How to register and login into a system — Marjan Kindalov, Netcetera
15:20 Break
15:30 AWS Lambda using Serverless — Goran Kopevski, Cuponation
15:50 Break
16:00 Java 9 Project Jigsaw — Katerina Doneva, Seavus
16:40 Closing — Tomche Delev, jug.mk
17:00 Networking & Beer
Building your smarthome with openHAB, RasberryPi and Arduino — Miki Jankov, Musala soft
Break
Spring Boot SSO in 15 min — Sashko Peshevski, Polarcape
Break
Reccomender systems: What, Why, How — Gorjan Zajkovski, Netcetera
Lunch break
Network Applications with Apache MINA — Branislav Bajlovski, Sourcico
Agile testing: why the tester is your best friend ever! — Michael Drost, Tricode
Coffee & Energy Break
Test easy and prosper with Spock Framework — Tomche Delev, FINKI
Break
MicroProfile quick start — Ivan St. Ivanov, VIDA Software
Break
Javaslang – Achieve functionally eloquence with Java8 — Blagoj Atanasovski, Sorsix
JAVASKOP

The Missing Manual
Netcetera

redis

In the agenda for today

LoRaWAN crash-course

Hardware prototyping

Rules & Architecture for IoT systems

Software Development

Extras

Warning

The video you're about to see is made completely by a software developer, and it is for demonstration purposes only.

If something similar is to meet the general public, it ***will*** be re-implemented by a trained professional ☺

SkopjePulse

Problems

- **extreme air pollution**
- excessive urban noise
- flash floods

No clear means for improvement

Solution

- leverage technology
- crowdsourced sensor network
- data analysis and availability
- warnings
- clearer insights and basis for action

https://skopjepulse.mk/faq

LoRaWAN

Crash-course

LoRa

Long**Ra**nge

Chirp Spread-spectrum radio modulation (~ OSI physical layer)

Low-power, long-range, low-cost communication enabler

Proprietary by **Semtech**

Can work on license-free ISM bands (433, **868**, 915 MHz)

Multiple channels, multiple spreading factors

LoRaWAN

Long **Ra**nge **W**ide **A**rea **N**etwork

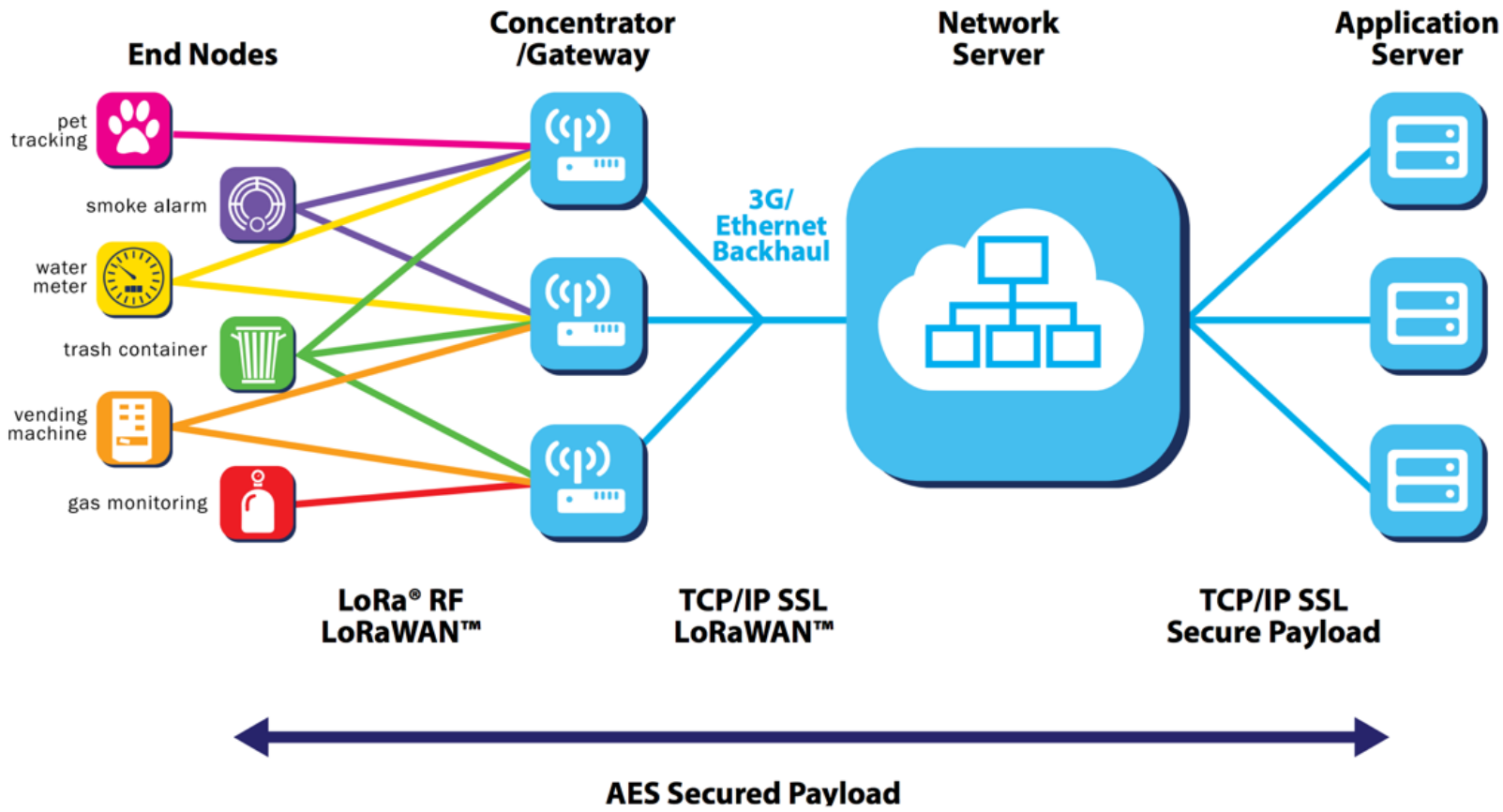
MAC layer on top of LoRa

De-facto the new IoT communication standard

Specification and development guided by LoRa Alliance

http://www.semtech.com/wireless-rf/internet-of-things/what-is-lora/

Architecture



Limitations

Low-Speed: 250 – 5470 bps (configurable with SF and BW, distance dependable)

Very small packages: (by provider) ~ 20 bytes

Less frequent: (by provider): 2-200 up/ 1-10 down

Class A LoRaWAN devices

One Uplink followed by two downlink windows (at 1s period)

OTAA or ABP authorization

Can be done with:

- RN2483 chip and sending MAC commands.
- RFM95w or similar with the LMIC library

LoRaWAN MAC example

mac reset 868

mac set rx2 3 869525000

mac set devaddr **<devaddr>**

mac set appskey **<appSkey>**

mac set nwkskey **<nwkSkey>**

mac set adr off

mac set ar off

…

…

mac set pwridx 1

mac set dr **<datarate>** (0 to 5)

mac save

mac join abp

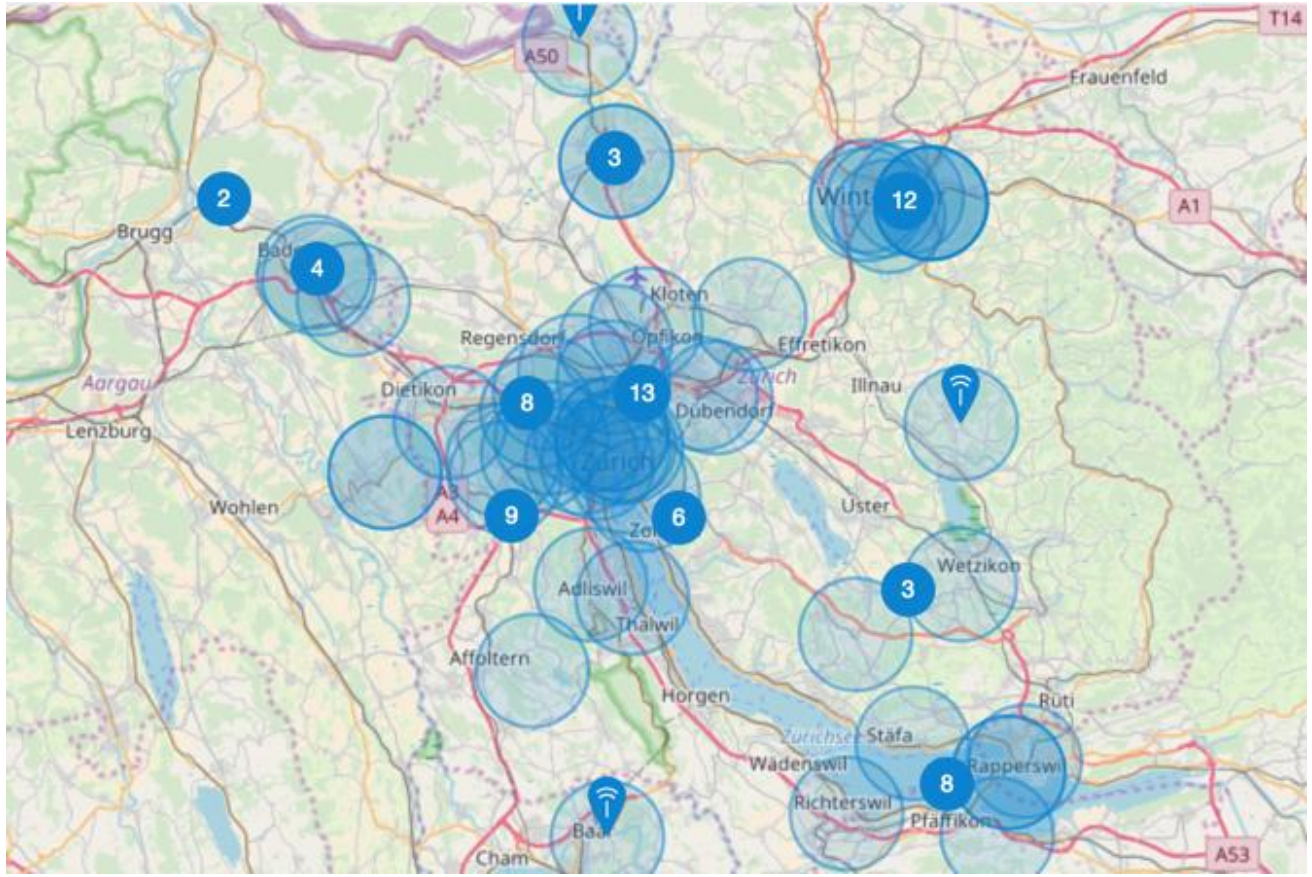
mac tx uncnf 1 **<dataToSend>**

TheThingsNetwork

Global, crowdsourced Internet
Of Things data network:

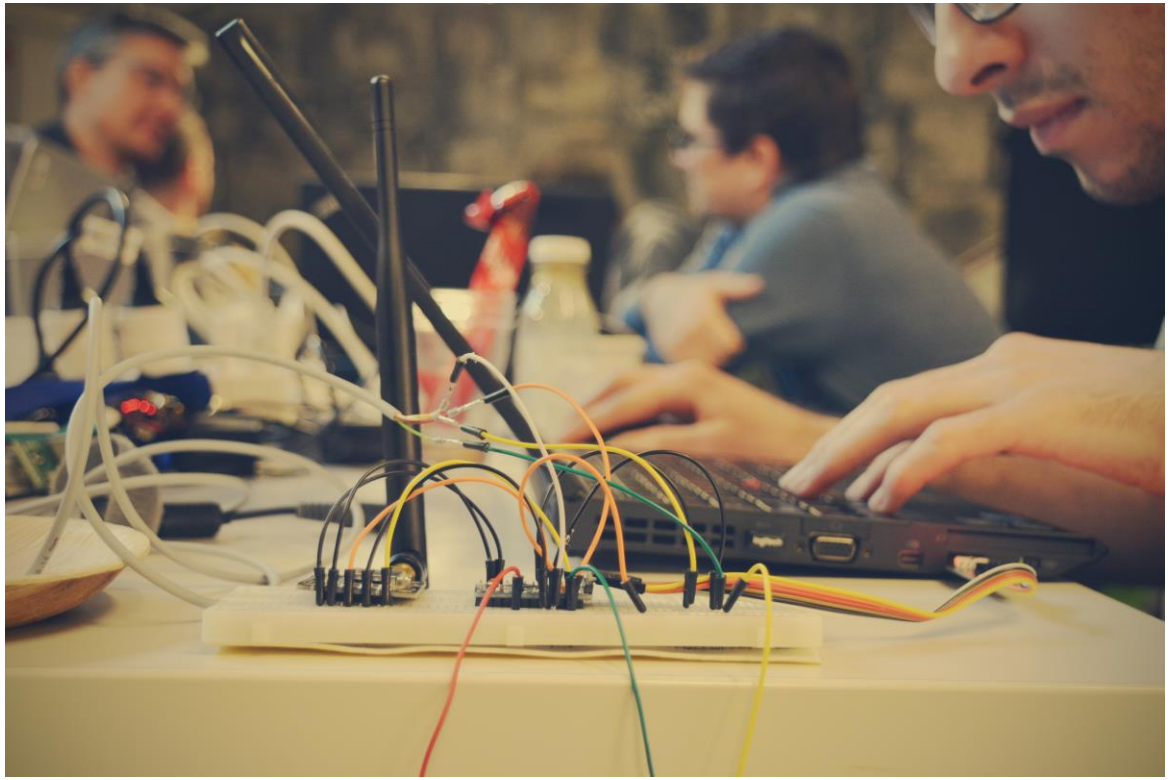
- community driven
- provided network/back-end
- free (fair use)
- LoRaWAN as base tech.

TheThingsNetwork - Zurich



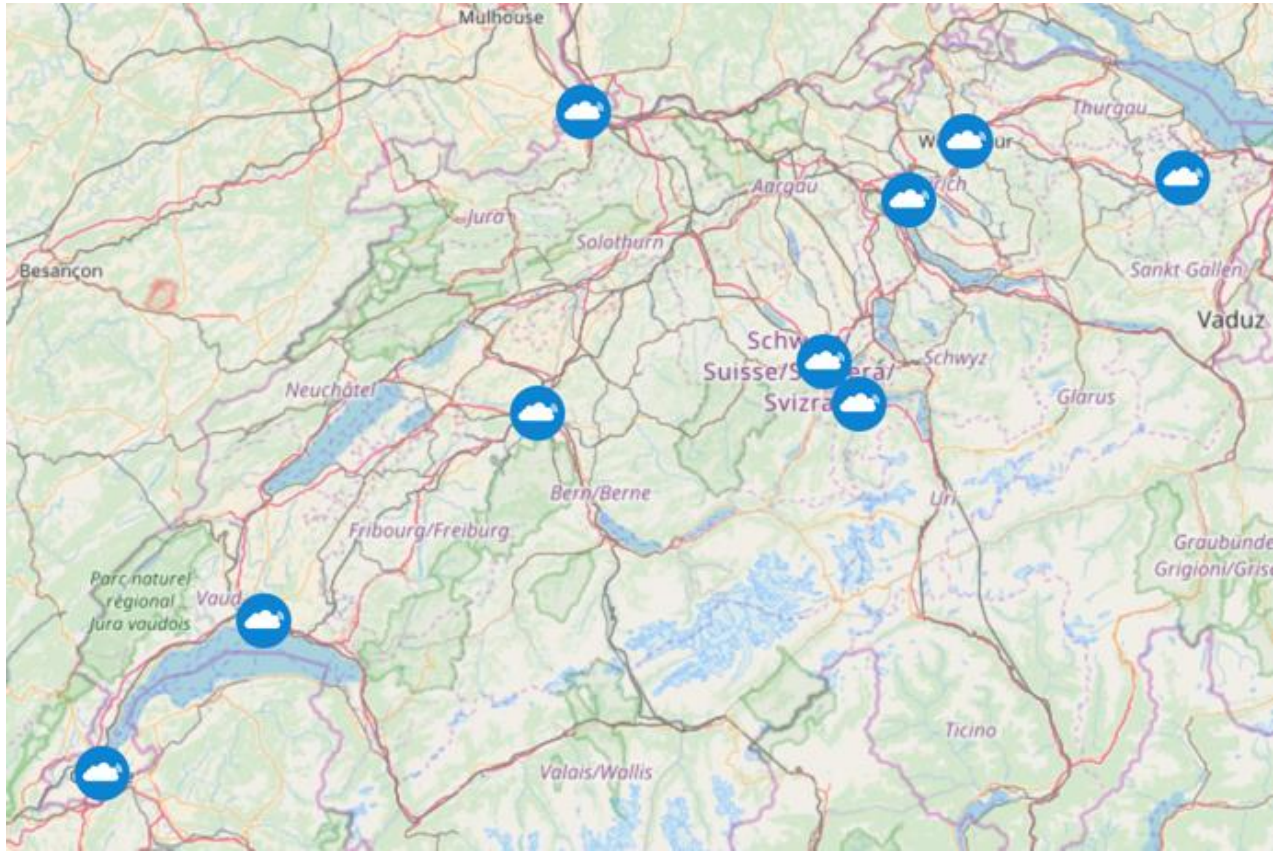
https://www.thethingsnetwork.org/community/zurich/

MakeZurich



https://makezurich.ch/

TheThingsNetwork - Switzerland



https://www.thethingsnetwork.org/country/switzerland/

TheThingsNetwork ZH - Contact

Gonzalo Casas

TTN ZH Initiator

https://www.thethingsnetwork.org/u/gonzalo

https://twitter.com/gnz

How to use TTN

Register at https://console.thethingsnetwork.org/

- Applications / devices
- Keys, UIDs, credentials
- Plugins / Integrations

Also in Switzerland

Swisscom LPN: http://lpn.swisscom.ch/e/

- Nationwide LoRa coverage
- Different offers based on intended traffic

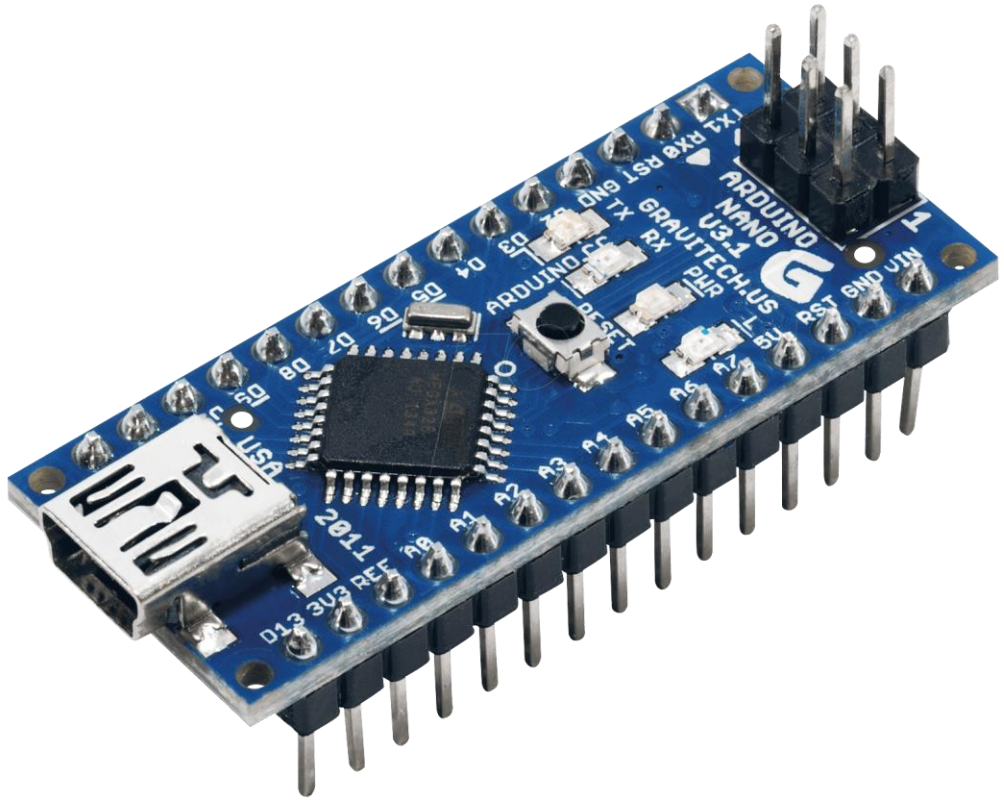
Loriot

- provide distributed backend
- you provide the network devices and coverage

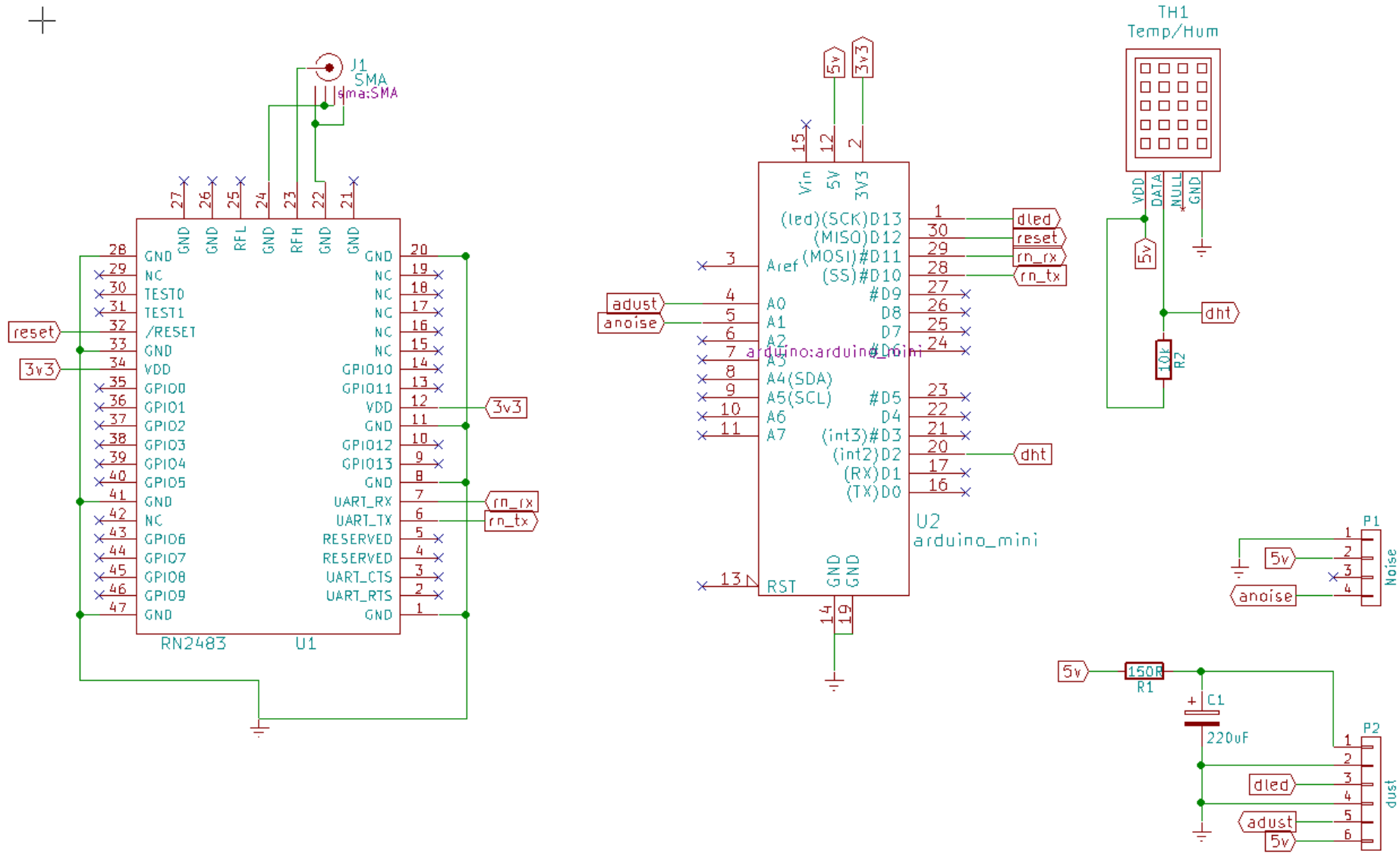
Hardware

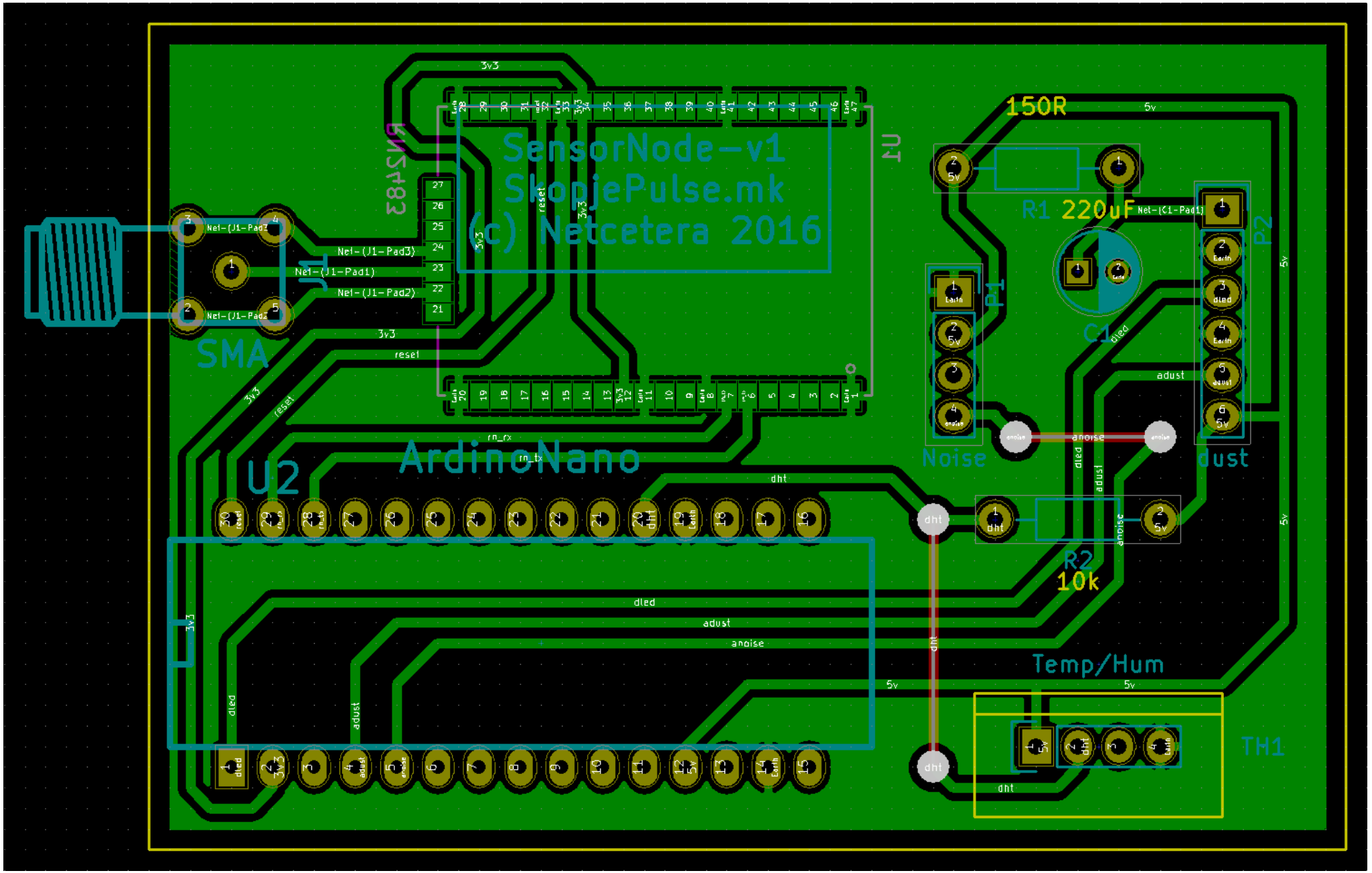
Prototyping and coding

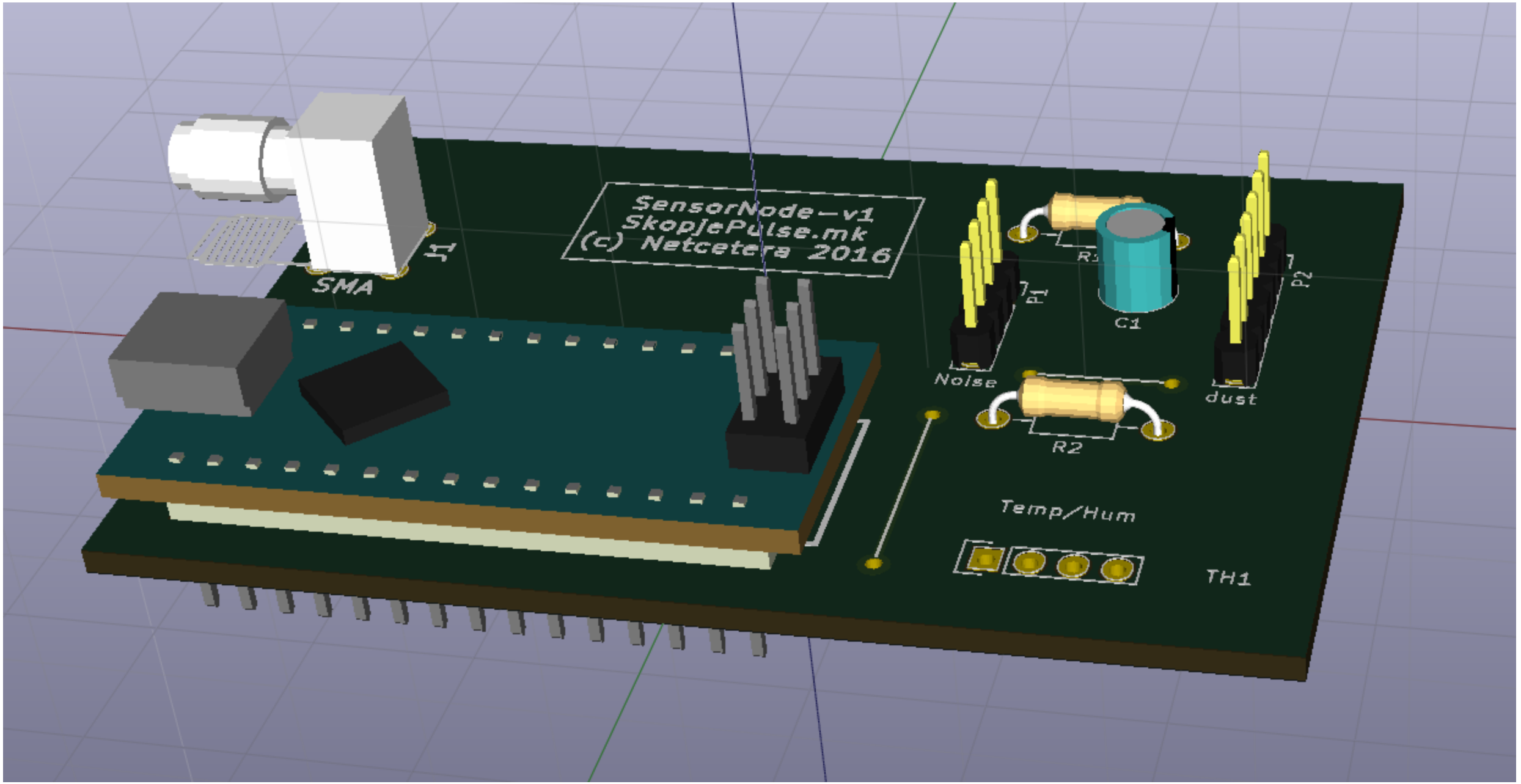
The basic package

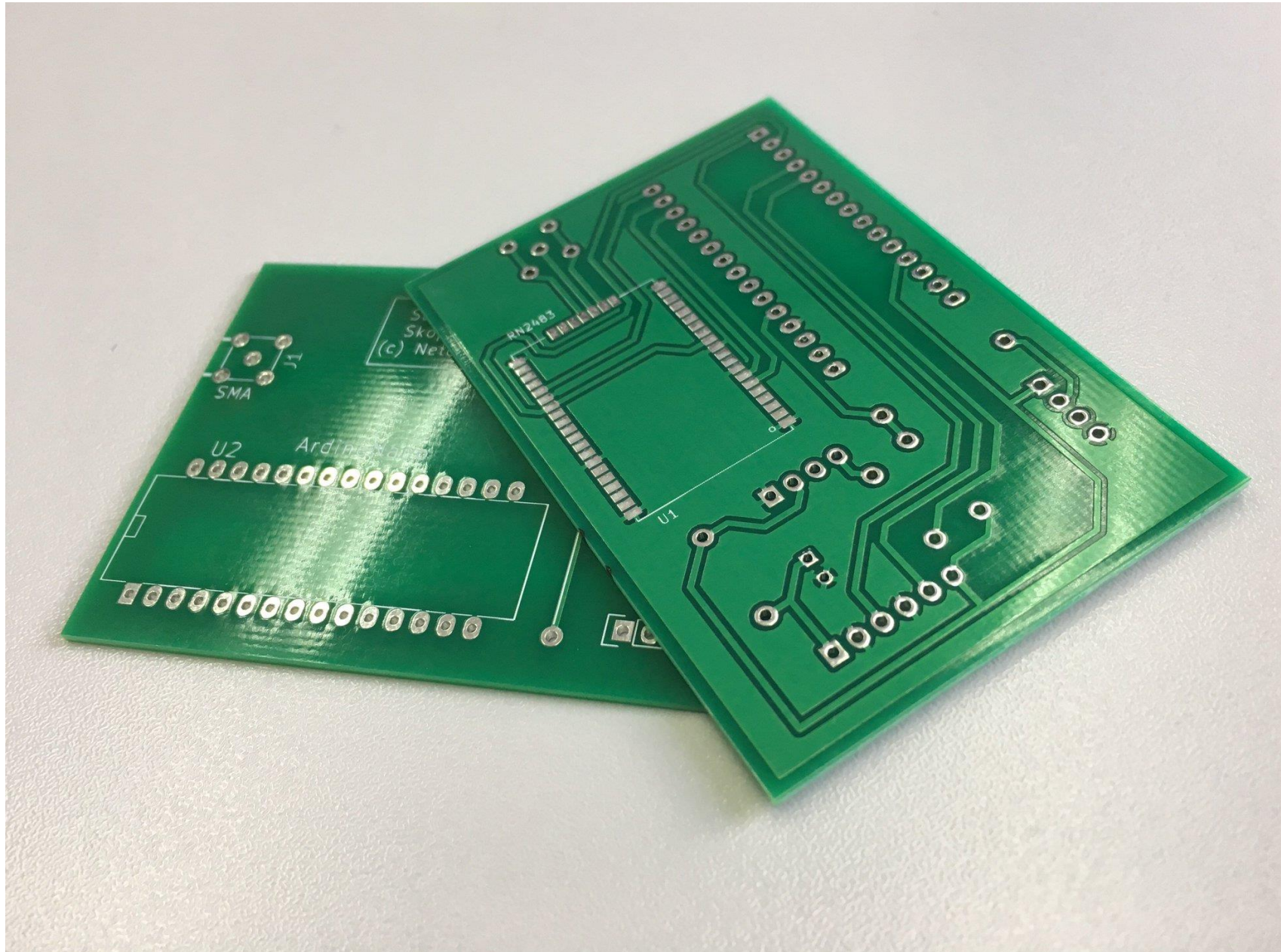


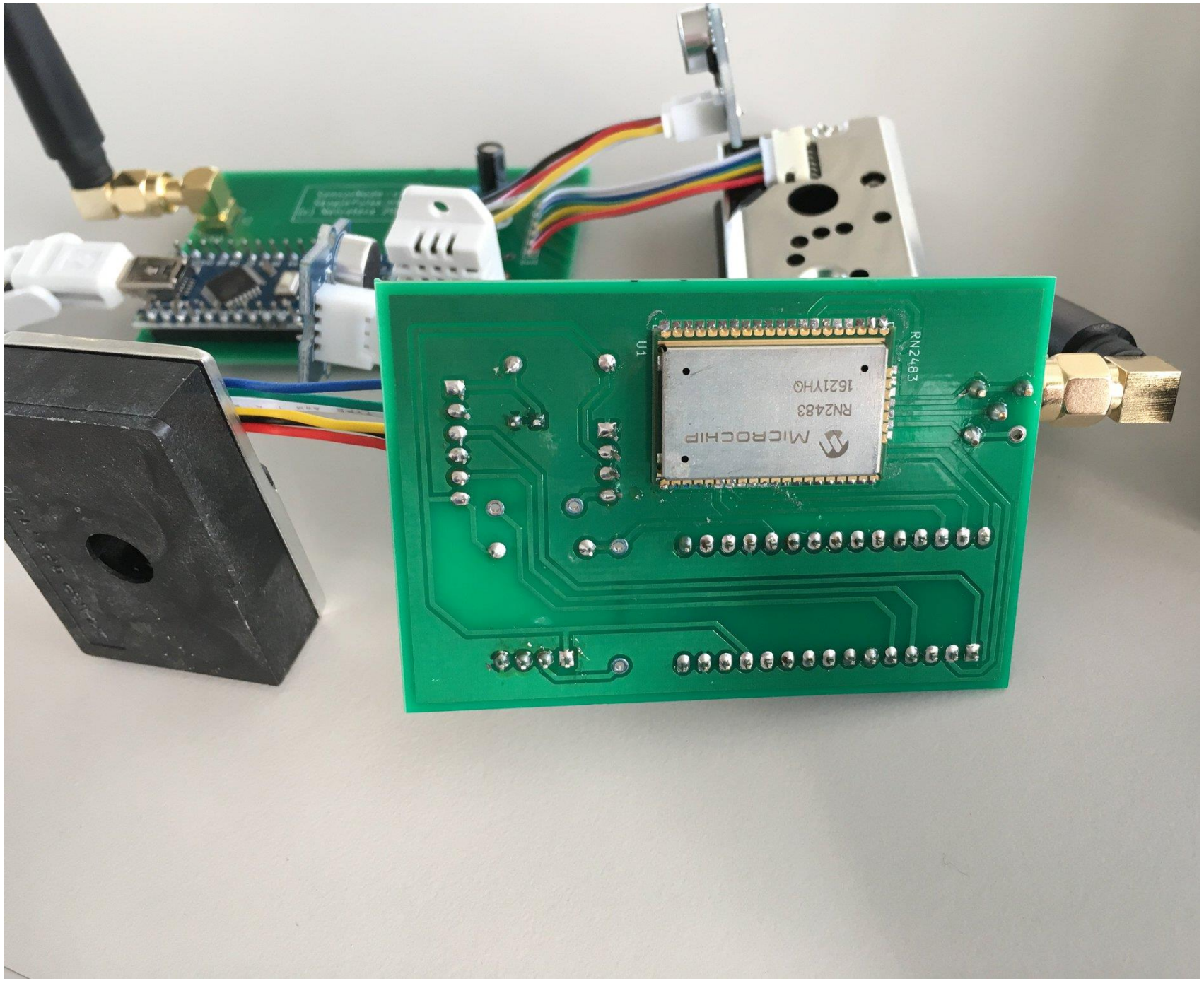
KiCad


J1
SMA
sma:SMA
RN2483
U1
reset
3v3
rn_rx
rn_tx
U2
arduino_mini
adust
anoise
dled
dht
TH1
Temp/Hum
VDD
DATA
NULL
GND
10k
R2
P1
Noise
150R
R1
C1
220uF
P2
dust

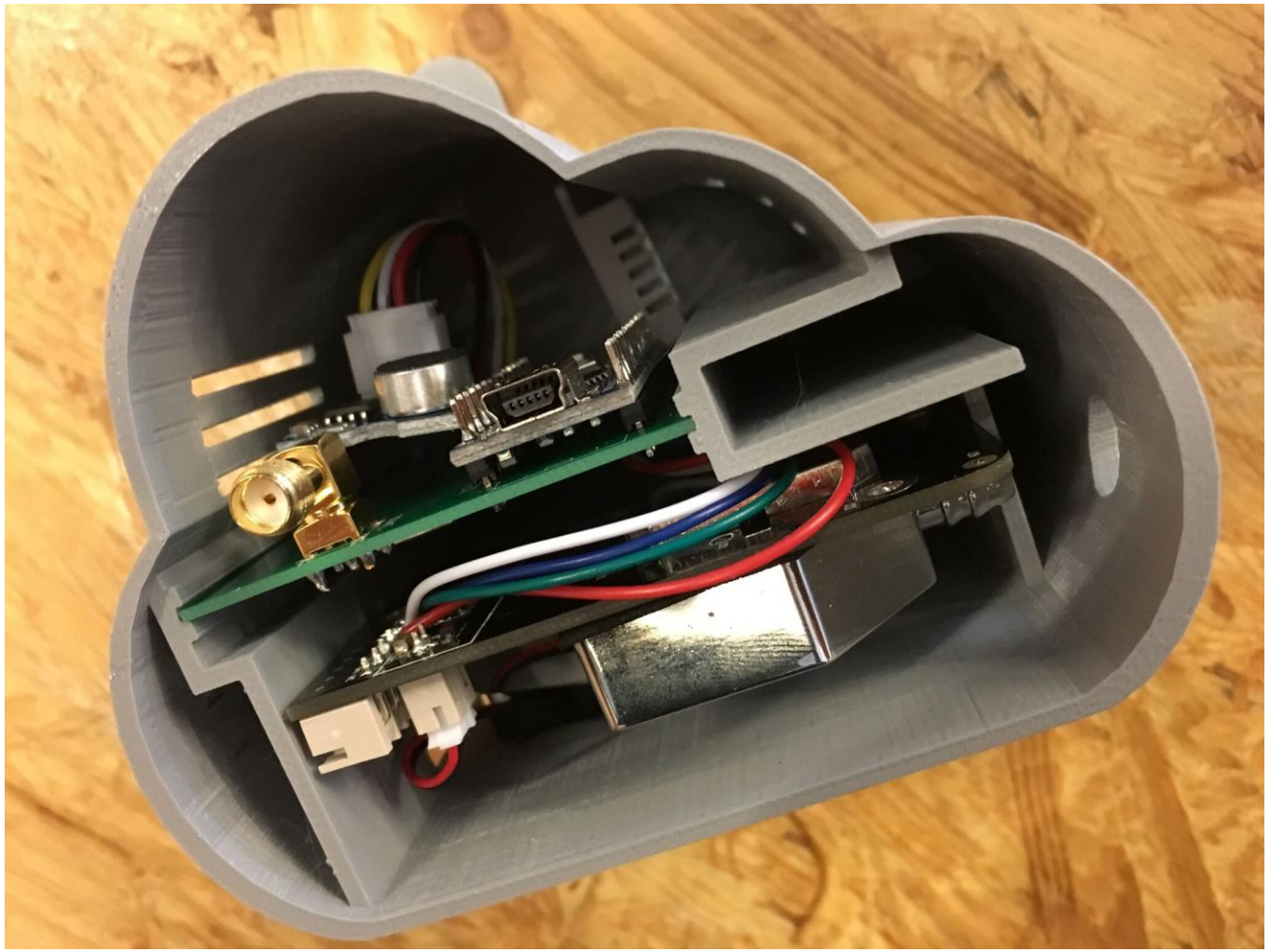

SensorNode-v1
SkopjePulse.mk
(c) Netcetera 2016
SMA
ArdinoNano
U2
150R
R1 220uF
C1
R2
10k
Noise
dust
Temp/Hum
TH1
P1
P2
3v3
reset
dht
dled
adust
anoise
5v


SensorNode—v1
SkopjePulse.mk
(c) Netcetera 2016
SMA
H1
P1
C1
P2
Noise
dust
R2
Temp/Hum
TH1


J1
SMA
U2
RN2483
U1


U1
RN2483
MICROCHIP
RN2483
1621YHQ

And finally



Embedded Development

Arduino C

Restricted environment (16MHz, 32KB flash, 2KB memory)

Perpetual non-observed execution

Rules & architecture

How to build an IoT system

Decouple

Clear separation of concern

- data acquisition and transmission
- data offering
- web
- analytics / processing

Robustness, resilience, scaling, fallbacks

tl;dr: containers and orchestrators

Optimize

(almost) No overhead

- binary protocols
- always on
- react and store fast
- short physical distance

*** Optimized MQTT is a good way to go.**

Store

IoT data is almost always time-series based

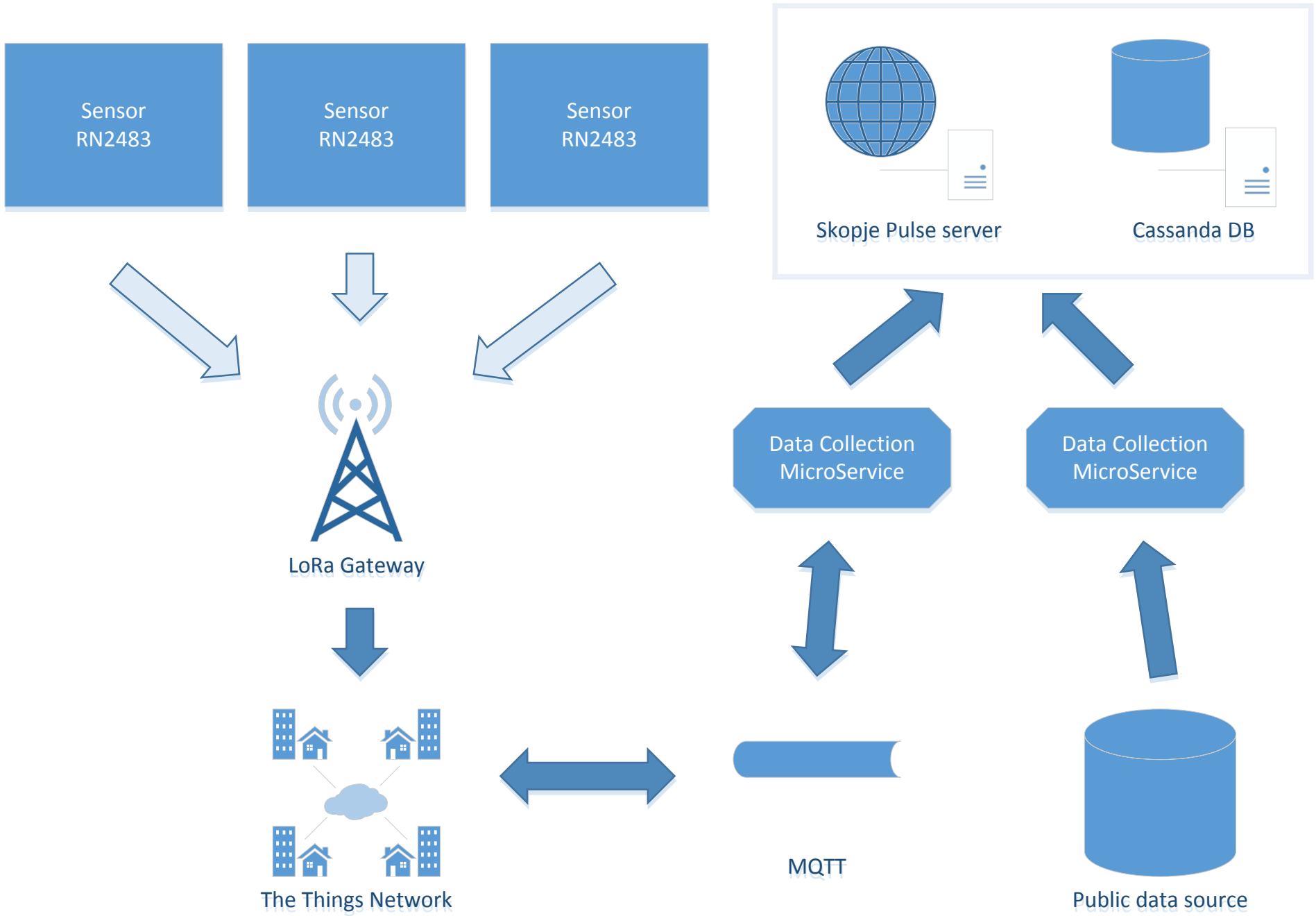
Redundant and impartial data

Append only

Don’t aggregate, but process

Live with eventual consistency

*** Apache Cassandra is a good way to go**


Sensor
RN2483
Sensor
RN2483
Sensor
RN2483
Skopje Pulse server
Cassanda DB
LoRa Gateway
Data Collection
MicroService
Data Collection
MicroService
The Things Network
MQTT
Public data source

Software development

Putting everything together

Getting to TTN

Spring Boot + Eclipse Paho client + Gson

- *@Component* client implementing *MqttCallback*
- connect in *@PostConstruct*
- *@Scheduled(fixedrate = …)* watchdog *@Component*

Details on MQTT URL, credentials and message formats:

https://www.thethingsnetwork.org/docs/network/migrate.html#mqtt

Storing data

Spring Boot + Cassandra Driver Core + Extras

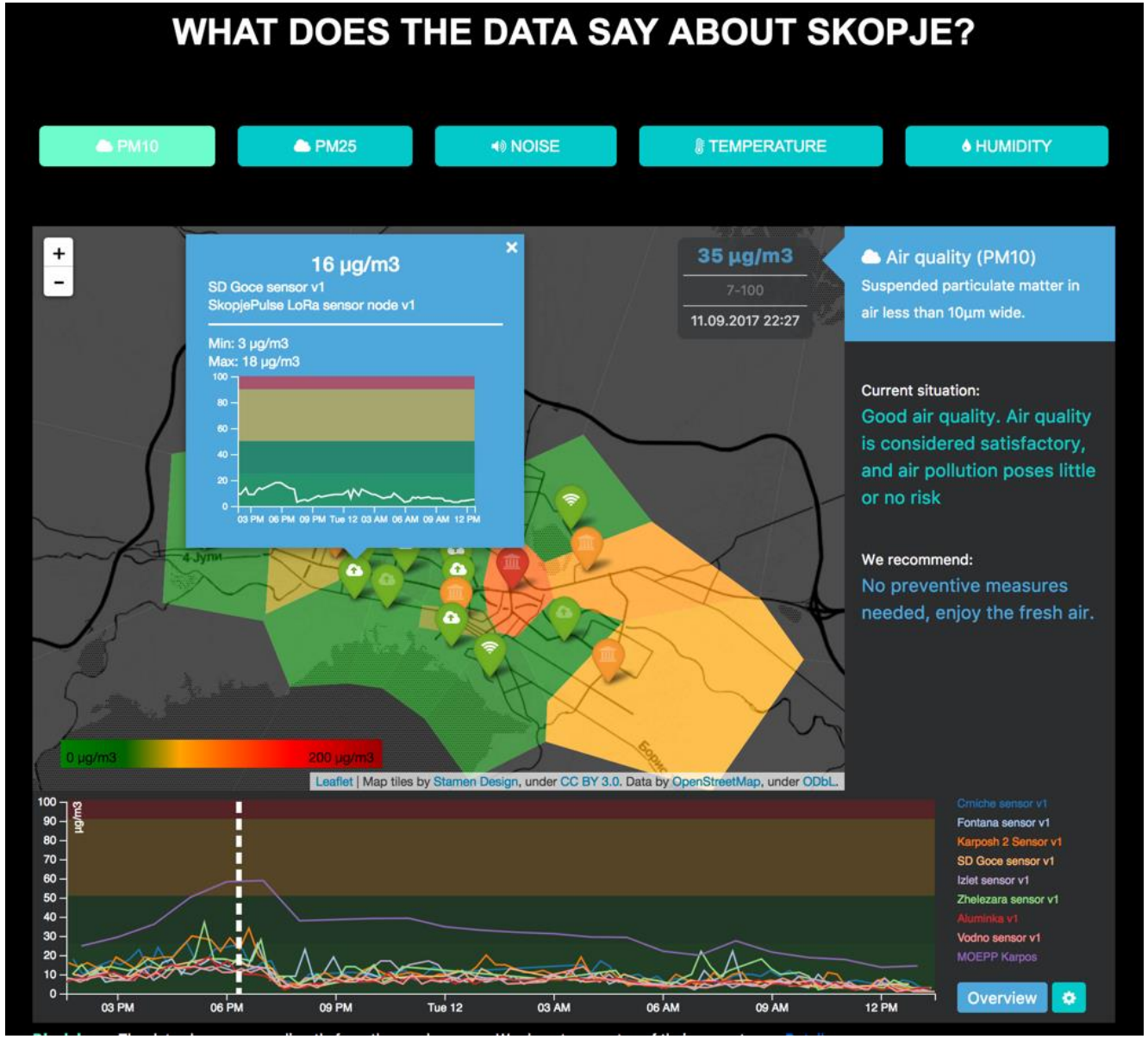
- Cassandra *Cluster* wrapped in *@Service*
- *InstantCodec* for java.time interoperability
- *QueryBuilder*
- No data filtering.

spring-data-cassandra seems like a poor choice.

Web (public)

Interactive cockpit on landing page

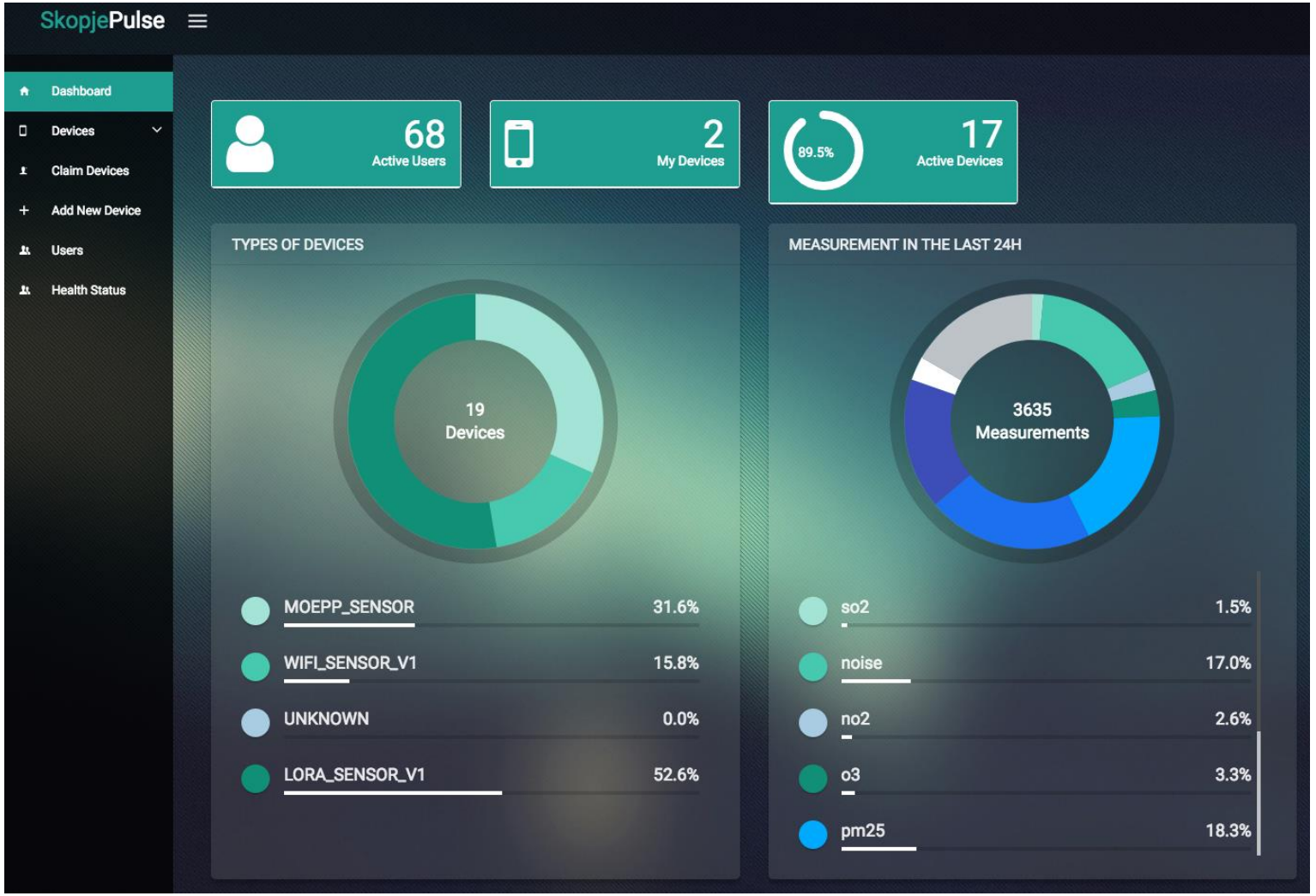
- **d3js** client-side visualizations
- **leaflet** + OpenStreetMap + Stamen



Web (admin)

Full-blown SPA

- Angular2
- ng2-admin
- SpringMVC



Extras

Additions, currently in the oven, inspirations and insights

WiFi devices

Where you ***really*** can’t do LoRaWAN

- ESP8266 powered device
- use TLS!!!
- provision device address securely
- implement own address -> key mapping

More: http://pance.mk/index.php/securing-esp8266-communication/

In the oven 1

Nostradamus – Time-series forecast service

- trainer + executor based on Python + StatsModels + Pandas & ARIMA.

Averaging service

- periodically scheduled scenarios, processing and decisions

Watchdog – sanity checker

- notifies sensor downtime and data irregularities

Water level sensors

- still in early phase. Based on water or sonic sensors.

In the oven 2

Notifications and warning service

- periodically analyses recent data
- sends digests to users
- filters out excessive situations and sends out warnings
- tweets for every digest and warning

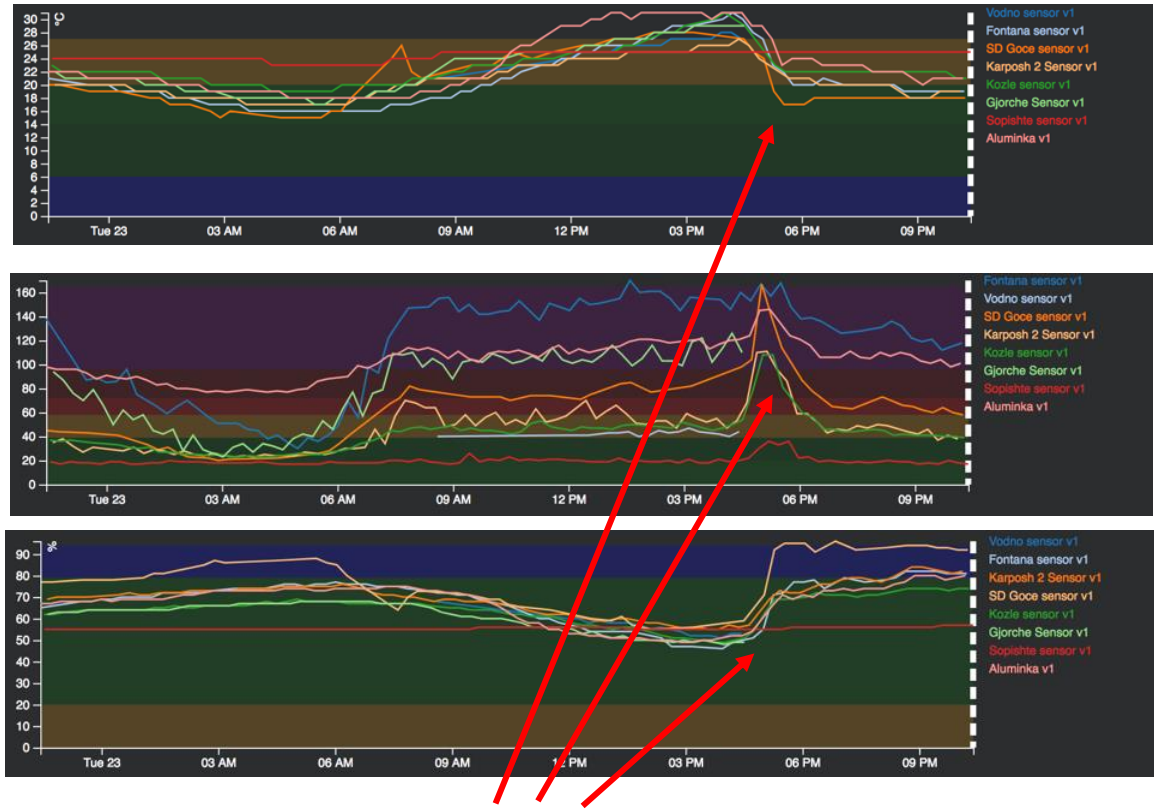
Story 1: Hardware (dis)trust

Carefully select and inspect sensors

Test for correctness (if possible)

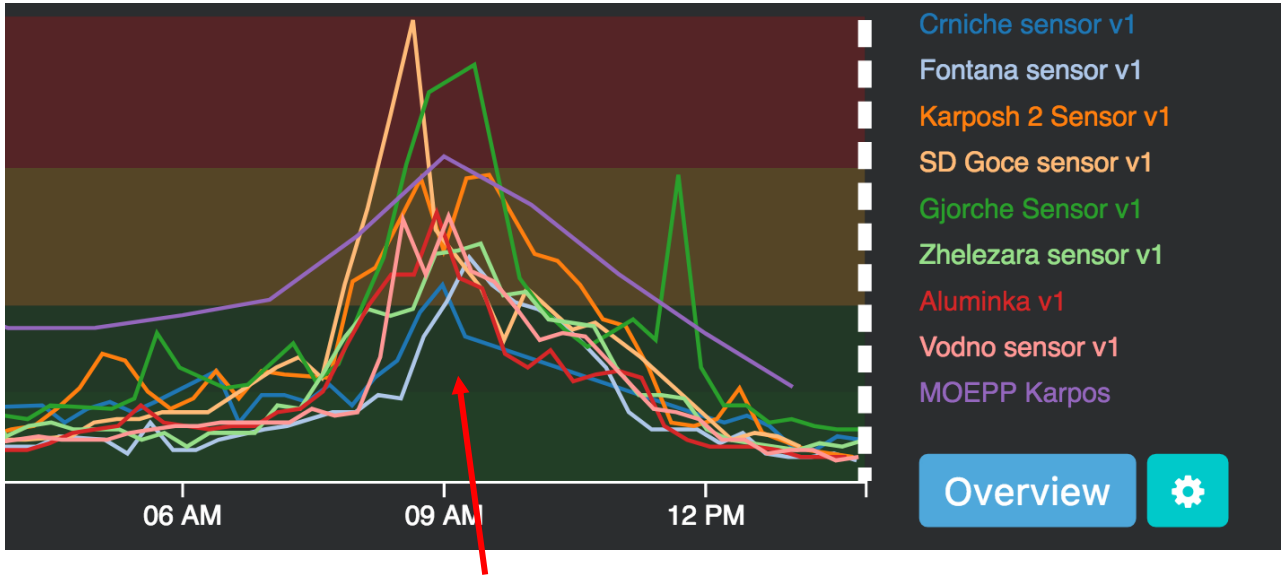
Beware of factory defects (cold sensitive RN2483)

Story 2: When it’s more than a number



Thunderstorm

PM10:

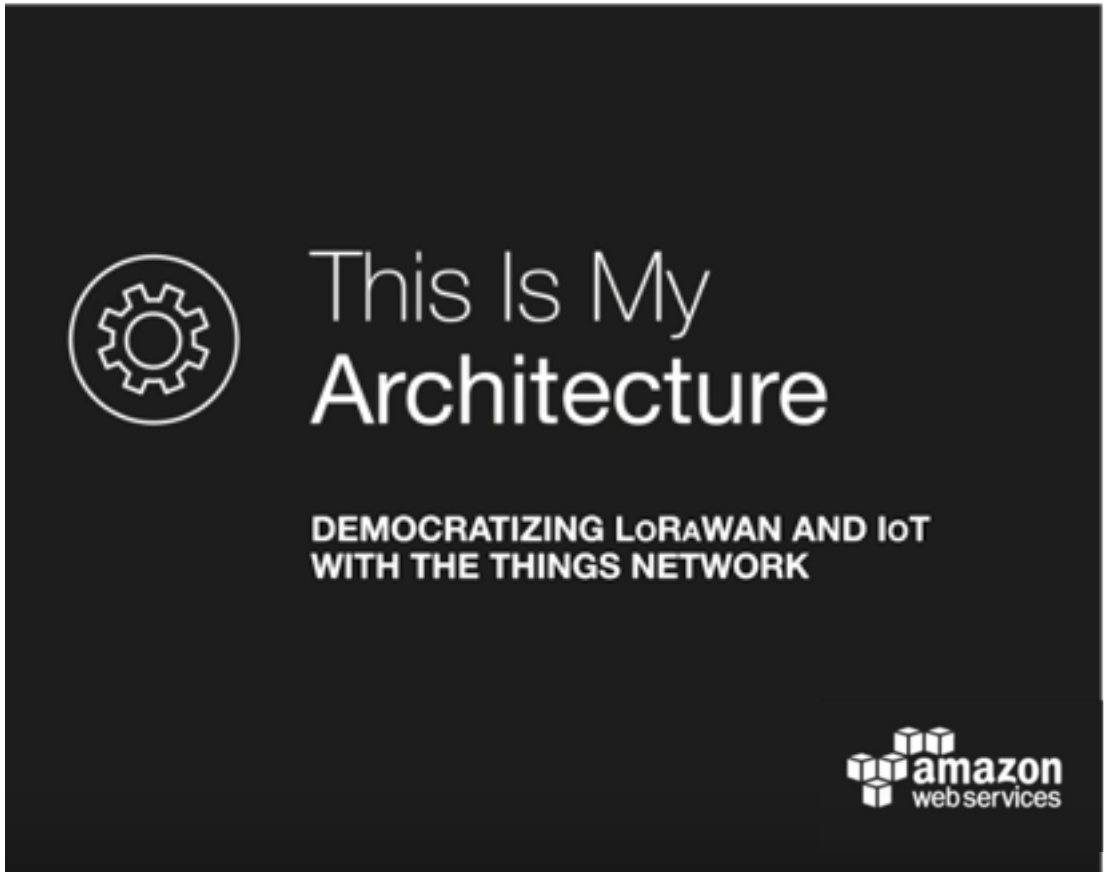


Forest fire (5km outside of the city)

Story 3: Share & inspire

Student projects ongoing

- Best café to sit at right now?
- Smart trash collection
- SkopjeDashboard



http://tiny.cc/awsttn

Q & A

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https://console.thethingsnetwork.org/
http://kicad-pcb.org/
https://www.thethingsnetwork.org/docs/network/migrate.html#mqtt
http://tiny.cc/awsttn