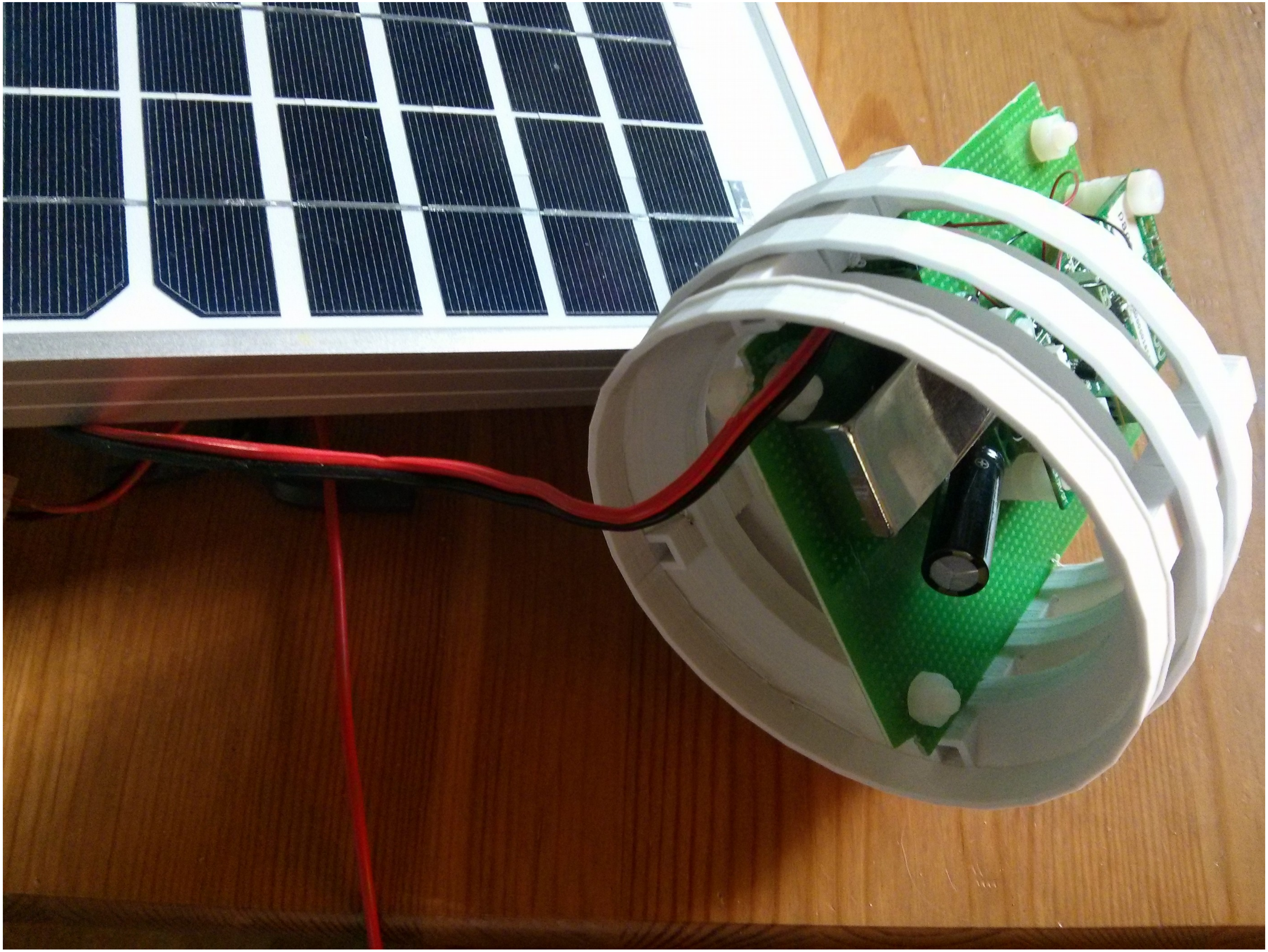
WIMEA-ICT



The WIMEA-ICT project

- Core partners:
  - Makerere University, Kampala, Dar es Salaam Institute of Technology, University of Juba, University of Bergen
- Associated partners
  - National Meteorological Agencies,
  - Benadir University, Somalia, CAR/NASRDA, Nigeria
- Objective:
  - Build capacity at african universities to
    - collect environment data,
    - produce weather forecasts
    - disseminate weather information to end-users
- Funded by NORAD 2013-2018

Research Components

- RC1: WRF forecasting
- RC2: Design National repositories and digitize legacy data
- RC3: Design and deploy an affordable weather station
  http://wimea-ict.gfi.uib.no/
- RC4: Dissemination of weather information to end users
- 8 PhD students and advisors

AWS Requirements:

- Measure reasonably accurate, as close to WMO-standars as possible)
  - Temperature and Humidity (possibly ventilated during daytime) at 2m
  - Atmospheric pressure (sink node)
  - Insolation at 10m possibly also at 2m
  - Precipitation , at ground level
  - Wind speed and direction at 10m
  - Soil temperature and moisture at ground level
- Autonomous wrt power supply and communication
- Affordable (< 2000 USD)

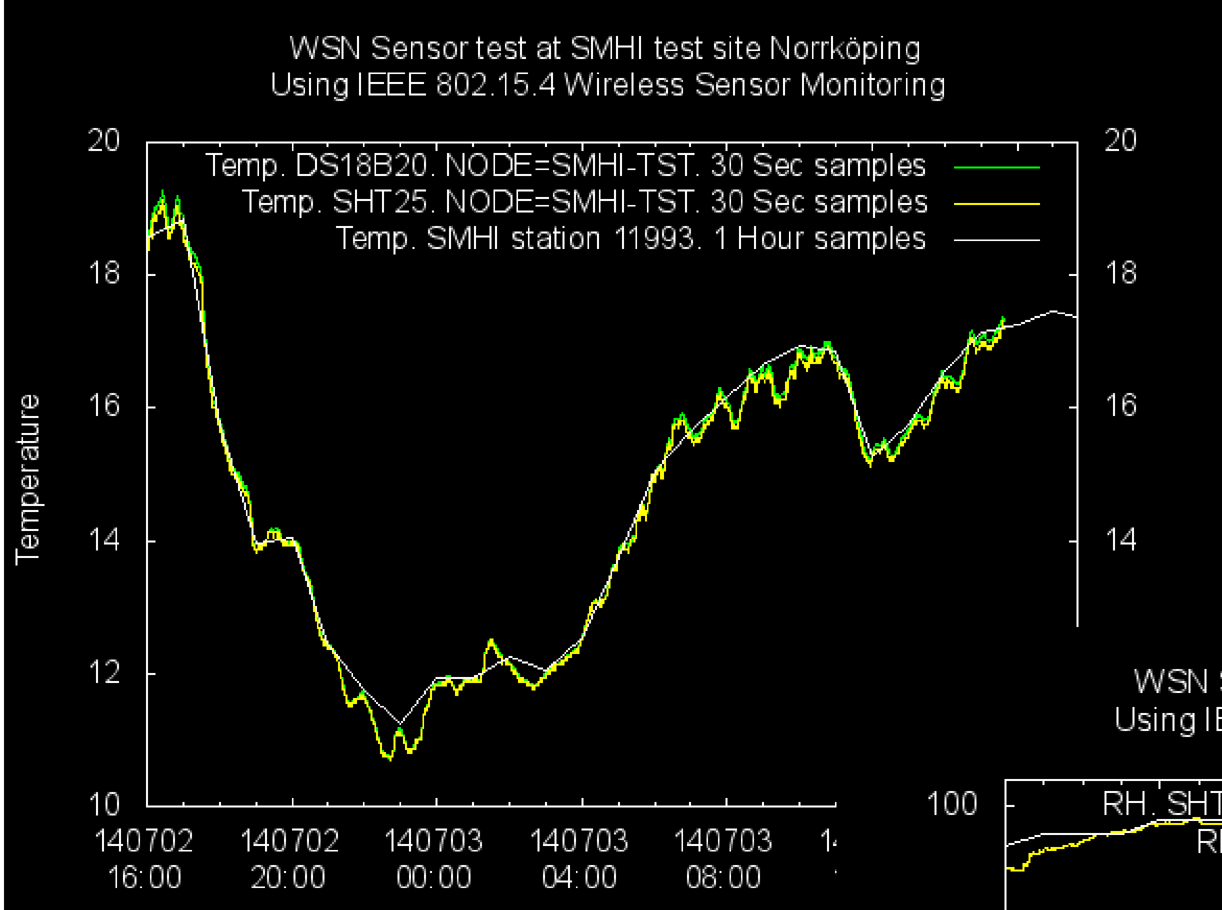
Working assumptions: Network architecture

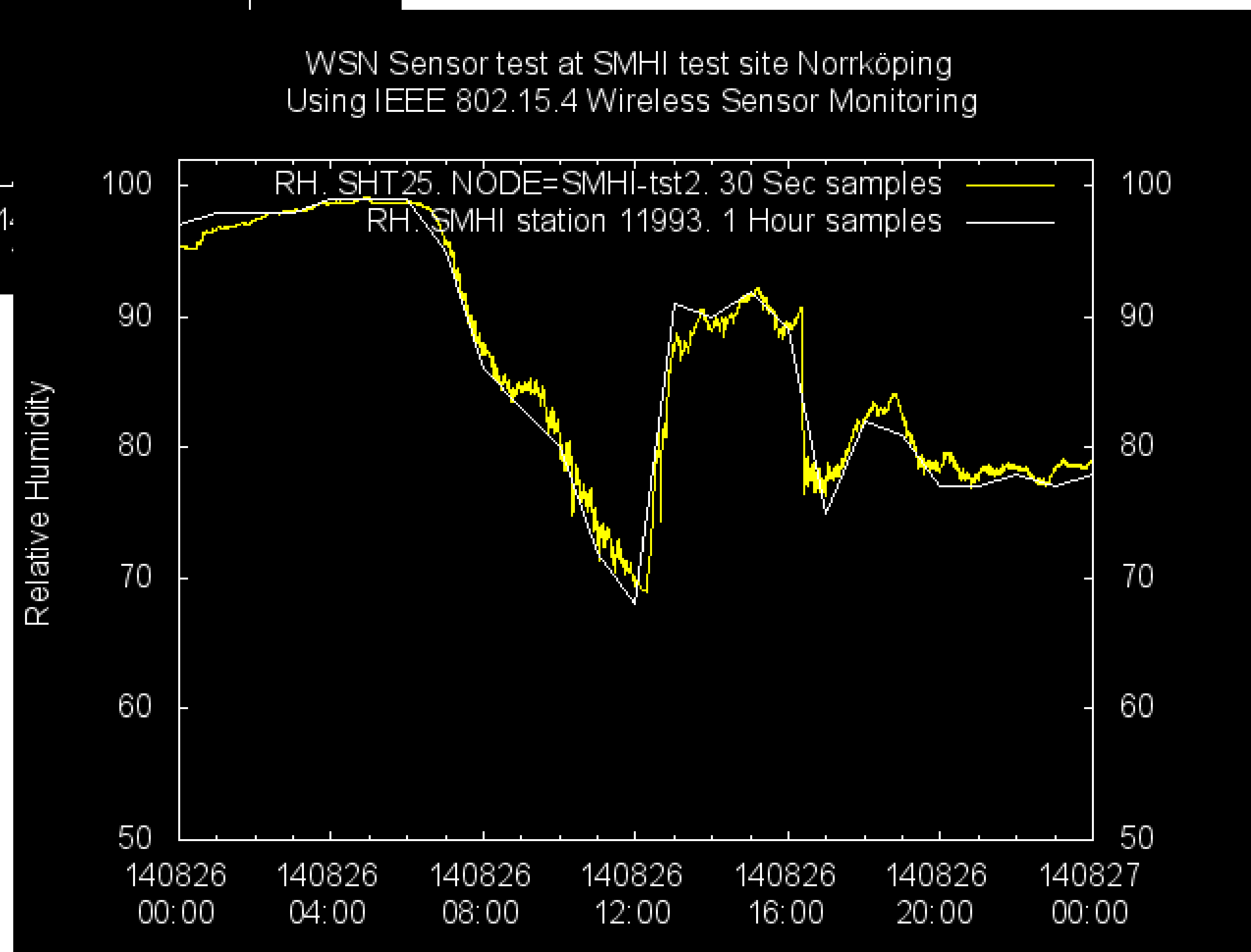
- A large number of AWS Observation stations to be deployed, ~70
  - Each station has typically 7-9 sensors
  - Distributed rather than centralized system: Each station a wireless sensor network (WSN) communicating with a sink node connected to an observation station gateway
- Upstream links connecting the observation station gateways to Internet so that captured data can be made available via regional and national repositories for research and analysis purposes
- Autonomous power supply

Examples of sensors tested in various projects

- Air temperature and humidity: SHT25,...
- Atmospheric pressure: MS5611, BMP180
- Insolation: three photo diodes under test
- Wind: E-Vane, Vortex-II (Hall-element)
- Precipitation: Rainwise,....
- Soil temperature TI DS18B20
- Soil moisture: TI Vegetronix

Benchmarking air temperature and humidity sensors





Motes tested

- Software: Contiki, TinyOS, mbedOS
- Hardware
  - Arduino based systems
  - ARM-Cortex M STM32, www.st.com
  - Atmel ATMega128RF (www.radio-systems.com)
  - Texas Instrument MSP430F1/2xxx
  - Libellium
- First generation based on ATMega128RF, Contiki, RIME broadcast

Observation station gateways and upstream links tested

- Criteria
  - IP-connectivity, power consumption, robustness, storage capacity, cpu-performance
- Tested gateways
  - Linux: Raspberry Pi, Odroid U3, BeagleboneBlack, Banana Pi
  - Openwrt: TL-MR3020,GL-iNet
- Upstream links
  - 2-4G, VHF/UHF, WiFi
  -

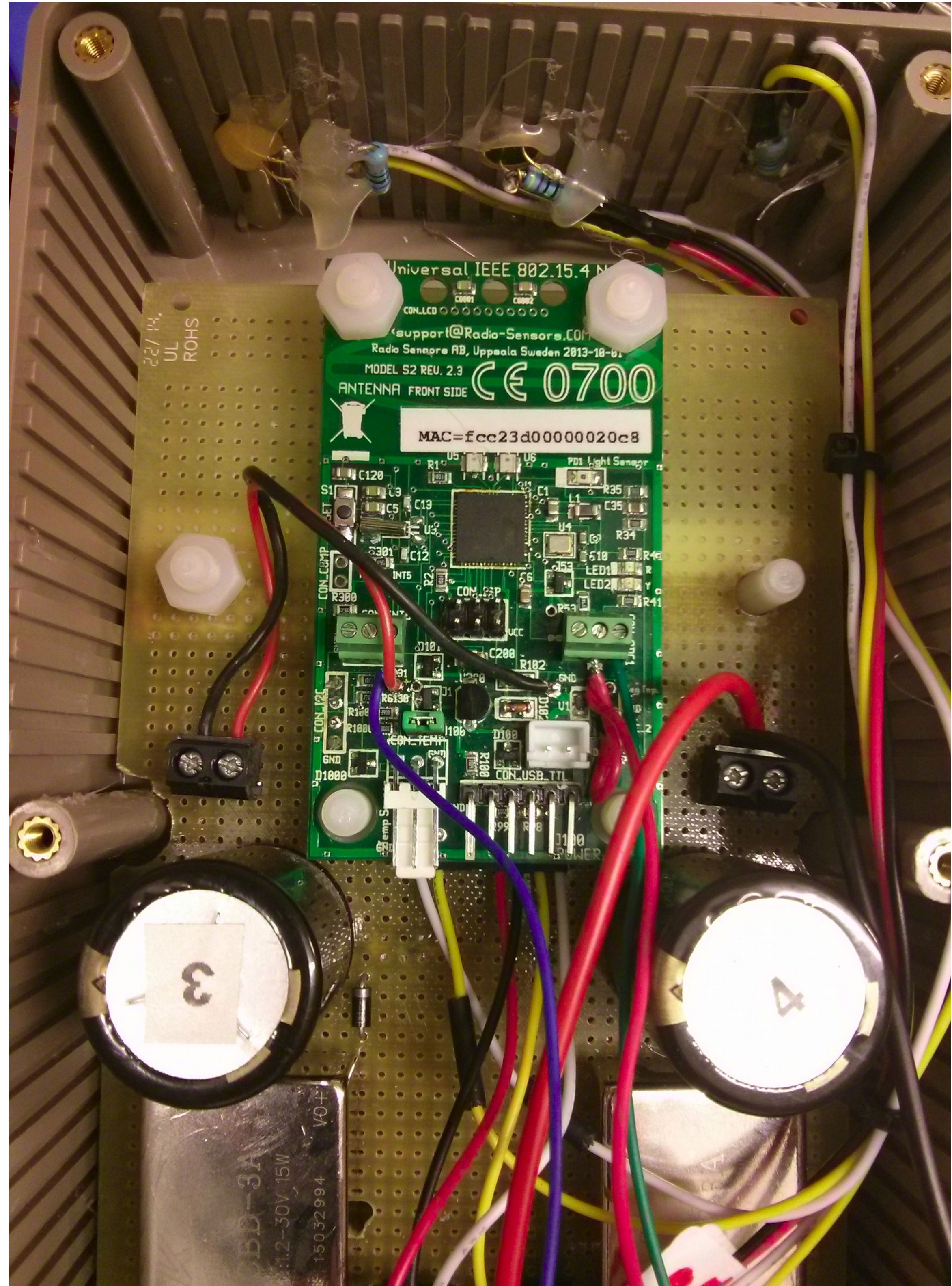
Prototype generations

- Generation 1, 2015, the Bergen prototype
  - SHT25, MS5611, Inspeed wind, Davies rain, Vegetronix soil moisture, DS18B20 soil temp
  - ATMega128RF/Contiki, RS-mote, Ultracap-batteries
  - Rime broadcast
  - Raspberry Pi2 gateway + sinknode, always awake
- Generation 2, 2016, the East African prototype
  - More power-lean gateway
  - Radio duty cycling
- Generation 3, 2017,The Production prototype
  - Manufacturing and mainteance concerns

Generation 1
The Bergen Prototype

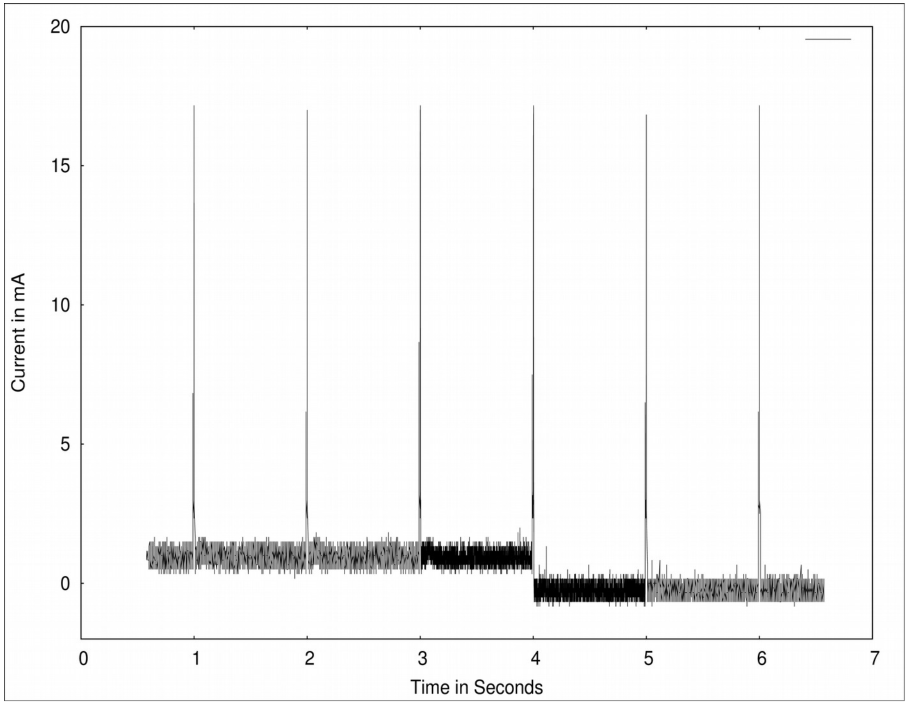
- Sink node+gwy
- Ground node
- 2m-node
- 10m-node

- wimea-ict.gfi.uib.no

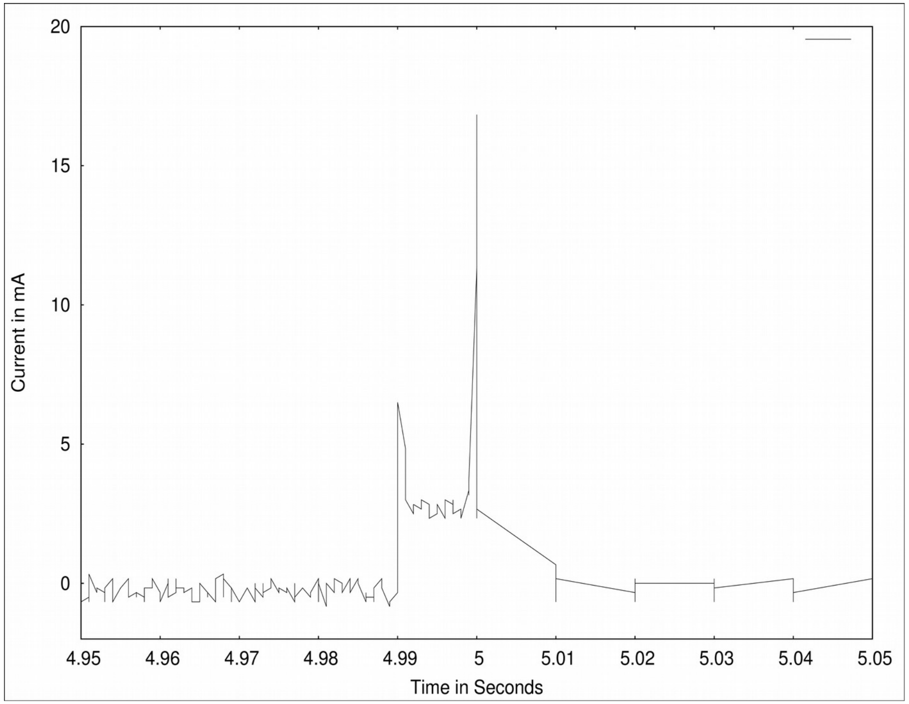


Powr supply: Mote load characteristics

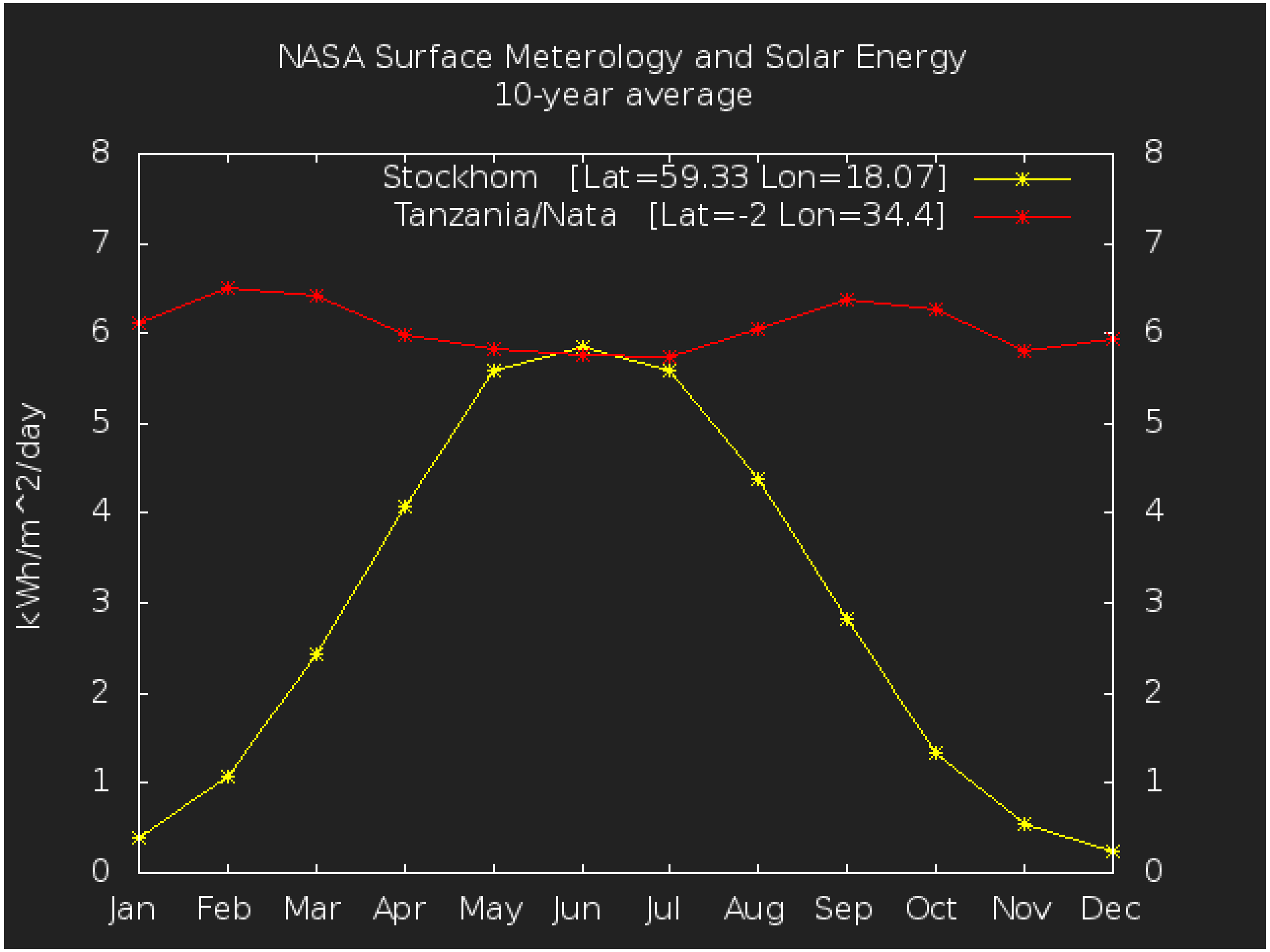
- **Periodic broadcast of Contiki/RIME packets**



- **Detail**



Source: Solar



Storage: Ultra-caps

- **Ultra-capacitors**
  - **First generation: EDLC, up to 5000F**
  - **Second Generation: LIC, up to 270F**

  - **A 16*3000F EDLC battery**

A 1500F EDLC and two 40F LIC

So what about 3D-printing?

- Feasibility study inspired by UCAR/IEPAS/MMA weather station
- Started with an irradiation shield
- The challenge is to stop direct and indirect radiation but not ventilation
- A few different designs have been printed and discussed with meteorologists
- Report at https://oar.sci-gaia.eu/record/28/
- A benchmarking test is being discussed

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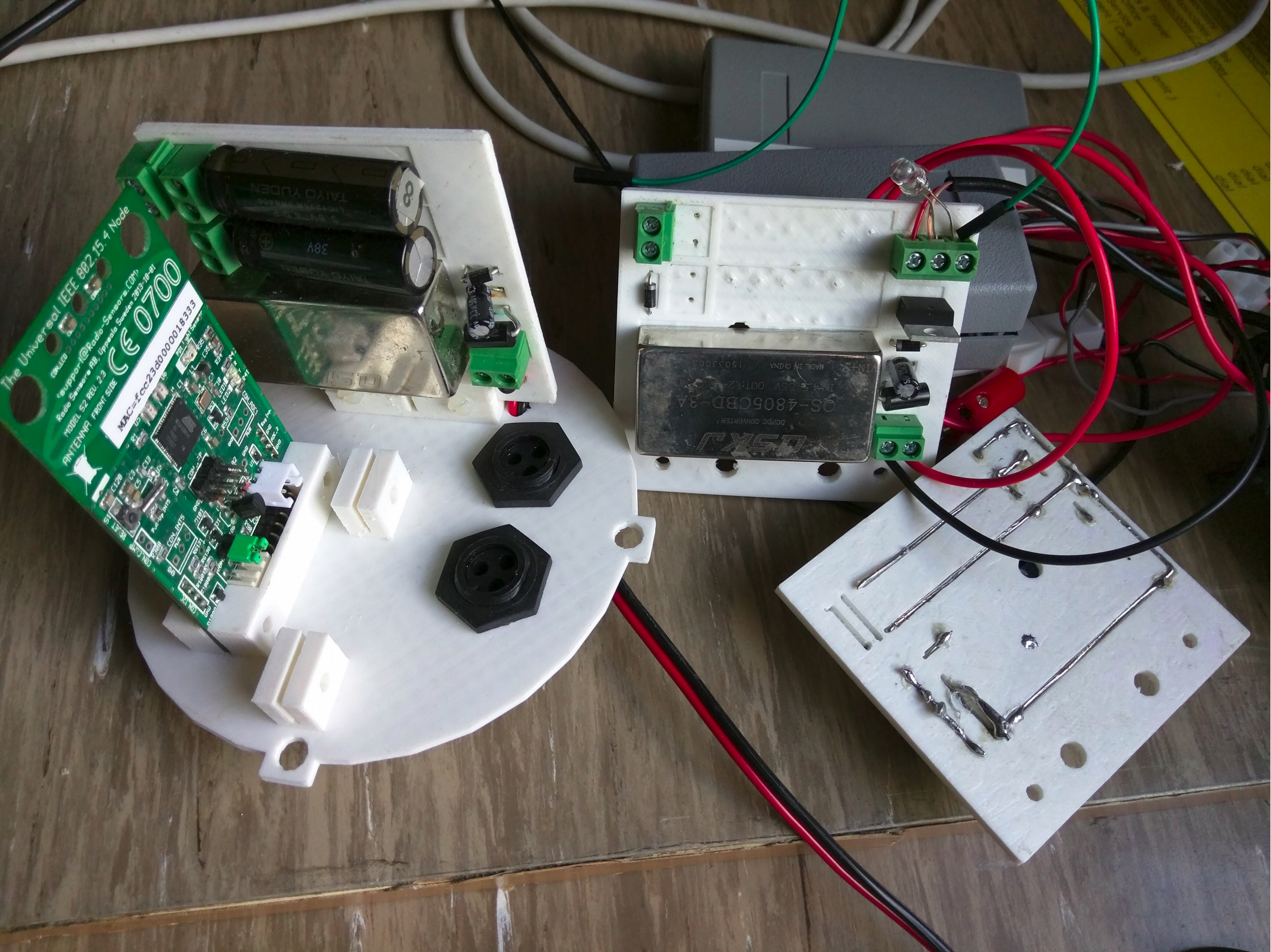
Conclusions

- Although 3D-printing as such seems still more of art than science, there is a lot of potential
- Enclosures, simple circuit boards, and what have you.


The Universal IEEE 802.15.4 Node
0700
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TAIYO YUDEN
QS-4805CBD-3A