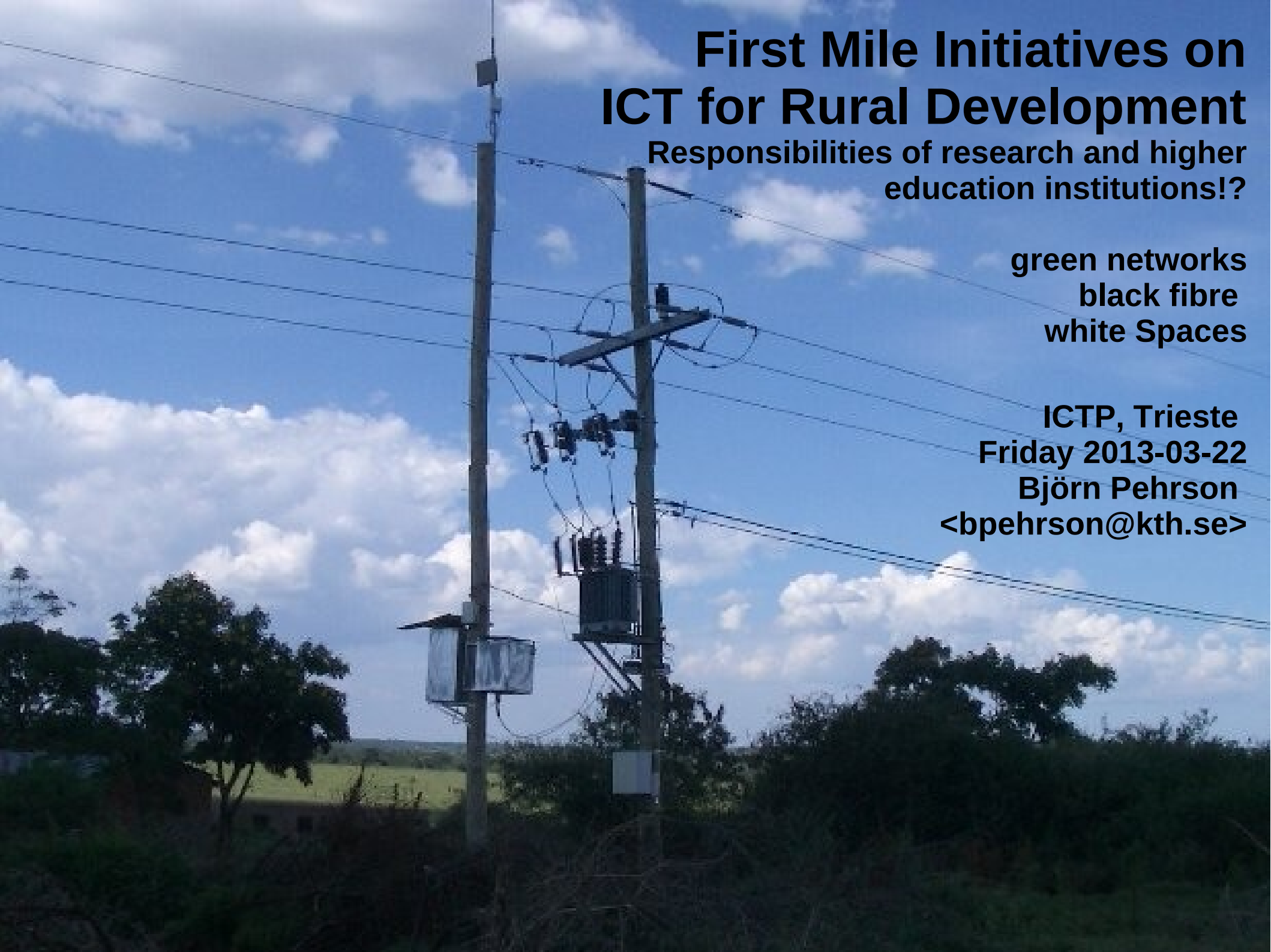

First Mile Initiatives on ICT for Rural Development

Responsibilities of research and higher education institutions!?

green networks
black fibre
white Spaces

ICTP, Trieste
Friday 2013-03-22

Björn Pehrson
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Serengeti Broadband Network

- An outcome of the Tanzania ICT for Rural Development Programme supported by Sida, COSTECH,DIT and KTH
- Designed and deployed by teams of students learning ICT for academic credit, starting 2005 (ttaportal.org, www.tslab.ssvl.kth.se)
- Optical fibre backbone in the grounding wire of the medium voltage power line Bunda – Mugumu/Serengeti (OPGW)
- Broadband island
  - Narrow band Internet connection, connection to NBB/TERNET pending
  - Currently connecting users via first mile wifi. first mile fiber on its way
  - District council offices, healthcare units, schools, AIRCs, private users
- Wireless backbone extensions in the Mara region
  - WiBACK mesh
  - Optical fibre extension
- Extension to become an African Great Lakes Rural Broadband Research Infrastructure around Lake Victoria AGLARBRI

Mara region, Northern Tanzania

How to establish sustainable telecom markets in under-served areas
From Social Business to commercial

- Consumers (All sorts of users)
  - Buy best available quality at lowest possible price
- Producers (The entire supply chain)
  - Social business rules: Satisfy local needs with whatever resources available on a cost related basis.
  - Commercial rules: Sell what users can accept at highest possible price and lowest possible cost to generate maximum profit to investors. Block competitors if you can.
- Policy makers and regulators
  - Define and enforce the regulatory framework
  - Collect tax
  - Mediate between operators
  - Represent public interests
  - Represent consumer interests, e.g. by stimulating competition. This is where RoW, Licence exempt and TV White Spectrum is important

The Utility (Cost based) perspective:
Open Access Infrastructure

Anyone can buy resources on any level and offer services on any higher level

5-7. Application Layer

4. Transport Layer End-to end
   - End users

3. Network Layer: Routing
   - Internet Service providers

2. Link Layer: Medium Access, reliable link
   - telecom operators

1. Physical Layer: mechanical, modulation

0. Medium: wire, fibre, em spectrum, audio
   - Infrastructure owners,
   - Owners of right of Way

ICT for Rural Development via First Mile Initiatives

Proposal submitted to UN Broadband Commission

- Act rather than wait to make commercial last mile arrive sooner rather than later
- Reduce risks by demonstrating demand and feasibility

- Jokkmokk 1996-2010

FMI challenges

- Awareness about benefits of using ICT
  - local services vs Internet access
- Ownership, leadership, Know how
- Lack of all sorts of infrastructure and supply chains
  - Power, communication, computer literacy,...

Methodology

- Focus on basic needs in the local community
- Team up with local research and higher education institutions supported by global peers in the technology transfer alliance
- Stimulate transformation of end-user work pocedures to take advantage of ICT
- Iterative pre-commercial procurements

Applications driving rural development

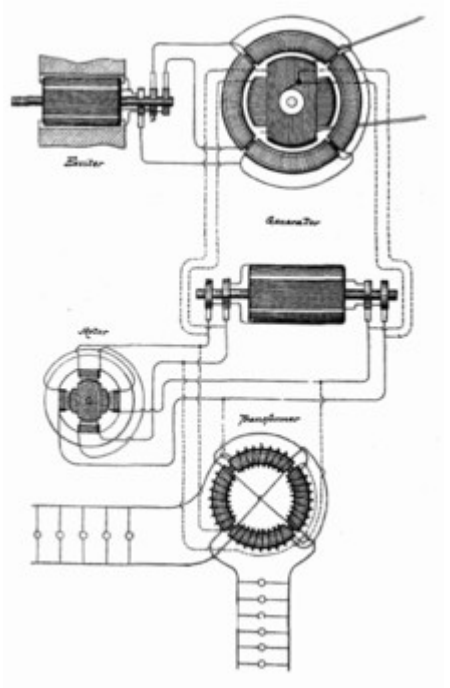
- Health
  - Sentinel surveillance, drug management
  - Continuing education of rural health workers
- Education
- Governance
  - Own administration and services to the citizens
  - Support to local entreprenuers, often farmers
  - Environment monitoring
    - Environment impact assessment
    - Synoptic weather observations
    - Water management, irrigation
    - Early warning systems, land slides, droughts,

Infrastructure Priorities

0. Integrate ICT and power management
1. Optical Fibre
   - Connecting servers providing the soft infrastructure of society
   - Wireless to support mobility of users
2. Terrestrial Wireless
3. Satellite
4. Physical Transport

Green networking

- Save energy to reduce the carbon foot print
- Survive with little power
- 12-48V DC micro grid
- Alternative Energy Sources and Storage
- Integrate processing, communication and power management



Carefully selected standard hardware and free open source software components

700 kpps

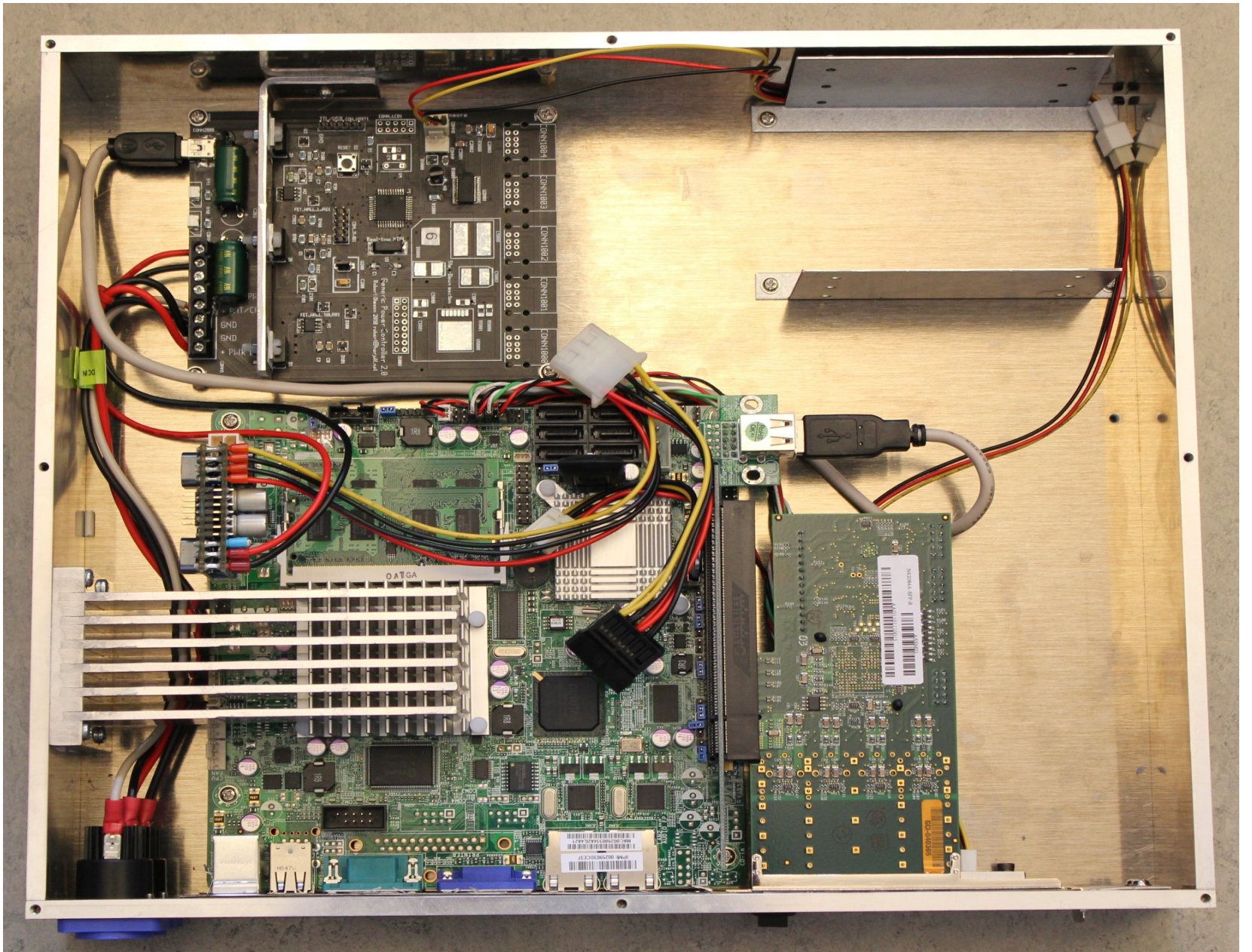
20W

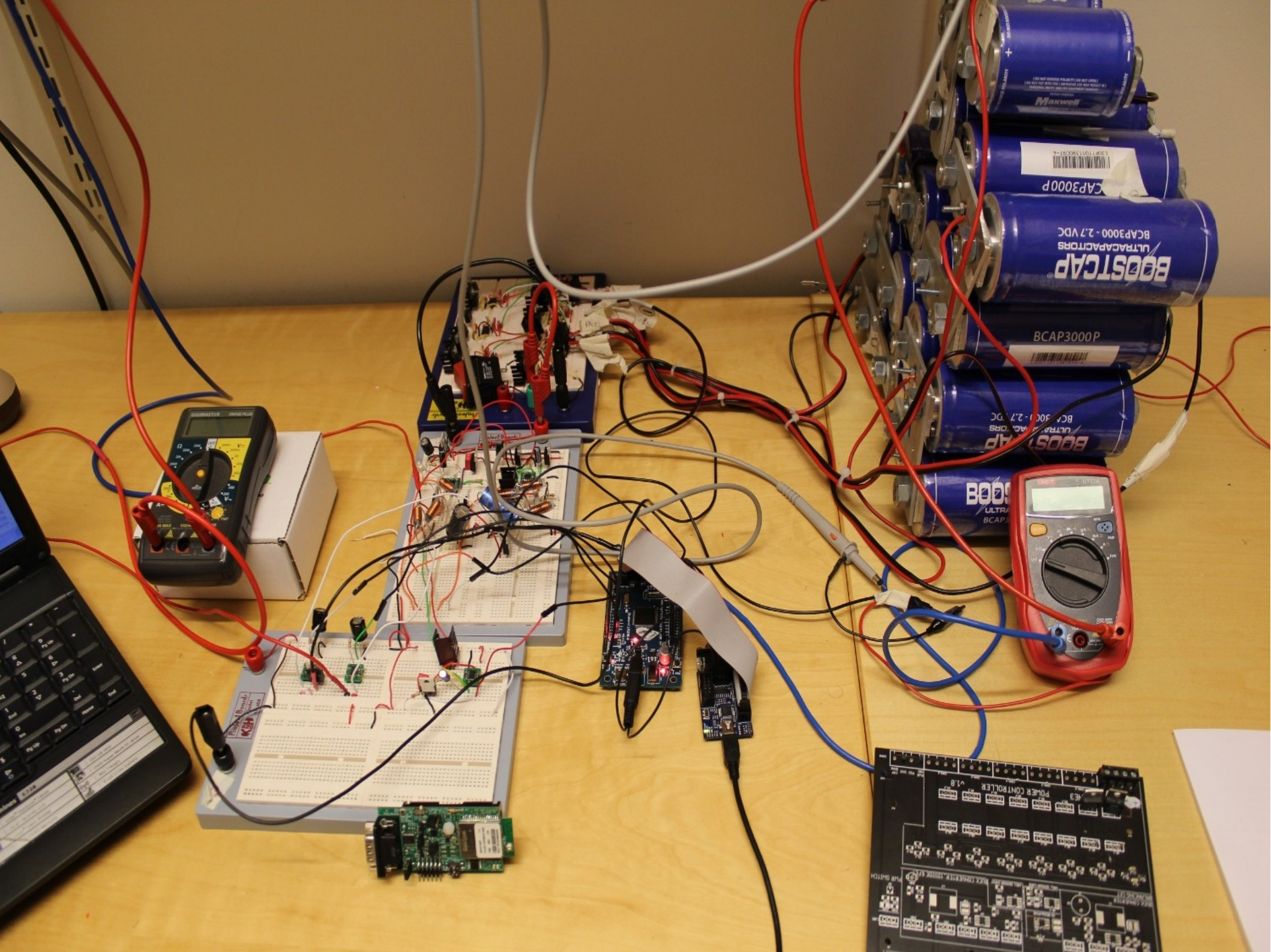
Integrated power management

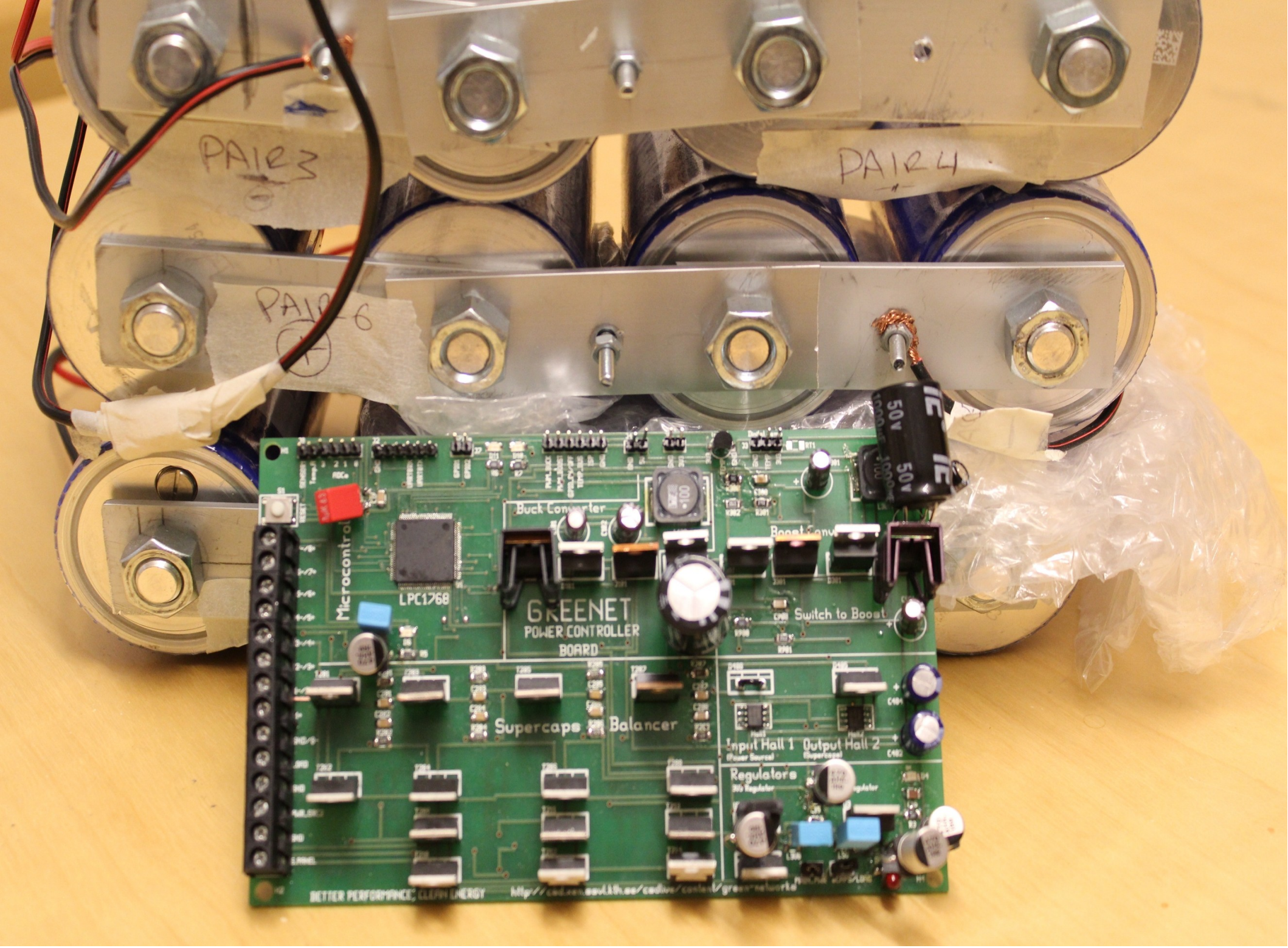
Any 12-20 V Power source

Power storage

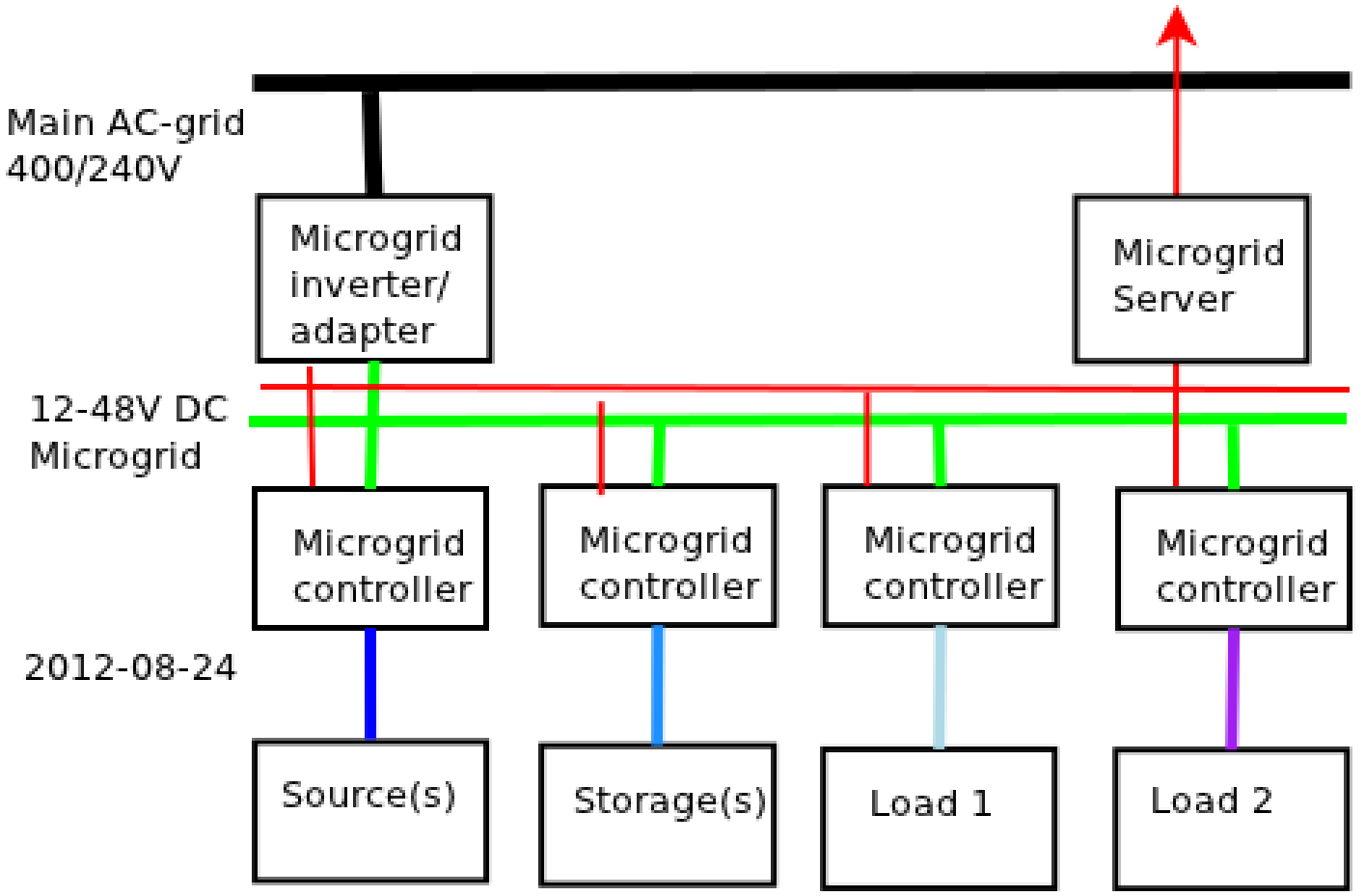
Capex < 1k€




BOOSTCAP
ULTRACAPACITORS
BCAP3000 - 2.7 VDC
BCAP3000P


PAIR3
PAIR4
PAIR6
LPC1768
GREENET
POWER CONTROLLER
BOARD
Buck Converter
Switch to Boost
Supercaps Balancer
Input Hall 1
Output Hall 2
Regulators
50V
50V

Microgrid designed to share investments in renewable energy sources and innovative storage



Internet of Things

- Sensor networks for
  - Environment monitoring
    - Synoptic weather parameters
    - Agriculture (soil temp and moisture dissipitation)
    - Water management
  - Healthcare and food security
    - Patient health parameters
    - Drug and food transport monitoring

Wireless Sensor Networks

Sensor nodes

- ATMega128rf Mcu, radio transceiver, adc
- Contiki-os
- www.herjulf.net/products/WSN/sensors

Sink node connected to gwy via USB

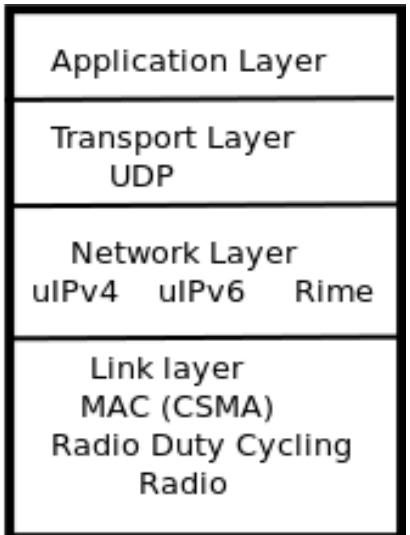
Sensors onboard, ttl, i2c and/or ow

Rime broadcast wakeup from deep sleep

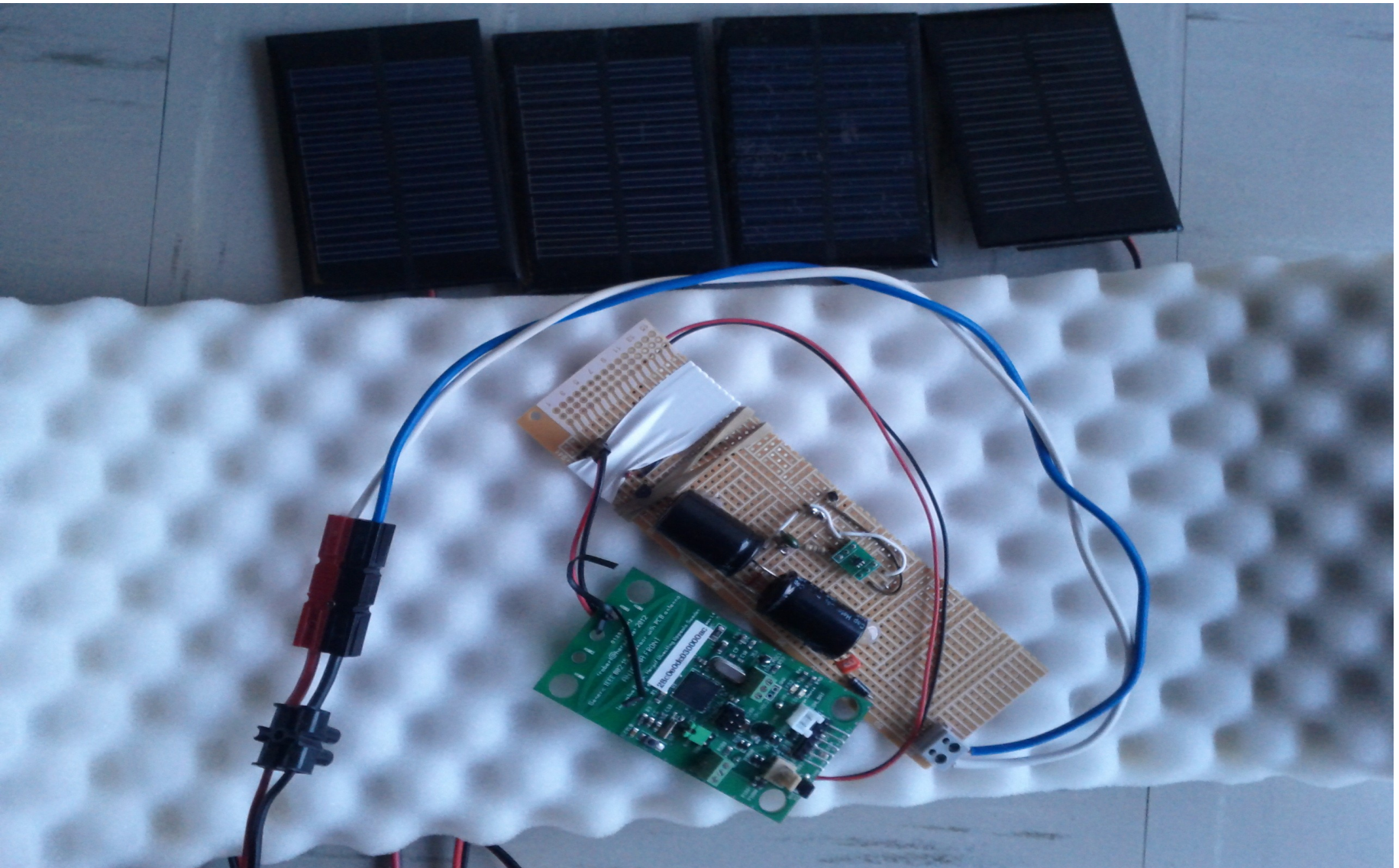
RPL IETF ROLL IPv6 Routing Protocol for Low power and Lossy Networks

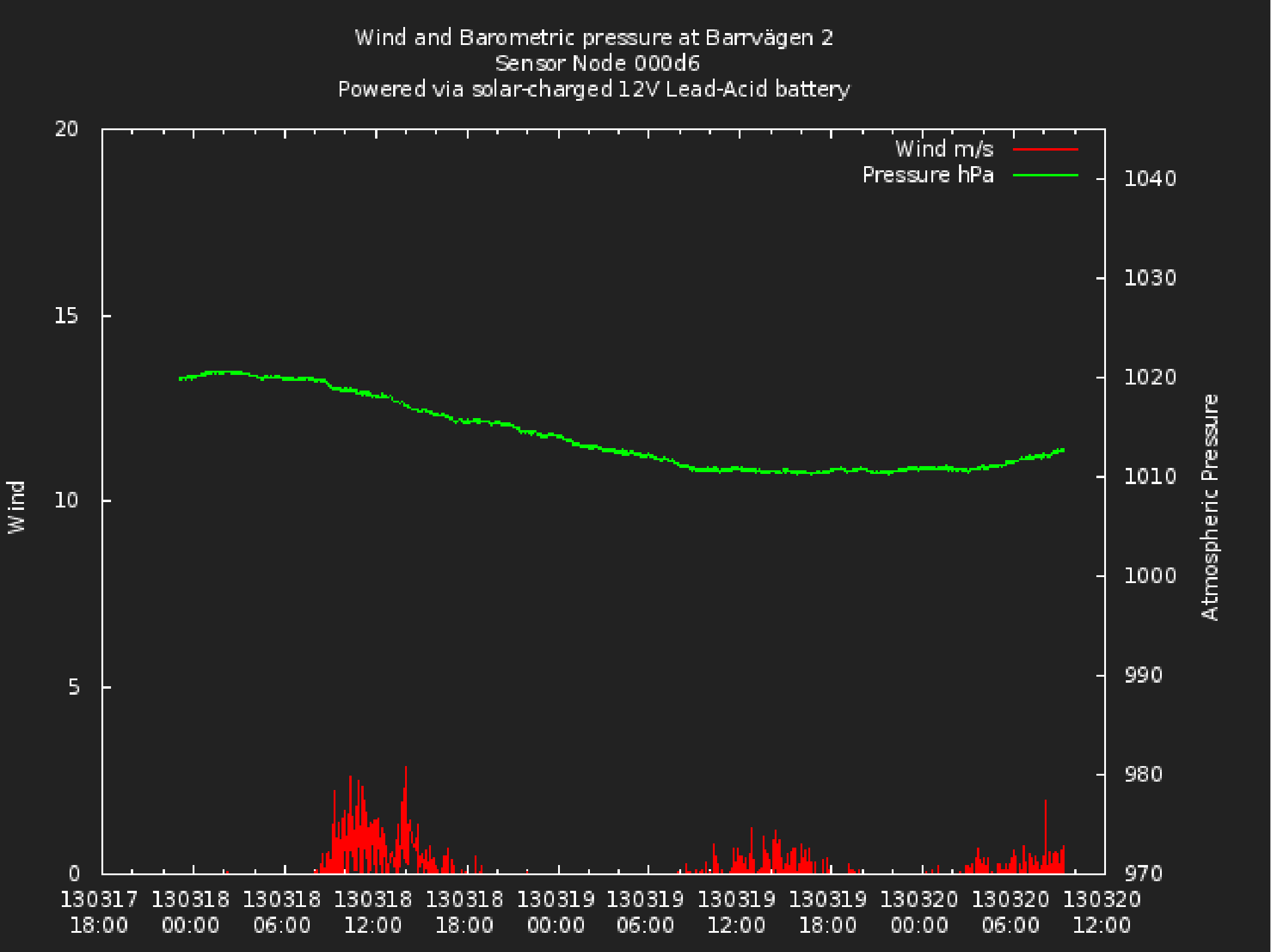
Radio duty cycling

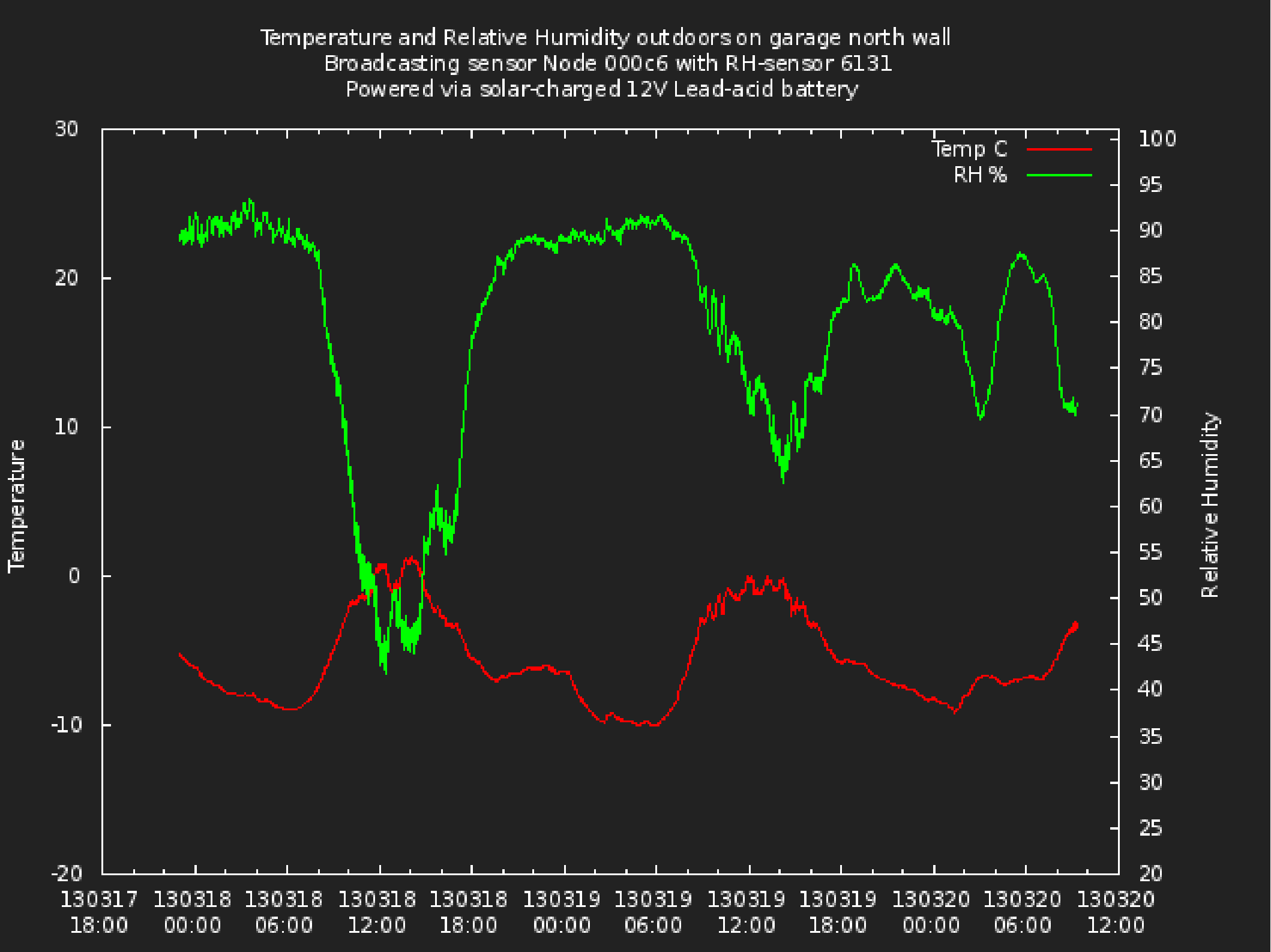
The Contiki protocol stack



- PSU: 2*20F Supercaps (max 2.7V) in series (to get 3V)
- charged by 4*4.5V solar cells in parallel, to charge fast enough
- Load: 1uA (~3uW) in deep sleep, 20mA (~60mW) when awake
- Sufficient for one transmission per minute and max ~ 20 hours darkness




Wind and Barometric pressure at Barrvägen 2
Sensor Node 000d6
Powered via solar-charged 12V Lead-Acid battery
Wind m/s
Pressure hPa
Wind
Atmospheric Pressure
20
15
10
5
0
1040
1030
1020
1010
1000
990
980
970
130317 18:00
130318 00:00
130318 06:00
130318 12:00
130318 18:00
130319 00:00
130319 06:00
130319 12:00
130319 18:00
130320 00:00
130320 06:00
130320 12:00


Temperature and Relative Humidity outdoors on garage north wall
Broadcasting sensor Node 000c6 with RH-sensor 6131
Powered via solar-charged 12V Lead-acid battery
Temp C
RH %
Temperature
Relative Humidity
30
20
10
0
-10
-20
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
130317 18:00
130318 00:00
130318 06:00
130318 12:00
130318 18:00
130319 00:00
130319 06:00
130319 12:00
130319 18:00
130320 00:00
130320 06:00
130320 12:00

Upstream connections from remote WSNs

- Optical fiber, own or leased
- Terrestrial wireless
  - license exempt spectrum
  - tv white spectrum
  - amateur packet radio (VHF, UHF, 44.0.0.0/8)
  - sdr/gnuradio/grc fcd, softrock, usrp
- Satellite
- Physical transport
  - dtn, bytewalla


Questions ?