

Introduction of flexible monitoring equipment into the Greenlandic building sector

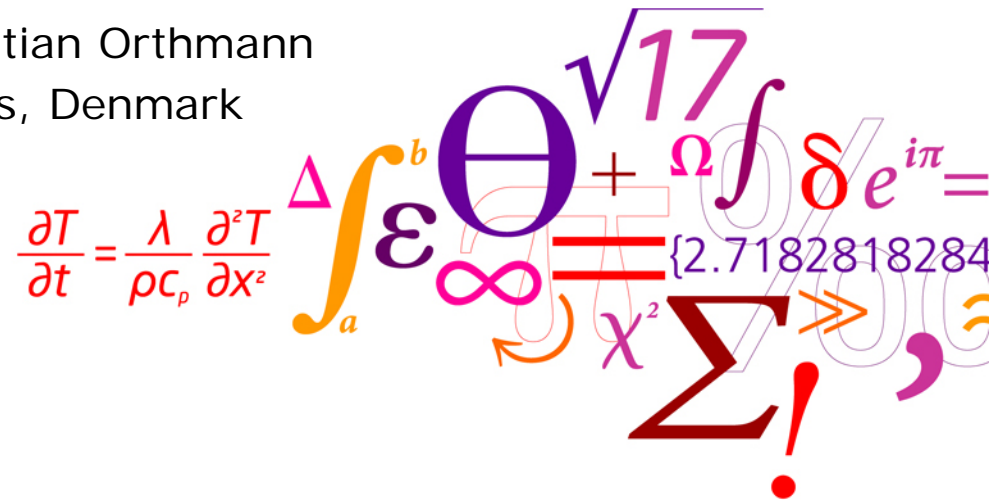
Sisimiut, Greenland

7-9 April 2014

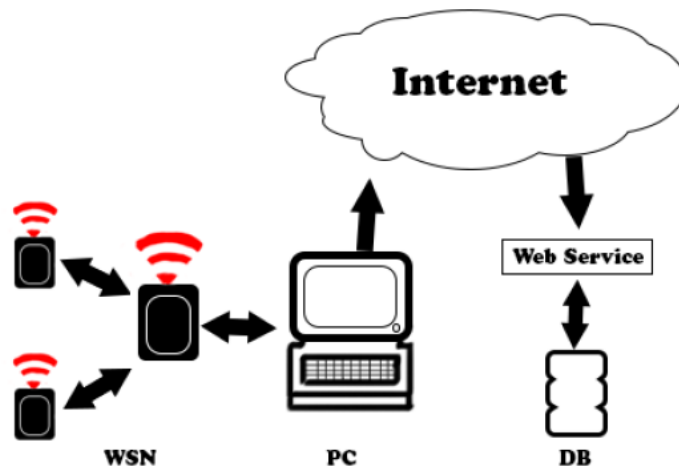
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Wireless Sensor Network (WSN) - Basics



- Sensors of any type
- Connected thought network
- Communication wireless
 - with a Synchronization node
 - with each other
 - through each other (hops)

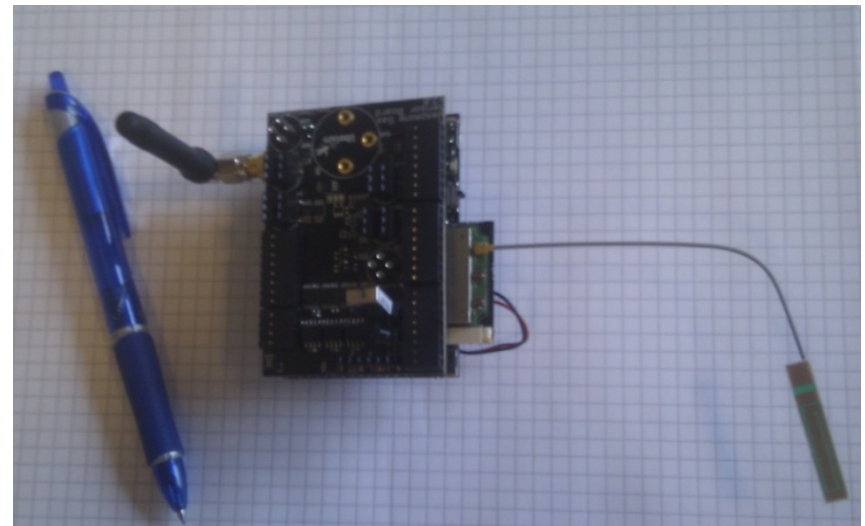
- Strength
 - Sensors can be added and removed in the running network
 - Sensors can communicate through each other
 - ... a very flexible self configuring platform

Development History

- 1st trial with SunSpots
 - Very good implementation of the WSN technology
 - Very bad implementation of the many sensors
 - E.g. Heat sensor was placed too near to the light diode
- 2nd trial with a development company
 - Lack of maturity
 - Lack of development infrastructure for programming the nodes
 - Very high price due to small production
- 3rd trial is the one presented here – Libelium Wasp mote

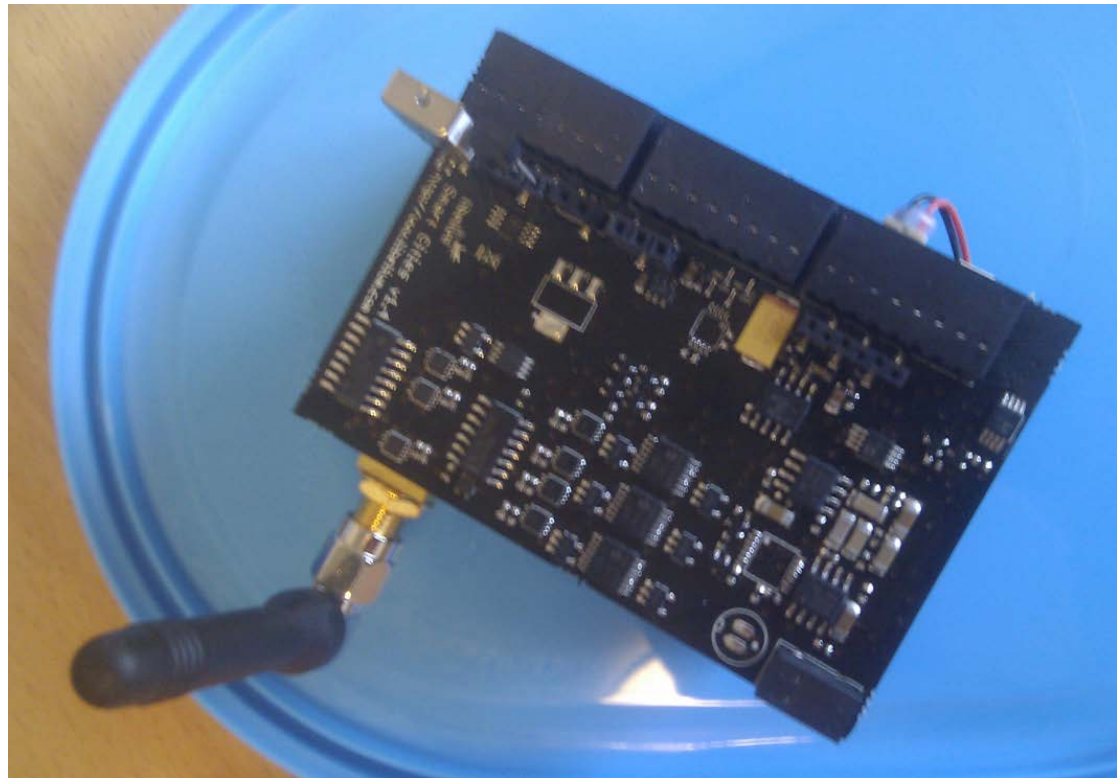
Waspnotes

- Extremely flexible development and demonstration platform
 - customizable
 - consisting of:
 - Sensor Board
 - Sensor Network modules (exchangeable)
 - Communication modules - plugins (GSM, Wifi, Zigbee etc.)
 - Battery packages
 - other characteristics
 - Open source
 - programming platform
 - policy
 - and community



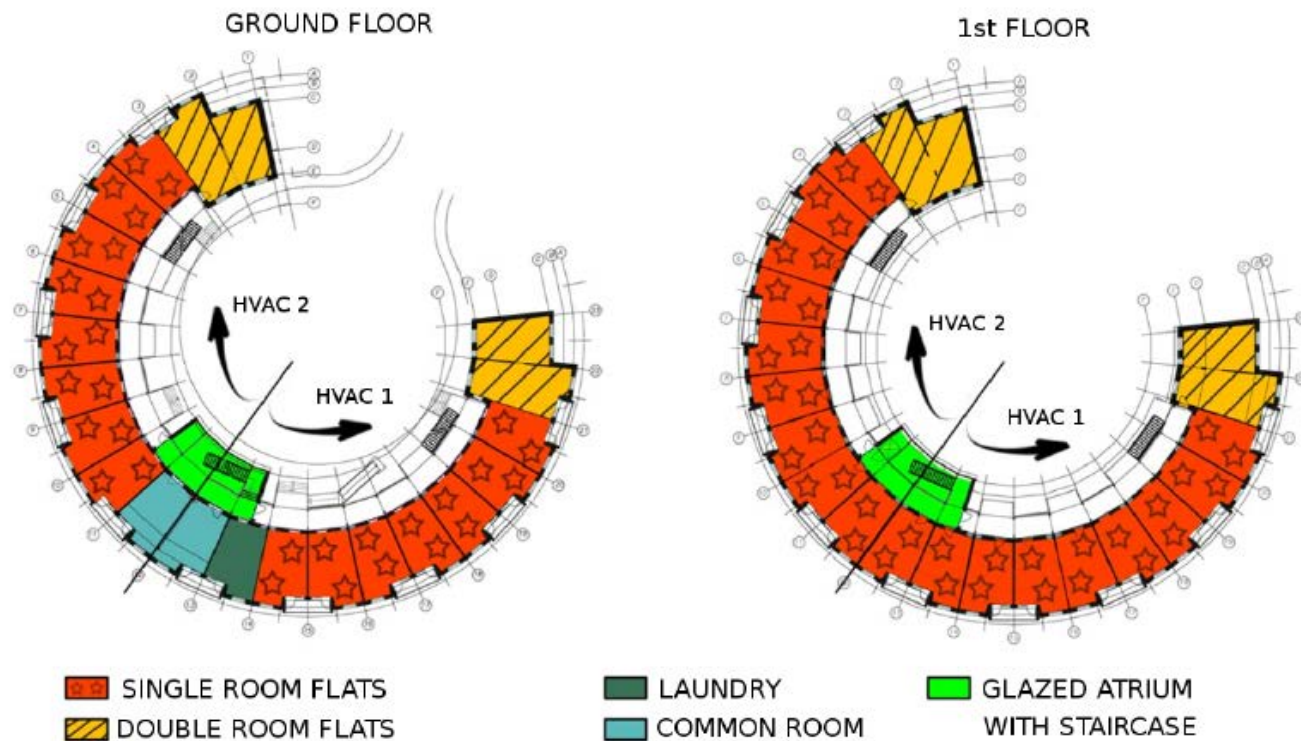
Laboratory testing

- Range in the free: 50 meters
- Range in buildings (steel-concrete and brick stones): 30 meters
- Battery charging and usage
- Sensor precision
- ... and much more



The Building – Apisseq - Dormitory

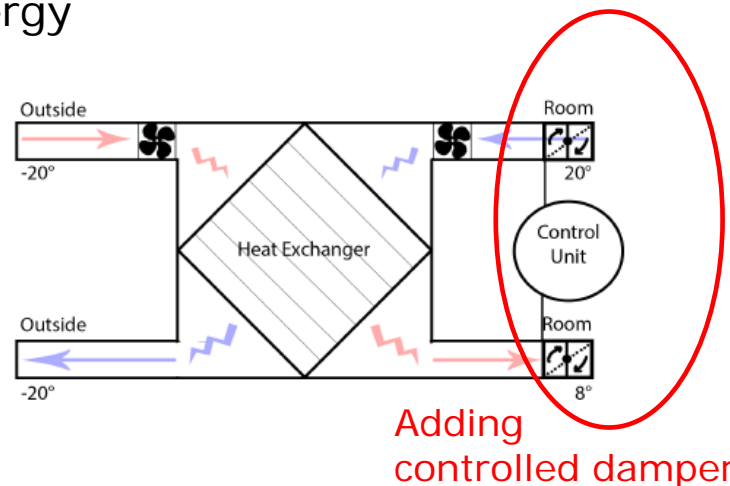
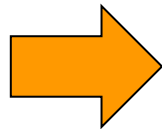
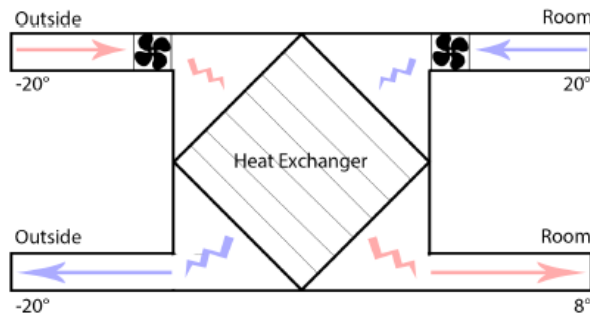
- Dormitory, built 2010



- Aim: To save energy and keep the indoor environment

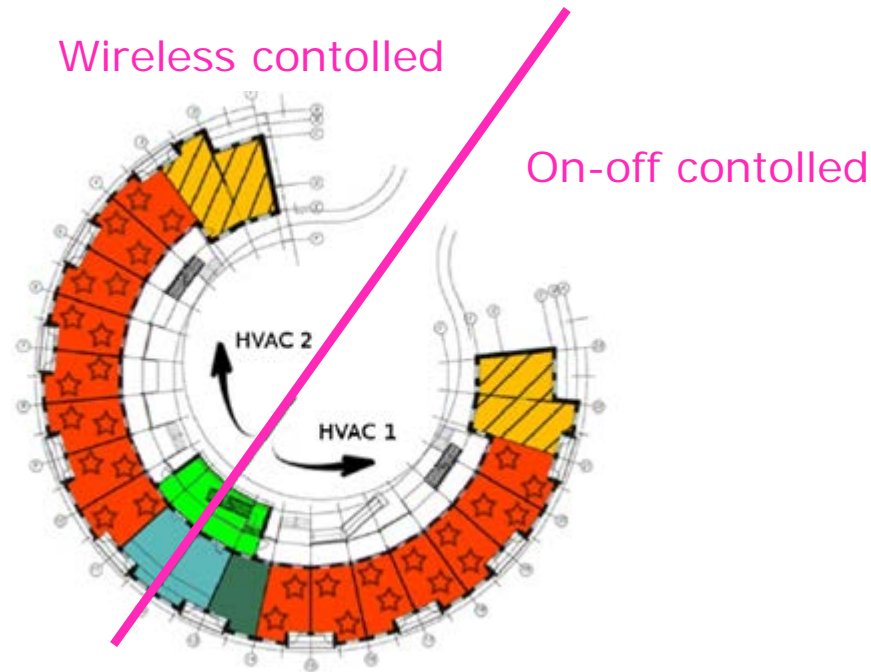
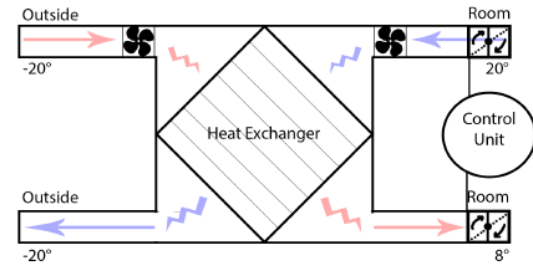
HVAC optimization

- Before:
 - On-off control which means on-all-the-time
- After:
 - Demand controlled on basis of CO₂-measurements in every room
- Requires:
 - Sensors
 - Control strategy
 - If one sensor is above a threshold => "On"
 - Else "Off"
- Expected savings = >70% ventilation energy



HVAC optimization

- Installation of 18 sensors
- .. on half of the symmetrical building
- Enables comparison of the two buildings
 - to be corrected for the influence of solar gain through windows



The Case Study Results – So fare ...

- Update software on any device to same state
 - Not the case by delivery
- Test sensors (until experiences are large)
- Configuring is straight forward
- Open source platform, Arduino with some changes
- Casing must be solved
- With a few sensors on can do the work as one goes
- With many sensors on has to build up procedures
- Configuration and programming may take a few days (not fulltime at all)

- Unfortunately no results on monitoring due to delays



Costs

Table 2. Price estimation for the wired solution

Item	Price (incl.VAT)
18x CO ₂ sensors (Vaisala CARBOCAP® GMW 22)	6,000 €
Programmable logic controller with web server (Prolon PID 4000) including installation	4,000 €
Installation of the sensors	6,000 €
Total	16,000 €

Table 1 Price estimation for the wireless solution

Item	Price (incl.VAT)
19x Waspote ZigBee PRO	3,800 €
18x Gases Sensor Board v2.0	2,160 €
18x Solid electrolyte CO ₂ Sensor TGS 4161	880 €
Meshlium ZigBee-PRO-AP	660 €
Installation of the sensors	500 €
Total	8,000 €

- plus configuration & programming for both solutions
- STATUS
 - Due to paternity leave, the project is derailed
 - Not installed yet (to be installed in April 2014)
 - To be reported in October 2014

Expected results above the case study

- Simple coupling to
 - "Internet of Things"
 - "Big data"
 - Building Automation / "Smart Buildings"
 - "Smart Grid"
- Applicable for Positioning

Further work and Opportunities

- Battery lifetime
- Battery charging
- ... standardization on
 - Configuration
 - Programming
 - communication protocols
 - ...
- Flexible monitoring system developments
 - Commissioning
 - Debugging
- Positioning – on basis of the node RSSI measurements (~ 40 cm precise)

Any Greenlandic reflection

- Assumptions:
 - Limited access to automation professionals in Greenland
 - Skilled labour is expensive
 - Demanding to come around
 - => Hence expensive to use professionals



Any Greenlandic reflection

- Drawback for WSN
 - Hardware can be cheap and expensive
 - (many possibilities – choose one)
 - Battery charging is not solved – el-wired is recommended
 - (not really wireless, well?)
 - Sensor quality depends on the sensors applied (price-performance)

Any Greenlandic reflection

- Strength of WSN
 - Extremely easy installation, after prepared configuration
 - Very cheap installation (if el-wired)
 - Remote configuration and programming
 - Remote and automated calibration of sensors (esp. CO₂-sensors)
 - Repurposing of hardware (a topic in itself)

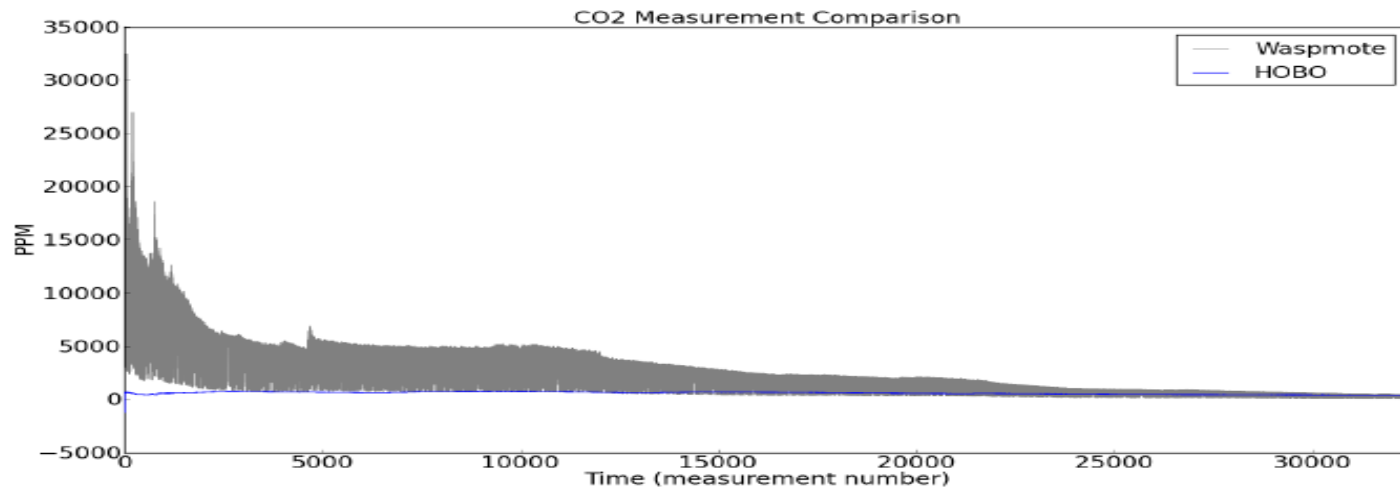
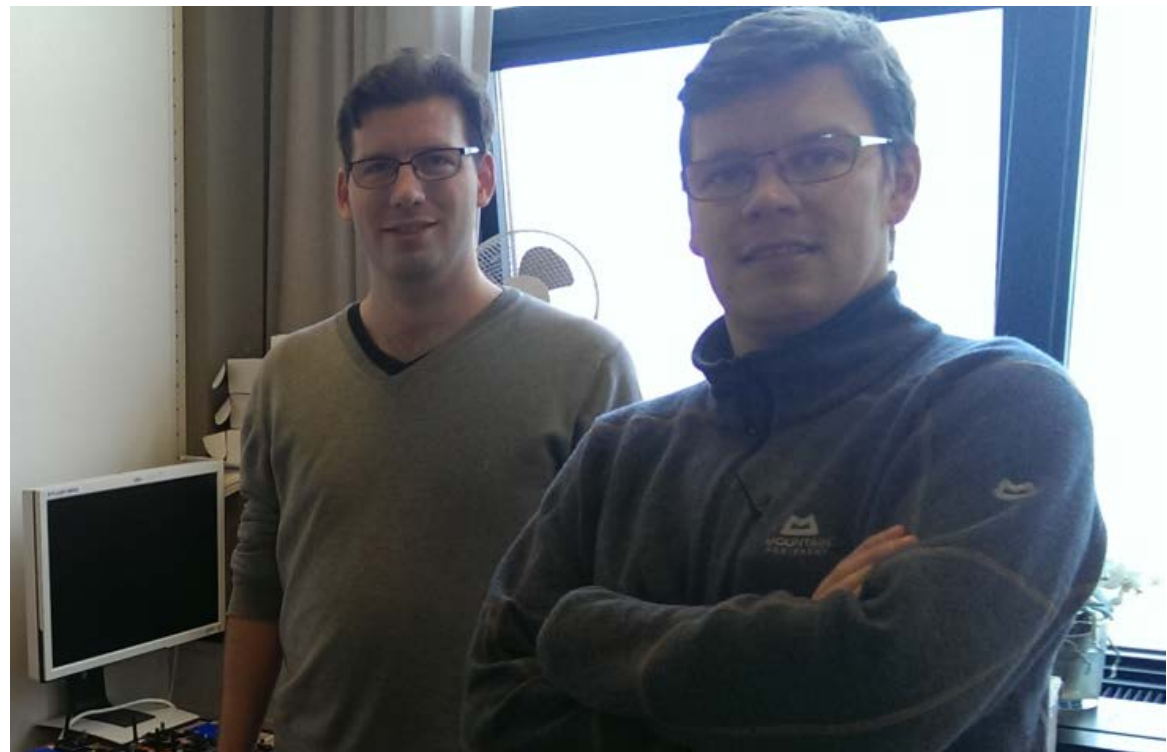


Figure 5.9: CO₂ measurements from the burning procedure

DThanks to ...

- my colleagues
 - Christian Orthmann
 - Martin Kotoľ
- Bjarne Saxhof Foundation



Alternative platforms

- National Instruments
- Digital Instruments
- MakeThisWork
 - Danish produced
 - Communication: Bluetooth Low Energy – good battery conditions
 - rather expensive, 6000 DDK/node with a set of sensors)
- ... and many more