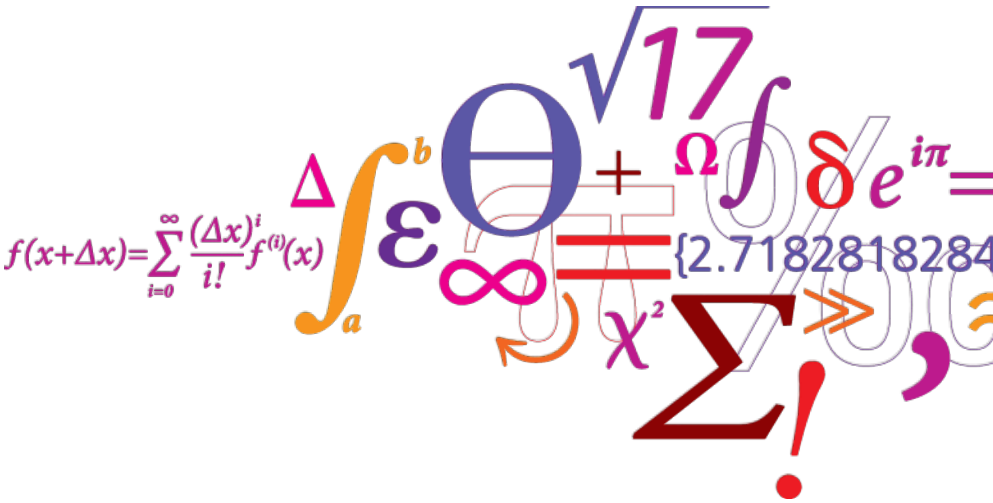
ETALEE2015

Active learners in Sustainable electronics and IT

-learning about sensors, protocols and Internet Of Things by developing a system



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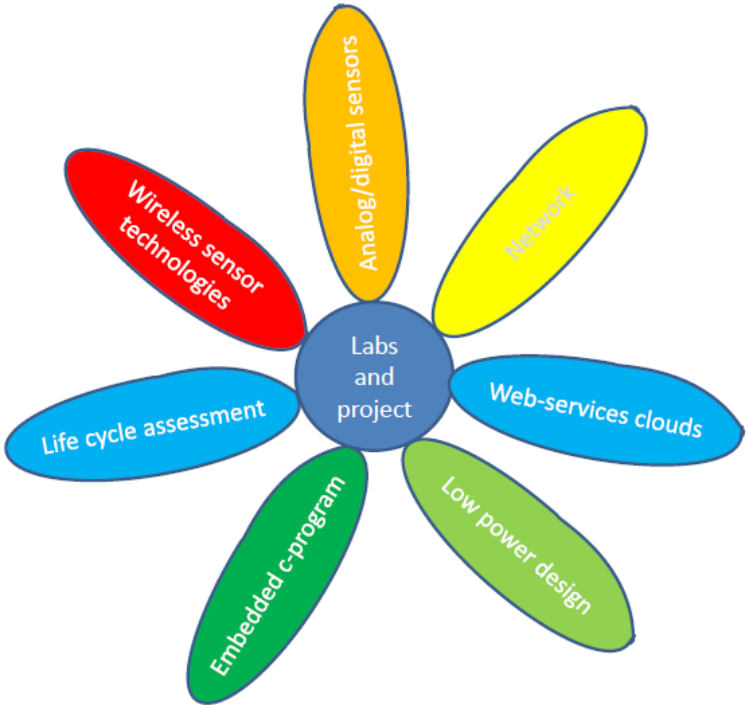
DTU Diplom
Center for Bachelor of Engineering Studies

Didactic Framing

- SUSIE during 13 week course - 10 ECTS
- Overall learning goal:
  - –design for sustainability
    in low power wireless sensor system



- 2 times 4 hours per week
  - 9 weeks with
    - 1 lecture and assignment/exercise
    - 1 Lab-afternoon
  - 4 week self-chosen team-project

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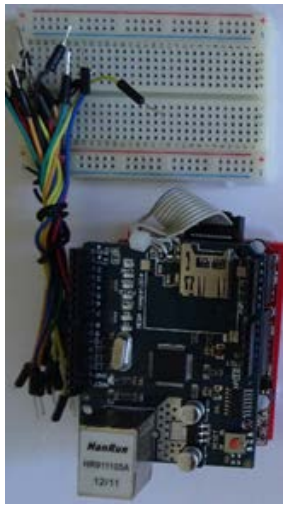
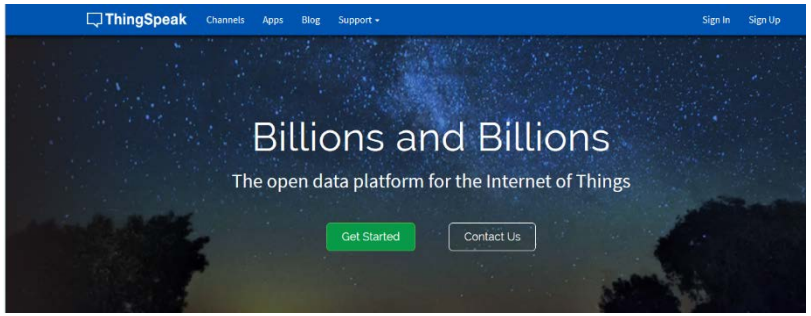
Materials - The susie kit



Bread-board /wires and a arduino (Olimexino)



Thingspeak.com cloud server

internet

Sensors

Wireless nodes

RaspBerry Pi

Course web site http://www.sustainableelectronicit.org/

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Lab exercises:

- Using digital and analog sensors together with the Arduino board
- Setting up a IEEE802.15.4 network using Xbee modules
- Embedded client-server controls of actuators
- REST web-service-api –using a given service ex thingspeak.com
- Energy consumption in an embedded system
- LCA analysis on the Xbee module

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Example on lab-exercise text

- Lab-exercise about Sensors
- Get a SUSIE-kit in the component hand-out - share one kit in groups of 3 to 4 students
- A NTC resistor 10 kohm @25^{o}C
- A LDR resistor
- A LM35 temperature sensor
- A Phototransistor SFH309
- A DSB20 Dallas one wire temperature sensor and DHT22/AM2303
- Use someDo some projects in atmel studio and use an appropriate library for the sensor

- Reflect and think
  - Look at the results - **How would you evaluate these results** –
  - **Find out to convert the sampled data to relevant units** and send the results out on the terminal presented in correct units ^{o}C and lux - the math.h library can support or use the map function or ?
- **Be ready for showing a demo in the next class the 11 th Sep.**

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Assignment example

- Study chapter 9 in interconnecting smart objects using IP.
- In your group answer these questions
  a. **Compare the different encoding-formats** for data in XML, JSON, CSV – which one is requiring least and most amount of ascii chars?
  b. Web-service – how would you describe that and compare it with c.?
  c. What is a REST – service – explain and compare with b

- Skim part 9.3 and Study the documentation for the API for thingspeak.com –
  – **How should a post request be formatted** API.
  – What is the security mechanism.

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Lab-exercises and studies leads to project

- Conclusion
  - Based on 8 lab-assignments the project can be implemented

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Some examples

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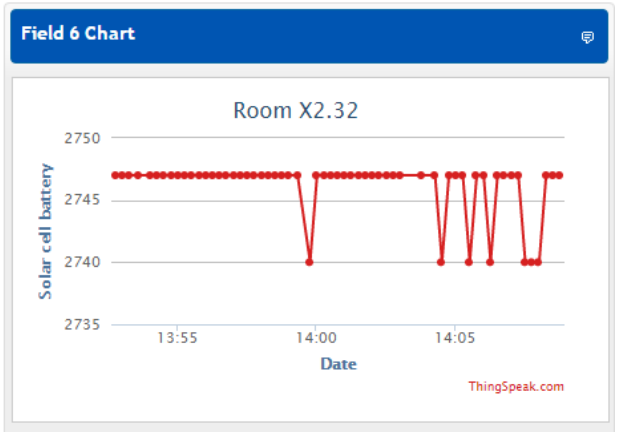
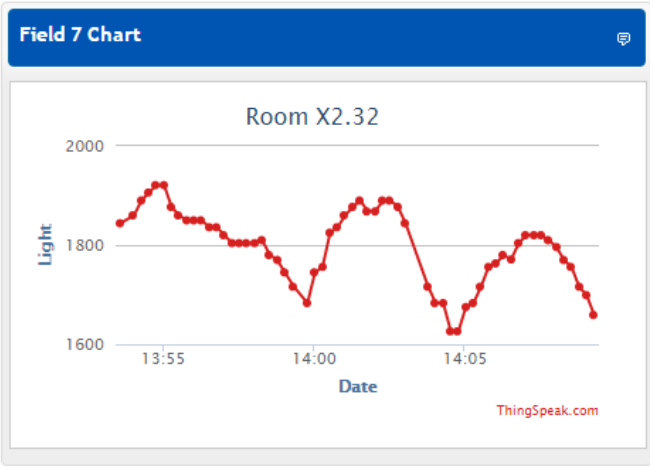
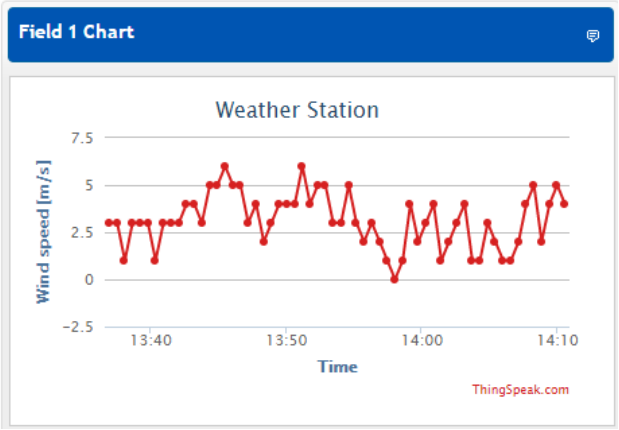
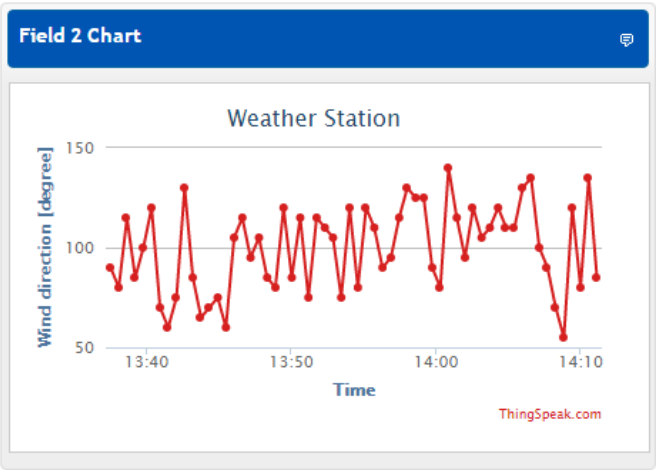
Weather data to the thingspeak.com -free cloud service









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A problem formulation

Heat control is a crucial part of our life. Whether we are living in house or flat we are involved. It is however making up a decisive part of our utility. Another fact is that we spend most of the time during a day away from home, but we still would like to return to a comfortable, warm home. It is a waste of resources to let the heat running all day long. How nice it would be to control the temperature somehow while we are away.

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Problem based project work

- Examples Indoor Climate in a house or class room
  - Low power temperature measurement and control of a model house

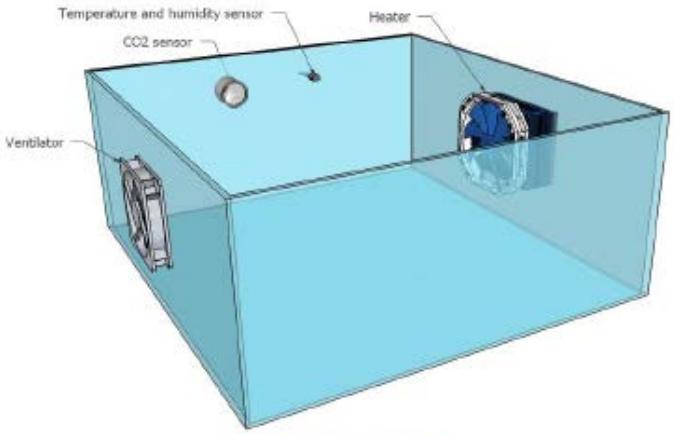

Figure 1: The room model

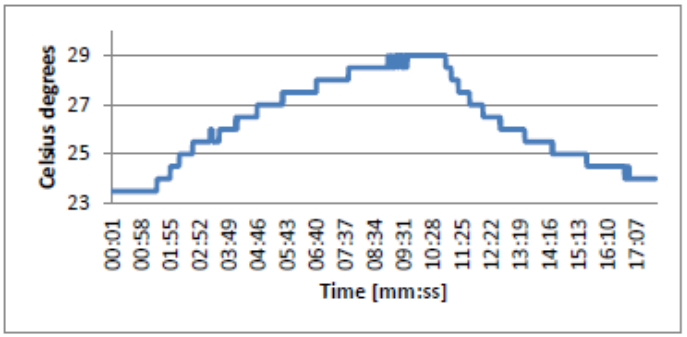

Figure 16: Test of the room model. Heat up and cool down time.

Energy harvesting

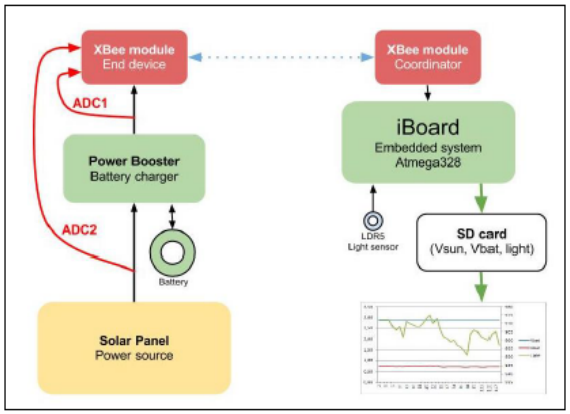

Figure 23: Test setup

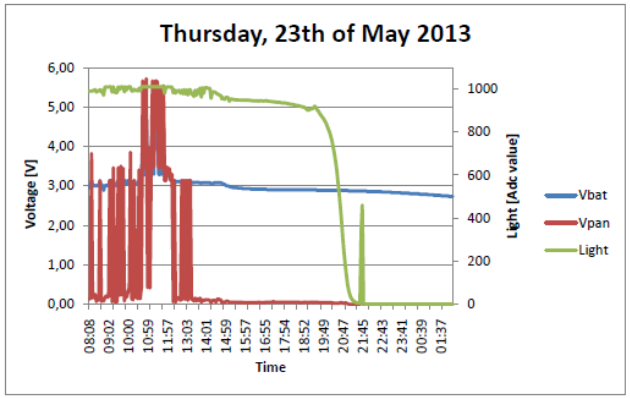

Figure 24: Reading from the XBee – Thursday

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LCA example - the MECO method used on XBee

LCA comparison method: MECO: Materials, Energy, Chemicals and Others

1. Define the Function unit
   ex. the wireless transmission of some data
2. Separate the device in pieces and get the weight for each part
3. Use Sigma Pro database calculate energy and mPR/kg

XBEE module			
Raw materials	Total quantity [kg]	mPR/kg	mPR
Aluminium	4.54E-03	1.5	0.006812
Chromium	1.50E-04	2.3	0.000346
Copper	8.90E-04	16.5	0.014682
Gold	5.96E-06	90000	0.536000
Iron	6.63E-03	0.08	0.000530
Lead	1.45E-05	80	0.001163
Nickel	3.73E-04	106	0.039544
Silver	9.07E-06	19000	0.172322
Tin	7.99E-05	90	0.007191
Zink	4.72E-05	33	0.001558

XBee module		
Energy resources	Total quantity	Total Energy Consumption
Renewable	0.604 MJ	0.60 MJ
Crude oil	0.0432 kg	2.16 MJ
Natural Gas	0.0575 m^3	0.20 MJ
Coal	0.21 kg	6.32 MJ
Total		9.28 MJ

mPR/kg: milli person resource per kg material
Highest number indicates scare resource

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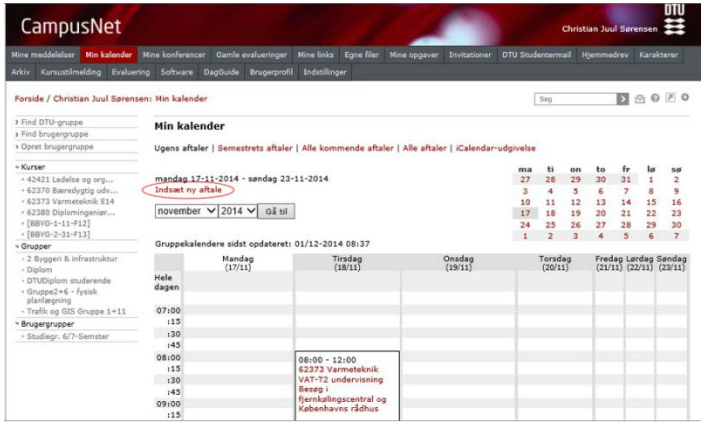
Room booking in sustainable design and production (SDTU) + SUSIE

Two different groups in the two courses cooperated



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Assesment

- Group presentation 5 minuttes per student
- Individually exam in the project and the curriculum for 15 minuttes
- Grade is given based upon quality of the report, project and the general understanding

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Thank you!

- Questions?

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Litterature list

- Litt. 1 Interconnecting Smart Objects with IP:

  The Next Internet, Jean-Philippe Vasseur and Adam Dunkels, Publisher Morgan Kaufmann imprint of Elsevier, 2010, ISBN 978-0-12-375165-2
- Litt 2: The Internet of things – key applications and protocols by Olivier Hersent, David Boswarthick, Omar Elloumi, Wiley 2012, ISBN97811199435 - Free at DTU – library as e-book. Use this http://findit.dtu.dk/
- Lit.3 Building Wireless Sensor Networks: with ZigBee, XBee, Arduino, and Processing [Kindle Edition], Publisher: O'Reilly Media; 1 edition (December 14, 2010) ISBN: 0596807732 (BWSNWZ) – can be downloaded from DTU's library
- Lit. 4: Introduction_microcontroller_on_the_Network.pdf
- Lit. 5: Green Mobile devices and Networks - energy Optimization and Scavenging Techniques, HrishiKesh Venkataraman and Gabriel-Miro Muntean, editors, Publisher CRC Press, 2010 ISBN 978-1-4398-5989-6 (GMDN)
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- Lit. 7: Network essentials 3rd edition, Jeffrey S. Beasley and Piyasat Nilkaew, publisher 2012 by Pearson Education (NE)

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