The Abdus Salam
International Centre
for Theoretical Physics

Developing a low-cost WSN for environmental monitoring

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Workshop on Scientific Applications for the Internet of Things

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Project requirements

- Lower the costs as most as possible
  - Available off-the-shelf WSN solutions were not a choice
  - Founding through students' donations. No financial support from University
- Short development time
  - Show us you can build a working prototype before December 2014 and the project is yours

Technical requirements

- Low power
  - Continuous operation during at least one month
- Wireless connectivity within a 20 m. range indoors
- Data visualization through web interface
- Local data logging
- On-the-fly sampling periods customization

Measured variables

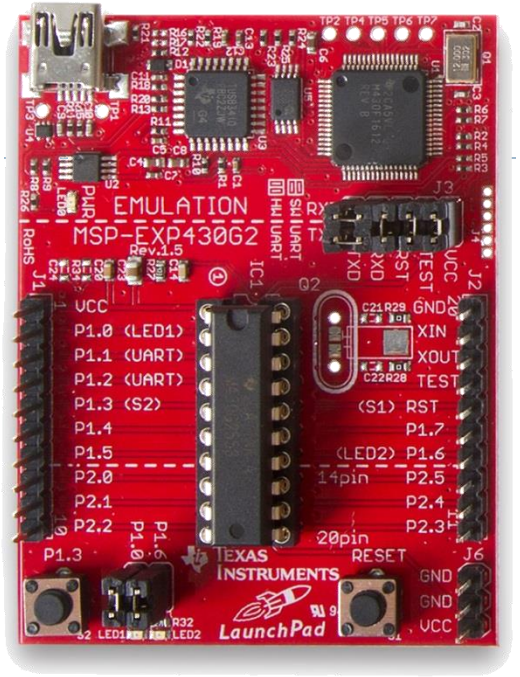
- Temperature
  - Resolution
    - +/- 1 °C
  - Range
    - 5°C to 40°C
- Humidity
  - Resolution
    - +/- 5%
  - Range
    - 10% to 100% range
- Atmospheric pressure
  - Resolution
    - +/- 1 hPa
  - Range
    - 700 hPa to 1100 hPa
- Illuminance (visible light spectrum)
  - Resolution
    - 10 lux
  - Range
    - 0 lux to 50000 lux

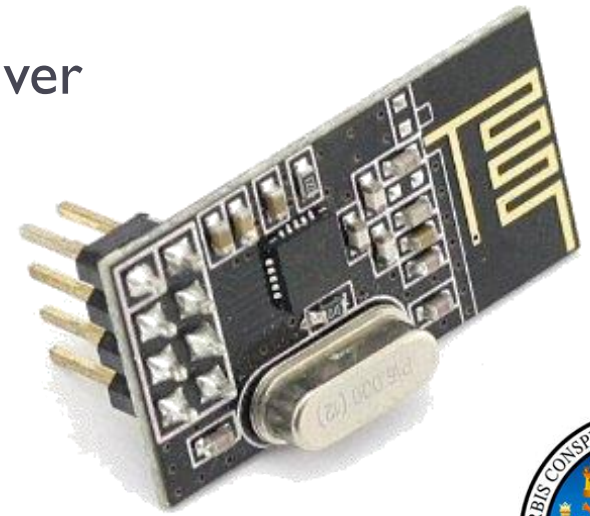
Modularity requirements

- Adding more sensors shouldn't be a big deal
- Nodes should support actuators through expansion boards

Chosen solutions

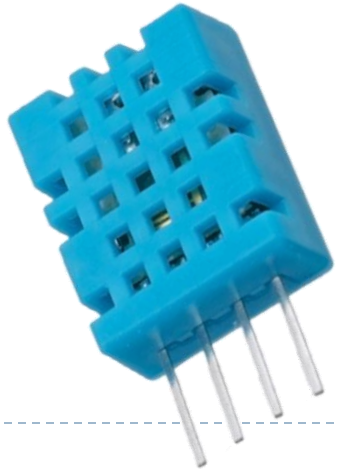
- Nodes
  - Texas Instruments' Value-line MSP430 microcontrollers
  - Nordic NRF24L01+ 2.4GHz Transceivers
- Gateway
  - Raspberry PI B+
  - Nordic NRF24L01+ 2.4GHz Transceiver
    - Tx power: +4 dBm
    - Rx sensitivity: -85 dBm
- Web interface
  - Exosite portal
    - Python API





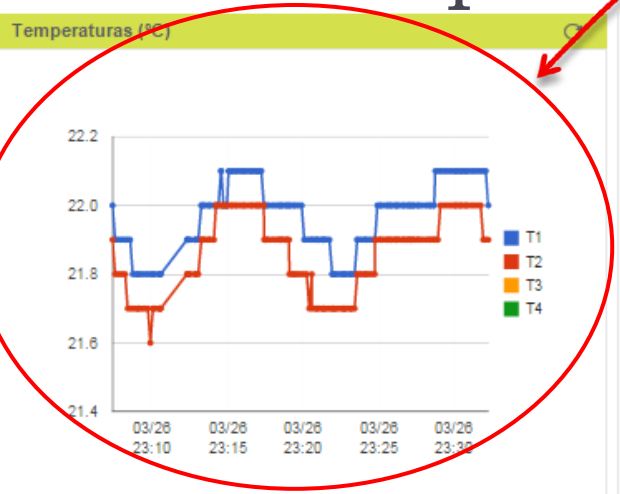
Chosen sensors

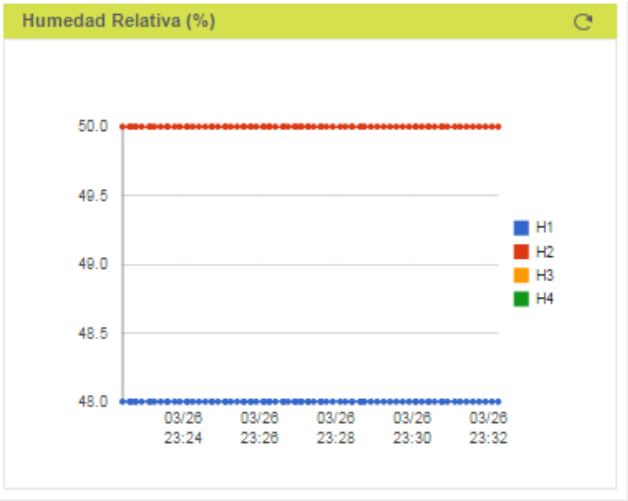
- Temperature + Pressure
  - Bosch BMP180 (I²C)
- Illuminance
  - BH1750 (I²C)
- Relative humidity
  - DHT11 (doesn't meet all requirements)
    - But still works as a proof of concept and is much cheaper than DHT22

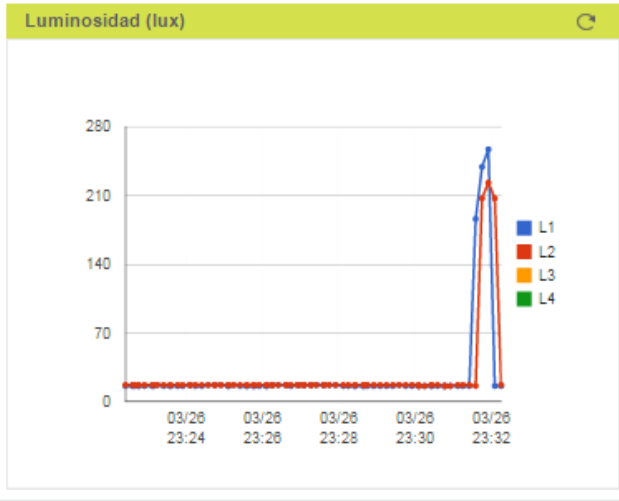


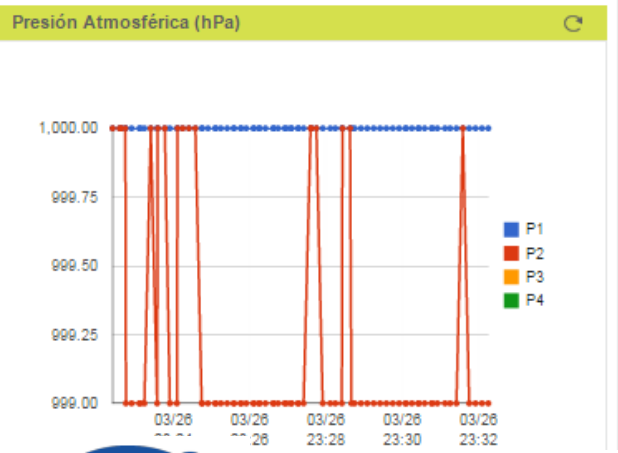
Exosite portal

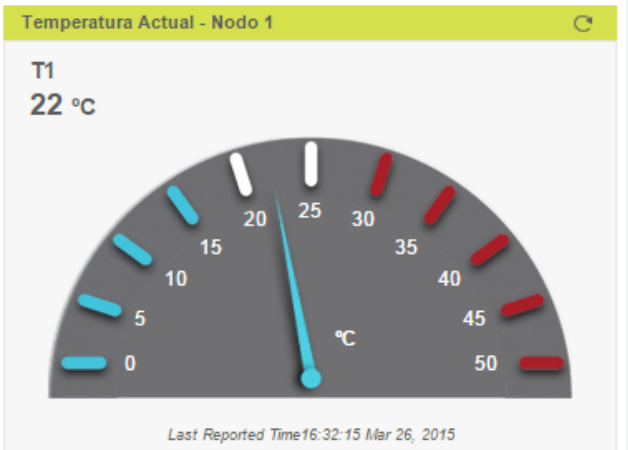
Nice temperature inside GGH dorms ☺!

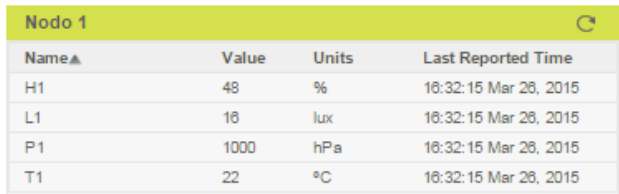








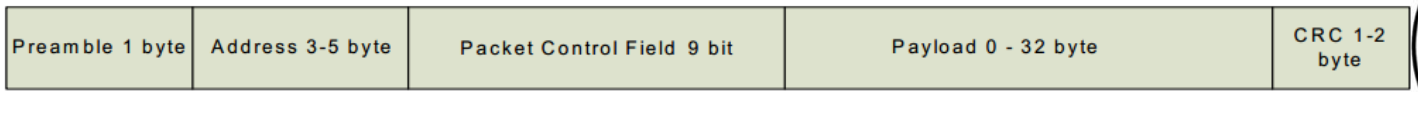




Name	Value	Units	Last Reported Time
H1	48	%	16:32:15 Mar 26, 2015
L1	16	lux	16:32:15 Mar 26, 2015
P1	1000	hPa	16:32:15 Mar 26, 2015
T1	22	°C	16:32:15 Mar 26, 2015

Achieved results

- Remember, this is a project into development stage!
  - Suggestions kindly accepted ☺
- Star-topology WSN
- Low power
  - Battery lifetime of 40 days (sampling every 15 minutes)
- Up to 16 nodes (software dependent)
- No hopping supported
- Low cost
  - Less than $12 each node (including sensors)
  - Gateway costs about $60
- Relatively long indoor range
  - Up to 30 meters, depending on walls' composition
  - More than what was expected from 2.4GHz + GFSK @ 1Mbps
    - These radios are great, even with Auto-retransmission disabled



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