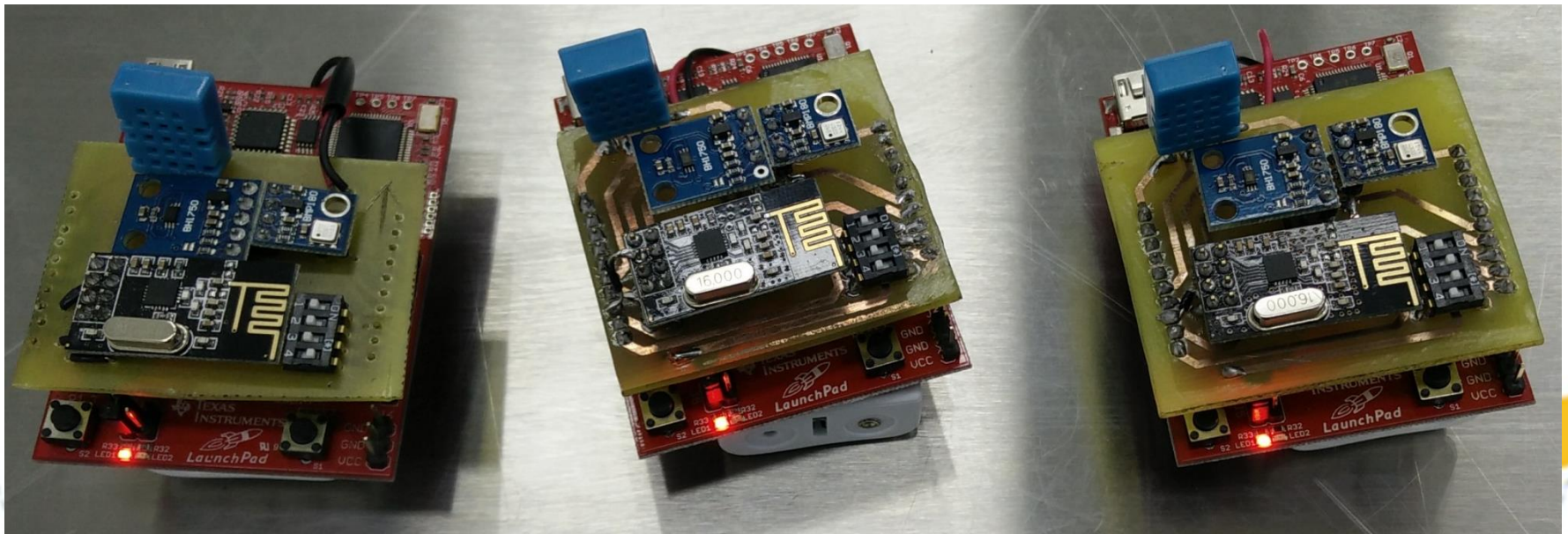


Using Arduino for Scientific Research in Guatemala

Iván René Morales
Universidad de San Carlos, Guatemala
Trieste, Italy, March 28th 2015

Case study

- ▶ Developing a low-cost and reliable Wireless Sensor Network in a record time



Project requirements

- ▶ **Lower the costs as most as possible**
 - ▶ Available off-the-shelf WSN solutions were not a choice (ZigBee, 6LoWPAN, etc.)
 - ▶ Funding through students' donations. No financial support from University
- ▶ **Short development time**
 - ▶ Arduino-based libraries were the fastest trustable well-known developing tools. They are open source and easy to work with!



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



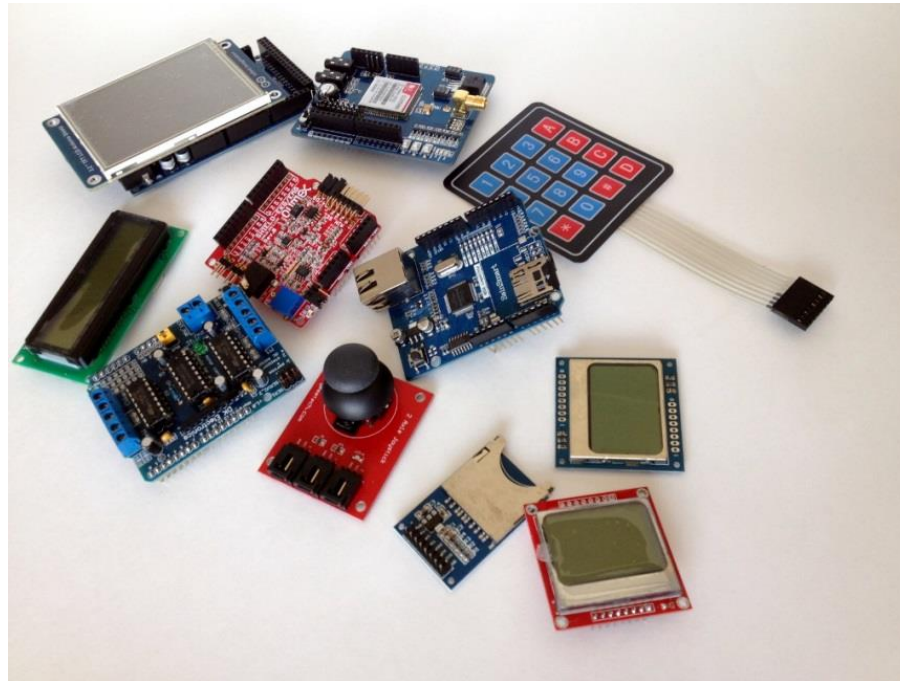
Measured variables

- ▶ Temperature
- ▶ Humidity
- ▶ Atmospheric pressure
- ▶ Illuminance (visible light spectrum)



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

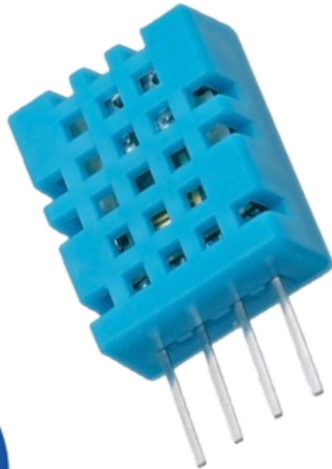
▶ Web interface

- ▶ Exosite portal
- ▶ Python API

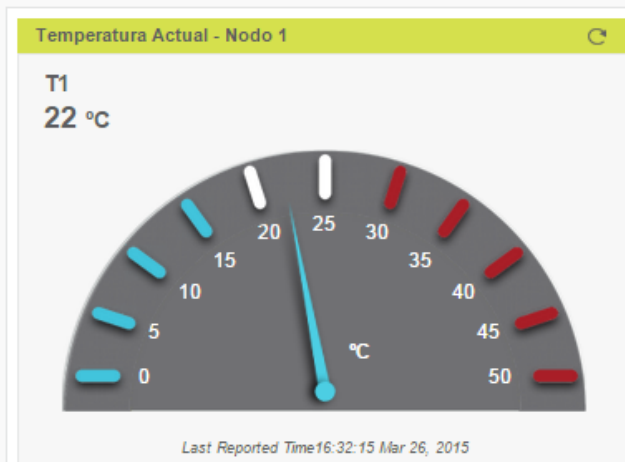
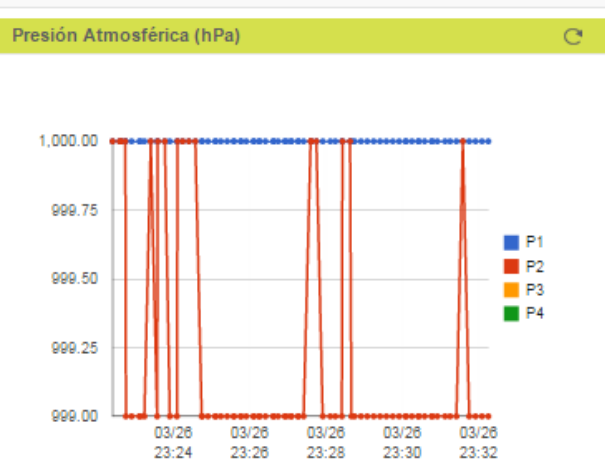
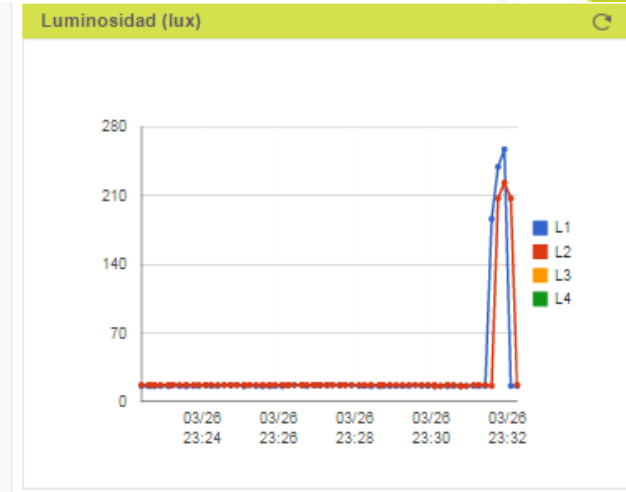
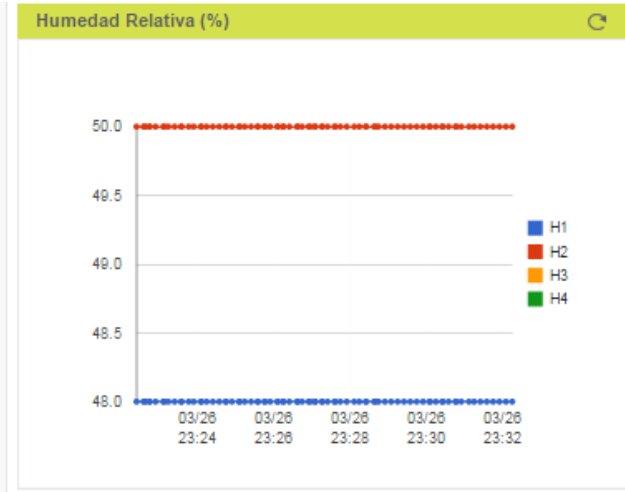
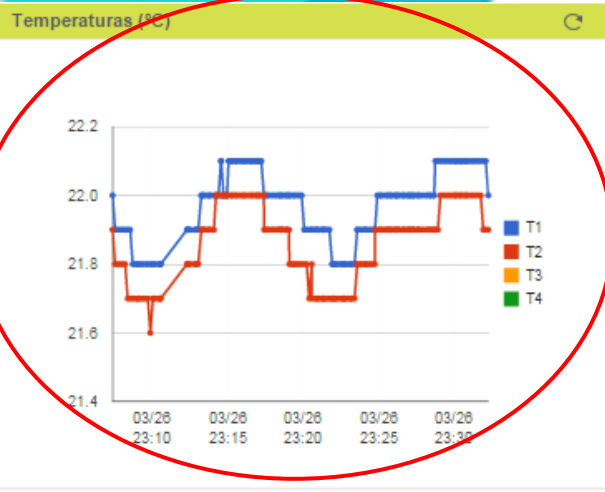


Chosen sensors

- ▶ Temperature + Pressure
 - ▶ Bosch BMP180 (I²C)
- ▶ Illuminance
 - ▶ BH1750 (I²C)
- ▶ Relative humidity
 - ▶ DHT11



Exosite portal



Nodo 1

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

- ▶ Star-topology WSN
- ▶ Low power
 - ▶ Battery lifetime of 40 days (sampling every 15 minutes)
- ▶ Low cost
- ▶ Relatively long indoor range
 - ▶ Up to 30 meters, depending on walls' composition
 - ▶ Better performance than expected of 2.4GHz radios



DEMO

Project page:

<https://github.com/imoralesgt/WSN>

