

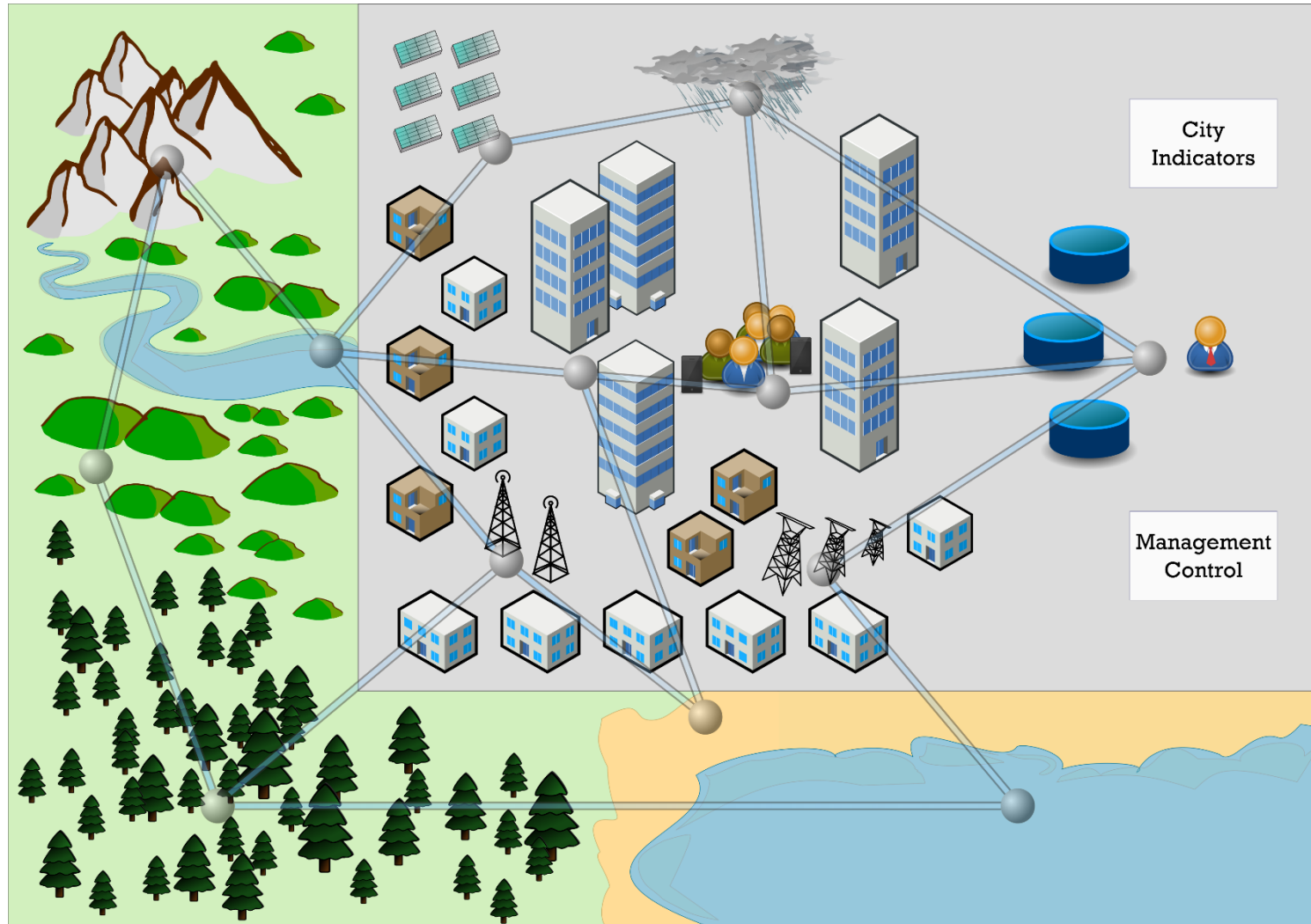


# Coupling a UDOO-based weather station with IoT Manager

*Bari, 28 September 2017*

*Luca Calderoni, Antonio Magnani, Dario Maio*

# Smart environments and IoT





# IoT Manager

---

IoT Manager is a general ICT architecture designed to manage several subsystems in urban and suburban contexts.

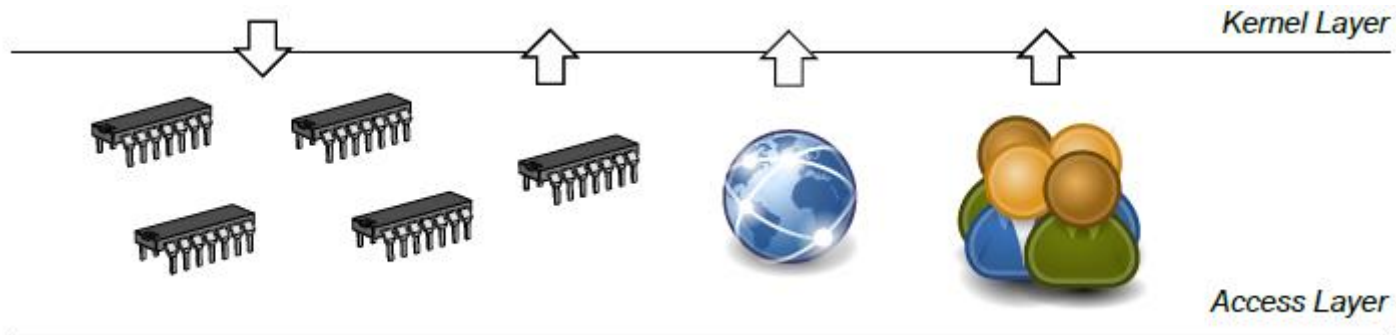
**The main aim of this framework is to enable an hands-on approach for our students during our Master's degree course.**

**«Smart City e Tecnologie Mobili»**

The framework is designed with respect to the three-layered scheme proposed by the author in the recent past.

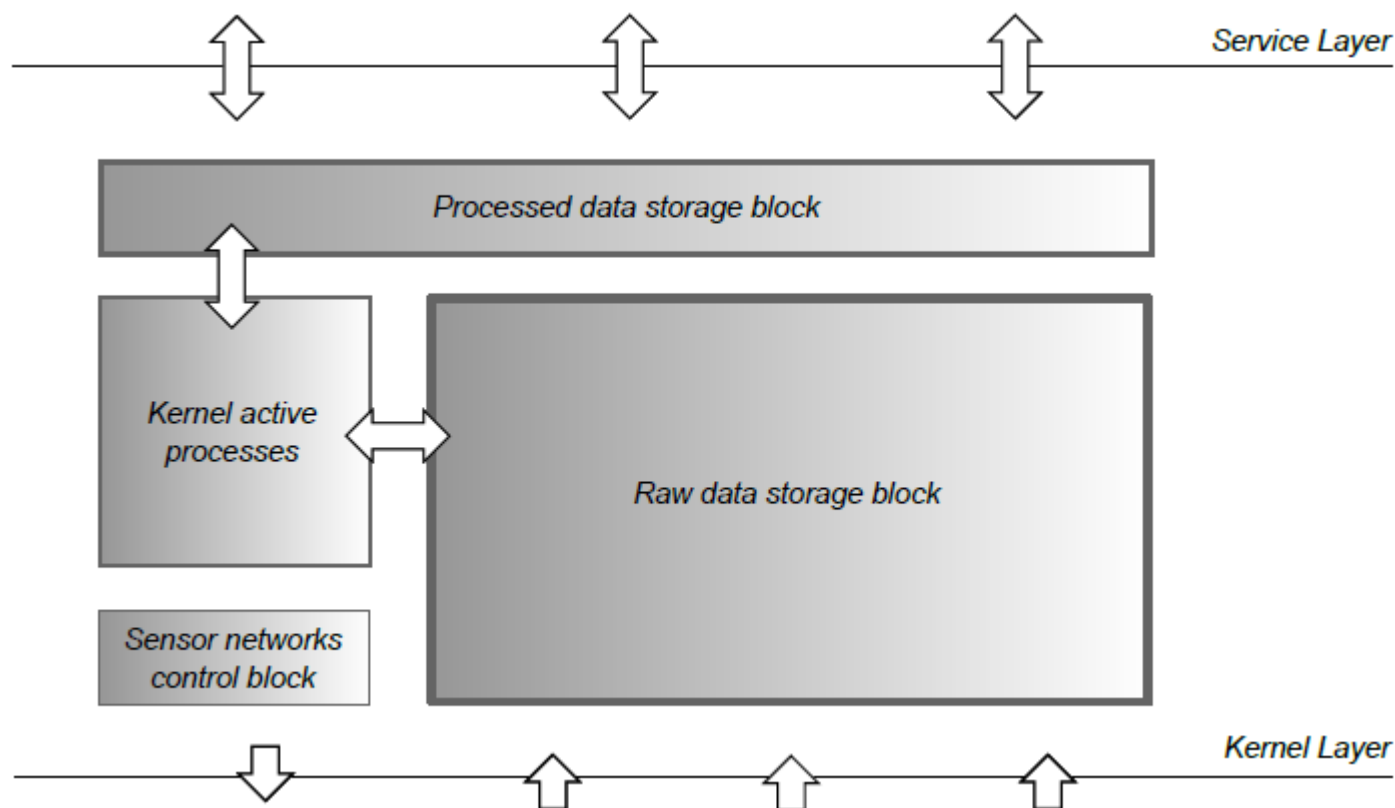
# IoT Manager: sensing layer

- This layer consists of a number of heterogeneous sensor networks. These subsystems may be deployed all around the globe and are responsible for raw data collection.



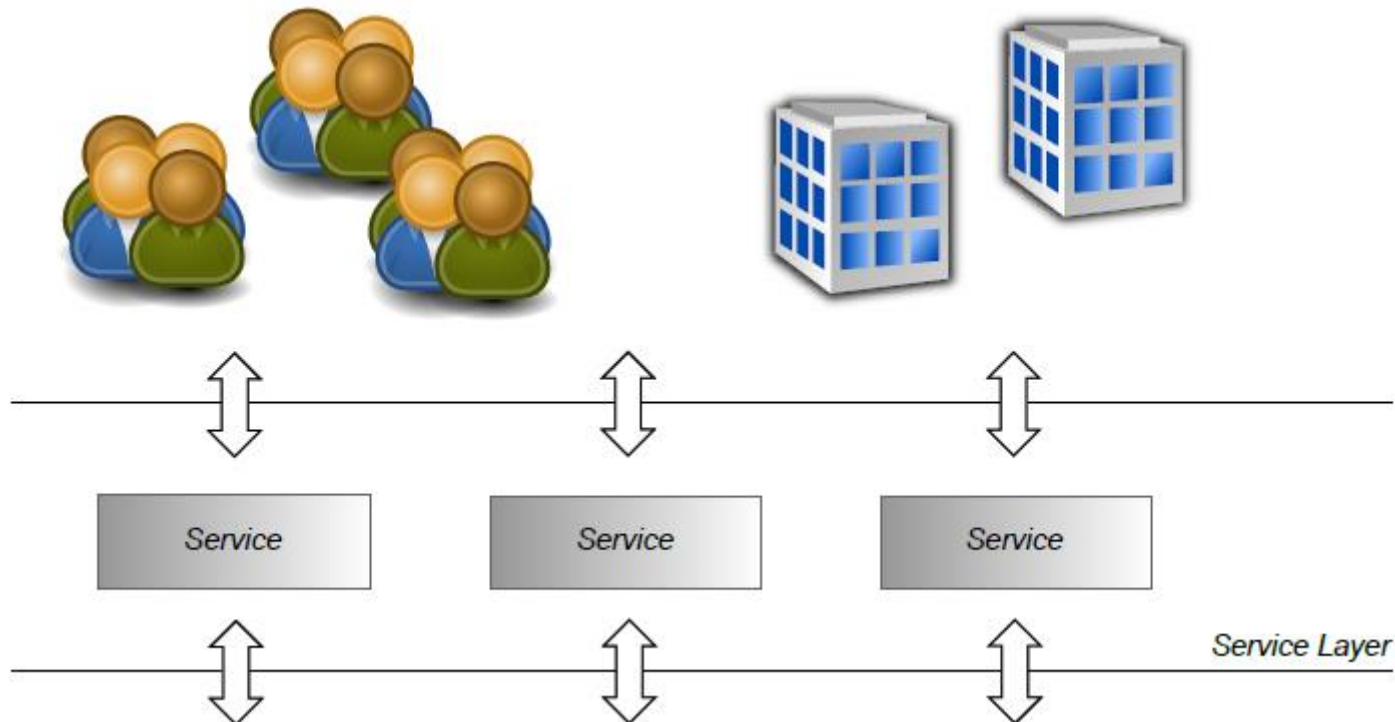
# IoT Manager: data layer

This layer represents the back-end of the system and sports two main features: on the one hand, it serves as a repository for all of the sensed information, on the other hand, it provides several API which may be called by client applications in order to query those data and retrieve them in a properly arranged format.

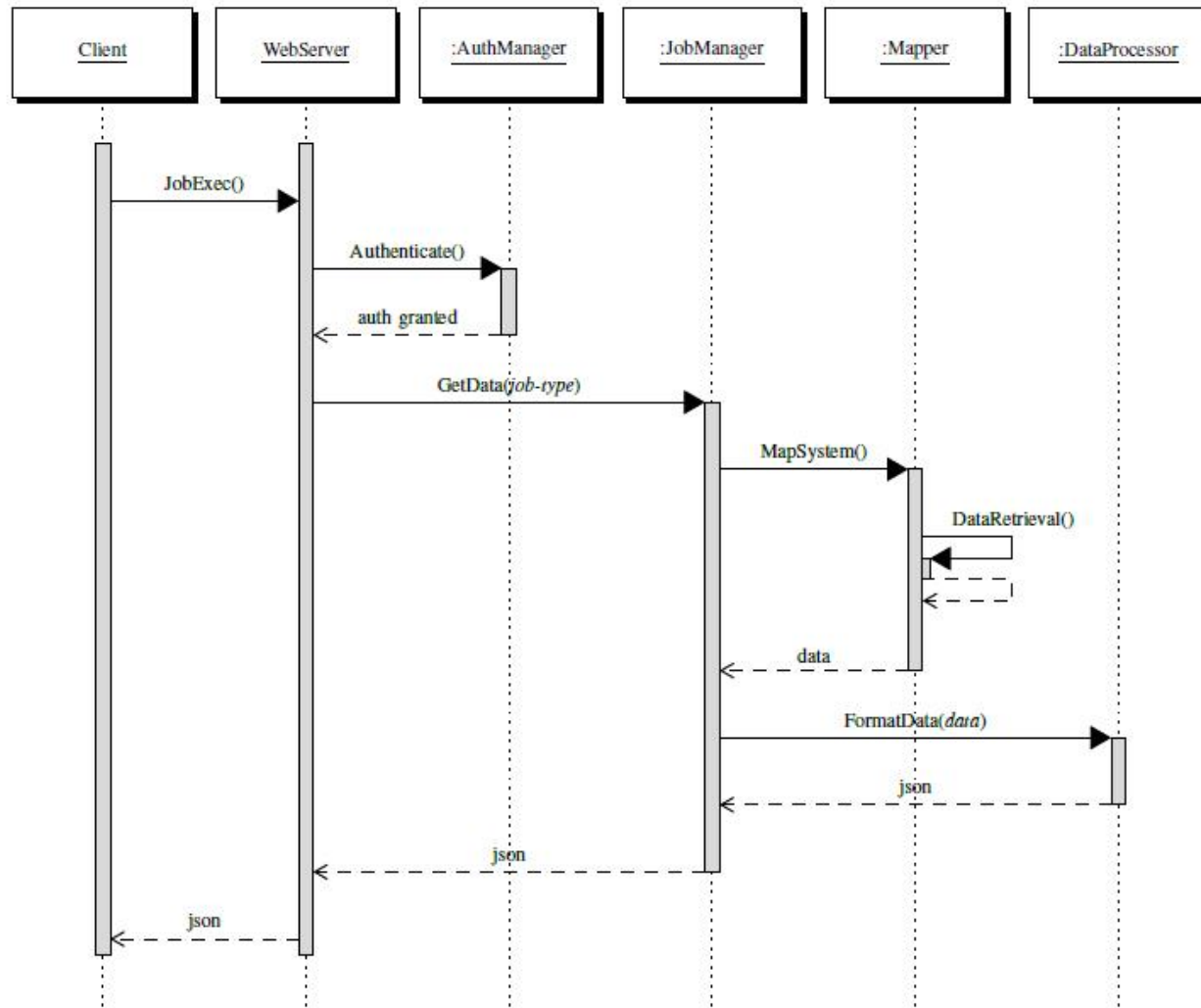


# IoT Manager: service layer

- The service layer consists of a number of client applications. The one here proposed is designed for mobile devices and asks the backend for sensor-related information. Clients are subject to a specific access policy and handle geo-referenced data.



# IoT Manager: request processing





# A simple weather station

---

We developed a simple weather station based on the UDOO board.

**Udoo:** A cheap and simple multipurpose board

**Udoo bricks:** cheap sensors which can be plugged to the I2C (serial) port in a cascade fashion.

- MPL3115 (*Altitude, Pressure, Temperature*)
- TSL 2561 T (*Luminosity*)
- SI 7006 A 20 (*Humidity, Temperature*)

Other (non-udoo) sensors were connected to the board in order to obtain a wider and more diversified set of data.

- Grove Gas Sensor MQ3 101020006 (*Gas Concentration*)
- Grove Dust Sensor 101020012 (*Dust concentration*)

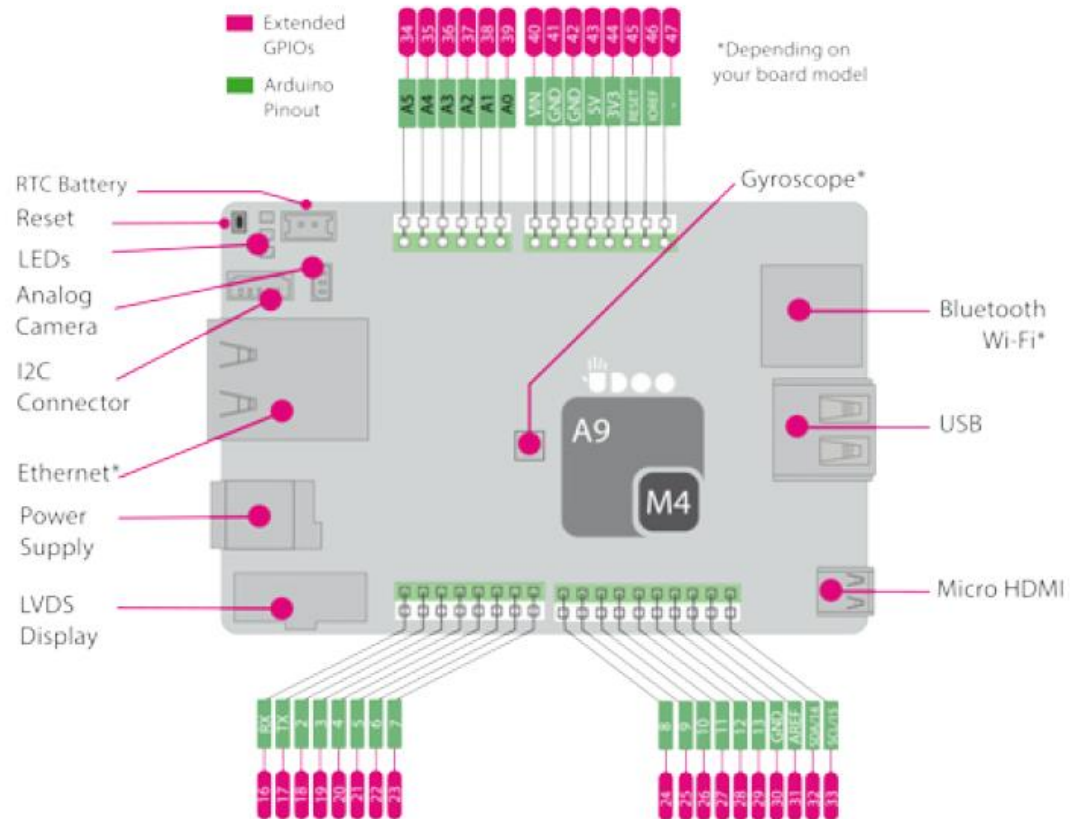


# The Udoo Neo Board

UDOO NEO is an **Arduino-powered Android / Linux single board computer** enriched with 9-axis motion sensors, Bluetooth 4.0 and a Wi-Fi module.

## Processor:

- 1GHz Cortex-A9 (Linux os)
- 200 MHz M4 I/O realtime coprocessor (Arduino)



# Udoo Bricks

Plugged through the **I2C snap-in connector** with the related cable. UDOO BRICKS work along a cascade configuration, so you can attach them all together without wasting space in a truly intuitive way.

## LIGHT



- 16bit digital output with I2C fast mode at 400KHz
- Supply voltage range from 2.7V to 3.6V
- Operating free air temperature from -30°C to 70°C

- Pressure: 20-bit measurement (Pascals): - 20 to 110 kPa
- Altitude: 20-bit measurement (meters): 698 to 11,775 m
- Temperature: 12-bit measurement (°C): -40 °C to 85 °C

## BAROMETER



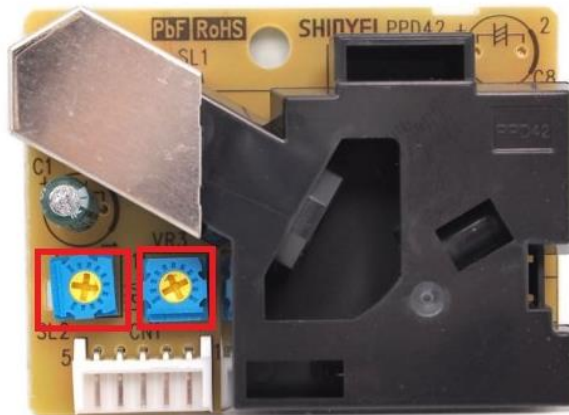
## HUMIDITY



- Precision Relative Humidity Sensor  $\pm 5\%$  RH (max), 0–90% RH
- High Accuracy Temperature Sensor  $\pm 1^\circ\text{C}$  (max), -10 to 85 °C
- Wide operating voltage (1.9 to 3.6 V)
- Factory-calibrated

# Grove Sensors

In order to plug the grove sensors we used an expansion Base Shield and we used the power regulator to uniform the power voltage.



## **DUST sensor 101020012**

- Detectable range of concentration 0-28.000 pcs/liter
- VCC 4.75-5.75 V
- Operating temperature 0-45°C
- Operating humidity 0-95%



## **GAS sensor MQ3 101020006**

- Detectable range of concentration 0.05-10 mg/liter
- VCC 4.9-5.1 V

# Lifecycle

Arduino  
Microcontroller (M4)

- Runs the main sketch
- Senses data through sensors

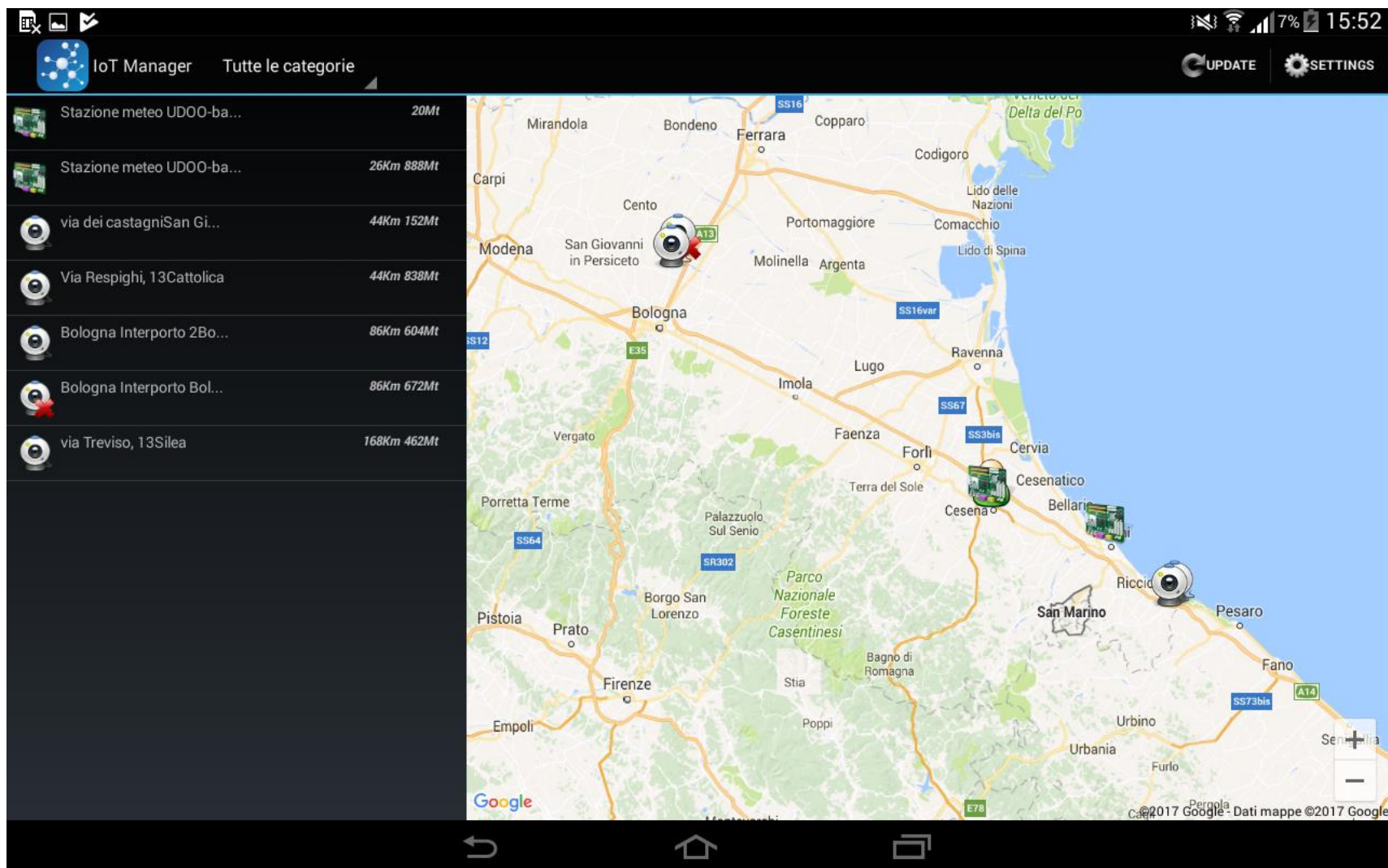
Linux OS  
(main core)

- Runs a python script via crontab
- Catches data from serial port

IoT Manager  
back end

- Exposes a PHP API
- Collects data through HTTP POST

# IoT Manager: client side (1)



The screenshot displays the IoT Manager application interface. The top bar includes the title 'IoT Manager', a 'Tutte le categorie' dropdown, and 'UPDATE' and 'SETTINGS' buttons. The left sidebar lists several IoT devices with their names, distances, and data usage.

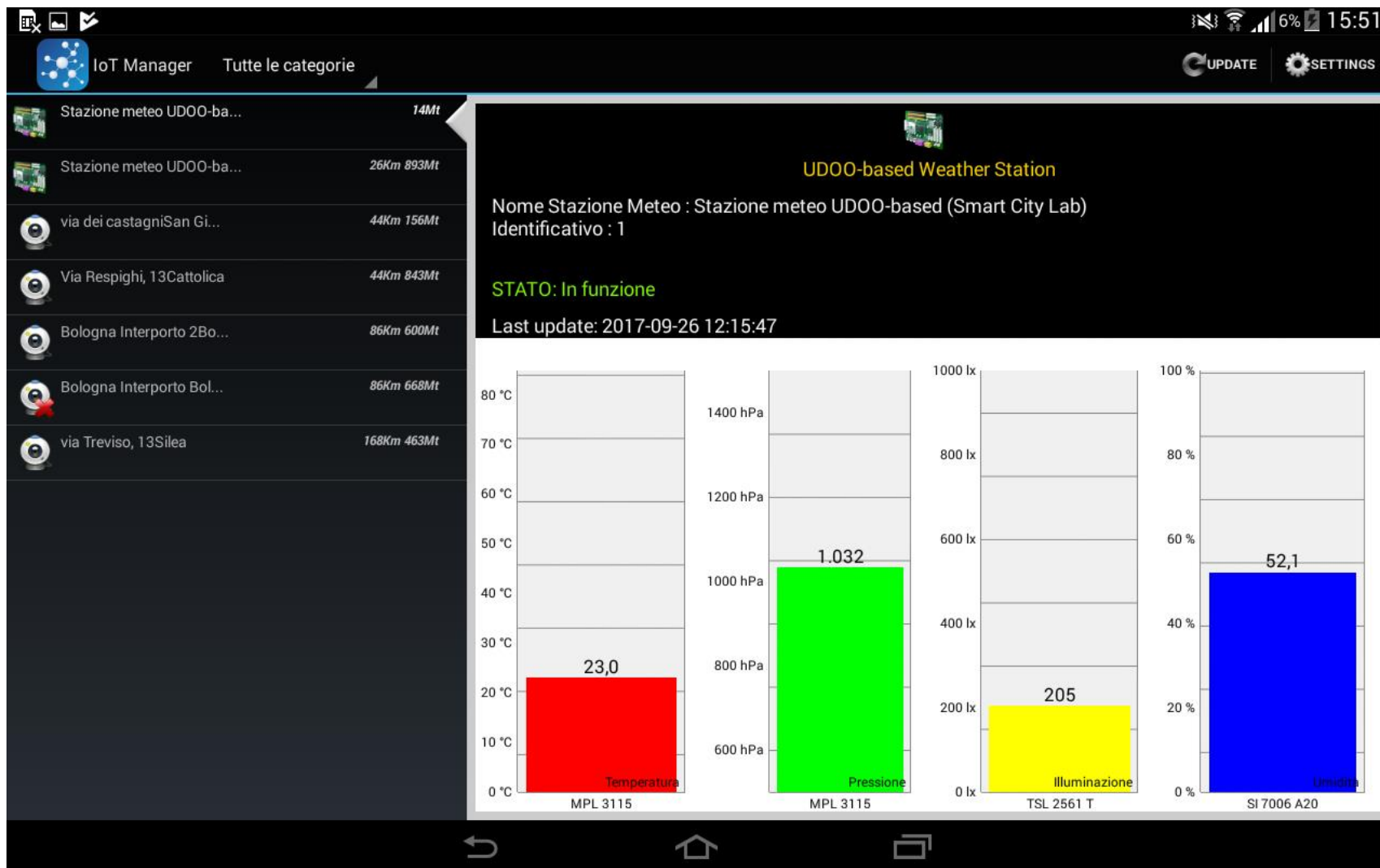
Device Name	Distance	Data Usage
Stazione meteo UDOO-ba...	20Mt	
Stazione meteo UDOO-ba...	26Km	888Mt
via dei castagniSan Gi...	44Km	152Mt
Via Respighi, 13Cattolica	44Km	838Mt
Bologna Interporto 2Bo...	86Km	604Mt
Bologna Interporto Bol...	86Km	672Mt
via Treviso, 13Silea	168Km	462Mt

The main area shows a map of the Bologna region with various IoT devices marked as camera icons. The map includes labels for cities like Bologna, Modena, Ferrara, and Ravenna, as well as roads and geographical features. The bottom of the screen shows standard Android navigation icons.





# IoT Manager: client side (2)



# Weather Station Cost

Udoo neo	Udoo bricks Baromet er	Udoo bricks Light	Udoo bricks Humidity	Grove Gas MQ3	Grove Dust	Base shield
\$ 49.90	\$ 9.90	\$ 8.50	\$ 8.90	\$ 10.50	\$ 20.90	\$ 11.40

Total cost:  
**\$ 120.00 → € 101.00**

# Conclusion (1)

---

- We have developed a small and cheap weather station
- It is based on the Udoo board, udoo bricks and grove sensors
- The station was provided with an API able to communicate with IoT Manager back end
- A proper class specialization was developed as well on IoT Manager client in order to display the gathered data correctly.

## **Future research:**

We are looking forward to connect a wider set of sensors to this board in order to extend the variety and precision of the gathered data.



# Conclusion (2)

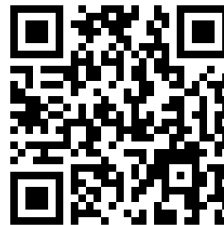
---

**Thank you!**

We have implemented IoT Manager Android client and we released the code for teaching purposes.

All the code is free for use (LGPL) and can be reached here:

<https://github.com/smartcitylabunibo>



**For more information:**

*smartcity.csr.unibo.it*



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA  
CAMPUS DI CESENA

**Luca Calderoni**

Dept. of Computer Science and Engineering

[luca.calderoni@unibo.it](mailto:luca.calderoni@unibo.it)

*[www.unibo.it](http://www.unibo.it)*