

Laboratorio IoT



Prof. Paolo Napoletano

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Smart Monitoring

Team

- **Gabriele Ferrario 817518**

Materials

Description of the ingredients employed

Components:

- 1x NodeMCU 1.0 (ESP8266)
- 1x 16x2 characters LCD display + PCF8574 I2C converter
- 1x DHT11 temperature and humidity sensor
- 1x Photoresistor
- 1x SW-520D roll ball tilt sensor
- 2x LED
- 2x 10k Ω resistor
- 2x 200 Ω resistor

Technologies:

- MQTT
- Flask
- Telegram
- MySQL
- InfluxDB



Flask



Other:

- Machine Learning
- Low power consumption

Recap

Description of the previous system

Assignment 1:

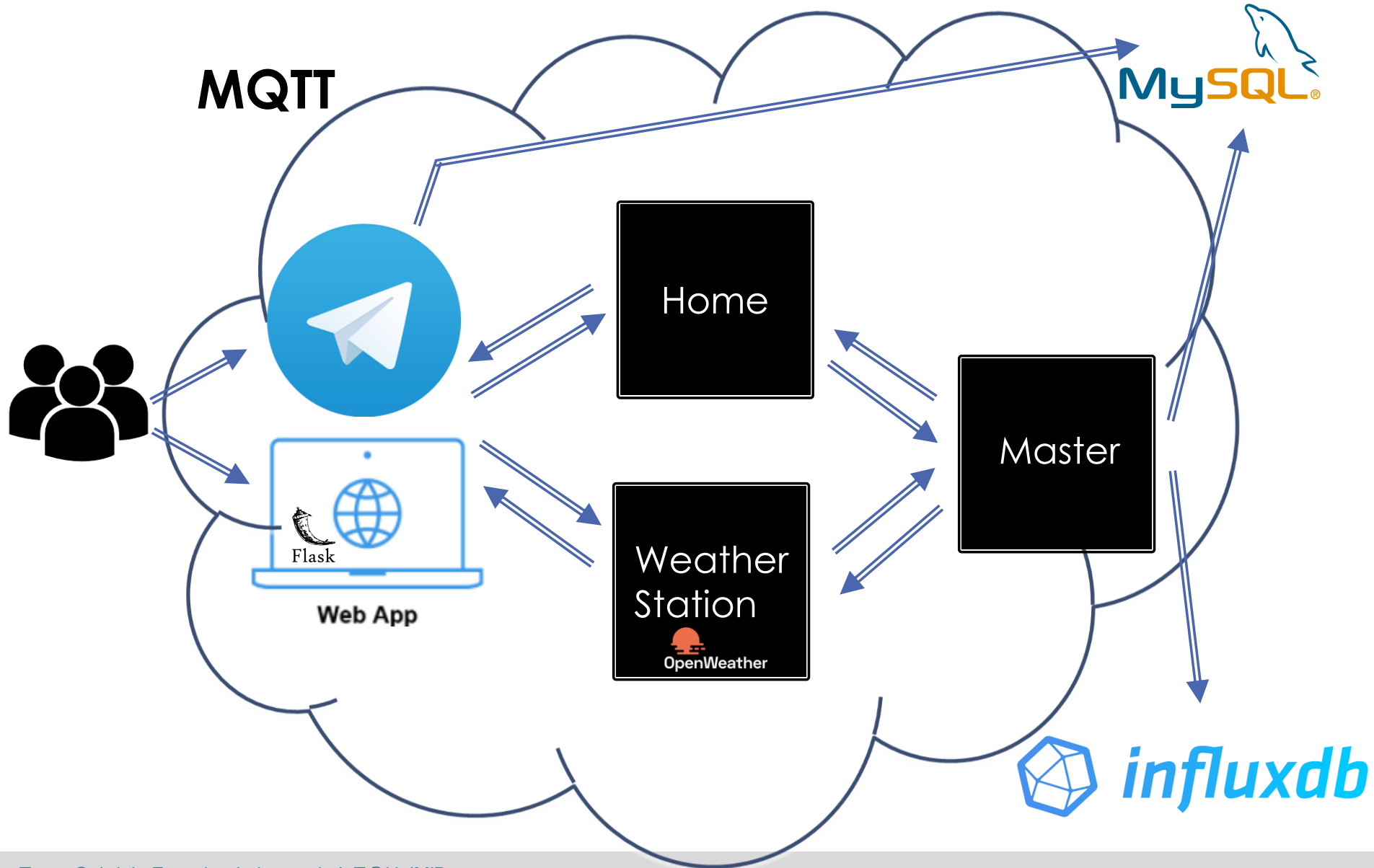
- **Home monitoring** system
- **Detection** of alert events
- **Web Server** on NodeMCU
- Constraint logging on **InfluxDB**
- InfluxDB **Dashboard**

Assignment 2:

- **Virtualization** of several **NodeMCU**
- **MQTT**
- **Weather** Monitoring
- Web Server with **Flask**
- **MySQL** for monitoring NodeMCUs
- Dynamic thresholds

Method

Description system: choices, parameters, use cases



Method - Telegram

Description system: choices, parameters, use cases

General:

[/registerMe](#) - registers the user to the monitoring system

[/removeMe](#) - removes user registration from the monitoring system

[/setup](#) sleepTime executionTime - updates the sleep time and the execution time of the ESP8266

Home Monitoring:

[/home](#) - activates home monitoring

[/stopHome](#) - deactivates home monitoring

[/setAlert](#) sensor lowerBound upperBound - sets the thresholds for the indicated sensor

Weather Station:

[/weather](#) - activates weather monitoring

[/stopWeather](#) - deactivates the weather monitoring

[/forecasting](#) city - weather forecasting for the indicated city

Possible value for setAlert:

- 1) light lowerBound upperBound
- 2) temperature lowerBound upperBound
- 3) wifi lowerBound

Method - Telegram

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General:

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Possible value for setAlert:

- 1) light lowerBound upperBound
- 2) temperature lowerBound upperBound
- 3) wifi lowerBound



[/registerMe](#) 14:33 ✓✓

Success: registration completed 14:33

[/registerMe](#) 14:32 ✓✓

Warning: already registered 14:32

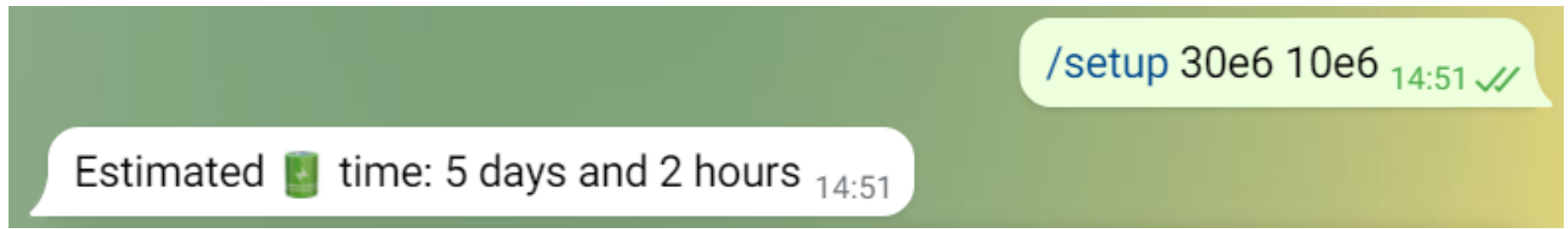
[/removeMe](#) 14:39 ✓✓

Success: deletion completed 14:39

Method – Deep Sleep

Description system: choices, parameters, use cases

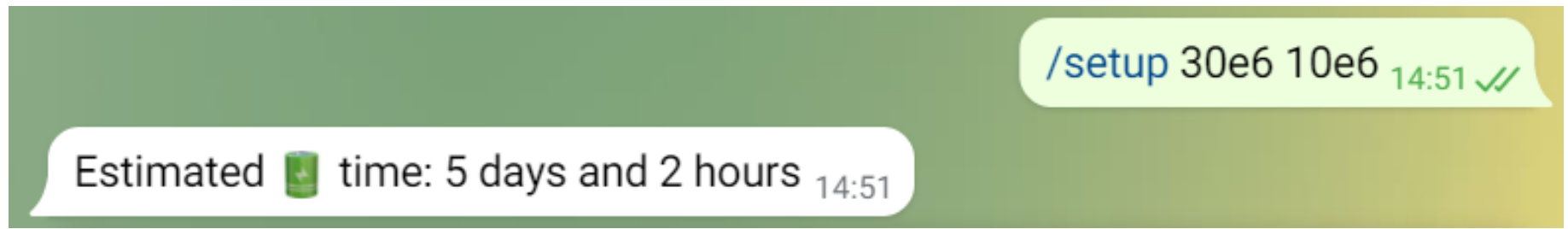
Temporaized Deep Sleep that varies according to measured values



Method – Deep Sleep

Description system: choices, parameters, use cases

Temporaized Deep Sleep that varies according to measured values



$capacity = 5200 \text{ mAh}$ $awake \text{ consumption} = 170 \text{ mA}$ $sleep \text{ consumption} = 24 \mu A$

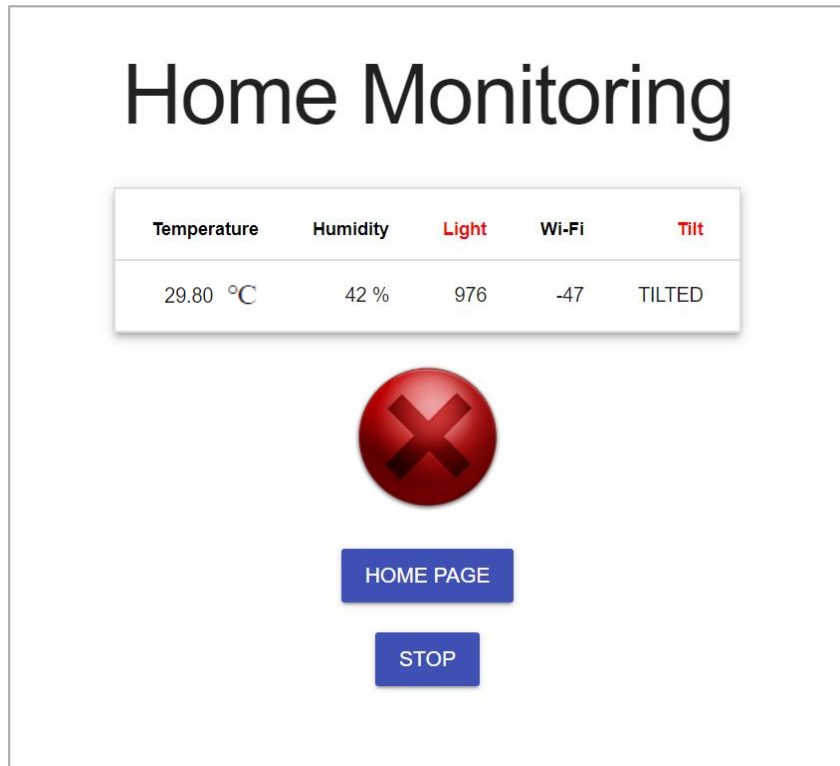
$$lifetime = \frac{capacity}{average \text{ consumption}}$$

$$average \text{ consumption} = \frac{(sleep \text{ consumption} \cdot sleep \text{ time} + awake \text{ consumption} \cdot awake \text{ time})}{(wake \text{ time} + sleep \text{ time})}$$

Method – Home Monitoring

Description system: choices, parameters, use cases

Web App




Method – Home Monitoring

Description system: choices, parameters, use cases

Web App

Home Monitoring

Temperature	Humidity	Light	Wi-Fi	Tilt
29.80 °C	42 %	976	-47	TILTED



HOME PAGE

STOP

Telegram Bot

Home Monitoring:
Temperature: 30.41°C
Light: 994 ●
Humidity: 41%
WiFi: -46
Tilt: TILTED ● 15:53

/setAlert light 200 900 12:31 ✓

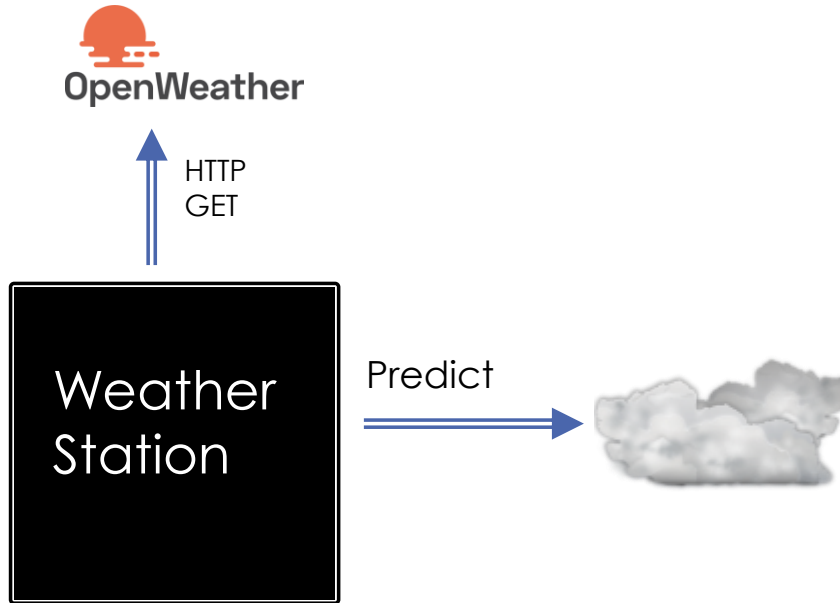
Success: light 12:31

/setAlert wifi 40 16:59 ✓

Error: wrong alerts for wifi sensor 16:59

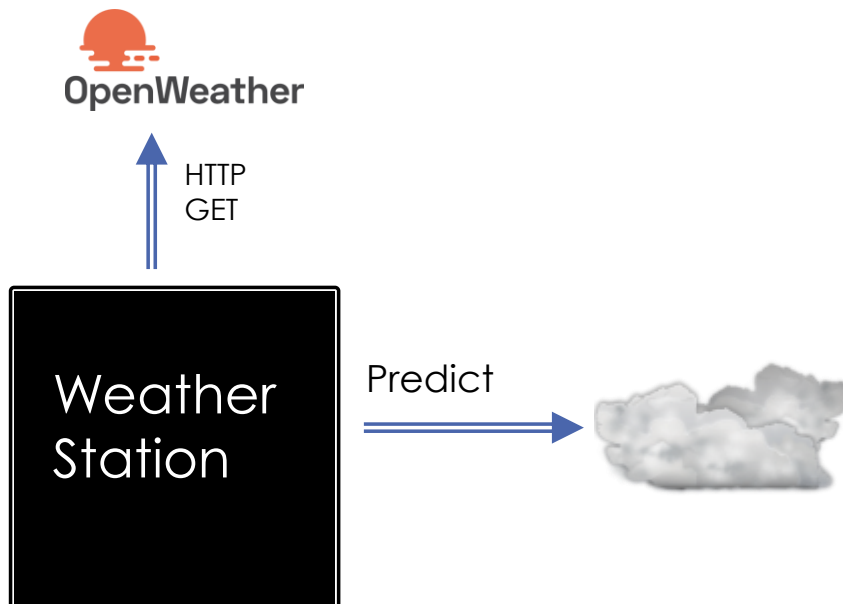
Method – Weather Station

Description system: choices, parameters, use cases



Method – Weather Station

Description system: choices, parameters, use cases



Machine Learning:

- **Weather prediction** (sun, cloudy, rain)
- Unbalanced Dataset



Oversampling (SMOTE)

- **SVM** (temperature, humidity, wind, pressure)
- **Hyperparameter optimization** (Grid Search)
- Accuracy ≈ 0.82
- **Conversion** to Optimized C code (MicroML)

<https://github.com/eloquentarduino/micromlgen>

Method – Weather Station

Description system: choices, parameters, use cases

Weather Monitoring

Temperature (°C)	Humidity (%)	Pressure	Wind Speed (m/s)	Weather
29.85	63	1008	3.6	cloudy



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STOP

Web App

Telegram Bot

Weather Monitoring:
Temperature: 30.26 °C
Humidity: 41%
Pressure: 1015
Wind Speed: 1.34 m/s
Weather: 🌞 15:59

Method – Weather Station

Description system: choices, parameters, use cases

Weather Monitoring

Temperature (°C)	Humidity (%)	Pressure	Wind Speed (m/s)	Weather
29.85	63	1008	3.6	cloudy



HOME PAGE

STOP

Weather Monitoring:
Temperature: 30.26 °C
Humidity: 41%
Pressure: 1015
Wind Speed: 1.34 m/s
Weather: ☀️ 15:59

Web App

Weather Forecasting

Date	Temperature (°C)	Humidity (%)	Pressure	Wind Speed (m/s)	Weather
2021-06-21 18:00:00	13.53	86	1014	4.56	☁️
2021-06-22 00:00:00	11.32	95	1017	4.8	☁️
2021-06-22 06:00:00	10.16	88	1018	5.06	☁️
2021-06-22 12:00:00	14.04	63	1020	4.49	☁️
2021-06-22 18:00:00	16.04	55	1021	3.68	☁️
2021-06-23 00:00:00	11.33	79	1024	2.79	☁️
2021-06-23 06:00:00	8.57	87	1024	2.21	☁️
2021-06-23 12:00:00	15.51	55	1024	3.56	☁️

HOME PAGE

Telegram Bot

Final remarks

Results, Discussion, conclusion

The system allows to:

- monitor the house and notify the users in real time
- set different alarms
- monitor the weather in real time via a Weather Station
- weather forecasting

Observation:

- simultaneous running of home monitoring and weather station can cause RAM problems

Future works:

- insert new sensor for house monitoring and replace Openweather with sensors
- predict more weather conditions
- weather forecasting via Machine Learning