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DEVELOPMENT OF A WEB APPLICATION FOR MONITORING TEMPERATURE AND HUMIDITY VIA LORAWAN TECHNOLOGY

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ABSTRACT

Access to real-time weather data will provide valuable information for informed decision making. This impact extends to event planning, academic activities and security measures, thus contributing to a safer and more efficient environment. This project focuses on the development and implementation of a web application for monitoring meteorological variables, specifically temperature and humidity using LoRaWAN technology. The system integrates sensors, a Gateway and a management platform that combines various software tools. The architecture is based on LoRa, a wireless technology that allows long-range remote communications and low energy consumption. The LoRaWAN protocol facilitates secure bidirectional connections and is compatible with open-source solutions. In terms of security, the project integrates the TTN infrastructure (The Things Network) as well as its counterpart The Things Stack, which allows communication with the Internet without the need for mobile networks or WIFI. The system incorporates several key technologies: Node-Red as a programming environment, InfluxDB as a time series database, MQTT as a message sending protocol between server and application, Grafana as a data visualization and Docker-Compose as a container tool for these technologies.

KEYWORDS: Internet of Things, Node, Meteorological, sensor, temperature, humidity, dashboard, gateway.

1. INTRODUCTION

For decades in the industry, control mechanisms have been applied to processes with the purpose of automating them. The basic cycle of these mechanisms works with the connection of sensors, which react to certain conditions, and actuators or controllers that receive feedback to determine what action should be applied to control the desired variable (the level of a tank, the temperature of a substance., the flow of a liquid, etc.). With the advancement of technology, traditional mechanisms have given way to the use of more sophisticated, but at the same time more precise, mechanisms.

With the arrival of the Internet of Things (IoT), we can talk about a very big step in the field of process control in industry and what has been called the Industrial Internet of Things (IIoT) has emerged. IoT is basically the wireless interconnection of devices, sensors, software applications and other technologies through the Internet network, and which works by transmitting data between sensors, data processors and actuator devices.

It is worth mentioning that IoT has a wide field of applicability, not only the industrial sector, which has served to illustrate the concept of IoT, but its use has extended to very diverse areas and is still expanding in very new fields.

How are the devices interconnected? We will see in detail in the following sections of this chapter. It is worth mentioning that the technology that supports interconnection; This is LoRa, a wireless technology, like WIFI, Bluetooth or LTE, that uses a type of radio frequency modulation proposed by Semtech. LoRa allows devices to be connected over distances of 2 to 5 km in urban areas. It also uses the ISM (Industrial, Scientific, Medical) bands, which are free to use.

Based on LoRa, the LoRaWan interconnection protocol is a protocol used for low-power, wide-area networks. LoRaWan is specially designed to manage and communicate LoRa devices and is composed of Gateways and Nodes.

The computing layer for this project was developed with Node-Red technology, which is a low-code and open-source programming environment, which was created to facilitate the interconnection of devices, sensors, actuators, etc., but which also facilitates the creating applications by providing developers with a visual environment.

We therefore have a basic overview that already places us at a starting point towards a more detailed description of all the technical foundations involved in this project and which we will break down in the following sections of this chapter.

2. MATERIALS AND METHODS

2.1 MATERIALS

For the development of the IoT Node was necessary to have the following materials: sensor for atmospheric humidity, and temperature and an antenna for better cellular signal reception.

2.1.1 SenseCAP 2101 SENSORS

SenseCAP 2101 shown in Figure 1 is a temperature and humidity sensors with long-distance industrial data acquisition and a wide range of -40°C to 85°C and 0 to 100%RH respectively. With Bluetooth 5.0 for easy setup and firmware upgrade, and a built-in replaceable battery for minimal maintenance, it also supports three different LoRaWAN network architectures, allowing you to easily join existing network gateways and servers to build a flexible and reliable sensor network. high performance. (IoT Store, 2024, paragraphs 5-6)

Figure 1: LoRaWAN S2101 Temperature and Humidity Sensor.

2.1.2 LoRaWAN Gateway IP67 MultiTech Conduit

The MultiTech Conduit IP67 Base Station is a robust gateway shown in Figure 2, designed specifically for the deployment of LoRa Networks, long as public as private, in outdoor environments. The highly scalable and certified IP67 Gateway Conduit can withstand the harshest environmental factors, including humidity, dust, wind, rain, snow and extreme heat. The device supports LoRaWAN applications in virtually any environment. Leveraging

Conduit, this device can support thousands of certified LoRaWAN end nodes, including wireless sensors, and mDotTM and xDot. Additionally, this gateway serves as an antenna with the ability to provide durable, low-power wide area network connectivity in support of M2M and IoT applications for both service providers and individual businesses looking to expand their LoRa network coverage. (MULTITECH, 2024, paragraphs 3-6)

Figure 2: LoRaWAN Gateway IP67 MultiTech Conduit.

2.1.3 **The Things Network & The Things Stack**

The Things Network forms a collaborative global IoT ecosystem based on LoRaWAN, providing tools and an open network to develop affordable, secure and scalable IoT applications. Its robust encryption system allows you to create a secure and cooperative IoT network on a global scale, with thousands of gateways serving millions of people in numerous countries. For its part, The Things Stack is an enterprise-level LoRaWAN network server, built on open source. (CloudStudio, 2021)

2.1.4 Node-RED

Is a versatile, browser-based tool with various applications. It´s used in IoT and IIoT for collecting data from industrial equipment and devices, creating control panels for visualization and event triggering. It´s also employed in automation, digital platform integration, business ETL processes, home automation, and data integration across multiple systems. Its flexibility allows adaptation to a wide range of needs, from industrial environments to smart homes and enterprise applications. (FlowFuse, 2024, p.1)

2.1.5 Grafana

Grafana is an open-source solution that enables visual data analysis and easy extraction of metrics for large datasets. It's useful for monitoring applications and hardware resources through attractive and customizable dashboards. (Martinez, 2021, paragraph 2).

2.1.6 InfluxDB

InfluxDB is an open-source time series database (TSDB) specialized in operations such as monitoring, applications metrics, IoT sensor data, and real-time analytics. Primarily developed in GO, InfluxDB is designed for high-performance, efficient storage. It can store thousands of data points per second, making it ideal for industrial-level applications. Once stored, data can be queried and analyzed using "Flux" language, an integral part of InfluxDB that allows advanced data manipulations and facilitates depth analysis. (Stack Hero, 2024, paragraph 1)

2.1.7 MQTT

MQTT is lightweight messaging protocol based on the publish/subscribe model, specifically designed to IoT applications in low-bandwidth and unstable network-connected devices with minimal code. MQTT is widely used in IoT, mobile internet, smart hardware, vehicle internet, smart cities, telemedicine, energy oil and other fields. (EMQ, 2024, p.1)

2.1.8 Docker compose

Docker Compose is a tool that simplifies the management of multi container applications. It allows developers to define the complete configuration of the development environment in a single container that is known as YAML file, including services, volumes and networks. With this tool, developers can specify all the necessary components for their application and using a single command, create and run all defined containers, thus streamlining the process of deploying and managing complex environments. (Imaginaformación, 2024, paragraph 2)

3. RESULTS AND DISCUSSION

3.1 RESULTS

The system architecture shown in Figure 3 consists of temperature and humidity sensor nodes that send and receive updates to a Gateway. This Gateway transmits data to a server located in The Things Stack, which then publishes an MQTT topic. Node-RED subscribes to this topic. Node-RED, Grafana, and InfluxDB are all located in containers within Docker-Compose.

Once subscribed to the MQTT topic, Node-RED begins receiving application information from The Things Stack. Node-RED then writes and stores this data in InfluxDB, which serves as a data source for Grafana. Grafana processes this data into graphs and sends them back to Node-RED. Finally, Node-RED implements the creation of a Dasboard that displays this processed information.

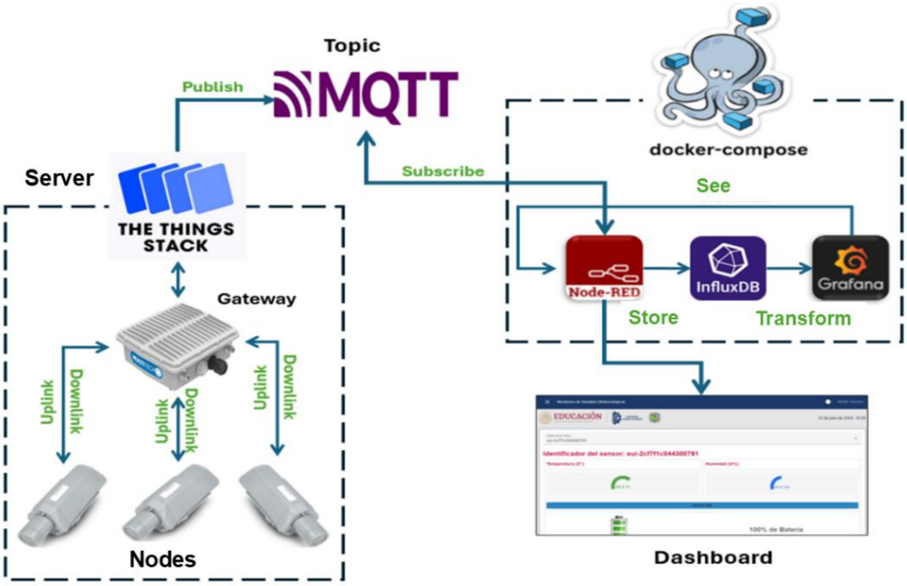

Figure 3: System architecture.

Building upon the previous description of the system architecture, we can now describe the user interface and data visualization. The dashboard, which is the final output of the system architecture architecture, is shown at the Figure 4 and presented through titled “Monitoreo de Variables Meteorológicas” (Monitoring of Meteorological Variables). This interface effectively displays both real-time and historical data collected by the IoT sensors and processed through the system described earlier. The sensor identifier (eui-2cf7f1c044300791) is clearly visible, allowing for easy tracking of specific devices. Current temperature and humidity readings are presented intuitive gauge style visualizations, with the temperature showing 28.4% °C and humidity at 47.5%. Additionally, the battery level of the sensor is displayed, indicating 100% charge in this instance.

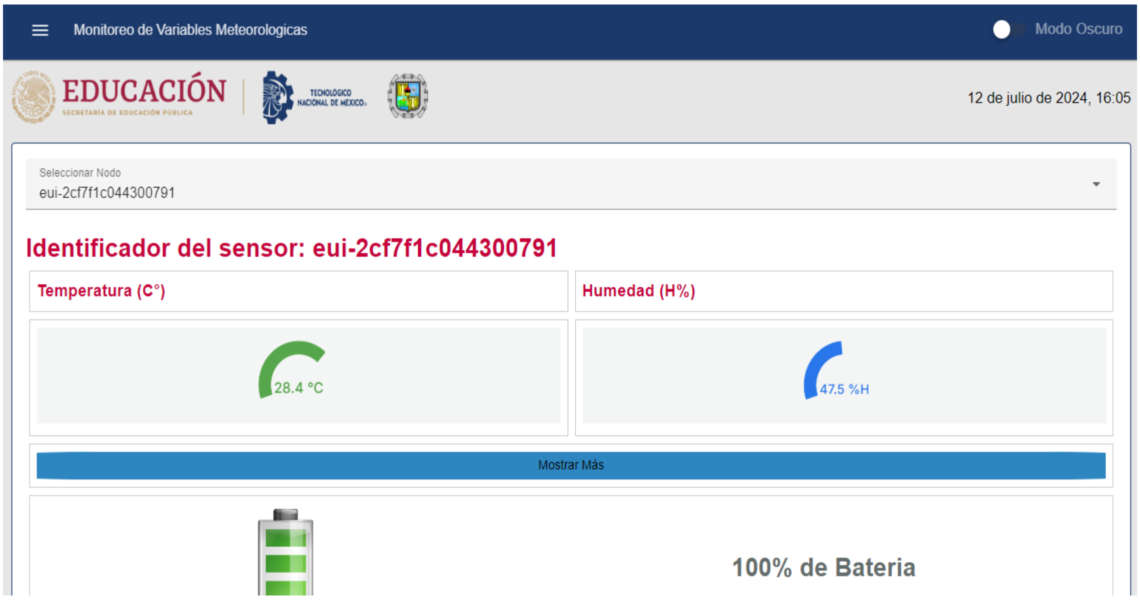

Figure 4: Weather variables control window.

Next reveals a historical data and statics section. In addition, Figure 5 presents two graphs that showing temperature and humidity trends over time, providing users with a visual representation of environmental changes. Beneath these graphs, key statics are displayed, including minimum, maximum, and average values for both temperature and humidity. The temperature ranges from a low of 21.3°C to a high of 30.3°C, with an average of 27.9°C, while humidity spans from 36.7% to 50.0% averaging 44.7%. The interface also offers options for viewing data across different time ranges, such as monthly, weekly, or custom periods, enhancing its flexibility for various analytical needs.

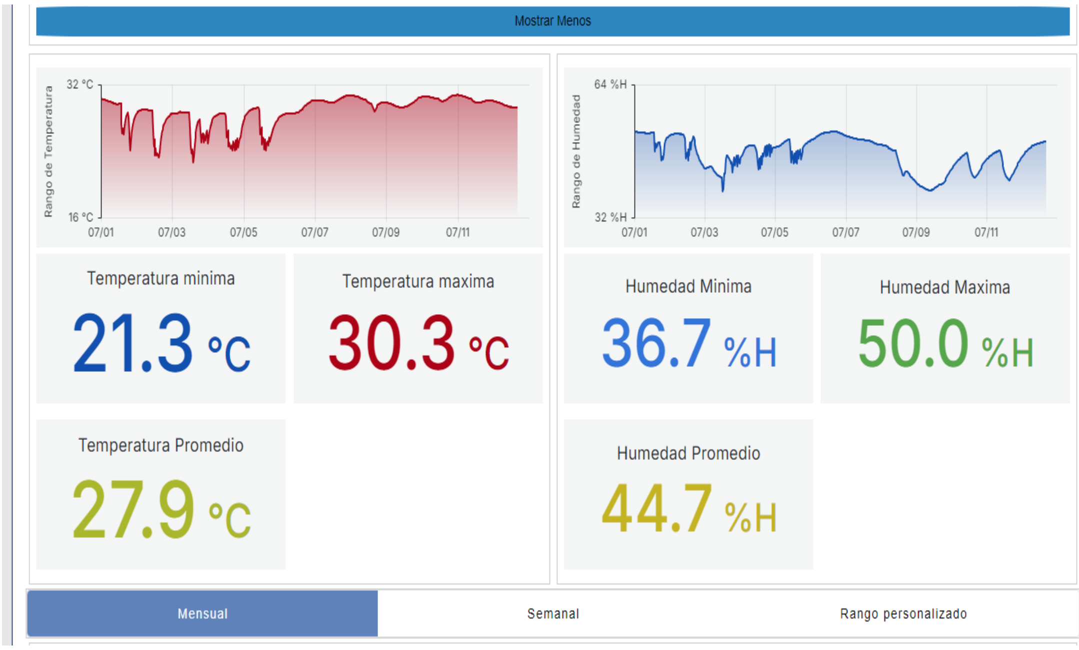

Figure 5: Selection of the display period.

4. CONCLUSIONS

The monitoring system allows for efficient capture and monitoring of real-time and historical meteorological data for the specified location. The readings show a temperature of 28.4°C and a humidity level of 47.5%, indicating warm and moderately humid conditions at the time of measurement. These values fall within the range observed over the period of record, as evidenced by the historical data. The historical data reveals temperature fluctuations between 21.3°C and 30.3°C with an average of 27.9°C. This suggests a relatively warm climate with significant daily temperature variations. The humidity levels range from 36.7°% to 50.0%, averaging 44.7%, indicating moderate humidity levels that fluctuate throughout the observed period.

Overall, this monitoring system demonstrates the effective implementation of IoT technology in environmental monitoring, providing a comprehensive and user-friendly interface for data visualization and analysis. The data collected and presented can serve as a solid foundation for informed decision-making in various applications that depend on accurate and timely meteorological information.

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