Engineering internship

Creation of an IOT application “Wave on Cloud”
and real-time data recording

"We need to get smarter about hardware and software innovation in order to get the most value from the emerging Internet of Things."

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Inside:

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SUMMARY

The Internet of Things (IoT) consists mainly of connecting physical objects to the Internet.
The emergence of the IoT offers great potential for the development of new services and applications that connect the physical world to the virtual world, a process that was not possible before.
Nowadays, there are many platforms and applications for IoT.
However, and to the best of our knowledge, they are generally limited in their scope to a simple data storage and retrieval scheme. In an attempt to take advantage of this opportunity, this internship report presents a theoretical model that offers a set of primitives and a new collaboration strategy for sharing data in the IoT world.

THANKS

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At the end of this work, we would like to express our most sincere thanks to Mr. Houssem Ouali, who agreed to supervise us and who gave us the benefit of his extensive knowledge and valuable advice during our project.

However, it should be noted that this work would not have been possible without the invaluable knowledge and know-how acquired in our honorable school, "Private Higher School of Engineering and Technology of Tunis".

It is therefore with great pride that we address our most distinguished thanks to all our teachers.

May they find here, as well as anyone who has contributed to the completion of this project, directly or indirectly, the expression of our sincere gratitude.

Finally, we express our most sincere thanks to the members of the jury.

SUMMARY

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General Introduction

The traditional means of transferring information no longer meet the criteria of efficiency and time constraints that are becoming increasingly severe. The use of sophisticated means of communication becomes unavoidable to ensure control of the hazards that can be encountered as well as satisfy our need for comfort. When we think of IOT technology, we immediately think of voice communication, sending and receiving SMS and MMS, mobile internet, and everything else that works using this modern.

Technology has made its way into our daily lives. It is less obvious to think that by using the services provided through this system, it is possible to monitor and control systems remotely using the IOT network. Applications can be used in various fields, such as remote control and command of machines, alarm and surveillance systems, control of doors, lighting of lamps, etc. In fact, the supervision by our IOT application (our project to be realized) presents itself as a simple and easy solution that can help us to ensure a good handling of the existing in order to achieve our goal.

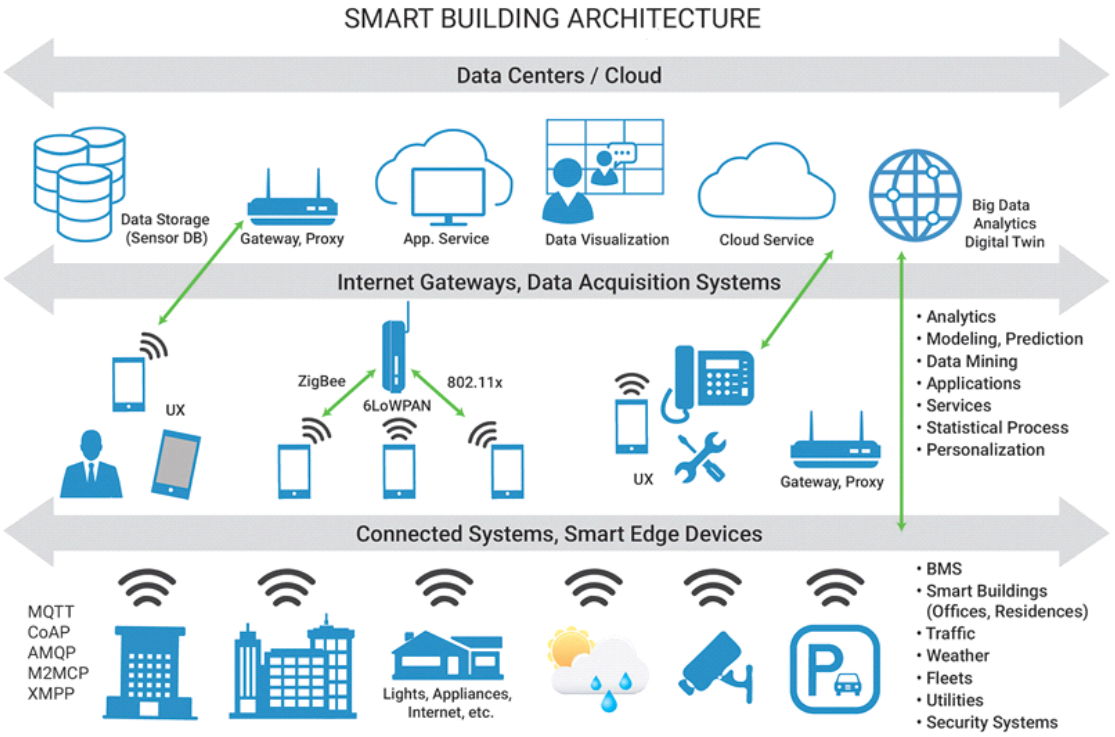

Figure 1: Smart Building Architecture

Chapter 1

- **Introduction**

Remote communication appears nowadays as a main component of modernization and technology transfer policies.

As part of our summer internship project, we conducted training with Alpha Technology Company for a month and a half.

The objective of our project is to design and develop an IOT application.

In this chapter, we first present the host company, "ALPHA technology". Then, we introduce a general conception of the project and its main objectives.

1.1Project Framework

This internship was done as part of the validation of the summer internship for 1st year computer engineering at ESPRIT.

1.2Presentation of the host organization

Alpha Technology is a computer engineering company that was created by M. Khaled Ouali. A former teacher at the national school of engineering of Tunis Since its creation in 2004, Alpha Technology has set out on the improvement of communicating implanted frameworks and the distribution of M2M and IOT arrangements. It has worked to master multidisciplinary know-how aimed at internalizing the value chain required for the development and implementation of arrangements based on brilliantly communicating objects.

1.2.1Objectives of the company

- knowledge in product research and development.
- Sourcing and knowing how to buy to satisfy the quality and cost dilemma.
- We know how to manufacture and qualify the performance of our products.

- Sharing know-how with our customers and developing a technological partnership
- Maintain progressive growth based on self-financing.

1.2.2ALPHA Technology services

The Alpha Technology company provides a variety of products such as:

a/ AlphaTec AVL Calculator Geolocation:

VEGEO is a configurable on-board computer intended for geolocation and remote vehicle supervision, integrating GSM/GPRS and GPS technologies.

b/ AlphaTec indoor & outdoor led screen manufacturer:

Figure 2: Standard Panel For Urban Display

Alpha Technology is an LED display wall manufacturer that designs, manufactures, and services its products.

Alpha Technology is also positioned as a digital content publisher for dynamic display solutions.

1.3 study of the existing

The realization of our project must be proceeded by a study of the existing.

1.3.1 Analysis of the existing system

ALMOST HALF OF COMPANIES STILL CAN'T use IOT DEVICE.

Belden sustainable infrastructure solutions (Smart Building Solutions) can maximize building efficiency, optimize resource use, enhance security & reduce operating costs.

1.3.2 Problematic

To meet the user's need for the right service at the right time and place, it is believed that there are several challenges to the successful implementation of the Internet of Things (IoT). As computer scientists, our concern is to combine the physical world and the virtual world. In other words, to work on the standardization of this new system by developing new applications and environments as well as new communication protocols.

For example, Nawaf has proposed a system that allows the identification and location of objects in real time using RFID (radio frequency identification), which is an automatic identification technology used in the registration and reception of data through electronic devices; the ZigBee protocol, a short-range wireless sensor network communication technology (Wireless Sensor Network) communication technology with a low speed, low power consumption; and cloud computing. However, the coverage area of their system is very geographically limited, and furthermore, their approach still uses the client-server principle, which has known flaws such as saturation, disconnection, and others, which puts the whole system at risk. On the other hand, Angulo Lopez and Jimenez Perez have proposed an application framework based on a multi-agent system to simplify the development and integration of applications in the IoT, which makes the sharing of data and services possible in a distributed environment.

Following a review of these and other works, we conclude that current research is severely limited in light of increasing data availability and underutilized services. How can we then create a system of collaboration and sharing between these data and services in a well-adapted and well-framed environment within the IoT?

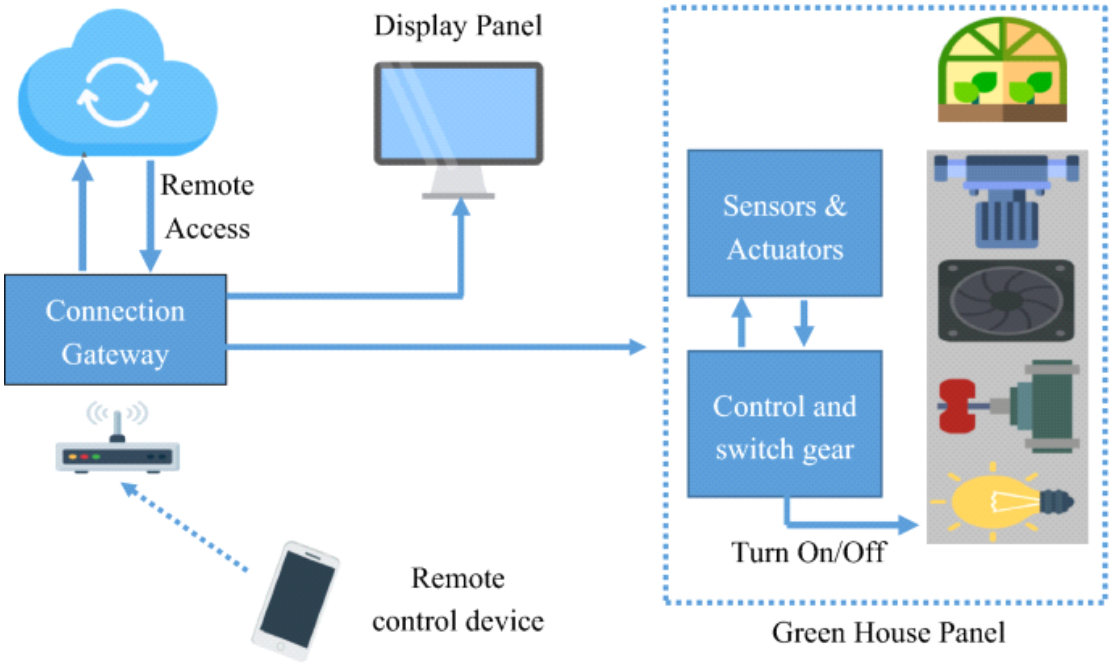

Figure 3: A diagram of an IoT network

In IoT, we often consider objects (sensors) that have hardware and software constraints that do not allow them to connect directly to the Internet. They connect to it through a gateway. Indeed, on the one hand, the Internet is not designed to manage the addressing of so many connected objects. On the other hand, IPv6 is a protocol that is often too heavy to be used directly by sensors. Today, IPv6 is used via the 6LowPAN (IPv6 Low Power Wireless Personal Area Networks) protocol, which is operated on top of network protocols governed by IEEE 802.15.4.

Gateways also translate proprietary protocols into a protocol that can be understood over the Internet, and some can act as network aggregators. The networks that connect them must also meet these needs for lightness, simplicity, and low cost. Thus, telecom operators must adapt because using cellular networks to transmit a few kilos of bytes per sensor is very expensive. Moreover, the 2G network is being dismantled. This opens the door to the development of long-range, low-energy wireless networks (M2M) with significantly lower data rates than cellular networks.

1.3.3 Suggested Solution

Our project consists of preparing a system that allows the user to control the operation of the systems remotely through the reception of a signal that gives information on the system.

1.3.4 The benefits of the system

- Reduction of the time of control of the system therefore saving time (faster for the edge of the machines) hence saving money.
- Remote control capability and real-time data recording

Conclusion

In the past chapter, we have introduced the host company and we have described our work motivations, leading to a better understanding of the project.

In the next chapter, we will present the technologies used in the development of our IOT application.

Chapter 2: Work Performed

- **Introduction**:

In this chapter, we are going to briefly describe the different stages of the realization of the project. We will route our work through the hardware and software environment that ensures the realization of our application.

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2.1 An illustrative example

To illustrate, let's assume that we are looking to develop a web and mobile application to offer collaborative physical quantities. Thus, it seems relevant to benefit from the Internet of Things (IoT) concept to collect data such as temperature, humidity, and luminosity in different places of the company. We limit ourselves, for the first time, to the collection of temperatures and humidity data at regular intervals.

In our example, the information we are looking for requires both the interconnection and the communication between the set of thermometers installed at different locations. An each thermometer or hygrometer is considered an object that will represent a room. These objects are connected to each other through the Internet, each one being able to request a service from the other and can in turn offer a service to the other. Thus, there is an exchange of data between different objects. Thus, an object which does not hold the information requested by the user can solicit the other objects with which it is connected to ask for the desired information. Thanks to this mechanism, the user can have the requested information even if the queried service does not hold this information in its database.

This is how our example of participative and collaborative service can become a reality.

2.2 The difference between SQL and NoSQL

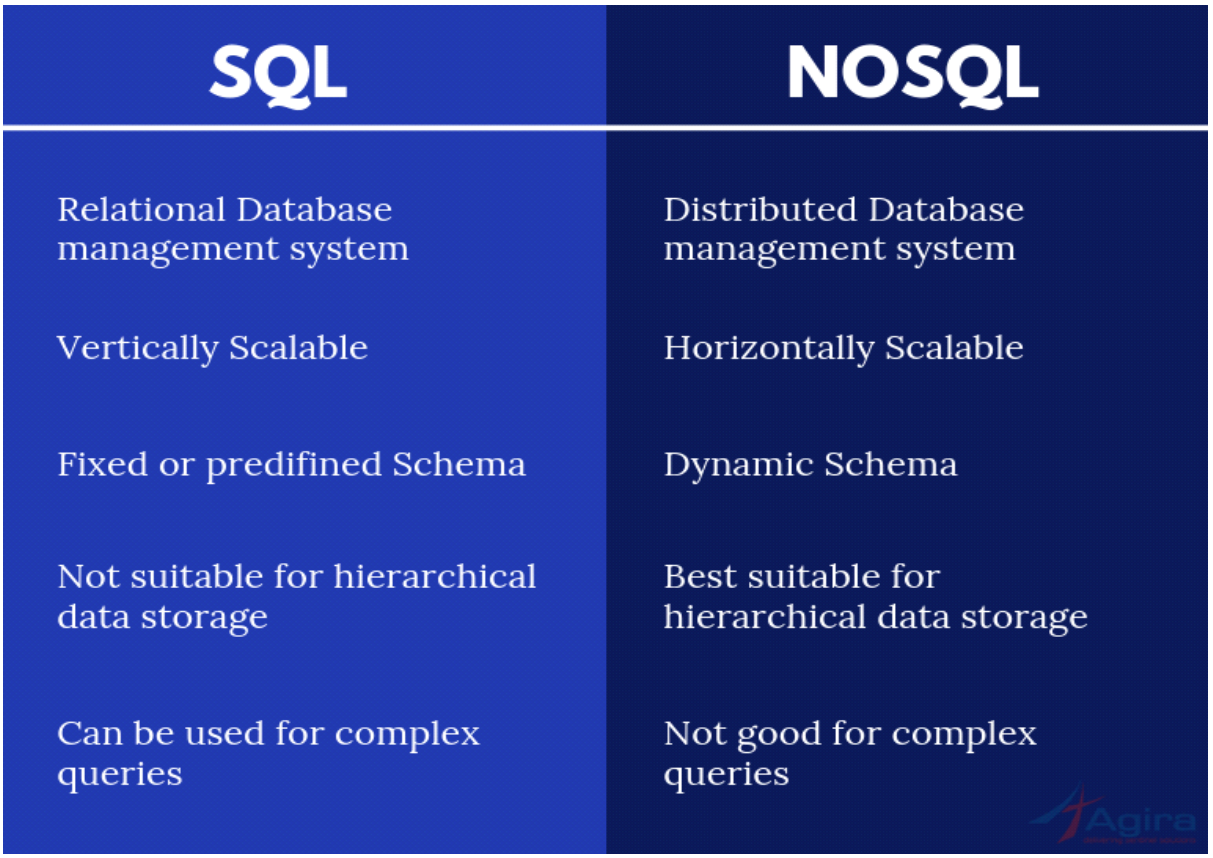

Figure 4: Difference-Between-SQL-AND-NOSQL

2.2.1 Data schemas in NoSQL databases

Existing NoSQL solutions can be grouped into four main families:

• Key-value: The data is simply stored as a pair of keys and values. The best known solutions are Redis, Riak, and Voldemort, created by LinkedIn. These engines offer simplified functionalities with less functional richness in terms of queries and excellent performance thanks to their simplified access model.

• Column-oriented engines: This model implements a structure close to the table.

Data is represented in rows and separated by columns, which are variable. Indeed, the number of columns can vary from one record to another.

This model is more used for important volumes. There are Hbase and Casandra as solutions.

• Document-oriented engines: This family is an extension of the key/value family by associating a key with a hierarchical document such as XML or JSON (JavaScript Object Notation). For this model, the most popular implementations are CouchDB (by Apache) and MongoDB.

•Oriented Graph: This model of data representation is based on the theory of graphs. It is based on the notion of nodes and the relations and properties that are attached to them.

This model facilitates the representation of the real world, which makes it suitable for processing data from social networks.

2.3 Data recovery

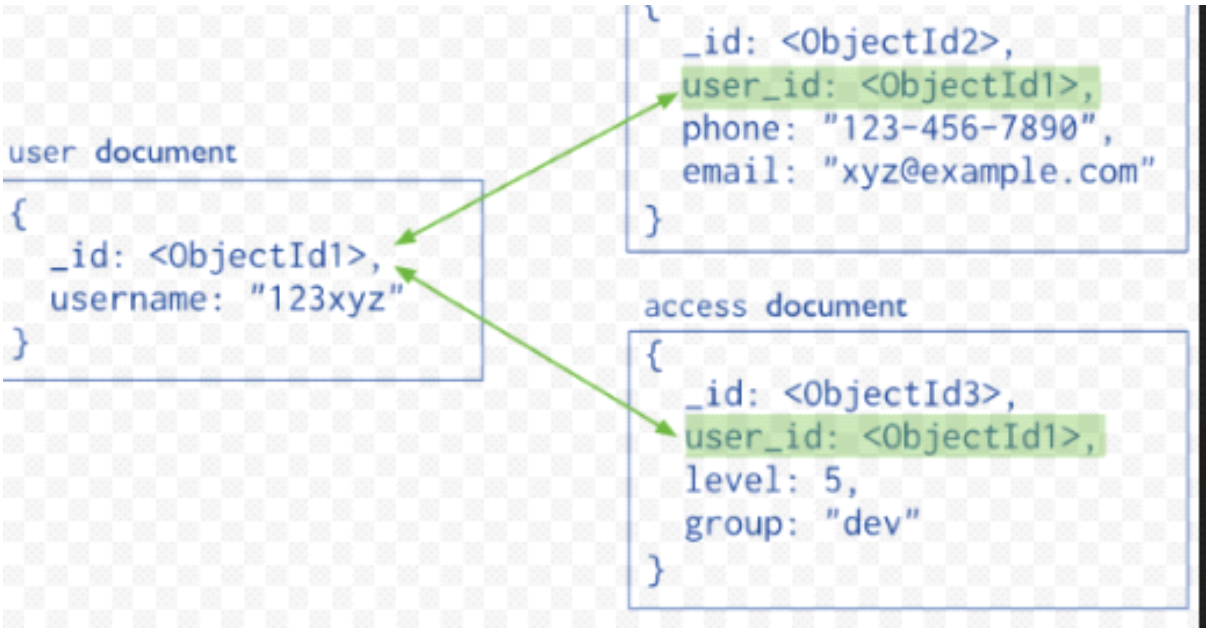

Figure 5: Data Recovery of a Client

Our switch is equipped with sensors to acquire physical quantities relating to the environment of the room:

- A temperature sensor measuring heat.
- A brightness sensor measuring the frequency of light from the lamp.
- A sensor that detects the presence of an individual in the room.

In addition, the switch has a shield, allowing it to accommodate new sensors. For the moment, we have only developed the acquisition of temperature and luminosity.

2.4 The temperature sensor

This sensor allows the temperature of the room to be measured.

An Arduino Shield connected to an Arduino board connects the sensor to the switch.

2.5 Study of the arduino card

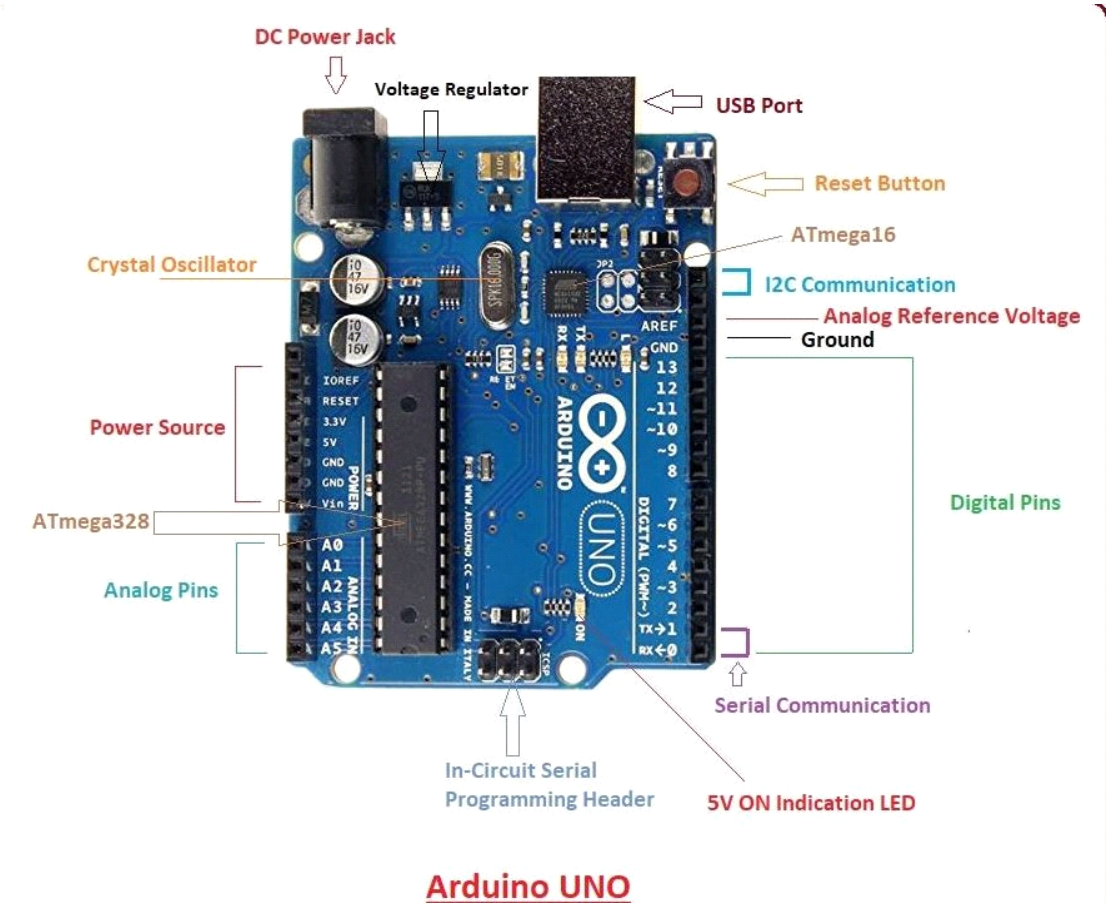

Figure 6: The Arduino Card Design

The Arduino Uno board is based on an ATMega328 clocked at 16 MHz. It is the latest and most economical microcontroller board from Arduino.

Connectors located on the outer edges of the board allow you to plug in a series of complementary modules.

It can be programmed with the Arduino software. The ATMega328 controller contains a bootloader that allows you to modify the program without using a programmer.

2.6.1Protocol MQTT

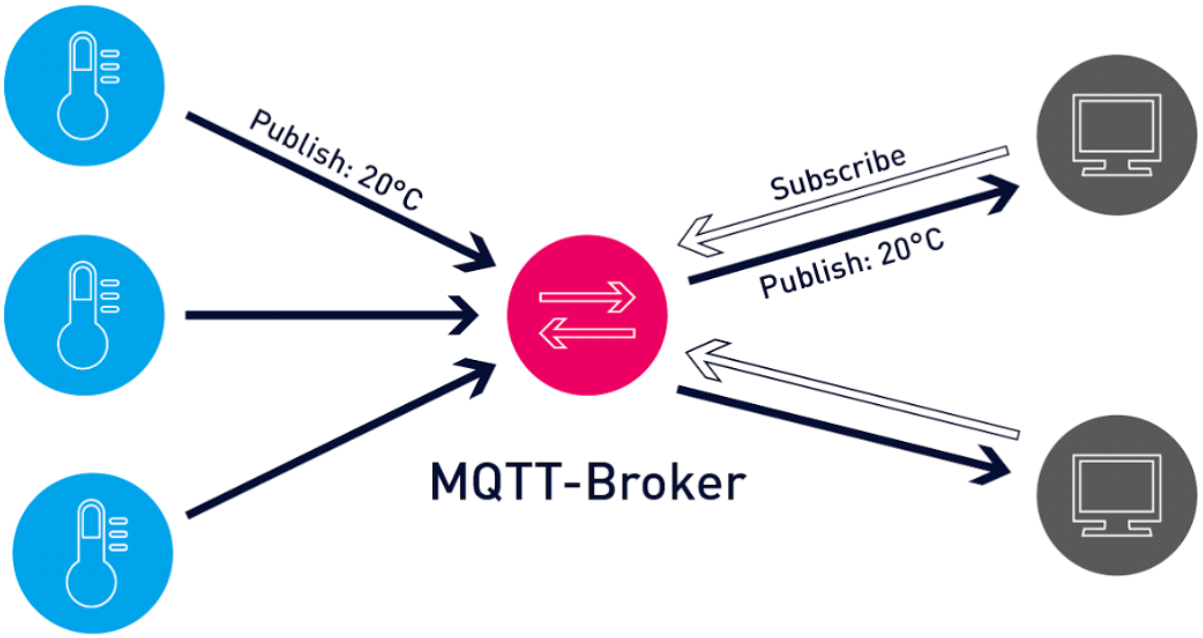

Figure 7: MQTT Broker

The MQTT protocol, based on TCP/IP, allows the exchange of data of up to 256Mb per subscriber/publisher system. per subscriber/publisher system. The advantage of this protocol for our project is that it combines the power of data communication without the need for a high-speed network.

For the "WAVE ON CLOUD" application, our Gateway client acts as a publisher and the MQTT server as a subscriber. All these exchanges are possible because the broker (MQTT server) is installed locally in the company.

When the Client Gateway sends the data, the application connects to the broker and publishes the data in JSON format in the Topic "2/#". To exploit this protocol, we have developed a scanning python application running on the normal client android that subscribes to the topic to view temperature, humidity, and light frequency data and adds the client data to the MongoDB each time a message arrives on this topic.

2.6.2 Reception extraction by the paho MQTT Python Client

Open a subscriber to the MQTT bus. When a new message arrives on the bus, the data is extracted and stored in our Mongodb database.

2.7 HTTP Server

In order to provide a web user interface, we installed the Apache HTTP server.

An HTTP server allows a web site to communicate with a browser using the HTTP(S) protocol and its extensions (WebDAV, etc.).

The purpose of our web interface is to allow users to view the information and data sent by our stations. This interface includes a monitoring page that displays the temperature, humidity, and luminosity of a room in real time.

The interface also allows you to list and manage all known stations, and to change their status (active, inactive, or deleted).

The interface also allows you to list and manage all known stations, and to change their status (active, inactive, or deleted).

The implementation of the interface is done thanks to Bootstrap, which is a framework, a collection of tools, useful for the creation of the design (graphics, animation and interactions with the page in the browser, etc.) for sites and Web applications (HTML and CSS code to make forms, buttons, navigation bar, search bar, etc.).

The use of Bootstrap and PHP requires installations of extensions and packages as well as the configuration of some modules (PHP in particular). One of the configurations allows us, for example, to send back alerts during the loading of our php pages if they contain errors, which is interesting for debugging.

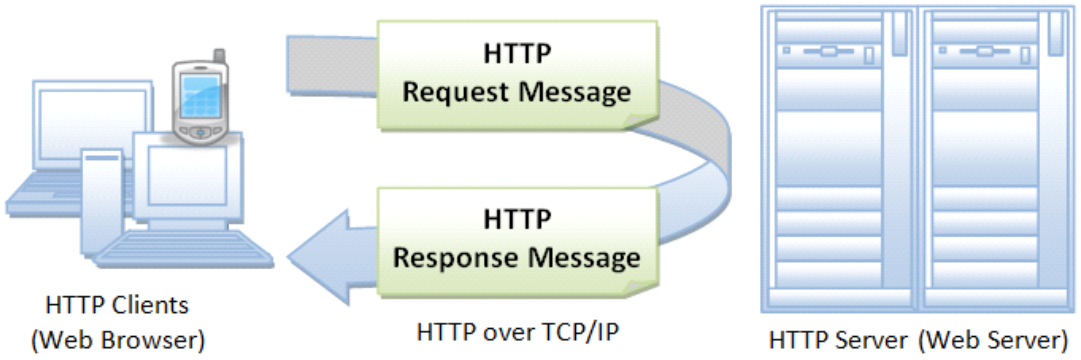

Figure 8: Communication HTTP Server

2.8 MongoDB database:

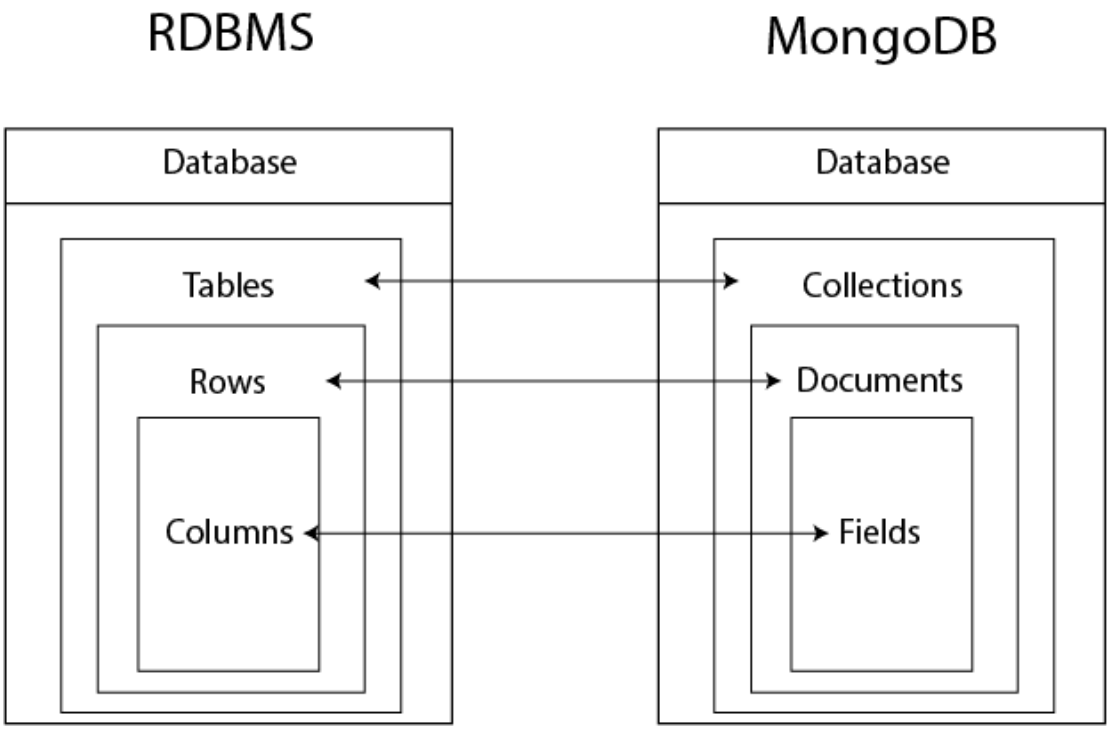

Figure 9: Approaching MongoDB Design

This is a noSQL database that allows you to store data in the form of documents using JSON syntax. This database is fast for some operations.

In our application, it will allow us to store in JSON format all our customers and their data in a single document.

Mongoose:

Mongoose is a NodeJS library that allows the use of the MongoDB database. MongoDB is a document-oriented database management system.

Its main interest is that it uses the JSON format without any predetermined schema, so we can rewrite the document easily.

Conclusion

In the past chapter, we have introduced the software and hardware used for the conception of our application.

General conclusion

My internship in the company "Alpha Technology" for one month and a half allowed me to acquire new technical knowledge and especially to discover the real meaning of teamwork, which is a strong professional experience for my next professional life. I'd also like to thank ESPRIT once more.