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Open Source Platforms Integration for the Development of an Architecture of Collection and Presentation of Information in "Internet of Things" Projects

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ABSTRACT

The goal of the Internet of Things (IoT) is to achieve the interconnection and interaction of all kind of everyday objects. IoT architecture can be implemented in various ways. This paper presents a way to mount an IoT architecture using open source hardware and software platforms and shows that this is a viable option to collect information through various sensors and present it through a web page.

Keywords - **Internet of Things, Open Source, IoT Architecture.**

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I. INTRODUCTION

The Internet of Things (IoT) tries to make everyday objects smart, giving them the ability to detect various conditions of their environment or of their own operation, communicate and respond to real-world events [1, 2].

Although the concept of IoT has existed for several years, the existing telecommunications infrastructure nowadays has allowed a notable development in this area. This is demonstrable, since the number of things connected to the Internet in 2008 exceeded the number of inhabitants of the planet [3], and analysts predict that by 2020 there will be 50 billion connected devices [1]. According to CISCO Systems, in 2013 the turnover of the things connected to the Internet amounted to approximately 475,000 million and represents a global business of 10,900 billion Euros in 5 years [3].

IoT services demand is diversifying, so to meet these needs there are some companies offering solutions that pose a “Project Stack" architecture that allows building and interacting with IoT projects [3]. Research has even proposed WSAN (Wireless Sensor and Actuator Network) solutions as network schemes for deployment scenarios [4]. These solutions, however, have the disadvantage that a rent that depends on the number of devices used has to be paid.

One way to avoid this inconvenience is by implementing IoT architectures that allow horizontal and vertical scaling, with the help of open source hardware and software. In this regard, in [5] a detailed explanation of the anatomy, construction and architecture of IoT is given, while in [4] a detailed analysis of various Open Source type hardware platforms analysis is performed and culminates with service-oriented software architecture for embedded systems. Furthermore, in [6] a modular design Middleware development for capture, storage and release is presented. In Alfonso *et al* a Field Operational Test (FOTsis) project

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is proposed, contributing to the deployment of an environment with services involving a considerable number of entities outside the vehicle, based on an Intelligent Tutoring System (ITS), while Boubeta*et al* propose a Service-Oriented Device Architecture (SODA 2.0) and Event-Driven Architecture (EDA). While the aforementioned works propose architectures and analyze open source platforms, they do not detail how conjoining them.

In this work, two IoT platforms are developed using open source hardware and software. Each collects information from the surroundings and communicates with a server through the Internet. It also shows a way to store, process and present the information obtained by each of the platforms. The diagrams, comparisons and example of IoT architecture presented in this paper offer the opportunity to identify the basic points for the collection and reporting of information with such platforms.

II. METHODOLOGY

IoT architecture.

Given the characteristics and diversity of devices that can be connected together, the IoT architectures over the years have evolved and begun to contemplate different forms and stages. However, it has come to generalize the idea that it is necessary to have a decentralized and distributed organization as to the manner in which the devices must be connected, based on structures of only hop, star, cluster, multi-hop or hierarchical [5].

Now, in order to establish the ways of how communication between the devices should be done, a service-based and event-driven orientation has been considered, thus providing interoperability between different devices and services [6] and, since devices and users connectivity is the goal, it is necessary to have services that can be accessed in various ways, for which it also considers the management, security, data flow control and processing within architectures [7].

The architecture proposed in this work includes the collection, transportation, processing, storage and reporting of information, to meet the challenges of interconnection of objects and enable communication between human and machine [8]. In Figure 1 the physical and logical constituent elements are shown:1) Data acquisition device (sensor), which collects information from the real world, for example, temperature, humidity, light, among others. 2) Wireless Communication, which enable devices to perform data transfer via radio frequency or Bluetooth.3) The micro controller card is responsible for performing the processing of the data obtained by the device, as well as granting access and control of these. It is therefore necessary that it implements a logic and processing unit that performs the processing of the collected data in order to convert and transform them into formats that will be useful for later reading and writing. 4) Security Layer. Prevents other devices can handle data reading and writing. 5) Firewall. It contains a series of rules that allow, in the event of a strike, react and preserve the logical integrity of the devices.6) Network connection device, which is an Interface that provides communication over the Internet with the use of TCP / IP protocols.7) API Rest data transport. It provides a standardized way to transport data. It has been widely used for its simplicity and minimal data consumption at the time of the transfer. 8) Servers. They are the infrastructure that allows receiving data from the various IoT devices, which are accessible through the Internet and therefore require security settings and a firewall.9) Data processing and classification layer. When the server receives data from different devices, it must be able to classify them based on the one that sent them. To do this, it is necessary to perform information processing. 10) Data Storage. When received data are saved, it is possible to query and analyze them at any time. 11) Local user interface. Provides access to IoT device locally, i.e. performs direct interaction with the device. 12) Remote user Interface. It provides access to the device but using a connection through the Internet to interact with it. 13) Devices control, analysis and monitoring. It allows controlling IoT devices through buttons and observing and analyzing collected data through graphs and widgets.

The open source hardware and software proposed in this paper (Arduino, Raspberry, Python, MongoDB, PostgreSQL) have been considered given their performance, active community, learning curve and accessibility, so that that they can be easily implemented in IoT projects.

Data scheme description.

Figure 2 shows how this architecture stores data through an unstructured scheme that displays the captured basic information and hierarchy under which storage is considered. This information, after being processed through a programming language like Python, can be stored in a database like MongoDB.

Data presentation.

The way in which data that were captured, processed and stored by the IoT devices are presented is a critical point. This is done through platforms or screens and it is necessary to consider the user experience (UX), taking into account the behavior and actions that allow users to understand the presented information [9].

In the platform developed in this work widgets are used. They allow presenting simple information aesthetically and understandably to the user

Development IoT Devices

To collect data two IoT devices were developed. Figure 3 shows the outline of Raspberry-based IoT I device, to which the following devices are connected: Humidity and

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temperature sensor, GPS transmitter, alcohol sensor, photo resistor (LDR), soil humidity sensor, passive infrared sensor (PIR), microphone, ultrasonic sensor and potentiometer. Its location is fixed. In Figure 4 the physical assembly of the device is shown.

In Figure 5 the scheme of IoT II device with a mobile platform based on Arduino is presented. The following devices have been used: Photo resistor (LDR), humidity and temperature sensor, gas sensor, microphone, potentiometer, GPS transmitter and gyroscope. Figure 6 corresponds to the physical mounting of this device.

These devices will be used to validate the case study described below.

Case study.
To validate the methodology described in the previous section, the following experiment was performed: Built IoT devices were set in different geographical locations. IoT I device in 22 del Bosque street, Col. Los Laureles del Sur, 29290, San Cristobal de las Casas, Chiapas, Mexico, with latitude: 16.705627 and longitude: -92.623613 and IoT II device in 8 Indigenistas street, Col. 14 de septiembre, 29210, San Cristobal de las Casas, Chiapas, Mexico, with latitude: 16.746696 and longitude: -92.634986, as shown in Figure 7.

With these devices a monitoring of different magnitudes, such as relative humidity, temperature, light intensity and noise was made. The information collected by each of them, was sent to the server through a 2 Mbps Internet connection. To this end, both IoT devices were connected to the corresponding WiFi module. The information on the server, can already be seen, manipulated and displayed from any computer with an Internet connection.

III. RESULTS

When performing the experiment described in the previous section, it was noted that the implementation of an IoT architecture with open source hardware and software is very practical, fast and flexible, as there is on the market a variety of devices and sensors of all kinds at very affordable price. There is also vast network information on how to install and configure most of these devices.

In this project, the two IoT devices mounted (Arduino and Raspberry), were able to interact without having observed any difficulty.

In Figure 8 it can be seen that by the sum, since the connection to the reception there are no more than 500 milliseconds and this is an acceptable time for the processing and storage platform speed. As mentioned in the previous section, an Internet connection of 2 Mbps was used. However, evidence of transmission of more complex data, such as photos or video was not performed.

In Figure 9 the temperature values (in Celsius degrees) measured simultaneously by both IoT devices in a certain time interval aredisplayed. The discrepancy of the values obtained by Arduino and Raspberry devices shown isbecause they are located in different places. The other properties measured by the sensors of the IoT devices exhibited similar behavior.

In Figure 10 some of the values measured by the sensors of the IoT devices (potentiometer, temperature and relative humidity gauge, distance, light intensity, noise)are displayed. The presentation of data through widgets is very nice and is considered adequate for displaying information of various kinds, without causing confusion to the user.

IoT devices could be located in any location with Internet coverage, always getting very similar results, from which it follows that the scope of IoT platforms is practically unlimited.

IV. FIGURES AND TABLES

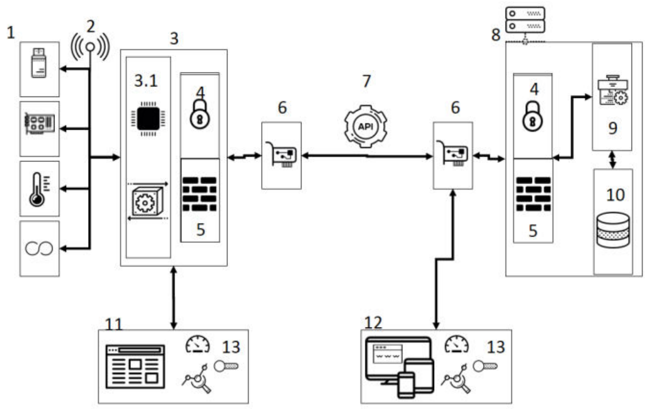

Figure 1. Architecture diagram for IoT projects.


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Figure 2. Unstructured scheme for data storage.

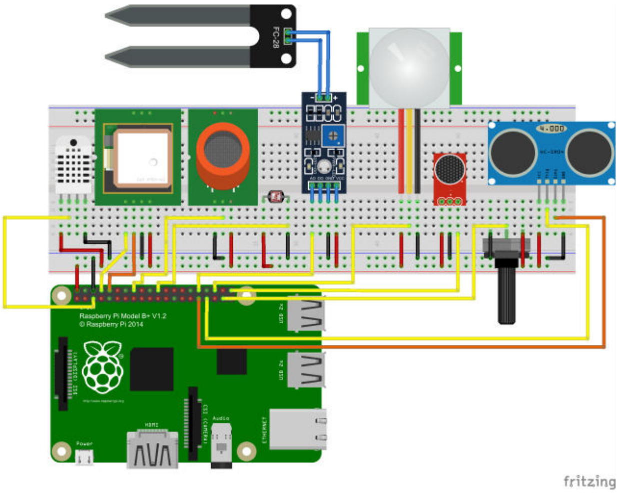

Figure 3. Raspberry IoT I device scheme.

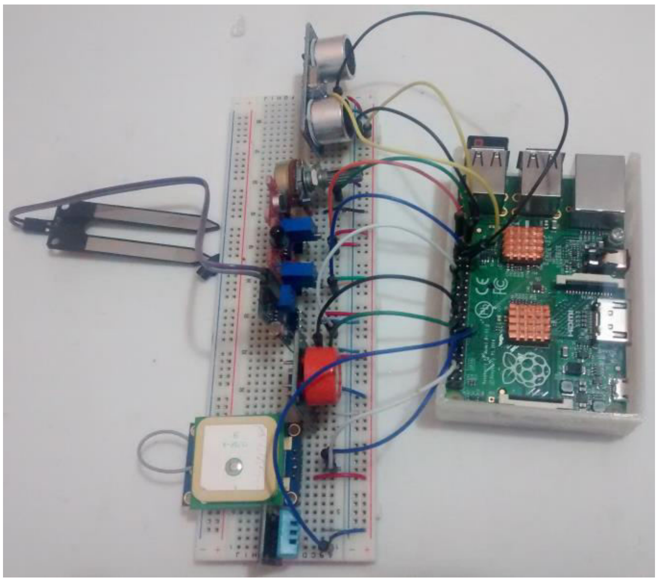

Figure 4. Construction of IoT I device with Raspberry.

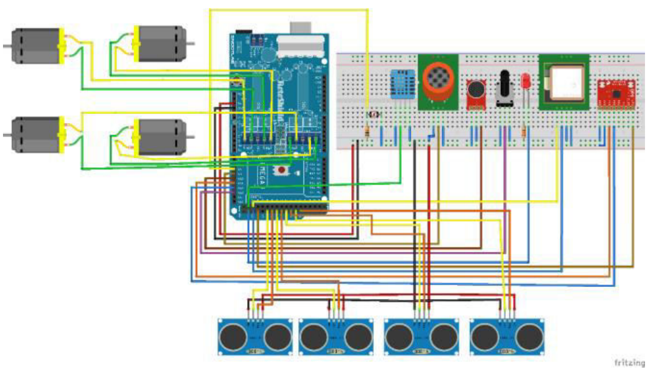

Figure 5.Arduino IoT II device scheme.

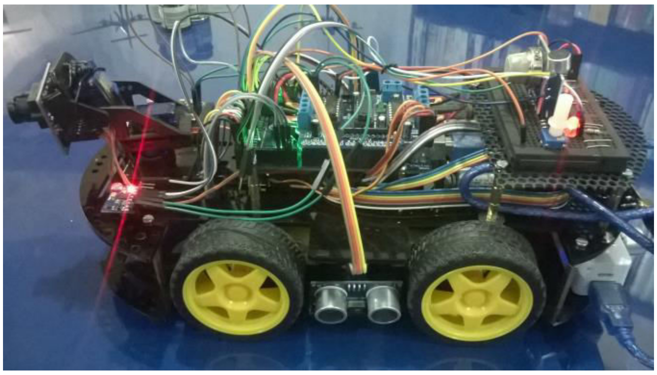

Figure 6. Construction of IoT II device with Arduino.

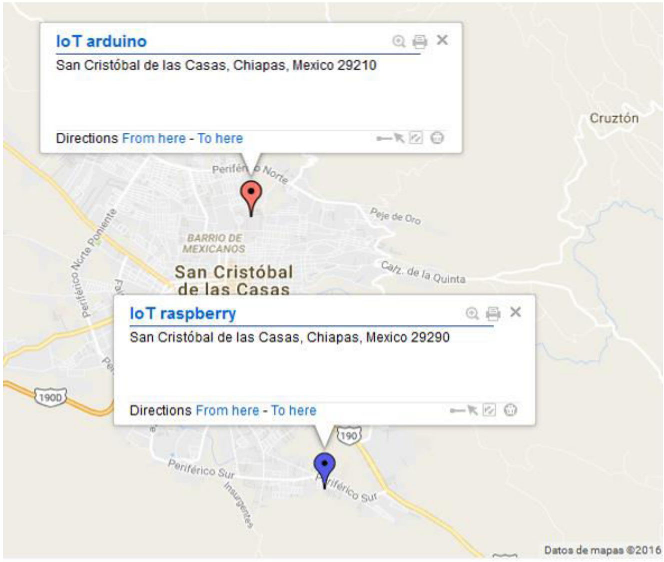

Figure 7. Location of IoT devices.

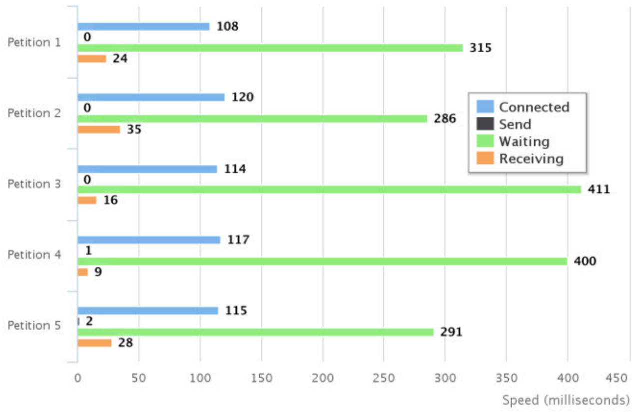

Figure 8. Data saving request speed via the Internet.

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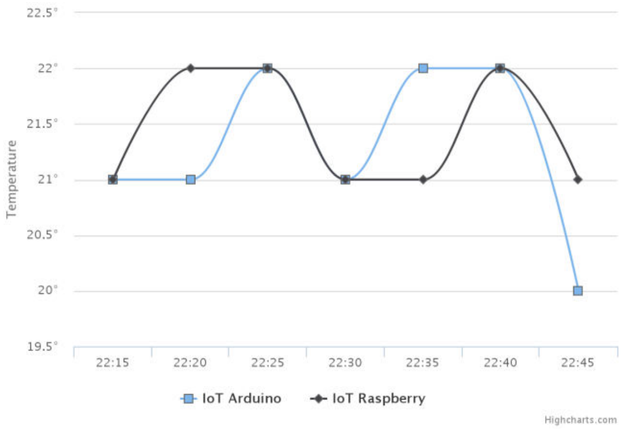

Figure 9. Temperature monitoring by IoT devices graph.

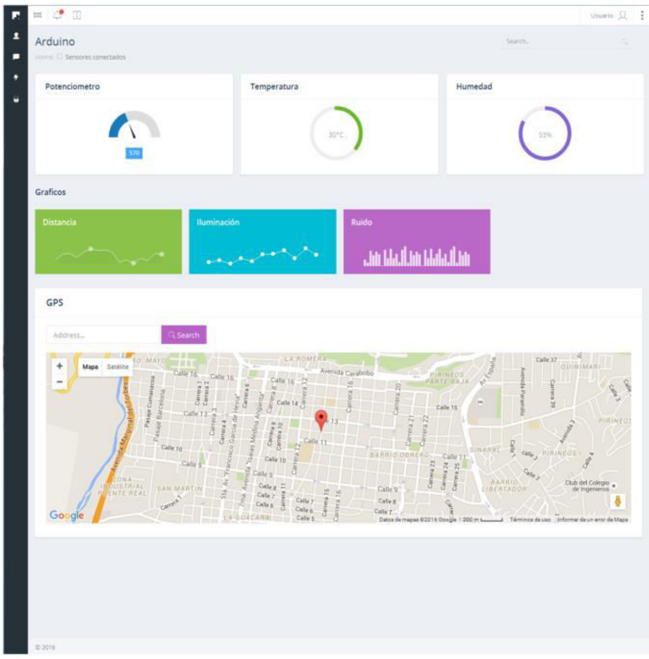

Figure 10. Devices monitoring panel.

V. Conclusion

The architecture proposed in this paper was implemented in a fast, economical and flexible way. The IoT devices built functioned correctly, both to gather information through its sensors and to send it to the server. Access to information from any computer connected to the Internet, was also very simple. It is worth mentioning that the data handled by this platform were very simple, however, it is intended to test transmission of images and video captured using a VGA camera as it has been mounted to the mobile platform shown in Figure 6, which will be reported later.

The potential in this area appears to be very large, given the versatility of the platforms used and the large number of devices that can be associated with them. Just an Internet connection is needed to communicate any kind of objects anywhere in the world. The breadth of this topic enables the development of multiple lines of research, such as the development of smart cities, for example.It is necessary, however, to analyze the reliability of the IoT architecture with open source hardware and software to determine whether it is feasible to entrust it critical tasks.

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