Mobile application for the optimization of milk production and goat feeding processes: Experimental farm of Universidad Francisco de Paula Santander, Ocaña, Colombia

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Abstract. The main objective of this article is to show the phases of the development of a mobile application. It allows to give support to the optimization of the milk production and goats feeding processes in the experimental farm of the “Universidad Francisco de Paula Santander, Seccional Ocaña”. In the first phase, an analysis was made of the different manual processes under physical formats currently carried out by the goat project manager, allowing the raising of system requirements. In the second, the systematization of information capture through user-friendly interfaces on a Mobile App is carried out. In the final phase, the processes were validated with the application impact. The features allowed a notable improvement in the processes execution. The goat project managers were able to have greater control of the information and a clearer focus on how productive each goat has been. As a result, the consultations, reports, traceability and identification of procedures and sanitary interventions to each one of the goats were speeded up. In the same way, it is possible to generate a support tool for decision making in all aspects of the administration of the experimental farm.

1. Introduction
“Universidad Francisco de Paula Santander (UFPS), Seccional Ocaña”, is the main university faculty in the region of Catatumbo, Norte de Santander, Colombia. It offers multiple academic programs focused on developing the productive sector of the region. The university has an agricultural, livestock and environmental farm where students of zootechnics and environmental engineering perform practices in laboratories of poultry, pigs, rabbits, cattle, among others. The computer engineering program develops projects on the farm. They have an impact on the region's agricultural and environmental sectors. They are also supporting all the processes carried out in the laboratories; based on internet of things (IoT) and virtualization processes and thus bringing them closer to the concept of smart.

Technology becomes a fundamental element of universities, without which none of their essential functions could be carried out [1]. In order to improve the management of their resources, universities design their strategic direction according to their own needs, but they do not take into account the national requirements that demand their innovation and competitiveness in areas such as technological infrastructure. Its development plans consider technology as a support, but not as a strategic necessity
for its operation. Its implementation is delegated to supply specific software and hardware needs, but the current capacity to contribute to the strategic objectives of the universities is not evaluated.

Being the basic pillar of the development of the communities of the future, they allow them to provide intelligence to all their areas and generate services that provide an improved quality of life to citizens and greater sustainability to cities and universities [2]. However, it should not be conceived only as a tactical element, should not be planned in isolation, but should be part of the overall planning of the university [3]. The development of infrastructures under the IPV6 protocol [4,5] is planned, which will allow the implementation of IoT devices generating smart environments within the university in a secure way, integrating them to the current network of the university, seeking the interoperability of the two protocols IPV4 and IPV6 [6-8], and supporting all security processes under the scheme of networks defined by software.

The article is presented in four (4) parts that are: (i) background review, (ii) methodology, (iii) results obtained to date and (iv) definition of conclusions about the object of study.

2. Background

Systems can closely integrate physical with virtual components [9,10]. This represents a research and development priority in the area of ICT, concentrated in different technologies, where the Internet of Things is highlighted [9]. Different works [10,11] propose architectures with a main emphasis on the agricultural area (smart farm), addressing issues such as sustainability and adaptability to environmental and market changes trying to optimize its performance, maintaining synergies between its components [12,13]. This is achieved, for example, through sensors that are used to monitor in the environment variables such as light, temperature and humidity, as well as with actuators such as water pumps, fans and lights for growing plants. For this purpose, a system architecture and relevant solutions are proposed, where different modules related to detection, communication and data analysis systems are successfully integrated into a complete system, which not only monitors the farm environment but also performs remote automation and user control [14].

Examples of technologies used in the solution of farm problems are the following: Wireless sensor networks (WSN) which are rapidly emerging as a potential network technology for use in various emergency situations [15]. PotatoScanner, can measure the surface temperature of plants and is controlled through an Android application [16]. ZigBee technologies enable the identification of crop pests, drought or increased humidity [17]. In the area of horticulture, there are studies of estimates and monitoring of crop growth. Volume measurement is important to evaluate the economic value of a tree [18,19]. Ifarma, for example, is an agricultural information system whose objective is to plan, monitor and maintain a record of all agricultural activities during the growing season [20]. To achieve an optimal result associated with crop growth an influential factor is the irrigation system, being at the same time, one of the most important problems because of the water and energy costs for its implementation [21,22].

3. Research Methodology

Descriptive research works on factual realities, and its fundamental characteristic is to present a correct interpretation. For this reason, in this project it has been defined to use the type of descriptive research in order to analyze the different physical formats used for the administration of the Milk Production and Goat Feeding processes with the aim of presenting the graphic interfaces and functionalities of the mobile application.

4. Results

To propose the most suitable network infrastructure for the organization of an IoT-based SmartFarm for Universidad Francisco de Paula Santander seccional Ocaña and to generate intelligent spaces under an IPV6 environment [8,23], taking into account the interoperability with the IPv4 protocol and the security risks to which these devices are exposed, based on the vulnerabilities and threats present for this technology. In Fig. 1, in the context of IoT, an IPV6 Intranet [7,8,23,24] is proposed to support everything related to the smart farm. The proposal for the organization of the communication
infrastructure can be observed, which shows a corporate network currently supporting all business processes of “Universidad Francisco de Paula Santander, Seccional Ocaña”. It has been proposed to route all traffic through SDN technology and an update server that is monitoring outdoors on possible updates by the manufacturer of IoT devices, without directly exposing the devices to the Internet in order to counteract some vulnerabilities present in the process of downloading updates. In the intranet, a VPN virtual private network is proposed to allow all IoT traffic to the corporate network to be extracted after the transfer to IPv4 has been carried out, see Figure 1.

![Intelligent farm communication infrastructure](image)

Figure 1. Intelligent farm communication infrastructure.

Implementation of access control lists on virtualized devices based on Mininet which is a network emulator that executes a collection of end devices, switches, routers and links in a single Linux core. Lightweight virtualization is used to make a single system look like a complete network. Running programs can send packets through what appears to be a real network interface, with a link rate and delay. The relationship between Mininet and SNDs is established by their similarity in working with nodes that physically do not exist, being able in both cases to define their configurations by software. An important feature of Mininet is that it allows to emulate software-defined networks with all their features. In particular, it works with the Openflow protocol, used by the SDNs to and from the wireless environment, where all the information from the intelligent devices will flow, a central that receives the information from the different agricultural and livestock areas, securing the information collected. With the information supplied from the IoT systems of the SmartFarm in the cloud will be subjected to a BigData [25] process for the generation of new knowledge.

The smart farm is a macroproject, which will cover different processes, typical of a farm, with the aim of efficiently managing the resources that are given and that are carried out manually [26]. One of the prototypes being developed is the CAPRINAPP application, which is a tool that allows decision making through fast data entry and a simple but effective method for reports. Through the tool individual
tracking of goats (growth, dairy production, diseases) will be possible, which will allow the generation of reports that will help decision making. Being able to make these reports implies being able to determine how much food corresponds to each of the goats, and therefore will be able to provide the exact amount of food for the one that produces more milk. Also, the development of a geolocation system for cattle: case of study farm UFPS, “Seccional Ocaña” [27]. Currently, the process of gathering cows on the farm to take them to the pens after grazing is performed manually, sometimes some of them are lost because the farm is too large. Through the tool the movement of each bovine can be tracked. An added value is that the tool will provide the route of the cow and at the same time it will be possible to determine if the cow is stressed (more travel than normal), which predicts that the cow is in heat, see Figure 2.

Figure 2. Smart farm application prototypes.

Information has been of vital importance for the sustainability of society, and every day the best way to store and protect information is sought. With the arrival of new technologies, it gives way to the change of manual systems to digital systems, which leads to move from the outdated methods of storing information such as file cabinets, journals and accounting books to databases, electronic agendas and digital information systems [28,29]. These information systems help people to manage, analyze and display specific information of an entity in an organized way and at the time they require it, see Figure 3 and Figure 4.

Figure 3. Login.  Figure 4. Main menu.
For this reason, “Universidad Francisco de Paula Santander, Seccional Ocaña”, is a higher education institution whose institutional objectives are to develop institutional capacities by promoting positive impacts on the region, the environment and the community through the creation of strategic alliances, the execution of relevant projects, increased coverage in extension activities and a commitment to social responsibility; all these objectives are developed by the different academic programs of the institution, some framed in the execution of the goat production of the farm, in which the milk production and goat feeding processes are carried out; however, the optimal mechanisms are not available [30]. Currently, all the information collected from these processes is scattered with little organization, the processes are carried out manually without any systematization which generates that within the processes information of great importance for the farm is lost, preventing its analysis in an efficient and effective way, without knowing the daily production of milk and control of the feed needed for each goat, preventing a greater reach in the region, see Figure 5 and Figure 6.

![Goat Log](image1.png)

**Figure 5.** Goat data recording.

![Goat History](image2.png)

**Figure 6.** Goat History.

Goat's milk is currently a highly coveted product in international markets having greater supply and demand in the European region, generating significant income to the gross domestic product (GDP) of each country, becomes more popular in world markets, crossing borders of those countries where it is already considered as one of the basic components of efficient livestock farming, that is to say: good quality animals, selecting dairy genotypes, with adequate food, good management and health. In the specific case of Colombia, goat production is concentrated in small regional markets where the greatest use is directed to animal meat, the greatest problem of the agricultural sector in the country, is the little organization and articulation thereof, which decreases the potential success of those people who are engaged in the production of meat and goat products.

5. **Conclusions**

The way in which the Internet of Things (IoT) has been growing worldwide by entering all sectors of our social, personal and professional life, highlighting industry, medicine, education, home services, surveillance, transportation and agriculture and so on, allowed to establish a vision of how to implement an IoT system that administers and manages the various processes of the farm of “Universidad Francisco de Paula Santander, Seccional Ocaña”.

This article shows the starting point for building a smart farm under an IPV6 environment safely minimizing the risk of compromising the organization's information assets.
An added value to the intelligent farm infrastructure is the networks defined by software since they will allow to take the control with regard to the security to the superior layers since it separates the hardware through the virtualization of the resources.

With the development of the mobile application, a remarkable speed in the execution of the processes was achieved, so that those in charge of the goat project have a greater control of the information and have a clearer focus on how productive the production of each goat has been.

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