International Journal of Advanced Technology in Engineering and Science
Vol. No.7, Issue No. 03, March 2019
www.ijates.com
ijates
ISSN 2348 - 7550

Wireless System for Control, Monitoring and Preventive Maintenance of Public Street Lighting

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ABSTRACT

The present article proposes a system of management, control and monitoring of street lighting, applying a distributed infrastructure through a network of field sensors defined by the Enhanced Shock Burst protocol which will be responsible for controlling and managing each of the lamps individually. Public lighting system, a gateway responsible for receiving each of the individual frames of the sensor nodes, consolidate the information and send them via TCP / IP to a database hosted on a remote server based on Open Source, the operator through We binder faces based on asynchronous update technologies and interaction with databases (AJAX, JAVASCRIPT and PHP) will have real-time information about what happens with the public lighting system. The development of the system is subject to the regulation 005/14 established by the ARCONEL Electricity Regulation and Control Agency, realizing a real time monitoring of the condition and operation of the lamps, alerting when the lighting service presents problems due to faults. In this way, the proposed system will optimize the resources of the institution regardless of the lighting technology used, generating reports for decision making to improve the service and in case of unexpected or interruptions of service, coordinate maintenance activities that solve the problems immediately.

Keywords –

bit error rate, wireless sensor network, telemanagement, service life , lamps, power, frequency bands, bit error rate, effective Transmission rate.

I. INTRODUCTION

In Ecuador, the public street lighting service suffers constant interference caused by several factors such as: fulfillment of the service life of the light source or damages of the ignition system, voltage and current transients in the electrical network and acts of vandalism . In the country, monitoring systems of existing electrical networks are destined to conversion stations and substations, where problems are corrected in a few hours .

However, it is necessary to develop a remote monitoring, control and management system of the public street lighting service. The Electricity Regulation and Control Agency (ARCONEL), in its 005/14 regulation titled parameters of continuity of the public lighting service, establishes that the electricity distribution companies are in charge of controlling the

II. MATERIALS AND METHODS

In the development of the proposed system a bibliographical research documentary was carried out where a concrete description was obtained of the telemanagement systems of public street lighting presented by [4-11], where they illustrate systems based mainly on the IEEE 802.15.4 standard applied to LED lights and managed through web interfaces. At the same time, an applied research was considered in order to reach fundamental objectives in the solution of the problems presented in the previous section, resulting with the following points.

- Analysis of the technical parameters of public street lighting to be considered in the proposed system.
- Definition of the set of sensors to be used depending on the lighting technology.
- Definition of the set of actuators to be used depending on the lighting technology.
- Definition of the WSN topology according to the geographical distribution of the public street light lamps.
- Modeling of the WSN using empirical propagation models dedicated to the frequency range from 1 GHz to 5 GHz.
- Calculation of the effective transmission rates of the Transceivers considering noisy environments.
- Design and construction of sensor nodes using Free Hardware platforms.

2.1.1. Proposed System

The implementation of the architecture of the public street lighting management system consists of a remote server where the registry of data from the wireless sensor network is stored. In the server, the status of the lamps and the management of variables such as the enabled power hours, the consumed energy power and the level of the electricity supply to the lamps are displayed in real time.

2.1.2. Wireless Sensor Network

This layer consists of several sensors that capture information associated with the lighting technology such as the current consumption (Current Sensor), the level of ambient lighting (Light sensor based on a photosensitive sensor) and for the case of LED lighting the pedestrian presence (Passive Infrared Sensor) in order to determine the energy consumed, the on/off control of the lamp and the regulation of the power delivered to it respectively. The information is processed by an ATMega328 microcontroller (Microcontroller used as a core in Open Hardware Platforms) for its corresponding digitization, filtering and generation of the SPI (Serial Peripheral Interface) frame, which will be sent to the communication device.

2.1.3. Transceiver

In the WSN field there are different standards for the formation of these network topologies, most of them operate in the ISM band (433 MHz, 868 MHz, 915 MHz and 2.4 GHz);

There are several advantages among standards that make them ideal for different applications since they support different transmission speeds, range, compatibility with other equipment

and energy consumption . In the present work we have opted for the NRF24l01 device which operates according to the manufacturer in the 2.4 GHZ - 2.525 GHz range, thus providing

RF channels both in the ISM band (2.4 GHz - 2.483) [5] and in non-free frequencies (2.483 GHz - 2.525 GHz), which makes them ideal for noisy and highly interfered environments, has

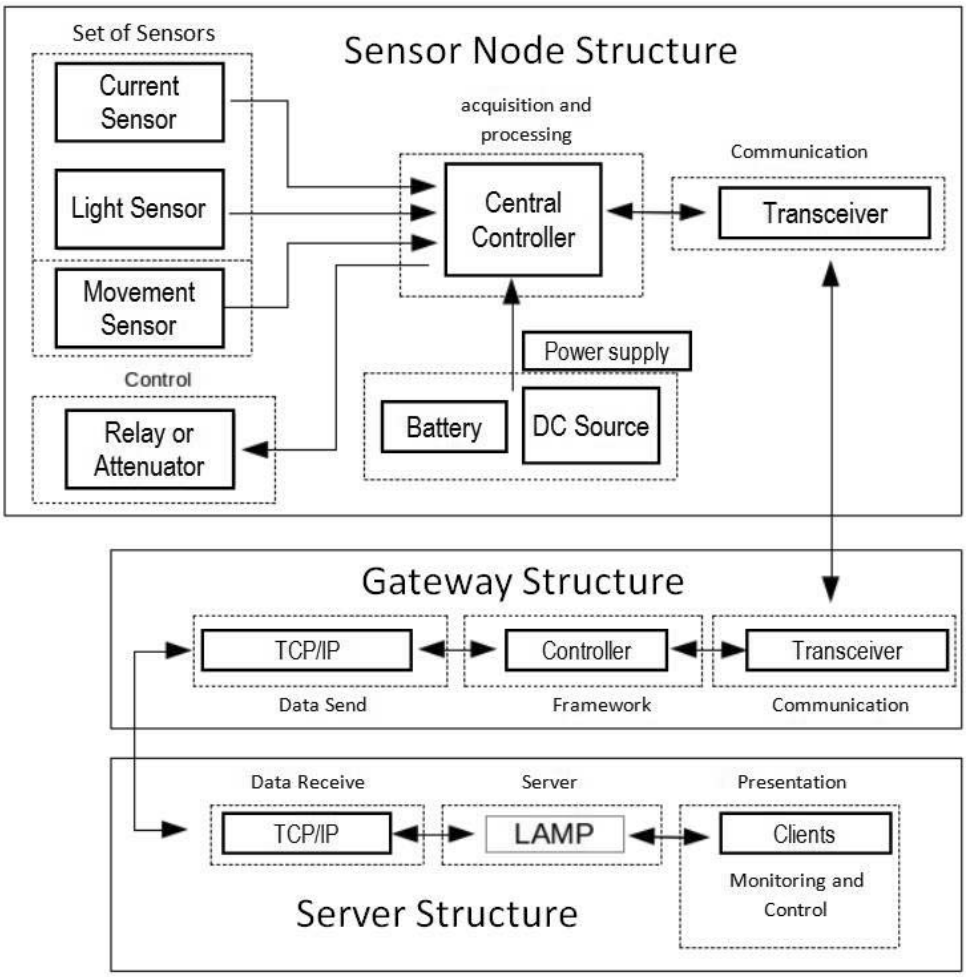
different transmission speeds configurable according to the application, uses the proprietary protocol Enhanced Shock burst of the company Nordic Semiconductor being in relation to
others a robust device and Low cost

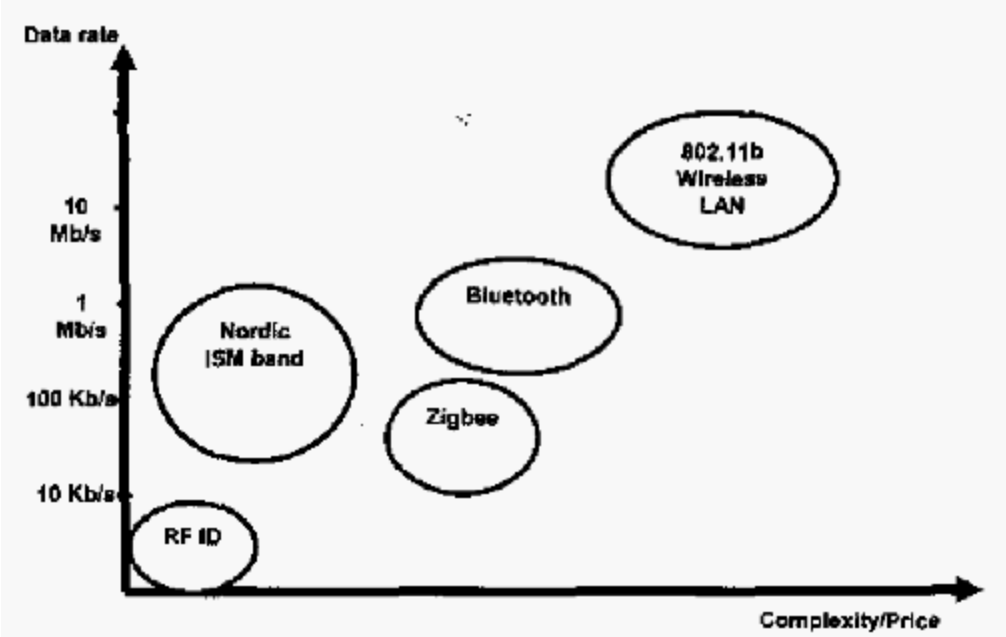
III. INDENTATIONS AND EQUATIONS

When implementing wireless systems, it is important to consider the communication problems caused by interference from devices working in the same frequency band, as well as noise generated by electrical conductors near the system .

For this reason, an analysis was made using empirical models considered valid for wireless systems that transmit in the 1800 MHz band up to 5000 MHz, where the behavior of the system is predicted in several environments with different levels of interference : The Log - Normal model is a model based on a reference of the losses at a preset distance, and applicable in enclosed environments using correction factors . In , the mathematical relationship of this model is presented.

IV. FIGURES AND TABLES





V. CONCLUSION

The technical parameters such as light bulb service life, lamp power, energy source efficiency and energy consumption analyzed in the present project, determined the variables that need to be monitored within the public street lighting installations. The monitoring system allows the user to monitor: if the bulb is operational, the lighting hours of the bulbs in order to determine how long their service life will last and their deterioration, the energy consumption which defines the efficiency of the energy source, and the level of illumination of the environment to define the lighting periods of the public street
lights.

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