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Design and Development of Sigfox Protocol at Node

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Abstract: *In recent years, electricity connections have been provided to all citizens. Thus energy use has doubled and improved the standards of living. It is observed that street lighting has become one more component of energy consumption in India. Street lighting is consuming 18-38% of the total energy bill. The reason behind this energy consumption is due to inefficient deployment of power resources. In this paper Sigfox technology is used to develop a system for monitoring energy usage. This is done by sensing the density of vehicles and public presence on pedestrians using a cloud base low power wide area network. The proposed work was able to save on average 30-35 percent of energy.*

***Key Word**: LPWAN; UNB.*

I. Introduction

Electric energy consumption is the usage of electricity for a given period. The actual energy claim put on current electrical supply is specified in terms of electric energy consumption. Both as a measure of economic and social growth andas a fundamental humanitarian necessity, energy plays a vital protagonist in the lives of humans and in the operations of the economy. As a result, energy consumption is viewed as a key measure of economic progress. The evolution of wireless-communication systems such as Zig-Bee, Bluetooth, WiFi, GSM [2], and Solar Street lighting have flaws that LPWAnetworks aim to address.

Sigfox is a low-power wide-area network(LPWAN) radio protocol that is known for its global reach, cost-effectiveness, energy efficiency, and simplicity. Sigfox uses ultra-narrow band (UNB) modulation to transmit and receive messages while operating in the unlicensed spectrum frequency band. This paper examines Sigfox-based network planning for smart street light management. The latest trend of global urbanization over the past decade or two has brought about tremendous technological advancements in the field of automation, and streetlight technology is one of them. So for reducing the energy consumption and energy-efficient solution designing and implementing sigfox technology at the node. The goal of this work is to automate streetlights in order to increase the system's accuracy and productivity while remaining cost-effective. It also permits wireless access as well as control over the system.

This paper consists of 6 sections. Section 2 describes the literature survey in brief to find out similar work carried out in the domain of Sigfox for energy consumption. Description of the proposed work with methodology is explained in section-3. The implementation of hardware and development of algorithms is presented in section-4. Section 5 gives the results and the Conclusion is mentioned in section 6.

II. Literature Survey

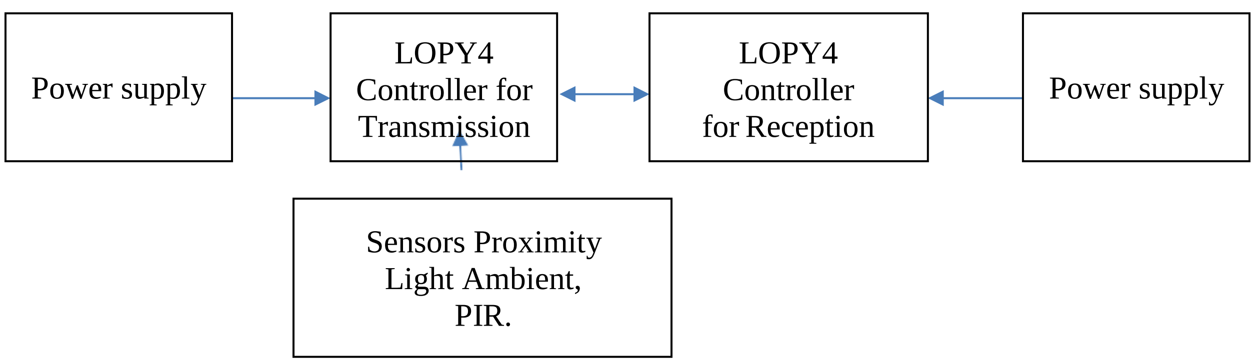
A variety of research focused on various features of smart street lighting systems were reported in the literature. The paper was published by Shahzad G. The project involves designing and developing a smart grid system basedon the open ZigBee standard [1]. Its goal is to implement a low-cost, interoperable network but also to improve energy efficiency through adaptive traffic control. Furthermore, the system is built on a framework that allows it to beeasily integrated into future low-power wireless networks with internet access and devices from many markets. The Zigbee and Bluetooth networks, on the other hand, have a limited network range. TSEC Mumbai's K.Y Rajput and three others also proposed, a GSM-based automatic street light monitoring system [2] which contains Several microcontrollers, as well as sensors such as a smoke detector, noise sensor, and a light ambient sensor. To determine a variety of parameters this technology can monitor ambient temperatures and noise levels and inform the system to take necessary action. The issue is that the GSM modem must be installed in each streetlight, which makes the system extremely expensive. It also has some troubles with connections.

Other work has been done to power a street lighting system using renewable energy [4] sources such as solar energy. Because the autonomous solar street light system is self-contained, it does not require any external wiring or grid connection. However, the disadvantage of this system is that it demands a higher initial investment than traditional street lighting. The amount of electricity generated for solar street lighting is entirely dependent on the weather.
In [11] was published by Parkash and Rajendra D is to design and implement sophisticated embedded system development for energy-saving street lighting. The proposed technology offers an energy-saving option. This is accomplished by employing an IR transmitter and IR receiver combination to detect a vehicle. Street lights are powered by the traditional electrical system, which uses non-renewable energy sources. In [12] was published by Gianni Pasolini describes network designs and communication technologies that might be used for smart public lighting applications, as well as the advantages and disadvantages of each smart light controllers and networks may be put on streetlights, and data is transmitted by IoT wireless devices in their area. Putting the spotlight on LED streetlights. Traditional wireless communication systems such as Zig-Bee, Bluetooth, WiFi, GSM[2], and Solar Streetlighting have flaws that LPWA networks aim to address.

III. Block Diagram of Design

To handle short communications, SIGFOX has established a lightweight protocol. Because there is less data to convey, there is less energy usage and hence a longer battery life.
As previously stated, each light contains sensors like PIR sensor, Ambient light sensor, Proximity Sensor. That continuously monitors the light's status and climate conditions. The power supply is given to the input of LOPY4 as driver voltage. Sensors act as an input to the LOPY4 controller. Once a vehicle is spotted by the PIR sensor, data is relayed via the transmitting node. Sensor data is processed by LOPY4. The data is sent to the receiving node through the sigfox protocol. Through the continuous monitoring of LED street lights according to vehicles and public density Energy can be saved. Due to this, bidirectional communication is possible through nodes. When no cars or pedestrians are present, data is delivered to the receiving end, and the street light is turned off automatically. Data may be monitored from the receiving node, resulting in more efficient power management in street lighting.

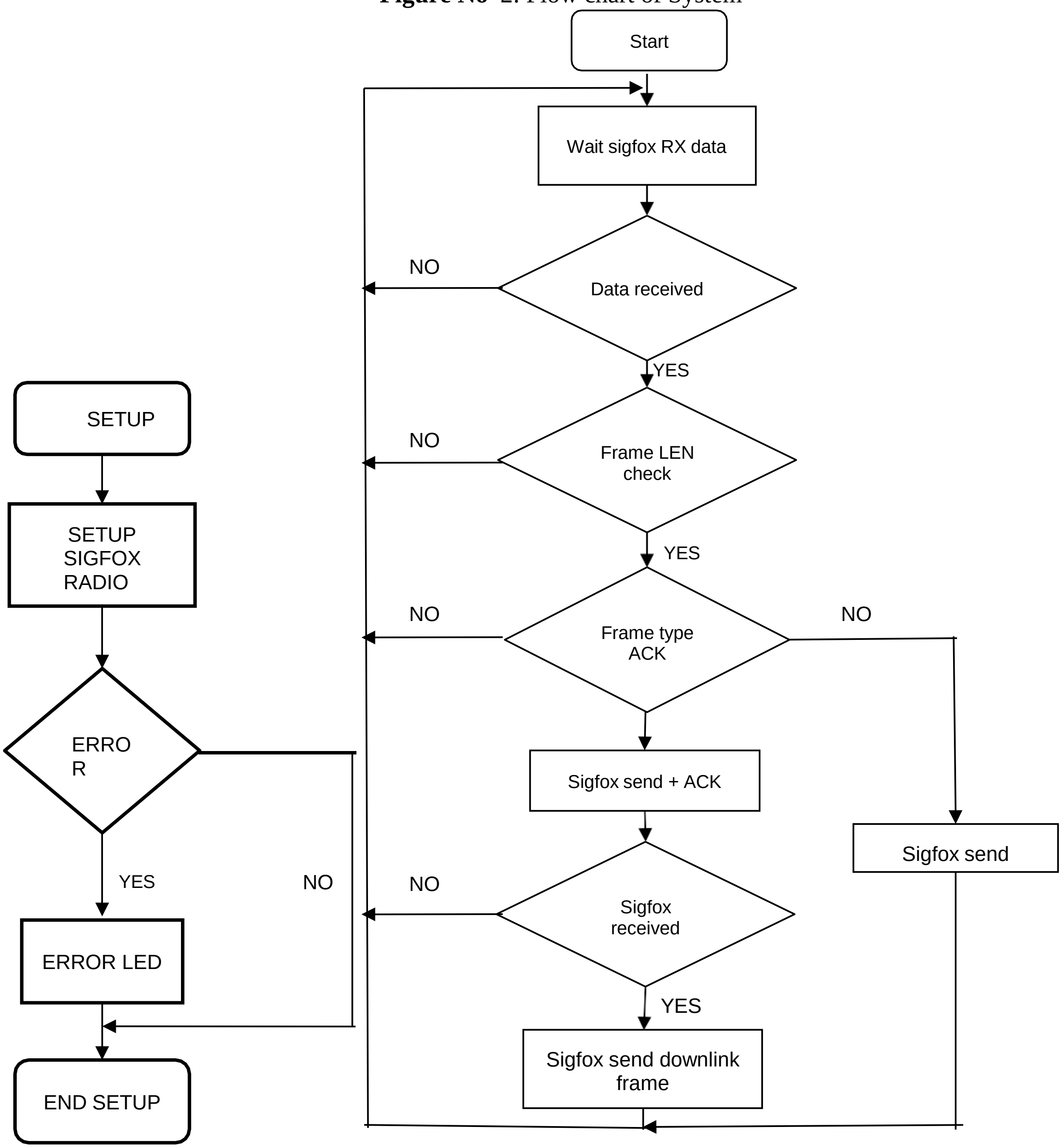
Figure No 1.: Development of Sigfox Protocol At Node



IV. Design and Development of Proposed Algorithm

The creation of an autonomous Sigfox sensor node capable of transferring data collected by a variety of sensors to a receiving node via the Sigfox protocol is described in this article. The payload of Sigfox messages is 12 bytes. That is the limit, but the payload is flexible: any data size between 1 and 12 bytes can be sent. If the user only needs a ping message, the user can even transmit a payload of 0 bytes.

Figure No 2: Flow chart of System



Sigfox Setup **Data transmission flow**

The startup of the sigfox configuration is explained in the first flow. It will examine whether there are any errors in the system after it is started. If an error occurs, the error LED illuminates, else System will turn on. The receiving node in a Data Transmission Flow will wait for data to arrive. The frame length of data is verified when it is received. The next stage in the execution process is for the system to recognise the frame type. At the receiving end, the Sigfox payload message and acknowledgement are verified. Sigfox then delivers a downlink frame. These total instructions work in a loop to avoid the time difference between two messages.

III. Results

For Prototype Energy Calculation

Power = Voltage * Current
= 5V * 0.025 mA
= 0.125 W
Energy Consumption Using 3 LED Lights = 0.125 * 3
= 0.375 W

For Actual System Energy Calculation

Power = Voltage * Current
= 230V * 3A
= 690 W
Energy Consumption Using 3 LED Street Lamps = 690W * 3 = 2070 W

Table no 1 . Comparison of Energy Consumption with and without Sigfox

Set Of LED Street Lights (One Set Contains =3 street Lights)	Total Energy Consumption Without Sigfox	Total Energy Consumption With Sigfox
Set 1	2070 W	1380 W
Set 2	2070 W	1380 W
Set 3	2070 W	2070 W
Set 4	2070 W	690 W
Set 5	2070W	1380 W
Total Energy Consumed	**10350 W**	**6900 W**

Total Energy Consumption Without Sigfox = 10350 W

Total Energy Consumption With Sigfox = 6900 W

Different energy consumption of a set of five street lights was used in the experiment. Sigfox protocol may also be used to vary energy usage. When compared to the previous system, the Sigfox-based street lighting system uses less energy. It can be seen that nearly 33% of Energy can be saved by using Sigfox Technology.

Figure No 3. : Experimental Set-Up

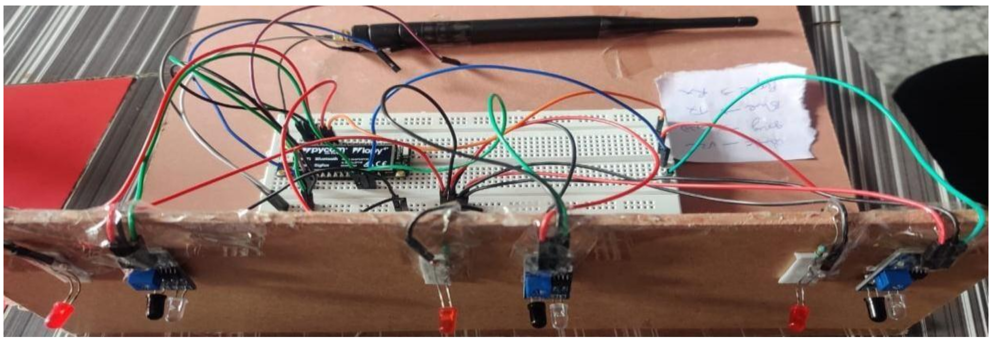


Figure 3. : Experimental Set-Up

IV. Conclusion & Future Scope

A Sigfox Technology is implemented on LOPY4 Processor to monitor Energy Consumption for Street Lights. In the future, this system can be used in smart cities to reduce maintenance costs and energy usage in street lighting. Following are the observations: -

- Effective communication was Successfully Established between Two nodes for Energy management using Sigfox Technology.
- The density of the vehicle as well as the public is sense using PIR sensor to reduce the energy consumption
- 30 to 35 percent energy consumption is achieved with this energy-efficient management system.

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