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WIRELESS SENSING AND COMMUNICATION DESIGN FOR THE INTERNET OF THINGS: AN ANALYSIS

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ABSTRACT

The Internet is evolving from a network that is centred on people to one that is centred on objects. By 2020, it is predicted that 50 billion things will be connected to the Internet. However, maintaining compatibility across diverse Internet things, such as handheld mobile devices, wireless connectivity, and Radio Frequency Authentication, becomes incredibly challenging as a result of this shift. Numerous little devices are now being used in various facets of daily life thanks to advancements in wireless information and electronic equipment. These devices are capable of sensing, computing, and communicating. Common parts include integrated CPUs, several intelligent systems, and low-power antennas. A WSN, which is necessary for sensing and monitoring environmental factors, is built using these sensors. In addition to WSNs, the idea of the Internet of Things (IoT) is gaining popularity. According to this definition, the IoT is the connection of identifiable objects to the internet for the purpose of detection and monitoring.

Keywords: wireless sensor network, Internet of things, identification, radio frequency, technology, devices, interoperability

INTRODUCTION

WSNs are small-scale sensor collecting nodes that are used to observe, sense, capture, and analyse data in the vicinity of an implementation— i.e., events of focus. As a consequence, these nodes are resource-hungry while also being highly reliant on battery management, storage, processing, data size, and available connectivity. Normally, these networks are fixed in a specific method and left as a single point in a residing in remote location to perform information tracking and gathering. The term "wireless" has evolved into a broad and vague term for telecommunications in which electromagnetic radiation are employed to transfer data over a portion or the entire communication line.

The phrase "Internet of Things" describes a broad area of scientific inquiry and technological advancement that enables online users to connect with the real world. There are, however, two main perspectives on what the Internet of Things means and, thus, what kinds of technological advances have to be assessed. [1] As an alternative, IoT usually employs strategies like RFID, low-range

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communications technologies, real-time localization, and network sensing. [2] According to this viewpoint, the usage of wireless detector communications, which facilitates gadget functionality, is the main component of IoT. However, one body of study contends that the term "thing" must not just refer to a physical thing but also to conceptual and virtual components, especially those connected to services. [3]

WSNs have piqued academics' interest due to fast technological advancements in wireless communication and integrated electronics. A typical WSN is made up of nodes, which are small devices. Embedded CPUs, limited processing capability, and sensor technologies are all present in these nodes. Endpoints are used to detect the environmental parameters like moisture, pressure, temperature, and vibration using these sensors. [4] Sensor interface, computation unit, transceiver unit, and power unit are typical components of a WSN node. These devices serve critical functions by allowing nodes to connect with one another in order to relay data collected by their sensors. To establish a centralised system, connectivity between the components is required.

[11-13] For a number of applications, such as monitoring systems, smart homes, social work, and public safety, WSNs offer indisputable advantages over traditional approaches. WSNs are a part of the IP that helps to create the Internet of Things by linking common things to the Internet. The mainstream has grown significantly as a result of advancements in detecting scope, and WSN devices have become more affordable. On the other hand, this has demonstrated a strategy for a large increase of tracking of sensor-equipped system information, structures, vehicles, and equipment. [14-17] The fundamental elements of wireless networks centre on recent developments in networking technology, including wireless technology, portable ad hoc connectivity, and device-coordinating strategies. [18-19] WSNs are therefore well suited for monitoring mobility infrastructures like mass transit, beds, gear, and bridges.[20]

SYSTEM ARCHITECTURE

The suggested system for incorporating WSNs into IoT is made up of several key components, including: 1. Wireless Sensor Network (WSN)
3. Middleware 2. Portal Server
4. Client for mobile devices

The WSN's communication channel is Zigbee, and the core network is IPv6. The connection between the gateway node, gateway, and portable client, on the other hand, is built on IPv4 over Wi-Fi. This architecture allows every device in the system to interact with other device, regardless of the multimedia technologies or network protocol utilised . The system structure is displayed in Fig 1.

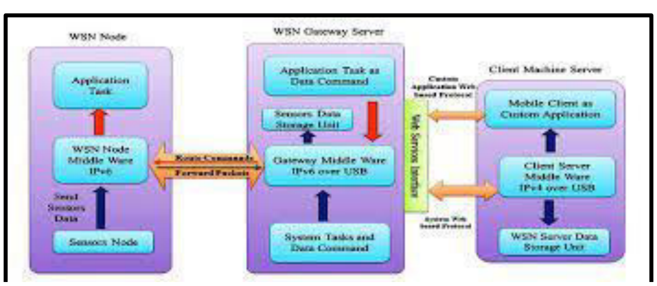

Fig. 1. System Architecture in General

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It shows the system's four primary components, as well as the essential subcomponents. The information flow between the system's many components is also depicted in this diagram. The operational sequence diagram, shown in Figure 2, displays the many elements of the system and also the links that exist between them.

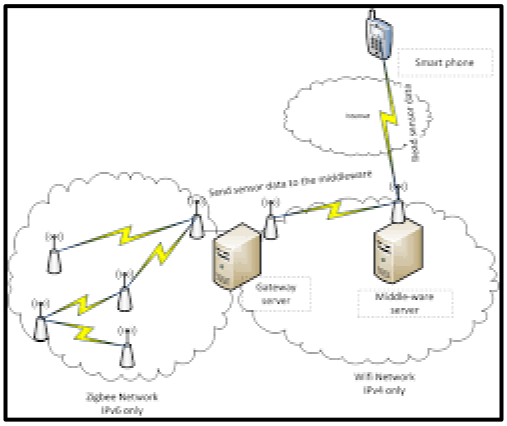

Fig. 2. Network Diagram

WSN

The WSNs test-bed is made up of seven Crossbow MPR2600 motes. The WSN was a multi-hop wireless service that connects the AODV routing technology from a network topology standpoint. It's an ad-hoc network in which motes can be deployed anywhere with no predetermined topology as much as there's at least one wireless transmission link.

WSNs Communication Architecture

A radio consists of two parts: a broadcaster and a reception. These two components must be provided for any node in order for it to communicate with other nodes fully. The radio collects information from the brain and distributes it to other sensor network during data transfer. The radio collects information from some other node's antenna and transfers it to the brain throughout data reception. The parent node receives all of the data received by the sensor node. This parent network is linked to a multi-functional desktop, allowing users to access data from other nodes via the computing device. If the user provides instructions, the instructions will be transferred to the multi-functional computer via the Internet.

Sensor Node

The sensory-motor component is the most crucial parts of any WSN. A small, low-power device called a sensor node. Despite its limited energy supply, it has concurrent processing capability and an affordable cost. In Figure 3, the components of a sensor node are shown. The specialised components of a sensor node are in charge of data collection and data transmission.

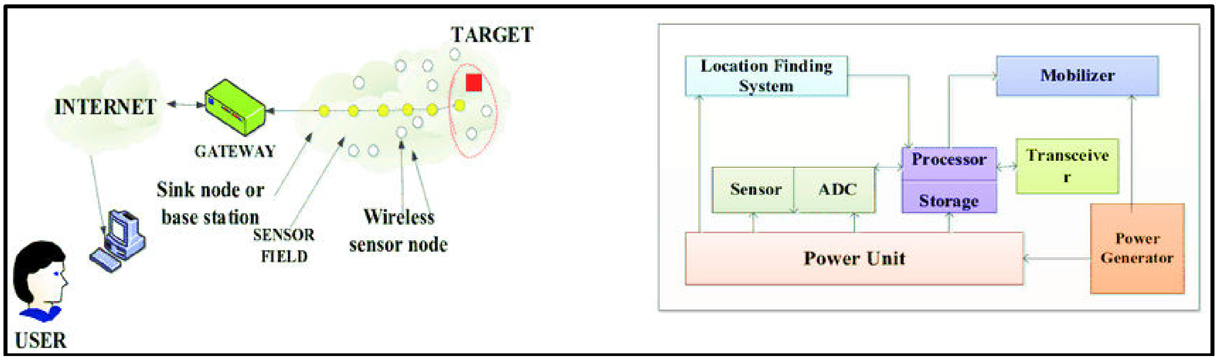

Fig. 3. WSN Components

IPv4/IPv6 Gateway

This is the most important part of the system. It deals with the issue of gatewaying between IPv4 and IPv4 networks, such as the Web and the WSN. While the WSN system only allows IPv6, other elements like middleware and the smartphone client do not require an IPv6 address, we still want those parts to be able to connect regardless of the IP technology utilised.

Power Source

The power supply is attached to the base of the sensor node. It powers a variety of sensor node components, including radios, CPUs, and sensing units (sensors). To keep performing sensing, cognitive, and communication tasks, energy is needed. Because of this, methods for obtaining ambient energy are used to power sensing element nodes. Examples of power sources include solar cells, rechargeable batteries, watch battery packs, and intelligent systems.

Gateway Server

The gateway server was an important part of the overall system. It gathers and inhales Wi-Fi frames before converting them to Zigbee frames and forwarding them to the sink by substituting the relevant frames headers. The gateway server, on the other hand, receives Zigbee frames carrying IP packets. These are encased in a USB framework, which is subsequently removed at the Gateway server - side to fit into a Wi-Fi frame. The gateway server was also in charge of receiving IPv4 messages and converting them to IPv6, as well as the other way around. It also has other features, such as collecting sensor information from the WSN and sending it to the middleware. In the event that the connection between the gateway node and the software is lost, the host computer saves the data.

A Zigbee frame wraps an IPv6 packet, which is transmitted to the mote sink, which extracts the IPV6 packet, wraps it in a USB frame, and then passes it to the gateway, where the TCP data packet is retrieved. The sensory information is transmitted to the middleware once it arrives at the gateway. The sensory input is temporarily saved in a database if the connection is down (Fig. 3). The mobile client providing On/Off commands to the gateway is depicted in this data flow diagram. Once the connection is established, all stored data is transmitted to the middleware and the dataset is cleared.

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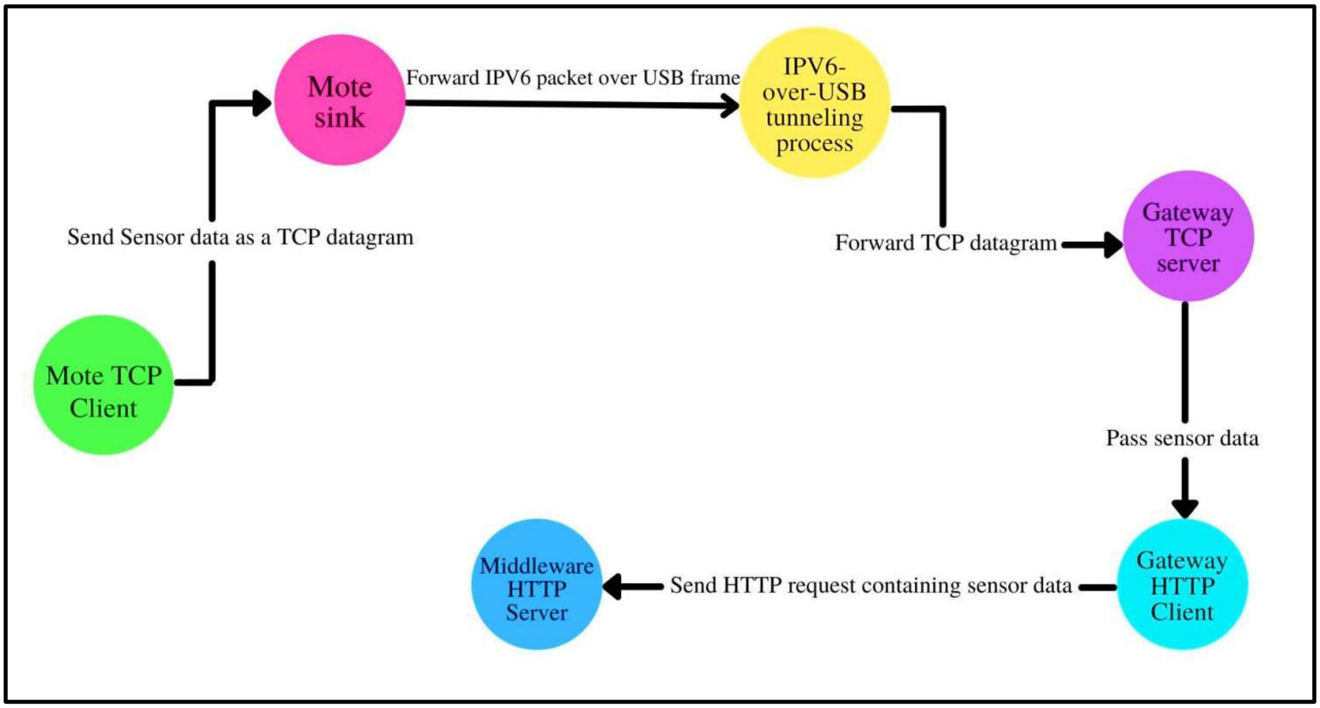

Fig. 4. The sending of sensory data is depicted in this data flow diagram.

Microcontroller

The CPU of a sensor was typically composed of a microcontroller and flash memory. Most sensor nodes have connectors so that additional external components and sensors could be easily connected to the primary unit. Taking judgments and managing data collected are two examples of the CPU's crucial tasks. The CPU keeps the data in flash memory until additional data is obtained. The microcontroller component of the CPU stores the data in envelopes, which are particularly effective at transferring data, after the system has gathered enough of it. The radio station receives these packets and broadcasts them..

Sensor Transducer

The most crucial part of a WSN is its sensors. Sensors translate environmental factors including light, pollution, temperature, and sound among others into electrical impulses. Various sensing techniques have advanced quickly during the past 20 years, simplifying the operation of sensors.

RESULTS AND DISCUSSIONS

Simulations were used to test the suggested cluster creation methodology. Furthermore, studies were carried out with varied numbers of nodes, starting with 100 nodes and testing up to 500 nodes. These nodes were spread out over a (100x100) m2 space. Table 1 lists the model parameters that were employed in this study.

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Table 1 Parameters for Network Simulation

Parameters	Simulation Area	No. of Sensor Nodes	Initial energy of nodes	Eelec	ε_{fs}	ε_{mp}	Packet size
Values	100x100 m^2	100	2 J	50 nJ/bit	10 pJ/bit/m2	0.0013pJ/bit/m4	4096 bits

We tracked the system's ability to run reliably and provide an acceptable degree of efficiency in order to evaluate it. To assess the study's validity, two experiments were carried out.

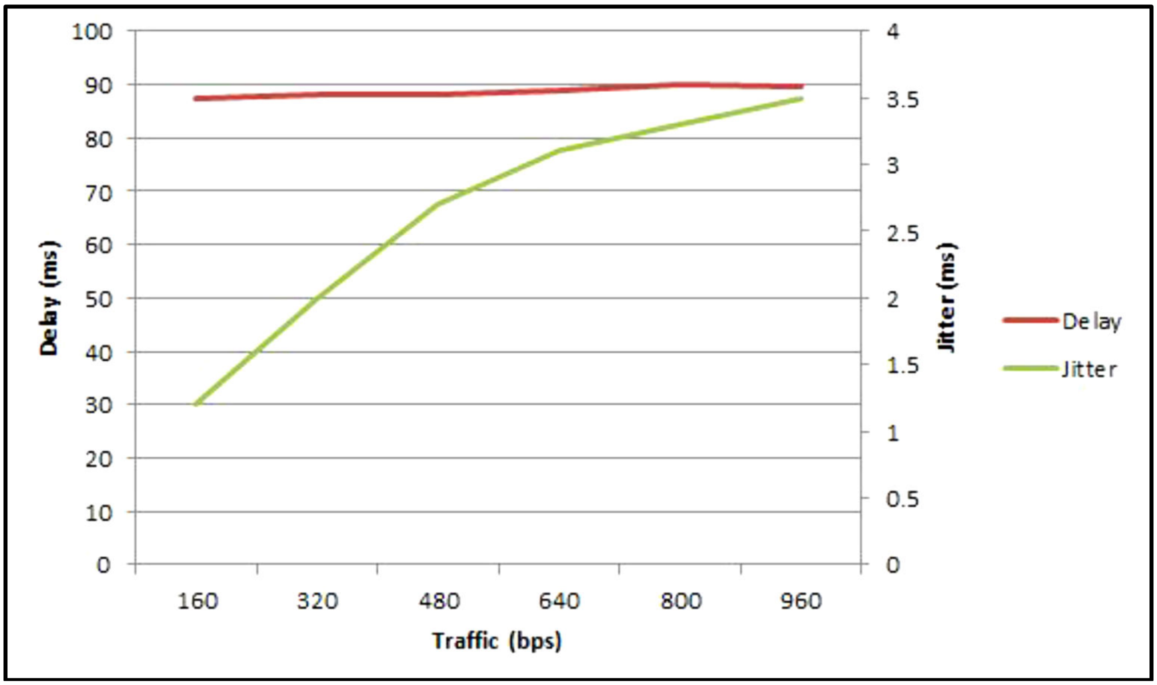

Fig. 5. Delay and Jitter variation with increasing traffic

The overall communication delay is caused by the Gateway Packet Transformation procedure. To put it another way, how much delay would the packet translation procedure add? The waiting time and jitter calculated over the time elapsed from packet sniffer in the Gateway Network Transition process to modification and transmission to the receiver are presented in the results. This was carried in 200 packets, each of which was sniffed and changed by the procedure. The elapsed time of the conversion system is determined in microseconds.

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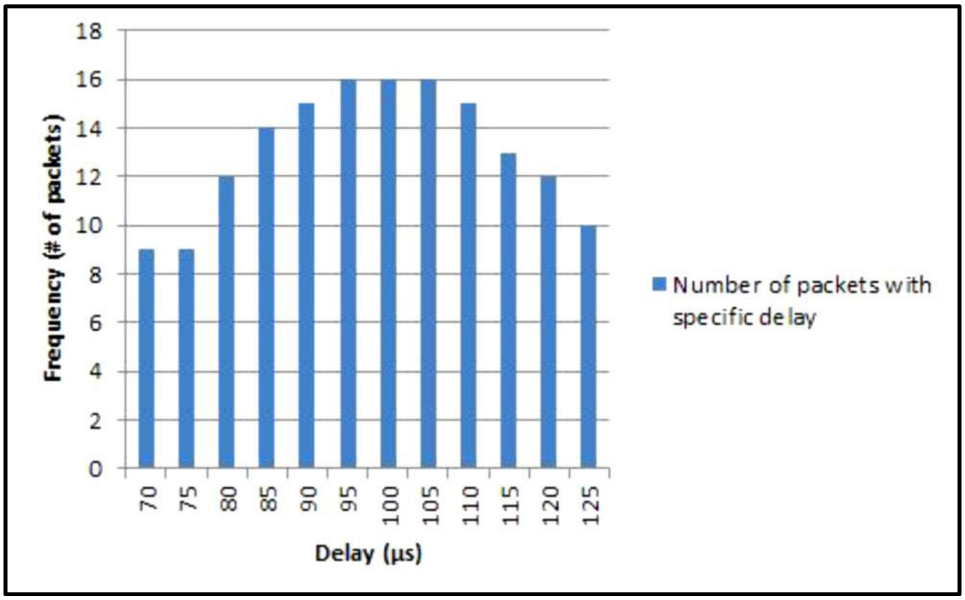

Fig. 6. Histogram of Delay Frequency

In addition, the variation of the delay rate is illustrated in the histogram portrayed in figure 6 based on the devices load. It is clear from this diagram that the latency is distributed normally. Furthermore, this experiment demonstrates that the Gateway Protocol Transformation procedure has a negligible impact on the overall delay.

Reliability:

The ability of a sensor node to sustain its network operations without disruption is referred to as reliability (or fault tolerance). Sensor node breakdown is a type of interruption that can happen due to a lack of energy, significant injury, or interference from the environment.

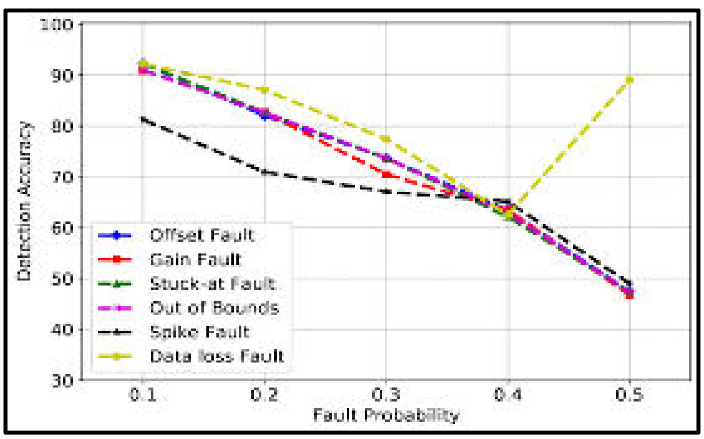

Figure 7 Reliability

Density and Network Dimension:

The user can deploy an unlimited number of sensor nodes to investigate a phenomenon under investigation. As a result, the density of these networks rises substantially, affecting the coverage

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area of study, as well as accuracy and reliability.

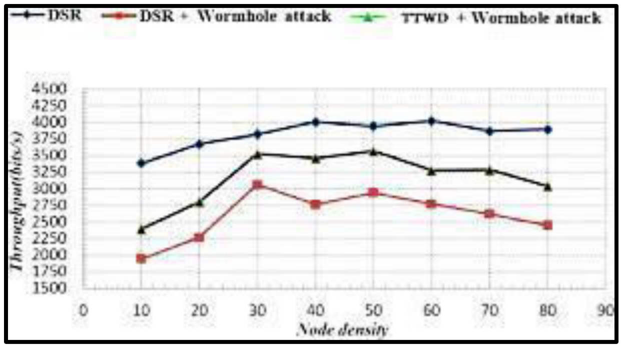

Figure 8 Density and Network Dimension

Topology of Sensor Network

Network topology has an impact on network speed, increasing network, and network resiliency. Moreover, network architecture influences the difficulty of data forwarding.

Energy Consumption:

Because sensor nodes are powered by batteries, their lifespan is likely to be influenced by battery life.

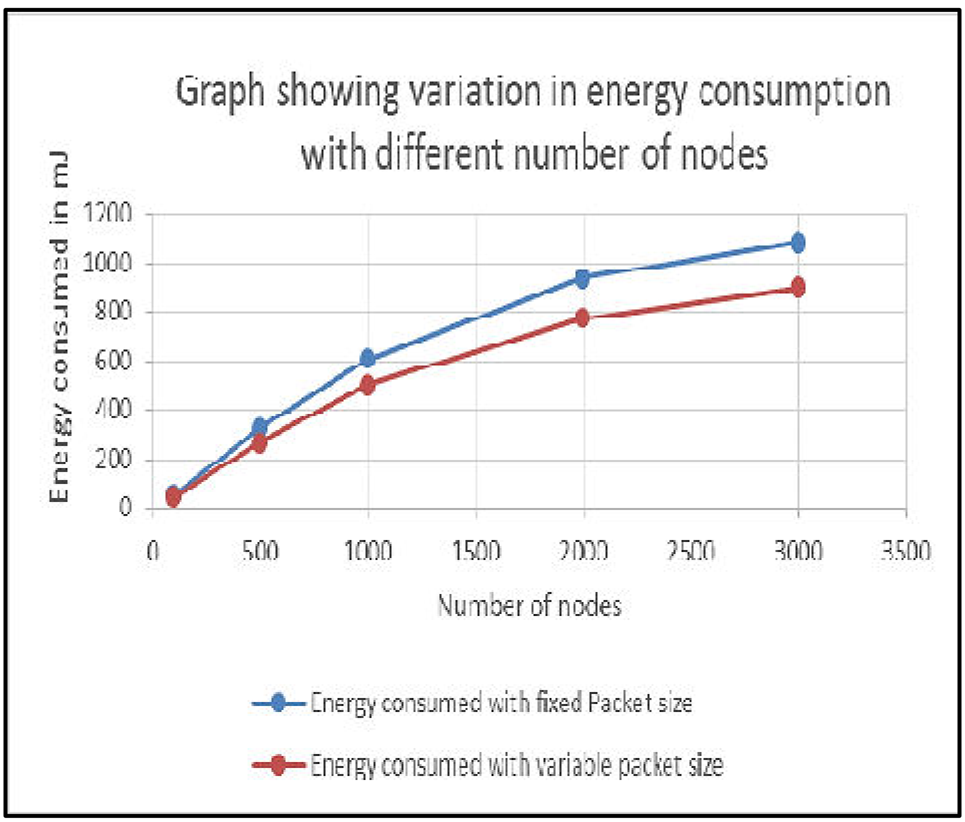

Figure 9 Energy consumption

Conclusion

We discussed the nuances of connecting wireless sensor networks with the Internet to regulate electrical items in this study. The architecture for installing a real-world testbed was defined. The given architecture is straightforward and adaptable to comparable deployments. We focused on essential issues, such as IPv4 to IPv6 gatewaying. We plan to continue researching the middleware subsystem in the future in order to support mobile wireless sensor motes and not limit distribution to specific specks. A few standards have previously been established in this area, such as IPv6, 6LoWPAN , and M2M. The incorporation of wsns into the Internet of Things is the topic of this article.

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