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ENHANCING THE LIFESPAN OF WSN BY PDBAC-LEACH PROTOCOL USING CLUSTERING APPROACH AS AN IMPLEMENTATION STRATEGY

Qusay Abdulrahman Noaman ALSATOOREE

Master's Thesis

Supervisor

Prof. Dr. Galip CANSEVER

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Qusay Abdulrahman Noaman ALSATOOREE

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ABSTRACT

ENHANCING THE LIFESPAN OF WSN BY PDBAC-LEACH PROTOCOL USING CLUSTERING APPROACH AS AN IMPLEMENTATION STRATEGY

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The (WSN) are known as Wireless Sensor Network; it is a fundamental mechanism of the internet of things that has witnessed a universal avail in its utilise in numerous sectors such as the army, automation, agriculture, environment, etc. Regarding WSN, energy efficiency and message delivery reliability are crucial for applications like wireless detection and monitoring. This motivates researchers to do more and more investigations. Many different routing protocols, many of which are based on clustering and hierarchical topology, have been developed to improve performance in WSN to optimise the network's energy usage. There are several routing protocols out there, but most do not consider all the metrics necessary to prolong a network's life. This work introduces Probability Density Based Adaptive-LEACH (PDBAC-LEACH), an improved algorithm of a LEACH "Low Energy Adaptive Clustering Hierarchical" protocol designed to equalise the energy exhaustion of sensors nodes of the network to increase the WSN lifespan. The proposed protocol uses sensor node residual energy to select clusters heads (CHs). Therefore, only nodes with a high enough current could participate in the (CH) selection. From there, it prioritises both current energies as well as the distance to the BS (base station) to choose a root CH with increased current energy over the average energy of clusters head (CHs) and a decreased average distance to the BS (base station). All root of cluster head (CH) information is contained within this parent CH. With the help of the multi-hop procedure amongst CHs, the root clusters head (CH) collect data and then transmits BS (base station) in a compressed manner. MATLAB R2016b is used to simulate an enhanced algorithm. The model results described that the providing protocol is superior to previous works that employed LEACH Protocols to prolong network lifespan.

Keywords: Cluster, Energy Exhaustion, LEACH Protocols, PDBAC-LEACH, Lifespan of Network; Distance, MATLAB Simulation, WSN.

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ABBREVIATIONS

LEACH	:	Low Energy Adaptive Clustering Hierarchy
PDBAC-LEACH	:	Probability Density Based Adaptive – LEACH
CH	:	Cluster Head
CCD	:	Centralised Cluster Designing
BS	:	Base Station
EEE LEACH	:	Energy Efficient Extended – LEACH
WSN	:	Wireless Sensor Networks
TDMA	:	Time Division Multiple Access
LBT	:	Load Base Threshold
CCD	:	Centralised Cluster Designing
C-LEACH	:	Centralized – LEACH
ACH	:	Asst Cluster Head

1. INTRODUCTION

1.1 OVERVIEW

Recently achieved success in cordless ad-hoc, as well as sensor-network research, might allow for the creation of inexpensive as well as energy-efficient instruments. Wireless sensor devices are typically small and compact, energy by batteries that can be tricky to recharge in real-world situations. These sensors were deployed in a particular location to detect and collect data for further examination. These devices are intended to function without the need for human intervention in hazardous or inaccessible conditions in the area where they have been deployed. Considering this, the dependability of a network and its capacity to persist are of the utmost importance. Clusters of such nodes transmit their sensing data to a single central base station (BS) in the vicinity via a multi-hop communication protocol [1].

The resource limitations of a wireless ad-hoc and sensor network include finite batteries (energy), limited processing abilities, reduced storing space, and lesser comm bandwidth. Even though it has a few flaws, it can be helpful in various real-world situations, such as monitoring health conditions, keeping an eye on the environment, and keeping track of buildings. Most research on wireless ad hoc and sensor networks primarily focus on methods that can reduce energy exhaustion to extend the amount of time that a battery can function, as evidenced by [1], [2]. Every single sensor device has a limited battery capacity that is proportional to the amount of time necessary to recharge the batteries for the very first time in a wide variety of settings where the participation of human operators is simply not possible [3].

Therefore, energy availability is a significant issue for long-term network viability in wireless ad-hoc and sensor systems. WSN lifespans are a single crucial parameter for measuring the functioning of telecommunications Ad hoc and sensing nets. Once from fundamental difficulties in telecommunications, Ad hoc, as well as sensing nets, are effective reuse for a battery since the lifespan of a network is typically determined by the network's residual energy (i.e., energy of the device) [4], [5].

One way to deal with the issue of energy conservation on telecommunications Ad hoc as well as sensing nets is to employ the clustering strategy. Clustering is a method in which related devices are gathered in one area. After nodes are grouped, one is chosen to serve as the cluster's head depending on several techniques. The other nodes in the cluster are referred to as member nodes. In a cluster, the " head " node is responsible for collecting data from all the other nodes. After then, it either uses a direct hop or a multi-hop to transmit information to a surrounding (cluster head) located on a centre terminal. Transmission of data within a cluster (intra-cluster) and between clusters (inter-cluster) are the two main types of cluster routing. With this cluster layout, a lot of energy can be saved throughout the system. In a wire-free ad hoc or sensor network, the nodes can number in the thousands. The increased energy needed to exchange data amid the network's unpredictable cumulative load and severe malfunctions is a result of its densely distributed nature. An inter-communication and Cluster Head (CH), as well as the various algorithms based on chosen CH as well as individual nodes, is considered a crucial role in easier grid longevity. It's the network design based on a flat architectural model. All nodes in a network with a balanced architecture have the same basic form and composition. Therefore, they lack self-sustaining conservation practices. Evidently, in a network based on a cluster architecture, elevated energy nodes which are suitably located as the CH also work as a (Gateway), playing a crucial role in resolving a wide range of problems. Because of its pathfinding, information combination, mistake tolerated, and E2E nature, a network that is built on cluster architecture is regarded to be an energy-efficient network. In addition, a network with a cluster architecture demonstrates significant advantages over a network with a flat architecture, which is as follows [5], [6].

a. It helps keep the energy and data loads on the nodes even while reducing transmission energy exhaustion.
b. Incorporating a topological technique lowers the network's overhead, which increases its resilience and allows it to operate for longer.
c. Reducing the need for intensive hop-by-hop communication helps keep collisions to a minimum.
d. It makes the cluster's head smaller.
e. It improves the nodes' ability to survive for extended periods. The cluster comprises a CH and several other nodes that the head connects with (see Figure 1.1).

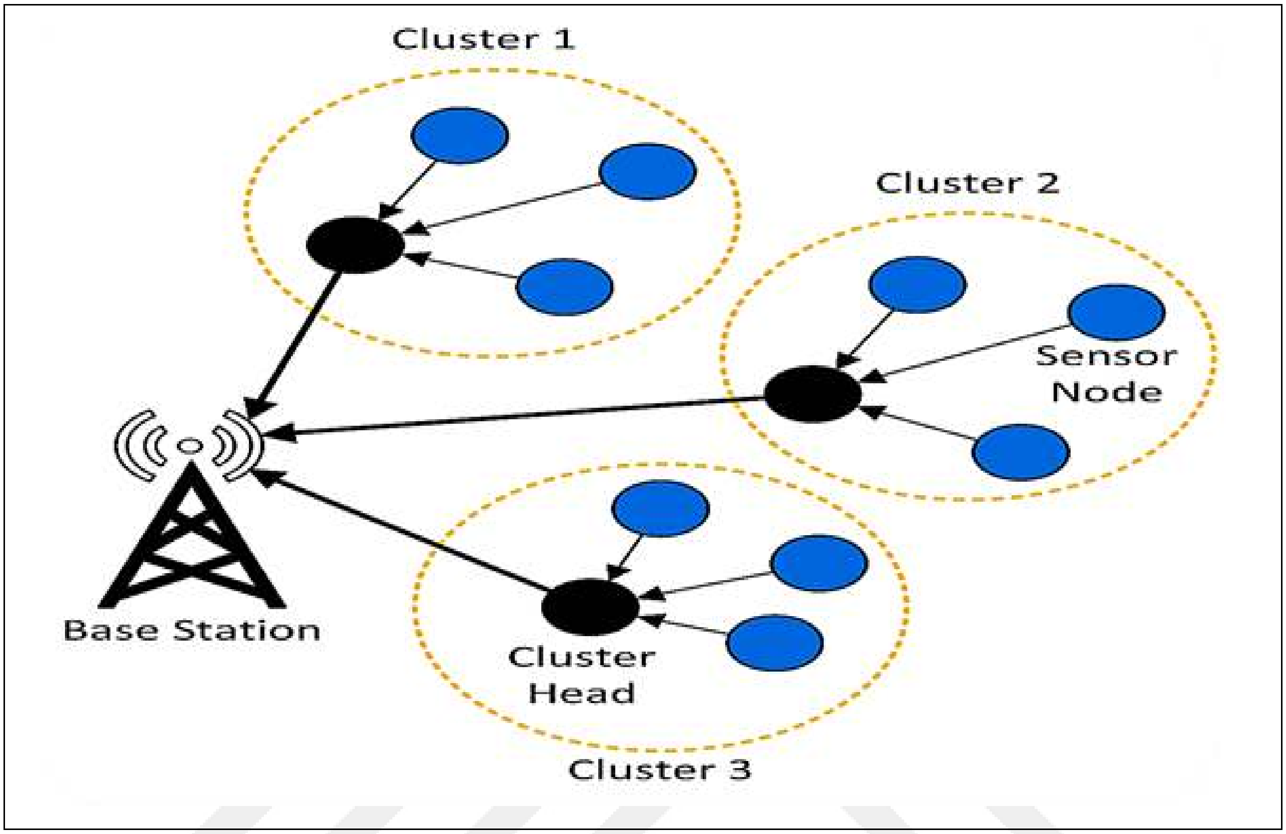

Figure 1.1: The cluster nodes that create the line

As previously shown in Figure 1.1, there are three distinct clusters inside the deployment area. Depending on specific clustering algorithms, a node is gathered jointly from a cluster. Using multi-hop communication, a CH compiles information and sends that to a central terminal. Sometimes, deployments of sensor nodes can be hostile due to the restricted energy of a sensor node, necessitating alternatives to the conventional clustering strategy. The network can be further compromised by energy leaking from the clusters head. As a result, a network's survivability may be compromised, significantly shortening its lifespan. Possible solutions for overcoming these limitations include rearranging the network's clusters or choosing a new CH. In such a scenario, the head of the cluster will cease to collect and distribute information. Not only that, but re-clustering may introduce extra overhead, slowing down the network and reducing the energy available to individual nodes.

Based on our understanding of the challenges of longevity on telecommunications Ad hoc and sensing networks, we propose a new method for increasing network lifespan by utilising a clustering-based routing strategy. Setup occurs when a cluster of sensor nodes is formed. The cluster is included in a steady state, and its boundaries are chosen at the same time. Finally, the data is routed from the CH of BS. To deal with both types of networks. The suggested methodology displays the architectural connections. By directing as well as multi-hop routing into the same scheme, the proposed approach reduces the network's overall energy exhaustion. The foundation of multi-hop communication is identifying a path from the source to the target [7].

1.2 RESEARCH OBJECTIVE

LEACH is among the more credible options, less-exhaustion hierarchical clustering path protocols that divide the network into multiple clusters using a probability pattern to select the CH. It is a protocol dependent on the notion of forming clusters in which regular nodes communicate data collected from the environment to their randomly selected CHs at the first of each round. After aggregating data from each node, each CH sends data condensed data to BS. A random sample of CHs without regard for the current energy of each node, as well as a connection among CHs and a BS, directly increases energy exhaustion, hence reducing WSN lifespan. For that purpose, a model created an improved protocol of LEACH with the overall objective of extending the network's lifespan.

1.3 THE GOAL OF STUDY AND SOLUTION

Ad-hoc networks and wireless sensors connect the physical & virtual worlds. It's becoming on-enabled due to cheaper sensors, handling, and communications. And to the match structure for a node concerned in a net, s key modelling purpose are to assure a particular network lifespan (called information gathering periods) and to assure which each machine on connections dies by a similar period. Unattended sensors are helpful for inaccessible places. Wireless sensors and ad-hoc networks are performing more functions, like network analysis, info merger, and information combination, needful for the usage of smaller energy, which increases network survivability. Nodes in these networks have restricted transmission range, processing capacity, as well as connection bandwidth, clustering selects a cluster head from a node. A cluster head gathers and sends information to the sink. Cluster rotation also extends node lifespan.

We offer a modern model clustering approach that reviews a sink's current energy and distance. Clustering is done utilising PDBAC-LEACH. The PDBAC-LEACH has five goals:

a. The WSN's lifespan can be extended if energy exhaustion is balanced across all nodes.
b. The CHs are calculated depending on the energy loss after processing.
c. Reduce the burden of aggregates on low-energy nodes as much as possible.
d. A root CH is chosen that maximises the energy of the current while minimising the distance of a sink.
e. Using the multi-hop approach reduces the energy of communication.
f. PDBAC-LEACH protocol enhances network life span by CHs and data collecting additional, balancing energy usage and considering CH distance and residual energy.

1.4 THESIS OUTLINE

Generally, this thesis are made up from five fundamental chapters, the sections of each chapter are presented as follows:

a. Chapter 2:

This chapter of the thesis illustrates a concise summary of the most recent context and related work.

b. Chapter 3:

This chapter of the illustrates the approach that is introduced for the proposed protocol and the work methodology.

c. Chapter 4:

This chapter illustrates the simulation process of the proposed protocol. Also, this chapter comprise a presentation for the reached results.

d. Chapter 5:

This chapter of the thesis illustrates the overall obtained results that are reached after carried out the simulation process and the discussion as well.

e. Chapter 6:

Eventually, this chapter of the thesis illustrates the reached conclusion after conducting this work. Also, this chapter presents the future work.

2. BACKGROUND AND RELATED WORK

2.1 RELATED WORK

In wireless sensor networks, there are multiple routing protocols from which to pick the LEACH one that has been proposed, and it would serve as a trailblazer in the field [8]. Several works that are related to LEACH have been presented in the research that has been published [9,10]. The previously proposed strategy makes the same techniques of distributed clustering techniques, which have now been made possible by additions to LEACH. Many different algorithms deal with the methodologies [10], [11].

To lower energy in wireless sensor networks using the clustering technique [12]-[19], an improved LEACH architecture is presented in which CH oversees sending data to clusters. To reduce the energy exhaustion compared to LEACH, they switched from a straight hop to numerous hops. However, with this group up, the cluster head (CH) could potentially crash or die because of the overwhelming amount of data it is responsible for to prevent these kinds of problems; it is common practice to have the central CH delegate authority to the vice-CH. The vice-CH is accountable for safeguarding the entire structure and addressing any network disruptions that may occur. The proposed hierarchical clustering algorithm method [20], the network lifespan can be extended using the cited algorithm. Energy Efficient Level Based Clustering Routing Protocol is a well-known hierarchical clustered routing technique suggested to enhance network longevity by minimising energy depletion and the corresponding number of dead nodes [21]. In this system, a cluster network is formed by deploying a random number of sensor nodes, *n*. The author assumes that the deployed sensor network has a central base station with a fixed number of identical sensor nodes and a finite energy supply. The dynamic energy data is transmitted from the intermediate nodes to the base station. To ensure that all the network's nodes are reached, the base station continuously broadcasts a signal to the side of the network that is perpendicular to the direction from which it receives data.

Then, the base station sends out a hello message that includes the upper limit (Ui) and lower limit (Li) of each level, which are used to determine how far away the receiving device is based on the signal strength. Energy Efficient Extended LEACH (EEE LEACH) protocol [22] is a suggested update to LEACH. Using a multi-level clustering strategy, they reduced the distance between the nodes in the improved LEACH protocol by introducing the Master cluster head and the cluster head. Therefore, a more significant number of clusters reduces the average transmission distance & enhances the energy effectiveness of the protocol. Overall, EEE-LEACH performs well than the standard LEACH protocol. To solve this problem, suggested a centralised cluster designing (CCD) variant of LEACH [23] in which the BS oversees choosing A cluster head & the ideal cluster size. Many CCD-related protocols use the same policy. The base station, the hub, is the ultimate arbiter of which node in the cluster will receive the bulk of the energy.

A centralised decision-making technique for choosing a cluster head is presented in C-LEACH (Centralised low energy adaptive clustering hierarchy) [24]. The clusters head are sent to all nodes in the network through C-LEACH. In terms of both energy efficiency and load balancing, C-LEACH performs admirably. Every single sensor node must update the sink node on its current location and remaining energy status. Global Positioning System coordinates can determine where anything is right now (GPS). For optimal cluster size, energy load should be distributed uniformly across all network nodes. Furthermore, the sink node also determines the average energy of the network. In the cluster electoral system, nodes with less than average energy cannot choose the cluster head. The simulated annealing approach is used by the base station to find clusters since finding the k cluster to solve is NP-hard.

Two techniques are given in [25] for a large-scale, homogenous wireless sensor network. Energy-efficient and dynamic clustering, often known as dynamic cluster designing (EEDC), is the focus of the first clustered architecture-related multi-hop routing algorithms are yet another example of an algorithm. An algorithm that is both energy-conscious and energy-conscious. Each node in the network periodically evaluates the strength of incoming signals from neighbouring nodes. All the nodes assess the status of the active ones in real-time by measuring the strength of the received signal. Then the best possible probability is determined for creating a cluster head. The energy consumed for communication within and between clusters can thus be reduced. For this reason, the node with the maximum energy is selected as the cluster head, and its lowest battery energy is referred to as $B_{\mathrm{m\,in}}$. If a node has a $B_{\mathrm{m\,in}}$ Over the threshold, it is called an active node. The CMS-related TPO of a cluster is also dependent on CH and is estimated using the received signal intensity indication. The cluster sizes in planned clusters are not uniform (RSSI).

The threshold-based loading trying to balance protocol for energy-efficient routing (TLPER) protocol [26] is a method that takes a similar cluster formation strategy and updates the proposed scheme. Through radio signals, distributed network nodes report their number and location to the BS. BS selects a CH according to the intensity of its nodes. When a decision is made to utilise CHs, a BS notifies all other network nodes of this fact. CHs use RSSI messages for status broadcasting. After receiving the RSSI MSG from the cluster head, each node determines whether it will serve as a cluster head. The highest-performing nodes among those that contribute to a cluster are selected as the asst cluster head (ACH), a task mass transfer threshold scheme & a load control threshold (LBT) method of distributing the weight of CH, ACH facilitates efficient CH rotation.

There are two benefits to wireless sensor networks [30] that use two cluster heads and hierarchical routing to extend their lifespan. In this paper, we offer a strategy for extending the life of wireless sensor networks by conserving energy with two cluster heads. Using the example of two cluster heads as opposed to a single cluster head reduces overhead, prevents collisions, and improves the dependability of data transmission. Energy Balanced Clustering in Wireless Sensor Networks [31] proposes algorithms for energy-balanced cluster construction, cluster head selection, and intra-cluster and inter-cluster communication.The effectiveness of energy-balanced clustering is compared to that of LEACH and the EEMC protocol.

Energy Adaptive Cluster-Head Selection [32] offers to optimize LEACH's method for selecting cluster heads at random. Limiting the network's total energy usage is essential if it is to last as long as feasible. Probabilistic cluster-head selection is utilized in multi-hop clustered wireless sensor networks [33] for energy usage and lifespan monitoring. This paper presents a novel energy model for calculating the power consumption of multi-hop WSNs.

Wireless sensor network fault tolerant clustering [34] uses a two-stage technique to detect and recover from problems. This study presents a method for salvaging sensors from failed gateways without shutting down the network or re-clustering its nodes.Energy Efficient Clustering Scheme [35] proposes a new system (EECS) for single-hop wireless sensor networks to support periodic data-gathering applications. Utilizing local radio transmission, the research proposes a mechanism for electing cluster heads with more incredible residual energy in an autonomous manner. It decreases the overall stress by distributing the work equitably among the cluster heads using a new distance-based strategy.

Energy-Efficient Communication Protocol for Wireless Micro-sensor Networks [36] describes LEACH (Low-Energy Adaptive Clustering Hierarchy). Cluster heads are randomly rotated to ensure that the network's sensors are not overworked. Wireless sensor networks have a more extended life period when energy is spread equally throughout their nodes. A technique for energy-efficient hierarchical clustering is presented in [37]; it employs a distributed, randomization-based strategy. The method produces a tree-like arrangement of cluster epicentres as additional nodes are added to the hierarchy and efficiency increases. The load-balanced clustering [38] technique was developed to distribute work fairly among nodes in a cluster. This technique emphasizes positioning sensor nodes near the cluster leader. By sharing the workload, sensor networks become more dependable, and users can communicate more effectively.

Researchers have created a novel cluster-based routing protocol [39] to extend the lifespan of the cluster head using the method outlined in this paper, sensors can cast votes for neighbouring residents to elect a governing board the nature of this system is hybrid a cluster design technique that integrates multi-hop routing and minimizes transmission power consumption a clustering approach that lowers overall energy use [40] Select cluster tips with the highest amount of remaining energy. Sensor clusters are created by adding nodes with minimal communication costs. It takes advantage of the fact that sensor node transmission strengths vary.

Following the study "A Routing Protocol for Extending the lifespan of Wireless Sensor Networks," [41] suggest the U-LEACH approach to address the problem in LEACH. To prolong the Network's endurance, the algorithm depends on a defined distribution approach for selecting CHs and their shared features with matched groups. Clustering with a single hop and minimal energy usage [42] in wireless sensor networks, cluster leaders are selected by majority vote they are utilizing their residual energy without human intervention via adjacent radio transmitters. Herein, we present a new distance-based method for dividing work fairly among the various leaders of subclusters.

As described in Hybrid Energy Efficient Distributed Protocol for Distributed Sensor Network over a Wireless Medium [43], the HHEED algorithm is recommended. It considers sensor nodes' different variety levels and identifies node energy variation due to variability in wireless sensor systems. Optimization of Hybrid Sensor Networks Through Clustering and Load Balancing with Roaming Cluster Nodes is a method [44] that focuses on the load distribution and placement of roaming cluster nodes. The amount of traffic in a sensor network includes stationary and mobile nodes. The document identifies the cluster's epicentre, or "cluster head." The Network can significantly impact the network lifespan; therefore, relocating the cluster head can have a significant effect. Increasing one's life expectancy is feasible if a network is not overstressed.

A load-balancing method based on multi-hop clustering is efficient wireless sensor networks [45] can network wireless sensors when utilized in uniform settings communication within a company is managed using a layered approach intra-cluster and inter-cluster communication. (EEDCP) Efficient Adaptive Protocol for Dynamic Clustering It is advised that networks be weight-based to extend their service lifespan use less energy.

To conserve energy consumption, the EEDCP presents a concept for low-energy-consumption computing infrastructure for virtual grid construction clustering together and entering a deep sleep cycle. Instead of relying on a popular vote, it determines the magnitude of the remaining energy based on the relevance of each individual's vote, resulting in far less time spent voting and fewer messages received. The concept of a low-power, high-throughput clustering technique (PECP) [46] is a heterogeneous clustering approach for improving the energy efficiency of wireless sensor networks, hence increasing their usable lifespan. In order to enhance the Network's durability and functionality, this article presents the design and implementation of a system that creates groups of sensors based on their location and then joins them within a sensor network.

2.2 ARCHITECTURE OF NETWORKS

The ability to manage data traffic efficiently is crucial for balancing the battery life of a node so that it can survive for a longer time. Most studies have found that data traffic modelling is the key to a more efficient network. The suggested approach is energy ed by an efficient clustering & routing technique made possible by the author's familiarity with data traffic modelling. Using node deployment, clustering, member node criteria, & specific routing strategy, the suggested network design improves a network's survivability in four ways. Clustering, in combination with the rotation of clusters, is used to solve the energy hole problem [23]. Figure 2.1 shows the Implementation of WSN in many areas.

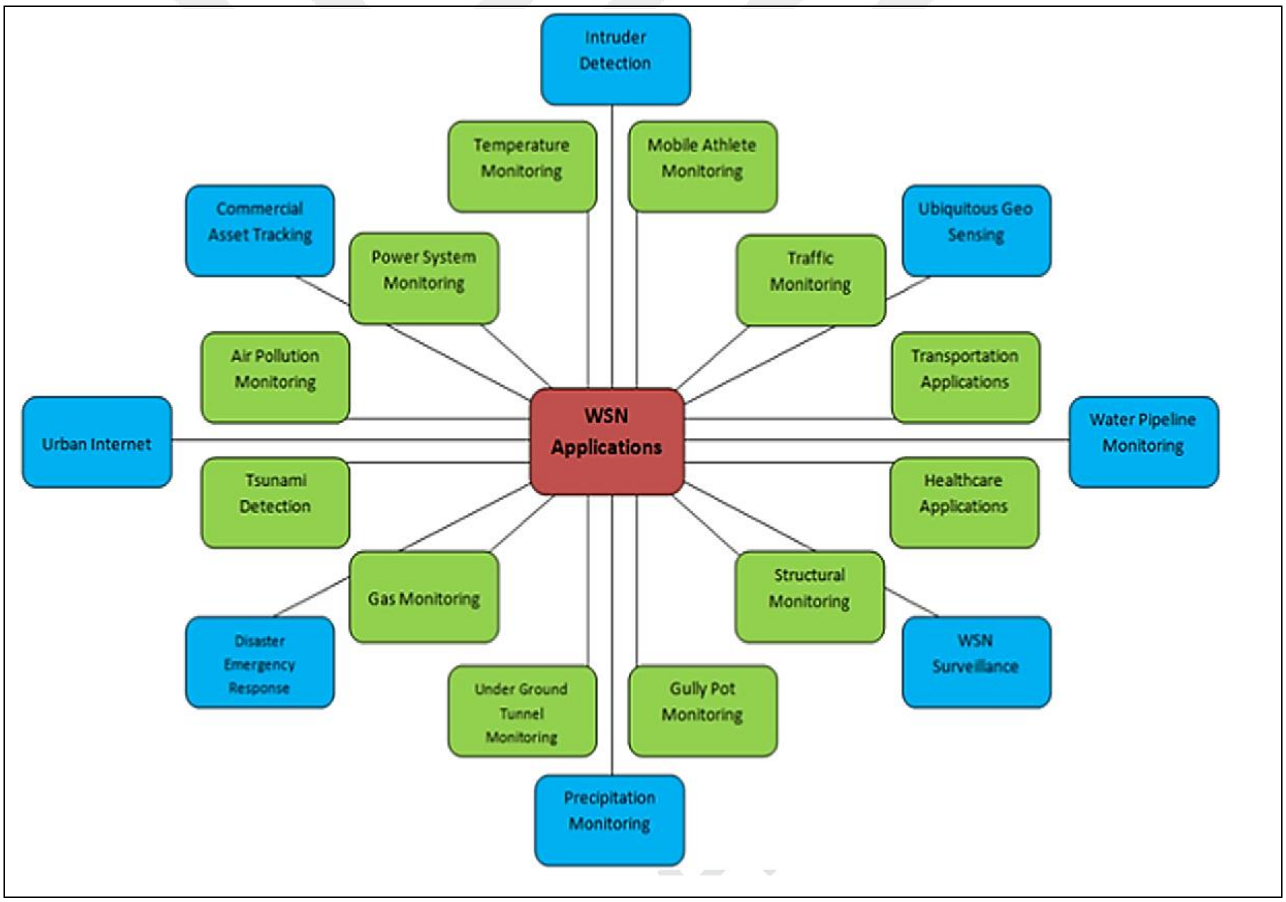

Figure 2.1: The Implementation of WSN in many areas

On the other hand, the routing method attempts to solve the issue of empty spaces. These initiatives simplify the clustering and routing algorithms, ultimately increasing the network's resilience. On the other hand, the routing method attempts to solve the issue of empty spaces. These initiatives simplify the clustering, ultimately increasing the network's resilience. The proposed network design is described in detail below [25]. Figure 2.2 shows the power system utilization in wireless sensor networks.

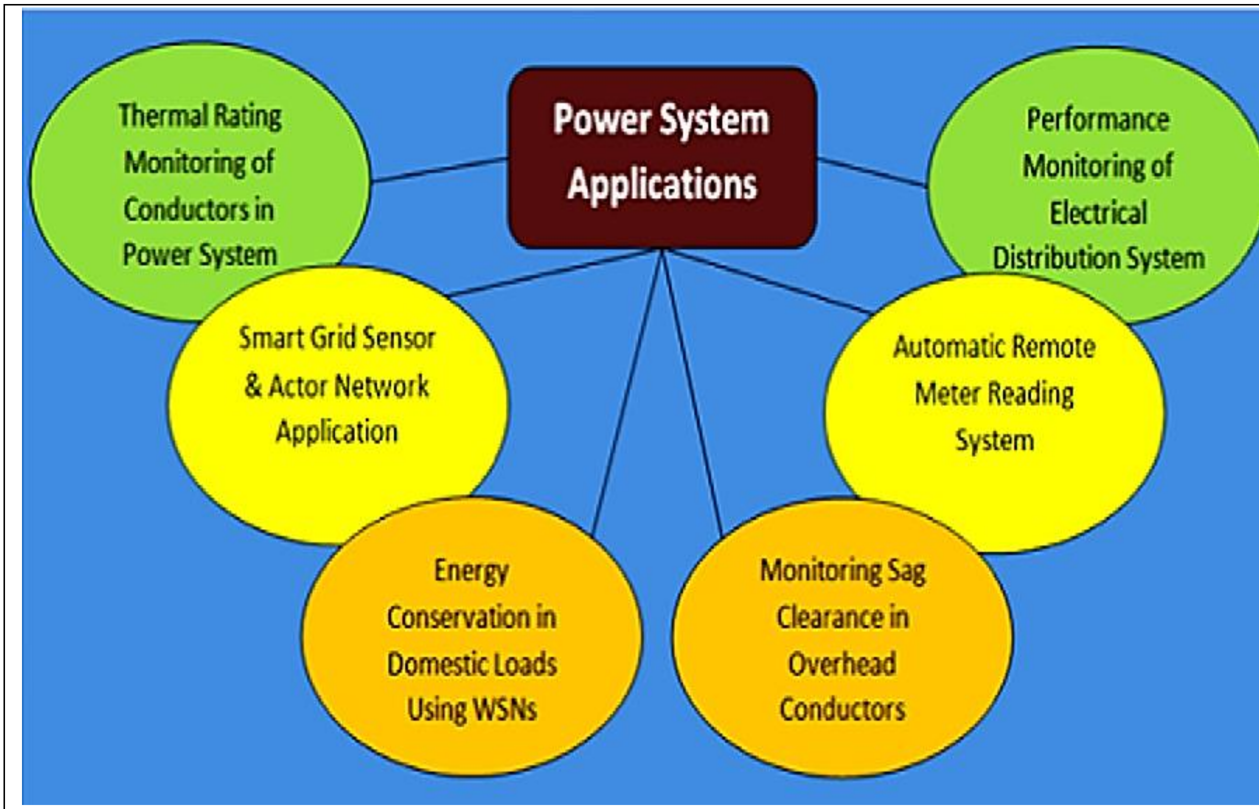

Figure 2.2: The power system utilization in wireless sensor networks

2.3 OUTLINE AND SPECIFIC RECOMMENDED NETWORK LAYOUT

a. We assumed all sensors share the same battery capacity & storage space to simplify. The Cluster head likely offers better energy storage & processing capabilities.
b. We also assumed that the data was routed using the protocol
c. Sensor nodes are Classified as heterogeneous because they can collect and process a wide variety of data types, including environmental and physiological measurements, and use actions.
d. In the end, all the nodes have stable radio transmission and can determine each other's locations.

2.4 SENSOR NODE AND CLUSTER HEAD FUNCTIONS

Sensor nodes play an essential part in the proposed design of our network, as they are responsible for analysing data and sensing external stimuli. Clusters' head, on the other hand, is accountable for doing calculations and acting as hubs for communication and information exchange. In one specific situation, the data is initially gathered by the sensor nodes, then transferred to the Cluster head to be processed, and finally delivered to the base station. In addition, the Cluster heads oversee the flooding process. They must broadcast the required control signals (joining requests from other clusters head, route requests, and so on), and they are also responsible for calculating the most suitable path back to the base station. Because of this, the sensor nodes do not need to perform any computations or choose the most suitable route to return to the base station. Table 2.1 explains the function of each sensor [29].

Table 2.1: Functions performed by deployed nodes

Functions Performed	Sensor	Cluster head
Sensing	✓	X
Path computation	X	✓
Data pross	✓	✓
Transmitting	✓	✓
Receiving	✓	✓
Comm. to sink	X	✓

2.5 PLACEMENT OF HIERARCHICAL NODES

While considering the issue of energy holes in the network, it is essential to strategically put nodes so that the ones closest to the base station do not fail early. To avert the "energy hole" issue [28], we hierarchically dispersed the nodes, with all the sensor nodes reporting back to a central hub. The knowledge is passed down from one head of a Cluster to the next (near the base station). The activity they engage in during the communication cycle may cause the cluster head geographically close to the base station to go extinct soon, while considering the issue of energy nodes in the network, to random put nodes in such a way that the ones that are physically located closest to the base station do not fail early. To avert the "energy node" issue [2], we dispersed the nodes randomly, with all the sensor nodes reporting back to a central hub. The knowledge is passed down from one head of a cluster to the next (near the base station). As an illustration, the burden of the cluster will be reallocated to a neighbouring node if the energy level of a cluster head falls below a specific threshold (a node closer to the cluster head). According to what is depicted in Figure 2.3, the newly established node will eventually take over as the head of the cluster.

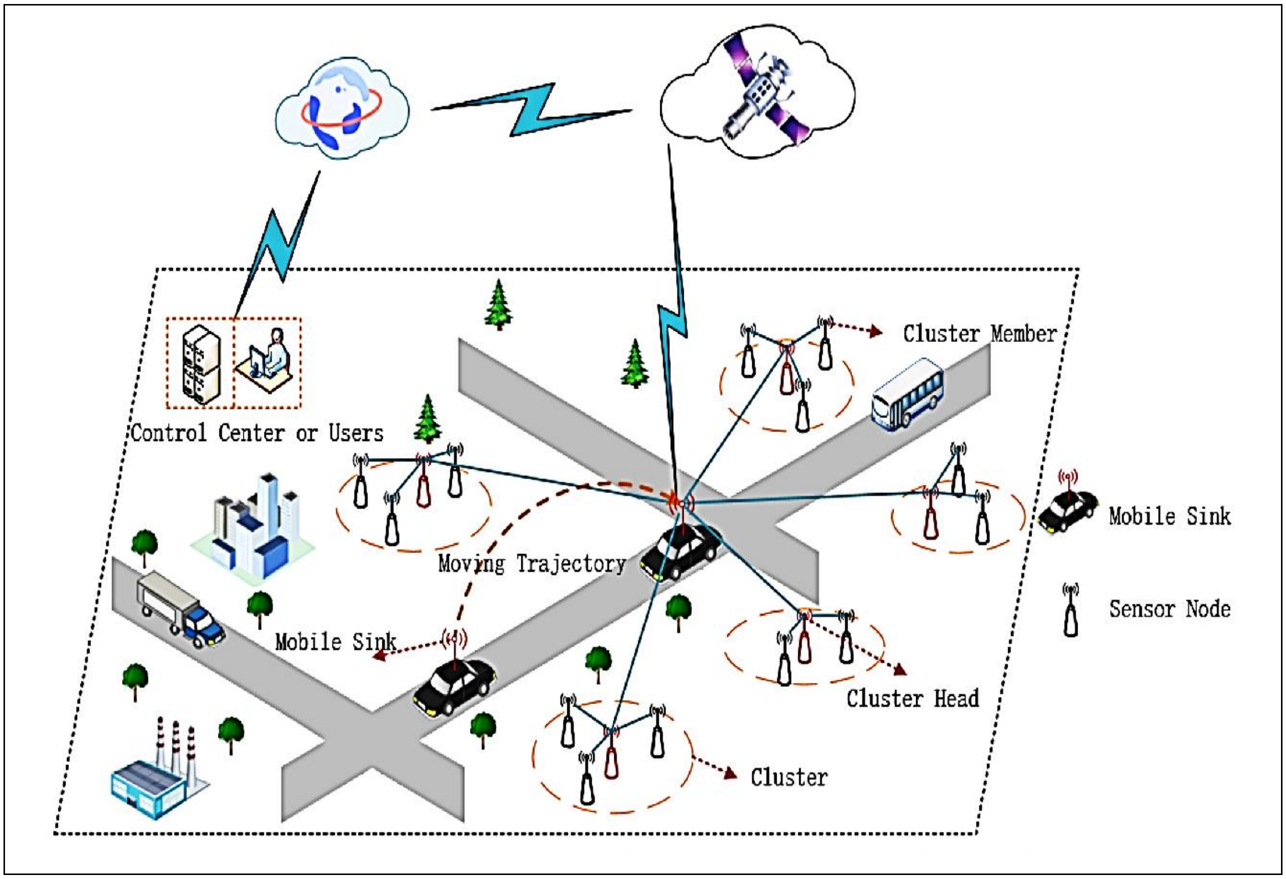

Figure 2.3: Clusters head and deceased Clusters head were chosen at random

2.6 MODEL OF THE SYSTEM

Under the group up, a network of n sensor nodes and a Cluster head would be in place to collect and process data (CH). We'll pretend that the elements of the collection R = (CL_1, CL_2, $CL_3 \dots CL_n$). Clusters head and deceased Clusters head were picked at random. S = (SN_1, SN_2,$SN_3 \dots SN_n$) is the group of source nodes, and D = (DN_1, DN_2, $DN_3 \dots DN_n$) is the group of destination nodes for a Cluster of n nodes. We have presumed the presence of orthogonal Time Division Multiple Access (TDMA) in the network to eliminate signal overlap.

2.7 EXHAUSTION MODEL OF ENERGY

In the radio model, to transmit a (b-bit) packet to the distant receiver (di-meters), a channel of emissions depletes $E_{Tx}\ (b, d)$ (Eq. 2.1 & Eq. 2.2). Otherwise, to accept a b bit packet, a receiving chain deprives $E_{Rx}\ (b)$ As described by the standard (Eq. 2.3), Figure 2.4 displays the energy exhaustion layout.

$$E_{Tx}\ (b, d) = \begin{cases} b.E_{elec} \\ b.E_{elec} \end{cases} + \begin{matrix} b.E_{fs}\ .d^2\ , d_i\ < d_0 \\ b.E_{mp}\ \ d^2, d_i\ \geq d_0 \end{matrix} \tag{2.1}$$

$$d_0\ \ = \sqrt{\frac{E_{fs}}{E_{mp}}} \tag{2.2}$$

$$E_{Rx}\ (b) = b{*}E_{elec} \tag{2.3}$$

The meaning of each indicator in the preceding formulas is as follows:

a. E_{Tx} : The amount of energy a sensor expended node to transmit (b-bit) data via (di-distance) between an emission chain & receiver.
b. E_{Rx} : The amount of energy a sensor node (b-bit) expended from the transmitter.
c. E_{mp} : Exhaust of energy via the amplifier circuit for transmitting (1-bit) data to zone at a multipath transmission.
d. E_{fs} : Lack of energy due to the amplifier circuit's transmission of (1-bit) data to the space zone.

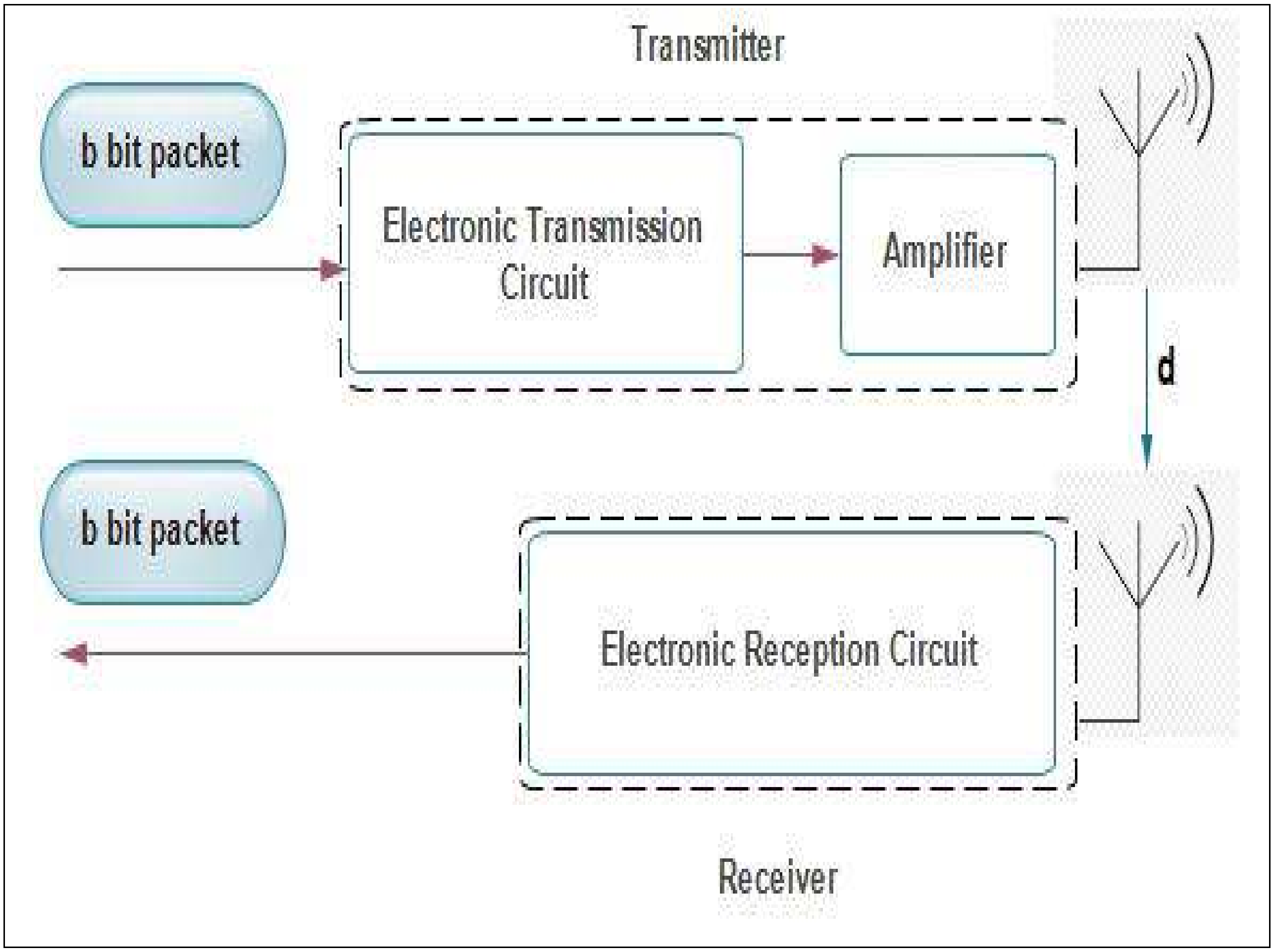

Figure 2.4: Energy exhaustion Design

3. PROPOSED METHODOLOGY

This chapter provides a summary of the PDBAC-LEACH protocol that has been proposed. First, we will describe the procedure that is followed by our protocol, followed by an explanation of the organisational structure of the algorithm that we suggest. In the second step of the process, we will define the parameters of the clustering and hierarchical approach.

3.1 PROPOSED MODEL

Due to the WSN's dynamic as well as an arbitrary selection of cluster heads (CHs), some nodes' energy reserves deplete faster than others as the CH collects as well as collects data from cluster members before transferring it to the sink. So, it utilises extra energy than a standard sensor node would. So, regardless of physical distance or the amount of energy carried by the (CH-current), the network's longevity is impacted by the efficacy of the communication between the (CH) and the sink. In this light, picking the best path to the sink is paramount. We suggest PDBAC-LEACH, a modified version of the LEACH protocol, in this work. Inside the WSN (CH), the most energy is expended on communication between nodes and the sink, measured by two measures: current node energy and distance to a sink.

Firstly, receiving every packet from cluster nodes, aggregating them, and delivering them to the BS causes the CH to spend extra energy than regular nodes. Therefore, should select the cluster head plus allow just nodes, including extra current energy, to join the cluster head to prevent the death of a node in the vicinity. Our system has an advantage in selecting cluster head based on the present energy. Second, communication among clusters head & BS also requires more energy depending on the distance. Consequently, the more excellent several clusters' head communicating with the base station, the more significant the increase in network energy exhaustion. Hence, choosing a single route to BS is essential to keep energy usage.

The second advantage of our approach is that the PDBAC-LEACH protocol chooses as the parent Cluster- head the CH with the highest current energy and the direct distance of a sink. The other cluster head sends the data to this root cluster head, which then transmits all the accumulated BS; Figure 3.1 description of the Proposed Protocol's Structure.

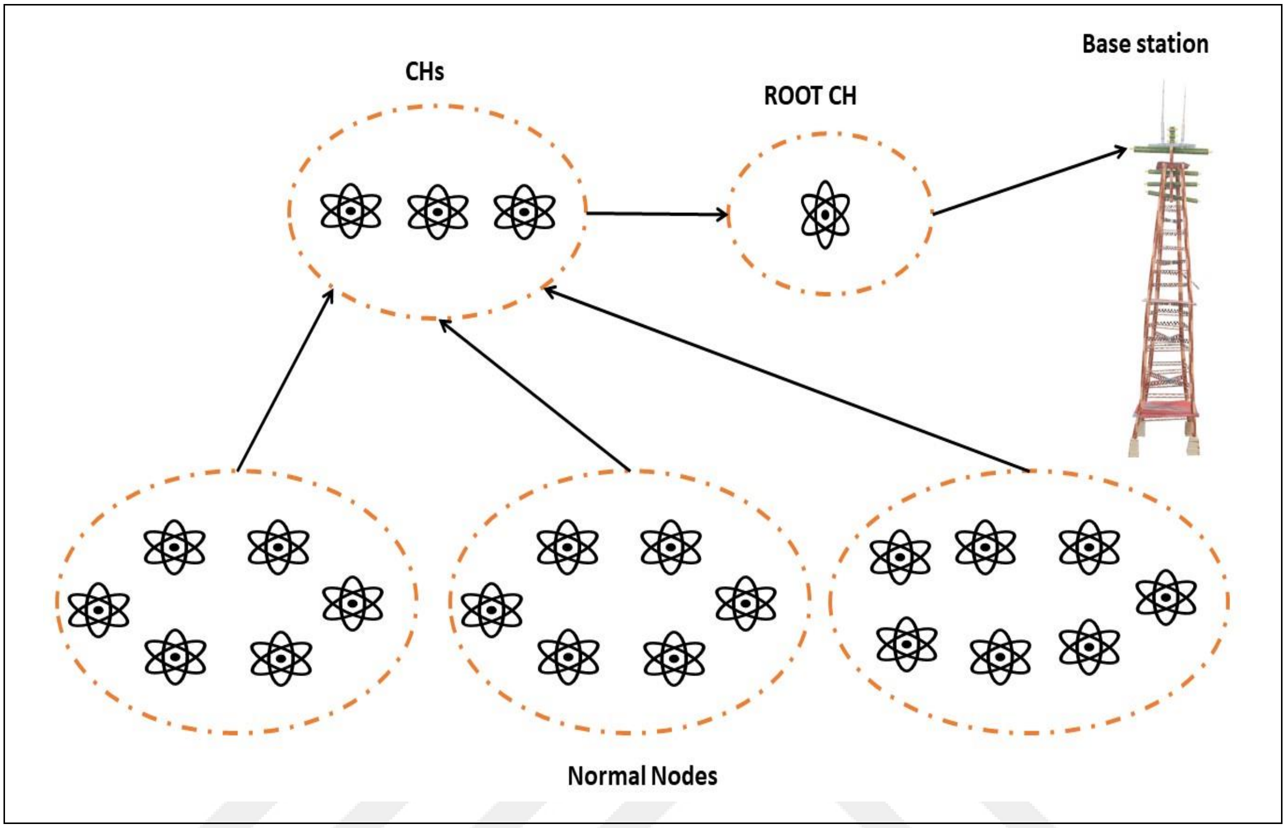

Figure 3.1: The Proposed Protocol's Structure (PDBAC-LEACH)

3.2 METHODOLOGY

Clustering is a standard method for expanding the lifespan of WSNs. Several different algorithms, such as V-LEACH [16], E-LEACH [22], B-LEACH [18], and LEACHTLCH [17], among others, have been created to enhance LEACH, which was the first clustering hierarchy routing protocol that conserved energy it can bring many more modern upgrades to earlier methods, which can be of great advantage to these methods. However, restrictions are imposed on the system because of the existing energy concentration, the requirement of making numerous hops to reach the BS, or the BS's physical location. Given this, each of these dimensions must be considered. Our algorithm's ultimate objective is to maximise the network's lifespan.

Typically, there are three stages to a Clustering algorithm: initialisation, maintenance, and distribution. To begin the communication process, the cluster must first be formed, which is part of the group-up phase. Since only control packets are being sent during this time, it is commonly referred to as the "offline" or "passive" phase. In addition, in the fixed and routing stage of operation, data arrives at the network to be aggregated and routed.

3.2.1 Self-Organising

After being randomly or uniformly installed, nodes activate their transceivers and send control packets to the network to validate their presence by the sensor. Other nodes will prepare tables after hearing their broadcast. The node's ability to evaluate the quality of the links and do other computations help make future decisions. All sensor nodes start with equal energy. Sharing and using information about nodes' positions, energy levels, and other data helps the network self-organise. Every round, the node compares the current energy of the average energy utilising equation (Eq. 3.1). Randomly choosing between 0 and 1 makes CH in the cluster return to node construction. If this value is smaller than $S(j)$ In (Eq. 3.2), this node will behave like a cluster head in the next cycle; otherwise, it will behave normally. After the CH broadcasts data, nodes calculate their own CHs based on the signal quality. Normal nodes send a message to validate near CHs, (Eq. 3.3) shows sensor-based cluster self-organisation.

$$E_{res} = E_0 - E_{cons} \tag{3.1}$$

$$E_{cons} = E_{Tx} + E_{Rx} \tag{3.2}$$

In where (Eq. 3.1) and (Eq. 3.2) determine E_{Txs} and E_{Rx} (Eq. 3.2), In our study, we introduce a novel threshold energy function for Cluster head formation, which is defined as (Eq. 3.3).

$$S(j) = \begin{cases} \dfrac{P_e}{1 - P_e * \left(R\% \left(\frac{1}{P_e}\right)\right)} * \dfrac{E_{res}}{E_i}, & J \in N \end{cases} \tag{3.3}$$

Where P_e Represents the fraction of clusters head, R represents a current round number, N represents a collection of nodes that haven't been cluster head at the previous rounds is $1 - P_e$, E_i

Represent nodes starting energy, and E_{res} Represents their current energy at the R round. Nodes having sufficient residual energy to cluster head are chosen based on the ratio of E_{res} to E_i.

3.2.2 Clustering Design

Nodes provide their density information with node (dm) to participate in cluster head computation. Using (E_{mp} & E_{fs}) are the amplifier parameters of the transmission nodes that correspond to the multi-hop fading model and the free-space model. These nodes activate their transceiver. It is signed by the packet sequence number and postfix counter '0'. The first communicating nodes save the sequence number and join the group. Maximum-information-density nodes will communicate this data. This postfix counter helps the packet sequence number distinguish between groups. The group's node (after the last member) talks with node (dm) to assign Packet (Seq-no) and postfix counter '0'. By picking the following round's node density, a node can choose its new cluster head (having the highest density of the next round). Reducing energy exhaustion during clustering extends network lifespan. Figure 3.2 depicts the model architecture.

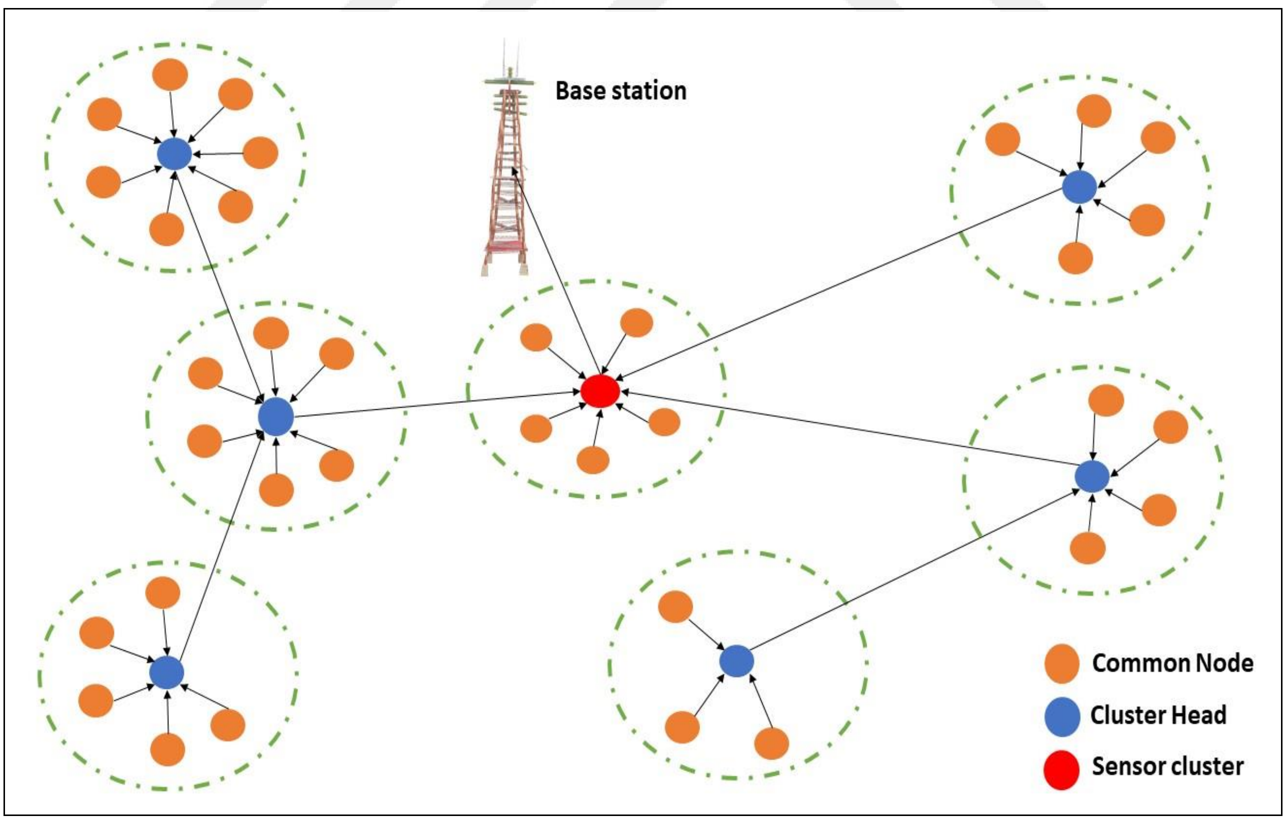

Figure 3.2: The proposed model architecture of PDBAC-LEACH

3.2.3 Cluster Members Election

When a Cluster is complete, the CHs make TDMA (Time Division Multiple Access) tables that consider the number of nodes at the cluster as well as the distance between them. Within its designated TDMA time slot, each sensor node sends data to a corresponding CH [28]. When scheduling TDMA time slots and shaping clusters, we choose a root CH with residue energy more than the average energy of CHs as well as a distance of BS lesser than an average distance among CHs and a BS, as specified via (3.4) and (3.5). These transmissions from the root CH have alerted the other CHs to the situation.

$$E_{ave} = \frac{\sum_{C=1}^{CL} E_{res} \ (C)}{CL} \tag{3.4}$$

$$d_{ave \ to \ BS} = \frac{\sum_{C=1}^{CL} d_{to \ BS} \ (C)}{CL} \tag{3.5}$$

Where the distance between each CH is displayed, a sink represents the energy CH possesses when the current round Concludes. BS (Eres) During the sense of communication, typical nodes collect input from their local surroundings and then use a multi-hop mechanism to transmit it to the CH in a hierarchy that is nearest to them. The CH is the only system component in constant communication with the sink. Table 3.1 shows the specifics of the transactions carried out, while Table 3.2 displays simulation parameters and Figure 3.3 depicts the proposed model flowchart.

Table 3.1: Details the transactions used

Details	Illustration
$\mathrm{R}_{(\,\mathrm{B}_{\mathrm{T_x}}\,)}$	Broadcast transition ranger
$\mathrm{Node}_{(\mathrm{R_x})}$	Broadcast receiving node info
$\mathrm{Node}_{(\mathrm{DM})}$	The ID of the Decision – making node
Count_{n_i}	Counting neighbouring
$Packet_{(\,\mathrm{seq-no}\,)}$	Sequence No. of a Packet
$Node_{(T_{\mathrm{id}})}$	Id of transition node
$Cnt_{(\,\mathrm{postfix}\,)}$	Postfix counter of the packet sequence number

Table 3.2: Parameter of the simulation

Parameter	Value
Sim area	100 x 100 m^2
Simulator	MATLAB
Sim time	3 mints
Network nodes distribution	Random distribution
Type of Node	Heterogeneous
No. of the nodes	10 in every cluster
No. of the Cluster	1- 9 Cluster
Maximum No. of the packets	100
The Cluster probabilities	10%
Starting energy of node	0.5 J
Data Aggregation Energy (DAE)	5 n J/bit
E_{fs} (Expending energy in the Amp to deliver indirect distance)	10 p J/bit/ m^2
E_{mp} (Expending energy in the Amp to broadcast over the indirect distance)	0.0013 p J/ bit/ m^4
The Size of the Packet	4000 bits
No. of round Expending	1728

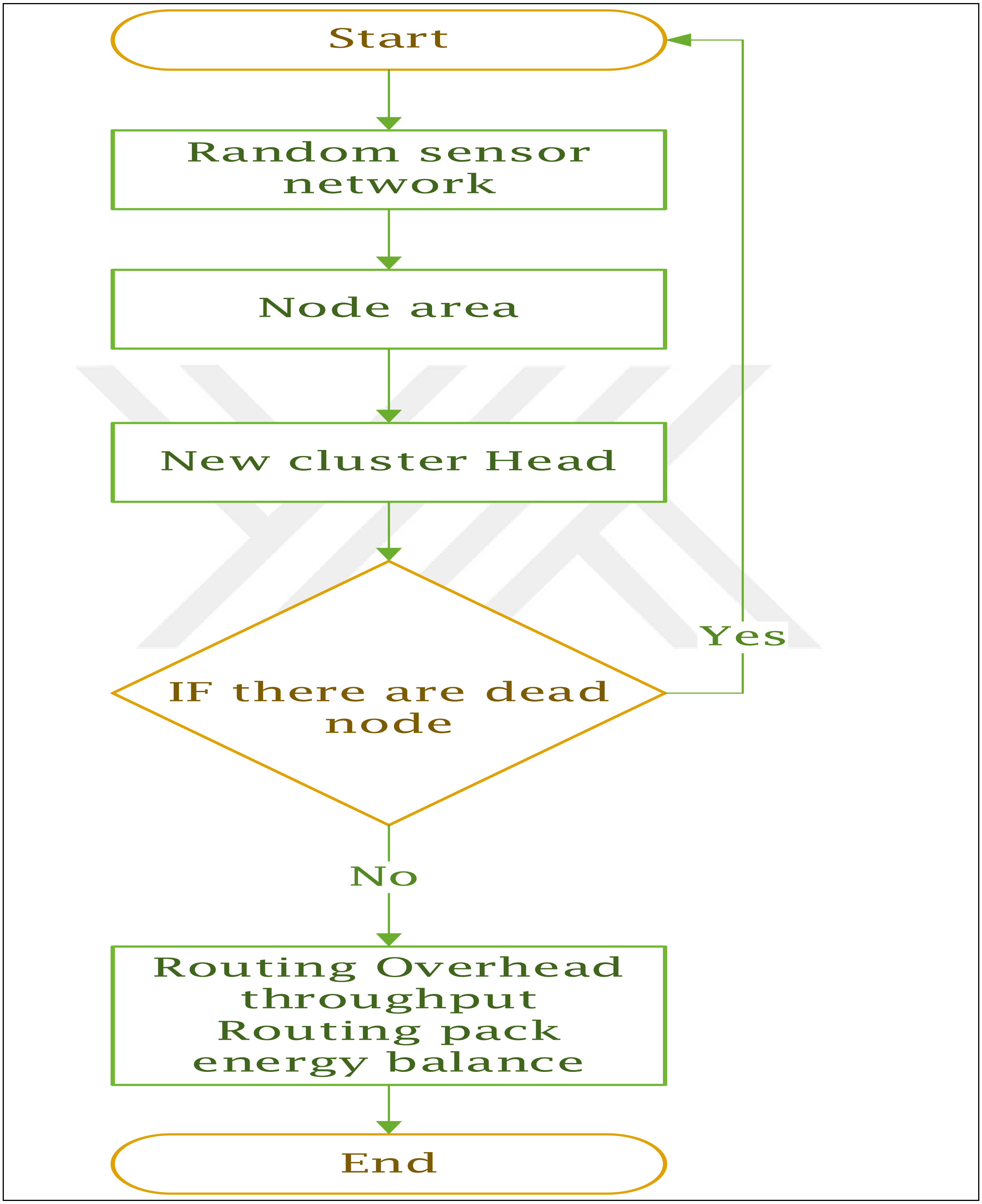

Figure 3.3: Flowchart of the PDBAC-LEACH

4. SIMULATION OF PROPOSED PROTOCOL AND RESULTS

This chapter introduces simulation results that provide a rough performing estimate for the proposed protocol (PDBAC-LEACH). The experiment is run on a computer with a 2.8 GHz Core-i7 processor & 16 Gigabytes of RAM utilising the MATLAB programming language. The simulation is conducted with a WSN that has been randomly generated and has 100 nodes spread across its network. Source and destination IP addresses are generated at random for each packet. Initially, you will need to determine the total number of nodes across all nine regions. Figure 4.1 describe an example of the one CH.

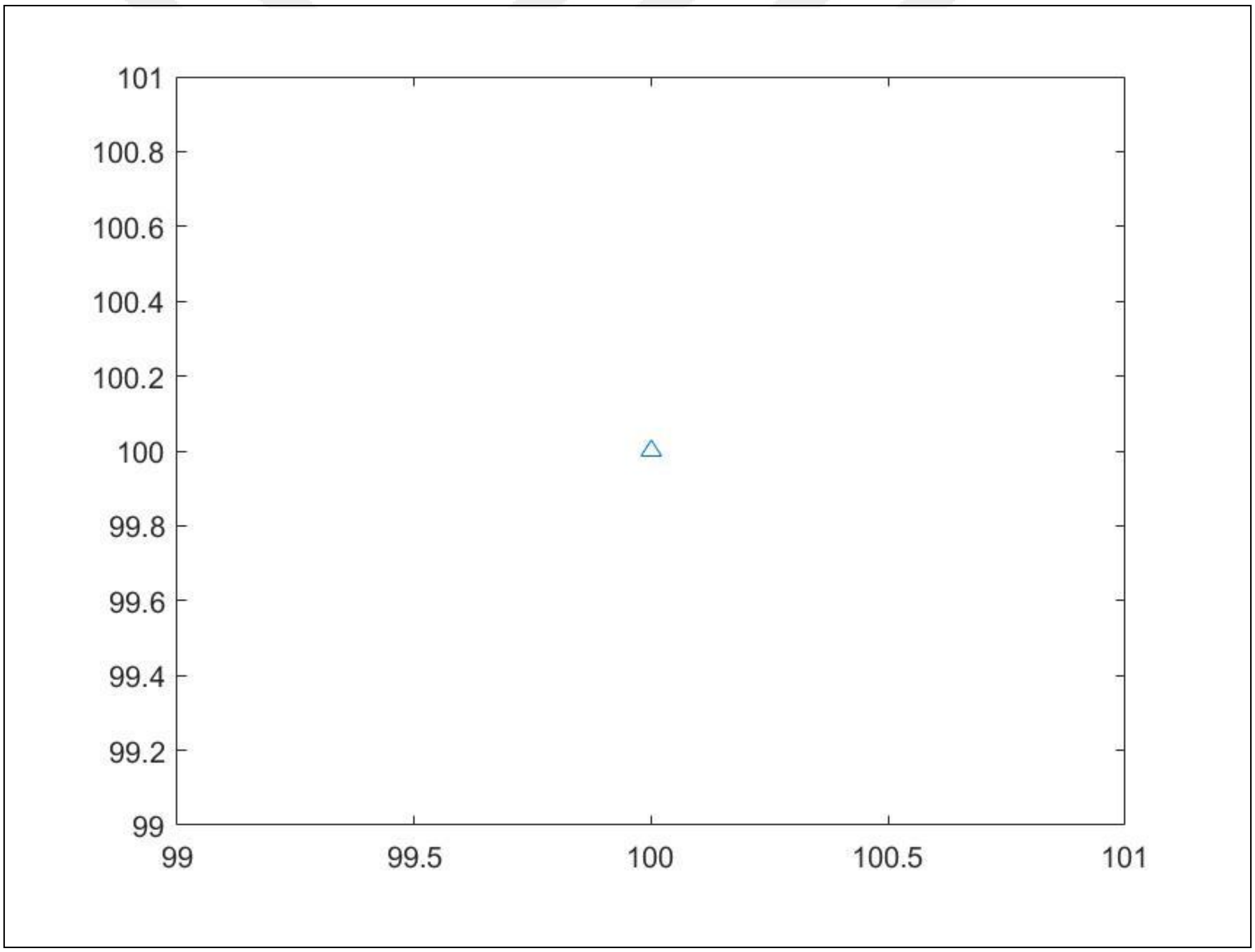

Figure 4.1: Describe an example of the one CH

The nodes and sensors at coordinates deployed randomly in 100 m×100 m areas are in Figure 4.2. In which black stars represent sensors and circles represent nodes.

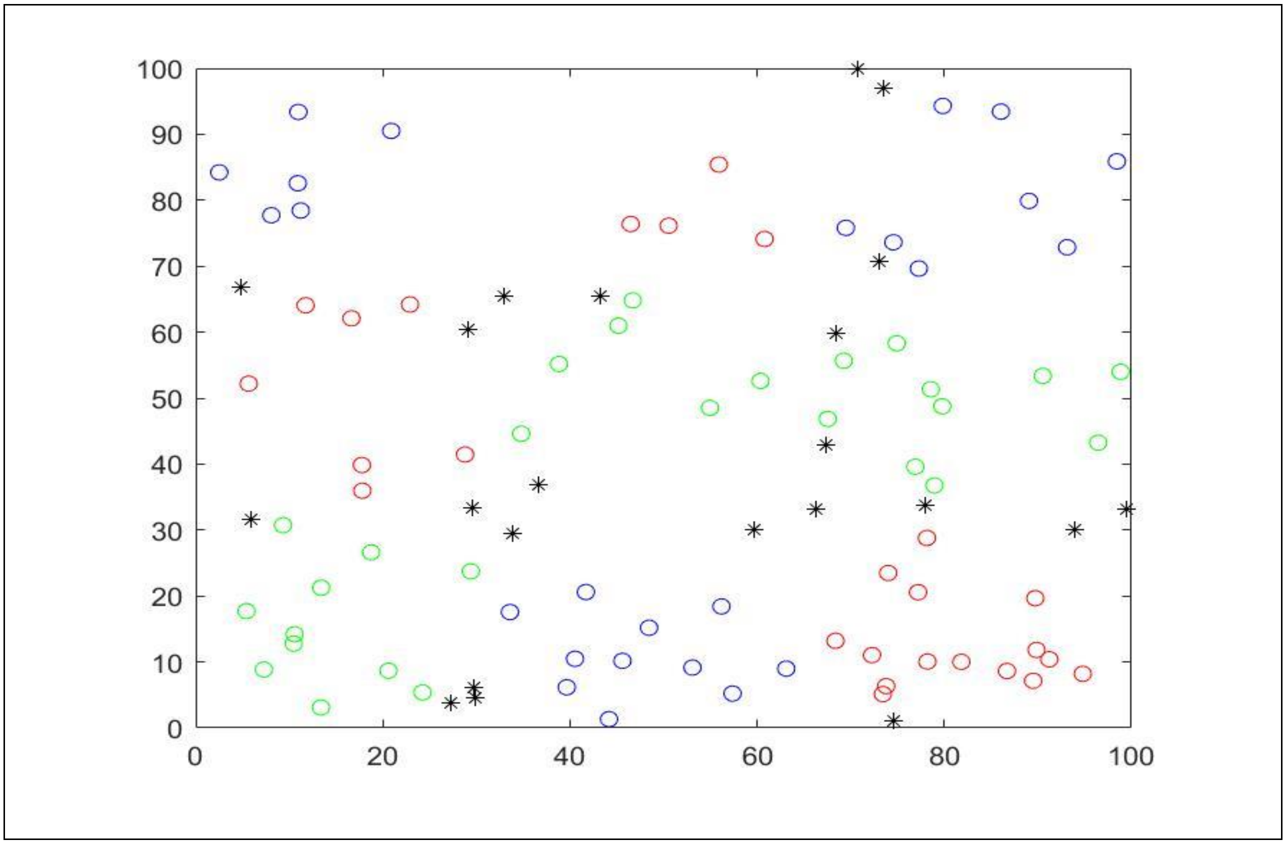

Figure 4.2: The Nodes and Sensors in the Network Placed Randomly

After identifying the sensors and their adjacent nodes and knowing the path tables for the proposed protocol (PDBAC-LEACH), which is the optimal path to reduce energy exhaustion of WSN, the next step is to determine a cluster head (CH) from 100 nodes. Figure 4.3 shows a network with a cluster head (CH); there are 9 clusters head shown in Table 4.1.

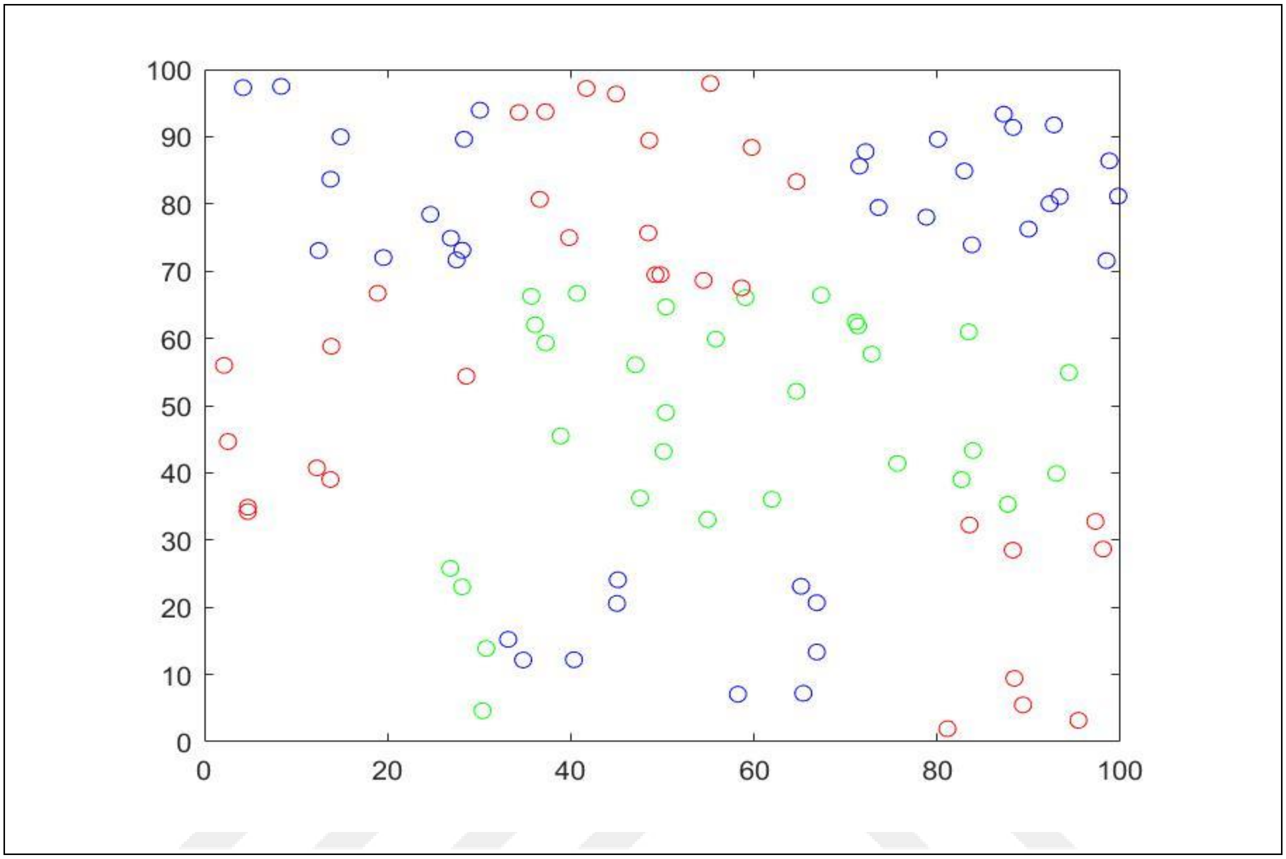

Figure 4.3: A network with a Cluster head (CH)

Table 4.1: The cluster head and the max no. of nodes that can be dead from the cluster

Clusters Head (CH)	No. of nodes that are dead
The 1st CH	91
The 2nd CH	97
The 3rd CH	99
The 4th CH	96
The 5th CH	92
The 6th CH	**100**
The 7th CH	76
The 8th CH	95
The 9th CH	87

It is evident from the above table that the Cluster head of CH 6 did not lose any nodes of the contract, i.e., there is no dead node; this conclusion leads us that the proposed method preserved all nodes using the proposed protocol, in addition to that, it extended the life of the network as a result of using the aggregation algorithm. Figure 4.2 describe the proposed model simulation outcome of the proposed model, the cluster method with the protocol (PDBAC-LEACH). That saved the network's lifespan without losing any nodes; with this, we have achieved the objective of our study.

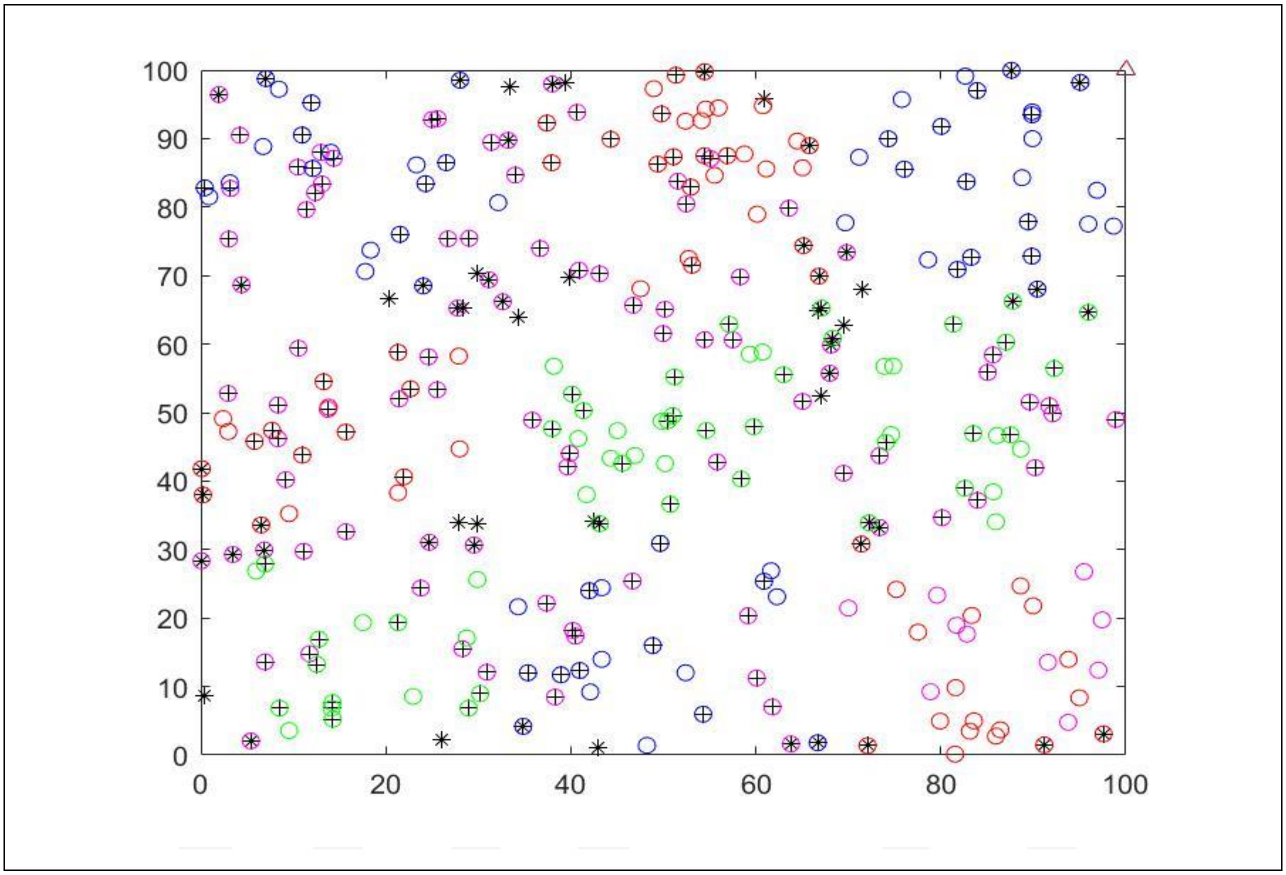

Figure 4.4: The outcome of the proposed method

5. RESULTS AND DISCUSSION

5.1 INTRODUCTION

This chapter includes the results and discusses the proposed scheme, a clustering algorithm called PDBAC-LEACH, and simulations to verify the results.

5.2 OBTAINED RESULTS AND DISCUSSION

We have considered per-node energy exhaustion, average per-node energy exhaustion in a Cluster, and energy exhaustion in Cluster designs other than broadcast to evaluate the proposed scheme. Our simulation environment begins with a deployment of 100 nodes randomly over a 100 m x 100 m area. At each stage, the authors of [27] randomly choose CHs as well as connect those clusters head of a sink via one hop.

Therefore, the network's sustainability is compromised by increased energy exhaustion necessary by these methods. The literature review reveals that energy efficiency is critical for WSNs. Considering the remaining energy to the sensor nodes as well as the distance of the sink, this study aimed to recommend a protocol that would increase the WSN network lifespan by reducing the amount of energy required for communication and data transfer. This strategy utilises a cluster formed by the PDBAC-LEACH.

The significant finding of the present study is that the reduction of node energy exhaustion is dependent on both residual energy and distance. Another considerable conclusion, as shown in Figure 5.1, is that the first ten nodes, when sent in the proposed way, increase their energy. Therefore, they can access CH, which allows for maintaining the network's lifespan as long as possible.

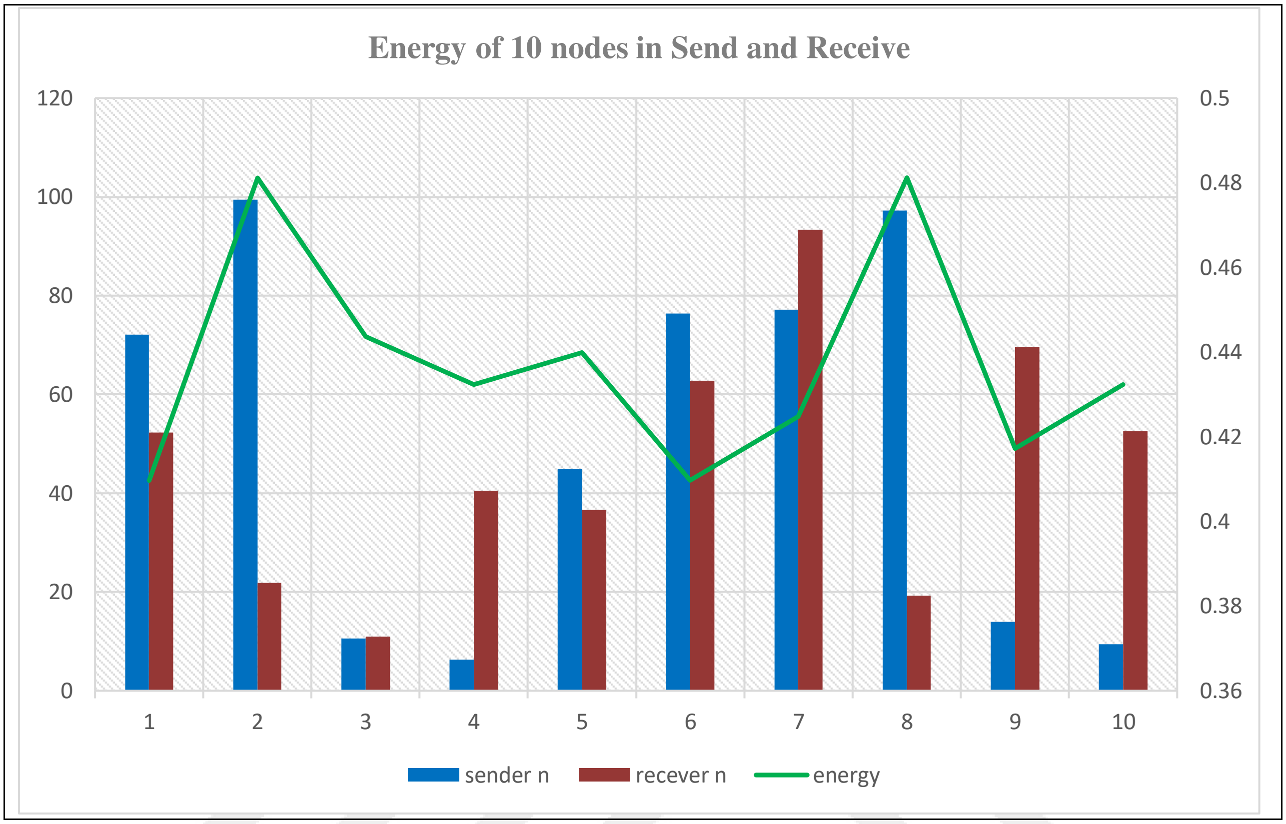

Figure 5.1: Sample for energy to the first ten nodes

Figure 5.2 describes the send and received nodes where 100 nodes were sent when applying the proposed method and based on the (CH.6) in which the number of nodes that died was zero from 100 nodes. Therefore, they were delivered without any losses. That leads to expansion and saving of the lifespan for WSN, as well as Figure 5.3 describes the average balance of 100 nodes in every ten sets of nodes. Figure 5.4 Describes the average of the send and received 100 nodes. The purpose of this research was to demonstrate the value of a proposed method as well as PDBAC-LEACH in prolonging the lifespan of a network.

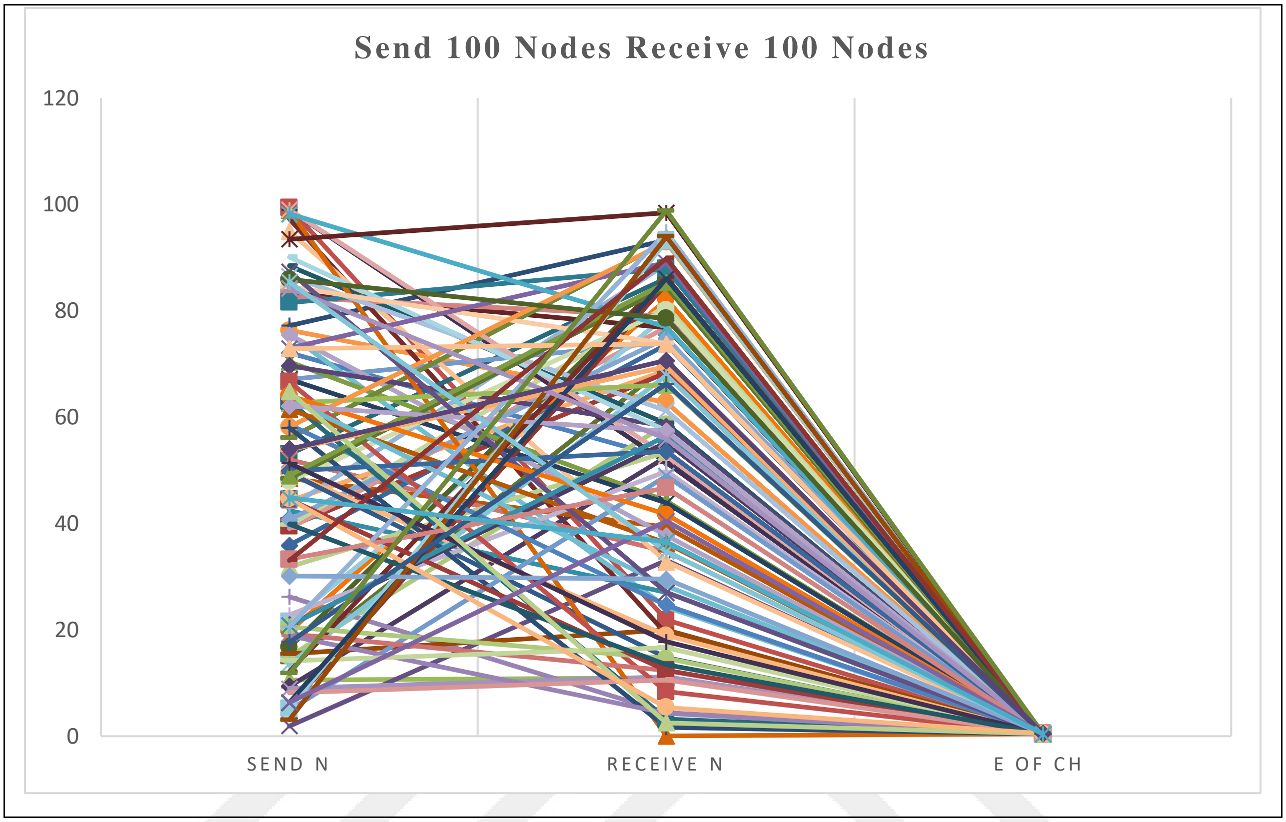

Figure 5.2: Describes the send and receive 100 nodes

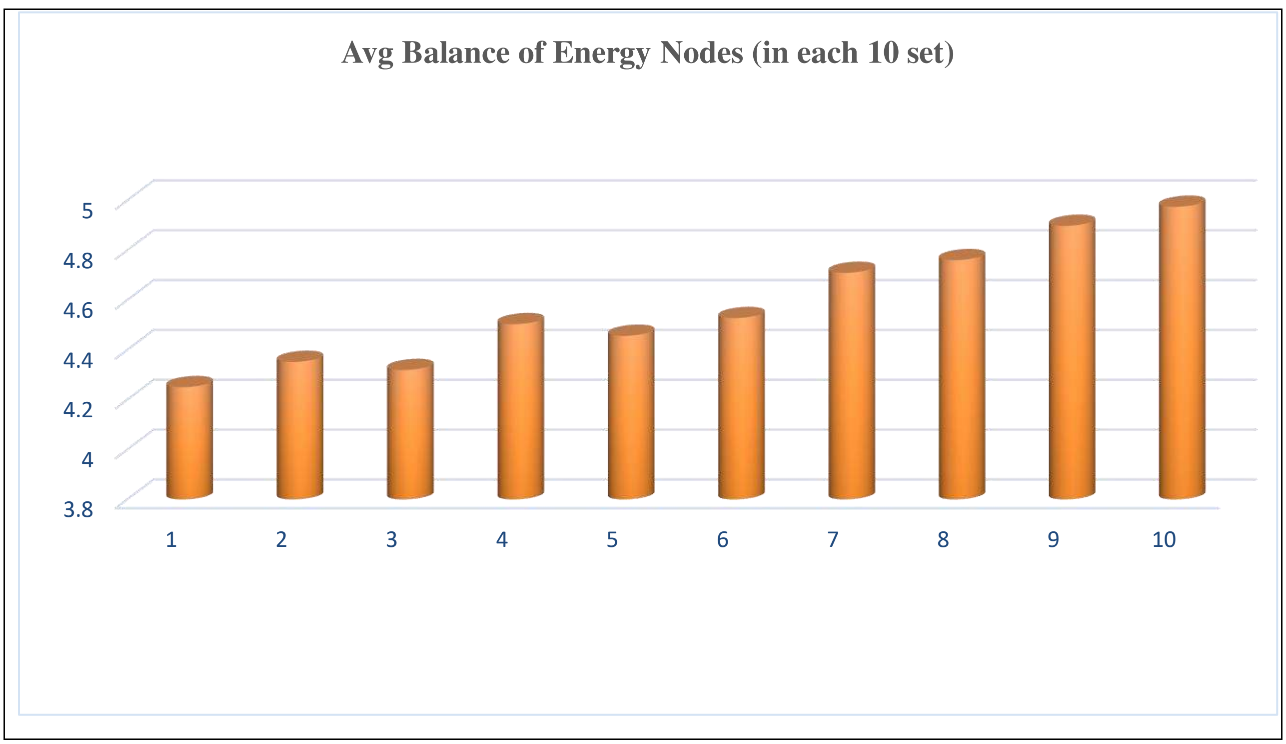

Figure 5.3: Describes the balance energy of 10 nodes

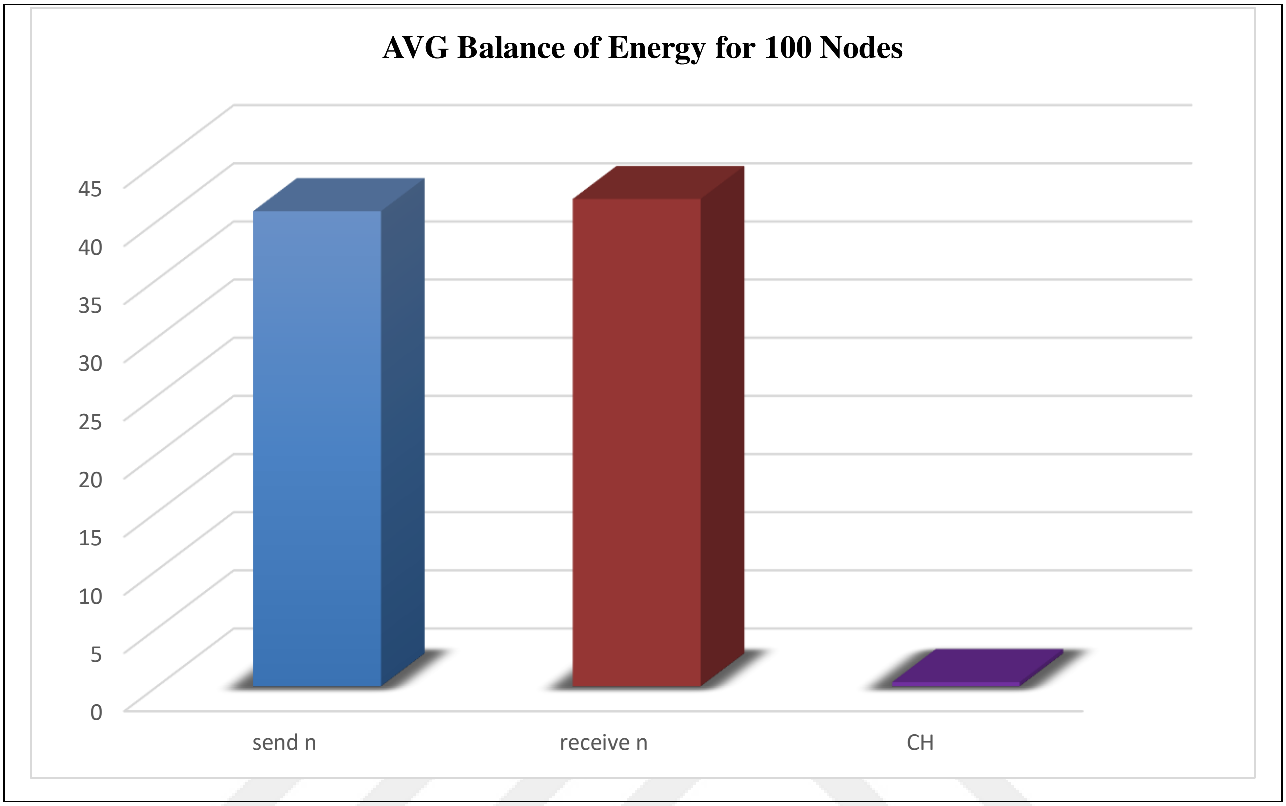

Figure 5.4: Describes the average of the send and received 100 nodes

Table 5.1 shows a comparison among the proposed model and the other studies in conditions of the amount of nodes, the amount of nodes that are dead, the amount of clusters head (CHs), the amount of rounds, the average energy, the packet size, and cluster head probability. It was highlighted that our proposed model is superior to other research in terms of the number of nodes that dead is less than in other studies in Figure 5.5, as well as the average energy is higher than in other studies in Figure 5.6, additional in Figure 5.7 shows the probability of cluster head.

Table 5.1 : Comparison between the proposed model and other studies

Studies and Proposed model	No of nodes	No. of dead nodes	No of round	No. of CHS	AVG energy	Packet size	CH Probability
EEE-LEACH [13]	200 nodes	1	5	8	0.4223	4000 bits	10%
2 Layer LEACH [22]	100 nodes	3	2	2	0.3320	4000 bits	7%
BCE- LEACH [29]	200 nodes	1	5	9	0.4697	4000 bits	10%
***Proposed Model**	100 nodes	**zero**	5	9	**0.4998**	4000 bits	10%

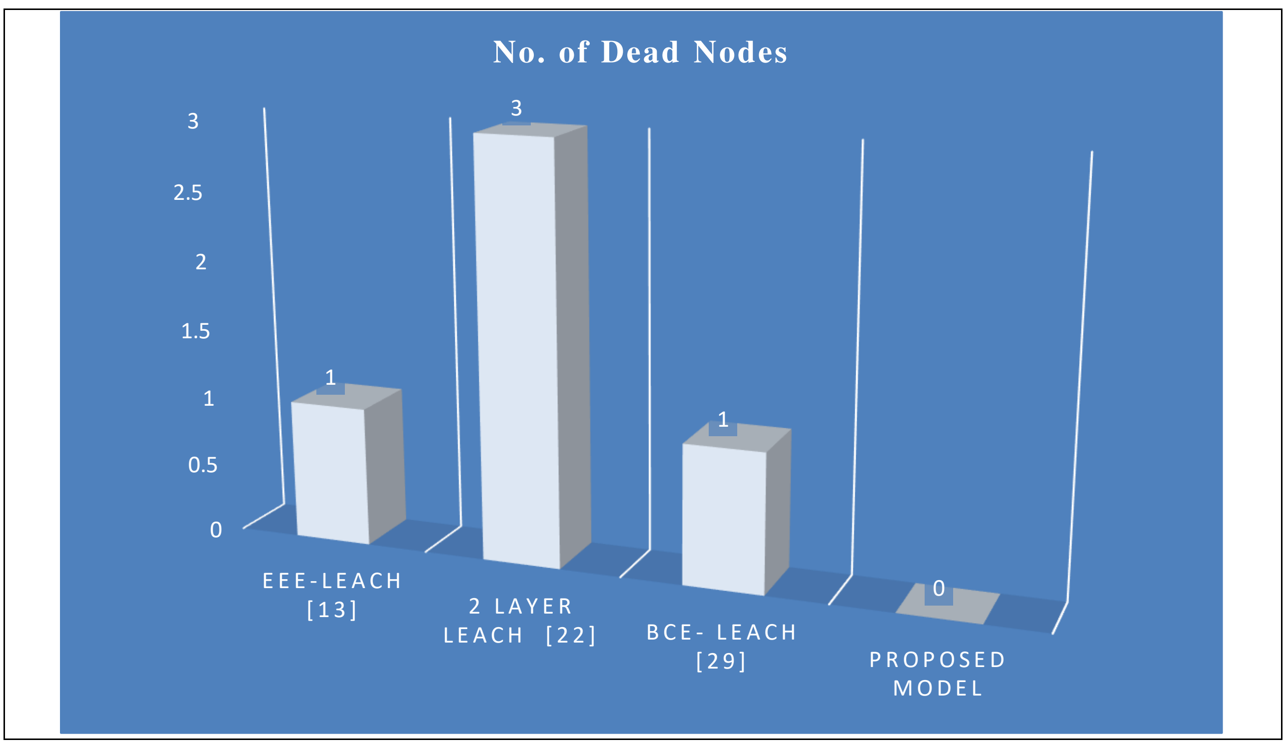

Figure 5.5: Diagram depicting a comparison between the amount of dead nodes in earlier studies and the suggested strategy

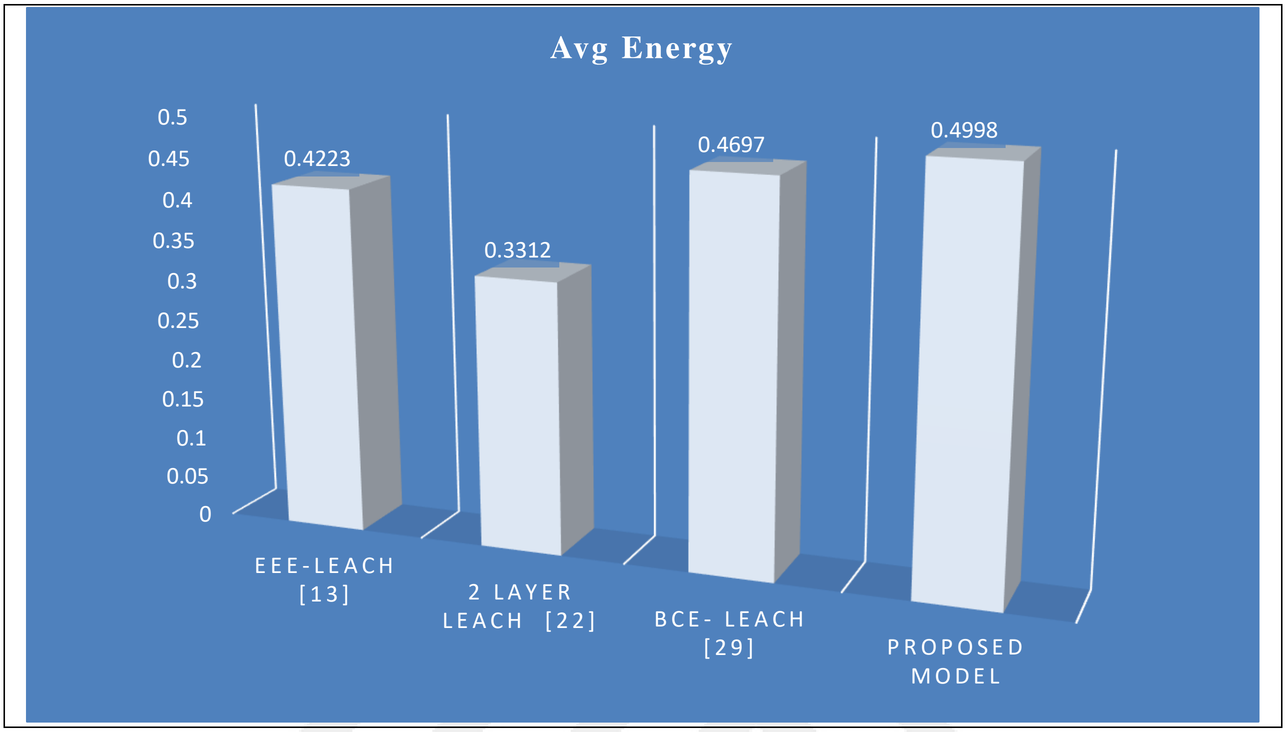

Figure 5.6: Average energy exhaustion between other studies and the suggested strategy

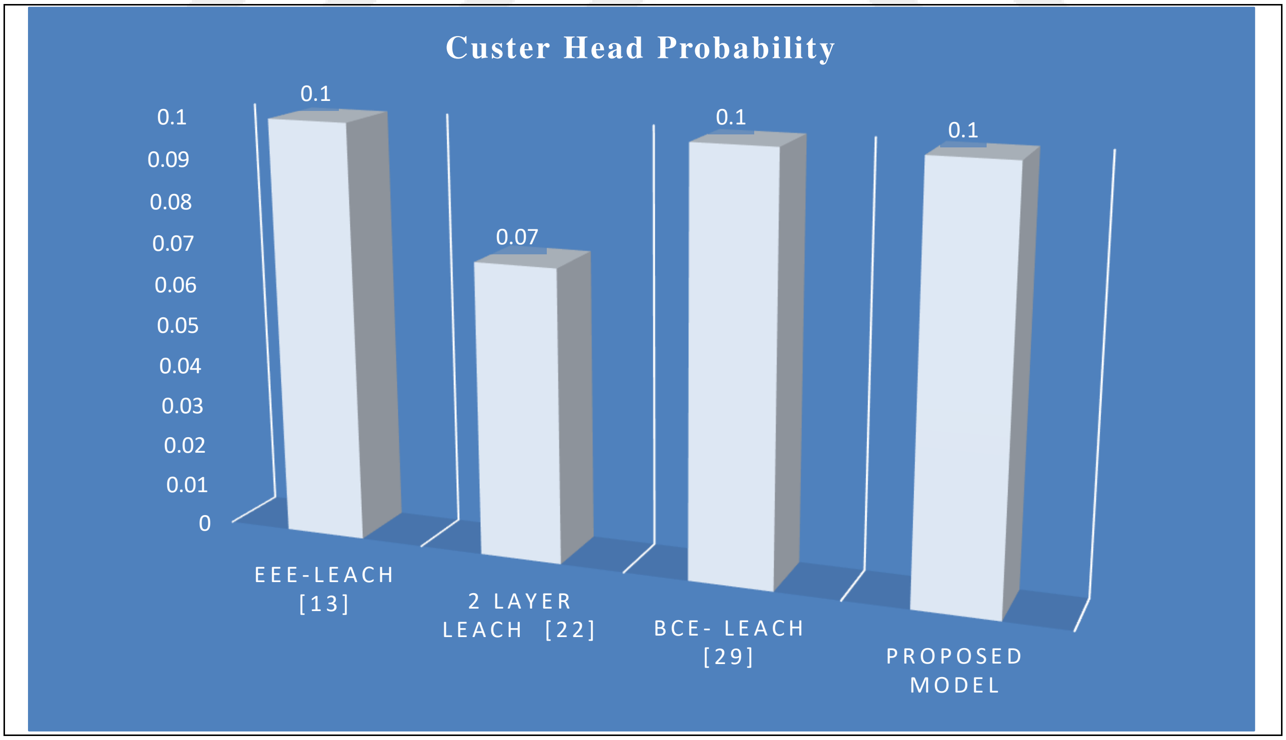

Figure 5.7: The probability of clusters head between earlier studies and the suggested strategy

6. CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

In LEACH, as well as a few of its enhanced protocols, randomly voting clusters head regardless of the excess energy of the nodes can result in a specific cluster head running out of energy closer than others. Thus, this dynamic selection of clusters head is the main ingredient that prevents all nodes with adequate current energy from becoming clusters head. Sending a cluster head to the BS regardless of energy and distance to the sink could exhaust the network lifespan. WSN protocol design must consider sink distance and energy fatigue. This work proposes a modern, improved protocol of LEACH called PDBAC-LEACH, which uses current energy to select cluster heads, considers current energy as well as the distance of sink to select the best path to reach a collector via choosing the root cluster head, and utilities a multi-hop technique to receive the root cluster head. This study compared PDBAC-LEACH and LEACH procedures using MATLAB simulation. The results show that the amount of dead nodes reaches zero, and the total energy of WSN nodes is higher than in other studies. In conclusion, PDBAC-LEACH outperforms LEACH protocols because it considers the remaining energy of nodes to select a cluster head and divide clusters before forming a clusters head, the current energy of the clusters head as well as distance among clusters head, and a sink to choose the root cluster head, thus expanding the WSN's lifespan. In the future, one of our primary goals is to create a cluster-based-data merger method that can be utilized for the examination of large amounts of data in wireless multi-sensor systems.

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