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ZSGEEHCP: Zonal Stable Gateway Based Energy Efficient Heterogeneous Clustering Protocol For WSN- Based IoT.

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Abstract: - In future most of the devices on the earth connected to the internet for making world of intelligent networks. The internet of things (IoT) and Industrial IoT play a very significant role for implementing such kind of smart networks. So, in that case, the transmission of packets of data sent to the base station from sensor nodes with minimum energy consumption in a homogeneous or heterogeneous environment to hike the stability of the network appears as a big challenge for IoT-based networks. But, such kind of problem can be overcome by using a proper clustering algorithm. In this work, different kinds of classical clustering algorithms are studied precisely. Most of the traditional clustering algorithm protocols presume that all the nodes have the same amount of energy, they are unable to fully exploit the presence of node heterogeneity and the same problem will be faced with IoT-based networks. In this specific piece of work, we recommend a gateway based heterogeneous energy-based clustering algorithm which is crucial for many wireless sensor networks along with IoT-based applications. In this concept geographical area is divided into three zone, Advanced, Intermediate and normal zone. Here, advance nodes send data through gateway to the base station while intermediate node use clustering algorithm for transferring data and normal nodes communicate data to the base station directly. ZSGHCP is driven by the mounded election protocol probabilities of each node elected as a cluster head depending on the rest of the energy. By simulation, we show that ZSGHCP invariably extends the stability time as compared to current clustering procedures. Finally, we investigate the sensitivity of our ZSGHCP protocol to network heterogeneity characteristics that capture energy imbalance, throughput, and no of alive nodes. We construct that ZSGHCP payout extends the durability region for excessive values of additional energy brought by extra higher-powered nodes.

Keywords: IoT, HEB, Heterogeneous, ZSGHCP, WSN, IoT Based Networks.

I. INTRODUCTION

Motivation: Battery based sensor nodes with insufficient processing capability, small storage, and limited communication capabilities make up IoT and wireless sensor-based networks [1]. Replacing an integrated battery is a challenging task once these sensor nodes have been deployed in the particular place. In order to extend the lifetime of the sensor-based network, we need to design energy-aware routing protocols. Customary strategies, for example, Direct Transmission and Least Transmission Energy don't give a fair dispersion of the energy trouble across the sensor organization's nodes [2].

With the assistance of direct Transmission (DT) sensor nodes broadcast straightforwardly to the sink, subsequently nodes that are uttermost away from the sink bite the dust first [3]. If information is sent using Minimum Transmission Energy (MTE), Nodes that are close to the sink have a higher likelihood of acting as relays under MTE than nodes that are far away. Nodes close to the washbasin thus frequently die. Both DT and MTE result in a biased field sensing mechanism since a section of the field is not monitored for a sizable amount of the network's lifespan. The LEACH system makes sure that the energy demand is allocated equally among clusters that are created dynamically, with cluster chiefs chosen dynamically using an a priori optimum probability [4]. Group heads accumulate reports from their bunch individuals prior to conveying data to the sink. If the group head job is reliably turned through all nodes, every node will in general use about a similar measure of energy over the long run.

Most of scientific ends for filter type frameworks are predicated on the idea that, as in homogeneous sensor organizations, the energy content of every node is steady. In this article, we analyze what heterogeneity means for node energy. On account of heterogeneous sensor organizations, we expect that a piece of the node populace has

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more energy than the other node in the network. We are persuaded by the thought that numerous applications would benefit extraordinarily from a superior comprehension of the effect of such heterogeneity. The re-empowerment of sensor organizations could be one of these applications. Since sensor networks have a limited life expectancy, it is important to recharge them by adding more nodes. These nodes will be furnished with more noteworthy energy than the nodes right now in activity, bringing about node energy heterogeneity. It ought to be noticed that delightful the standard for ideal circulation across various kinds of nodes as portrayed in [5] isn't generally imaginable attributable to reasonable/cost limitation.

The spatial thickness of sensors is likewise a limitation in certain applications. Expecting that the expense of a sensor is multiple times that of coordinated batteries, it will be beneficial to examine whether the organization's lifetime might be reached out by essentially dispersing additional energy to specific existing nodes instead of presenting new nodes [26, 27].

The most critical thing to remember is that node heterogeneity as far as energy is only a consequence of how the organization capabilities as it gets more evolved. nodes might use fluctuated measures of energy over the long haul (like lopsided territory) contingent upon factors like radio transmission attributes, irregular events like transient connection disappointments, or morphological characteristics of the field.

Energy efficiency in wireless sensor networks is the most challenging task. The advancement of an energy-efficient routing algorithm makes the examination in this space really energizing. Various conventions, for example, ESRA [17], HEED [18], and DEEC [19], as well as LEACH [13] and its determined protocols, SEP [14], I-SEP [15], SEP-V [16], and all subsidiaries and upgraded variations of the SEP protocol, are being created to increment network life span. In order to conserve energy in sensor nodes, hierarchical techniques have also been deployed. The nodes are grouped utilizing this strategy, and information conglomeration is done on the cluster head (CH). For WSNs, progressive steering procedures offer impressive energy reserve funds. In an order based steering approach, bunches are developed, and each group is given a cluster head (CH) utilizing a specific limit esteem T(n). Bunch organizations can be isolated into two classes: homogeneous sensor organizations, where every node gets a similar introductory energy esteem, and heterogeneous sensor organizations, where every node gets an alternate starting energy esteem. [21]. These group heads can work consistently during the organization's life expectancy. The cluster heads are dependably under load as they total information and convey the collected information to the far-off significant distance base station [22]. They thusly die first, bringing about network unsteadiness [23]. In a heterogeneous organization, network execution breaks down once the primary node passes on [24].

1.2 Parent Protocol Analysis

EZ-SEP is extended zonal stable routing protocol for heterogeneous wireless sensor network. When the energy level of each node is distinct. This technique used two methods to connect the sensor node and sink: (a) direct communication between the nodes, and (b) communication via a hierarchical clustering approach. In EZ-SEP use two kind of nodes (a) standard ordinary nodes that are passed close on to base station, and (b) advance level nodes that are sent a good way off from the BS. In contrast with cutting edge nodes, customary nodes have less basic energy. Three zones make up the geological region of the sending. zone 1, zone 2, and zone 3. Zone 1 has ordinary sensors put. A couple of cutting-edge nodes are set in zone 2, while some are set in zone 3[11]. Typical nodes impart and send information in direct mode while connected straightforwardly to the base station. However, the cluster head and extended advance node from the cluster head combine the data from their member nodes. With the use of a hierarchical clustering approach, the cluster head transfers the information for the base station after aggregating it. It gets harder for the extended advanced nodes to connect with the BS in the large geographic area as the field length communicate the data directly to the base station; this will require a lot of energy. As a result, the network lifetime will be shortened. This will influence how the extended advanced nodes choose the cluster head. The EZ-SEP protocol is briefly detailed below in brief:

a) Energy is expended in direct connection with the base station. The sensor node's battery life and computing power are currently constrained. Only extended advanced nodes generate clustering and cluster head elections. A CH will gather and transfer sensed records from its member nodes to a BS. As a result of excessive energy consumption and the speedy depletion of these nodes, network instability results.
b) Given that under these distinct protocols for routing, Among the advanced nodes, the cluster heads are chosen at random, there's a good chance that one of these advanced nodes will have low energy available, which runs out fast and leads to network instability. When the cluster's first head node fails, instability results. The cluster becomes unbalanced as a result. Furthermore, if a significant number of nodes fail, it's possible that the cluster will lose its cluster head.

c) The cluster's head nodes age more quickly as the field's deployed area rises because they require more power to transfer data to the sink, which contributes to the instability of the EZ-SEP protocol in the sensor network. Given that there is a direct proportionality between the two. Moreover, cluster heads in extended advanced nodes and regular normal nodes communicating directly between nodes and the base station.
d) In EZ-SEP protocol for transferring the data use hierarchical clustering approach. In this approach one cluster head transfer the data to subsequent cluster head and finally data is transfer to the sink. But this is practically not possible for large geographical area, because node which are near to sink used multiple times for transferring data.as a result excessive energy consumption and the speedy depletion of these nodes, network instability results.

1.3 Submission Preview

We accepted in this exploration that the BS and gateway possesses infinite energy and that the unfurled region's size is obscure. This calculation offers three unique kinds of nodes: (1) Normal Nodes, (2) Intermediate Nodes, and (3) Advance Nodes. Powerful sensors are a long way from the BS, while low introductory energy nodes and moderate node are put close by. Three zones—Zone 1, Zone 2, and Zone 3—comprise the forced sending region of ZSGHCP. In zone 1 those nodes are sent which are close to BS. Advance nodes are conveyed in zone 2 and transitional nodes are sent in Zone 3. Ordinary nodes ready to impart the information straightforwardly to the base station, in transitional nodes information conveyed utilizing bunching calculation while for the situation ZSGHCP of advance hub group head impart the information to resulting group head and ensuing bunch head with the assistance of entryway convey information to the sink. This model affects both the reduction in cluster head power consumption and the extension of the usable life of the sensor network, which affects the decrease in bunch head power utilization and the expansion of the sensor network administration life. The reenactment's discoveries show that the proposed ZSGHCP strategy outlasts the presently utilized group based heterogeneous parent conventions and further develops network security.

As in LEACH, every node picks an irregular number somewhere in the range of 0 and 1 in the primary round. This sensor hub is picked as the bunch head for this round of calculation in the event that the picked number is not exactly the limit. Every node extra energy level is refreshed at the finish of the principal round. In the event that a sensor node has really remaining energy, it will have a superior possibility turning into the group chief for the following round. The principal hub's life expectancy is reached out by utilizing this procedure, which is significant for the organization's security. Also, the parent calculation will be utilized to assess the way of behaving of EZ-SEP while considering appraisal circumstances like (1) moving the base station, (2) changing the hub thickness in the field, and (3) altering the underlying energy of the nodes.

Paper Organization: The rest of the paper is spread out as follows. The model of theoretical framework is introduced in Area 2. Our energy model is characterized in Segment 3. The ZSGHCP operation is tended to in Area 4.Our the recreation results are introduced in Segment 5. In Segment 6 concludes the whole research work.

II. THEORETICAL FRAMEWORK

2.1 *Routing Protocols for Wireless Sensor Networks*

A region's actual qualities, like sound, light, temperature, stickiness, and others, can be identified or constrained by few sensors, which are gadgets. Remote sensor nodes utilize remote channels to speak with the base station, sink, and different hubs, as displayed in Figure 1. A particular measure of force, memory, and central processor is accessible to sensor nodes. At least one detecting units, a handset, a radio wire, a power unit, a handling unit, and discretionary parts like a position tracking down framework, a power generator, and an actuator make up a sensor hub. Sensor node volumes range from cubic nanometers to cubic decimeters [7]. The real or logical communication between network nodes and all other devices establishes the topology, regardless of whether the location of sensor nodes in a network is known or unknown. Several topologies for a WSN are possible depending on the network and tasks for nodes. WSN extensively depends on the reliability and speed of data supply. How data travels via the network are decided by routing protocols. WSN directing methods ought to take energy utilization, inclusion region, and different elements into account. WSN routing protocol can be classified as level, area mindful, or progressive relying upon the organization geography [8].

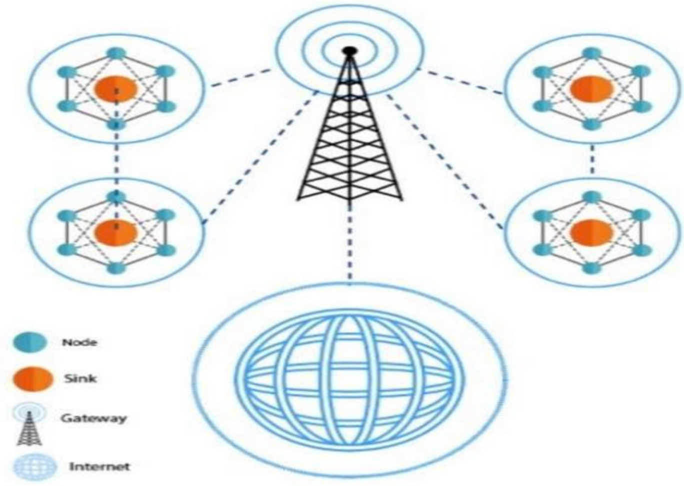


Figure 1. **Typical wireless sensor network architecture**

2.2 Wireless Sensor Networks using IoT Architecture

The three domains that comprise the Internet of Things (IoT) architecture are depicted in Figure 2: device or hardware, network or communication, and a service and interface layer. Sensors and actuators make up the top layer. For example, a sprinkler system may consist of separate sprinkler heads, temperature, moisture, and actuator sensors, all of which are networked via different protocols. The end devices at this tier utilize the Interplanetary File System (IPFS), which is utilized for distributed data storage and data integrity while taking into account the issues with centralized systems, Real Time Operating System (RTOS), hardware operating system, ARM or X86 architectures, and more technologies [9]. For the application software layer, there are drivers, third-party libraries, proprietary programmers, and cryptographic protocols. The network domain, sometimes referred to as the communication layer, facilitates the gathering and transmission of data to the application domain. To link things to gateways, the internet, and cloud services, various protocols are employed. Due to IoT sensor node constraints, a gateway device and the sensors must be able to communicate with one another. Traffic from wireless sensor networks (WSNs) is converted via the gateway into IP protocol traffic for use on traditional data networks. A lot of sensor nodes may be present in some wireless sensor networks. These nodes might just be battery-powered and have very little compute power. These nodes can only communicate over a very small range due to power constraints. Protocols are used in this situation to let sensor data travel from node to node until it reaches the gateway. Using the IEEE 802.15.4 standard, IoT wireless protocols can be arranged into a variety of wireless topologies, including the hub-and-spoke, star, mesh, and cluster tree topologies. If the nodes have their own IPv6 protocol stacks and messaging protocols, they can connect directly with the cloud or data center without needing to translate it into IP through an IoT gateway. Otherwise, the data must be transferred from one node to another in order to reach a gateway. The Application Domain (interfaces and services) layer offers management services for applications that use data from IoT devices, including data processing and analytics, storage, smart energy management, and connectivity management [10].

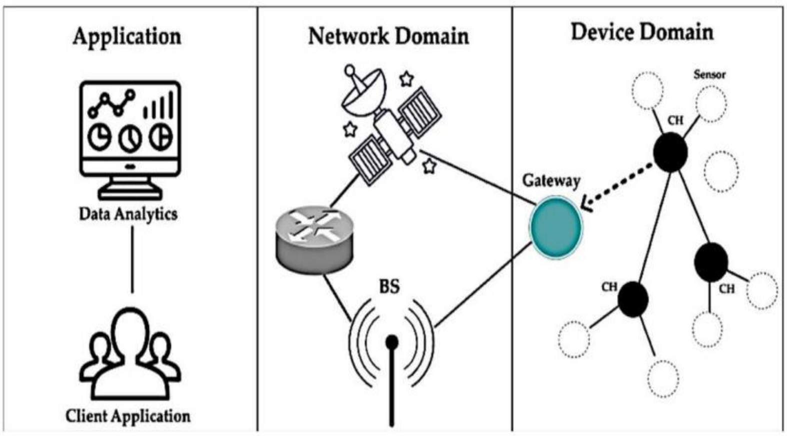


Figure 2. IoT Architecture Layer Diagram.

2.3 Related Work

The essential capability of sensor nodes is to detect their quick climate, accumulate information on the ground, process it, and send it to the BS. On the off chance that the sensor hub can send the message straightforwardly to the BS, it will require a great deal of energy to move the information, which could make their assets run out soon. Data is transmitted in this way, making multiple hops from one node to another before arriving at the BS, conserving energy. One of the biggest difficulties in WSN is energy efficiency. Therefore, routing protocol which minimize the consumption of energy play significant role and very important domain for research works. This protocol's key function is to reduce energy usage. Heintzelman et al. [15] offer Low Energy Adaptive Cluster Hierarchy (LEACH), a clustering technique for homogeneous networks. LEACH is a cluster-based routing method that uses a random CH rotation to spread the energy burdens on the network's sensor nodes equally.

There are two moves toward the drain calculation system. (2) Consistent state stage after the arrangement stage. Group readiness and CH determination occur in the initial step. A preset node "p" recognizes itself as CH in the way displayed underneath: Node chooses a number somewhere in the range of 0 and 1 at irregular. The ongoing round's group not set in stone by whether the irregular number falls underneath the end edge, T(n). Work out the rate to turn into the bunch CH, the ongoing round, and hubs "G" that weren't chosen as a CH in the past (1/P) round utilizing the condition beneath. The accompanying condition can be utilized to figure T(n):

$$T(n) = P/(1-P(r*mod(1/P))) \quad if\ n \in G \tag{1}$$

where G denotes a group of nodes involved in the CH election. Each hub has a "P" percent chance of turning into a CH in cycle 0 (r = 0), and nodes chose for CHs in cycle 0 are ineligible to be chosen for CHs in adjusts 1/P and then some. Since just fewer nodes are able to become group heads, the likelihood of the excess nodes becoming CHs increments. Sending a transmission message to the excess nodes is an obligation relegated to each recently made CH. Following message advertisement, signal is received by all non-CH nodes, who then choose the cluster based on signal strength. The CH node creates a Time Division Multiple Access (TDMA) schedule after receiving messages from nodes and assigns a time slot for each node to transfer data. Every node in the cluster broadcasts this TDMA schedule. Real data is transmitted to BS during the steady state phase. Compared to the layout process, this stage takes more time to accomplish. In this step, after sensing the data, communicate it to the CHs. All information from neighboring nodes is gathered by the CH node, compiled, and sent to the BS. A new cluster is chosen in the next cycle after the network returns to the lay out stage after a certain amount of time [16].

LEACH performs well in a consistent setting. Every node in LEACH has an equivalent chance of turning into a cluster head. LEACH, however, is ineffectual in a variety of situations. Multilevel heterogeneity is demonstrated by the Distributed Energy-Efficient Clustering Protocol (DEEC) [4]. The average network energy and the node's residual energy facilitate cluster head building in DEEC. In this mechanism, the cluster head is the node with the highest energy compared to nodes with lower energies. Assume that N_i is the number of CH selection rounds for nodes S_i. $P_{opt}N$ demonstrates the ideal number of CHs for each round. CH is more likely to occur in nodes with high energy than in nodes with low energy. Therefore, for each round, the CHs value is equivalent to $P_{opt}N$. P_i is the likelihood that each node in S_i will become a CH. P_i, a high energy node, is more valuable than P_{opt} [17]. E'(r) at round r can be used to represent a node's average energy.

$$E'(r) = \frac{1}{N}\sum_{i=1}^{N} Ei(r) \tag{2}$$

In DEEC CH selection probability is

$$Pi = P_{opt}\left[1-\frac{E'(r)-Ei(r)}{E'(r)}\right] = Popt\,\frac{Ei(r)}{E'(r)} \tag{3}$$

Total number of CH during each round is

$$\sum_{i=1}^{N} P_i = \sum_{i=1}^{N} P_{opt}\frac{Ei(r)}{E'(r)} = P_{opt}\sum_{i=1}^{N}\frac{Ei(r)}{E'(r)} = NP_{opt} \tag{4}$$

The probability that a node will become CH throughout a round is denoted as P_i. G designates a group of nodes suitable for round r of CH. Each node selects a random number between 0 and 1 for every round. The node is chosen as a CH for that round if the chosen number is less than the threshold value; otherwise, it is not.

$$T(s_i) = \begin{cases} \frac{P}{1-P\left(r*mod\left(\frac{1}{P}\right)\right)} & if\ n \in G \\ 0 & otherwise \end{cases} \tag{5}$$

$$P_{nrm} = \frac{P_{opt}(1+\alpha)}{(1+\alpha m)} \tag{6}$$

$$P_{adv} = \frac{P_{opt}}{(1+\alpha m)} \tag{7}$$

P_{opt} was substituted for the aforementioned equation 6 in equation 3 and can be written as:

$$P_i = \begin{cases} \frac{P_{opt}Ei(r)}{(1+\alpha m)E\prime(r)} & if\ s_i\ is\ normal\ nodes \\ \frac{P_{opt}(1+\alpha)Ei(r)}{(1+\alpha m)E\prime(r)} & if\ s_i\ is\ the\ advanced\ nodes \end{cases} \tag{8}$$

The multi-level heterogeneous network is included in equation 7 as:

$$P_{multi} = \frac{P_{opt}N(1+\alpha i)}{(N+\sum_{i=1}^{N}\alpha i)} \tag{9}$$

Equation 3 can be used in place of equation 8 above to obtain pi, as seen below:

$$P_i = \frac{P_{opt}N(1+\alpha i)Ei(r)}{(N+\sum_{i=1}^{N}\alpha i)E\prime(r)} \tag{10}$$

It is possible to determine the network's average energy E(r) in DEEC at any round by using

$$E'(r) = \frac{1}{N} E_{total}(1-\frac{r}{R}) \tag{11}$$

R stands for the entire network lifetime and is determined using

$$R = \frac{E_{total}}{E_{round}} \tag{12}$$

E_{total} denotes the energy used throughout each round, whereas Etotal denotes the network's overall energy usage. SEP (Stable Election Protocol) is a heterogeneous protocol that depends on the underlying energy of the nodes. This protocol introduces normal and advanced nodes as two different sorts of nodes Advance nodes are more energetic than regular nodes. Assume that $E_0(1+\alpha)$ is the energy for the advanced nodes and that E_0 is the beginning energy of the normal nodes. It implies that more energy is available to advanced nodes than to standard nodes. Assuming that the normal and advanced nodes have weighted probabilities that are P_{nrm} and P_{adv}, respectively. Nodes having $n\times(1+\alpha.m)$ energy equal to a typical node's starting energy. The average number of cluster heads in each round within an epoch must equal $n\times (1+\alpha.m) \times p_{nrm}$. in order to maintain the expenditure of minimal energy [12].

Responding protocol TEEN is made for applications that must be completed quickly [5]. TEEN was recommended for homogeneous networks. The selection criteria for a cluster head in TEEN are the same as in LEACH, but TEEN also includes hard and soft thresholds to cut down on transmissions and save energy on nodes. This lengthens the network's lifetime and stability duration. Accordingly, the weighed probability is for both normal and advanced nodes.

$$P_{nrm} = \frac{P_{opt}}{(1+\alpha m)} \tag{13}$$

$$P_{adv} = \frac{P_{opt}(1+\alpha m)}{(1+\alpha m)} \tag{14}$$

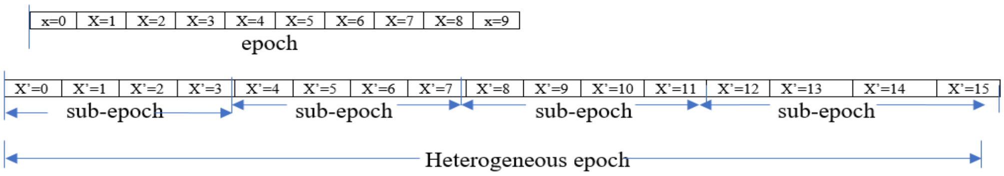
We substitute the weighted probabilities for p in condition (1) to decide the edge that is used to pick the bunch in each round. The limit for standard nodes is signified by $T(S_{nrm})$, while the edge for cutting edge nodes is meant by $T(S_{adv})$. Thusly, we have the ordinary nodes.

$$T(s_{nrm}) = \begin{cases} \frac{p_{nrm}}{1-p_{nrm}(r*mod\frac{1}{p_{nrm}})} & if\ s_{nrm} \in G' \\ 0 & otherwise \end{cases} \tag{15}$$

Here, r addresses the ongoing round, and G' is the gathering of ordinary nodes that poor person been assigned bunch bosses throughout the span of the ages beyond $1/p_{nrm}$ adjusts. The number of inhabitants in $n(1+m)p_{nrm}$ is exposed to the edge, T(S_{nrm}). Each ordinary hub will turn into a bunch head unequivocally once every (1+m) per age, with a normal of n(1-m)p_{nrm} group heads per round per age being typical hubs. In similar way, for advanced node, we have:

$$T(s_{adv}) = \begin{cases} \frac{p_{adv}}{1-p_{nrm}(r*mod\frac{1}{p_{adv}}} & if\ s_{nrm} \in G' \\ 0 & otherwise \end{cases} \quad (16)$$

Here G` represent the set of advance nodes that have not declared as cluster head during last $\frac{1}{p_{adv}}$ rounds of the epoch, and for the population of advanced nodes *T(s_{adv})* is declared as a threshold. On every $\frac{1}{p_{opt}} \times \frac{1+\propto m}{1+\propto}$ rounds guarantees that each normal node will become cluster head exactly once. This period of time will be referred to as a sub-epoch. It is evident that each epoch (In our heterogeneous scenario, let's call this a "heterogeneous epoch") includes (1+) sub-epochs. Every round of nm×p_{adv} has an average number of cluster heads that are advanced nodes for each heterogeneous epoch (and sub-epoch).



Advance nodes in SEP have higher energy than regular nodes. In this way, advanced nodes have more probability to become cluster heads, SEP is not the best suit for the development of CHs.

III. PROPOSED WORK

3.1 *Energy consumption model*

The proposed convention utilizes the correspondence module displayed in Figure 3 as a review case.

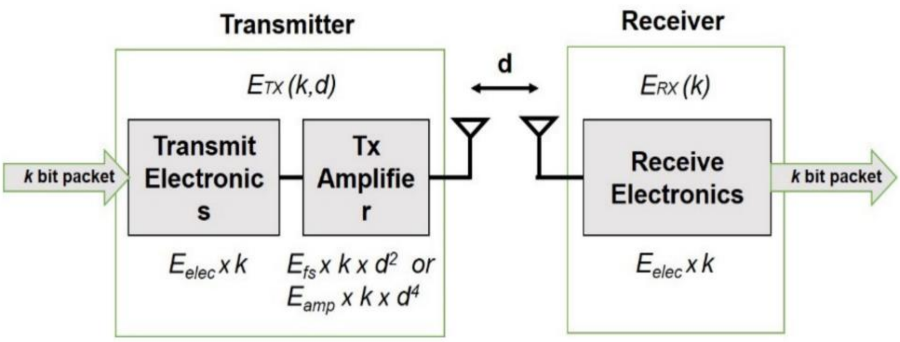


Figure 3. Radio Communication Model

The free space model is considered assuming the distance between the cluster head and its related nodes is small; if the distance is longer, the multipath fading model is employed [16].

The free space model is considered assuming the distance between the cluster head and its related nodes is small.

$$E_{TX}(k,d) = E_{TX_{elec}}(k) + E_{TX_{amp}}(k,d) \quad (17)$$

$$E_{TX}(k,d) = \begin{cases} E_{elec} * k + E_{fs} * k * d^2,\ d \le d_0 \\ E_{elec} * k + E_{amp} * k * d^4,\ d > d_0 \end{cases} \quad (18)$$

$$E_{RX}(k) = E_{RX_{elec}}(k) + kE_{elec} \quad (19)$$

$$d_0 = \sqrt{\frac{E_{fs}}{E_{amp}}} \quad (20)$$

where d is the Euclidean distance between the sending and getting nodes, E_{elec} is the energy consumed by the collector and transmitter per bit, and $E_{elec}*k$ is how much energy utilized by the radio module to get a bundle of information containing k pieces. E_{fs} and E_{amp} represent free space and multi-way blurring enhancer energies, separately.

2.2 Proposed Methodology:

In some protocols arbitrarily distribute sensor nodes throughout the network, which results in inefficient use of their energy. In proposed ZSGHCP protocol divide the network into three zone based on nodes' separation from the BS. This protocol uses three different types of nodes—normal, intermediate, and advanced—and has three levels of heterogeneity. Normal nodes are less energetic than advanced and intermediate nodes. As a result, base station zone zero is designated for normal, whereas zone one and zone two are designated for intermediate and advanced nodes, respectively. Normal nodes in this network structure broadcast data to the base station directly. Intermediate nodes create a cluster, and advanced nodes build a hierarchical cluster with the assistance of their neighbors. As indicated in Figure 4, one node is chosen to serve as the cluster head in this instance, and subsequent nodes join the cluster as members and submit data to the cluster head. The cluster head then transmits data to the BS after aggregation.
Let E_0 represent the energy of regular nodes N and E_0 (1 + b) represent the energy of advanced nodes with the fraction χ having more energy than normal nodes equal to b. $E_0(1 + \alpha)$, where $\alpha = b/2$, is the energy of intermediate nodes with fraction y. Equation (21), (22) is used to calculate the total initial energy distributed across the various types of heterogeneous WSN nodes [17].

$$E_{total} = N.E_0(1-x-y)+N.y.E_0(1+\alpha)+N.x.E_0(1+b) \quad (21)$$

$$E_{total} = NE_0(1+y.\alpha+x.b) \quad (22)$$

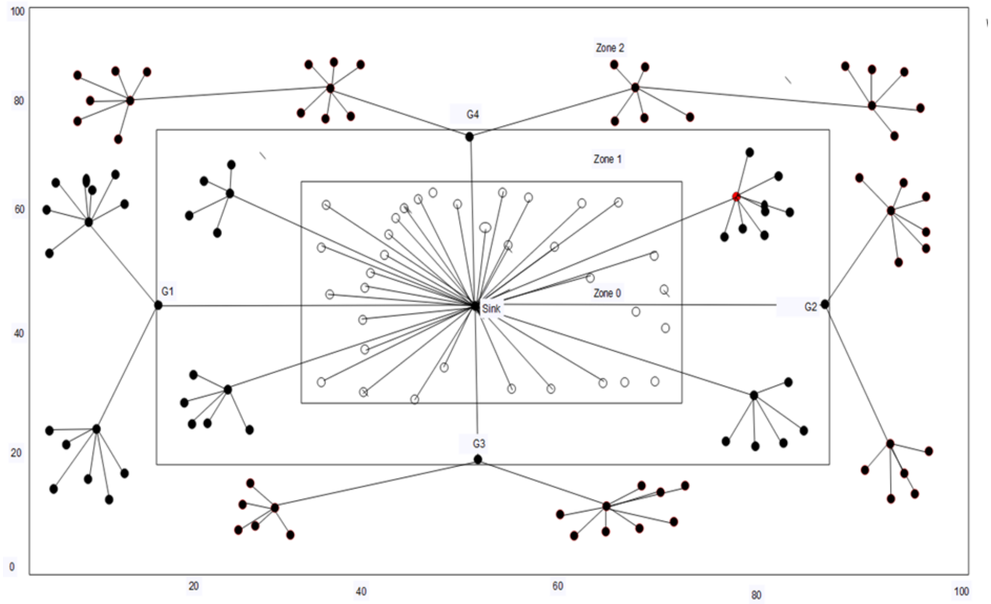


Figure 4. Connection of Nodes to Base Station and Gateway

IV. ZSGHCP OPERATIONS

This section basically focused on the operation of proposed protocol.

4.1 *Setup Phase*

In this phase, based on distance from BS, network is divided into three regions. Normal node that has minimal initial energy deployed near to BS (i.e., N-Zone 0) while intermediate node that have additional energy than normal are deployed in N-Zone1 and advanced nodes are deployed N-Zone2.

- N-Zone 0(Base Station Register): The deployed nodes in this area are relatively close to the BS. Hanse, these nodes transmit data to BS directly.
- N-Zone 2: All the nodes are little bit far away from BS. In this region nodes are sending data to nearest CH's and CH's send data to the BS. In this way, consumption of energy minimize.
- N-Zone 1(Intermediate node Region): In this region deployed are little bit far away from BS and four gateway G1, G2, G3 and G4 are deployed near to sink. In this mechanism nodes are sending data with the help of CHs to BS via gateway. As result, they minimize the consumption of energy.

4.2 CH Selection

In each round, normal node transmits their data directly to the BS. while intermediate node transmit data to the CH's. For intermediate nodes, select their cluster based on weighted probability. With the help of Equation (23), Probability of CH for intermediate to be computed.

$$P_{INT} = \frac{P_{opt}\,(1+\alpha)}{(1+y.a+x.b)} \quad (23)$$

With the help of Equation (24), Probability CH for advanced to be computed.

$$P_{ADV} = \frac{P_{opt}(1+b)}{(1+y.a+x.b)} \quad (24)$$

PINT represents the probability of selecting the best CH for intermediate nodes, P_{ADV} is the probability of choosing the best CH for advanced nodes, and p_{opt} is the reference for P_{INT} or P_{ADV}.

Equation (25) is used to calculate the threshold for advanced nodes $Th(N_{ADV})$ in the CH region.

$$Th(N_{ADV}) = \begin{cases} \frac{P_{INT}}{1-P_{INT}*\left(r*\mathrm{mod}\left(\frac{1}{P_{INT}}\right)\right)} \times \frac{E_{res} \times K_{opt}}{E_{AVG}} & \text{if } N_{INT} \in G' \\ 0 & \text{othewise} \end{cases} \quad (25)$$

Equation (26) is used to calculate the advanced nodes threshold $Th(N_{ADV})$ in the CH region.

$$Th(N_{ADV}) = \begin{cases} \frac{P_{ADV}}{1-P_{AVD}*\left(r*\mathrm{mod}\left(\frac{1}{P_{ADV}}\right)\right)} \times \frac{E_{res}*E_{opt}}{E_{amp}} & \text{if } N_{ADV} \in G' \\ 0 & \text{otherwise} \end{cases} \quad (26)$$

Where G and G′ are the assortment of halfway and high-level nodes that haven't changed into CH in that frame of mind round of age, K_{opt} is the ideal number of CH, Eres is the leftover energy of the hubs, N_{INT} is the quantity of middle of the road hubs, N_{ADV} is the quantity of cutting-edge hubs, and N_{INT} is the quantity of CH.

4.3 Scheduling

Each CH makes a Time Division Numerous Entrance (TDMA) plan during the group development process and distributes a schedule opening to every one of its part hubs. To save energy, the leftover hubs in the group nod off while every hub in the bunch sends its information to the pertinent CH as per its time allotment.

4.4 Link Communication

Three methods of link communication with BS are built into the ZSGHCP protocol.

4.4.1 Direct Communication

Due to its low energy and intensive BS allocation, Zone 0 is where typical nodes are put. These nodes have the ability to sense their surroundings and transmit data straight to the BS. The cluster head is chosen utilizing Condition (14), similar as in a SEP approach for typical hubs, after the groups and cluster heads are delivered involving the standard Drain calculation in the main round. After information move, the energy utilization of every sensor hub in the organization changed relying upon the hub. The d-layered distance between the sending and getting hubs influences energy use. The bunch head is found in the accompanying cycle involving the improved condition in

Condition (16). The cluster head notifies all of the pertinent cluster's member nodes about its cluster head announcement after being chosen for the current round. Based on the strength of the received message signal, the remaining sensor nodes that are not cluster heads choose whether or not to join this cluster head. The group head disperses and distributes TDMA timetables to the part hubs, permitting them to communicate information at different timeslots and forestalling information crashes in the organization [25]. The cycle repeats until all rounds are completed and all of the network's nodes have expended all of their energy. It is the setup phase that is in doubt.

4.4.2 Communication via cluster head

In zone 1, After the bunches and group heads are framed involving the standard Filter calculation in the principal round, the bunch head is picked utilizing Condition [14], similar as in a SEP strategy for ordinary hubs. The energy utilization of every sensor hub in the organization after information move shifted relying upon the hub. Energy utilization is impacted by the layered partition between the sending and getting hubs. In the ensuing round, the better condition in Condition is utilized to find the bunch head [16]. After being selected for the current round, the cluster head sends information about its announcement regarding the cluster head to all of the relevant cluster's member nodes. The remaining sensor nodes that are not cluster head determine whether or not to join this cluster head based on the strength of the message signal that was received. The cluster head distributes and publishes TDMA schedules to the member nodes, allowing them to transmit data at various timeslots and preventing data collisions in the network. The cycle repeats until all rounds are completed and all of the network's nodes have expended all of their energy.

4.4.3 Communication via gateway

The zone 2 contains hubs that near the passage hub. In this zone CHs either send information straightforwardly to base station or CHs send information to the following ensuing CHs and resulting CHs send information to the base station through door hubs. Thus, they utilize less energy to move their information.

V. SIMULATION AND RESULT ANALYSIS.

In this section, simulate the proposed algorithm and its parent protocols. Additionally, we considered several evaluation scenarios and examined our protocol's output results in comparison to other available protocols in terms of performance behavior. Table 1 lists the network model parameters that were taken into account during MATLAB simulations.

In this situation network checking region is partitioned into three zones in light of nodes distance from the BS. Four entryway hubs G1, G2, G3 and G4 are conveyed at the focal point of detecting field. After organization, the entryway hub is fixed and battery-powered to help the quantity of dynamic hubs and extend the network lifetime. Utilizing the MATLAB 2021a climate, the exhibition of the proposed ZSGHCP convention is assessed by examination with Z-SEP and EZ-SEP. The boundaries utilized in the organization reproduction is given in Table 1.

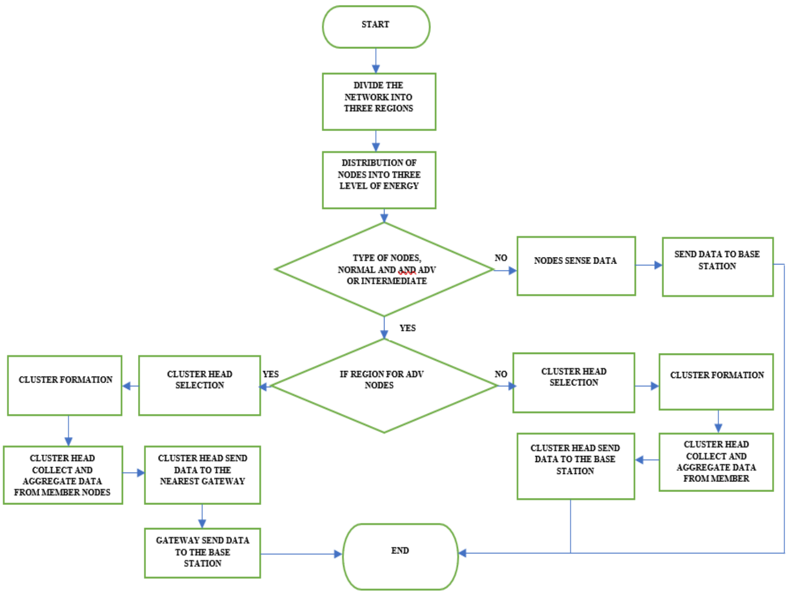


Figure 5. Flowchart for the proposed ZSGHCP protocol

Table 1. The simulation parameter used in the network

Type of parameters	**Value**	**Symbol**
Network diameter	100x100m^2	M
Nodes	100 Nodes	N
Initial Energy	0.5J	E_0
Energy depletion of node's electronic circuit to transmit or receive the signal	50nJ/bit	E_{lec}
Data Aggregation Energy	5nJ/bit	E_{DA}
Transmit Amplifier Energy. If dist<T_d	10pJ/bit/m^2	E_{fs}
Transmit Amplifier Energy.dist≥ T_d	0.013pJ/bit/m^4	E_{amp}
Optimal Probability	0.1	p_{opt}
Bas station	(50,120)	BS

An initial quantity of energy (E_0) is provided to each node, which is used for node amplification and reception. Data transfer between two CHs requires more energy (E_{fs}), and the latency of data transmission requires additional energy. It uses the abbreviations "energy transfer and reception for data packets" (E_{TX}/E_{RX}). With the help of these parameters, the ZSGHCP algorithm initiates the network routing process, improving the resulting network parameters.

- Compose more active nodes.
- Hike the efficiency package delivery rate.
- Minimize the consumption of power.

Plots of the aforementioned parameters against the number of live, active nodes, the rate at which packages are delivered, and the amount of energy still in reserve are made using the two WSN protocols.

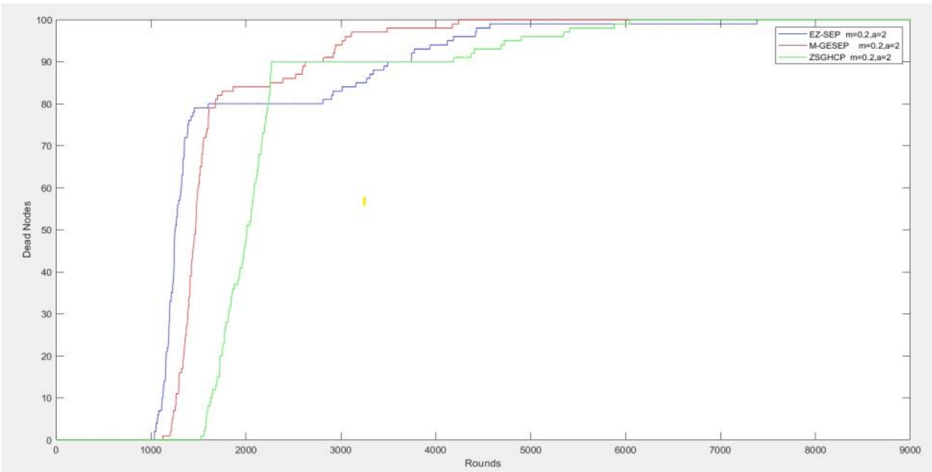


Figure 6. Dead Node Representation

A blue variety line addresses the EZ-SEP convention, a fuchsia variety line the M-GESEP convention, and a green variety line the proposed ZSGHCP calculation. The charts in the delineation exhibit that the ZSGHCP convention plays out the most awful right off the bat in the organization when contrasted with the other two conventions. In the EZ-SEP convention, network unsteadiness and the demise of the primary hub start at cycle 1161, however they start in the EZ-SEP convention at cycle 1461. The proposed ZSGHCP convention at first shows a 5% improvement over the parent EZ-SEP convention as the quantity of rounds approaches 2000. Nonetheless, it likewise shows a superior lifetime for the primary hub demise at the 1461st round, though with EZ-SEP the principal hub kicked the bucket at the 1161st round. The proposed ZSGHCP execution performs better compared to the EZ-SEP convention after 3000 cycles, exhibiting a superior and more dependable soundness period. As the organization keeps on working, the M-GESEP calculation regularly experiences fewer dead hubs than the other three conventions. The proposed ZSGHCP convention, as found in Figure 4, performs better at 6000 rounds, enormously dragging out the organization lifetime. Hub demise is thought about around in the parent convention.

The organization bundle conveyance rate to a BS is displayed in Figure 5. Information transmission from hubs to a base station is a WSN's principal obligation. Long haul network use will expand the organization's effectiveness since additional information will be detected, more natural data will be delivered, and a greater amount of it will be shipped off the sink. The graph showing the delivery of data packets to the BS via all three methods is shown below. By sending more than 2.4×10^5 packets to BS, it is clear from the graph that the ZSGHCP method performs considerably better than the other protocols. Figure 5 illustrates how the other three compared protocols can't outperform the new algorithm that is being proposed.

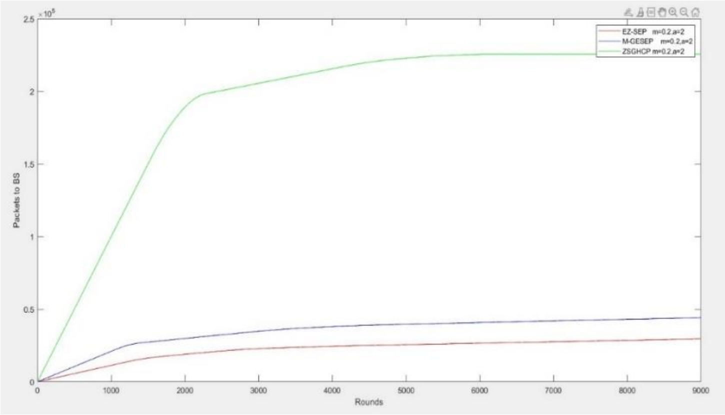


Figure 7. Packets delivery ratio to BS

The graph below shows how many active nodes are still there in relation to how much energy each node uses when the network is in use. The graph shows that, in comparison to the alternative ways, our suggested protocol outperforms them in terms of living nodes. Due to the fact that ZSGHCP algorithm requires less energy for a particular number of rounds. which, as seen in Figure 6, will ultimately be reflected in a rise in the number of active nodes, a rise in the volume of packets transmitted to the BS, a rise in the service lifetime of the network, and, as a result, a rise in the effectiveness of the network

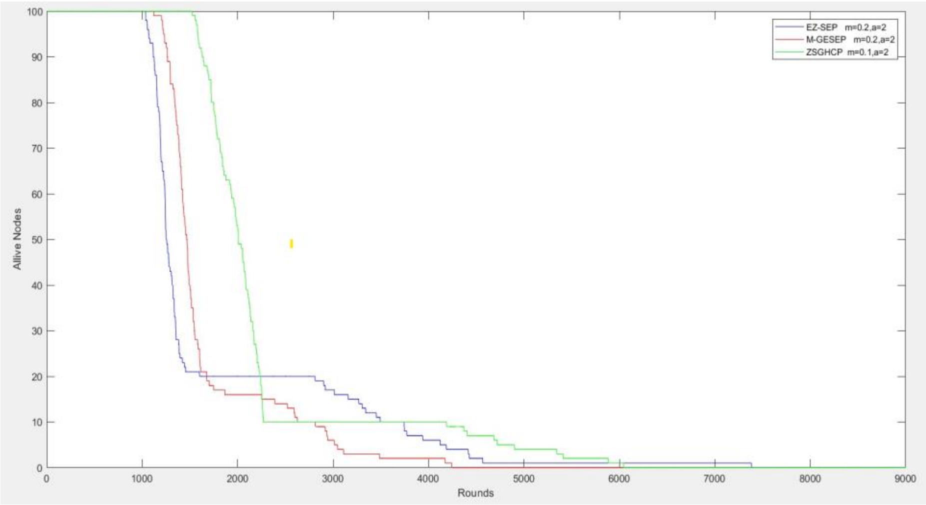


Figure 8. No of alive nodes.

To lead further exploration and difference the suggested ZSGHCP calculation with the two conventions recently referenced, three different organization conditions have been noticed for attributes like dead nodes, bundle conveyance rate, and the quantity of enduring hubs concerning leftover energy. These are the supposed organization issues:

5.1 Changing the base station position

The organization execution of our proposed convention is contrasted with the presentation of different conventions when the BS areas sink.x and sink.y are changed from 50 to 75 without changing some other boundaries. These adjustments meaningfully affect dead node execution, bundle conveyance rate, and normal power utilization. These elements, as indicated in Table 2(c), yield better results in the proposed ZSGHCP than the parent processes, in accordance with simulation experiments. When data routing first begins, EZ-SEP performs better than the suggested ZSGHCP in terms of node life, but after a few rounds, the ZSGHCP algorithm improves and improves until the conclusion. In comparison to the other two protocols, ZSGHCP transmits more packets and has a higher packet delivery ratio. Furthermore, the EZ-SEP and M-GESEP algorithms consume more energy in comparison to the other protocols. Nodes' residual energy in the proposed ZSGHCP at around 2000 is approximately 0.1 J, whereas it is virtually zero in the EZ-SEP. The protocol that uses the most energy is EZ-SEP. Because our suggested protocol uses less energy than others, it consequently increases the stability of the sensor network over time and increases its usable life.

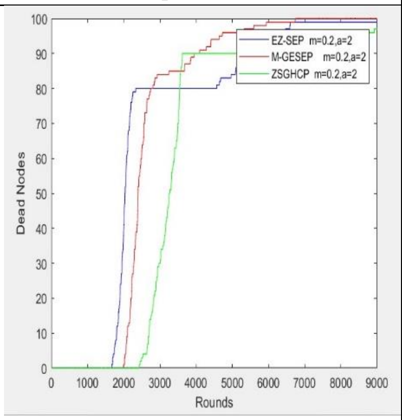
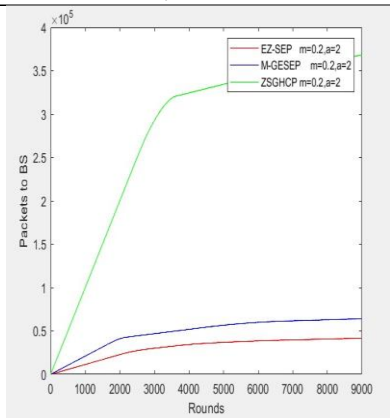
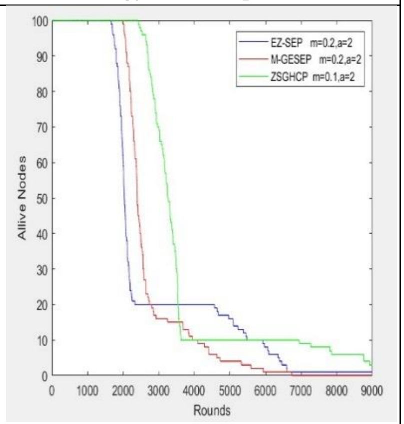
5.2 Altering the field density of nodes.

The distribution of nodes in the field is altered in this instance, with a sizable percentage going in zone 1 and the remainder in zone 2, for example. In the middle still stands the base station. On the x-axes and y-axes of the region, skewed nodes are possible. In these circumstances, the proposed ZSGHCP protocol's performance is compared to that of the other protocols. The outcomes in Table 2(b) show that the proposed ZSGHCP performs better than competing protocols when the locations of the network's nodes are changed. The behavior of the entire sensor network changes. When compared to the EZ-SEP, M-SEP protocols, these protocols are not providing very promising results in terms of the stability duration of living nodes. Up to the 2000th round, M-GSEP and ZSGHCP operate similarly, however after that, the suggested ZSGHCP has a longer node lifetime and node stability than M-GESP. EZ-SEP supply much less data than the suggested method in terms of data transmission ratio, although EZ-SEP maintains a close proximity to ZSGHCP. In any instance, the parent protocol performs worse than the ZSGHCP protocol. EZ-SEP is the protocol that uses the most energy compared to others, while our suggested approach has a superior energy consumption line in the graph.

5.3 Changing the initial energy of nodes.

The most important component of a wireless sensor network (WSN) is the initial energy of each node because nodes are battery-restricted and cannot replenish their batteries after they are deployed in the field. By raising the nodes' starting energy E0 from 0.5 J to 0.8 J, we can examine how the network behaves and contrast our suggested protocol with current practices. Increased network energy will undoubtedly have an effect on longevity and stability times. We explore the impacts of the extra energy in cutting edge nodes on the whole organization framework all through the group head political race process and the information disintegration considerably since cutting edge hubs utilize more energy than standard hubs and have different energy after bunch heads are picked. From that point onward, bunch heads are made utilizing the excess waste energy. The energy utilization of the organizations is shown in Table 2(a). The charts in the picture show that when the underlying energy of the nodes is changed, the proposed ZSGHCP convention performs better compared to the next two conventions. ZSGHCP uses the least amount of energy, whereas M-GESP uses the most. However, the new additional value in EZ-SEP and ZSGHCP does lengthen the network compared to the initial baseline value. Because of this, nodes are almost about to exhaust after the 2000th round, but round 1000 caused them to exhaust twice as quickly. This is something that EZ-SEP runs into in round 3000 whereas ZSGHCP runs into it in round 3500. The fact that the first node perished in round 1707 and that every node was dead by round 4000 indicates that EZ-SEP performs the worst. Almost all the way until round 9000 and even after the first node death at round 2467, nodes in the ZSGHCP protocol had the longest stability period. M-GESP round 1610, which has the poorest index, is when the first death occurs. Even though the parent protocol EZ-SEP has the best index and is far more unstable than the suggested ZSGHCP, the first node dies in that protocol at round 2489. Therefore, the suggested method functions better when nodes have more beginning energy. ZSGHCP sends much more data overall when compared to EZ-SEP since it displays more packets delivered in the 2500–8500 round range and is close to it after that.

Table 2. Different network condition comparisons

<table>
<tr><th></th><th>Dead Node Representation</th><th>Packet Delivery Ratio</th><th>Node Energy Consumption</th></tr>
<tr><td>Incrementing Nodes Initial Energy(a)</td><td>
</td><td>
</td><td>
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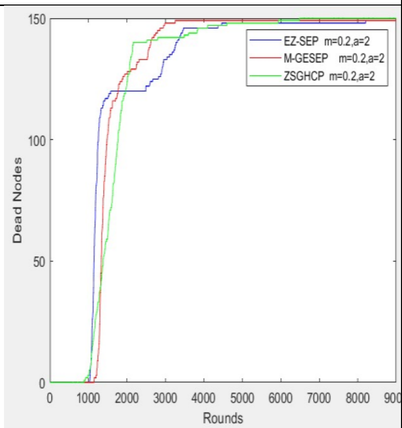
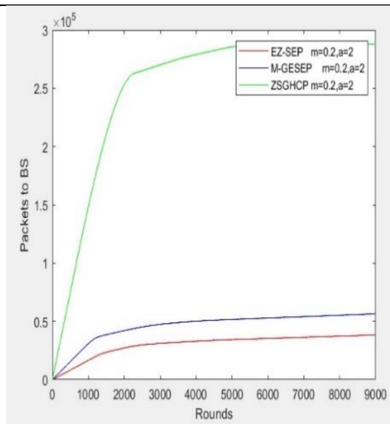
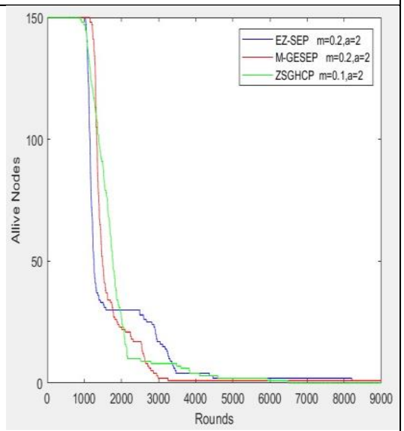
<tr><td>Changing Field Density of Nodes(b)</td><td>
</td><td>
</td><td>
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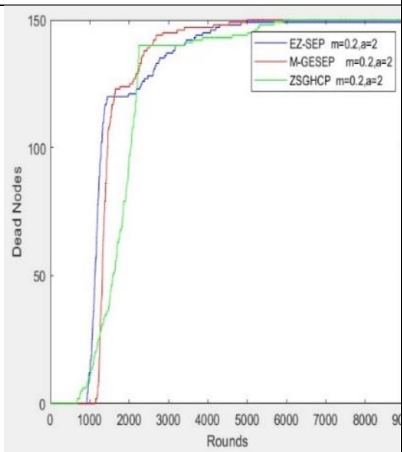
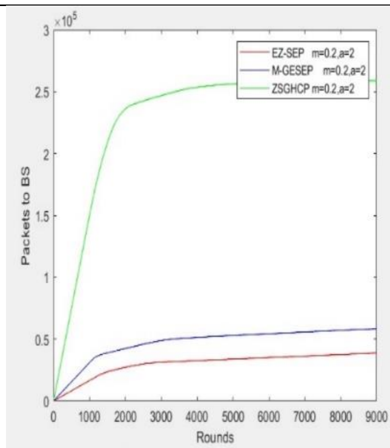
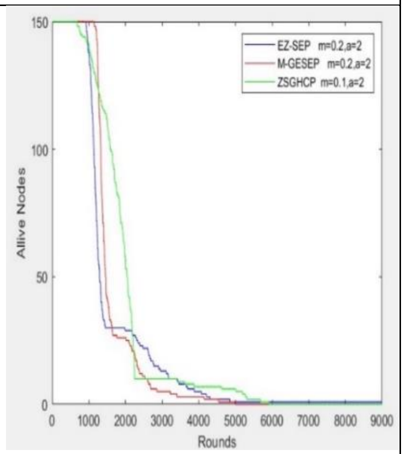
<tr><td>Altering Base Station of Position(c)</td><td>
</td><td>
</td><td>
</td></tr>
</table>

5.4 Comparative Evaluation of the Observed Protocols

Within this section, we simulate the suggested algorithm and parent protocols. Additionally, we considered several evaluation scenarios and examined our protocol's output results in comparison to other available techniques in terms of performance during performance. For the above-mentioned examined protocols, various attributes and Table 3 lists the combined results of the evaluations. Network level refers to the homogeneity or heterogeneity of energy. Energy efficiency is the algorithm's measure of energy use. The time between the first node's birth and demise is known as the stability period. Scalability determines the network's scalability.

Table 3: Table of several features in comparisons

Parameters Protocol	Energy Efficiency	Scalability	Network Level Homo/Hetero	Network Stability
EZ-SEP	**Medium**	**Medium**	**Heterogeneous**	**Medium**
M-GESP	**Low**	**Medium**	**Heterogeneous**	**Medium**
ZSGHCP	**High**	**Medium**	**Heterogeneous**	**Medium**

EZ-SEP and M-GSEP are worst compared to ZSGHCP, on other hand ZSGHCP performs better in the against them. The aforementioned characteristics show that EZ-SEP exhibits superior indexes to its parent protocols.

VI. CONCULUSION

Energy economy and network durability are the two most crucial aspects to consider while designing a network routing algorithm. It is difficult to build a system that distributes network demand while being energy-efficient. M-GSEP is a good method for this, although it still has several issues. In addition to a modified cluster head selection mechanism, a two-level heterogeneous, hierarchical cluster-based routing protocol termed zonal stable gateway-based energy efficient allows nodes to communicate with the sink. Since normal nodes transmit data directly to the base station, intermediate nodes employ a clustering approach, and advance nodes employ a clustering technique with a gateway, the nodes in ZSGHCP transfer data to their BS in a hybrid fashion. In contrast to the parent M-GSEP protocol, which aims to extend the network's lifespan considering the dissipation of network energy, by choosing the cluster head among the nodes based on the remaining energy, a more effective routing method may be achieved. This method increases the number of active nodes in the network and lengthens the period during which the network is stable before the first node fails. As a result, the packet transmission ratio is increased, enabling the base station to monitor, sense, and deliver more environmental events. The simulation's findings show that network performance has increased in terms of measures like lifetime, packets sent to BS, and energy consumption. The proposed ZSGHCP algorithm has been observed and compared to two distinct protocols, EZ-SEP and M-GSE, with ZSGHCP displaying higher performance by cutting average power consumption by 34% and reducing the number of dead nodes by 48%.

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