Productive Energy Consumption for Cluster Selection in WSN using Modified LEACH-Based Routing Scheme

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Abstract.
Wireless Sensor Networks assist in maintaining reports regarding of different forms of natural variables such as temperature, dampness, and so forth, and then to transfer those circumstances in the form of voltage transmission to a central location. The Little Energy Adaptive Clustering Hierarchy has a difficulty with the number of groups that it can produce while using limited power. The presence of numerous of groups in every round causes disruption to the WSN structure. New LEACH is presented in this study in order to provide a longer lifespan and more efficient energy on the design of wireless sensor networks. In New LEACH, the Ground Station is in charge of selecting the centroids, and it takes into consideration the additional power of every group. This may ensure a set clustering algorithm are produced on each cycle, which can be guaranteed. Furthermore, this functionality even has the potential to lessen the strain on power consumption of every unit, resulting in a lifespan system that is superior than LEACH. Furthermore, the distribution network is more flatly connected to the feature assessment than the previous irregular topology on LEACH, which is a significant improvement. The Enhanced LEACH method for Cluster Head (CH) identification is the primary subject of this paper. Compared to the previous LEACH scenario, the new LEACH computation has much superior efficiency based on the Quality of Service (QoS) metrics of active unit, longevity, power usage (throughput), and effective power.

Keywords. Wireless Sensor Networks; LEACH; Quality of Service (QoS); Cluster selection; efficient energy

1. INTRODUCTION

A wireless sensor network (WSN) is made up of a collection of little, inconspicuous detectors. A sensor is composed of many components, including a central processor, a power component, and components for wireless transmission. Sensor devices are in responsible for supervising the surroundings, recording the physical status of objects, and transmitting gathered information to ground stations [1, 2, 3, 4, 5, 6]. The domain of danger and natural catastrophe identification is where WSN activation is taking place. Among some other issues, it is used to aid in the detection of disasters, quakes, storms, and collapses, among some other factors. One kind of application is the early identification of disasters, wherein sensor networks may be constructed and linked to specific equipment that really can monitor displacements, which signals the presence of seismic events. So that it can broadcast data to the community as rapidly as possible and also that managing damages ground shaking and injuries may be minimized to the greatest extent feasible [2].

Efficiencies in the sensor node (SN) have been studied in the context of a connection that becomes unreliable once the first sensor node (SN) fails [3]. Keep in mind that SN had minimum space, a short lifetime, and computational restrictions. As a result, a major difficulty emerges, such as how to control power usage and memory at units which have low capabilities but superior efficiency. Despite the fact that the WSN software has expanded the capacity just on detector in order to assure long - lasting battery, the device still need a connection that spends energy more effectively.

Integrating energy consumption into computerized broadband network is one straightforward approach to comprehend connectivity in computerized system architecture. Nodes in the WSN have limitations such as short battery life, which necessitates the changing of batteries on a frequent basis, contributing to economic growth and complication. Modifications to the battery may regulate the functioning of the WSN node, however the capacity, expense, and mass of the battery will all rise dramatically as a consequence. Techniques for increasing the battery life of sensor nodes (SN) that are energy efficient have been extensively researched.

The duration of SN, on the other hand, is strictly restricted. Despite the fact that this approach extends the program life and reduces the amount of time required to replace the WSN batteries, the connection still needs additional power. Other factors to take into account at WSN include growth requirements, high availability, environmental situation, and so on. This would be used to cross reference different WSN techniques or protocol implementations. Despite the fact that hygrometers are very significant in a variety of facets of our everyday routines, SN's shortage of power sources is a fundamental limitation that causes the process to be slowed.

The navigation arrangement is dependent on its most common constellation at the present in the WSN, which would be the Low-Energy Adaptive Clustering Hierarchy (LEACH). This really is due to the fact that LEACH has been shown to be an energy-efficient networking technology. This routing method is quite efficient when it comes to transmitting data to the Base Station (BS) [4]. This protocol may be used to gather data and transfer it to BS via one or more-unit clusters, depending on the situation.

There seem to be numerous varieties of LEACH which have been updated by running groupings of units to enhance energy consumption, and these variations are listed below. [5] presented a rise in strength LEACH-C, which stands for Low Energy Adaptive Clustering Hierarchy-Central Construction, as a result of the study conducted (LEACH-CC). This approach, which converts the distance of units into cluster formation, may be used to optimize the dispersion of system power allocation. When contrasted to its comparison, the findings reveal that LEACH-CC may increase the longevity of a system significantly.

Analytical and numerical studies are used to monitor the effectiveness of the assessment process and structure presented. A network that lasts a lifetime, organized in an adaptable and power manner. This method is being used to maintain energy equilibrium and to prolong the life of a connection. Power and maturity level systems are among the testing should be done on the most essential criteria in the world of wireless sensor networks. According to the comparative and assessment of current methods, CH-leach results in a decrease in energy usage during LEACH and DEEC.

Innovative LEACH based routing approaches, which are modeled that use the NS-2 simulation system, are the focus of this study, which also explains them. While choosing the Cluster Head (CH) in the Modern LEACH proposed method, the conversion efficiency of every node is taken into consideration. As a result, avoid introducing reduced connections into CH. Additionally, it seeks to increase the lifetime and boost the effectiveness of sensor nodes. Because of this, a new LEACH pathway predicated on LEACH-based renewable energy was developed to disseminate all network devices that were spread to the standard of and across the Ground Station. After which, by going to compare LEACH as well as New LEACH on Entire life, Power Efficiency, Bandwidth, and information obtained at BS, it was determined which was superior.

2. Related Study

When it comes to wireless sensor networks, the low-energy adaptive clustering hierarchy (LEACH) is a navigation system that is suggested to effectively control the energy utilization (WSNs). The receive additional in this method [6] are organized into clusters, as well as the group leaders are selected randomly by the sensor devices. Sensor hubs in every group broadcast information automatically to the cluster formation, eliminating the need for any intermediate processing. Cluster heads collect information and relay it to the ground station. Because the network nodes are randomly chosen, the power dissipation is distributed equally across all sensor network in this configuration. Unfortunately, since the spacing here between recently appointed neighboring nodes and core network may not even be appropriate in large size WSNs, this approach results in a disproportionately higher energy usage in these networks. LEACH algorithm with predictable cluster formation based on the required range among all detector cluster members seems to waste fewer power than randomized cluster formation, at least based on intuition. Despite the fact that this strategy extends the lifetime of the WSN, it is operationally expensive when used to huge WSNs. Using the cluster formation metric, we are able to choose the cluster center in our study. We detect a considerable decrease in energy use while using the LEACH protocol, despite the fact that the methodology has less skill required. They also demonstrate that predictable choosing of member nodes depending on the proximity centrality metric outperforms random assortment in terms of the lifespan of WSN. Since their extensive usage in medical services, environment tracing, emergency preparedness, farming, surveillance regions, and flame locating, among other application scenarios, wireless sensor networks (WSNs) have drawn a great deal of interest. It is necessary to enhance the lifespan of WSNs in order to expand their usage in a wider range of applications. Grouping with the ideal cluster head is among the most successful strategies for extending the lifespan of a network's connections (CH). In this paper, the author presents an optimization algorithm (PSO) approach application of fuzzy logic (FL) low-energy adaptive clustering hierarchy (LEACH) approach [7]. Group creation is accomplished via the use of a combination PSO as well as a K-means grouping method. FL is used to choose the principal CH (PCH) and secondary CH (SCH) from a pool of candidates. Comprehensive computations were carried out with the help of a computer simulation in order to verify the effectiveness of the patterns. Also considered were standard techniques including fuzzy c-means (FCM) grouping and FLS-based Systematic sampling to ensure the sustainability of WSNs for atmospheric remote monitoring, the LEACH-Fuzzy grouping procedure, and LEACH depending on the power expenditure equilibrium. The findings revealed that the suggested protocol successfully controls power usage in order to increase wireless communication efficiency while simultaneously maximizing bandwidth. In the simulations, network lifespan was increased by more than 46 percent, and assignment consists was increased by 17.6 percent, according to the findings. Due to the concern that the small sampling of LEACH Reactive Routing cluster heads in a wireless sensor network (WSN) will result in the limited lifespan of hubs and the connectivity, an e-leach method based on power betterment is suggested in paper [8], which maximizes the hierarchical clustering stage by taking into account all power as well as length variables, and exposes the approximate value of node remaining energy, as well as the length among hubs and ground station as parameterization towards the criterion in the cluster head selection stage. An entirely new threshold judgement formula is developed, and also the cluster head network is chosen in accordance with it, such that the network that is closest to the ground station, has the most transmission power and the least regarding power transfer is much more likely to be chosen as the cluster head. The modeling findings demonstrate that the e-leach method may increase the lifespan of a connection and its nodes while also providing enhanced results. The Internet of Things (IoT) is a popular term in advanced technologies, and it is expected to turn actual objects become artificially intelligent things. In order to be successful, the Internet of Things must encourage Gadget diversity, Manageability, Analysis of big data interaction through presence cordless smart sensors, Energy-efficient remedies, Segmentation as well as monitoring skills, Personality skills, Mechanism for dealing and database administration, and Ingrained user privacy retaining processes. Grouping is critical in the Internet of Things design, since it allows for the creation of cooperative, cross, and complex interaction amongst disparate items, which is vital for the Internet of Things. This paper is focused on creating an adequate way of communicating amongst identical gadgets via an agglomerative clustering technique, as well as on how effectively groups may be established in a mobility and adaptive uniform wireless connection [9]. ACHs-LEACH method is an alteration to the widely used wireless communication routing protocols, LEACH and Modified-LEACH(M-LEACH), which outperformed the original protocols in terms of power consumption, bandwidth, network congestion, packet transmission, and other performance indicators (e.g., packet delivery ratio). Research is concentrated on choosing the Cluster-Head(CH) and Assistant Clustering Heads(ACHs) in order to lower the show's power consumption and hence extend the network's lifespan. They also attempted to integrate the removal of rogue sites, which might also pose a threat to the protection of information, as well as the re-clustering of the whole connection when a mobile node moved into some other group. A novel strategy is proposed in [10], in which the author suggests a new method for improving the lifespan and data transmission time of wireless sensor networks (WSNs) by minimizing the package delay time [11] [12]. In the next section, we compare the simulation performance of the proposed method with those of the basic LEACH protocol with fixed parameters.

3. METHODOLOGY

Creation takes place in stages. The LEACH technique is divided into two major phases, which are the steady-phase and the setup-phase. The setup phase is the period of time during which groups are formed on the network. From the definition of a group head node through the connection of non-CH nodes to every cluster head, everything is automated. Some computations are used to determine the location of the cluster head[13]. After every criterion has been computed, a simple random sample between 0 and 1 is assigned to the node. As a result of the criterion computation, two parameters are produced. When the node that was picked to become the leader of the group in the earlier round would be granted a criterion with a score of 0, the node is considered successful. As soon as an unit has not really been picked as the neighboring nodes in the earlier cycle, the criterion assessment is conducted in accordance with a predetermined formula. Then there will be a rule that applies if the sum of different numbers is within a certain target value. When the number of nodes is fewer than that of the criterion, the cluster head serves as the node for the round. If it is greater than the criterion, the nodes are considered to be the associated component [14] [15]. The implementation stage is the continuous, wherein the high bandwidth process is performed, spanning from moving information in the group to the Ground Station through CH, as seen in Figure 1. Figure 1 depicts the LEACH method procedure during group establishment.

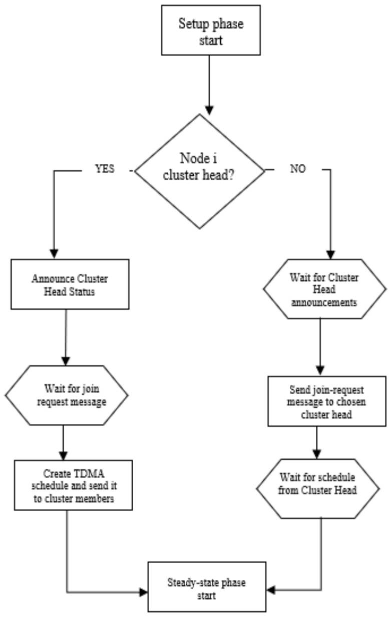

Figure 1: Algorithm for the Setup Phase

The initial stage is the choosing of the sensor nodes. This pick is based on a number of different criteria. It is necessary to identify the required group amount (k) during first phase, where k is an essential input. The very next step is to figure out what the criterion is for another individual node. The criterion (Pi(t)) provided in equation (1) is used to calculate the calculator to determine:

$$P_i(t) = \begin{cases} \dfrac{k}{N - k + (r \bmod \frac{N}{k})} & : \ C_i(t) = 1 \\ 0 & : C_i(t) = 0 \end{cases} \qquad (1)$$

Inside the cutoff computation in equation (1), there seem to be two types of target value to consider. The formula for the first output value is derived from the condition $C_i(t) = 1$. This feature ensures that now the unit has never been a group leader in the $(r \, mod \, \frac{N}{k})$ previous session or round. While r denotes the amount of meetings which have been previously conducted, N represents the total number of sites, and k denotes the required clustering results. While $C_i(t) = 0$ is the second/last best approximation inside the formula, $C_i(t) = 1$ is the first output value (1). As a result, every node serves as the cluster head once every N / k rounds.

To choose the cluster head to use the minimum option in equation (1), the group membership or site placed on the system should be aware that perhaps the CH is a site in round or round-robin phase of the algorithm. A warning demand is distinguished from other requests by including the ID of the demand as well as a headers even by site that would be the cluster head inside the response sent from the unit that would be the cluster head. Each non-CH node identifies its own group by picking the CH that requires the least amount of telecommunication power, which is determined either by transmit power obtained by transmitting letters to all of the CH that are nearest to that site.

As far as the node construction process and CH choice and group members are concerned, they are in stable state (CM). Whenever an unit transmits information from the CM towards the CH, the cluster head determines the amount of information to be delivered to the node based on the slot that has been allocated. Because the length of every high bandwidth session for every site is fixed, the total time related to information communication is determined by the amount of nodes in the network of clusters, which is a constant. It is necessary for the CH to remain operational at all times during the steady phase in order for information from the CM to be saved in the groupings.

Whereas if transport length and information recipient are both included in bundle one, then perhaps the quantity of electricity used to transfer data may be determined using the equation (2):

$$E_{Tx}(l,d) = E_{Tx-elec}(l) + E_{Tx-amp}(l,d) = \begin{cases} lE_{elec} + l_{\epsilon fs}d^2, & d < d_0 \\ lE_{elec} + l_{\epsilon fs}d^4, & d \geq d_0 \end{cases} \qquad (2)$$

In addition, the following equation (3) describes the energy allowed to obtain information:

$$E_{Rx}(x) = E_{Rx-elec}(l) = lE_{elec} \qquad (3)$$

For the purposes of these equations, E_{elec} in equations (2) and (3) means that the power consumed by communication systems to function loops, so although E_{amp} represents the power consumption by communication systems to enhance data signal so that transmissions arriving just at recipient even now reach the basic significance which restricts the recognition of data transmissions to the listener, which is referred to as distance between transmitter and receiver [14].

NS-2 computations of the LEACH and Modern LEACH procedures with a variety of settings will be discussed in detail in the next section.

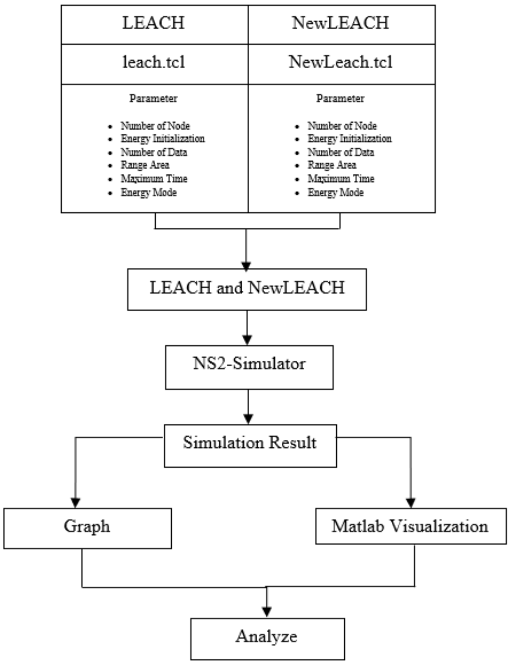

Figure 2: The LEACH and Modern LEACH designs were created utilizing a variety of factors.

a. New LEACH Protocol Algorithm

The Modern LEACH protocol, that we suggest in this research and which improves on the efficiency of the LEACH protocol, is the name of the procedure we offer in this research. The LEACH protocol, which is built on the dispersed group key method, has a range of benefits. However, this procedure doesn't really give an ideal situation for the number and location of sensor nodes. Since the group is adaptable, wherein adaptable refers to the ability to easily modify (oneself) to certain surroundings. As a result, the establishment of grouping that is just not ideal as during initialization stage has little impact on the overall performance of a connection. A central management technique for gathering a large number, on the other hand, will generate groups with uniformly dispersed head clusters throughout the network if the approach is used. This is the foundation of the New LEACH, which makes use of a centralized classification model which have the same target sequences as the LEACH protocol as its predecessor.

The Modern LEACH technique is used to pick centroids, and it is used to make this decision. During in the Modern LEACH configuration stage, every device broadcasts towards the BS data about its geolocation and metabolic rate levels. Whether there are any sites that were below energy, BS guarantees that now the power burdens are spread evenly across all sites by computing the average physical and neurological and identifying whether there are any nodes with above-average power generation. This is done in order to identify units that have the potential to be cluster chiefs. When data is sent to the cluster head from a site besides the source node, this approach ensures that the quantity of electricity used by the unit besides the network model is kept to a minimum.

A situation exists if the central server and circuit consisting both connect; in this case, the BS transmits a communication with the cluster formation ID for every node on the network. In contrast, if the cluster members ID doesn't really equal, the unit will identify the TDMA slot for information transfer and afterwards the unit will rest until it becomes time to transmit information itself.
The variables that were utilized to compute the power estimation equation from the circuit were as follows: New LEACH NL(ni) power estimate for cluster head selection is represented by Equation (4):

$$NL(n_i) = (1-\alpha) + \frac{\sum_0^j NL(n_j)}{d_{out}^{ji}} / \sum_{k\in NH} d_{out}^{jk} * CO(n_j) * \alpha \quad (4)$$

The vote is based on eqn (4), where NL is the neighboring group again for k. The electorate is based on equation (4).
The remaining part of an unit is not taken into consideration by the LEACH protocol for picking a cluster head. It may enable units with extremely little power to be become cluster leaders, as well as early failures from groups that can have a negative impact on the longevity of the whole connection. Furthermore, since the LEACH protocol doesn't really take into account excellent sites when selecting a cluster head, some problematic nodes may be promoted to cluster heads, causing distorted data to be gathered or inaccurate statements to be sent.
By using the novel approach in LEACH, while selecting cluster heads, we take into account the power of the node, so eliminating the reduced node from becoming a cluster head among two adjacent groups. The following is the procedure for the novel LEACH routing scheme, as seen in Figure 3:

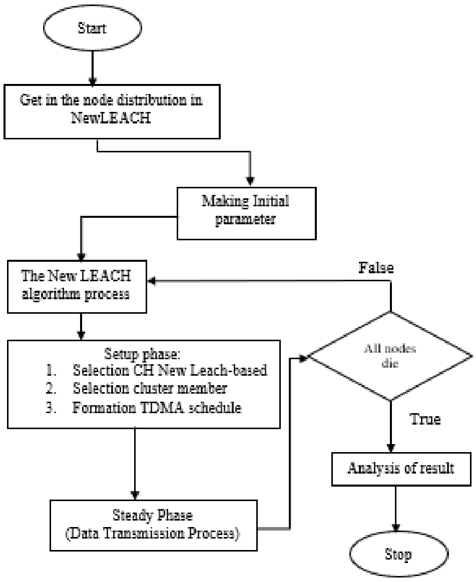

Figure 3: An illustration of the Modern LEACH networking system's diagram

As shown in equation (4), the Modern LEACH comprises the separation distance towards the BS, the length among sites to every node in the network, the computation of the minimal expenditure from the Modern LEACH energy, and doesn't even include CH as it did in the preceding stage. This will save money and effort since it will exclude sites which does not match the standards to be CH from the beginning and priorities the sites which are most eligible to be CH.
We think that the quantity of n elements has indeed been dispersed throughout the M x M network's geographical region. The position of the Ground Station serves as the channel's core hub. The following is the outcome of the modeling:

a. The connections are all chosen at random.
b. All terminals are identical in that they all begin with the same amount of energy.
c. All stations get the capability of receiving and transmitting data in both directions.
d. If stations' energy reserves are depleted, they are no longer functional in the connection.

4. RESULTS AND DISCUSSIONS

a) Network Simulation Parameters

In the next experiments, we utilize the same values for beginning energy that we used in the recent techniques. The settings for the experiment are set up as given in Table 1.

Parameter Name	Value
Initial Energy	2 J
Area of simulation	1000*1000 m^2
Number of Node	100
Packet Size	2000 bits
RSSI Threshold	-60dbm
Simulation Time in Round	3600

Table 1: Variables for the Simulation

b) Simulation result and comparison

The number of living nodes vs the number of rounds is such statistic that used study circuit longevity. The dependability of a fantastic technique, notably LEACH and Modern LEACH, is assessed by comparing the amount of people who are living vs the amount of deaths in a round. Every season's observations showed how much power the component has left in it, based on the quantity of power it has left. The assessment of the variety of living nodes versus cycle would've been carried out using the situation depending on the position of the Ground Station in the cable network core. The arrangement of the connections is purely unpredictable. The following chart displays the relationship between the number of nodes active as well as the amount of each round identified BS in a mobile nodes topology:

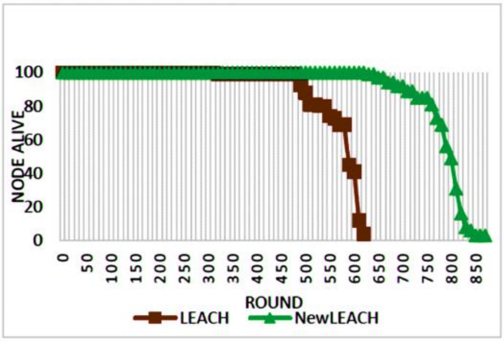

Figure 4: Among LEACH and Modern LEACH, there is an active node.

Based on the chart in Figure 4, we may infer that now the Modern LEACH versus round against technique performed best than just the LEACH algorithm in terms of total quantity of living nodes, with the triangular shape just on network performing better than just the standard size.

The findings of the subsequent experiments include the average lifespan, power consumption, productivity, and effective power of every test plus the number of groups used in the test.

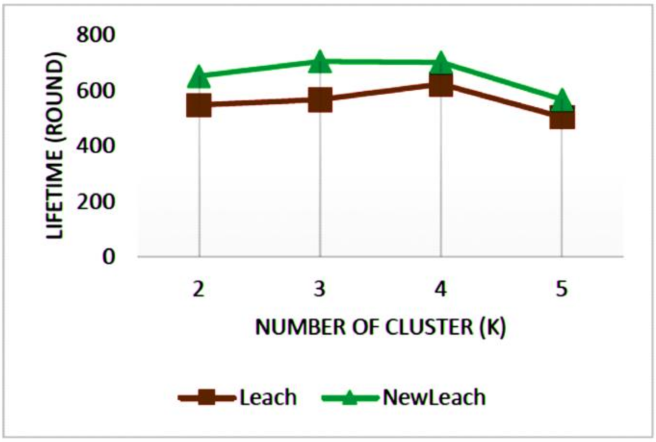

Figure 5: LEACH and Modern LEACH have a long shelf life.

Based on Figure 5, it could be inferred that now the Modern LEACH method outperforms the LEACH method in terms of lifespan vs the number of nodes. The triangular form from the network usually appears higher on the network than that of the standard size of the number of nodes that are currently present.

Diagram of power consumption for LEACH and Modern LEACH is shown in Figure 6.

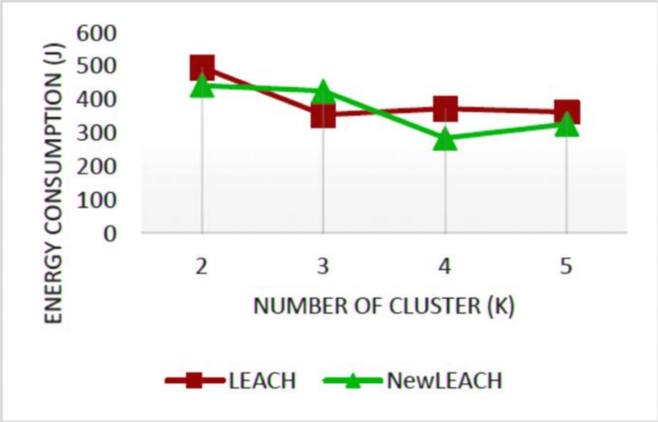

Figure 6: LEACH and Modern LEACH both use a burst of power.

The power consumption shown by the pyramid form of the chart is not certainly lower than that of the power consumption shown by the standard size of the chart for every number of clusters. In cluster 3, overall power consumption for Modern LEACH has increased at a faster rate than that of the demand for LEACH. When the number of nodes is increased to three, the range between the CHs in every one of the three clusters is longer than the length between the CHs and the BS in the original procedure. This results in a significant increase in energy usage since topology is used in an ad-hoc manner.

For LEACH and Modern LEACH, a chart of performance is shown in Figure 7.

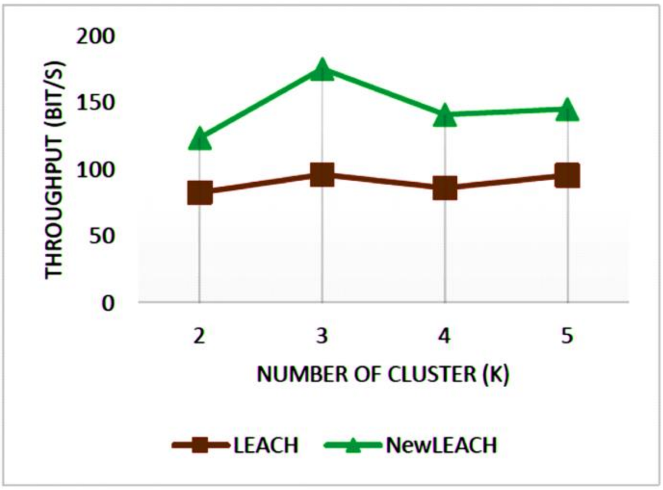

Figure 7: LEACH and Modern LEACH both have high output.

When it comes to performance, the pyramid form from of the data transmission graph seems to be superior than that of the standard size. Interestingly, this really is the identical information that was previously obtained for cluster 3 in Modern LEACH.

Diagram of Effective Power for LEACH and Modern LEACH: Figure 8 shows the relationship between these two variables.

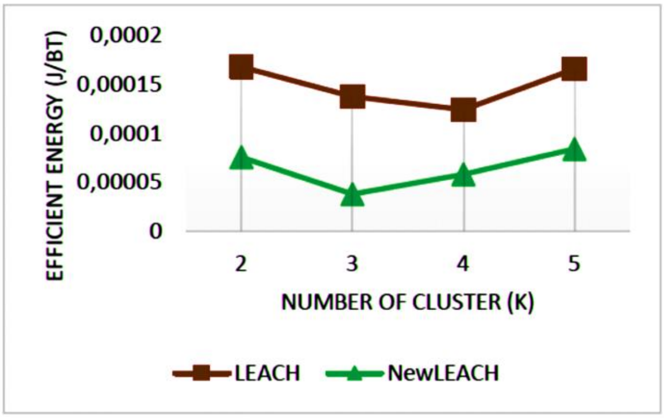

Figure 8: Efficiencies in LEACH energy production and the introduction of new LEACH technologies

Based on Figure 8, it could be stated that now the Modern LEACH technique outperforms the LEACH method in terms of lifespan vs the number of nodes generated. In terms of Effective Power, its high efficiency in this area demonstrates that the Modern LEACH technique is significantly more effective than the LEACH methodology based just on BS position on topology selected at random.

5. CONCLUSION AND FUTURE SCOPE

Our suggested system, which uses the Modern LEACH technique, outperforms the LEACH method in terms of various Quality of Service metrics: alive unit, lifespan, power consumption, capacity, and sustainable power use. The choosing of the cluster head is very important in the process of achieving the cheapest power for WSN. Also when picking a CH, our proposal takes into account the remaining energy of each node, which prevents nodes with low energy from becoming CH and instead chooses the network with the maximum energy from across all nodes in each cluster.In the future, if a high number of sensor nodes is reached, the protocol may be applied in the real world, allowing the results achieved to be maximized in accordance with the outcomes of the model. We also want to use simulation to test the effectiveness of our approaches in large-scale settings.

6. REFERENCES

[1] M. Assim and A. Al-Omary, "Design and Implementation of Smart Home using WSN and IoT Technologies," 2020 International Conference on Innovation and Intelligence for Informatics, Computing and Technologies (3ICT), 2020, pp. 1-6, doi: 10.1109/3ICT51146.2020.9311966.

[2] S. Umbreen, D. Shehzad, N. Shafi, B. Khan and U. Habib, "An Energy-Efficient Mobility-Based Cluster Head Selection for Lifetime Enhancement of Wireless Sensor Networks," in IEEE Access, vol. 8, pp. 207779-207793, 2020, doi: 10.1109/ACCESS.2020.3038031.

[3] J. Ren, H. Zhang, X. Liu and Y. Qin, "Energy Efficiency-centric Channel Selecting in Energy Harvesting Cognitive Radio Sensor Network," 2019 IEEE 4th Advanced Information Technology, Electronic and Automation Control Conference (IAEAC), 2019, pp. 2736-2739, doi: 10.1109/IAEAC47372.2019.8997673.

[4] N. Us Sama, K. Bt Zen, A. Ur Rahman, B. BiBi, A. Ur Rahman and I. A. Chesti, "Energy Efficient Least Edge Computation LEACH in Wireless sensor network," 2020 2nd International Conference on Computer and Information Sciences (ICCIS), 2020, pp. 1-6, doi: 10.1109/ICCIS49240.2020.9257649.

[5] MA, Zhen-Fu; LI, Guang-Ming (). [WORLD SCIENTIFIC 2016 International Conference on Artificial Intelligence Science and Technology (AIST2016) - Shanghai,China (15 – 17 July 2016)] Artificial Intelligence Science and Technology - Improvement on LEACH-C Protocol for Wireless Sensor Network. , (), 362–368. doi:10.1142/9789813206823_0048

[6] V. Aditya, S. Dhuli, P. L. Sashrika, K. K. Shivani and T. Jayanth, "Closeness Centrality Based Cluster Head Selection Algorithm for Large Scale WSNs," 2020 12th International Conference on Computational Intelligence and Communication Networks (CICN), 2020, pp. 107-111, doi: 10.1109/CICN49253.2020.9242639.

[7] M. Gamal, N. E. Mekky, H. H. Soliman and N. A. Hikal, "Enhancing the Lifetime of Wireless Sensor Networks Using Fuzzy Logic LEACH Technique-based Particle Swarm Optimization," in IEEE Access, doi: 10.1109/ACCESS.2022.3163254.

[8] M. Yuan, "Simulation and Analysis of Clustering Routing Protocol Based on Improved LEACH," 2020 IEEE International Conference on Power, Intelligent Computing and Systems (ICPICS), 2020, pp. 922-925, doi: 10.1109/ICPICS50287.2020.9201981.

[9] N. Kumar, J. R. Desai and D. Annapurna, "ACHs-LEACH: Efficient and Enhanced LEACH protocol for Wireless Sensor Networks," 2020 IEEE International Conference on Electronics, Computing and Communication Technologies (CONECCT), 2020, pp. 1-6, doi: 10.1109/CONECCT50063.2020.9198666.

[10] S. Nasr and M. Quwaider, "LEACH Protocol Enhancement for Increasing WSN Lifetime," 2020 11th International Conference on Information and Communication Systems (ICICS), 2020, pp. 102-107, doi: 10.1109/ICICS49469.2020.239542.

[11] R, Thandaiah Prabu and M, Benisha and V, Thulasi Bai, Design of Wearable Antenna in Wireless Body Area Network (July 31, 2019). Proceedings of International Conference on Recent Trends in Computing, Communication & Networking Technologies (ICRTCCNT) 2019, DOI: http://dx.doi.org/10.2139/ssrn.3429752.

[12] Prabu RT, Benisha M, Bai VT. Characteristics of Alpha/Numeric Shape Microstrip Patch Antenna for Multiband Applications. InInternational Conference on Intelligent Systems Design and Applications 2018 Dec 6 (pp. 880-895). Springer, Cham.

[13] M. Benisha et al., "Design of Wearable Device for Child Safety," 2021 Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV), 2021, pp. 1076-1080, doi: 10.1109/ICICV50876.2021.9388592.

[14] Anitha, G. A Performance Analysis on Social Based Routing Protocols for Mobile Sensing Networks. Turkish Journal of Physiotherapy and Rehabilitation, 32(2), 3515-3522.

[15] Bai VT, Srivatsa SK. Wireless Tele Care System for Intensive care Unit of Hospitals using Bluetooth and Embedded Technology. Information Technology Journal. 2006;5(6):1106-12.