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Network Lifetime and Energy Management Analysis in Heterogeneous Wireless Sensor Network

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***Abstract*— Heterogeneous WSNs is consist of the nodes that have the different ability to perform or we can say the different sensing power. The main thing that makes it heterogeneous is the different power provided to the nodes. These nodes sense the physical condition data and sent it to the BS through the CHs. So, the main concern in the WSNs is the energy consumption of the nodes while transmitting the data to the CHs. As we know they have very limited power, so we have to maintain the clustering in such a way that there is a maximum number of transmissions will be done by the node and the lifetime of the node will be maximized. There are many clustering algorithms like LEACH, AODV, etc. So many works are already there to improving these protocols to obtain the better result of a lifetime and the energy wastage of the nodes. In this proposed work, we are improving the traditional LEACH protocol for clustering. The algorithm for selection of the CHs, and their connection between the normal and advance node to transmitted the data to the BS. This will improve the Lifetime of the networks in this proposed work.**

Keywords*— *WSNs; Energy Dissipation and Wastages; CHs; T-LEACH; I-LEACH; BS; Sink;

I. INTRODUCTION

In the present world, the WSNs has become the most popular technology in which there are many sensor nodes that are aggregating and compassing the collected data to the base station via the cluster heads [1][2]. These nodes are collecting the physical data like heat, temperature, humidity, etc. to the receiver like the base station. These all nodes are small pricing easily operable and the limited power sensor nodes [2][3]. So, they are completely different from the other wireless networks. The major concern of WSN is the Lifetime which is maintained and improved in this work. To obtain a high network lifetime of wireless sensor networks while considering the main task of the node: capturing, sending of data to cluster heads and processing, the energy during the transmission should be saved.

The sending of data during the transmission consumes more energy which depends upon the distance between the cluster heads and the size of packets. Therefore, in many cases, the lifetime of sensor nodes will be over when the power ends. So, there are many algorithms and the protocols were proposed to overcome this issue and make the nodes more effective in terms of their lifetime and energy consumption and wastage [6]. Many of these protocols were proposed to reduce the communication overhead through the multi-hopping from the source node to the cluster heads and then to the base station. Whereas other proposed the work on improving the routing algorithm. The main is the optimal selection of cluster heads in such a way that it will have a minimum distance to all other normal sensor nodes [6]. If the distance between the nodes and cluster head is minimum, then the energy consumption to transmit the data will be very low which tends to the high network lifetime. The objective of this proposed work is to compare the tradition LEACH and the improved LEACH [7]. The clustering algorithm is modified and improved to get a better energy efficient algorithm in such a way that there should be minimal use of energy in each transmission of data which increases the network lifetime.

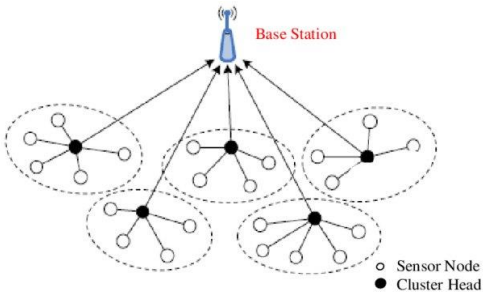

Fig 1. WSN Architecture

II. METHODOLOGY

In order to manage and analyze the lifetime and energy consumptions in WSN the simulation of some nodes is plotted in a certain area with limited power and the amplification power to transmitted data to the CHs and then to the base station. As being a heterogenous WSN, each node has a different power of transmission. In each round, the efficiency of the power dissipation was calculated and the analyses in both traditional and the improved LEACH. Energy dissipation and the lifetime of the network is the main component of WSN is improved in this work. The MATLAB environment is there for simulation of the WSN work. The simulation result is generated by running the program and the transmission is done about 4000 times to obtain more accurate results as the first node dead at 750 rounds in traditional LEACH and at 1150 rounds in improved LEACH. And we have increased nearly 300% of network lifetime as compared to the traditional one to the new improved one.

III. WSN CLUSTERING PROTOCOLS

LEACH- Low Adaptive Clustering Hierarchy is the hierarchal protocol which is self-organizing and adaptive

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cluster-based routing protocol for wireless sensor networks which separates the nodes into cluster heads. LEACH was proposed by Wendi B. Heinzelman, et al. LEACH is the protocol in which the normal sensor nodes collect, compress, and aggregates the data to its nearby cluster head. Then the same work is done by the cluster nodes, it also compresses the data that came from nodes and then sent it to the base station. Nodes that have been once clustered cannot be cluster again for R rounds where R is the desired random probability for the election of cluster heads.

R=(p/(1-p*mod(r,round(1/p)))

Where p is the probability 0.1, r is the number of round r=4000;

There are many proposed works and the formulas for selecting the cluster heads.

The mentioned algorithm is for traditional LEACH protocol for clustering. In this proposed work in order to maintain the lifetime of the wireless sensor network, the existing methodology is improved. In the improved LEACH, energy consumption is very low than the traditional one. Hence the network lifetime is also increased.

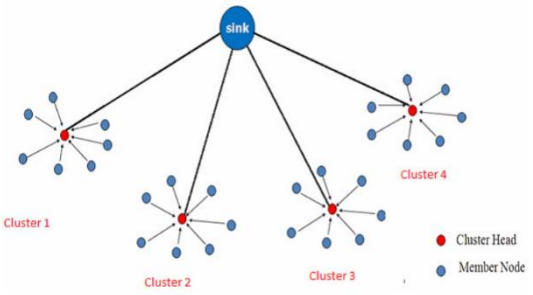

Fig 2. Clustering in WSNs

The selection of the cluster head is determined by the random probabilistic method. In this work the random probabilistic method is slightly changed, the algorithm is modified to get the better result. The new formula for selecting the cluster heads is:

R=(p/(1-p*mod(r,round(1/p))))*(S(i).E/total_energy))

Where p is a random probability, r is a number of rounds, S(i) is the residual energy and total_energy is the total energy of node.

Initially, the value of this variable dead node, advance dead node, cluster head, data sent to the cluster is set to zero. There are hundred alive nodes initially to obtain the better result of the new algorithm, the program is run many iterations. In each iteration, the transmission of data to the cluster head and then to the base station was done. After some rounds, the power of the node will start to finish and then it is called a dead node. The energy dissipation of each node and the cluster node is calculated in order to compare the result from the traditional LEACH and the improved LEACH and then the lifetime of the network will also be analyzed. Energy dissipation is calculated by the formula given below:

S(i). E=S(i). E- (ETX*(4000) + Emp*4000*(min_dis * min_dis * min_dis * min_dis));

Where ETX is transmission energy, min_dis is the minimum distance from the node to cluster head.

IV. SIMULATION RESULT

A. *Simulation Environment*

The deployment of nodes and the implementations are the most important part of work so this work totally is done the simulator. It will help to obtain better results and the performance in terms of different parameters. There are many network simulators for measuring the network performance, but in our work, we used the MATLAB simulation environments it is simple and easy to use with the basic programming concepts.

B. *Hardware Characteristics*

The complete work and the simulation are done in the same machine features as given below:

- Intel Core i5, 2.95 GHz
- RAM 8 GB
- Windows 10 OS 64 bits

C. *Network simulation parameter*

The most important things in the simulation are the number of rounds, number of nodes and the initial energy associated with it. The all simulation parameter is fixed as shown in table 1 below:

Parameter	Values
Network Area(meter)	100x100
Number of Nodes	100
Location of Sink	50,50
Initial Energy	0.5 J
ETX	50 nJ
Eda	5nJ/bit/signal
Efs	10pj/bit/signal
Emp	0.003pj/bit/signal
No. of Round	4000
Routing Protocol	LEACH
P	0.1

Table 1. Simulation parameters

D. *Results*

Fig 3. Shows the plotting of the nodes and the cluster nodes. In each round, the cluster heads are changed. It also shows that how the nodes send data packets to the by cluster head and then the cluster sends data to the base station.

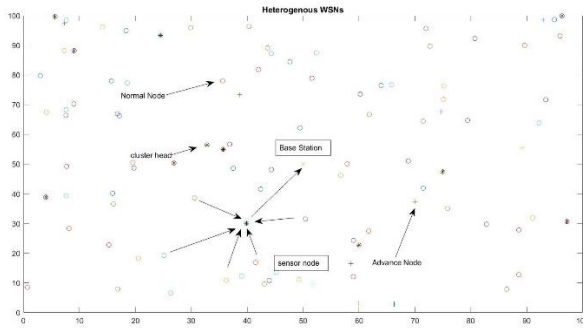

Fig 3. Scattering of nodes

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All 100 nodes are scattered in the area provided; the selection of cluster heads was done accordion to the algorithm an alive.

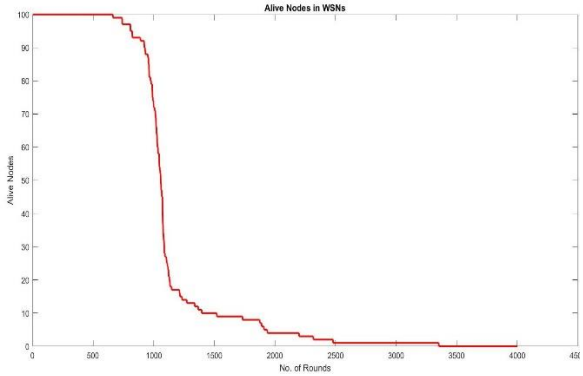

Fig 4. An alive node in Traditional LEACH

In fig 4 the graph of an alive node in traditional LEACH is shown. The iterations were done about 4000 rounds and as we can see the first node was dead at 750 rounds and then so on. In this protocol, the energy of the node gets over quickly so the overall lifetime of the network is less.

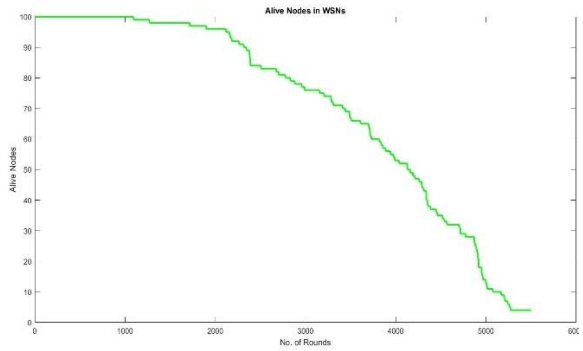

Fig 5. An alive node in Improved LEACH

In fig 5 the graph of an alive node in improved LEACH is shown. The iterations were the same as the traditional LEACH and as we can see the first node was dead at 1100 rounds and then so on. In this protocol, energy consumption by the node in each transmission was less so the lifetime of the network is high.

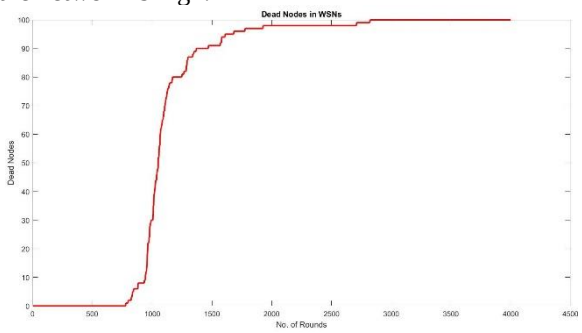

Fig 6. Dead nodes in Traditional LEACH

Fig 6 shows the dead nodes in the traditional LEACH in which the number of the round is the same. The first node dead at 750 rounds of transmission where the last node dead at about 3000 rounds.

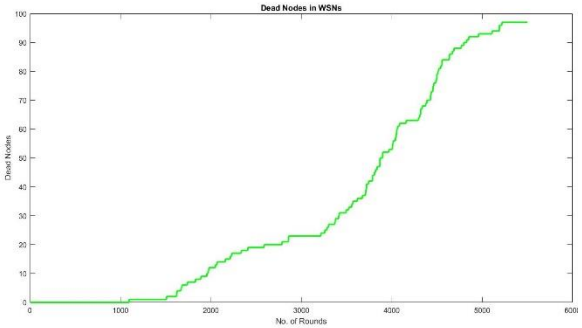

Fig 7. Dead nodes in Improved LEACH

In fig 7 the dead node in the improved LEACH is shown. Where we can clearly see the improvement in the stability of the node. The energy consumption is less and the network lifetime is high than earlier.

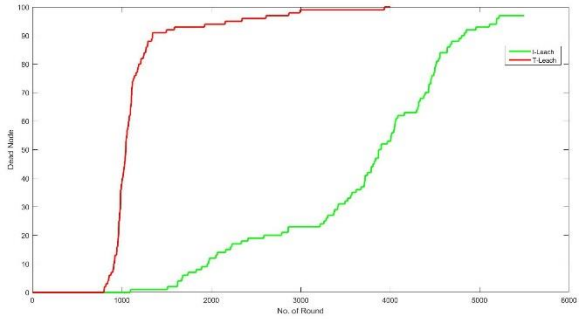

Fig 8. Dead node comparison in T-LEACH and I-LEACH

In fig 8 the comparison graph of the dead node of the T-LEACH and I-LEACH is shown. In which we can say that there is a huge difference in the lifetime of the network. The energy consumptions of nodes in each round of transmission is less than the traditional one. Overall there is a great difference in both the terms of network lifetime in the traditional and the improved work.

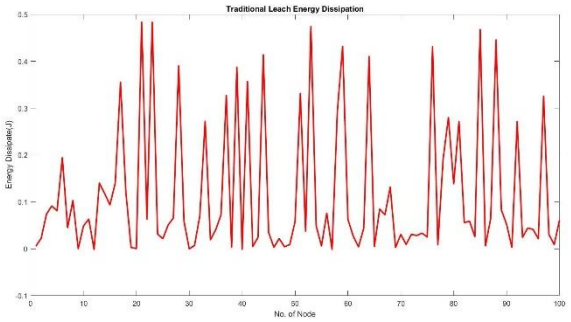

Fig 9. Energy wastage in T-LEACH

In fig 9 the energy wastage of the nodes in traditional leach was shown. Each node has consumed more energy in its transmission of data to the cluster heads. High wastage will lead to less lifetime if the network in WSNs. In traditional protocol the loss is high so in this work, the improvement in energy efficiency is done.

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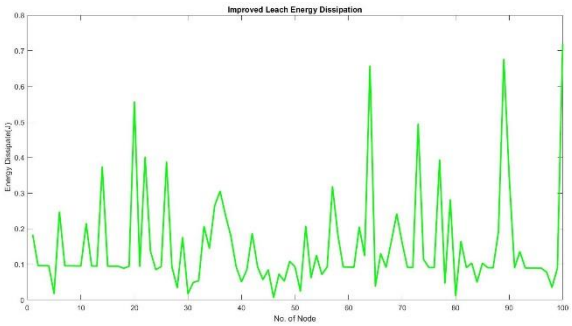

Fig 10. Energy wastage in I-LEACH

Fig 10 shows the energy wastage of nodes in improved leach. The nodes have wasted less amount of energy during the transmission so that the lifetime of the node is high in comparison to the traditional protocol to improved protocol. In this work, we have improved the energy wastage and hence the lifetime of the traditional LEACH.

V. CONCLUSION

In WSN the network lifetime and energy dissipation are the major things in the WSNs. These are simulated and analyzed in MATLAB. The traditional and the improved LEACH are performed and the obtained result was compared. In this proposed work we have obtained a high increased in the network lifetime and there is a great enhancement in the energy dissipations of the nodes to transmit the data to CHs. We gave a brief discussion on the clustering algorithm. And the proposed work in the LEACH tends to minimize the use of energy and the high network lifetime. Hence the lifetime is increased and energy dissipation is minimized in the improved LEACH than the traditional LEACH in the WSNs.

VI. FUTURE WORK

The clustering algorithm for the selection of the CHs and the distance and energy calculation formulas can be further improved in order to get the better result in the use of energy and a better lifetime of the sensor node. The design of the routing protocol can be more enhanced to send data to BS efficiently. The future work can include the greater number of nodes and their mobility and hierarchy of nodes.

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