ENHANCING PERFORMANCE OF HETEROGENEOUS WIRELESS SENSOR NETWORK(WSN)-A MODIFIED APPROACH

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ENHANCING PERFORMANCE OF HETEROGENEOUS WIRELESS SENSOR NETWORK(WSN)-A MODIFIED APPROACH

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Declaration of Authorship

This is to certify that the work done in this thesis book is the outcome of research carried out by the students under the supervision of Dr. Nafiz Imtiaz Bin Hamid,Assistant Professor and Department of Electrical and Electronic Engineering(EEE),Islamic University of Technology(IUT).

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List of Acronyms

WSN	Wireless Sensor Network
QoS	Quality of Service
BS	Base Station
LEACH	Low Energy Adaptive Clustering Hierarchy
EAMMH	Energy Aware Multihop Multipath Hierarchy
PEGASIS	Power Efficient Gathering in Sensor Information Systems
TDMA	Time Division Multiple Access
DEEC	Distributed Energy Efficient Clustering
EDEEC	Enhanced Distributed Energy Efficient Clustering
DDEEC	Developed Distributed Energy-Efficient Clustering
TDEEC	Threshold Distributed Energy efficient Clustering
WBDEEC	Weighted Balance Distributed Energy Efficient Clustering

Acknowledgements

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Abstract

Wireless sensor networks have received considerable attention in recent years. They were initially employed for surveillance by the military. It has now grown into industrial and civilian applications like as weather forecasting, pollution control, traffic control, healthcare, and other sectors. Developing an energy-efficient routing strategy is one of the most difficult challenges in wireless sensor networks. Due to the limited available power of sensor nodes, energy saving is a critical challenge in wireless sensor networks for nodes and network longevity. An application-specific protocol is preferable to layered protocols when dealing with harsh and difficult environments. The primary goal of this study is to provide a way for ensuring more efficient network or data transfer. This study presented a mechanism called as Weighted Balance Energy Efficient Clustering (WBDEEC) to improve network efficiency. MATLAB was used to run the simulations. In terms of factors such as number of living nodes, number of dead nodes, packets to BS transmission, and number of clusterheads at the conclusion of specific rounds, simulation results demonstrate that WBDEEC outperforms LEACH,DEEC,EDEEC, and DDEEC.

Chapter 1

Introduction

1.1 Wireless Sensor Networks

Wireless Sensor Network is a promising technology with a wide range of applications[1]. One critical aspect of a wireless network is that its nodes are unattended, resource constrained, and have an energy limitation[2]. Wireless sensor networks are made up of a slew of tiny self-powered sensing nodes that collect data on any subject. For a certain environment, a wireless sensor network enables knowledge to communicate the acquired data wirelessly to a base station. This base station is also known as the 'sink.' To finish, the sensor nodes must send the aggregated data to the sink[3]. Wireless sensor networks are becoming increasingly popular in applications involving environmental and health monitoring. Wireless sensor network nodes should have low power consumption, as well as a cheap cost and minimal human interaction. Because of advancements in design, portable devices now enable a wide range of critical wireless applications.[21]

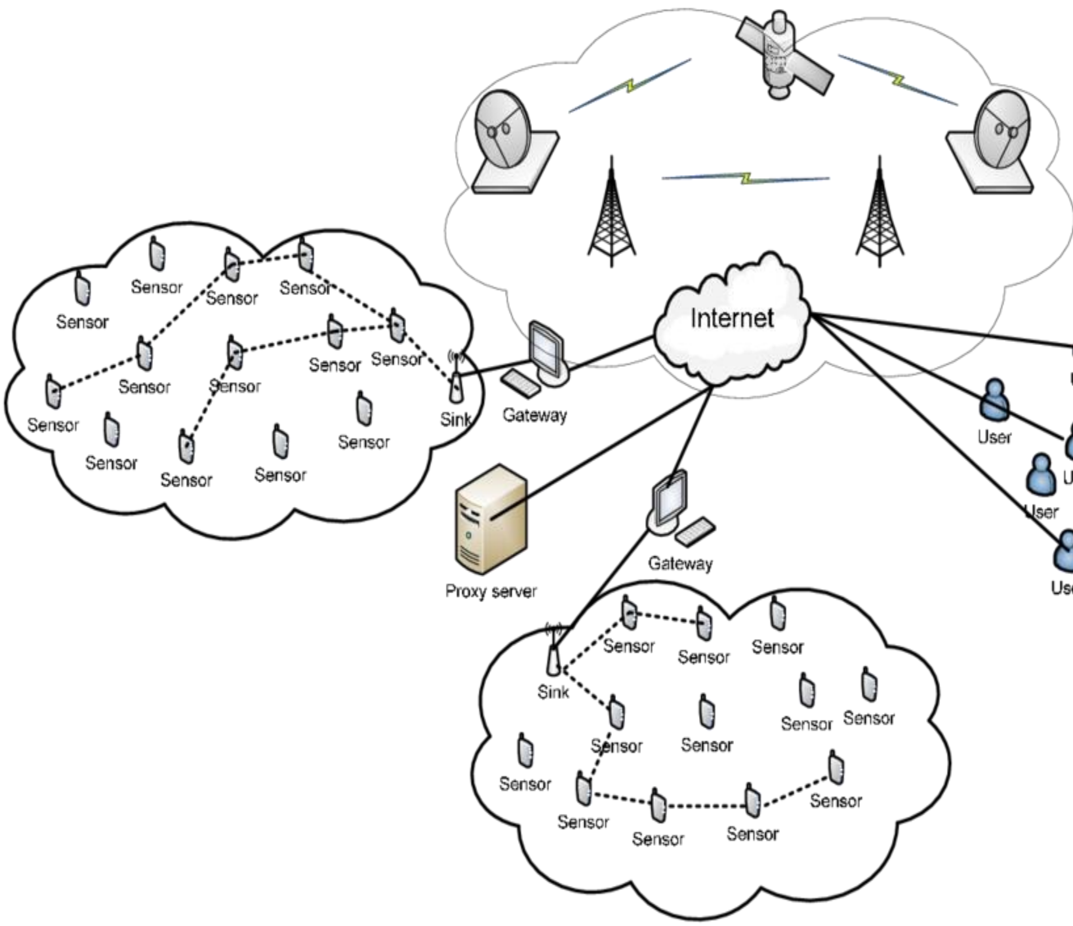

Figure 1.1: Conventional view of WSN[22]

1.2 Wireless Sensor Network Applications

Some major applications of Wireless Sensor Networks are shown in the figure:

Figure 1.2: Application of Wireless Sensor Network[6]

1.3 Objectives of this work

1) Create a network design that is energy efficient.

2) To compare the network lifespan and certain other metrics of DEEC,DDEEC,EDEEC,LEACH with that of WBDEEC suggested in this article.

Chapter 2

Background of the work

2.1 Wireless Sensor Network basics

Wireless sensor network (WSN) is essentially, a set of sensors that are physically scattered and dedicated to tracking the circumstances. Routing protocols are required for transmitting data from one node to another, and unique routing protocols have been suggested on occasion for WSNs. WSNs typically consist of one or more sinks (or base stations) and hundreds of sensor nodes. Sensor nodes may sense physical and system records and document them to the sink by integrating data sensing, computing, and wi-fi communication. In turn, the sink asks the sensor nodes for data.[7]

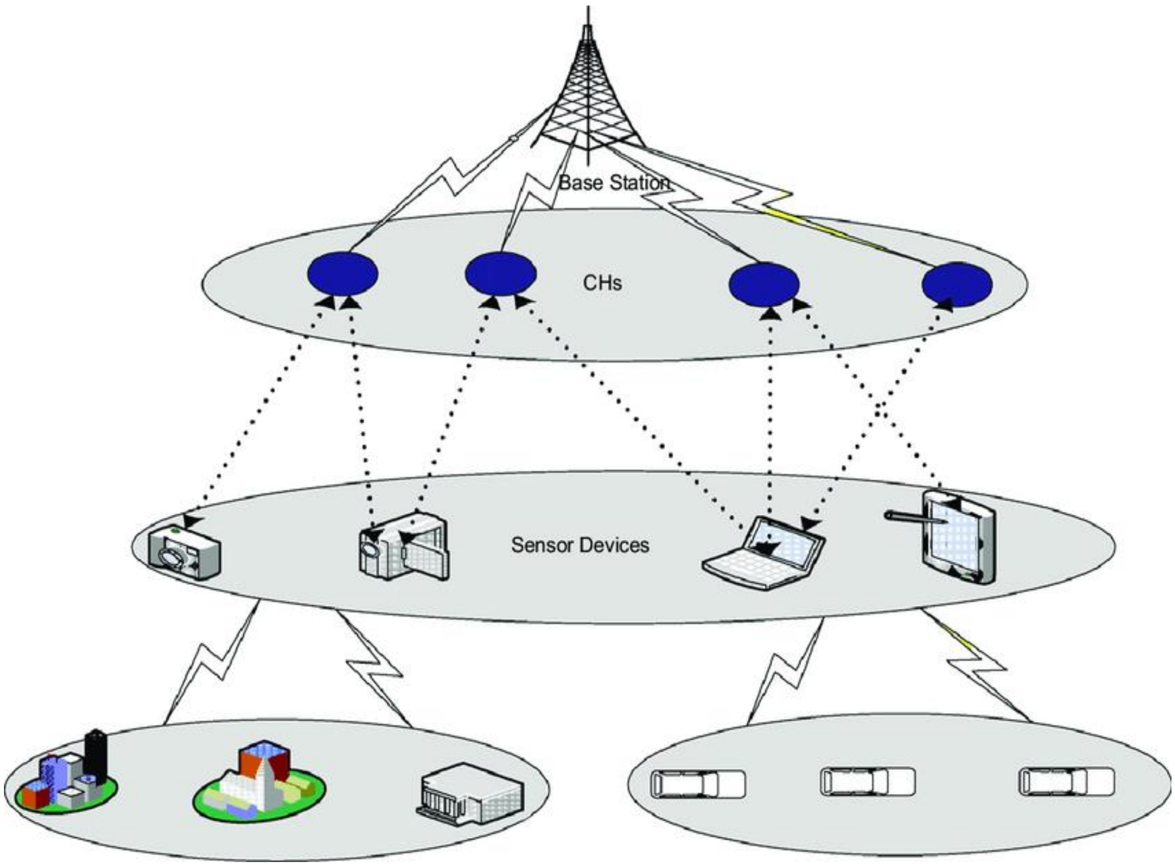

Figure 2.1: General view of WSN[4]

2.2 Wireless Sensor Network Characteristics

Lifetime:

It is one of WSN's most crucial aspects. Sensor nodes in a wireless sensor network are primarily utilized for data transmission and distribution. The shortest routing path, routing protocols, mobility, and other factors can all play a role in extending the life of a wireless network. Any node failure might cause difficulties in the network.

Power consumption:

The word "power consumption" refers to the quantity of energy utilized by sensor nodes. In order to construct a wireless sensor network, researchers are focusing their efforts on WSN power usage. The majority of the research is aimed at reducing the power consumption of wireless sensors used for data transmission. WSN research and development is concentrating on the construction of low-power devices to increase network lifetime in the context of constrained energy supply.[8]

Channel Bandwidth:

The channel bandwidth is an important parameter to consider while designing a wireless network path. Before beginning a data transmission activity, it is critical to determine whether a route can supply adequate bandwidth. Many research papers have acknowledged the drawbacks of identifying routes with the fewest hops.[9]

2.3 Clustering algorithm

Wireless Sensor Networks feature several sensor nodes placed in tough environments to detect, collect, and transmit data to sink. These nodes have minimal power. The clustering approach is extensively used to improve WSN lifespan by reducing packet transmission. In the clustering approach, the nodes chosen as cluster heads spend more energy due to their high overload. The use of wireless sensor networks is increasing day by day, necessitating the use of energy efficient as well as aggregation methods in bigger contexts. An energy-efficient protocol may be obtained by assuring hierarchical routing and electing cluster head for each of the clusters.[10]

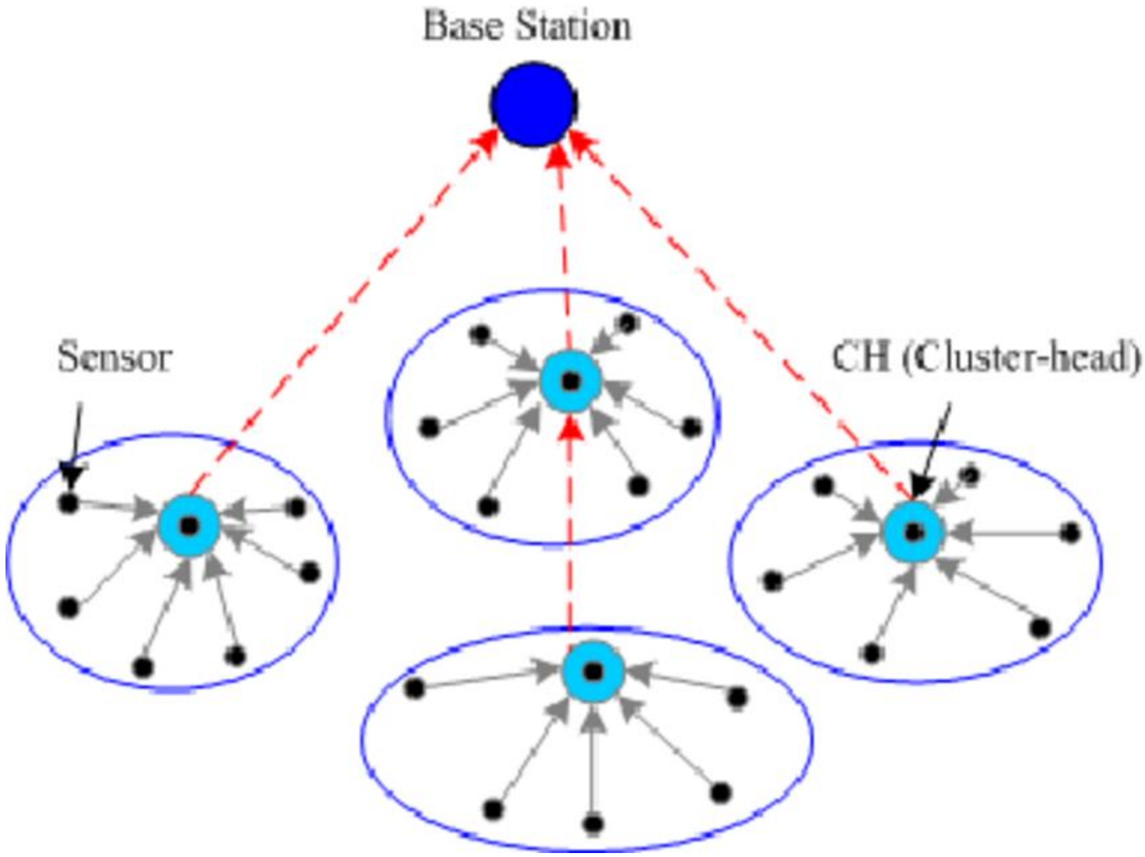

Figure 2.2: Cluster based model

2.4 Challenges related to Wireless Sensor Networks

Wireless Sensor Networks (WSN) are self-organized systems that may accomplish several jobs in different geographical regions. Sensor networks should be able to detect changes in parameters as well as environmental monitoring, surveillance, target tracking, and so on. Energy saving is a crucial challenge in order to extend the lifetime of WSNs [11]. Wireless sensor networks have a number of challenges, including implementation. The use of adaptive power regulation in IP networks that employ routing protocols, QoS (Quality of Service), ensures network stability.[12]

Chapter 3

LEACH & other Homogeneous Wireless Sensor Network Protocols

3.1 LEACH

LEACH (Low Energy Adaptive Clustering Hierarchy) is a cluster-based routing technology that extends network lifespan[13].A sensor node has a finite amount of energy. When building WSN routing protocols, one of the main concerns is how to use the nodes' energy effectively while also extending the network's lifetime[14]. Sensors that are close together are put together to create a cluster in clustering-based routing algorithms. Each cluster has a specific sensor known as the Cluster Head (CH), which collects data from the other sensors in the cluster. Finally, the BS receives the aggregated data. The goal of clustering-based routing is to consolidate information or data in the CH. It reduces the quantity of energy that is squandered.

3.2 Architecture of LEACH Protocol

LEACH is a cluster based protocol which has the following features:

a. It has self-configuring cluster formation.
b. It has localized control for data transfers
c. It aggregates data.[15]

Because of the substantial connection between data signals from nodes adjacent to each other, clustering architecture was chosen as the foundation for LEACH[16].The nodes in LEACH arrange themselves into local clusters, with one node serving as the cluster-head in each cluster. When a cluster-head depletes all of its battery energy, it dies, and the other nodes in the cluster lose communication capability. As a result of LEACH ensuring randomized rotation of the cluster head, the energy load of the cluster head is evenly spread across the nodes.[17]

LEACH protocol has mainly two phases:
1) Set-up phase
2) Steady phase[4]

Phases of leach protocol are as follows:

A) Set-up phase

The main steps of Set-up phase are[18]:

1) Advertisement of cluster head.
2) Setting up cluster.
3) Creating transmission schedule.

B) Steady phase

The key steps of the steady state phase are as follows:

1) Cluster node data is delivered to the cluster head.
2) The cluster head sends data to the base station after aggregating all of the acquired data.[31]
3) After a certain period of time, the network returns to the setup phase.

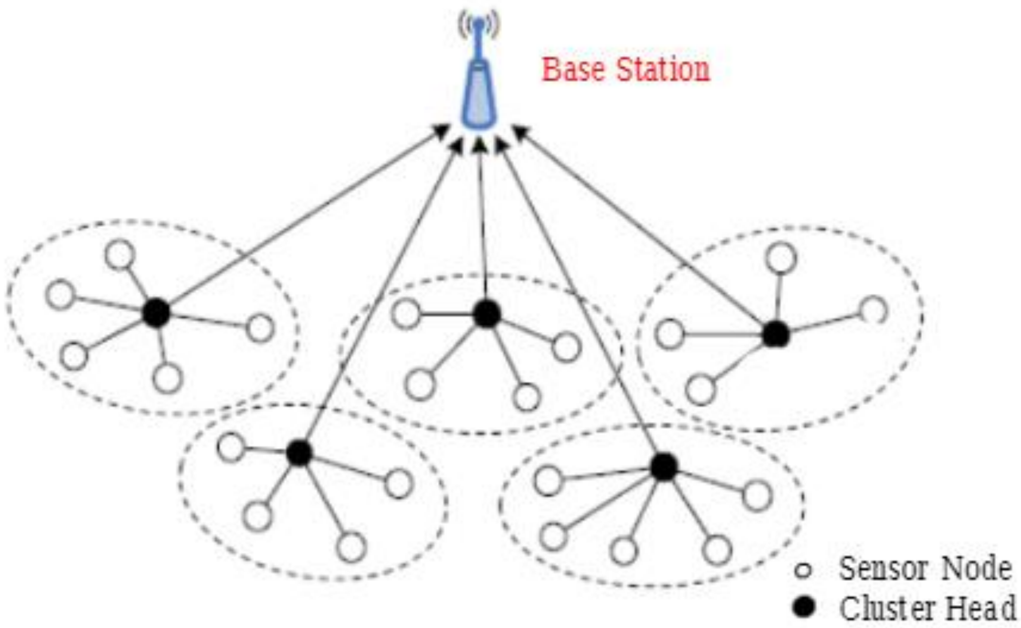

Fig 3.1: LEACH Architecture

3.3 Advantages and disadvantages of LEACH Protocol

3.3.1 Advantages

The following are some of the benefits of the LEACH protocol:

1. Traffic in the network is decreased as a result of the cluster head's aggregation of all data. [20]

2. It saves energy due to one hop routing.[19]

3. The network's lifespan is extended.

3.3.2 Disadvantages

The following are some downsides of the LEACH protocol:

1. LEACH does not provide the total number of cluster heads in the network.

2. If the Cluster Head dies for whatever reason, the Cluster will become inoperable.[19]

3. Clusters are randomly separated, resulting in an increase in energy usage that is not desirable.[19]

3.4 Single hop and Multi hop communication

Single hop communication occurs when data packets transit from source to destination utilizing a single networking device. Multihop communication, on the other hand, occurs when a data packet goes from a source to a network utilizing more than one networking device.

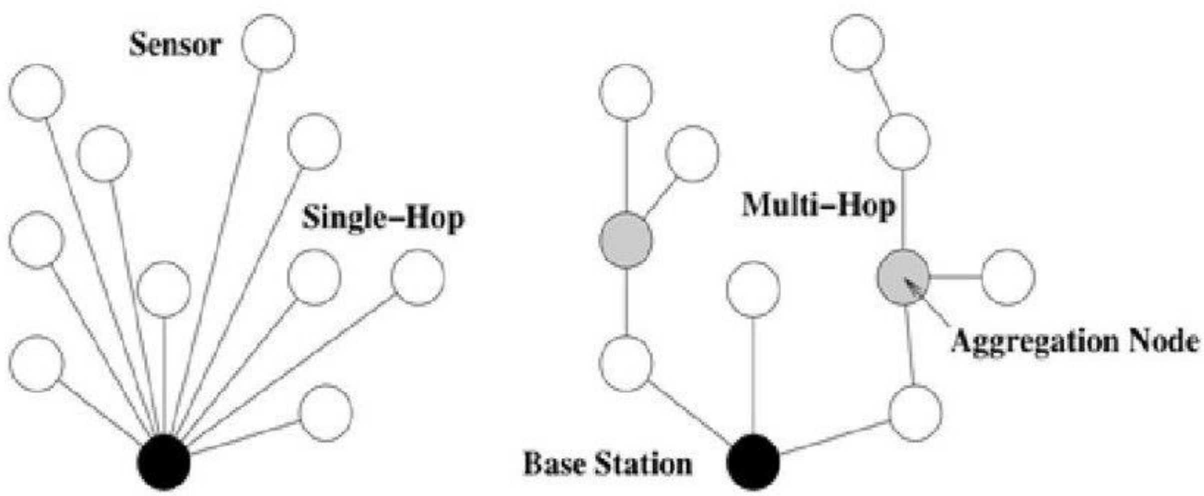

Fig 3.2: Single hop vs Multi hop communication

3.5 Comparison of LEACH with PEGASIS and EAMMH Protocol

3.5.1 LEACH and EAMMH

i) LEACH has single hop communication whereas EAMMH has multi hop communication.

ii) LEACH better than EAMMH in terms of energy as long as number of nodes is less.If number of nodes increases a lot,then EAMMH becomes better than LEACH.

iii) LEACH generates fewer dead nodes than EAMMH if number of nodes is less. With the increase of the number of nodes, EAMMH provides fewer dead nodes than LEACH.

iv) So LEACH is suitable for small network whereas EAMMH is better for large networks.**[23]**

3.5.2 LEACH and PEGASIS

i)In LEACH, data aggregation happens, but in PEGASIS, data aggregation does not occur.

ii)LEACH is primarily a cluster-based model, whereas PEGASIS is mostly a chain-based one.

iii)Because the number of dead nodes in LEACH is more than that in PEGASIS, PEGASIS outperforms LEACH in terms of network lifetime and percentage of node deaths.

iv)LEACH is suited for small networks and PEGASIS, on the other hand, is better suited for vast networks.[24]

Chapter 4

Heterogeneous Wireless Sensor Network

4.1 Heterogeneous Wireless Sensor Network basics

A heterogeneous wireless sensor network is made up of sensor nodes with varying capabilities, such as range and power. Its topology is more sophisticated than that of a homogeneous WSN. In heterogeneous networks, multihop routing is employed to reach the cluster head. In sensor nodes, there are three forms of resource heterogeneity:i)computational heterogeneity, ii) link heterogeneity, and iii) energy heterogeneity.

4.2 Reason for choosing Heterogeneous Wireless Sensor Network

Advantages of wireless sensor networks are described below:

Better Response Time: Computational heterogeneity as well as and link heterogeneity can reduce the waiting time and thus overall response time is decreased.

Improved Lifetime: Average energy consumption is less in heterogeneous sensor networks,therefore lifetime is increased.[5]

Suitable for real life applications: Heterogeneous WSNs are more used in real life applications than that of homogeneous WSNs.[32]

For the above advantages and mainly for suitability for real life applications,Heterogeneous WSN is chosen over Homogeneous WSN for our work.

4.3 Heterogeneous Wireless Sensor Network Protocols

Some important Heterogeneous Wireless Sensor Network Protocols are described below:

4.3.1 DEEC

A heterogeneous WSN technique is Distributed Energy Efficient Clustering (DEEC). Some of its fundamental features are as follows:

i) By rotating the cluster-head role, it allows each node to grow energy equitably.[25]

ii) Cluster heads are chosen by a probability that is dependent on a ratio.It is the ratio of each node's residual energy to the network's average energy.[25]

iii) Cluster-heads are more likely to have strong initial and residual energy.[25]

4.3.2 EDEEC

Enhanced Distributed Energy Efficient Clustering (EDEEC) is a heterogeneous network method. Its characteristics are as follows:

i)It uses the same technique as DEEC to estimate energy in the network.[26]

ii)It has super nodes, which increases the network's heterogeneity.[26]

4.3.3 DDEEC

DDEEC (Developed Distributed Energy-Efficient Clustering) is a modified DEEC protocol with the following characteristics:

i)The network balances cluster head selection across all nodes.[27]

ii) When the energy of each advanced node declines to a certain level, the chance of CH election for these nodes equals that of normal nodes.[27]

4.3.4 TDEEC

Threshold Distributed Energy Efficient Clustering (TDEEC) is a modified DEEC technique that has the following characteristics:

i)The threshold value is modified, based on which a node selects whether or not to be a cluster leader.[28]

ii)The cluster head is determined by the node with the most energy.[28]

Chapter 5

Weighted Balance Distributed Energy Efficient Clustering method

5.1 Network Model

The following network model properties are[28]:

1)There are N nodes in a M X M network field.

2)Sensor Nodes are distributed equitably across the network.

3)A single Base Station is positioned in the center.

4)The data must be sent to the base station by the nodes.

5)In a homogenous WSN, all nodes have identical processing and communication capabilities.

6) Each node has a distinct beginning energy, and some nodes have more energy than others. It is intended for heterogeneous WSN.

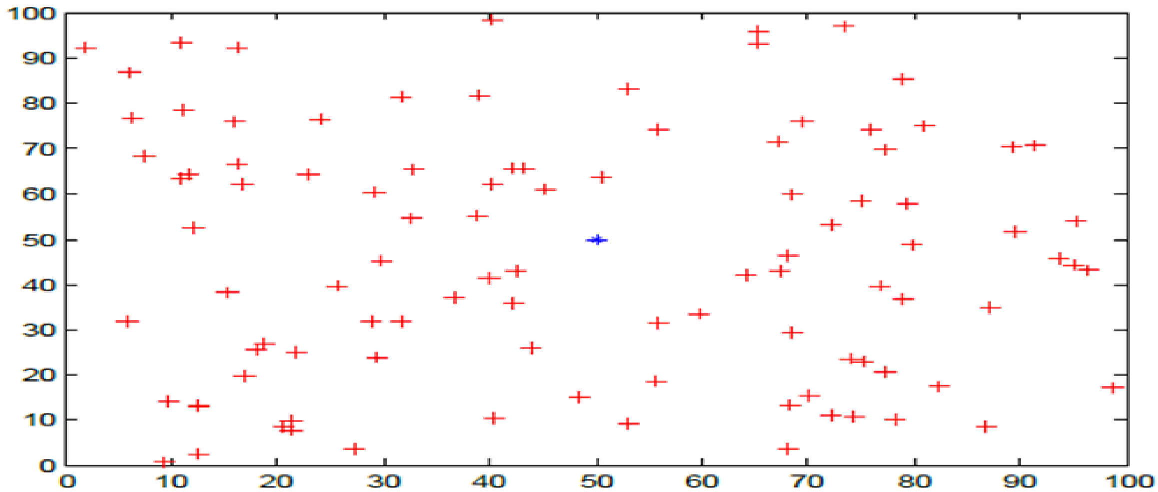

Figure 5.1: Network model sample

5.2 Normal nodes,Advanced nodes and Super nodes

There are three types of nodes in a three-level heterogeneous WSN based on energy level. They are classified as normal, advanced, and super nodes. Normal nodes contain Eo energy. Advanced nodes have more energy than normal nodes, and a proportion m of advanced nodes have a times more energy than normal nodes, with their energy equal to Eo(1 + a). Super nodes, on the other hand, have a proportion of mo nodes and have b times more energy than regular nodes, with their energy equal to Eo(1 + b). If N is the entire number of nodes in the network, then the total number of super nodes is $N.m.mo$ total number of advanced nodes is $N.m.(1 - mo)$ in the network.[29]

5.3 Performance metrics of DEEC model

In DEEC, let ni indicates the number of rounds to be a CH for node .Popt*N is the ideal number of CHs in the network. As in homogenous network, when nodes have equal measure of energy through every epoch,so choosing Pi=Popt will guarantee Popt*N CHs through every round.Pi is the probability of nodes to become CH.E(r) indicates average energy of the network during round r shown in equation 1.[30]

$$E(r) = \frac{1}{N} \Sigma_{i=1}^{N} E_i(r) \qquad (1)$$

In DEEC,Probability for Cluster Head selection is given in equation 2 as:

$$P(i) = P_{opt} \left[1 - \frac{\bar{E}(r) - E_i(r)}{\bar{E}(r)}\right] = \frac{P_{opt} E_i(r)}{\bar{E}(r)} \qquad (2)$$

5.4 DDEEC and EDEEC analysis

DDEEC utilizes same strategy as DEEC only difference is that it sets a threshold residual energy for the nodes to be a CH. If a node doesn't have a certain amount of residual energy, It simply won't be a CH. The threshold value of the residual energy is given in equation 3 as[27]:

$$Th_{REV}=E_o[1+\{aE_{dissNN}/(E_{dissNN}-E_{dissAN})\}] \qquad (3)$$

In DDEEC,the average probability for CH selection in DDEEC is given in equation 4 as[27]:

$$\mathbf{P(i)} = \begin{cases} \frac{P_{opt}*E_i(r)}{(1+m(a+m_0b))E_{avg}} & ;\ S_i \textit{ is normal node} \\ \frac{(1+a)\ P_{opt}*E_i(r)}{(1+m(a+m_0b))E_{avg}} & ;\ S_i \textit{ is Advanced node} \\ \frac{(1+b)\ P_{opt}*E_i(r)}{(1+m(a+m_0b))E_{avg}} & ;\ S_i \textit{ is Super node} \end{cases} \qquad (4)$$

EDEEC is also same approach as the DDEEC but the only difference is that with DDEEC model EDEEC also uses a threshold for CH selection. In every round, a random value between 0 and 1 is selected and by this,nodes take a decision whether to become a CH or not. If value is smaller than threshold T(S),nodes choose to be a CH for that specific round.[26]

$$T(Si) = \begin{cases} \frac{Pi}{(1-Pi(rmod\ 1/Pi))} & \text{if } p_i \in G^{\wedge\prime} \\ \frac{Pi}{(1-Pi(rmod\ 1/Pi))} & \text{if } p_i \in G^{\wedge\prime\prime} \\ \frac{Pi}{(1-Pi(rmod\ 1/Pi))} & \text{if } p_i \in G^{\wedge\prime\prime\prime} \\ 0 & \text{otherwise} \end{cases} \qquad (5)$$

5.5 TDEEC analysis

TDEEC utilizes same technique as the other models specially EDEEC. TDEEC mostly uses more optimistic approach by balancing the threshold according to the residual energy to the average energy. It uses optimal clusterhead numbers to determine if a node will be clusterhead. Threshold value suggested by TDEEC is specified in equation 6 as[28]:

$$T(S) = \frac{p * residual\ energy\ of\ a\ node * Kopt}{(1 - p(rmod1/p)) * average\ energy\ of\ the\ network} \qquad (6)$$

5.6 Weighted Balanced Distributed Energy Efficient Clustering analysis

Our proposed WBDEEC protocol uses as the same technique as the TDEEC & EDEEC but we are proposing a weighted method for selecting cluster head. Our idea is to modify the limits and conditions based on which the cluster heads are nominated. The probability functions in the previous EDEEC, DDEEC and TDEEC took a approach towards the optimal power whereas our approach was towards the number of nodes. We calculated the approximate number of cluster heads beforehand in accommodation of active power that occurs free space loss and multipath loss. Selecting the threshold for the super nodes are done accommodating the average energy and the residual energy. We should bear in conscience that the average energy can be higher or lower than the residual energy hence taking the absolute value. If we only select cluster heads only in accordance to average energy or residual energy like done in EDEEC and TDEEC model; there is good probability that a node might be nominated for being a super node but not having enough residual energy to carry the data forward thus there will be occurrence of packet loss. That is why our approach for the probability equation takes into account optimal number of cluster heads and desired probability. If we set our desired probability beforehand; the number of cluster heads gets limited hence nodes are not overflown by the cluster heads. Optimal number of cluster heads are opted for super nodes according to the losses hence chances of a super node having not enough power for the functionality is very slim.This is reflected in the figure 5.3 that the nodes are kept alive for a long duration of time. We are introducing a weighted factor ‘τ’ for the probability function in equation 7 as follows:

$$
P(i) = \begin{cases} K_{opt} * E_i(r) * P_{des} \frac{1}{(1+m(a+m_0 b))E_{avg} * \tau} & ; S_i \textit{ is normal node} \\ (1+a)\, K_{opt} * E_i(r) * P_{des} \frac{1}{(1+m(a+m_0 b))E_{avg} * \tau} & ; S_i \textit{ is advanced node} \\ (1+b)\, K_{opt} * E_i(r) * P_{des} \frac{1}{(1+m(a+m_0 b))E_{avg} * \tau} & ; S_i \textit{ is super node} \end{cases} \quad (7)
$$

Here Pdes represents the desired probability of CH. We have come to the conclusion that the Pdes value of 0.2 gives us the best result. We don't want to abruptly increase the CH number as it will increase the latency of the network and make it unstable. The weighted balanced threshold is suggested in equation 8 as follows:

$$
T(s) = \frac{p_i * \tau * abs(1 - \frac{E_{avg}}{E_i(r)})}{1 - p_i * r * mod\left(\frac{1}{\tau r}, \frac{\tau * P_{opt}}{P_{des} * p_i}\right)} \quad ; \text{ if } p_i \text{ belongs to G} \qquad (8)
$$

The optimal number of clusterheads are given by considering the heterogenous three level WSN model. It is given in equation 9 as:

$$
k_{Opt} = \frac{\sqrt{N}}{\sqrt{2\pi}} \sqrt{\frac{E_{Fs}}{Emp}} \frac{M}{d^2 t_0 Bs} \qquad (9)
$$

5.7 Simulation

We did our simulation in MATLAB.The simulation parameters that we have used for WBDEEC are as follows:

Parameters	Value	Parameters	Value
Area(x,y)	(100,100)	Free space loss	$10 * 10^{-13}$
Base station(x,y)	(50,50)	Multipath loss	$5 * 10^{-9}$
Nodes(n)	100	Effective data aggression	$5 * 10^{-9}$
Desired Probability(P_des)	0.2	Max rounds	10,000
Initial energy	0.5	Data packet size	4000
Transmitter Energy	$50 * 10^{-9}$	m (fraction of advanced nodes)	0.8
Receiver energy	$50 * x10^{-9}$	a (energy factor between normal and advanced nodes)	1.5
Weighted factor (τ)	0.95 $(0<\tau<1)$	Mo (fraction of super nodes)	0.4

Table 5.1: Simulation parameters

5.8 Analysis of curves

5.8.1 DEEC vs WBDEEC vs EDEEC vs DDEEC vs LEACH

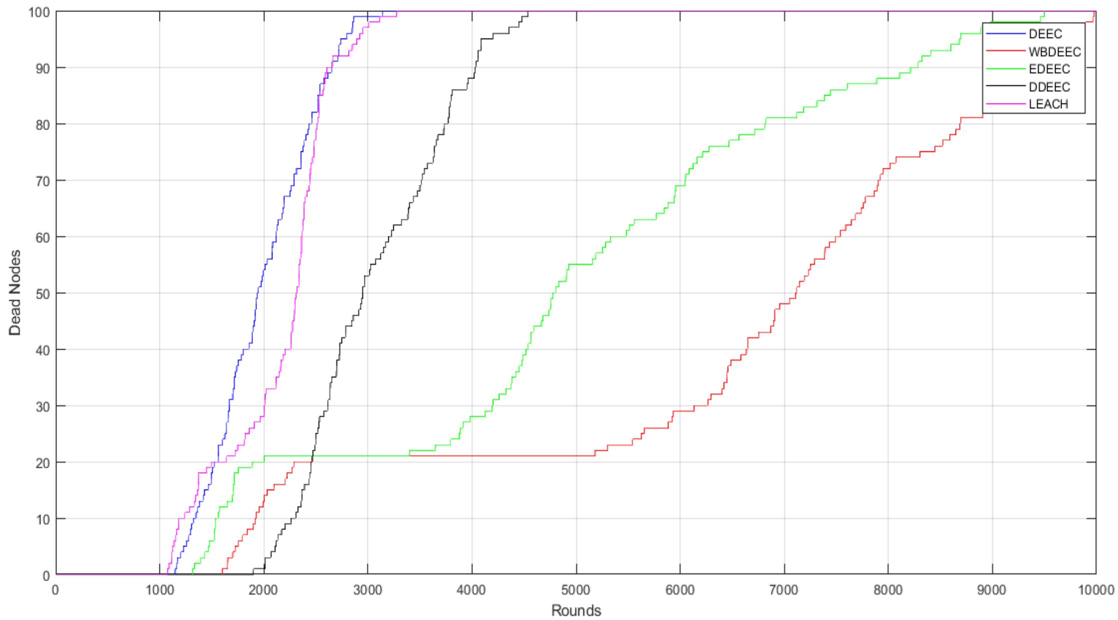

Figure 5.2: DEEC VS WBDEEC VS EDEEC VS DDEEC VS LEACH(In terms of no of dead nodes vs no of rounds)

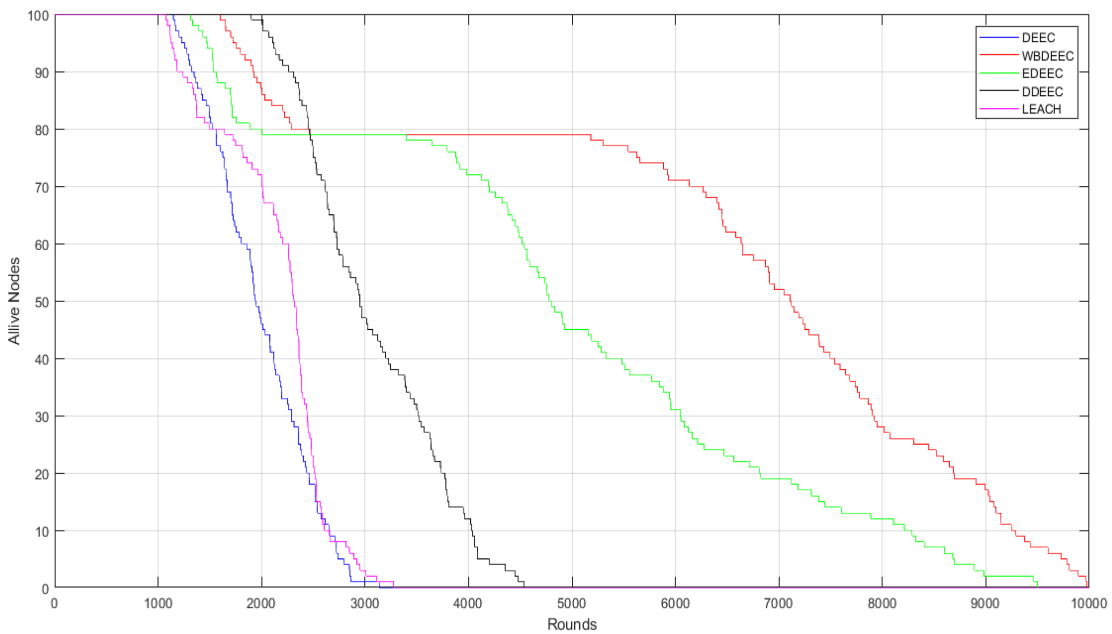

Figure 5.3: DEEC VS WBDEEC VS EDEEC VS DDEEC VS LEACH(In terms of no of alive nodes vs no of rounds)

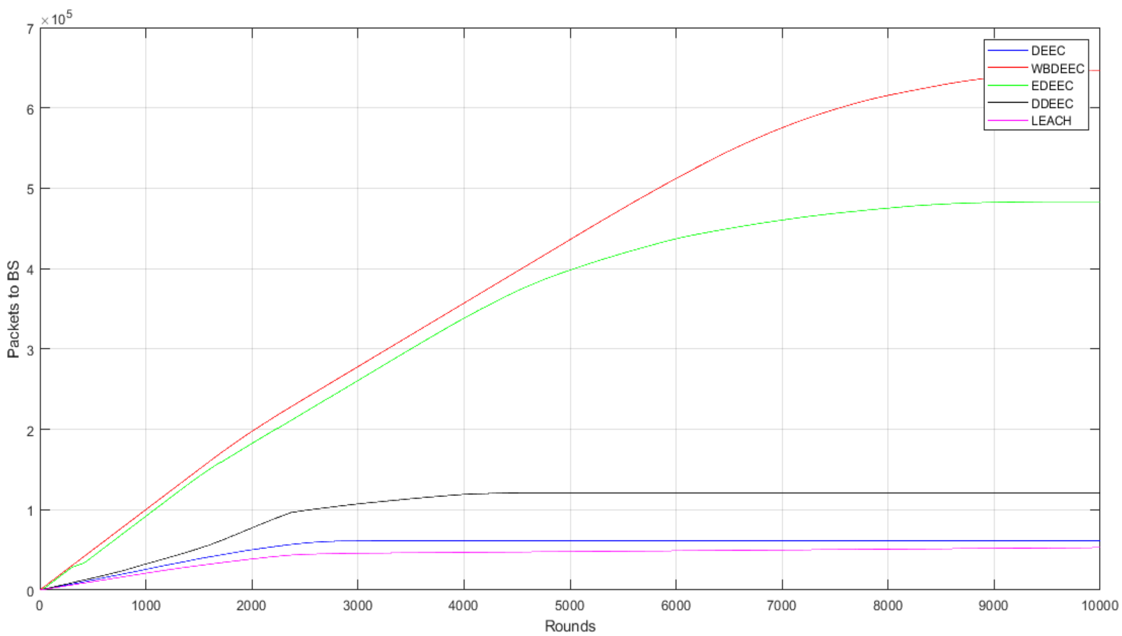

Figure 5.4: DEEC VS WBDEEC VS EDEEC VS DDEEC VS LEACH(In terms of packets to BS vs no of rounds)

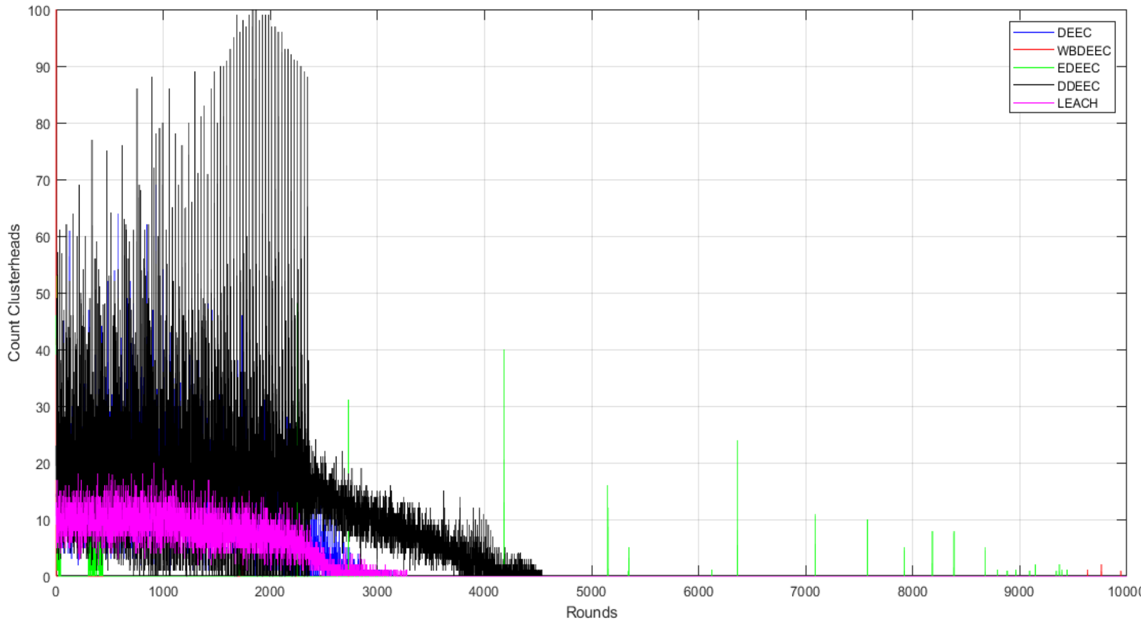

Figure 5.5: DEEC VS WBDEEC VS EDEEC VS DDEEC VS LEACH(In terms of Count clusterhead vs no of rounds)

In figure 5.2,it is observed that no. of dead nodes is minimum for WBDEEC compared to DEEC,EDEEC,DDEEC and LEACH.It takes longer time for the nodes to die out in case of WBDEEC compared to other protocols.From figure 5.3,it is evident that number of alive nodes of WBDEEC is way more than DEEC,EDEEC,DDEEC and LEACH.So from these two graphs it is clear that the network lifetime for our proposed WBDEEC is more than that of other protocols mentioned here.In figure 5.4, packets to BS transmission is maximum for WBDEEC compared to other protocols.So more data is being carried,packet loss decreases which eventually increases the efficiency of the network.In figure 5.5,count clusterhead indicates how many nodes are nominated for clusterheads.It is seen that WBDEEC is at an optimal level which reduces the latency in data transmission and thus efficiency of the network increases.

5.8.2 Close look of alive nodes of WBDEEC vs EDEEC

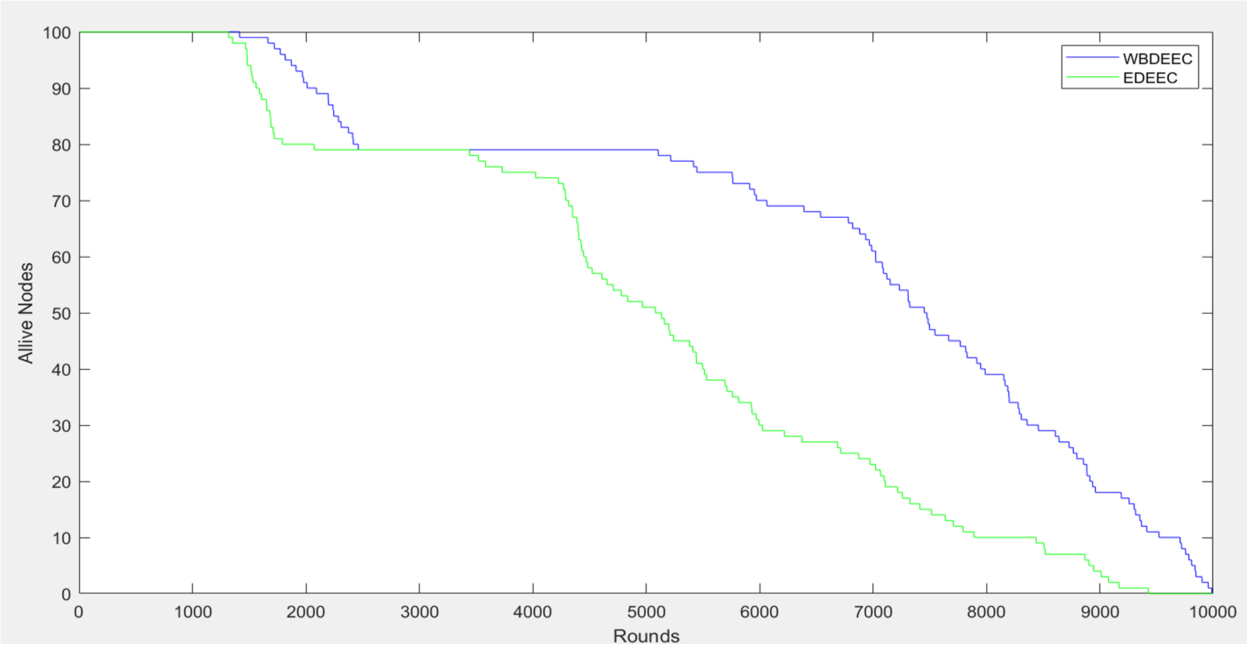

Figure 5.6: Close look at the alive nodes of WBDEEC vs EDEEC

From the curves,it is seen that number of alive nodes for WBDEEC is more than that of EDEEC throughout the whole cycle and at the end of 10000 rounds.So the nodes lifetime has significantly prolonged.

5.8.3 Close look of dead nodes of WBDEEC vs EDEEC

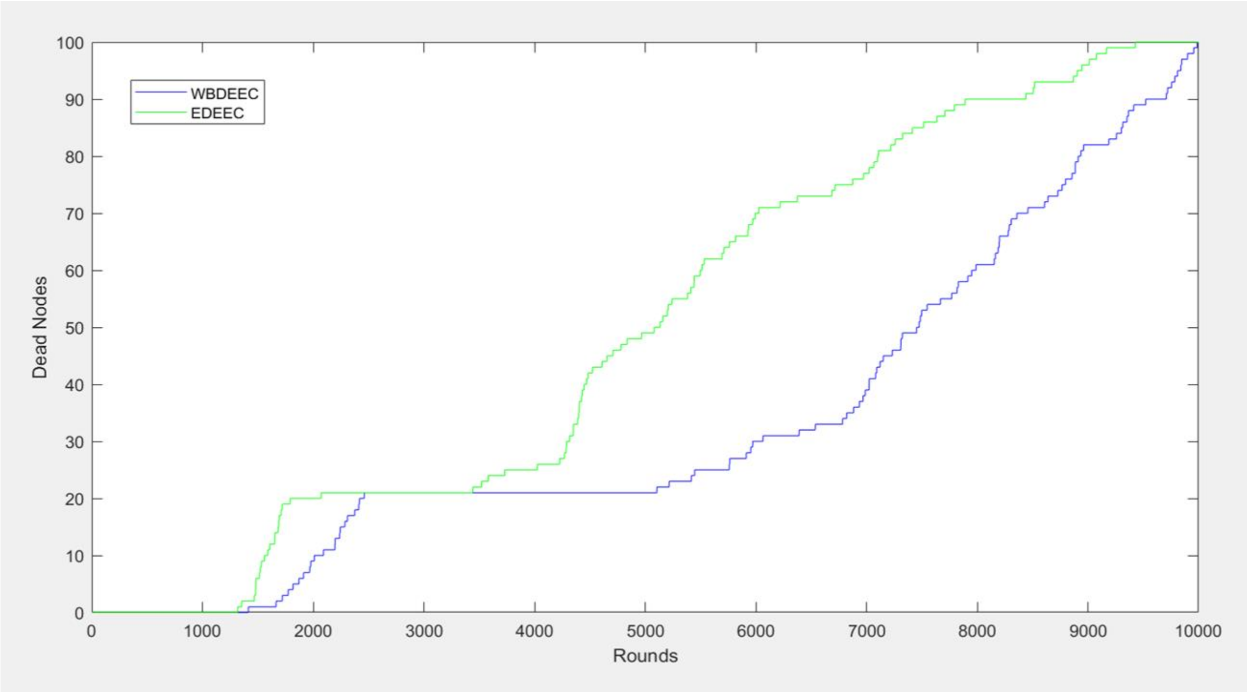

Figure 5.7: Close look at the dead nodes of WBDEEC vs EDEEC

From the curves,it is seen that first dead nodes have appeared at 1500^{th} round(approx) for WBDEEC whereas in EDEEC the first dead node appears at 1234^{th} round. So the nodes lifetime has significantly prolonged.

5.8.4 Close look of packets to BS of WBDEEC vs EDEEC

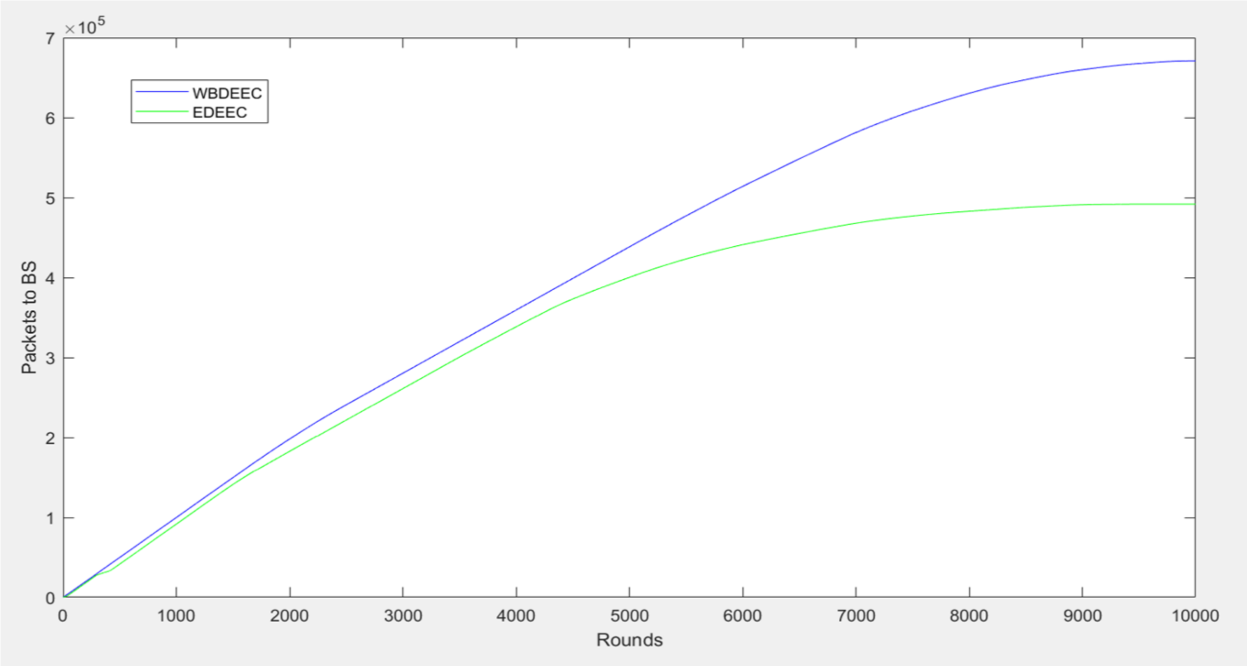

Figure 5.8: Close look at the Packets to BS of WBDEEC vs EDEEC

If we look at the data packet sent to BS, WBDEEC has sent 657869 packets whereas EDEEC has sent 492386 packets which is significantly greater than that of EDEEC.Packet loss decreases,more data is being carried and so it improves the efficiency of the network.

5.9 Result analysis

From a graphical standpoint, it can be observed that the proposed WBDEEC performed substantially better than the other protocols in terms of the number of dead nodes, the number of living nodes, the number of packets to BS, and the number of clusterheads at the conclusion of specific rounds. As we perform additional simulations, our suggested model (WBDEEC) maintains the output at maximum efficiency. When comparing WBDEEC to EDEEC, the slope from 3500 to 5200 rounds in terms of living nodes is zero (0), indicating that the network is working at its peak efficiency. The greatest efficiency gap occurs between WBDEEC and EDEEC on the 7000th round. After 5000 cycles of traversing the network, significant performance increases can be noted.WBDEEC begins to perform significantly better than the EDEEC onwards while saturating the performance after 14000 rounds compared to EDEEC after 8000 rounds.

Longer lifetime has led to the increased number of packets sent to the BS. Comparing the number of the clusterheads; WBDEEC has significantly smaller number of clusterheads. This smaller number of clusterheads leads to reduced queue time in the supernodes thus sending the packets of data faster compared to EDEEC. As a downside, reduced number of clusterheads is compromised to number of multihops the network can handle. As the number of supernodes are low, huge number of multihops will increase the system latency and introduce buffering that's why our proposed model is suggested for a network structure which is static designed to sustain specific purpose.

5.10 Advantages and Disadvantages of Weighted Balanced DEEC

5.10.1 Advantages

1.Improved transmission speed.

2.Prolonged nodes lifetime.

3.Reduced latency and energy consumption.

4.Improved Cluster Head distribution.

5.10.2 Disadvantages

1.Data rate is slow for short time traversing.

2.Weighted factor should be as close as 60-90% for best performance.

3.Raising the probability of CH reduces the lifetime of the network.

4.Increasing the super node fraction also reduces the lifetime of the network.

Chapter 6

Conclusion

6.1 Conclusion of this work

In this work,WSN has been studied and the main concern was the limited battery life of the sensor nodes of WSN.Like many other approaches,we also proposed an approach known as WBDEEC.The main target was to improve the overall efficiency of the network.A lot of approaches and protocols were proposed before which enhanced the performance of WSN in terms of network lifetime,data transmission rate,residual energy etc.We intended to propose a method which shows better performance than some of those more popular and established protocols. The probability functions in the previous EDEEC, DDEEC and TDEEC took a approach towards the optimal power whereas our approach was towards the number of nodes. Selecting the threshold for the super nodes are done accommodating the average energy and the residual energy.If we only select cluster heads only in accordance to average energy or residual energy like done in EDEEC and TDEEC model; there is a good probability that a node might be nominated for being a super node but not having enough residual energy to carry the data forward thus there will be packet loss. That is why our approach for the probability equation takes into account optimal number of cluster heads and desired probability. If we set our desired probability beforehand; the number of cluster heads gets limited hence nodes are not overflown by the cluster heads.We observed the simulation results performed in MATLAB and from all the analyses of our work,it is evident that Weighted Balance Distributed Energy Efficient Clustering(WBDEEC) method is more efficient than other protocols such as DEEC,DDEEC,EDEEC,LEACH that are described in this book.So we are suggesting WBDEEC as an improved overall efficient Heterogeneous three level WSN approach.

6.2 Discussion and future work

From our analyses and work,it is seen that WBDEEC improves the overall efficiency of the network.But there are a number of disadvantages as well of our proposed approach.For example,we have observed that in WBDEEC,data rate is slow for short time traversing.To improve the speed of data for short term traversing can be a thing of research in the future,Besides this,weighted factor should be maintained around 60-90% for best performance so there are some constraints.More flexibility in keeping the value of Weighted factor can also be a thing of research in the future. The probability of improving the overall performance of WSN is endless. Just using one algorithm might not be ideal for all situations as dynamic networks are always evolving in its own way and optimizing the routing route. Our research takes a leap towards a more efficient way of managing wireless network without any compromise on performance.

References

[1] Sulekha Kumari, “Performance Analysis of LEACH, SEP and ZSEP under the Influence of Energy”, *International Journal of Advanced Engineering Research and Science (IJAERS)*, **Apr-2017**, Vol-4, Issue-4.

[2] Junpeii Anno, Leonard Barolli, and Fatos Xhafa, “A Cluster Head Selection Method for Wireless Sensor Network Based on Fuzzy Logic”, *Proc. of the TENCON 2007 - IEEE Region Conference*, **2007**, pp. 1-4.

[3] Mr. Ritesh S. Gujarkar, and Prof. B. J. Chilke, “Review on a Lifetime Maximization of Wireless Sensor Network Using Support Vector Machine”, *Proc. of the International Conference on Recent Trends in Engineering Science and Technology (ICRTEST 2017)*, January **2017**,Volume: 5 Issue: 1(Special Issue 21-22).

[4] Sudhanshu Tyagi,Neeraj Kumar,”A systematic review on clustering and routing techniques based upon LEACH protocol for wireless sensor networks,March 2013,Journal of Computer and Network Applications 36(2):623–645.

[5] Sudarshan T V, Manjesh B N,” A Survey on Heterogeneous Wireless Sensor Networks”, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-Vol. 4 Issue 04, **April-2015.**

[6] Indu, and Sunita Dixit, “Wireless Sensor Networks: Issues & Challenges”, *IJCSMC*, June **2014**,Vol. 3, Issue. 6, pg.681 – 685.

[7] Jun Zheng, Nirwan Ansari, and Victor O.K. Li, et al. “Guest Editorial Network Coding for Wireless Communication Networks”, *IEEE Journal on Selected Areas in Communications*, June **2009**, Vol. 27, No. 5, pp. 577-581.

[8] Pasquale Daponte, Luca De Vito, and Gianluca Mazzilli et al., “Power Consumption Analysis of a Wireless Sensor Network for Road Safety”, *Proc. of the 2016 IEEE International Instrumentation and Measurement Technology Conference Proceedings*, **2016**, pp. 1-6.

[9] Feng Chen, Hongqiang Zhai, and Yuguang Fang, "Available Bandwidth in Multirate and Multihop Wireless Sensor Networks", *Proc. of the 29th IEEE International Conference on Distributed Computing Systems*, **2009**, pp. 281-288.

[10]. Harpinder Kaur, Navjot Kaur and Sandeep Waraich, "Comparative Analysis of Clustering Protocols for Wireless Sensor Networks", *International Journal of Computer Applications (0975 – 8887),* **April 2015**, Volume 115, No. 1, pp. 35-43.

[11] Neeraj Kumara, Sudhanshu Tyagib and Der-JiunnDeng, "LA-EEHSC: Learning automata based energy efficient heterogeneous selective clustering for wireless sensor networks", *Journal of Network and Computer Applications*, **November 2014**, Volume 46, Pages 264-279.

[12] Carlos F. García-Hernández, Pablo H. Ibargüengoytia-González, Joaquín García Hernández, and Jesús A. Pérez-Díaz, "Wireless Sensor Networks and Applications: a Survey", *IJCSNS International Journal of Computer Science and Network Security,* **March 2007**, VOL.7 No.3,pp.264-273.

[13] Sunil Kumar Singh, Prabhat Kumar, and Jyoty Prakash Singh, "A Survey on Successors of LEACH Protocol", *IEEE Access*,**14 February 2017** Volume 5, pp. 4298-4328.

[14] Beibei Wang, Chong Shen, and Jing Li, "Study and Improvement on LEACH Protocol in WSNs", *Proc. of the International Conference on Automatic Control and Artificial Intelligence (ACAI 2012)*, **2012**, pp. 1941-1943.

[15] Mr. Halke Rajesh, and Mrs. Kulkarni, "Design of Enhanced LEACH Routing Protocol for Wireless Sensor Network", *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE),* pp. 7-12.

[16] Mr. Rajesh Halke, and Mrs. Kulkarni, "En - LEACH Routing Protocol for Wireless Sensor Network", *International Journal of Engineering Research and Applications (IJERA),* July-**August 2012**, Vol. 2, Issue 4, pp. 2099-2102.

[17] Navneet Kaur, and Prof. Dinesh Kumar, "Analysis of Clustering Algorithms In Wireless Sensor Network", *IOSR Journal of Engineering (IOSRJEN),* **May 2014**, Vol. 04, Issue 05, pp. 1-5.

[18] Lalita Yadav, Ch. Sunitha, "Low Energy Adaptive Clustering Hierarchy in Wireless Sensor Network (LEACH)", International Journal of Computer Science and Information Technologies, Vol. 5 (3), **2014.**

[19] Reenkamal Kaur Gill, Priya Chawla and Monika Sachdeva, “Study of LEACH Routing Protocol for Wireless Sensor Networks”,International Conference on Communication, Computing & Systems (ICCCS),**2014.**

[20] Yrjölä Juhana. Summary of Energy-Efficient Communication Protocol for Wireless Microsensor Networks, **13th March 2005.**
[21]Stan Kurkovsky, Bhagyavati, and Arris Ray, “A collaborative problem-solving framework for mobile devices”, *Proc. of the 42nd annual Southeast regional conference,* **2004.**

[22]Gyanendra Prasad Joshi,Seung Yeob Nam,”Cognitive Radio Wireless Sensor Networks: Applications, Challenges and Research Trends Sensors **2013**, 13, 11196-11228; doi:10.3390/s13091119.

[23] Taspia Salam , Md. Sharif Hossen,”Performance Analysis on Homogeneous LEACH and EAMMH Protocols in Wireless Sensor Network”,Wireless Personal Communications,**July 2020** pg 9-32.

[24] Payal Jain, Dr. Anu Chaudhary,”The Comparison between Leach Protocol and Pegasis Protocol based on Lifetime of Wireless Sensor Networks”,International Journal of Computer Science and Mobile Computing,IJCSMC, Vol. 6, Issue. **12 December 2017**, pg.15 – 19.

[25] Li Qing, Qingxin Zhu, Mingwen Wang,” Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks”,Journal of Software 29(12):2230-2237,**August 2006.**

[26]Parul Saini, Ajay.K.Sharma,” E-DEEC- Enhanced Distributed Energy Efficient Clustering Scheme for heterogeneous WSN”,**2010** 1st International Conference on Parallel, Distributed and Grid Computing (PDGC - 2010).

[27] Brahim Elbhiri, Saadane Rachid, Sanaa El Fkihi, Driss Aboutajdine,” Developed Distributed Energy-Efficient Clustering(DDEEC) for heterogeneous wireless sensor networks,”**2010** 5th International Symposium On I/V Communications and Mobile Network.

[28]Parul Saini, Ajay K Sharma,” Energy Efficient Scheme for Clustering Protocol Prolonging the Lifetime of Heterogeneous Wireless Sensor Networks.” **September 2010**,International Journal of Computer Applications.

[29] T.N. Qureshi; N. Javaid; M. Malik; U. Qasim; Z.A. Khan,"On Performance Evaluation of Variants of DEEC in WSNs,"**2012** Seventh International Conference on Broadband, Wireless Computing, Communication and Applications."

[30] L. Qing, Q. Zhu, M. Wang, "Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor network", ELSEVIER, Computer Communications 29, **2006**, pp 2230- 2237.

[31]Khushbu Kumari,Shailesh Khaparkar,"Performance Evaluation and comparative analysis of LEACH and SEP Routing Protocol For WSN, 2018 JETIR **April 2018**, Volume 5, Issue 4.

[32]Shipra Singla,Karamjot Kaur,"Comparative Analysis of Homogeneous N Heterogeneous Protocols in WSN", International Journal of Science and Research (IJSR), Volume 5 Issue 6, June **2016**.

ENHANCING PERFORMANCE OF HETEROGENEOUS WIRELESS SENSOR NETWORK(WSN)-A MODIFIED APPROACH

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