Balanced Energy Efficient Network Integrated Super Hetrogeneous Protocol for WSN

Vandana Katoch[1] Kamal Kumar[2]
[1,2]Department of Computer Science
[1,2]SDDIET,Barwala(Haryana)

Abstract— BEENISH Protocol is used for the Energy efficiency purpose. The WSN network has the various nodes is used for transmit and receive the data or packets. For this transmission, these nodes used the maximum energy. When the maximum energy is used during transmission than the lifetime of the network will be decrease or the stability period of the network will also decrease. Many protocols are used to overcome this problem. BEENISH is one of the energy efficiency protocol which is used for prolong the network lifetime of the network and for save the energy of the nodes. Here, Cluster Heads (CHs) are elected on the bases of maximum energy of nodes. Simulation results show that it performs better than existing clustering protocols in heterogeneous WSNs. Our protocol (BEENISH)achieve longer stability, lifetime and more effective messages than Distributed Energy Efficient Clustering (DEEC), Developed DEEC (DDEEC) and Enhanced DEEC (EDEEC).

Key words: Wireless Sensor Networks, Cluster Heads, Residual Energy, Heterogeneity, Efficient

I. INTRODUCTION

With the proliferation in automated devices and the development in wireless technologies WSNs have gained worldwide attention in recent years. WSNs as an exciting emerging domain of deeply networked systems of low-power wireless nodes with a tiny amount of CPU and memory for high-resolution sensing of the environment [1]. The wireless nodes are nothing but a large number of low-cost, multifunctional sensor nodes that are deployed in a region of interest. The sensor nodes not only senses but also processes the data to make itself meaningful by using its embedded microprocessors and also communicates those meaningful data through its transceiver [2]. They communicate over a short distance via a wireless medium and collaborate to accomplish a common task, for example, environment monitoring, battlefield surveillance, and industrial process control [3]. WSNs are made up of a large number of inexpensive devices that are networked via low-power wireless communications [4, 5]. Due to the networking capability that fundamentally appears in a sensor network, it overcomes the flaws present in a mere collection of sensors, by enabling cooperation, coordination, and collaboration among sensor assets [6]. Wireless sensor network technology is expected to have a significant impact on our lives in the twenty-first century by harvesting advancements in the past decade in microelectronics, sensing, analog and digital signal processing, wireless communications, and networking. Wireless sensor networks differ fundamentally from general data networks such as the internet, and as such they require the adoption of a different design paradigm [7, 8]. Often wireless sensor networks are application specific, they are designed and deployed for special purposes to solve some intended applications. In the context of wireless sensor networks, the broadcast nature of the medium must be taken into account. Because of the battery-operated sensors, energy conservation is one of the most important design parameters, since replacing batteries may be difficult or impossible in many applications [9]. Thus sensor network designs must be optimized to extend the network lifetime. In view of energy consumption in a wireless sensor network, data transmission is the most important with respect to others. Within a clustering organization, intracluster communication can be single hop or multihop, as well as intercluster communication [10]. Researchers have shown that multihop communication between a data source and a base station is usually more energy efficient than direct transmission because of the characteristics of wireless channel [11]. Although many protocols proposed in the literature reduce energy consumption on forwarding paths to increase energy efficiency, they do not necessarily extend network lifetime due to the continuous many-to-one traffic pattern. In a sensor node, energy consumption can be "useful" or "wasteful" [12, 13]. Useful energy consumption can be either due to the following items: transmitting/receiving data, processing query requests, and forwarding queries/data to neighboring nodes. Wasteful energy consumption can be due to the items: idle listening to the media, retransmitting due to packet collisions, overhearing, and generating/handling control packets [14, 15].

As compared with traditional wireless communication networks WSN has the following unique characteristics and constraints.

- Dense node deployment: sensor nodes are usually densely deployed in a field of interest. The number of sensor nodes in a sensor network can be several orders of magnitude higher than that in a MANET.
- Battery-powered sensor nodes: sensor nodes are usually powered by battery. In most situations, they are deployed in a harsh or hostile environment, where it is very difficult or even impossible to change or recharge the batteries.
- Energy, computation, and storage constraints: sensor nodes are highly limited in energy, computation, and storage capacities.
- Self-configurable: sensor nodes are usually randomly deployed without careful planning and engineering. Once deployed, sensor nodes have to autonomously configure themselves into a communication network.
- Application specific: sensor networks are application specific. A network is usually designed and deployed for a specific application. The design requirements of a network change with its application.
- Unreliable sensor nodes: sensor nodes are usually deployed in harsh or hostile environments and

operate without attendance. They are prone to physical damages or failures.
- Frequent topology change: network topology changes frequently due to node failure, damage, addition, energy depletion, or channel fading.

A. Clustering Scheme Overview

1) What Is Clustering?

In a clustering scheme the sensor nodes in a WSN are divided into different virtual groups, and they are allocated geographically adjacent into the same cluster according to some set of rules. Under a cluster structure, sensor nodes may be assigned a different status or function, such as cluster head or cluster member [16]. A cluster head normally serves as a local coordinator for its cluster, performing intra cluster transmission arrangement, data forwarding, and so on. The cluster heads can consolidate the data and send it to the data centre as a single packet, thus reducing the overhead from data packet headers. Clustering has advantages for reducing useful energy consumption by improving bandwidth utilization (i.e., reducing collisions caused by contention for the channel), reducing wasteful energy consumption by reducing overhead. Most of the algorithm aims to extend the network lifetime by balancing energy consumption among nodes and by distributing the load among different nodes from time to time[17]. During the reformation of clusters, the cluster head is changed along with the members affiliated to it. Clustering provides resource utilization and minimizes energy consumption in WSNs by reducing the number of sensor nodes that take part in long distance transmission. In WSN the primary concern is the energy efficiency in order to extend the utility of the network [18].

2) Why Do WSN Require Clustering?

It has been shown that cluster architecture guarantees basic performance achievement in a WSN with a large number of sensor nodes. A cluster structure provides some direct benefits like spatial reuse of resources to increase the system capacity, with the nonoverlapping multicluster structure, two clusters may deploy the same frequency or code set if they are not neighboring clusters[19]. Clusters also give performance enhancement in case of routing, because of the set of cluster heads normally form a virtual backbone for intercluster routing. Clustering in WSNs is very challenging due to the inherent characteristics that distinguish these networks from other wireless networks like mobile ad hoc networks or cellular networks[20]. First, due to the relatively large number of sensor nodes, it is difficult to identify every sensor and the sensed data. Furthermore, sensor nodes that are deployed in an ad hoc manner need to be self-organizing as the ad hoc deployment of these nodes requires the system to form connections between themselves

3) What Is the Cost of Clustering?

In a clustered network, the cost is divided into intra- and intercluster cost. The intracluster communication cost is from the nodes inside a cluster to the head[21]. The intercluster communication cost is from the heads to the base station. The parameter energy efficiency of a clustered sensor network depends on the selection of the heads. The cost of clustering is a key issue to validate the effectiveness and scalability enhancement of a cluster structure[22]. By analysing the cost of a clustering scheme in different aspects qualitatively or quantitatively, its usefulness and drawbacks can be clearly specified.
- When the underlying network topology changes quickly and involves many mobile nodes, the clustering-related information exchange increases drastically.
- Some clustering schemes may cause the cluster structure to be completely rebuilt over the whole network when the CH's residual energy goes out of limit.
- Another metric is the computation round, which indicates the number of rounds in which a cluster formation procedure can be completed.

II. HETEROGENEOUS PROTOCOLS

In heterogeneity sensor network architecture, there are two types of sensors namely line-powered sensors which have no energy constraint, and the battery-powered sensors having limited lifetime, and hence should use their available energy efficiently by minimizing their potential of data communication and computation. The WSN contain various types of heterogeneous protocol like DEEC, DDEEC, EDEEC and BEENISH. These protocols are energy efficiency protocol. Using this protocol we can save the energy of the nodes and improve the network lifetime. Briefly explain these protocols are given below:

A. DEEC (Distributed Energy Efficient Clustering)

In 2006, Q. Li, Z. Qingxin and W. Mingwen [23] projected Distributed Energy Efficient Clustering Protocol (DEEC) protocol. DEEC protocol is a cluster based method for multi level and 2 level energy heterogeneous wireless sensor networks. In this scheme, the cluster heads are chosen using the probability based on the ratio between residual energy of every node and the average energy of the network. The era of being cluster-heads for nodes are entirely different according to their initial and residual energy. The nodes with more initial and remaining energy have greater chances of the becoming cluster heads compared to nodes with low energy.

B. DDEEC (Developed Distributed Energy Efficient Clustering)

DDEEC protocol is proposed by Brahim Elbhiri et al. This protocol is also used for energy efficiency protocol. DDEEC is based on residual energy for CH selection to balance it over the entire network. DDEEC uses same method for estimation of average energy in the network and CH selection algorithm based on residual energy as implemented in DEEC. Difference between DDEEC and DEEC is centered in expression that defines probability for normal and advanced nodes to be a CH. In DEEC advanced nodes are continuously a CH and they die more quickly than normal nodes. To avoid this problem DDEEC protocol is introduced.

C. EDEEC (Enhanced Distributed Energy Efficient Clustering)

This protocol is proposed by P. Saini*et al.* In EDEEC protocol the three level of energy level of nodes is used. This protocol is three level heterogeneous WSN model. Normal nodes, advanced nodes and super nodes are used in EDDEC. The super node is used for the selection of the CH

because the super nodes have the highest energy as compare to normal and advanced nodes. Normal nodes contain energy of E_o, the advanced nodes of fraction (m) are having (a) times extra energy than normal nodes equal to $E_o(1+a)$ whereas, super nodes of fraction m_o are having a factor of (b) times more energy than normal nodes so their energy is equal to $E_o(1+b)$.

D. BEENISH (Balanced Energy Efficient Network Integrated Super Heterogeneous Protocol for Wireless Sensor Networks)

In this section we present details of our BEENISH protocol. The BEENISH protocol is designed by the Researcher T. N. Qureshi. The BEENISH is a more stability and lifetime as compare to other protocols and more packets send to BS as compare to other. In BEENISH the four type's energy level of nodes is introduced: Normal nodes, advanced nodes, super nodes and ultra – super nodes. The ultra – super nodes is used for CH in BEENISH because the ultra – super has high energy as compare to other nodes. High energy nodes

$$p_i = \begin{cases} \frac{p_{opt}E_i(r)}{(1+m(a+m_o(-a+b+m_1(-b+u))))E(r)} \\ \frac{p_{opt}(1+a)E_i(r)}{(1+m(a+m_o(-a+b+m_1(-b+u))))E(r)} \\ \frac{p_{opt}(1+b)E_i(r)}{(1+m(a+m_o(-a+b+m_1(-b+u))))E(r)} \\ \frac{p_{opt}(1+u)E_i(r)}{(1+m(a+m_o(-a+b+m_1(-b+u))))E(r)} \end{cases}$$

Threshold is calculated for CH selection of normal, advanced, super and ultra-super nodes by putting above values in equation below:

$$T(S_i) = \begin{cases} \frac{p_i}{1-p_i(r \bmod \frac{1}{p_i})} & if\ S_i \in G \\ 0 & otherwise \end{cases} \quad (3)$$

In the equation of $T(S_i)$, we find that nodes with greater remaining energy $E_i(r)$ at round $r$are more possibly to become CH as compare to low energy nodes. The aim of this mechanism is to efficiently divide the energy consumption in the network and extend the stability period which is defined by first node die and network lifetime defined by last node die from the start of WSN.

III. PROPOSED WORK

The improved version BEENISH protocol is proposed in which the number of rounds as well as stability of network is increased as compared to original BEENISH protocol. The ideas behind proposed BEENISH protocol are given below:

A. Multilevel Clustering:

In proposed BEENISH the multilevel clustering is employed in which five levels of nodes is defined which is better suited for defining heterogeneous environment as compared to four levels of nodes defined in the multilevel clustering model of original BEENISH protocol. It must be noted that the total energy of network is kept same as that of original BEENISH protocol. This new clustering model helps in increasing the network stability in heterogeneous network.

B. Distance based routing:

The distance between member nodes and nearby cluster heads is calculated, after calculation distance a comparison is made that ensures the minimum distance between the member node and the cluster head and then the join request message is only send to that cluster head which fulfill the condition of minimum routing distance. In this way the energy consumption via transmission of data from member node to CH is reduced to possible extent which results in improve network lifetime. So, the no of rounds gets increased to possible extent without affecting the network stability.

are more often elected as CH as compare to low energy nodes. So BEENISH is proved more efficient protocol as compare to other protocols. Because the BEENISH uses the more energy level of nodes, so BEENISH provide the better result as compared to DEEC. Let $p_i = \frac{1}{ni}$is probability of node to become CH during epoch nirounds. When all the nodes have same every level at each epoch, selecting the average probability $p_i$to be p_{opt}can ensure that there are $p_{opt}N$CHs every round and approximately all nodes die at the same time. If nodes are having different energy then nodes with more energy have $p_i$larger thanp_{opt}.

The average energy of rth round in BEENISH can be obtained as follows:

$$\bar{E}(r) = \frac{1}{N}E_{total}\left(1-\frac{r}{R}\right) \quad (1)$$

In real, WSN has more energy levels of nodes.CH is selected based on the probability for every energy level. The probability for normal, advance, super node and ultra-super nodes are given below:

$$\begin{cases} if\ S_i\ is\ the\ normal\ node \\ if\ \ S_i\ is\ the\ advanced\ node \\ if\ S_i\ is\ the\ super\ node \\ if\ S_i is\ the\ \ ultra-super\ node \end{cases} \quad (2)$$

C. Cluster head selection at each round:

The proposed BEENISH ensures that selected cluster head is different at different round. After completion of first round the previously selected cluster head is released from the role of cluster head without checking its residual energy. Instead of checking residual energy of previously selected cluster head the proposed BEENISH checks for the node which has maximum residual energy in whole cluster so that it becomes new cluster head for next round. This cycle repeat itself for the defined number of rounds. This method guarantees the uniform energy consumption of the network by selecting different cluster heads at different rounds thus the stability gets increased to possible extent without affecting the number of rounds.

Simulations show that BEENISH is more efficient protocol than DEEC, DDEEC and EDEEC for WSN containing five and multi-level heterogeneity in terms of first node die and last node die.

IV. SIMULATIONS AND RESULTS

A. Results

This section presents the results obtained for the original IBEENISH protocol and the Proposed BEENISH protocol as well as its comparison with other protocols like DEEC, DDEEC,EDEEC and BEENISH. All of the algorithms are

simulated in MATLAB. The result part is further divided into two parts that are explained below:

B. Implementation Procedure

The initial parameters taken to implement the BEENISH protocol are mentioned in Table 5.1. and the values of some of these parameters cannot be changed as they are fixed from the time of LEACH protocol.

Parameter	Description	Value
xm xym	Dimensions of Field	100m x 100m
N	No of Nodes	100
Rmax	Max no of Rounds	4000
P	Probability of a node to become CH	0.1
Eo	Initial energy of each node	0.5 J
ETX	Transmission energy of node	50*0.000000001 J
ERX	Receiving energy of node	50*0.000000001 J
EDA	Data aggregation energy	5*0.000000001 J
Efs	Energy dissipation for free space	10*0.000000000001 J
Emp	Energy dissipation for multi-path delay	0.0013*0.000000000001 J
Packet	Packet size	4000

Table 4.1 Initial parameters for implementing the BEENISH protocol

In the implementation procedure, a multilevel clustering model is employed in which the nodes with different energy levels are randomly deployed within a space region called field. The values of initial parameters are shown in table 4.1.

In first step the sink or base station is plotted with coordinates at the centre of field, as shown in Figure 4.1. It is to be noted that the distance on X and Y coordinates in Figure 4.1 is in meters. The size of field is 100 x 100m, the Figure 4.1 is zoom version to illustrate the location of the sink.

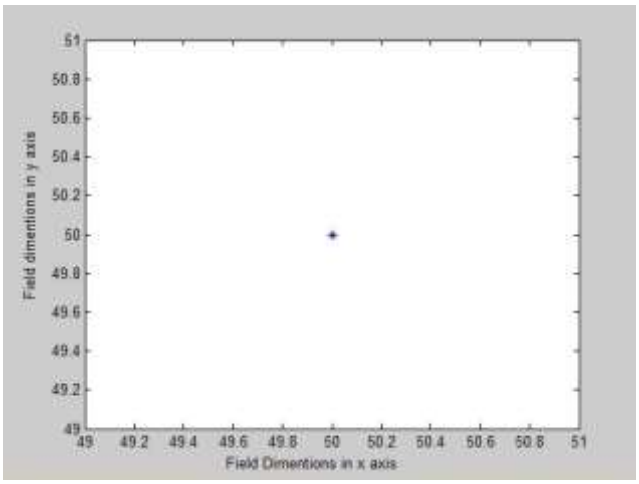

Fig. 4.1 Plot of sink/base station at center of the field.

To simulate heterogeneous environment, there are five energy levels of nodes in proposed BEENISH multilevel clustering model as compared to four level clustering model of DEEC.

Parameter	Value
Percentage of normal nodes	% of Total nodes
Percentage of advanced nodes	% of Total nodes
Percentage of super nodes	% of Total nodes
Percentage of ultra-super nodes	% of Total nodes
Percentage of super-ultra-super nodes	% of Total nodes

Table 4.2 Parameters Associated with Multilevel Clustering model

The five levels of nodes are as follows: normal nodes, advanced nodes, super nodes, ultra-super nodes and super-ultra-super nodes. The parameters associated with multilevel clustering model are given in Table 4.2.

C. Results and Comparisons

The results obtained from proposed BEENISH protocol shows improvement in number of rounds, stability of network as well as throughput of the network.

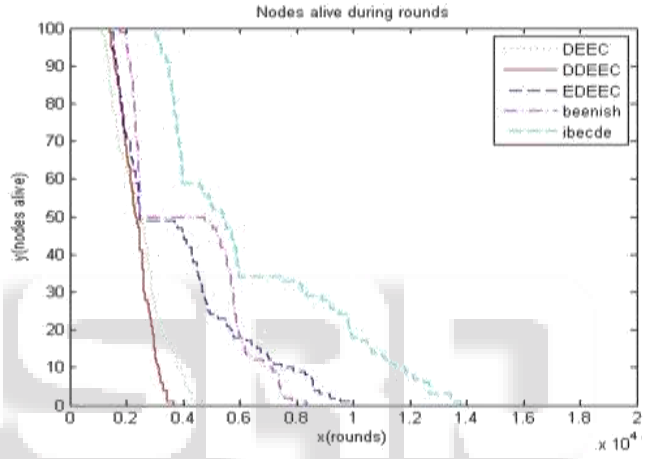

Fig. 4.2 Alive nodes v/s. number of rounds plot for original BEENISH protocol.

The Figure showing alive nodes versus number of rounds plot for original BEENISH protocol. The FND (First Node Dead) also known as stability period is at 1661th round means that the network is stable up to 1661 rounds. The LND (Last Node Dead) also known as instability period is at 6903th round also it shows that network lifetime is about 6903 rounds by using original DEC protocol.

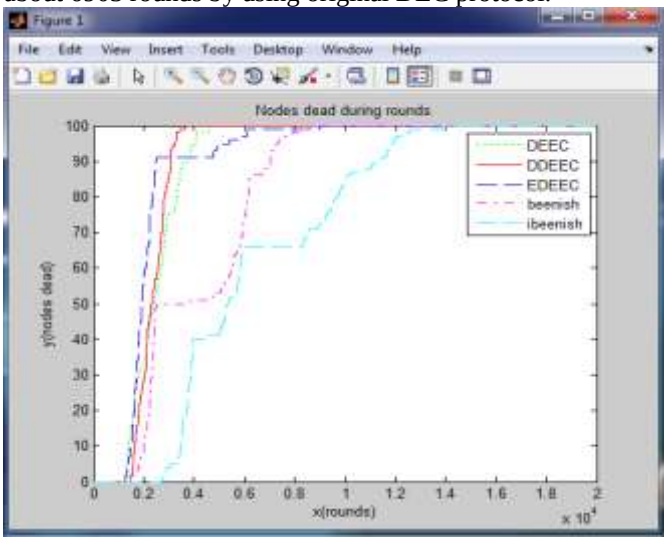

Fig. 4.3 Nodes dead during rounds in proposed IBEENISH Protocol

The Figure 4.3 showing nodes dead during rounds plot for Proposed BEENISH protocol. The FND (First Node Dead) also known as stability period is at around 2828th round means that the network is stable up to 2000 rounds. The LND (Last Node Dead) is at around 2400th round also it shows that network lifetime is about 2400 rounds by using proposed BEENISH protocol.

In Figure 4.3, the nodes alive during rounds.

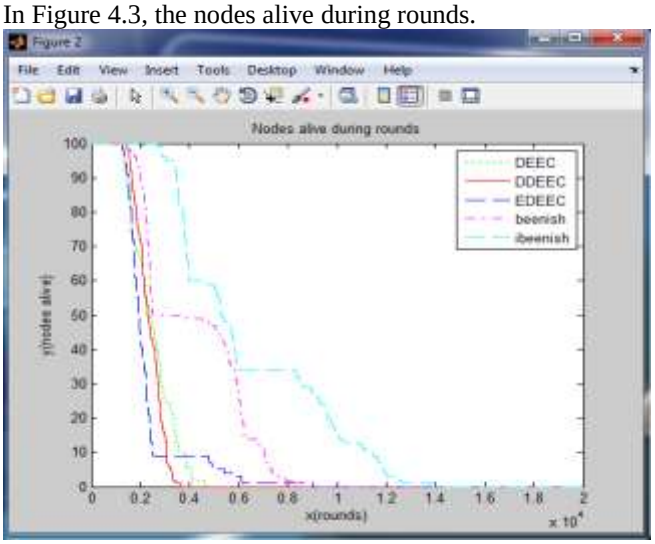

Fig 4.4 Nodes alive during rounds in IBEENISH Protocol

Figure 4.4 shows Proposed BEENISH in terms of Packets of BS versus number of rounds.

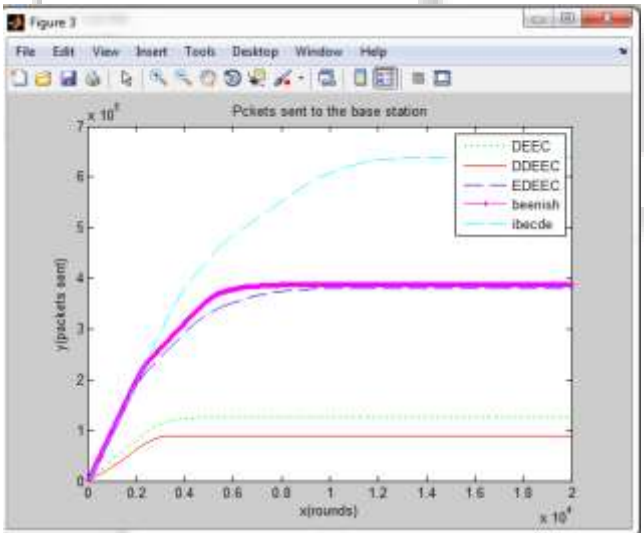

Fig. 4.5 Packets to BS v/s number of rounds plot comparison.

Table 4.5 showing comparison of proposed BEENISH and existing BEENISH protocol verifying the improvement from Original BEENISH to proposed BEENISH protocol.

Parameters	**Existing BEENISH**	**Proposed BEENISH**
Number of rounds till first node died i.e. network become stable	1661 rounds	2828rounds
No. of rounds till network survived.	2350 rounds	2400 rounds
Number of rounds till network have some energy remaining.	2350 rounds	2400 rounds
Number of rounds till rate of packets sends to base station is stable.	2350 rounds	2400 rounds

Table 4.3 Comparison between existing BEENISH protocol and the proposed BEENSIH

The proposed BEENISH performs better than other protocols. The packets sends to base station are stable as compared to DEEC,DDEEC and EDEEC and also duration of stable rate of sending packets which is better than original BEENISH protocol.

V. CONCLUSION

Our proposed IBEENISH is energy-aware clustering protocol for heterogenous WSNs, with the concept of five types of nodes. Election of CH based on residual and average energy of the network. So, nodes with high energy have more chances to get selected as CH, as compare to the low energy nodes. Proposed IBEENISH is proved to be the most efficient protocols as compared to DEED, DDEEC and EDEEC for all types of WSNs in terms of stability period, network lifetime and throughput. The simulation is done by using MATLAB. The proposed IBEENISH performs better than other protocols. The packets sends to base station are stable as compared to DEEC,DDEEC and EDEEC and also duration of stable rate of sending packets which is better than original BEENISH protocol.

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