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Comparitative Analysis Of Deec, Eddeec & Tdeec Heterogeneous Wsns

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Abstract: Wireless Sensor Networks (WSNs) have many sensor nodes having restricted battery power, which transmit sensed data to the Base Station that needs high energy consumption. Numerous routing protocols have been proposed in this regard getting energy efficiency in heterogeneous situations. Though, each protocol is inappropriate for heterogeneous WSNs. Efficiency of WSNs declines as varying the heterogeneity of sensor nodes. This paper has evaluated the performance of various Distributed Energy- Efficient Clustering based protocols like DEEC, EDDEEC and TDEEC under numerous scenarios; comprising various level of heterogeneity. MATLAB tool is used for experimental purpose. The comparison has shown that the EDDEEC has very effective results over other DEEC variants due to its special feature of T-absolute i.e. it treats all heterogeneous sensor nodes with same election probability when each node has lesser energy than T-absolute.

Keywords: WSNs, DEEC, EDDEEC, TDEEC, super nodes, T-absolute

I. INTRODUCTION

A wireless sensor network is defined as a arrangement of low size, low battery power, have limited memory and computational capability devices denoted as nodes that can sense the situation and communicate the information collected from the monitored field through wireless links; the sense data is forwarded, possibly via several hops relaying, to a base station (controller or monitor) that can use it nearby, or is attached to other networks (e.g., the Internet) through a gateway.

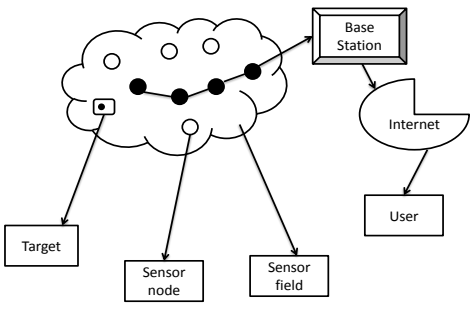

Fig.1. Architecture of WSN

A node in sensor network consists of CPU (for data processing), memory (for data storage), battery (for energy) and transceiver for receiving and sending signals or data one node to another node. The nodes can be fixed or moving. They can be location-aware or not. It can be homogeneous or heterogeneous. Sensor networks can be classified into different ways. One way is whether the nodes are independently addressable and another is the data in the network are collected. Whether addressability is needed depends on the application.

WSNs) consist of more than hundreds of low power sensor nodes. They are among the widely used types of ad-hoc wireless networks. Main objective of WSNs is to classify, collect, and development of the information within a monitoring area. A sensor node comprises of four units that are sensing, communication, processing and power supply. The sensing unit means the unlike parameters from the environment like temperature, humidity, pressure etc and changes them into an electrical signal. Processing of such signals reveals some properties about the things or events occurrence in the surrounding of sensors. After processing these signals it can be transferred to destination called as sink (base station) by using radio transmitter either direct manner or through an intermediate gateway.

The fundamental features of a sensor network are self organizing capability, dynamic network topology, having

limited battery power, short range broadcast communication, nodes mobility, routing and large scale of deployment. The purpose of the WSN involves many fields such as the armed field, reforest fire finding, earthquake detection, air pollution structure monitor and other intense environments, civil, climate and habitat monitoring, vehicle tracking, disaster management, medical observation and acoustic data gathering.

A) Sensor node

Sensor nodes are power-constrained devices, common and large distance transmissions should be kept to minimum in order to extend the network lifetime. Thus, direct communications between nodes and the sink are not confident. Because the huge part of energy in the network is devoted in wireless communication in a WSN, it has been proposed several communication protocols to understand power-efficient communication in these networks. The sensor nodes in WSN have restricted power, memory and computational capability. A sensor node makes use of its communicating mechanism in order to transmit the data, over a wireless channel, to a base station (sink).

One efficient approach is to separate the network into several clusters, each elect one node as its cluster head. The cluster head collects data from sensors in the cluster which will be merged and transmitted to the sink. Thus, only some nodes are necessary to transmit data over a long distance and the rest of the nodes will need to do only short-distance transmission. Then, some of the energy is saved and overall network lifetime can be extended.

Since the major portion of energy utilization in sensor nodes is due to communication, variety of a capable algorithm considerably reduces the communication energy. By clustering of sensor nodes into some groups called clusters, sensor nodes of each cluster send their data to definite sensor nodes in the cluster called Cluster Heads (CHs).

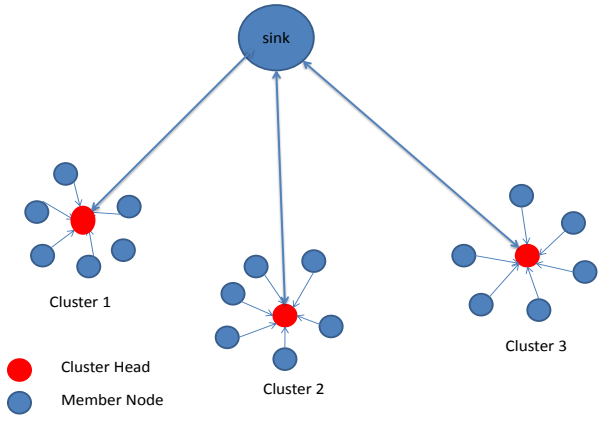

Fig.1 Sensor Nodes Showing Sink and Cluster Nodes.

B) Clustering

Clustering method enables the sensor network to work better. It increases the energy utilization of the sensor network and hence the lifetime. The most important role of cluster head is to provide data communication among sensor nodes and the base station efficiently. So the cluster head should have more energy as compared to other nodes and also it performs the data aggregation. It can be of two types of clustering techniques. They are homogeneous and heterogeneous clustering schemes. The clustering method applied in homogeneous sensor networks is called homogeneous clustering schemes, and the clustering method applied in the heterogeneous sensor networks is referred to as heterogeneous clustering schemes.

The main idea of clustering is to decrease the network traffic from node to base station. Nodes have limited battery life so to protect energy clustering technique was introduced; in which out of thousands of nodes few nodes turn into cluster head and they control the entire network. Cluster head is a node which is dependable for maintain cluster, collect data from nodes in the cluster and communicate with sink. By using clustering method it has been observed that there is huge quantity of energy that has been saved.

C) Energy efficiency

Energy is very critical issue in WSN, because of limited energy in sensor nodes, so to save energy clustering method was introduced; in which out of thousands of nodes few nodes become cluster head and they handle the entire network. Since, sensor nodes are power controlled, numerous and long-distance transmissions should be kept to least in order to extend the network lifetime. Thus, direct interactions between nodes and the base station are not confident.

One successful move toward is to partition the network into a number of clusters, each electing one node as its cluster head. The cluster head collects data from sensors in the cluster which will be combined and transmitted to the base station. Thus, only some nodes are necessary to broadcast data over a long distance and the rest of the nodes will have to do only short-distance communication. Then, more energy is saved and generally network lifetime can thus be extended. Many energy-efficient routing protocols are designed based on the clustering formation where cluster heads are chosen frequently.

D) DEEC

DEEC is clustering-based algorithm in which cluster head is selected on the basis of probability of ratio of residual energy and average energy of the network.

It is designed for heterogeneous network in which sensor nodes are advanced with more energy than normal nodes. DEEC is a distributed energy-efficient clustering

algorithm for heterogeneous wireless sensor networks which is based on clustering, when the cluster heads are elected by a probability based on the ratio between residual energy of each node and the average energy of the network.

The nodes having high outstanding and high preliminary energy will be CHs more time than with little energy nodes. DEEC is used to increase the network life time. In DEEC, there are two types of nodes such as advanced and normal nodes but DEEC is multi level heterogeneous network. There are 3 types of DEEC variants.

1). EDEEC (Enhanced DEEC)
2). DDEEC (Developed DEEC)
3). TDEEC (Threshold DEEC)

II. VARIOUS CLUSTERING TECHNIQUES

A) LEACH

LEACH (Low Energy Adaptive Clustering Hierarchy) is the first hierarchical cluster-based routing set of rules for wireless sensor network. In LEACH, the nodes classify themselves into local clusters. A dedicated node preferred as cluster-head is dependable for creating and manipulating a TDMA (Time Division Multiple Access) plan and aggregating the data coming from different nodes and sending it to the BS. The process of LEACH is divided into round. Each round consists of two phases: Set-up Phase and Steady-state Phase.

B) TEEN

The main features of TEEN protocol are that nodes have to broadcast to their CH to scatter less energy, added calculation is done only by CH to keep energy, CHs present at high level of hierarchy have to send out data which use more energy. To overcome this difficulty, all nodes will be CH for a time period T (cluster Period). In TEEN, nodes sense surroundings all the time and transmission is done only when there is a severe change.

HT is the total value of a quality to generate on its transmitter and account to its respective CH. HT allows nodes to transmit data, if the data occurs in the range of interest. Therefore, a significant reduction of the transmission setback occurs. Moreover, ST is the small change in the value of the sensed quality. Next broadcast occurs when there is a minute change in the sensed quality once it reaches the HT. So, it further decreases the numeral of transmissions**.**

C) HEER

HEER (Hybrid energy efficient routing protocol) improve the stable area for clustering hierarchy procedure for an immediate network in homogeneous and heterogeneous surroundings. It has been applied the original and remaining energies of the nodes to turn into CH related to that of DEEC. It does not necessitate any global information of energy at any election round. When cluster arrangement is done, the CH transmits two threshold values, i.e. hard threshold and soft threshold. Hard thresholding is the absolute value of an attribute to trigger a sensor node whereas Soft thresholding is the small change in the value of a sensed attribute.

The residual energies of the sensor nodes are used to find the optimal cluster heads. It does not necessitate any global information of energy at any time during the lifetime of WSNs. When cluster establishment is finished, the CH communicates binary threshold values selected using HS values, i.e. hard threshold (HT) and Soft threshold (ST). Every sensor node senses its situation frequently and if a constraint from the attributes set exceeds its HT assessment, the sensor node changes its stage and communicates the data packets.

The Confidence Value (CV) on that first broadcasting happens is stored in an interior variable in the sensor node called Sensed Value (SV). It decreases the amount of broadcasts. Now the sensor nodes will again communicate the packets in identical cluster time when the difference of the $CV$and SV is more than the ST i.e. if the CVvaries from $SV$by a quantity equivalent to or more than ST, then it supplementary decrease the number of communications.

D) DDEEC (Developed DEEC)

DDEEC uses same way for finding of typical energy in the network and CH group algorithm based on residual energy as implemented in DEEC. Difference between DDEEC and DEEC is centred in saying that defines opportunity for normal and advanced nodes to be a CH.

It is found that nodes with more residual energy at round r are more probable to become CH, in this way nodes having advanced energy main beliefs or advanced nodes will become CH more often as compared to the nodes with lower energy or normal nodes .A point comes in a arrangement where advanced nodes having similar remaining energy like normal nodes. Although after this point DEEC continues to punish the advanced nodes so this is not best way for energy allocation because by doing so advanced nodes are continuously a CH and they expire more quickly than normal nodes.

To keep away from this rough case, DDEEC makes some changes to keep away advanced nodes from being punished over and again.

E) EDEEC (Enhanced DEEC)

It used perception of three stage heterogeneous network. It contains three types of nodes normal, advanced and super nodes based on original energy.

p_i is the possibility used for CH collection and p_{opt} is indication for p_i.

$$p_i = \frac{p_{opt}\, E_{i(r)}}{1+m(a+m_{0b})E(r)} \text{ if } s_i \text{ is the normal node}$$

$$p_i = \frac{p_{opt}\,(1+a)E_{i(r)}}{1+m(a+m_{0b})E(r)} \text{ if } s_i \text{ is the advanced node}$$

$$pi = \frac{p_{opt}\,(1+b)E_{i(r)}}{1+m(a+m_{0b})E(r)} \text{if} s_i \text{ is the super node}$$

F) TDEEC (Threshold DEEC):
It uses similar method for CH selection and standard energy assessment as proposed in DEEC. At each about nodes has been determined whether it can become a CH or not by choosing a random number between 0 and 1. If quantity is less than threshold then nodes want to become a CH for the given round.

In TDEEC, threshold value is used to and based upon that rate a node decides whether to turn into a CH or not by introducing residual energy and average energy of that round with respect to best likely no of best possible no of CHs.

G) EDDEEC (Enhanced Developed DEEC)
It is based on the possibility for CH choice based on original, remaining energy stage of the nodes and usual energy of network as supposed in DEEC.
The usual energy of r round is given as:

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

R denotes total rounds during network lifetime:

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

E_{round} is the energy dissipate in a network during single round and calculated as:

$$E_{round} = L(2NE_{elec} + NE_{DA}k \in_{mp} d^4_{toBS} + N\in_{fs} d^2_{toCH})$$

III. RELATED WORK

A Protocol E-DEEC [1] has been proposed which include heterogeneity in the network by introducing the super nodes having energy more than normal and advanced nodes. In this it has been checked DEEC, EDEEC, DDEEC, and compared this protocols with recommended method [2] Enhance distributed energy efficient clustering with Particle Swarm Optimization (EDEEC-PSO) under different heterogeneity in order to conclude the behaviour of those protocols. It has been proposed scheme [3] that selects the CH not at random, but considering the residual energy when the energy level drops below 50% of the initial energy.

For each node, the CH to link is determined by not only the signal power but also residual energy of the CH. In this it has been proposed [4] (EEHC) energy efficient heterogeneous clustering protocol for WSNs. Then, the energy efficiency and ease of deployment make EEHC a popular and robust protocol in order to improve the lifetime, stability period and performance of the network.

A new protocol EESAA [5] (Energy Efficient Sleep Awake Aware) protocol is there. In this CHs are chosen on the basis of residual energy nodes also switches between sleep and active modes in order to reduce energy consumption. In this a new protocol is proposed TDEEC [6] which should be designed for heterogeneous WSNs, by modifying the threshold value of a node based on which it decides to be a CH or not.

In homogeneous WSNs [7] all of the nodes have the same possibility to be transformed into cluster heads; it cannot be used in heterogeneous WSNs (HWSNs). The advances in micro-electromechanical technology [8] have made the expansion of such sensors an option. While WSNs are more and more equipped to touch composite functions such as data aggregation, information fusion, calculation and broadcast activities, these sensors need using their energy efficiently to expand their effective network existence time. Since sensor nodes are flat to energy drainage and failure, thus stable re-energizing is required as elderly sensor nodes die out. This can break and threshold of the network system if energy is not properly utilized.

The WMSNs [9] put forward higher requirements for the dependability of the broadcast of multimedia data, so the research on the consistency of routing is focused in WMSNs. Traditional WSNs routing protocols are mostly targeted on minimal energy utilization in WMSNs, however, the beginning of video, images and other multimedia information makes QoS a very vital issue, not only to consider the energy utilization of routing protocol plan, scalability and fault acceptance of the networks, but also to obtain immediate and reliability into consideration.

In this, a protocol that is based on SGCH [10] makes the amount of clusters is equal to expectation. All the nodes are separated into groups based on the initial energy that extend the battery duration. MH-DEEC and H-DEEC [11] look capable; there are still many challenges like smaller instability time, sensor nodes localization and intrusion among the sensor nodes that want to be solved in routing of sensor networks. Then the mobility of sink [12] in all protocols is used to contrast their performance. HTEEN outperforms in case of mobile sink and all further protocols perform enhanced in case of static sink.

A protocol called as DDEEC [13] is used in which all sensor nodes separately elects itself as a cluster head based on its original and remaining energy and devoid of

any global information of energy at every election surrounding. To enlarge more the DEEC protocol performances, the DDEEC implemented a fair and lively way to allocate the spent energy more justifiably between nodes. In this it has been proposed a new protocol called (ACH) [14] Away Cluster Head. In this it has been forced those nodes which have not becomes CHs and close to each other or intersecting. The energy of nodes are conserved in this way and network lifetime and stability period is prolonged.

In this it has been compared the act [15] of DEEC, E-DEEC, T-DEEC and DDEEC for heterogeneous WSNs containing diverse level of heterogeneity. It has been shown that DEEC and DDEEC execute well in the networks containing high energy variation between normal, advanced and super nodes.

A protocol as EDDEEC [16] protocol that is adaptive energy conscious protocol which vigorously changes the possibility of nodes to become a CH in a fair and efficient way to allocate equal quantity of energy between sensor nodes. A protocol called as energy efficient heterogeneous clustered scheme for WSN (EEHC) is used [17] in terms of network lifetime and numeral of messages established by base station.Thus EEHC is further efficient in provisions of growing the network lifetime. A protocol called as DEEC [18] an energy-aware adaptive clustering protocol used in heterogeneous WSN. To manage the energy payments of nodes by resources of adaptive approach, DEEC use the usual energy of the network as the mention energy.

Thus, DEEC does not necessitate any overall information of energy at all election adjoining. For multi-hop data forwarding [19], from cluster head to base station, distance among the forwarding cluster head and in-between cluster head shall be maintained around same, during diverse data gathering rounds to make sure equal amount of energy utilization due to their data forward to or towards the sink. A protocol HEER [20] is used which minimize the energy utilization by first distribute weight to all high energy nodes and then on to small energy nodes.

IV. SHORTCOMINGS OF EARLIER WORK

The survey has shown that the every WSNs protocol has some limitations; i.e. no one is perfect in every case. In the most of the existing literature most of the researchers has neglected at least one of the following:

1. The most of the existing researchers has neglected the use of the distance between the sensor node and the base station while selecting the cluster head.
2. The optimum numbers of clusters in every round are not consistent in LEACH as well as in DEEC variants.
3. The use of the hard and soft thresholding is also neglected in the most of existing research.

V. SIMULATION AND RESULTS

In this section, it has been simulated different clustering protocols in heterogeneous WSN using MATLAB and for simulations it uses 100 nodes at random placed in a field of element area. For simplicity, it has been considered all nodes are either fixed or micro-mobile and ignore energy loss due to signal impact and interfering between signals of different nodes that are due to dynamic random channel conditions. In this scenario, it is considering that, BS is located at center of the network field.

It has been implemented DEEC, EDDEEC and TDEEC for three-level and multi-level heterogeneous WSNs. Scenarios describe values for number of nodes dead in first, teenth and all dead values as well as values for the packets sent to BS by CH at different values of parameters area and initial energy and rest all parameters are constant in every comparison such as m, x, a, b. Network lifetime become high or low according to area defined.

Table 1 Value of Parameters

Parameter	Values
Area (x, y)	100,100
Base station (x, y)	50,150
Nodes (n)	100
Probability (p)	0.1
M	0.3
X	0.3
A	3
B	1.5
Initial Energy	0.1
Transmitter_Energy	$50*10^{-9}$
Receiver_Energy	$50*10^{-9}$
Free Space(amplifier)	$10* 10^{-13}$
Multipath(amplifier)	$0.0013*10^{-13}$
Effective Data Aggregation	$5*10^{-9}$
Maximum Lifetime	1500
Data Packet Size	4000

In heterogeneous WSN, it has been used radio parameters mentioned in Table 1 for different protocols deployed in WSN and estimate the performance for three level heterogeneous WSNs. Parameter m refers to fraction of advanced nodes containing extra amount of energy $a$in network whereas, xis a factor that refers to fraction of super nodes containing extra amount of energy bin the network.

From Fig. 2 and 3, we examine that first node for DEEC, EDDEEC and TDEEC dies 113, 145, 287 rounds respectively. Teenth node dies at 133, 197, 359 rounds

respectively. All nodes are dead at 714, 1297, 836 rounds respectively. It is obvious from the results of all protocols that in terms of stability period, TDEEC performs best of all, EDDEEC performs better than DEEC but has less performance than TDEEC. Stability period of DEEC and EDDEEC is lower than TDEEC because the probabilities in TDEEC is defined separately for normal, advanced and super nodes whereas, DEEC and EDDEEC do not use different probabilities for normal, advanced and super nodes so their performance is lower than TDEEC. However, results of all the protocols that in terms of network lifetime, EDDEEC performs best of all, TDEEC performs better than DEEC but has less performance than EDDEEC. TDEEC performs better than DEEC.

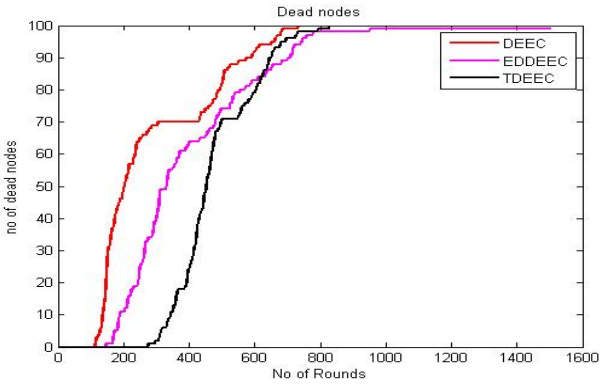

Fig.2. Node dead during rounds

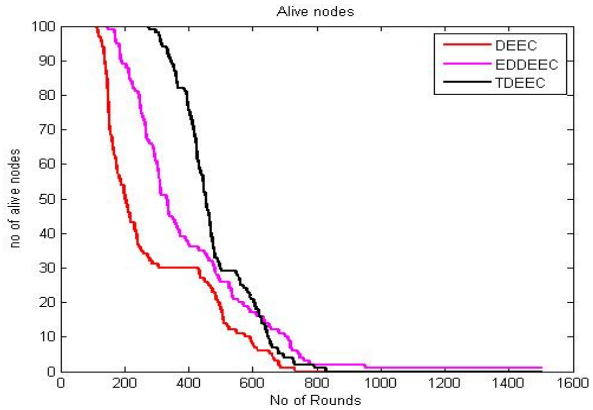

Fig.3. Node alive during rounds

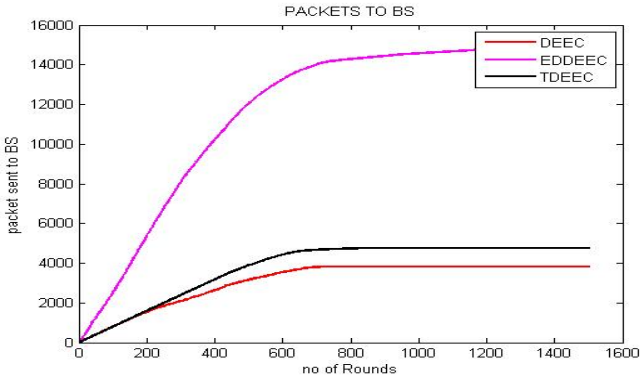

Fig.4. Packets sent to base station

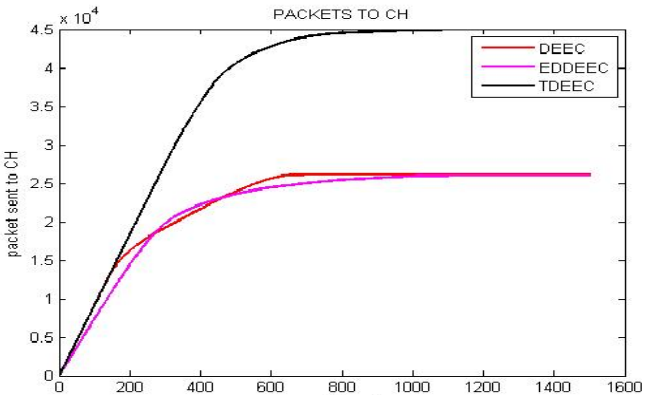

Fig.5. Packet sent to CH

Similarly, by examining results of Fig.4 packets sent to the BS by DEEC, EDDEEC and TDEEC have been defined. Now we see that packets sent to BS for EDDEEC is almost higher than TDEEC and DEEC. TDEEC performs better than DEEC in sending the packets to BS. DEEC performs almost poor of all. In Fig. 5, packets sent to CH by EDDEEC, TDEEC and DEEC. TDEEC performs best of all. EDDEEC performs better than DEEC in sending the packets sent to CH but it has less performance than TDEEC.

Now considering second case in which the parameter change to area, x axis=150 & y axis=150, initial energy=0.25 and network lifetime=3500. From Fig. 6 and 7, we examine that first node for DEEC, EDDEEC and TDEEC dies 247, 275, 736 rounds respectively. Teenth node dies at 319, 508, 876 rounds respectively. All nodes are dead at 1730, 0, 2782 rounds respectively. It is obvious from the results of all protocols that in terms of stability period, TDEEC performs best of all, EDDEEC performs better than DEEC but has less performance than TDEEC.

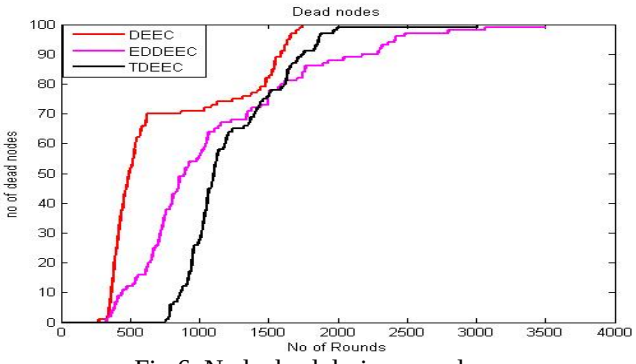

Fig.6. Node dead during rounds

Stability period of DEEC and EDDEEC is lower than TDEEC because the probabilities in TDEEC is defined separately for normal, advanced and super nodes whereas, DEEC and EDDEEC do not use different probabilities for normal, advanced and super nodes so their performance is lower than TDEEC. However, results of all the protocols that in terms of network lifetime, EDDEEC performs best

of all, TDEEC performs better than DEEC but has less performance than EDDEEC. TDEEC performs better than DEEC. Similarly, by examining results of Fig. 8, packets sent to the BS by DEEC, EDDEEC and TDEEC have almost same as in case 1. In Fig. 9, packets sent to CH by EDDEEC, TDEEC and DEEC have almost same in case 1.

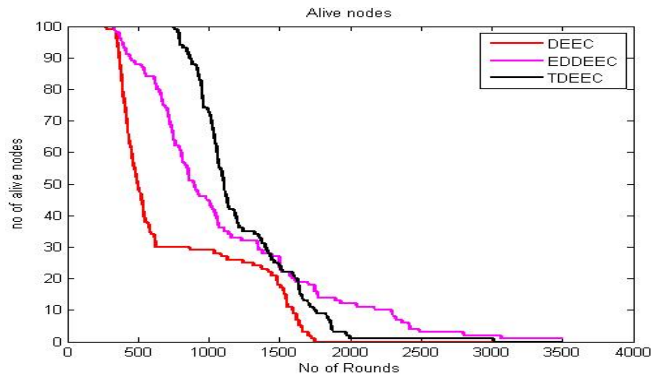

Fig.7. Node alive during rounds

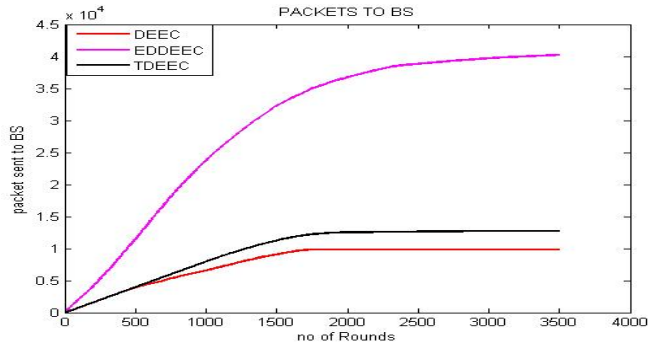

Fig.8. Packets sent to base station

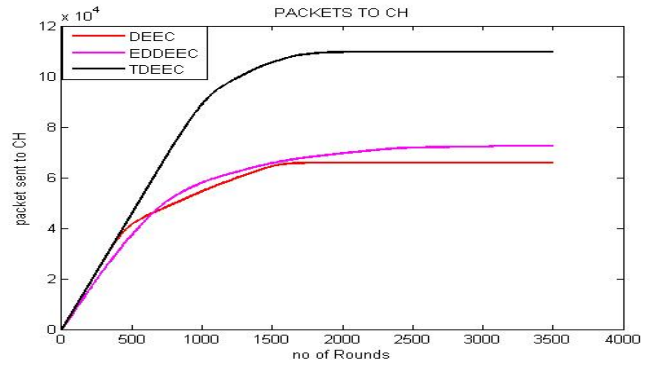

Fig.9. Packets sent to CH

Now again considering third case in which parameters changes to area, x axis=50 & y axis=50, initial energy=0.5 and network lifetime=4000. From Fig. 10 and 11, we examine that first node for DEEC, EDDEEC and TDEEC dies 500, 627, 1233 rounds respectively. Teenth node dies at 584, 765, 1658 rounds respectively. All node are dead at 2690, 0, 3227 rounds respectively. It is obvious from the results of all protocols that in terms of stability period, TDEEC performs best of all, EDDEEC performs better than DEEC but has less performance than TDEEC. However, results of all the protocols that in terms of network lifetime, EDDEEC performs best of all, TDEEC performs better than DEEC but has less performance than EDDEEC. TDEEC performs better than DEEC.

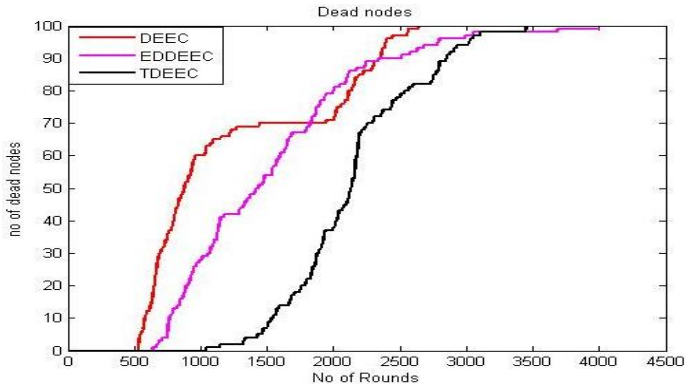

Fig.10. Node dead during rounds

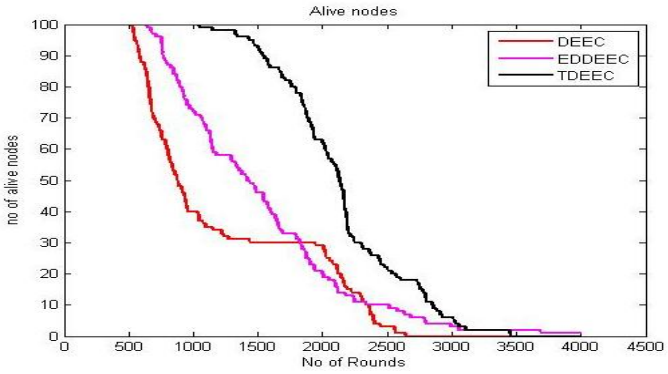

Fig.11. Node alive during rounds

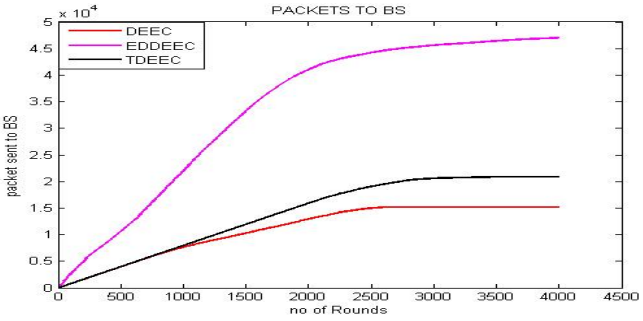

Fig.12. Packets sent to base station

Similarly, by examining results of Fig. 12, packets sent to the BS by DEEC, EDDEEC and TDEEC have been defined. Now we see that packets sent to BS for EDDEEC is almost higher than TDEEC and DEEC. TDEEC performs better than DEEC in sending the packets to BS. DEEC performs almost poor of all. In Fig. 13, packets sent to CH by EDDEEC, TDEEC and DEEC. TDEEC performs best of all. EDDEEC and DEEC are almost same in sending the packets to CH.

Now considering the fourth case parameters area, x axis=75 & y axis=75, initial energy=0.75, network lifetime=1500. From Fig. 14 and 15, we examine that first node for DEEC, EDDEEC and TDEEC dies 118, 148, 235 rounds respectively. Teenth node dies at 134, 202, 377 rounds respectively. All nodes are dead at 700, 1383, 962 rounds respectively. It is obvious from the results of all protocols that in terms of stability period, TDEEC performs best of all, EDDEEC performs better than DEEC but has less performance than TDEEC. Stability period of DEEC and EDDEEC is lower than TDEEC. However, results of all the protocols that in terms of network lifetime, EDDEEC performs best of all, TDEEC performs better than DEEC but has less performance than EDDEEC. TDEEC performs better than DEEC.

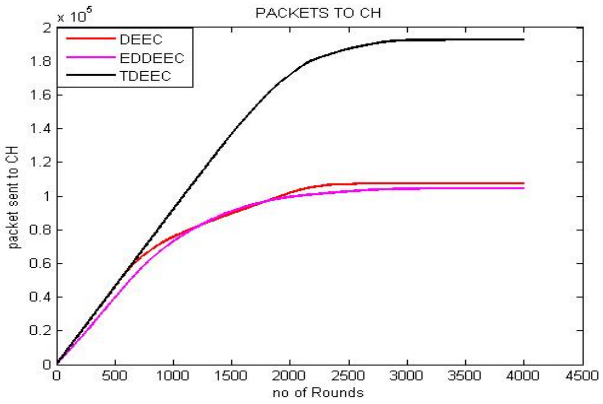

Fig.13. Packets sent to CH

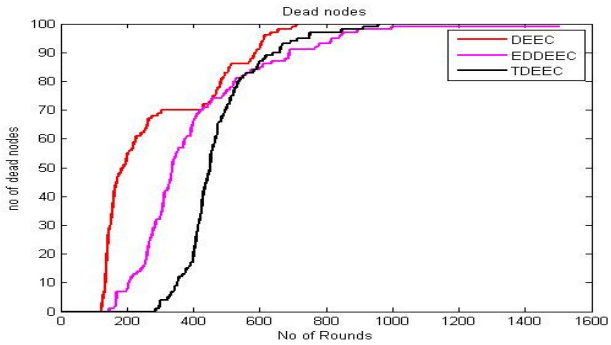

Fig.14. Node dead during rounds

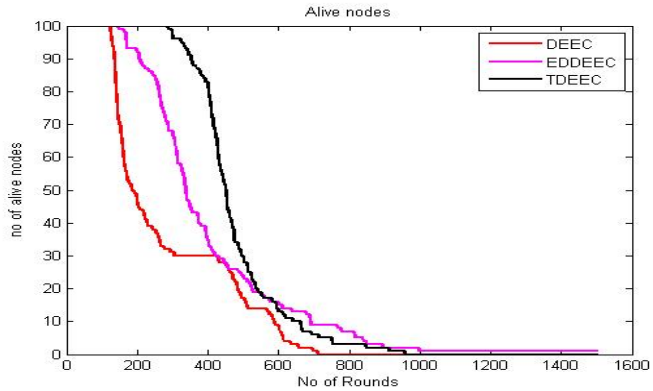

Fig.15. Node alive during rounds

Similarly, by examining results of Fig. 16, packets sent to the BS by DEEC, EDDEEC and TDEEC have been defined. Now we see that packets sent to BS for EDDEEC is almost higher than TDEEC and DEEC. TDEEC performs better than DEEC in sending the packets to BS. DEEC performs almost poor of all. In Fig. 17, packets sent to CH by EDDEEC, TDEEC and DEEC. TDEEC performs best of all EDEEC and DEEC are almost the same in sending the packet to CH.

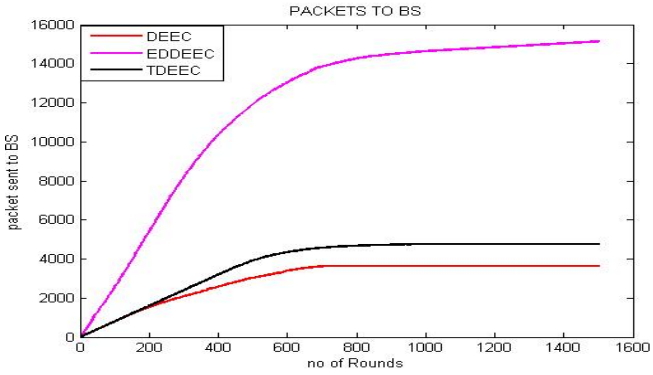

Fig.16. Packets sent to base station

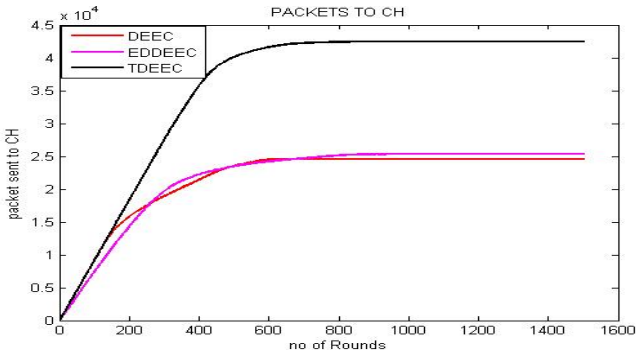

Fig.17. Packets sent to CH

CONCLUSION AND FUTURE SCOPE

This paper has evaluated and compares the well-known heterogeneous WSNs energy efficient protocols i.e. DEEC variants. The comparison has shown that the EDDEEC has quite effective results over the other DEEC variants. Although EDDEEC has shown quite significant results over existing WSNs protocols but it has neglected the use of waiting time of node to become CHs. So may some nodes will not become CHs for a long time even they have more confidence to become CHs.

So to overcome this problem in near future it would be used minimum fuzzy logic to cover the sensor field in the most efficient way. Fuzzy logic will have ability to overcome the problem of the too small and too high cluster heads. No implementation is considered in this paper so in near future we will use suitable simulation tool to implement the modified EDDEEC protocol.

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