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Performance Analysis on Energy Efficient Protocols in Wireless Sensor Networks

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Abstract:Wireless sensor networks (WSNs) were projected to wind up plainly the texture of our condition and society. However, they are yet not ready to defeat various operational difficulties, for example, limited system lifetime, which suppress their general deployment. To prolong WSN lifetime, most of the existing clustering schemes are geared towards homogeneous WSN and heterogeneous WSN. This paper is a comparative review on the critical problem of system lifetime of WSN and extravagantly looks at seven distinguished but prominent routing protocols namely LEACH, TEEN, PEGASIS, DEEC, DDEEC, EDEEC and EDDEEC for some general situations.

Keywords:Wireless Sensor Networks (WSN), Energy, Clustering, Sensing element and Cluster Head (CH)

I. INTRODUCTION

Due to tremendous scope of applications, recent scientific developments prepares an approach to those events about wireless sensing element networks [1] which might be imagined and examined to develop the material of our environment and specific social order. The variety of applications include health care [2], military, critical infrastructure protection [3, 4], and non-military personnel (e.g., disaster management). In addition, it is likewise unrealistic to restore or exchange the battery of as of now of deployed nodes [1]. Hereafter, many applications of WSN requires an operation for energy-efficient network to persist efficient for some time. The real energy consumption is done because of communication, and nodes disseminate a massive quantity in their strength in routing knowledge from sensing elements to the BS. Rather than direct transmission energy mechanism, sensing elements have to utilize various hop to hop communications in vision of reserved power and it's varying. The routing procedures which can be existed in WSN can either be ordered into centralized way or distributed manner. The centralized approach needs whole network's state data and consequently is not practical because of its high communication value [6]. And just in case of distributed approach, it simply needs the network data and is a lot of sensible than past one. [7].

In addition, the distributed algorithms make use of a concept which is both consistent with node and in step with cluster facts distribution in an organized request. Rather than conventional systems, sensor systems demonstrate a kind of an arrangement of patterns of disproportionate traffic. This arrangement is increasing nowadays due to functionalities of WSN, i.e., nodes frequently send detected data to the BS, and now and again, BS directs manipulates messages to nodes. An enormous percentage of these applications utilize severe resource-constrained sensors which reports information to base stations (BS) both explicitly and by way of relationship through cluster heads (CHs). The system availability and network coverage are the two noteworthy problems in WSN because of arbitrary distribution of nodes [5].

The traffic of WSNs can be categorized into two ways i.e. single hop and multi-hop. However due to amount of transmit/receive nodes, the multi-hop can be further divided into two category [2]. Some routing protocols, especially cluster-dependent procedures, assume a vital part when there is a task to achieve efficiency of energy. As indicated by above technique, individuals from a similar cluster pick a Cluster Head [8] and nodes having a place with that cluster send detected information to Cluster Head which advances the combined information to Base Station [9-12]. Clustering of nodes may be performed either in homogeneous wireless sensor networks or heterogeneous wireless sensor networks [13]. Range of nodes ready with comparable degree of energy in homogeneous wireless network, and in heterogeneous wireless networks, nodes has not same level of energy, even their energy levels differs.

Low-energy adaptive clustering hierarchy (LEACH) [11] is proposed for homogenous Wireless Sensor Networks (WSNs) and LEACH's performance degrades in case of heterogeneous systems. Distributed energy-efficient clustering (DEEC) [14], developed DEEC (DDEEC) [15], and enhanced DEEC (EDEEC) [16] are the examples of heterogeneous WSN protocols.

In this paper, the performance of various clustering algorithms for saving energy in wireless sensor networks is examined**.** In this sensor network, transmission of sensed data from node to base station is done through cluster head. The cluster-heads aggregates the data of their respective cluster members and transmits it to the base station (BS), from where the end-users are able to access the data. However, the nodes are equipped with the same energy in the beginning and due to the radio communication, the networks cannot evolve equably for every node in expending energy, characteristics, random events such as short-term link failures or morphological characteristics of

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the field .Therefore, WSN are more possibly can be heterogeneous networks and homogeneous networks. The protocols which are mentioned above should be able to fit for the characteristic of both heterogeneous and homogenous wireless sensor networks.

A. Features of WSNs

Contrasting to conventional wireless sensing element networks like MANETs, WSN has a few precise features which might be given under:

a) *Dynamic Network Topology*: The foremost characteristic of WSN is dynamic network topology. In this, the topology of dynamic network topology frequently changes as often as possible and due to this nature the nodes can be included or removed and that leads to sensing node disappointments, energy reduction, or channel diminishing (fading).

b) *Application Specific:* WSN is specific to applications and the requirement of design for the system fluctuates with essential application.

c) *Power constrained*: The sensing element ought to be power constrained because nodes are of portable nature and they have enormously limited energy, computation and storage capacities. So we can consider it as an important design in thought of WSN.

d) *Self-configurable:* In self-configurable environment, the nodes are randomly arranged without assistance of any suspicious planning. Once the nodes are randomly deployed then nodes needs to autonomously configure themselves into a correspondence arrange.

II. WSN ROUTING PROTOCOLS

The optimized energy utilization within the system intends to execute the routing algorithms i.e. specifying some set of rules so that we get to know how the message packets transfers from source to sink efficiently in a wireless sensor alongside less power utilization. Figure 1 describes the types of Wireless Sensor Networks WSNs [18] routing protocols.

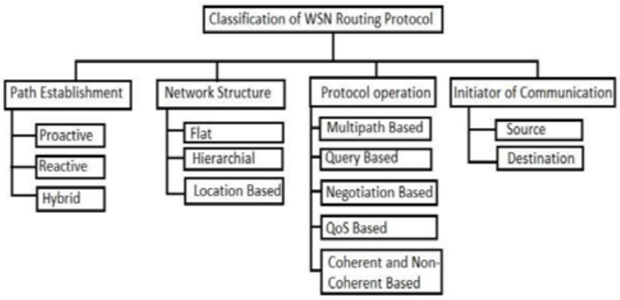

Fig 1: Types of WSN Routing Protocols

A. Course Establishment

a) *Pro-Active (or Table Driven) Routing:* Proactive routing can be defined in this manner that the protocols register all the routes using traditional routing approaches.
For example, in DSDV, they actually needed distance vector and after that they stores these routes in a routing table for every node. At that point as soon as the route changes, the change is spread periodically throughout the network. Since WSN includes a large number of nodes and requires a better charge for the refreshing of routing chart and for every sensing element, the routing table would need to keep tremendous charge and hence proactive protocols are wrong for WSNs.

b) *Reactive (or on-demand) Routing Protocols:* These protocols determine routes from source to sink just when they're required by utilizing broadcast route question or direction request question/messages within the system.

c) *Hybrid protocols*: Hybrid protocols contain the combination of Proactive Routing protocols and Reactive Routing protocols.

B. Network Structured Protocols

a) *Flat-based Routing Protocols:* Each node plays an equivalent role at same level while executing a detecting job and all sensing elements are associates.

b) *Hierarchical-based Routing Protocols:* On this shape of routing, sensing elements are organized into groups, where the elements which have the lower energy act as Cluster Members (CM) and which have better energy act as cluster head (CH),of cluster which can be utilized to gather information from their individual cluster member. At that point the detected information is send to cluster heads by sensing elements where all combined information is carried out to diminish the rate of amount of transmitted messages to sink. This procedure builds the lifetime of system lifecycle, system scalability, and system dependability.

c) *Location-based Routing Protocols:* In this kind of routing procedures, communication between sensing elements is carried out on the idea of position of every sensing node with another sensing node. This separation or position can be measured in two routes- both with the aid of separation between two neighboring nodes which can be approaching by incoming signal quality from the supply or with the aid of the use of utilizing Global Positioning System (GPS).

C. Protocol Operation

a) *Multipath-based Routing:* regardless of utilizing single path, multipath based routing utilizes multiple paths in way to expand adaptation to internal failure of the system on cost of expanding power utilization and overhead of directing periodic messages to the alternative routes with a particular end goal to keep them alive.

b) *Query-based Routing:* During this routing operation, the destination sensing element spreads a question/query to the network for sending the information. The sensing element which matches with the query/question of information that sends the information to desired node. Oftentimes the queries which are utilized for sending the information exist in consistent language.

c) *Negotiation-based Routing*: This sort of routing protocol continues choices about

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correspondence and that relies on upon accessibility of resources in the system, suppressing identical redundant information and keep repetitive information from being sent to the following up and upcoming sensor node.

d) *QoS-based Routing:* With a specific end destination to fulfill some quality of service (QoS) metrics like delay and bandwidth, capacity, QoS-based routing protocol settles the system between power utilization and information value.

e) *Coherent-based Routing:* In this routing protocol, the constrained preparing of information is either in light of or done by minimum processing (intelligible) or by full handling (non-coherent).

III. CLUSTERING ALGORITHMS AND PROTOCOLS FOR WSN

There are several different approaches to distinguish and categorize the clustering algorithms used in Wireless Sensor Network (WSN). Most of the identified algorithms for WSNs can be distinguished on the basis of Cluster Head Selection process.

A. Energy-Efficient Communication Protocol for Wireless Micro sensor Network (LEACH)

There is different Energy-Efficient Communication Protocol aimed at Wireless sensor Network. LEACH stands for Low-Energy Adaptive Clustering Hierarchy. It is the primary hierarchical routing protocol in Wireless Sensor network [11].

In this protocol (LEACH), sensing elements are separated into just two classes; one is normal sensor nodes and another one is cluster heads (CH). At first interval, the ordinary sensing elements are assembled and shape clusters and from each cluster, one element is assigned as a Cluster Head (CH node). The procedure of CH selection is a random selection procedure where every node is allocate a random value and this is compared with a threshold value (T(n)). If the node's random value is a lesser amount than the T(n), then the individual node can act as a CH. The T(n) is computed by the following formula which is given below. In this way, in every cluster, there occurs one CH.

$$T(n) = \begin{cases} \dfrac{P}{1 - P * \left(r \bmod \frac{1}{P}\right)} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

Where,

n = number of nodes.

p = the priori possibility of a node being chosen as a cluster head.

r = an arbitrary number between 0 and 1 that is chosen by a sensing element. If this arbitrary number is less than the threshold value T(n), then the particular node come to be the cluster-head.

G =the set of nodes that have not been as cluster-heads in the last "1/p" events.

At first ordinary sensor nodes diffuse their data to their respective CHs. On getting these data, the CHs combined them in a compressed form and additional carry them to the BS. Finally BS received all compressed data from dissimilar CHs present in the network.

B. Power-Efficient Gathering Sensor Information Systems (PEGASIS) [19]

Power-Efficient Gathering Sensor Information Systems (PEGASIS) is well-thought-out as an optimization of the primary LEACH algorithm. But instead of arranging sensing elements in clusters as done in LEACH, this algorithm frames chains of the sensing elements. By utilizing this construction, every sensing element transmits to and gets from just a single nearest node of its neighbors and with this determination, the nodes directs the energy of their transmissions [12]. The node accomplishes the combination of data and advances the aggregate data to the node in the chain which imparts by the sink. At every single round, one node in the chain is chosen to communicate with the sink and the chosen chain is developed by the greedy algorithm. The following algorithm explains the PEGASIS.

Step1: The closest node to BS is elected as the chain LEADER.

Step2: The source nodes that want to transmit data will transfer the data to its closest neighbor.

Step3: The forwarding node forwards the data to closest neighbor.

Step4: The procedure proceeds until information scopes to the chain LEADER.

Step5: The chain LEADER exchanges the information to the BS.

C. Threshold sensitive Energy Efficient Sensor Network Protocol (TEEN)

It is centered at reactive networks and is that the primary protocol created for reactive networks. In this plan, at each cluster adjustment time, the cluster-head transmits data to its cluster members. [20].

- ***Hard Threshold (***HT)**:** Hard Threshold is considered as a threshold value for the detected trait. It is the approximation of the characteristic on the far side that, the node which is detecting this limit esteem need to change (switch) on its transmitter and give report of this changing to its cluster head.
- ***Soft Threshold (***ST)**:** Soft Threshold is little bit different from hard threshold i.e.in this there is a minor change in the estimation of the detected property which triggers the sensing element to switch on its transmitter so they can transmit the sensing elements with the goal that they can detect their condition persistently.

The first run through, a framework from the arrangement of attributes reaches to its hard threshold cost, and the sensing element switches on its transmitter sends the detected or identified information. The detected cost of the sensor node is secured in an internal variable (called the *sensed value (SV)).* The sensing elements will together the transmitted data in the present cluster time frame, exactly when both the going with conditions is legitimate:

a) The existing value of the detected attribute is larger than the hard threshold.

b) The existing value of the detected attribute fluctuates from sensed value *SV* by an entirety comparable to or more conspicuous than the soft threshold (>= soft threshold).

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D. Distributed Energy Efficient Clustering Algorithm for Heterogeneous Wireless Sensor Networks (DEEC)

In DEEC the cluster heads are picked through likelihood in perspective of the extent between residual energy of every sensing element and therefore the average energy of the network. The methodology used to turn out to be the cluster heads for nodes are totally distinctive in DEEC because of their primary and remaining energy. The writers have admitted that each sensor nodes of sensor system are furnished with dissimilar quantity of power. In this protocol's algorithm, two levels of heterogeneous nodes are measured and after that an overall answer for multi-level heterogeneity is originated To avoid that each element ought to know the global data of the system, DEEC evaluates the suitable worth for the life-time of system, that is utilized to process the reference energy so that every sensing element have to distribute through a round. In this approach, as behavior of cluster count is of variable nature which leads to uneven clusters [14].

Cluster Head Selection Algorithm for DEEC:

Step-1: Evaluate the alive nodes.
Step-2: Compute Cluster Head percentage.
Step-3: Compute $E_i$and $E_r$of each node that is alive. // E_i = initial energy &E_r = residual energy of node.
Step 4: R= E_{total}/E_{round} // R = total rounds of system lifetime,
Step-5: At present round, determine the average energy of network

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

// E_{total} =total energy of the network &E_{round} =energy expenditure throughout each round.
Step-6: Now on the premise of leftover energy and average power of node, decide the possibility of every node to turn out to be CH based by given under equation:

$$p_i = p_{opt}\left[1 - \frac{\bar{E}(r)-E_i(r)}{\bar{E}(r)}\right] = p_{opt}\frac{E_i(r)}{\bar{E}(r)}$$

Step-7: If Node has not been a cluster head in past rounds.
Step-8: Node belongs to set G where G is set of nodes fit to become a CH & choose an arbitrary number b/w 0&1.
Step-9: If Random Number selected is less than threshold fraction ($T(s_i)$)

$$T(s_i) = \begin{cases} \frac{p_i}{1-p_i\,(r \bmod 1/p_i)} & \text{if } s_i \epsilon G \\ 0 & \text{Otherwise} \end{cases}$$

Then, Node is cluster head for the present round and goes to step10.
else, Node is cluster member & sends data to suitable CH.
Step-10: End

E. Developed Distributed Energy-Efficient Clustering for Heterogeneous Wireless Sensor Networks (DDEEC)

DDEEC [15] relies on DEEC algorithm, in which all sensing elements utilize the initial and remaining energy level to choose their cluster heads. During this protocol each sensing element must have the overall information of the systems, much the same as DEEC; DDEEC estimates a perfect value of system life that is utilized to enroll the reference power that every node ought to consume throughout every round. In this sensor network, the network depends right into a clustering hierarchy, and in this way group heads assembles ascertained data from cluster members and transmits the joined information to the sink specifically. Moreover, the creators have expected that the system topology is steady and no-changing on time. The evaluation among DDEEC and DEEC is restrained in the expressions which describe the possibility to be a cluster head (CH) for ordinary and advanced nodes.

Cluster Head Selection Algorithm for DDEEC:

Step-1: Determine no. of alive nodes
Step-2: Evaluate percentage of Cluster Head.
Step-3: Compute $E_o$and $E_r$of every alive node. // E_0 = initial energy &E_r = residual energy of node
Step-4: R= E_{total}/E_{round}// R= total rounds of system lifetime
Step-5: Now at present round, calculate average energy of network.

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

//E_{total} is total energy of the system and E_{round} is energy expenditure during each round.
Step-6: After calculating average energy, compute the threshold residual energy.

i.e. $Th_{REV} = E_o\left(1+ \frac{\alpha E_{disNN}}{E_{disNN}-E_{disAN}}\right)$

Threshold residual energy is specified as in [11] and given beneath:

i.e. $Th_{REV} = \left(\frac{7}{10}\right) E_o$

Step-7: If accepting energy of sensor node is larger than (>) 0.7*initial energy of normal node
Then compute probability to become Cluster Head.

$$\text{i.e. } p_i = \begin{cases} \frac{P_{opt}E_i(r)}{(1+\alpha m)\,\bar{E}(r)} & \text{for normal nodes} E_i(r) > Th_{REV} \\ \frac{(1+\alpha)\,p_{opt}E_i(r)}{(1+\alpha m)\,\bar{E}(r)} & \text{for advanced nodes } Ei(r) > Th_{REV} \\ \frac{c\,(1+\alpha)\,p_{opt}E_i(r)}{(1+\alpha m)\,\bar{E}(r)} & \text{for normal, advanced node } E_i(r) \le Th_{REV} \end{cases}$$

else,
modify probability of node to become CH.
Step-8: end

F. Enhanced Distributed Energy-Efficient Clustering for Heterogeneous Wireless Sensor Networks (EDEEC):

EDEEC consumes idea of heterogeneous networks as illuminated formerly [17]. EDEEC holds three sorts of nodes i.e. ordinary nodes, advanced nodes and super nodes which concentrate on initial power. Moreover DEEC, EDEEC additionally appraises the best estimation of system lifetime and this perfect esteem is utilized to ascertain the reference energy so that each sensing element will be able to expand during each round. In this pattern the system is organized into a clustering hierarchy, and the group heads

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gathers measured data from cluster members and transmits the collected information to the sink specifically. EDEEC follows the preceding of DEEC and adds another type of node which is known as super node which is utilized to expand the heterogeneity in the system.

Cluster Head Selection Algorithm for EDEEC:

Step-1: Compute total no. of nodes that are alive.
Step-2: Then, calculate the percentage of Cluster Head.
Step-3: Compute $E_i$and $E_r$of every node alive. . // E_i = initial energy &E_r = residual energy of node
Step-4: R= E_{total}/E_{round}//R= total rounds of network lifetime
Step-5: Calculate average energy of network at present round.

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

//E_{total} is total energy of the network &E_{round} is energy expenditure during each round.
Step6: Now, Assign probabilities depend ending on its three types (for normal, advanced and super nodes).

$$\text{i.e. } p_i = \begin{cases} \dfrac{p_{opt}E_i(r)}{(1+m(\alpha+m_o b))\bar{E}(r)} & \text{if } s_i \text{ is normal nodes} \\ \dfrac{(1+\alpha)\, p_{opt}E_i(r)}{(1+m(\alpha+m_o b))\bar{E}(r)} & \text{if } s_i \text{ is advanced nodes} \\ \dfrac{(1+b)\, p_{opt}E_i(r)}{(1+m(\alpha+m_o b))\bar{E}(r)} & \text{if } s_i \text{ is super nodes} \end{cases}$$

Step-7: If Node was not a cluster head in past rounds.
Then, Node definitely belongs to a set G where G is set of nodes which are suitable to become a
Cluster Head & after that, choose a random number b/w 0&1.
Step-8: If Random Number selected is less than threshold fraction ($T(s_i)$).
Then,

$$T(s_i) = \begin{cases} \dfrac{p_i}{1-p_i\,(r \bmod 1/p_i)} & \text{if } p_i \epsilon G' \text{ // G' is the set of normal nodes} \\ \dfrac{p_i}{1-p_i\,(r \bmod 1/p_i)} & \text{if } p_i \epsilon G'' \text{ // G'' is the set of advanced nodes} \\ \dfrac{p_i}{1-p_i(r \bmod 1/p_i)} & \text{if } p_i \epsilon G''' \text{//G''' is the set of super nodes} \end{cases}$$

Step-9: Now, Node is cluster head for the present round and goes to step11.
Step-10: else, Node is cluster member & sends data to appropriate CH.
Step-11: End

G. *Enhanced Distributed Energy-Efficient Clustering for Heterogeneous Wireless Sensor Networks (EDDEEC)*

In light of a few parameters like primary power level of sensing elements, remaining power level of sensing elements and average energy level of nodes, EDDEEC equips assumed possibilities for choice of CHs in the network [21]. EDDEEC shields the super and advance nodes from being over imprisoned, on the grounds that because of intermittently choice of Cluster Head, some super and advance nodes have same leftover energy level when contrasted with ordinary nodes after a few rounds. EDDEEC guesses likelihoods of normal nodes, advance nodes and super nodes. These fluctuations emphasized on absolute residual energy level i.e.$T_{absolute}$, which is the value in which advance and super nodes containing same power level as of normal nodes. The rumored states that underneath $Tabsolute$ all normal nodes, advance nodes and super nodes have equal probability for selecting cluster heads. It succeeds extensive stability period, system lifetime, and throughput than the other traditionalclustering algorithms in heterogeneous environments

Cluster Head (CH) Selection Algorithm for EDDEEC:

Step-1: Compute total no. of alive nodes
Step-2: After computing no. of alive nodes, calculate percentage of Cluster head.
Step-3: After that, Determine $E_i$and$E_r$of every alive node. . // E_i = initial energy &E_r = residual energy of node
Step-4: R= E_{total}/E_{round}//R= total rounds of system lifetime
Step-5: Now, compute average energy of network by the side of current round

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

// E_{total} is total power of the system where $E_{round}$is energy expenditure throughout each round.
Step-6: After step 4, Calculate Threshold residual energy

$$T(s_i) = \begin{cases} \dfrac{p_i}{1-p_i(r \bmod 1/p_i)} & \text{if } s_i \epsilon G \\ 0 & \text{Otherwise} \end{cases}$$

Step-7: If received energy of a sensing element is greater than (>) 0.7*initial energy of normal node.
Step-8: Then, calculate probabilities depending on its three types:

$$p_i = \begin{cases} \dfrac{p_{opt}E_i(r)}{(1+m(\alpha+m_o b))\bar{E}(r)} & \text{if } s_i \text{ is normal nodes} \\ \dfrac{(1+\alpha)\, p_{opt}E_i(r)}{(1+m(\alpha+m_o b))\bar{E}(r)} & \text{if } s_i \text{is advancednodes} \\ \dfrac{(1+b)\, p_{opt}E_i(r)}{(1+m\,(\alpha+m_o b))\bar{E}(r)} & \text{if } s_i \text{ is super nodes} \end{cases}$$

Step-9: else, modify probability of node based on $T_{absolute}$

$$p_i = \begin{cases} \dfrac{p_{opt}E_i(r)}{(1+m\,(\alpha+m_o b))\bar{E}(r)} & \text{;for Nml nodes (if } E_i(r) > T_{absolute}) \\ \dfrac{(1+\alpha)\, p_{opt}E_i(r)}{(1+m(\alpha+m_o b))\bar{E}(r)} & \text{;forAdv nodes (if } E_i(r)\ T_{absolute}) \\ \dfrac{(1+b)\, p_{opt}E_i(r)}{(1+m(\alpha+m_o b))\bar{E}(r)} & \text{;for Sup nodes (if } E_i(r) > T_{absolute}) \end{cases}$$

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$$\frac{c(1+b)\, p_{opt} E_i(r)}{(1+m(\alpha+m_o b))\bar{E}(r)}\ ;\text{for Nml, Adv, Sup nodes (if } E_i(r) \le T_{absolute})$$

The value of absolute residual energy level, $T_{absolute}$, is written as: $T_{absolute} = zE_o$ where $z \in (0, 1)$

Step-10: End

IV. EXPERIMENTAL SETUP

The simulation results for LEACH, PEGASIS and TEEN (homogeneous wireless sensor network (WSN)) and DEEC, DDEEC, EDEEC, and EDDEEC (heterogeneous wireless sensor networks (WSN)) are presented in this section using MATLAB **.**In this experimental set up WSN comprises of 100 nodes are arbitrarily organized in an range of 100 m × 100 m dimension with a Base Station (BS) that is centrally located. Either all sensing elements are fixed or micro-mobile are considered or the loss of energy due to collision and intrusion between signals of various altered nodes is disregarded.

The performance metrics used for the evaluation of the protocols are: stability period and network lifetime. The different parameters that are utilized as a part of simulations are given in Table 1.

Table 1 Simulation Parameters

Parameters	Values
Initial Energy (E_0)	0.5 J
Packet Data Size (*l*)	4000 bits
Radio Electronics Energy (E_{elec})	50 nJ/bit
Free Space Energy($\in_{fs}$)	10 nJ/bit/m2
Multipath Routing Energy($\in_{mp}$)	0.0013 pJ/bit/m4
Data Aggregation Energy (E_{DA})	5 nJ/bit/signal
Optimal Election Probability (P_{opt})	0.1

V. SIMULATION RESULTS

The following observations have made from figure3&4 for the network lifetime for LEACH, PEGASIS and TEEN (homogeneous wireless sensor network (WSN))and network lifetime for DEEC, DDEEC, EDEEC, and EDDEEC (heterogeneous wireless sensor networks (WSN)).

- In Homogeneous protocols, 100 nodes are considered in network with energy 'E_i'. During the network lifetime, Figure 3 shows the total number of alive nodes with respect to number of rounds. The first one node dies at 808, 1225 and 1665 rounds for LEACH, TEEN and PEGASIS respectively and apart from first node, rest of nodes dies at 1789, 3467 and 4645 rounds for LEACH, TEEN and PEGASIS respectively. The simulation result of homogenous WSN shows that TEEN captivating less delay while LEACH and PEGASIS captivating high delay than that of TEEN. The numeral of rounds outcome shows that for a selected size of network, PEGASIS captivating the least consumption of energy with rounds whereas for TEEN consuming the succeeding for setup environment.
- In Heterogeneous protocols, 20 normal nodes are taken in network with an energy 'E_i', in which 30 are the advanced nodes which consumes twice energy than normal nodes, and 50 super nodes having 3.5 times extra energy than the ordinary nodes. The number of alive and dead nodes throughout the system lifetime is shown in Figure 4. The first node dies at 967, 1350, 1430, and 1720 rounds respectively for DEEC, DDEEC, EDEEC, and EDDEEC and apart from first node, rest of nodes dies at 5537, 5672, 8637, and 8637 rounds respectively for DEEC, DDEEC, EDEEC, and EDDEEC.
- As from above shown results we can see that EDDEEC is the supreme amongst the other given protocols as far as stability period, and lifetime of network is concerned. As can be seen from Fig4, EDDEEC executes better than the other given protocols. Table 2 represents comparison between some Clustering Protocols for Wireless Sensor Networks (WSNs).

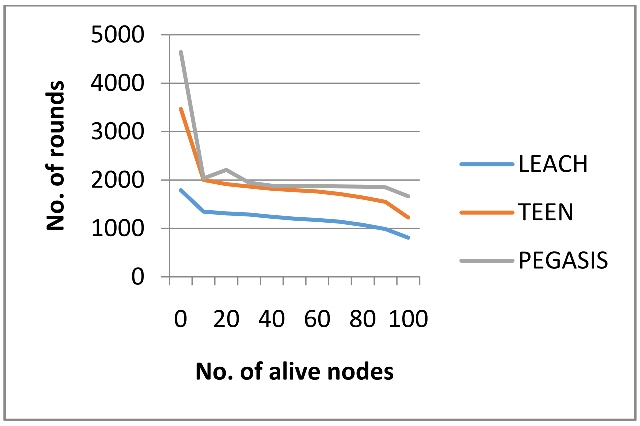

Fig3: Network Lifetime of Homogeneous WSN

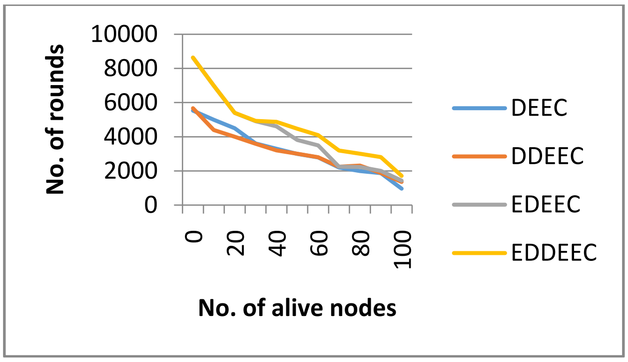

Fig4: Network Lifetime of Heterogeneous WSN

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Table 2. Comparison between some Clustering Protocols for Wireless Sensor Networks (WSNs)

Approach used for Clustering	Deployment of nodes(Uniform/ Random)	Heterogeneity (Y/N)	Method used for Clustering [Distributed (D)/ Centralized (C)/Hybrid (H)]	Heterogeneity Level	Cluster Count Fixed(F)/ Variable (V)	CH Selection based On Initial Energy	CH Selection based On Residual Energy
LEACH	Random	N	D	X	V	No	No
TEEN	Random	N	H	X	V	No	No
PEGASIS	Random	N	X	X	V	No	No
DEEC	Random	Y	D	Two/Multi	V	No	Yes
DDEEC	Random	Y	D	Two/Multi	V	Yes	Yes
EDEEC	Random	Y	D	Three	V	Yes	Yes
EDDEEC	Random	Y	D	Multi	V	Yes	Yes

VI. CONCLUSION

Two major contributions are taken into consideration. The first one is an analysis of performance for homogeneous routing protocols and another one is the performance analysis of heterogeneous routing protocols.

The energy consumption for PEGASIS is less than other homogeneous routing protocols. Apart from the homogenous nature, EDDEEC is an energy aware routing protocol in heterogeneous environment which vigorously deviations the prospects of sensing elements for becoming the Cluster Heads (CHs) in a stable and proficient mode. Stability period and lifetime of network are some of the entitled performance metrics for this exploration. While talking about simulation results, PEGASIS and EDDEEC executes in an enhanced way for the designated performance metrics in comparison to the present cluster construction based protocols.

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