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Performance Analysis of Energy Efficient Clustering Protocol in WSN

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Abstract

Recently, there has been an increase in the use of ad hoc wireless sensor networks for monitoring environmental data (temperature, sound levels, humidity etc) throughout a whole bodily space. In sensor networks, sensor nodes are used to collect nearby records and communicate with different nodes. Wireless sensor network (WSN) is built of various ―nodes‖ from a few to countless hundreds or even thousands, the place every node is linked to one (or occasionally several) sensors. The important challenging venture in this network is routing. There are one-of-a-kind types of protocols in WSN used to route the packets from source to destination. They are information centric, hierarchical, location–based and QoS aware. Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is one of the fantastic hierarchical protocols using the probabilistic mannequin to control the strength consumption of WSN. However LEACH presents unguaranteed election of cluster head and election is not guaranteed to be optimal. In this paper, Deterministic Energy-efficient Clustering protocol (DEC), a deterministic mannequin is developed to analyse the community performance. A deterministic energy-efficient clustering protocol promises a higher election of cluster-heads and is dynamic, distributive, self-organizing and extra electricity efficient than the current traditional LEACH protocols. Then the overall performance parameters such as wide variety of rounds and electricity dissipation of LEACH and DEC protocols are determined and analyzed by varying coverage area, packet size and nodes. The simulation is done by way of the usage of MATLAB. The simulation result shows that DEC protocol has higher performance than the current LEACH protocol.

Keywords: Energy efficiency, DEC, LEACH, Wireless Sensor Networks.

I. INTRODUCTION

Sensor networks have additionally currently emerged as an important computing platform. Sensor nodes are normally much less cell and greater densely deployed than Mobile Ad-hoc NETworks (MANETs). Sensor nodes should be left unattended e.g., in adversarial environments, which makes it tough or not possible to re-charge or exchange their batteries (solar energy is now not always an option). This necessitates devising novel energy-efficient routing protocols in sensor network. LEACH is one of such probabilistic-based mannequin of hierarchical protocol. The lifetime of WSN is prolonged with the help of LEACH by way of managing energy consumption [1], [2]. One of the dreams of this protocol is to lengthen the WSN lifetime by using the use of the world facts derived from the network barring considering the neighborhood

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facts i.e. the residual energy of every node. The downside of such protocols is that there is no assurance that the favored variety of Cluster Heads (CHs) will be elected or the elected CH will have enough power to operate its responsibility as a leader. However this mannequin suffers from comparable trouble of unguaranteed cluster-head election per spherical as with the different probabilistic-based models[3], [4], [5]. Although, LEACH makes use of an choicest putting that can warranty the pleasant performance the usage of their stochastic model, however most of the time the result may want to be sub-optimal due to the uncertainties in the cluster-head election process. In this paper, an attempt has been made to enhance deterministic energy-efficient clustering protocol for a variety of coverage area, packet size and nodes to analyse the performance of the network. The overall performance parameters such as quantity of rounds and strength dissipation are decided and analysed. The relaxation of the paper is equipped as Section 2 offers with dialogue of the WSN, and their routing protocols with a special discussion on the hierarchical routing protocols. It similarly describes about the elements of LEACH protocol. In Section 3, the deterministic energy-efficient clustering protocol for wi-fi sensor networks is mentioned and their traits are additionally explained. Section 4 describes about the simulation model of WSN the use of DEC Protocol and LEACH protocol. The performance parameters of each protocols are also discussed. Conclusion is drawn in Section 5.

II. WIRELESS SENSOR NETWORKS

A WSN consists of spatially distributed self sustaining sensors to screen physical or environmental conditions, such as temperature and pressure, etc. and to cooperatively bypass their information thru the community to a primary location. The extra current networks are bi-directional, additionally enabling manage of sensor activity. The development of wireless sensor networks, [7] was influenced with the aid of army applications such as battlefield surveillance; nowadays such networks are used in many industrial and purchaser applications. Routing protocols of WSN are categorised as data-centric, hierarchical, location-based and QoS based totally routing protocols. Hierarchical protocols are one of the energy efficient routing protocols used to decrease the electricity consumption in WSN. Hierarchical Protocols Many lookup projects in the final few years have explored hierarchical clustering in WSN from exceptional perspectives. Clustering is an energy-efficient conversation protocol that can be used with the aid of the sensors to report their sensed information to the sink. A sample of layered protocol is described with quite a few different clusters of sensors [8]. Each cluster is managed by using a one-of-a-kind node, called cluster head, which is accountable for coordinating the facts transmission things to do of all sensors in its cluster. As proven in figure 1, a hierarchical strategy breaks the network into clustered layers .Nodes are grouped into clusters with a cluster head that has the responsibility of routing from one cluster to the different cluster heads or base stations. Data journey from a lower clustered layer to a greater one. Although, it hops from one node to another, but as it hops from one layer to some other it covers larger distances. This moves the records faster to the base station. Clustering affords hierarchical-based routing protocols for WSNs.

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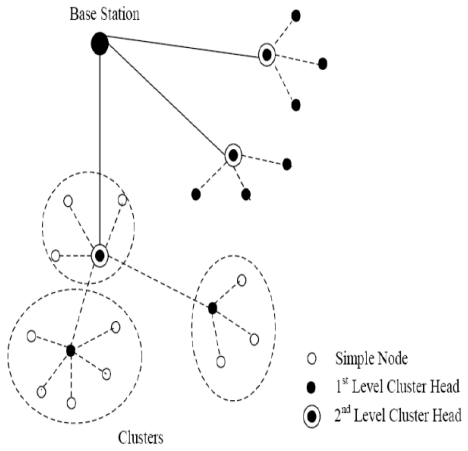

Figure 1: Cluster-Based Hierarchical Model

Low-Energy Adaptive Clustering Hierarchy (LEACH) LEACH is the first and most famous energy-efficient hierarchical clustering algorithm for WSNs [9], [10], that was proposed for reducing power consumption. In LEACH, the clustering mission is turned around amongst the nodes, primarily based on duration. Direct conversation is used by using each cluster head (CH) to forward the statistics to the base station (BS). It uses clusters to extend the life of the wi-fi sensor network. LEACH is primarily based on an aggregation (or fusion) approach [11] that combines or aggregates the original facts into a smaller measurement of data that elevate solely meaningful records to all individual sensors. LEACH divides the community into various clusters of sensors, which are constructed by means of the use of localized coordination and control no longer only to reduce the amount of facts that are transmitted to the sink, however additionally to make routing and data dissemination more scalable and robust. LEACH uses a randomize rotation of high-energy CH position alternatively than deciding on in static manner, to give a danger to all sensors to act as CHs and keep away from the battery depletion of an man or woman sensor and dying quickly. The operation of the clustering method [12] starts with a setup segment when all nodes use the indicator function for election as CHs. The elected CHs broadcast Advertisement message (ADV) using the non-persistent Carrier Sense Multiple Access Medium Access Control (CSMA MAC) protocol. This message contains the CH's ID and header that point out it as an announcement message[13]. The non-elected nodes known as cluster members (CMs) determine their cluster by means of selecting the CH with the minimal communication price based totally on the obtained signal strength of the commercial message. The CMs ship join-request to their chosen CH the usage of CSMA MAC protocol. This message consists of the Cluster Member-ID (CM-ID), Cluster Head-ID (CHID) and the header that suggests the message as a request [14]. The CHs set up a Time Division Multiple Access (TDMA) for their intra-cluster communication, which ends the setup phase. The steady-state phase starts when sensed facts are sent from CMs to CHs and from CHs to BS. The inter-cluster conversation is also carried out using the Direct Sequencing Spread Spectrum (DSSS).

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III. CLUSTERING PROTOCOL

A deterministic clustering protocol uses residual electricity of each node in the cluster for election procedure of CH. DEC [6] looks to be comparable to an best answer as shown in figure.2. Nevertheless, the reservations in the cluster-head elections have been minimized in DEC. The setup section used in LEACH is modified, however the steady-state phase is stored same as that of in LEACH protocol. Since node's energy can be decided a priori, the CH election procedure is reorganized via using the RE of each node. In DEC, the BS elects Nopt cluster-heads at round m for the network. The BS be able to only take part in the election of CHs if and only if m=1. The elected CHs promote their function using CSMA MAC just as in LEACH. However, in DEC in contrast to in LEACH, the join-request message will comprise CM-ID, CHID, CM-RE (cluster member-residual energy) and the header that shows it as a request. This way the RE statistics of CMs is known to their respective CHs, for this reason localized and it can be utilized for CH rotation in the subsequent rounds.

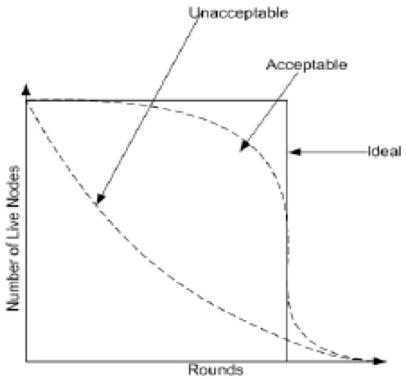

Figure 2: Behaviour of Node Energy Consumption Overtime

After the setup segment ends, the regular section begins, but earlier than the quit of this phase, the modern-day CHs exams the piggy-backed CM-RE's information obtained to decide whether they will remain as CHs or relinquish their roles by deciding on any node in their clusters with the absolute best RE as the new CHs. After this selection is made for the new CHs and all the records from the cutting-edge round is communicated to the BS, the current round (r=m) ends (a perfect synchronization is assumed, simply as in LEACH). The subsequent round r=m+1 begins; but because the new CH's are already chosen in the preceding round, they broadcast their role in the new round, CMs be a part of their cluster as already defined above. The regular phase begins again. This system continues in each spherical until the remaining node dies. With this method, the battery lifestyles of WSNs is extensively optimized. Based on the simulation studies, the followings are observed, which makes the DEC protocol desirable:

The CH election is regionally decided based totally on every node's RE. And each spherical is impartial of the subsequent round not like in LEACH. two DEC guarantees every node a threat of election as long as RE of every node is greater than its neighbors. DEC ensures a constant

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Nopt cluster-head is chosen. DEC ensures that every CH has enough strength to take up its role, until at least the quit of the community lifetime, in contrast to in LEACH.

IV. SIMULATION RESULTS

The wi-fi sensor network mannequin the usage of DEC and LEACH protocol is simulated by the use of MATLAB. The performance parameters such as range of rounds and strength dissipation of deterministic energy-efficient clustering protocol and low-energy adaptive clustering hierarchy protocols are decided by means of varying nodes, coverage location and packet length. The parameters used for simulation is given in the Table 1.

Table 1 Simulation Parameters

Simulation Parameters	Values
No of Nodes	100,200,300
Coverage Area(m^2)	100*100,150*150,200*200,250*250, 300*300
Packet Length(bytes)	6400,8400
Initial Energy(Joules)	0.5
Rounds Max	9999

Analysis of Rounds with respect to Nodes, Coverage Area and Packet Length The simulation process is carried out to analyze the range of rounds for a number of coverage area, packet length and nodes. A) Coverage Area Vs Rounds It is observed from the discern three and 4, that the quantity of rounds of DEC protocol is higher than LEACH protocol through various the insurance location with consistent packet length of 6400 and 8400 bytes. The purpose is due to the make bigger in the wide variety of alive nodes in DEC which uses residual strength for the election criteria of cluster head. Further, it is additionally inferred that as the insurance place increases, the number of rounds decreases. The reason is due to the involvement of the path for the information transmission is extra when the coverage region is increased. Hence, the nodes die at a quicker charge by way of lowering the variety of rounds in the network.

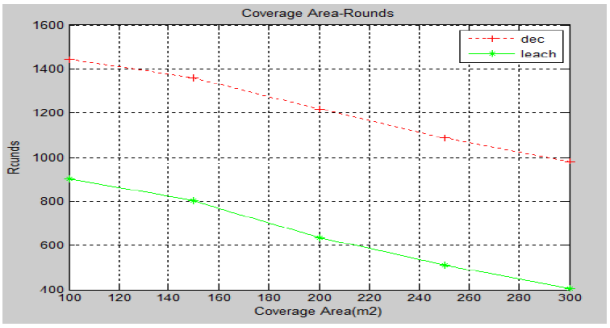

Figure 3: Coverage area with respect to number of rounds considering packet length of 6400 bytes

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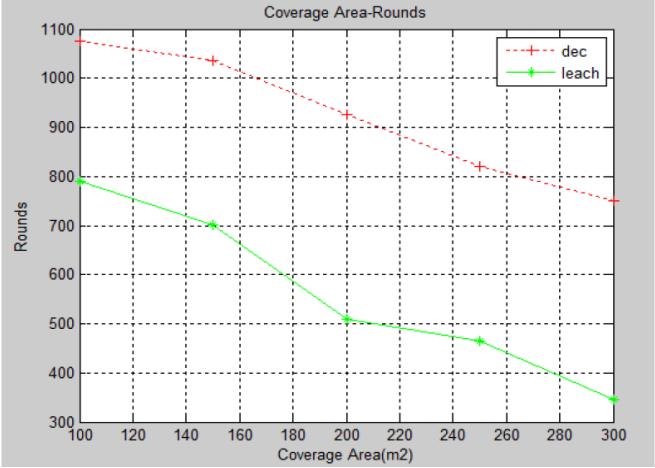

Figure 4: Coverage area with respect to number of rounds considering packet length of 8400 bytes

B) Packet Length Vs Rounds It is determined from the figure 5 and 6, that the quantity of rounds of DEC protocol is greater than LEACH protocol by means of varying the packet size with consistent wide variety of nodes as a hundred and 200. The motive is due to the limit in the number of useless nodes in DEC which makes use of residual energy for the election criteria of cluster head. Further, it is also inferred that as the packet length will increase the quantity of rounds decreases. The reason is, as the packet length increases, more wide variety of nodes is over and over used for the facts transmission process. Since fixed numbers of nodes are considered, the quantity of rounds is decreased as the nodes die at a faster rate. Therefore, the number of rounds in precise system is diminished when the packet length is increased.

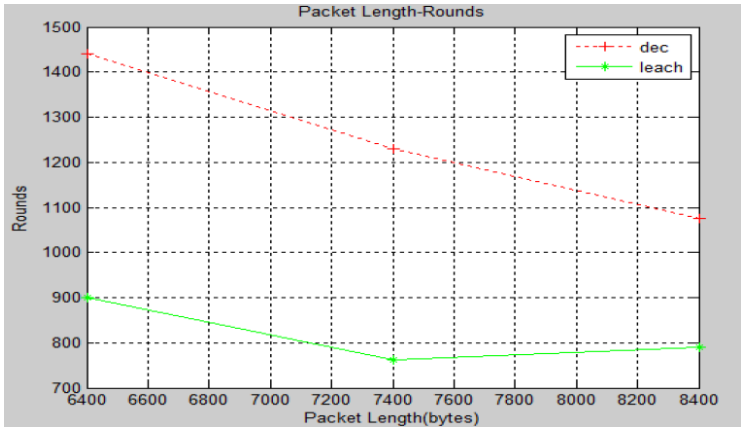

Figure 5: Packet length with respect to number of rounds considering 100 nodes

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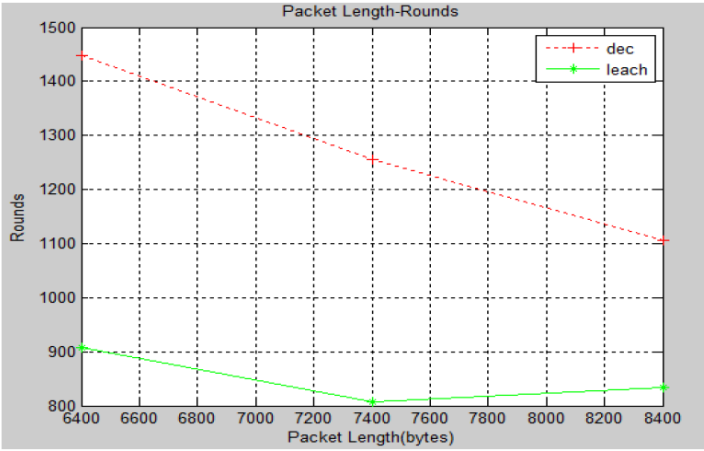

Figure 6: Packet length with respect to number of rounds considering 200 nodes

C) Nodes Vs Rounds It is demonstrated via the simulation end result proven in discern 7 and 8, that the variety of rounds of DEC protocol is higher than LEACH protocol by means of varying the nodes with constant packet length of 6400 and 8400 bytes. The reason is due to the amplify in the wide variety of alive nodes in DEC which uses the deterministic clustering approach. Further, it is additionally inferred that as the nodes increases, the variety of rounds additionally increases. This is due to the involvement of nodes for the statistics transmission system is less which will increase the greater range of alive nodes. Hence wide variety of the rounds in the network is extended when the nodes is increased.

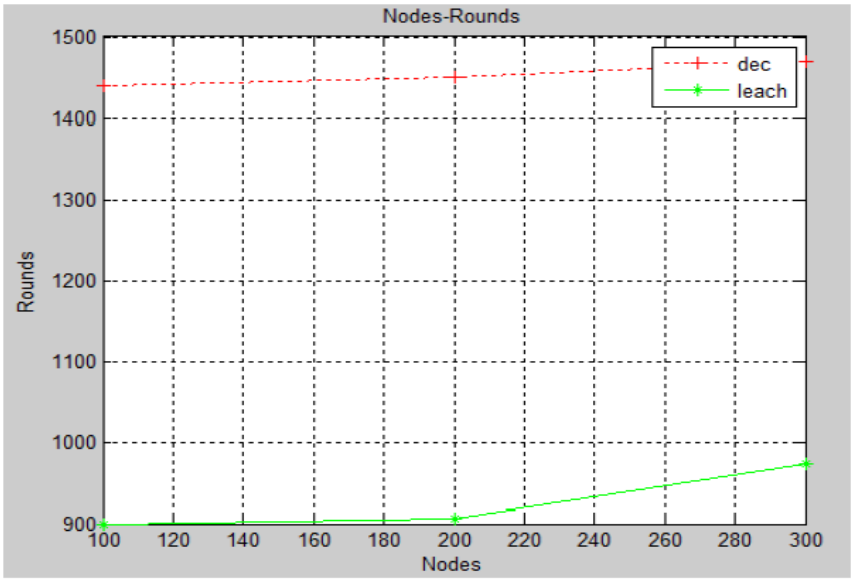

Figure 7: Nodes with respect to number of rounds considering packet length of 6400 bytes

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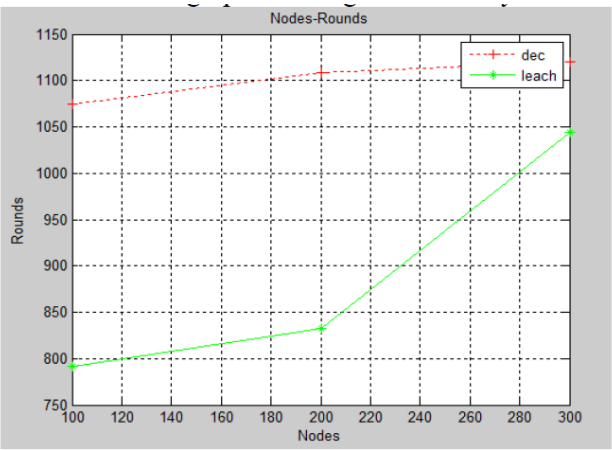

Figure 8: Nodes with respect to number of rounds considering packet length of 8400 bytes

Analysis of Energy Dissipation with respect to Nodes, Coverage Area and Packet Length

The determination and analysis of energy dissipation is done through simulation by varying coverage area, nodes and packet length. D) Coverage Area Vs Energy Dissipation

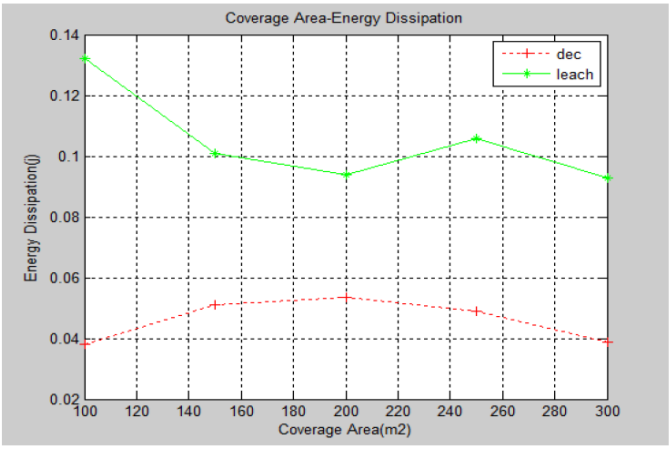

Figure 9: Coverage area with respect to Energy Dissipation

It is inferred from the parent 9, that the energy dissipation of DEC protocol is decrease than LEACH protocol by varying the coverage area. The reason is due to the utilization of nodes based totally on residual electricity for routing method in DEC. Further, it is additionally determined that as the coverage region increases, the strength dissipation increases. This is because more wide variety of nodes is concerned for information transmission, when the coverage place is increased. Thus, as coverage location increases, electricity dissipation will additionally increase.

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E)Nodes Vs Energy Dissipation

It is verified thru the simulation result proven in parent 10, that the strength dissipation of DEC protocol is decrease than LEACH protocol via various the nodes. The purpose is due to the nodes worried for records transmission is much less in DEC which makes use of the deterministic clustering approach. Further, it is additionally inferred that as the nodes will increase the energy dissipation decreases. This is because; the records transmission procedure is carried out with less range of nodes.

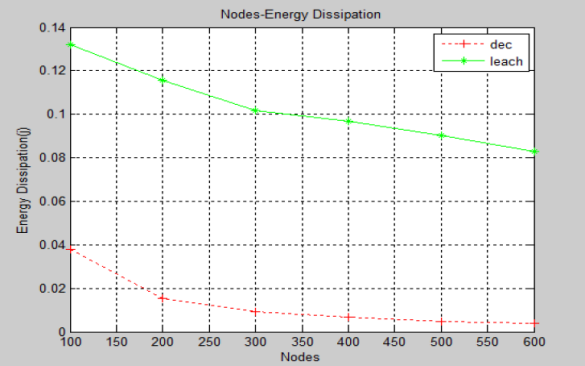

Figure 10: Nodes with respect to Energy Dissipation

F) Packet Length Vs Energy Dissipation

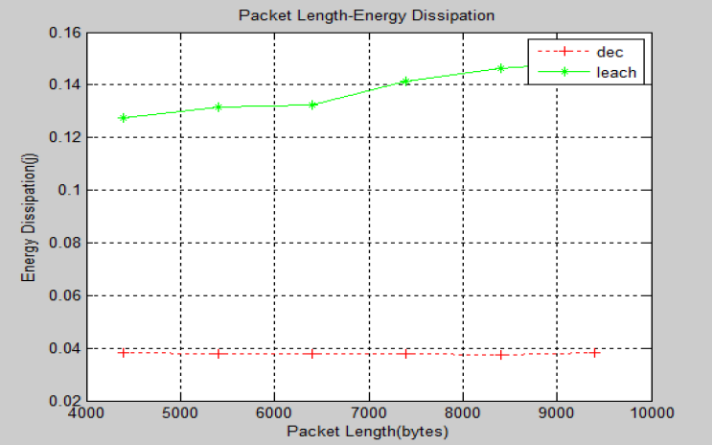

Figure 11: Packet length with respect to Energy Dissipation

It is determined from the parent 11, that the strength dissipation of DEC protocol is lower than LEACH protocol by various the packet length. The reason is due to the path worried for statistics switch operation is less in DEC which makes use of residual electricity for the election criteria of cluster head. Further, it is also inferred that as the packet size increases, the data transmission is

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more which outcomes in more strength dissipation. Therefore, the energy dissipation increases with extend in the packet length.

V. CONCLUSION

LEACH is a probabilistic-based model used to manipulate energy consumption in WSNs via the usage of the international data derived from the community barring considering the local data i.e. the residual power of every node. DEC outperforms the probabilistic-based models by way of guaranteeing that a fixed variety of cluster-heads are elected per round. DEC determines CH election primarily based on the residual energy of each node. DEC proves to be extra strong and steady than the probabilistic-based models. In this paper, LEACH and DEC are simulated by way of using MATLAB. The overall performance parameters of LEACH and DEC protocols (Nodes Vs Rounds; Packet Length Vs Rounds; Coverage Area Vs Rounds) are determined and analyzed. The power dissipation of DEC and LEACH protocols has additionally been analyzed. From the simulation results, it is determined that DEC protocol outperforms LEACH protocol in terms of rounds as properly as in power dissipation. Hence it will increase the life time of sensor network.

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