Comprehensive Analysis of Energy Aware Clustering and Routing Protocols used in WSN

Paramveer kaur[1], Neelam Chouhan[2]
[1,2] *Golden College of Engineering and Technology Gurdaspur, India*

***Abstract*- The evaluation and up gradation of wireless sensor Network (WSN) requires transfer of data from source to destination. Nodes within wireless network are sensors having limited energy associated with them. Nodes collaborating together form clusters. Data transmission takes place from distinct clusters towards base station. Energy of sensors needs to be preserved in order to enhance lifetime of network. This paper presents various techniques used to enhance lifetime of network. Lifetime of network ensures degradation in terms of packet drop ratio. Comparative analysis of techniques is also presented to determine approach that can be used for future enhancements.**

***Index terms*- WSN, Clusters, Lifetime, Packet drop ratio**

I.INTRODUCTION

[1]Wireless sensor network consist of spatially distributed devices used to maintain physical or environmental conditions. Nodes used within WSN could be of distinct configuration. These nodes form heterogeneous environment. Heterogeneous environment requires protocols in order to establish communication among distinctly configured nodes. IEEE 802.11 standards established for Wi-Fi connectivity is commonly used protocol for transmission within WSN. Nodes following common protocols form clusters. The Present time is such where people don't have much time. The people wish to carry out their occupations in a hurry. Physically nearness at the specific area may not be plausible. For this reason client depends vigorously on innovation. Cell innovation is one of the instrument by which client will move the data without truly to the inaccessible place. The cell system is accomplished with the assistance of confinement. The restriction thusly is finished by the utilization of obscure hubs and stay hubs. The grapple hubs are those through which data about the obscure hubs can be gotten. The obscure hub position at the end of the day will rely on the stay hub positions. It has much real application in agribusiness explore. Other than this there is considerably more materialness of WSN in University and schools however working with restricted computational power and constrained memory. It gives full administration of remote sensor items, programming advancement and arranged counseling administrations to business. WSN are utilized as a part of numerous territories to screen a physical condition, for instance,

- Source of Light
- Pressure taking care of component
- Sound creating frameworks
- Humidity checking framework
- Checking Soil ripeness recognition
- Determining Air Quality checking
- Quality of water checking

In WSN there is no need that system site get close to it we can impart the system site get a long way from this. Remote sensor organizes gather information which is in vogue, and we get data about the information.

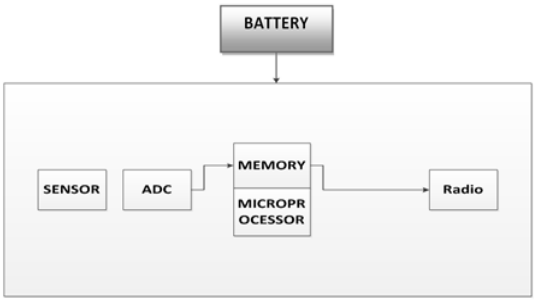

Fig. || Wireless Sensor Network Operation

Sensor unit comprise of Analog to advanced converter. The ADC will get the simple flag and changes over it into the computerized shape. The advanced information has greater lucidity related with it. The discrete signs will be its case. The sensor hubs will be influenced by number of parameters. The parameters will choose the lucidity(easily

understand) by which transmission happens. The parameters are separated into following classes :

- Temperature
- dampness and
- vibration

There are such a significant number of capacities, for example, environment, sense movement, and measure light quality.

Power Source: The power source is the basic segment related with the WSN. It is utilized to give the ability to the sensor hubs inside the WSN. Without battery no sensor can work. The upside of sensors is they are little vitality devouring gadgets which don't require a great part of the power source.

Radio: This is a little gadget which is utilized I request to transmit the data from source hub to the goal hub. The source is known as Radio source and goal is known as Radio Destination.

The Electronic Brain: The sensor hub will comprise of remote system which is utilized to transmit the data to goal. The microchip chip is utilized to coordinate the information toward the goal. The microchip will have number of pins related with it. Each stick will have certain capacity related with it. The power source is a basic piece of the electronic mind. It is utilized to give the ability to the sensor hubs inside the WSN. Without battery no sensor can work. The upside of sensors is they are little vitality devouring gadgets which don't require a great part of the power source. The Radio is likewise utilized as a part of request to guarantee remote correspondence. This is a little gadget which is utilized I request to transmit the data from source hub to the goal hub. The source is known as Radio source and goal is known as Radio Destination.

1. ENERGY EFFICIENT CLUSTERING TECHNIQUES IN WSN

Large number of protocols researched over a decade to enhance lifetime associated with the network. This section discusses various protocols falls under energy efficient category.

1.1 LEACH

[4], [8]Low Energy Adaptive Clustering hierarchical protocol is used to enhance energy efficiency associated with transfer process. Time division multiple access protocol is integrated within LEACH. Cluster head selection is a problem within LEACH. In fact cluster head selection does not take place and data is transmitted from transmitter towards random selection of node selected as head. Aggregation is performed at cluster head and when threshold value is reached, packets are transmitted forward. In case cluster head energy dissipated completed, all the packets aggregated at node will be lost. Properties associated with LEACH are listed as under

- Hierarchical in nature
- Random Cluster Head Selection is involved
- Adaptive membership of cluster
- Aggregation of data at cluster head
- Communication involves nodes and cluster head
- Threshold values involve during transmission

LEACH protocol is represented as under

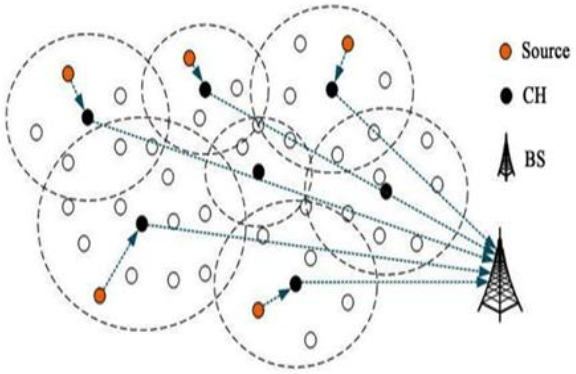

Fig.|| Leach Protocol

1.2 DEEC

This protocol is advancement associated with LEACH. [9], [10]Cluster head selection is complex in case of DEEC. Maximum energy nodes are elected among available nodes. The node with the highest probability of conserving energy is selected as cluster head. A distributed multilevel clustering algorithm for heterogeneous wireless sensor networks is considered with following characteristics

- The cluster head is elected by a probability based on the ratio between the amount residual energy present at each node and the average energy of the network.
- The lifetime of a cluster head is decided according to its initial energy and residual energy. So always the nodes with high initial and residual energy have a better chance to become a CH.
- DEEC is implemented based on the concepts of LEACH algorithm. The role of cluster head is

rotated among all nodes of the network to make energy dissipation uniform.

- Two levels of heterogeneous nodes are considered in this algorithm to achieve longer network lifetime and more effective messages than other classical clustering algorithms.
- It also works better for multilevel heterogeneous networks.

In DEEC, all the nodes must have the idea about total energy and lifetime of the network. Average energy of the network is used as the reference energy.

DEEC protocol is represented through the following figure

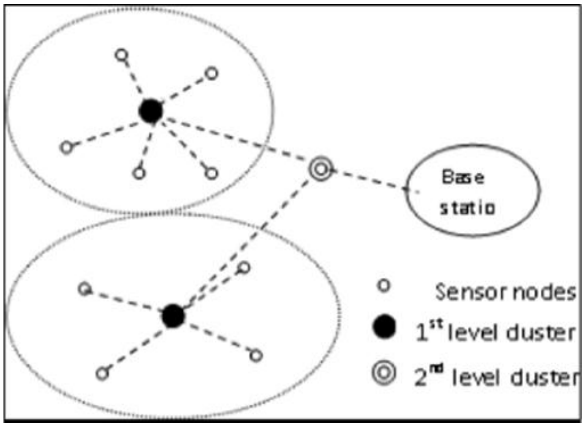

Fig.|| DEEC protocol

1.3 SEP

[10]SEP concentrate the effect of heterogeneity of Clusters, as far as their vitality, in remote sensor arranges that are progressively bunched. Following properties are considered

- In these systems a portion of the nodes progressed toward becoming bunch heads, total the information of their group individuals what's more, transmit it to the sink.
- It accept that a rate of the populace of sensor hubs is outfitted with extra vitality assets which is a wellspring of heterogeneity which may come about from the underlying setting or as the operation of the system advances.
- It additionally consider the sensors are arbitrarily (consistently) appropriated and are not versatile, the directions of the sink and the measurements of the sensor field are known.
- It is assumed in SEP that nodes cannot take full favourable position of the nearness of hub heterogeneity.
- SEP, a heterogeneous-mindful convention to draw out the time interim before the passing of the principal hub (we allude to as strength period), which is pivotal for some applications where the criticism from the sensor organize must be solid.
- SEP depends on weighted race probabilities of every hub to end up bunch go to the rest of the vitality in every hub.

[11], [12]SEP is advancement associate with DEEC. Energy is conserved and lifetime of network is improved considerably by the use of this protocol.

Representation of SEP is as under

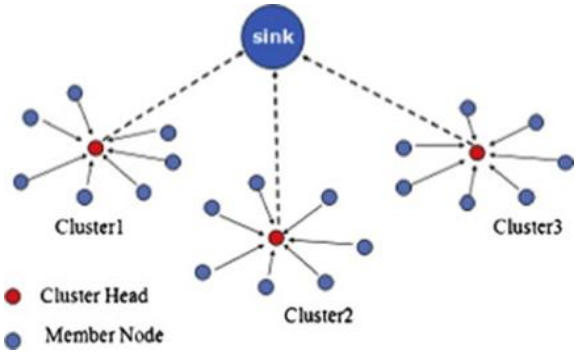

Fig.|| Representation of SEP

1.4 EDEEC

[13]–[15] Remote Sensor Networks (WSNs) comprises of across the board arbitrary sending of vitality obliged sensor hubs. Following properties exists of EDEEC.

- Sensor hubs have distinctive capacity to detect and send detected information to Base Station (BS) or Sink.
- Detecting and in addition transmitting information towards sink requires substantial measure of vitality.
- In WSNs, save vitality and delaying the lifetime of system are incredible difficulties. Many directing conventions have been proposed with a specific end goal to accomplish vitality productivity in heterogeneous condition.
- EDEEC for the most part comprises of three sorts of hubs in amplifying the lifetime and solidness of system.

Enhanced distributed energy efficient clustering protocol is advancement of DEEC that conserve energy and reduce packet drop ratio considerably. Further enhancement in DEEC can be made to enhance performance DEEC by reducing distance

between nodes in which data is being transmitted. Today's world needs some technologies to fulfil their routine work. [16]WSN is that technology which fulfills the routine work of the society. Wireless sensor network senses the physical world whether it is temperature, pressure, humidity and some other environment activities. WSN is used in an environment where the wires or cable are not possible to reach. It is easy to install compared with the other cables network. Now, these day's WSN are using mainly for the data transfer purpose. [17]Sensor nodes in the wireless network transfer the data packets from source to destination. Wireless sensor network includes sensors nodes and a base station (sink) and there are so many sensors which create a network. All the sensor nodes in a network communicate with each other and transfer the data packet from source node to the sink. Sensor nodes can communicate directly with the base station. Sensor nodes consume a lot of energy while data transfer. On the other hand, sensor nodes also consume energy after transferring the data packets. Due to this consumption, the lifetime of the network also gets reduced. This is the major issue of the sensor network. [18]There are more issues of the network but energy consumption and improve the lifetime of the network. Taking these issues in concern, there is one method which is very much useful to resolve these problems called clustering. Clustering, the technique in which large network region is divided into smaller one. With this technique, sensor nodes do not require direct communication with the base station.

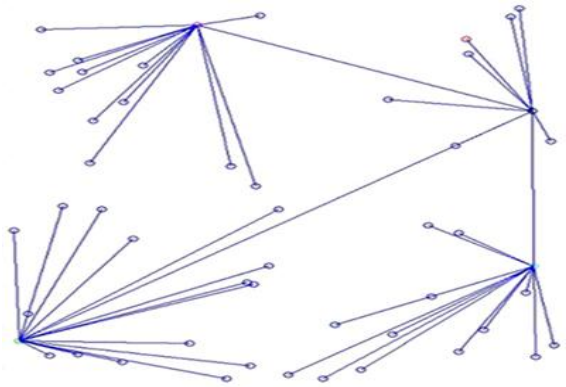

Fig.|| Representation of EDEEC

In every cluster, there is a cluster head which collects the data from all the network nodes and then transmits that data to the base station. The cluster head is elected on the basis of maximum energy of the node. The node which has highest energy is selected for cluster head. Basically only cluster head is responsible for the communication in the network. Cluster head needs more energy for the data aggregation and transmitting the data. So after transmission of the data, its energy reduces and the node which has second highest energy is selected for cluster head. There is so many clustering protocols which not only reduces the energy consumption but also enhance the network lifetime. These protocols are LEACH, HEED, DEEC, EDEEC, SEP etc. These protocols are cluster-based protocol and a lot of work has been done with these protocols. LEACH is the first protocol which came into the existence in the clustering protocol. DEEC is also a cluster-based protocol in which cluster head is selected based on the residual energy of the sensor nodes and the average energy of the network. EDEEC is the enhanced version of the DEEC protocol and requires a heterogeneous network. LEACH is the homogeneous network.

Next section describes background analysis or literature survey to determine best possible protocol for future enhancement.

II. LITERATURE SURVEY

Techniques have been devised for improvement of performance in WSN. The WSN performance is critically analysed using this paper. The worth of study is proved using this literature survey. [19] proposed distance and energy aware LEACH. The cluster head selection in this approach was adaptive and allow packet drop ratio to reduce considerably. The aggregation mechanism was the drawback associated with this approach. In case cluster head go down, every packet aggregated at source could be lost. [20]proposed EAP for conserving energy during transmission of data from source to destination. Inter cluster coverage was introduced in this approach. Data gathered at particular cluster was according to probability distribution factor that reduces energy consumption and enhances lifetime of network. [8] discussed energy efficiency achieved through LEACH protocol. Time division MAC was integrated to achieve energy efficiency and lifetime within the WSN. [21]proposed a mechanism to analyse energy dissipation through Multi-Chain PEGASIS. This

protocol constructs a chain of routing path. Multi hop routing was used under PEGASIS. Overall protocol was energy and power efficient but complex. In other words time and space complexity was enhanced using PEGASIS. Future modifications required in order to enhance performance of examined system. [22] proposed LEACH, a hierarchical protocol for achieving energy efficiency within WSN. Adaptive cluster head selection allows performance enhancement however aggregation mechanism used within WSN has merits and demerits associated with it. Energy conservation was achieved with the risk of enhancement of packet drop ration in case of cluster head failure.

[23] Proposed energy efficient DEEC protocol. DEEC protocol uses probability distribution function to determine cluster head out of number of nodes available within WSN. Probability assigned with each node within WSN was analysed for selection of cluster head. Probability associated with nodes varies during each round. Higher the probability more will be chance of node being selected as cluster head. DEEC performance decreases by the application of aggregation mechanism leading to increase in packet drop ratio. [13]proposed enhancement in DEEC protocol to achieve more energy efficiency. Lifetime of network significantly improved by the application of E-DEEC. As packets moved from one node to another, energy associated with nodes will be analysed. Node having highest energy will be selected as cluster head. Packet being received by node having highest energy. Lifetime of network was considerably enhanced but packet drop ratio increases hence requires improvement. [9]proposed a sleep awake protocol for WSN data transmission. Node being idle was set to sleep and energy conservation was achieved. The problem of topology breakage occurred as node was made to sleep. In order to wake the node sufficient amount of energy was required to be dispensed with. [15]discussed a super energy aware protocol by accomplishing modifications to the existing DEEC protocol. Modified mechanism of electing cluster head was proposed. Node selected as cluster head was evaluated against several criteria's before electing it as cluster head. Complexity in terms of cluster head was extremely high.

[24]Proposed a priority based application specific congestion control algorithm. Packets can be initiated through any node and hence traffic could be a problem. To handle traffic, congestion control mechanism was proposed by maintaining priority queue. Packets from distinct nodes were maintained within queue. As congestion becomes high, enqueue operation takes place. As traffic becomes moderate dequeue operation takes place. This mechanism results in decreasing packet drop ratio. But energy consumption in this mechanism still requires improvement. [25]advised gateway based energy routing protocol (M-GEAR) for WSN. Depending on their location in the sensing area, they divided the nodes into four zones. In this protocol, they placed the base station out of the sensing zone and placed a gateway at the middle of the sensing area. The node uses the direct communication if the distance of the sensing node from the base station or gateway is less than the prescribed distance. They also divided the remaining nodes into equal zones. Selected cluster heads in each zone are independent of each other. They compared the performance of proposed protocol with LEACH. Analysis results show that their assigned protocol perform greatly basis on the consumption of energy and lifespan of the network. [26]said that in the upcoming time, WSNs require a great need of spreading the nodes and also enhance its applications in all fields because in the future most of the devices will be connected to each and everything. So spreading of these nodes is the greatest challenge, keeping this in mind a new protocol is given called TDEEC used for the heterogeneous network. TDEEC protocols use three levels of heterogeneity. It is a reactive protocol and used basically for reactive networks. Reactive networks are those which react quickly to any change arise in any parameter.

The comprehensive literature survey conducted in this paper suggest, considerable improvement in terms of energy efficiency and packet drop ratio within WSN is required. Some techniques suggested such as DEEC provides efficient low complexity mechanism to accomplish the same but distance based criteria's are absent within DEEC. To improve the performance of DEEC, distance between nodes must be considered. This could be the future course of action.

2. COMPARISON OF ENERGY AWARE SCHEMES WITHIN WSN

Comparison of protocols consuming energy, initial energy, number of dead nodes and complexity is given as under

PROTOCOL	YEAR	Number of Dead Nodes	Initial Energy	Residual energy	Complexity
LEACH [27]	2017	90 out of 100 after rounds complete	1.5 Joules	0 after all the rounds	High
ELEACH [28]	2015	70 out of 100 after rounds complete	1.5 J	0.5 after all the rounds	Low
SEP [29]	2013	80 out of 100 after rounds complete	1.5 J	0.3 after all the rounds	High
DEEC [30]	2016	60 out of 100 after all the rounds	1.5J	0.2 after all the rounds	Low
PAGASIS[31]	2017	80 out of 100 after all the rounds	1.5J	0.35 after all the rounds	High
CCM [32]	2016	85 out of 100 after all the rounds	1.5J	0.15 after all the rounds	High
HEED [33]	2014	73 out of 100 after all the rounds	1.5J	0.25 after all the rounds	High
ECS [34]	2016	62 out of 100 after all the rounds	1.5J	0.30 after all the rounds	Low
TTDD [35]	2005	85 out of 100 after all the rounds	1.5J	0.29 after all the rounds	High

Table 1||Comparison of protocols in terms of energy consumed and complexity

TABLE

Table 1: Comparison of Techniques of Clustering used within WSN

From comparison table it is concluded that techniques associated with clustering algorithm within WSN requires considerable improvement in terms of energy conservation and packet drop ratio. Distance handling among WSN is critical for this purpose.

III. RESEARCH GAP

Energy conservation is one of the prime issues associated with existing clustering protocols. Cluster head selection causes huge amount of energy to be consumed. In case cluster head selected is not optimal, it may cause large amount of packets to be lost. The packet drop ratio is another parameter which is critical in analysis of performance of clustering algorithm. Distance consideration is missing or shortest path algorithm is not considered causing degradation of performance in existing system. To overcome the problems of existing system distance based approach in DEEC can be proposed. Problems in existing literature are listed as follows

2.1. Energy conservation is high

2.2. Packet drop ratio is high

2.3. Residual energy is low

2.4. Distance based mechanism is not considered

IV. CONCLUSION AND FUTURE SCOPE

This paper present comprehensive survey of techniques used within WSN to achieve increase in lifetime of sensor within WSN. Enhancement in lifetime involves mechanism such as sleep and wake up protocol but has demerits associated with it. Critical analysis of various efficient protocols used in WSN are discussed and concluded as under.

The idle nodes are made to sleep but topology breakage is the result. In order to restore the nodes to their initial state sufficient energy is required leading to loss of packets. Distance conservation mechanism is not considered in case of DEEC hence packet drop ratio is high. In case of leach aggregation at cluster head causes problem since cluster head if dead all the packet collected at cluster head will be lost. From analysis of existing techniques it is identified that there exist a tradeoff between energy and packet drop ratio.

In future this tradeoff between energy and packet drop ratio is to be eliminated by considering distance between nodes before selection of cluster head. Use of priority queue can also be merged within existing approach for enhancing performance of WSN.

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