Energy Efficient Routing Protocol and Data Aggregation in Wireless Sensor Network

THESIS SUBMITTED IN PARTIAL FULFILMENT OF REQUIREMENT
FOR THE AWARD OF THE DEGREE OF

Master of Technology
in
Software Engineering

Under the guidance of
Mr. Vinod Kumar
(Associate Professor)
Delhi Technological University

Submitted By
Dheeraj Nagar
(Roll No. 2K17/SWE/08)

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)
Shahabad Daulatpur, Main Bawana Road, Delhi-110042

June 2019

DECLARATION

I hereby declare that the thesis work entitled "***Energy Efficient Routing Protocol and Data Aggregation in Wireless Sensor Network***" which is being submitted to Delhi Technological University, in partial fulfillment of requirements for the award of degree of Master of Technology (Software Engineering) is a bonafide report of Major Project-II carried out by me. The material contained in the report has not been submitted to any university or institution for the award of any degree.

Place: Delhi

Date:

Dheeraj Nagar

Roll No. 2K17/SWE/08

CERTIFICATE

This is to certify that Project Report entitled "***Energy Efficient Routing Protocol and Data Aggregation In Wireless Sensor Network***" submitted by Dheeraj Nagar (roll no. 2K17/SWE/08) in partial fulfillment of the requirement for the award of degree Master of Technology (Software Engineering) is a record of the original work carried out by him under my supervision.

Place: Delhi

Date:

SUPERVISOR

Mr. VINOD KUMAR

(ASSOCIATE PROFESSOR)

Department of Computer Science and Engineering

Delhi Technological University

Bawana Road, Delhi -110042

ACKNOWLEDGEMENT

I am very thankful to **Mr. VINOD KUMAR (Associate Professor)** and all the faculty members of the Computer Science and Engineering Department of Delhi Technological University. They all provided us with immense support and guidance for the project.

I would also like to express my gratitude to the university for providing us with the laboratories, infrastructure, testing facilities and environment which allowed us to work without any obstructions.

I would also like to appreciate the support provided to us by our lab assistants, seniors and our peer group who aided us with all the knowledge they had regarding various topics.

DHEERAJ NAGAR

Roll No. 2K17/SWE/08

M. Tech. (Software Engineering)

Delhi Technological University

ABSTRACT

There are so many applications where Wireless sensor networks (WSNs) can be used like tracking, monitoring etc. As we know WSNs have immense prospective and are deployed in various application of environments, but there are some restrictions as the sensor nodes have limited processing power, limited battery capability, limited bandwidth for communication and limited memory partition. WSNs contain battery powered nodes where replacement of nodes is impractical. Routing protocols in WSNs aim to increase total life time of network and energy used by the sensor nodes. Lots of work has been done on how to increase the energy efficiency of the WSNs.

Clustering techniques are used to increase total life time of network. It minimizes total transmission cost and redundancy of data. Sensor nodes transmit the data towards their cluster heads. Further they collect the data and transmit it towards the base station. Clustering also enhances the stability time period for the network which is the period till all the nodes are alive in the network. Various data aggregation techniques have been proposed to increase the network life time. Thus clustering and data aggregation are important techniques to increase total life time the network. In this thesis we consider heterogeneous networks to evaluate the performance of proposed energy efficient clustering and data aggregation technique. Our goal is to reduce the energy use and increase the life time and stability of network.

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LIST OF ABBREVIATIONS

WSN:	Wireless Sensor Network
BS:	Base Station
SMP:	Sensor Management Protocol
CH:	Cluster Head
SPIN:	Sensor Protocol for Information via Negotiation
HEED:	Hybrid Energy Efficient Distributed Clustering
LEACH:	Low Energy Adaptive Cluster Hierarchy
EEUS:	Energy Efficient Unequal Clustering
PEGASIS:	Power-Efficient Gathering in Sensor Information Technology
GAF:	Geographic Adaptive Fidelity
SEP:	Stable election Protocol
TDMA:	Time Division Multiple Access
TEEN:	Threshold sensitive Energy Efficient sensor Network protocol
APTEEN:	Adaptive Threshold sensitive Energy Efficient sensor Network
GEAR:	Geographical and Energy aware Routing
LEACH-F:	Low Energy Adaptive Cluster Hierarchy with Fix Cluster
PMN:	Primary Master Node
SMN:	Secondary Master Node
ACK:	Acknowledgement

Chapter 1 Introduction

1.1 Wireless Sensor Network

When we talk about wireless sensor node, it is a very tiny device. And the beauty of this device is that it is operated by battery. There are so many uses of these devices like they can sense the environment activities, processing of signals, they can collect the data etc. with the help of Advancement in technology there is a possibility of reducing the price, overall size and total weight of sensor nodes. And performance of sensor nodes is also increased. We can also call these advanced technology wireless sensor nodes in a combined form for resolving real life problems and this combined is also known as wireless sensor network. In WSN we include so many wireless sensor nodes. WSN can perform so many operations like they can observe the data and further if there is a need than they can process this data also. They are used to transmit the combined for accomplished a project. There are so many advantages of wireless sensors networks like they can be used to operate abandoned in really tough environments in which modern human monitoring ideas are dangerous, unproductive improbable [1]. Because of direct sending from nodes towards the sink of data packets in the network there will be increment in communication cost in the form of residual energy, delay and network life. It is difficult to choose the routing protocol if we want to deliver the packets towards their destination [2]. There are so many uses of these devices like they can sense the environment activities, processing of signal, they can collect the data etc. Figure 1.1 defines the sensor node architecture. A sensor node has three modules sensor module to sense the environment, processing module to convert the information from analog to digital signals and wireless communication module to transmit the information to the CHs. Figure 1.2 if we want to neglect the direct communication then we have to build the clusters. And the cluster heads are used to transmits data towards the base station. All nodes which are spread are responsible for transmitting the data what they have to the CHs. Further CHs needs to do some extra work for reducing the network's load and further this is useful in increasing total working effectiveness of the network. When we talk about wireless sensor node, it is a very tiny device. And the beauty of this device is that it is operated by battery.

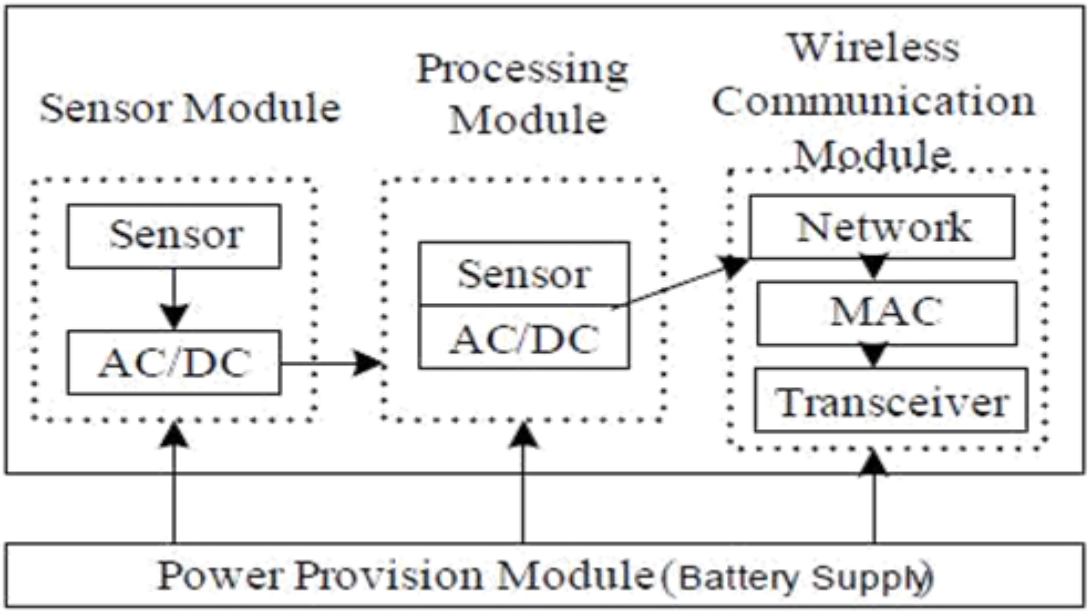

Figure 1.1 Architecture of WSN Node

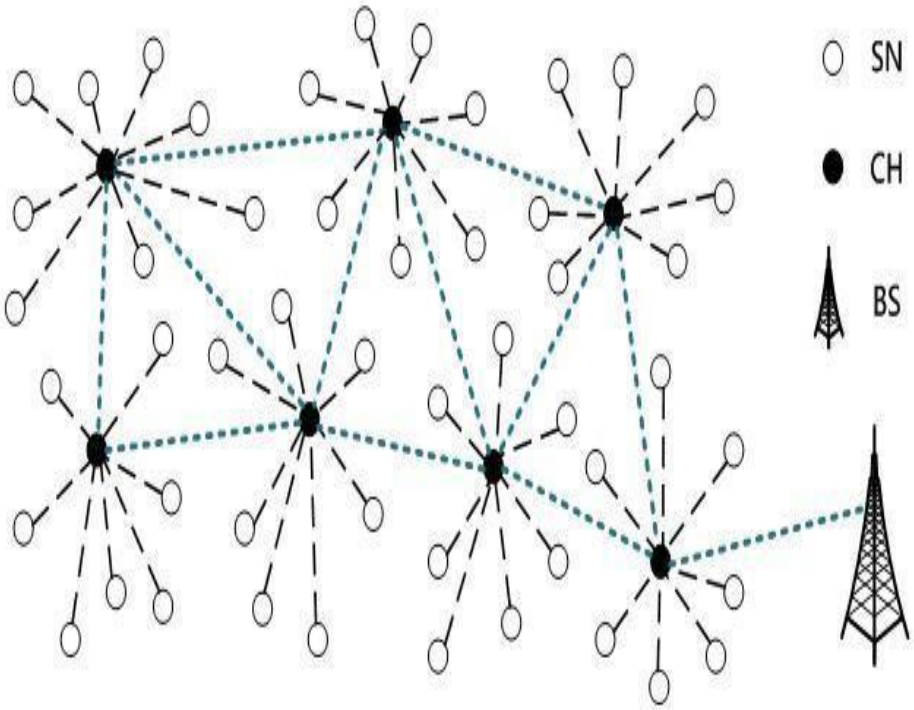

Figure 1.2 Communication Process in WSNs

WSNs have different qualities like power utilization imperatives for vitality gathering, capacity to oversee node disappointment, heterogeneity of nodes, portability of hubs, capacity to confront brutal condition conditions and usability.

Working framework utilized by sensor nodes of remote sensor system is straightforward and wasteful in contrast with other broadly useful working frameworks and consequently Sensor hubs have the constrained handling capacity.

The BS is the focal specialist which has boundless power and has loads of correspondence and calculation ability and it goes about as a transitional correspondence connect between the end client and sensor hubs.

1.1.1. Purpose of Wireless Sensor Network

It contains a variety of functions like:

1. *Event recognition and exposure:*-It can be used for many applications like detection of fire in forest, unusual activities detection, and fro military uses also.[3].
2. *Data congregation and episodic exposure:*-It contains many functions like it can observe the condition of environment like temperature, wind blow, pollution measurement[4]. For measuring these we need to monitor the area for long time and send this data towards the sink.
3. *Tracking based functions:* - Applications like fringe observation, developments of suspicious items, following exercises and style of examples for creepy crawlies, winged animals and creatures are incorporated into this class of utilizations.

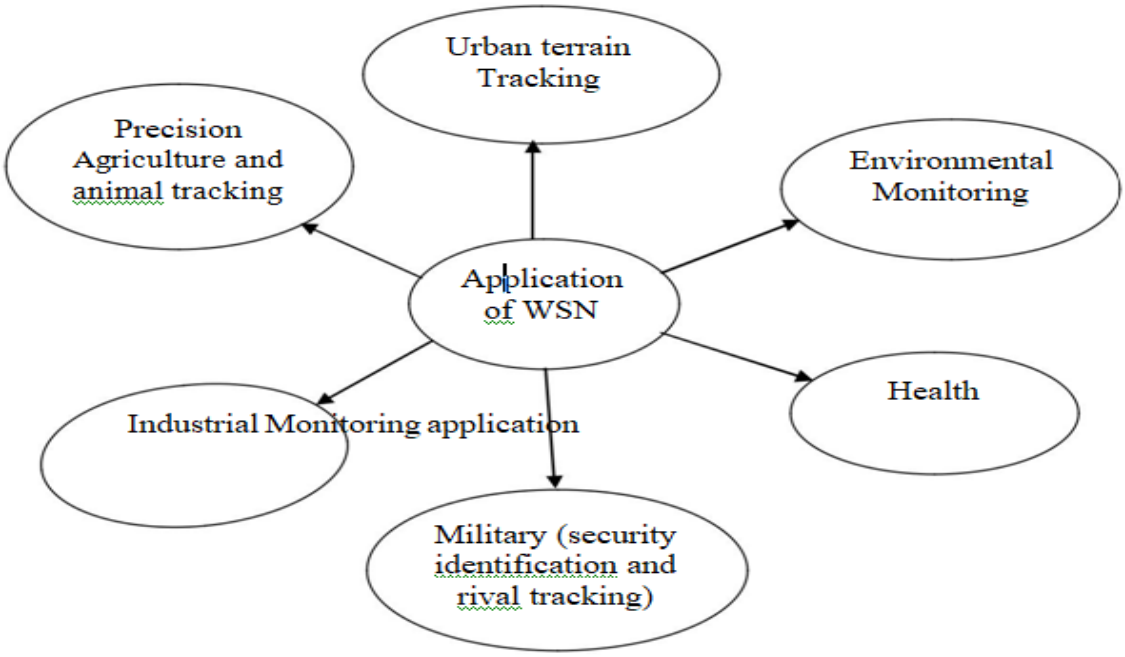

Figure 1.3 Wireless Sensor Network Applications Overview

1.2 Wireless Sensor Network Protocol Stack

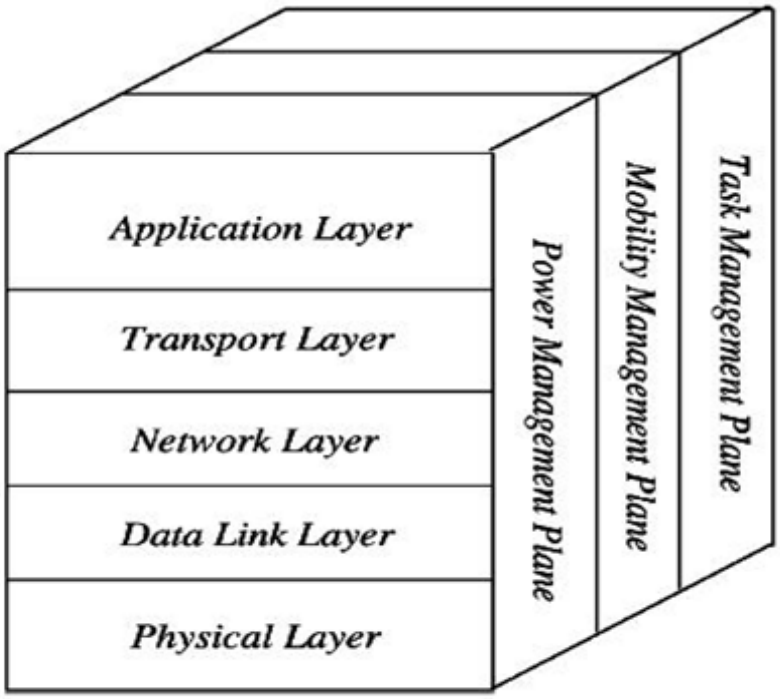

Figure 1.4 Design of WSN Protocol Stack

This stack's behaviour is as same as traditional protocol stack, with all the network layers. The wireless sensor network should be conscious about management schemes for performing operations efficiently: Task Management, Mobility Management, and Power Management Planes [5].

1. Power Management plan manages power uses and turn off the operations of the nodes which are not in use to save the power.
2. Mobility Management manages movement of nodes and register, to maintain the route from nodes to sink.
3. Task Management responsible for sensing task and data communication should be lower power consumption.

When we are developing the protocol for wireless sensor network, we must address of these management planes.

1. *Physical Layer:* -Physical layer manages selection of frequency, generation of carrier frequency, modulation and encryption. Its main concern for energy minimization.

2. *Data Link Layer:* -It is used for management of multiplexing for the data flow. It is also used for detecting the data frames, error control and medium access control. Specialize medium access control should be associated with sensor network for resolve the problem of energy conservation and data centric routing issue and power saving mode operation.
3. *Network Layer:* -In Designing of network layer must be considered some factor, energy efficiency, location awareness and data centric network. Maintenance of topology or complex route searching should not be more energy consuming.
4. *Transport Layer:* -Transport play role for communication, when system required communicating from outer world. Communication problem between sink and user because data packet does not have information about destination as sensor topology or complex route searching should not be more energy consuming.
5. *Application Layer:* - SMP help interaction between system programmer and administrator. Sensor Management protocol make transparent use for sensor network management application. Data Aggregation, Clustering ,Exchange Information for finding location algorithm, Time synchronization, Moving Sensor for enable these communication we have to enable interaction between application between user. SMP provide rules for interaction.

Each layer provides functionality to routing protocol for maintaining the contact for both nodes and BS. When we develop a routing technique, we have to maintain the each of the management planes and issues related to all the layers. This provides functionality of communication between nodes, sink and outside world. We must take into consideration lack of global information and infrastructure in WSNs.

1.3 Routing in WSN

Routing resembles the basic issue for WSN that give strategy on how the information would be moved. It is a fundamental test because of low power WSN and because of an inalienable trademark that makes out from another system like cell and especially ad-hoc system [6].
Various routing technique in wireless sensor network classified as:

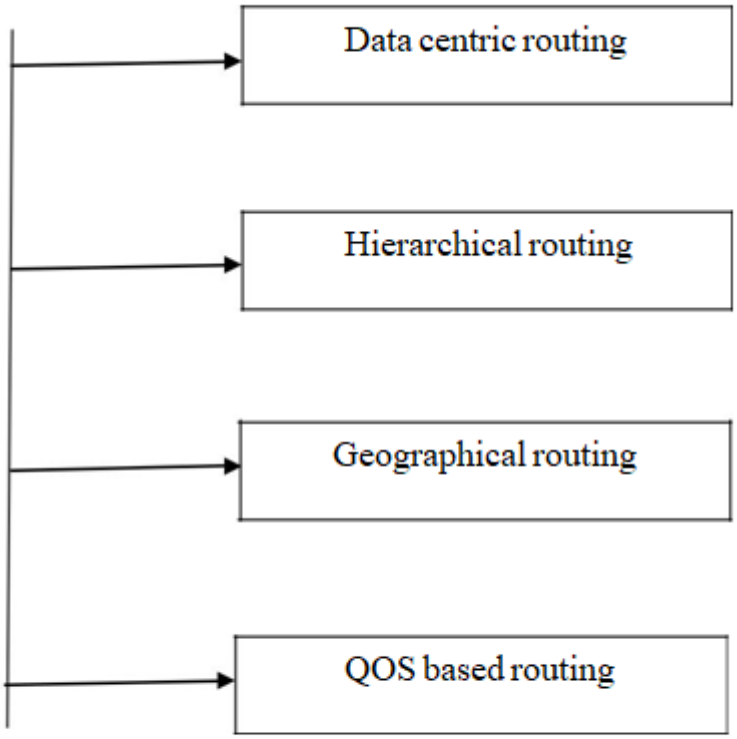

Figure 1.5 Routing Techniques in Wireless Sensor Network

It is too difficult to communicate with particular group of nodes in wireless sensor network as they do not have global identification because in this technique we have random exploitation of sensor nodes. So when nodes send data with redundancy. We study various data centric routing protocol such as Directed Diffusion [7], Cougar [8], and Rumor Routing [9],the sensor protocol for information via negotiation (SPIN) [10].In DD base station broadcast interest for particular type of data.

Timestamp and several gradient fields associated with interest message. Direction and data rate specify by the gradient.

In SPIN hub (initiator) publicize the information to neighbor hub on the off chance that information coordinate the intrigue sort of neighbor, at that point neighbor demand for information. At that point initiator sends information to sink and arrangement is finished utilizing the abnormal state information descriptors which disposes of the information repetition by utilizing the 3 messages of ACK, REQ and DATA. Each hub which gets the

information bundles communicates to every one of the neighbors that it has gotten an information message. The ACK contains the meta-information of the information the hub has gotten. At that point the neighbor hubs who are worried in information will transmit a REQ correspondence towards the hub. At that point they will transmit the DATA message towards the hubs which REQ for the information. This is the manner by which the transmissions are decreased in and subsequently SPIN expands the proficiency of the convention.

Hierarchical routing techniques nodes are grouped are called cluster and each of these cluster have cluster head, cluster member transmits data towards cluster head, and then it will collect this data further it will transmits this data towards the sink. Some hierarchical protocols are Leach [11], PEGASIS [12], TEEN [13], APTEEN [14] and HEED [15].In Leach cluster change after each round and cluster head choose on the basis of threshold value. Leach removes the redundancy and long transmission. S. Lindsey et. al[11] proposed improvement of leach in PEGASIS avoid clustering, and node send data to neighbour node and one node send data to sink and aggregation also perform. TEEN reports the sudden change in sensing environment such as temperature.

In geographical type of routing sensor nodes are tagged by mean of their location. Sensor network required their location with the help of location we can estimate the remoteness between the two separated nodes and easily estimate the energy consumption. Geographical routing techniques are GAF [16], GEAR [17]. J. Heidemannet.et.al [16] projected an energy aware routing algorithm for energy conservation. In GEAR routing nodes are aware to about location and residual energy and residual energy of neighbour.

QOS aware routing protocol review end to end stoppage during planning of path in the network. Each node contains information regarding the neighbour and also geographic location f find the path and it gives guarantee end to end delivery. In power constrained WSNs real time application need energy but QOS protocol use low latency and high reliability for deliver the critical data.

1.3.1 Routing Challenges and Design Issues in WSN

There are so many restrictions in wireless sensor network like restricted processing power, power, and restricted bandwidth. Main objective of WSN is to attain data announcement when imitating to increasing the life time for network [6]. There are so many factors that

dominate scheming of routing algorithm. Here we showed few confronts and design subjects that can influence routing procedure.

1. *Energy expenditure without trailing correctness:* -as we know it is very difficult to replace the nodes in WSN so we need to work harder on energy uses of WSN. Because they have very limited battery power for operating their operation so there is need to utilize energy very efficiently.
2. *Scalability: - As we know that there are so many nodes in wireless sensor network so each and every routing should work properly for WSN*. They should be sufficient good for responding the base station when any event occur in sensing area.
3. *Network dynamics:* -We study mostly sensor node are fixed and base station too. In various application nodes and base station can be mobile .Decide the route of message from node to base station will be difficult and topology stability is main issue and addition to energy or bandwidth.
4. *Connectivity:* -Connectivity based on deployment of nodes. Network size shrinks due to limited energy and node failure. Node should be highly connected because high node density prevents them from cut off to other nodes.
5. *Data aggregation:* -The main task of this property id to remove the duplicity from data. When sensors sense the data it can be possible two or more node sensing the same area and sending same information to other node or cluster head. So data aggregation contains various functions which help to remove the redundancy. These techniques improve the efficiency and optimize the information.
6. *Quality of service:* -Some application need data after certain amount of time if data not delivered at particular time, it is useless. Some application does not concern about the energy conservation they require quality of data. If we are not focusing quality of data the information will be useless. In many applications conservation of energy, relate to life time of network.

1.4 Objective

From the motivation we concentrated on vitality proficiency of WSNs. In this thesis we propose another power efficient protocol which improves the soundness and life span of the system. Principle reason for this calculation is to safeguard the power in each round to make the system progressively steady. When the sensor nodes are sent they can't be supplanted or energized. We use MATLAB to check the presentation of proposed calculation. We contrast

the proposed calculation and existing calculations based on dependability period and alive hub after each round

1.5 Thesis Organization

Chapter 1 contains detail introduction of wireless sensor network, routing technique and protocol architecture of sensor network. Literature review, related work, clustering protocol and first order radio model is explained in Chapter 2. In Chapter 3 We describe about the proposed energy efficient algorithm and also the node deployment strategy. Network parameter, Multi-hop communication and Performance results are demonstrated in Chapter 4.We conclude our work with future scope in chapter 5.

Chapter 2 Literature Survey

To achieve the goal of energy saving there are so many routing protocol which are energy efficient in behaviour have done many work in this field and all the protocols have special characteristics for fulfilling the same purpose. As we know we use push division in SPIN protocol for specific flat networked The SPIN protocol which uses push diffusion under Flat networked based data because here sending processes are depends on local knowledge whereas there is no assurance of data delivery because of there is a change in actions for the concerned nodes. When there is a need of accuracy and release of data is primarily thing than we should not apply SPIN algorithm [18]. There is no need of maintaining a global network like we use in SPIN protocol but because DD use flooding in case of plenty of intermediate nodes are there and sinks are present in less number used[7]. One phase pull dispersion can be a productive Flat based system information accumulation convention as it doesn't utilizations flooding to think about the intrigued hub however ought not be utilized when the sink loan cost is high. Along these lines the level based system information collection method can be utilized according to the necessities and exchange off to choose the most appropriate is talked about. Group Based strategy is investigated alongside its assortment of directing conventions with the points of interest and burdens of individual conventions of bunch based procedures. Another approach information similarity based clustering algorithm can be used to save energy as it does not need any global information for the nodes and only cluster heads knowledge is sufficient but increases the burden of the respective cluster head. LEACH protocol used cluster based technique. Various energy proficient routing algorithm proposed by researcher to enhance the stability period of network.

plenty of research already has been completed on improving the energy capability. Energy proficient clustering protocols helps in geting better the performance of network because it provides load balancing and manage energy aware communication. In Chapter 1 we discussed some of the routing techniques and challenges in designing of routing protocols.

2.1 Clustering in wireless sensor network

In direct transmission, every node sends information towards the sink and correspondence happen legitimately. Be that as it may, some restriction related with remote sensor system, for example, constrained handling ability, low power battery; low transmission capacity for correspondence and less memory space. Supplanting of sensor hubs is incomprehensible. Loads of work has been done on the most proficient method to expand the vitality effectiveness of the remote sensor systems. Grouping present by W.R. Heinzelman to improve the presentation of remote sensor arrange. We make the gathering of hubs and pioneer of gathering. Each gathering part sends information to pioneer. These gatherings called by bunches and pioneer of gatherings known as group head. After determination of bunch head it communicates the message to group part and based on condition which we set part join the bunch. We will ponder different calculation how we select group head. Bunch head perform different errands, for example, total and convey to sink. Accumulation evacuates the excess. What's more, different total methods exist. We are decreasing transmission cost with the assistance of group. Information Communication happens between bunch part and group head. Bunch head send information to base station.

Clustering enhance the life span for WSN as compare of direct transmission. Transmissions cost is high as compare to computational cost in WSN. Various clustering technique proposed in WSN. Clustering enhance the stability for the WSN. When we deploy the nodes in network they are correlated and sense the same s environment so redundancy occurs in data. So Cluster head use the data aggregation function to remove the redundancy and reduce the cost of transmission as well. Cluster heads choose by various algorithms and there is not useful if cluster head does not perform the data collection to remove the duplicity.

Transmission is too costly as compare with computational cost in WSN. Various clustering technique proposed in WSN. Clustering improves the stability of the sensor network. If we try to deploy the nodes in network they are correlated and sense the same s environment so redundancy occurs in data. So Cluster head

Figure 2.1 explains about the several cluster and cluster heads, cluster member sending the data to CH and further CH sending towards the sink.

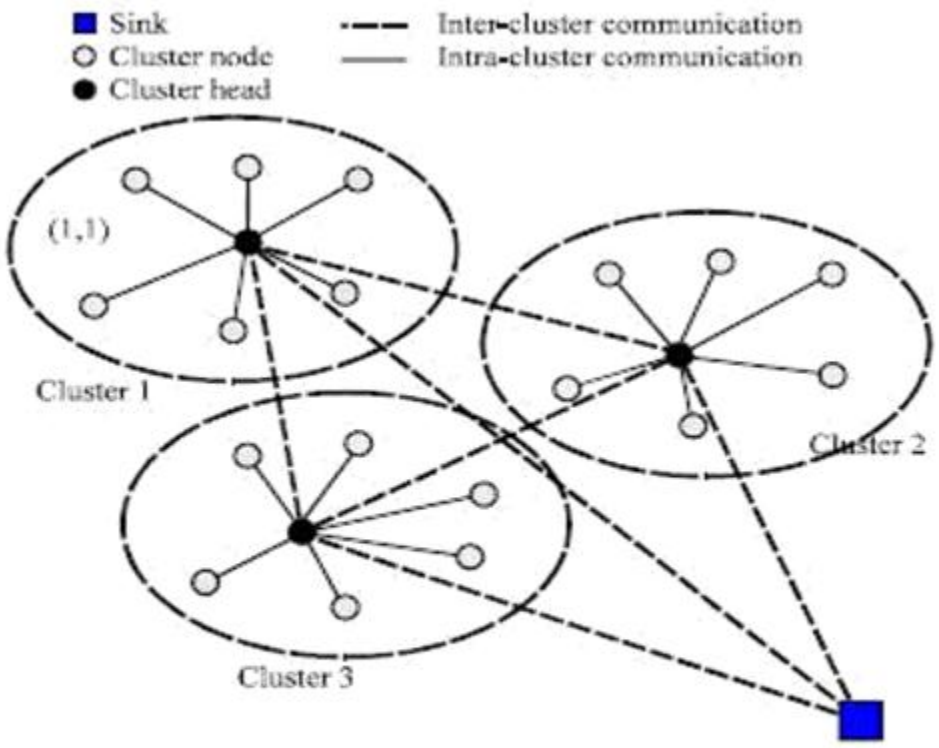

Figure 2.1 Clustering in Wireless Sensor Network

2.2 Classification of clustering in WSNs

There are so many arrangement on different criteria for clustering in WSN. In the event that we are utilizing parameter for choosing the CH, at that point calculation can be sort deterministic and versatile. Unique quality of sensor hub measured in deterministic methodology, these characteristics are hub id and number of neighbor. Lower id hub progresses toward becoming bunch head yet this calculation not reasonable for vitality compelled arrange. In versatile plan group head select based on higher weight. Unified and Distributed calculation is a piece of bunching calculation. Worldwide data requires in brought together calculation, Performance of incorporated calculation isn't great in enormous scale organize. For enormous scale system conveyed calculation is suitable in light of the fact that sensor hub use data got just its neighbour for joining the bunch or become CH. Bunching calculation can be single bounce or multi jump [19].

2.3 Challenges Of Clustering Algorithm

When we design the clustering algorithm various challenges arise. Some challenge discuss below [19].

1. *Rotating the Role of Cluster Heads:* - In WSN sensor node transmits the data towards particular cluster head. Further it will perform signal dispensation and send the data towards base station. power dissipates by CH quickly as match up to normal nodes. So there is a need to change CH after each round to achieve the energy efficient communication. Frequently change the cluster head more interruption in network and cluster overhead. If we do not change the cluster head quickly then node will die early.
2. *Optimal Cluster Size:* -Another important parameter is size of cluster. If Cluster size is less then energy consumption is low within each, but cluster heads will be more. Cluster heads dissipate more energy. If we increase the cluster size then each cluster dissipate more radio frequency power. Some clustering protocol contains the equal size of cluster but resulting unequal load on cluster heads. If we use the multi hop communication then which cluster head near from base station which dissipates the more energy. How we can construct optimal size of cluster without location information of nodes this is challenge in sensor network.
3. *Most favourable Mode of Communication:* - Cluster is constructed by sensor nodes and Cluster head gets data from members of cluster. Data communication between cluster nodes and CH can be seen as multi hop and single hop. for multi hop, the node transmitts data to nearest node and in single node it directly sends data to cluster head.

When we are planning the clustering algorithm for the WSN, consider issues and threats occurs .How we can fix these issues and can make the energy efficient algorithm. We have to create the efficient utilize of this energy to boost the total life for the network and it totally based on how we efficiently use the clustering technique. Optimal Clustering depends on the energy model used to achieve better result and how we maintain intra cluster topology. Optimal clustering strategies give better result for energy preserving in every round and make network established. These points are describing how we can achieve better algorithm such as maintain transmission cost.

2.4 Clustering Objective

Goals of clustering are to satisfy the fundamental necessities of the applications. Network Clustering has various popular objectives [20].

1. *Load Balancing:* -This is huge issue to accomplish the In the event that heap isn't adjust in system some hub will kick the bucket rapidly because of direction of system will be fall flat. With the help of same amount cluster algorithms we can poise the load and increase the network's total life time.
2. *Fault Tolerance:* - Sensor system convey in cruel condition and there hazard to physical harm and shot of breakdown. Bunch head require keeping away from the loss of data. On the off chance that bunch head is fizzle than structure the group once more. Re bunching disseminate the vitality.
3. *Increased Connectivity and Reduce Delay:* -CH speaks base station and transmits the information towards the base station. When we select thee groups head from the sensor hubs, guarantee that thee exist a way from the bunch head towards the base station. With the help of same amount cluster algorithms we can solve this problem.
4. *Maximal Network Longevity:* - Sensors in WSNs have limited power so network life time is major issue. We have to design efficient clustering algorithm which reduce the energy uses. If cluster head place close to sensor node then energy consumption will be low in intra cluster. If we distribute the cluster head load as mention in first point then network life time will be extend.

Application heartiness must be the higher need in WSNs when we structure the grouping calculations and steering convention and planned calculation effectively adjust the assortment of use necessity. On the off chance that grouping calculation does not satisfy the prerequisite of use, at that point it will be futile for specific determination.

2.5 Energy Efficient Clustering Protocol

First clustering convention was LEACH. In this convention we form groups moreover, each group have sensor centres, which sense the information and transmits the data to CH. W. Heinzelman et al proposed LEACH to improve the prompt transmission show. earlier than LEACH sensor center points used to send direct data towards the BS and a couple of center points can be utilized as CH transmits the data towards the sink. In every round, we pick the CH and they accept obligation for data transmission towards the BS and every center point will be bundle head in one age. Age is time interval when each center point partakes for

bundle head which center satisfy edge will be gathering head for a particular round. We keep up set G in LEACH G contains those center points which will be gathering head in further changes. In first round each center point have same probability for bundle heads decision, when those picked in first round, they won't be pick as gathering head till next 1/p alters those center points that were not picked as gathering head in first round will have higher probability of getting the opportunity to be in coming about rounds. Every hub related with irregular number in sensor arrange for turning into the bunch head (0-1).Sensor hubs qualified for group head on the off chance that they contain arbitrary number not exactly the edge. Group head total the information with the assistance of capacity and send to base station. Different upgrades made by analyst in LEACH. Drain F proposed in this bunch is fixed. Group head will change after each round. Wendi Rabiner Heinzelman et al. contrasted LEACH and least transmission vitality (MTE) and direct correspondence.PEGASIS is upgrade variant of LEACH convention, we doesn't make different group in this convention. Notice diminish the multifaceted nature of LEACH. It utilizes level of hub and leftover vitality or thickness of hub for choice of group head. Regard is otherwise called power adjusting convention. Notice expand the LEACH based on four essential objective initially diminish control overhead second objective is determination group head is distributive and minimal bunch ,third increment arrange life time based on circulating vitality utilization and fourth objective is after consistent cycle end the grouping procedure. In LEACH for cluster head selection initial percentage C_{prob} is predefined.

Where $E_{residual}$:-current estimated residual energy, E_{max} :- highest energy of node at fully charge battery. In HEED cluster can be tentative CH_{prob} <1 or final cluster head if CH_{prob}=1 during the round after selection of cluster heads they announcement message about tentative or final cluster head. In HEED cluster head percentage improving with help of residual energy and node selecting as cluster head in successive rounds then it have high residual energy comparison of other nodes.

In chapter 1 we examine about two algorithms and they are the TEEN, APTEEN [21] is broadened rendition of TEEN based on execution. LEACH collects the data at regular intervals and TEEN respond on time based occasion. APTEEN is cross breed convention which catches the information occasionally and responds on unexpected change in sense

esteem In APTEEN vitality productive correspondence happens among sensor and sink since it utilizes hierarchal bunching idea.

Siva Ranjani et. al [22] proposed ECBDA (Energy Efficient cluster based data aggregation) protocol to enhance the stability period of network. In which network is divided into layer and each layer contain the set of cluster. Cluster form by K-means algorithm and we will select CH regarding the residual power. This protocol contain the maintenance phase which help to maintain cluster, when we choose cluster head for particular round if it contain more energy from the threshold this cluster head can be used for another rounds as well until the total energy of cluster head less than the threshold value. We does not form cluster also after each round because it use the concept of re clustering. Re-clustering means when the clusters have less than $N_{init}/2$ nodes. When the total nodes in the cluster is half of thee neighbouring cluster the two clusters are merged and a single cluster is formed. So we are not forming cluster after each round which saving the energy and providing better results.

J. Wu et. al [23] proposed energy capable unequal clustering algorithm to improve total Network's life and its mechanism based on periodical data collecting in WSN. In EEUS cluster size is smaller which are close to sink as comparison. to far from base station and cluster head closer to sink preserve more energy. node. Secondary master node collects the data after that it transmits towards the BS. These CH are selected based on different criteria. Primary master nodes select on the basis of residual energy . We will also check one more thing that how many times that node have already occurred as cluster head. Secondary memory node select on the basis of time factor and data collection performs in efficient manner.

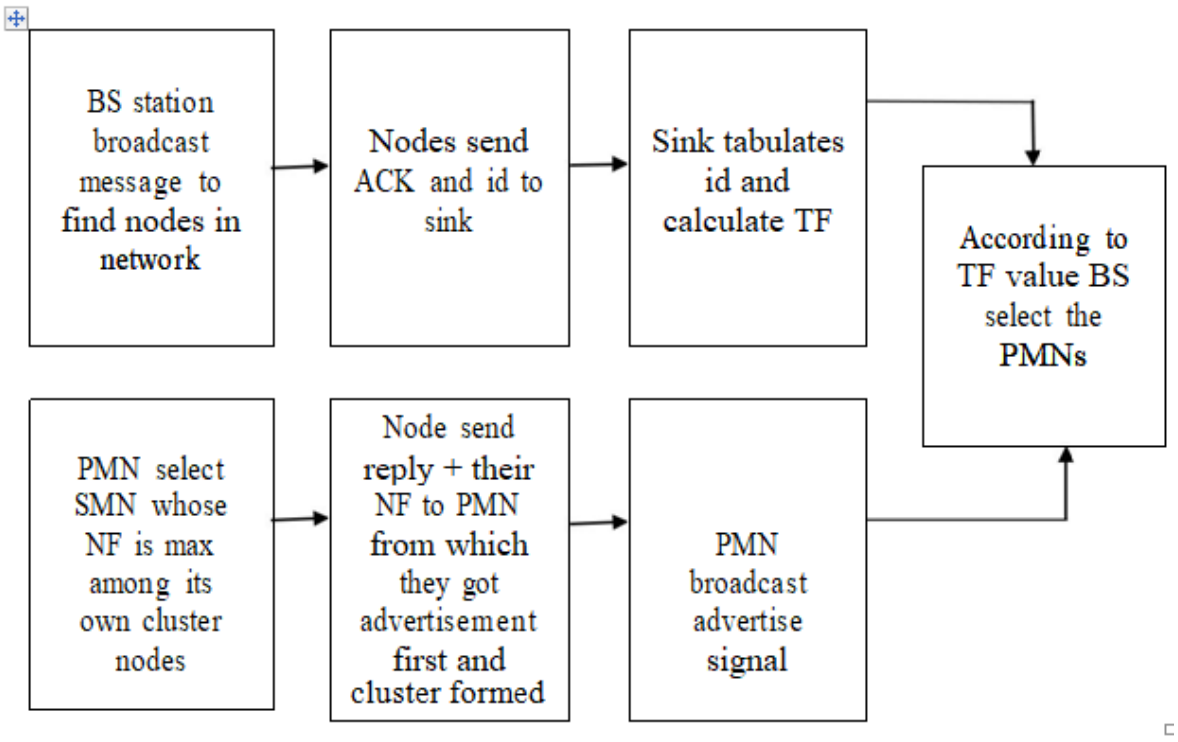

Figure 2.2 Cluster Formation Process

Nikhil Marriwala et al [15] proposed an approach for increasing the wireless sensor network's life time. LEACH provides a method for selecting cluster heads which based on random number generation. We cannot ensure that who will be the cluster head in next round. LEACH contains some drawback. Nikhil et al try to overcome the drawback of LEACH. They made improvement in CH selection algorithm and optimal path for data transmission.CH is selected on the basis of total residual energy. When cluster head selection process is completed then optimal path from between the cluster heads for data transmission and this approach increases the network life time.

Asha Ahlawat et al [16] proposed the V-LEACH for improving the scalability of the topology. V-LEACH introduce a concept that there should be a vice cluster head. This can be an alternative option when cluster head will die then it will take the responsibility as cluster head. We can select the vice CH on the basis of maximum remaining energy. It works efficiently to increase the network life time. If cluster head die then whole cluster will be useless and energy also dissipate, to avoid this condition we use this technique and vice cluster take the responsibility as a cluster head.

Ding et al [17] proposed DWEHC to achieve the better result as comparison to HEED. DWEHC main aim is cluster size and intra cluster topology should be optimal. In DWEHC weight function calculates by nodes on the basis of energy preserve and neighbour proximity. Which node has largest weight function will be cluster head and other will be cluster member. Cluster head direct link from sink or base station for communication in first level member. Weight calculates by the each sensor node after neighbour node allocating in this area.

Zhong Liu et al [18] proposed modified LEACH protocol for increasing the total life time for sensor network. Modified LEACH improves the CH selection and volume of cluster is restricted. Cluster head selection improves by the Chaos PSO. PSO provide the optimum solution for cluster heads selection in WSNs.

Edward J. Coyle et al [19] proposed hierarchal clustering algorithm to achieve the message passing approach use limited energy. Data communication preserves energy in each round for escalating the total life span for the network. For this algorithm cluster form by distributed, randomized algorithm. Hierarchies of cluster heads use this algorithm and increase the level of hierarchy to save the energy. Main aim of this algorithm to minimize the total spent energy for communication. This algorithm provides the optimal parameter to minimize the total energy.

Morteza M. Zanjireh et al [20] proposed A New Clustering protocol for Wireless Sensor Network (ANCH).This algorithm focus on the uniformly distribute cluster head over the entire region. Because we want to gets equal size of cluster for each round. Morteza et al focus on the suitable cluster heads to achieve each round optimum cluster. Selection of Cluster head is crucial in wireless sensor network to achieve better. ANCH reduce the energy consumption for increasing the total life time for the network. And these reductions in ANCH improving performance as compare to existing algorithm. Cluster size is essential to increase the performance of network. If clusters are low in network, there will be lots of energy consumption to send the data by cluster member to cluster head .Clusters are high in the network, there cluster head selection consume more energy. And communication range will also be increase because we are increasing cluster head so transmission will increase also. If cluster size is not uniform there is lots of energy is wasting. ANCH aims to form optimum size of cluster to preserve the energy and select the suitable cluster head.

This algorithm proposes technique to make the group of cluster member with the help of different cluster heads and Huiying Wei et al [21] calculate the average value. Main aim of this algorithm each cluster head dissipate energy to get the average value. Each node calculates the approximate distance from sink with the help of sink broadcast message for all

node. This algorithm balances the load and average consumption of energy. When each cluster head dissipate the average energy for communication thus network stable period increase and network life of sensor network.

Clustering Protocol has two broad categories Homogenous and Heterogeneous. LEACH, TEEN, ANCH are homogenous and SEP, DEEC are heterogeneous protocol. Heterogeneity in sensor node energy because of we introduce some higher energy node, Transmission levels can be different for sensor nodes and initial energy can be different [22].In Heterogeneous network some node can be introduce with higher energy known as advance nodes. We will select the cluster head considering the residual power of that node, proceed node will be CH which help to maximise the life span for the network. CH contain more energy as comparison of the cluster member.

Various clustering algorithm proposed for heterogeneous network also. Heterogeneity helps to improve the stability period of sensor network. Advance node concept arrives from stable election protocol in this algorithm advance nodes have higher energy as comparison of other nodes. Advance nodes select as cluster heads which will perk up the overall performance of the network. Cluster heads selection in LEACH on this basis of random number generation and Cluster heads do various task such as aggregations and transmits the data towards BS. We can say select high energy node as cluster head with in transmission radius.

Georgios Smaragdakis et al proposed an algorithm for heterogeneous sensor network which are heterogeneous in nature. Sensor nodes are not mobile and it improves the time of first node death which known as the permanence phase of network. Stable election protocol depend each node weighted selection probabilities to become cluster head each node remaining energy. Stable region improve by the steady selection algorithm.Heterogeneity parameter use by the clustering hierarchy such as advance nodes which contain more energy as compare to normal nodes and additional energy. Balance energy consumption try to maintain by Stable election protocol. Advance node should be cluster head as comparison of normal nodes which contain the initial energy. Existing LEACH improvement make by increase the epoch proportion to energy. We increase the epoch which is based on energy increase oof nodes. Stability period of Stable election protocol is higher due to this throughput of stable election protocol is greater as compare to other protocol. LEACH very sensitive about the heterogeneity and it is not stable when network is heterogeneous.

In Stable election protocol we do not require about the energy global knowledge after each selection round and provides the optimal clustering technique and this works on

the probabilistic algorithm. Stable election protocol uses the two levels of hierarchy nodes. Here we have two different category of nodes one is advance and the other is normal nodes and we have to indicate also how much fraction more energy contains by the advance nodes and with the help of fraction we improve the epoch. Stable election protocol tries to maintain the balance of power to achieve the stability. Stable election protocol contain problem to maintain well distributed energy consumption constrained in the stable period. There can be worse if all normal nodes select as cluster heads so we have to maintain the well distributed energy consumption constrained. Threshold increases with number of round and each epoch. Stable election protocol improves stability as comparison of other energy efficient protocol and it also improves network life time and throughput.

Ravi Tondon et. al [13] proposed weight based clustering in wireless sensor network for increase the overall working of network. Cluster head dissipate more energy as comparison of other nodes. Advance nodes select as cluster head improve the performance. In this algorithm cluster head selection on the basis of weight based clustering for heterogeneous network. WBCHN consider on various point residual energy, how many sensor node live neighbour and with the help of forecast method. If energy of sensor node is more than average energy of all neighbourhoods, node will elect itself as cluster head. There is exception in rule after selection of cluster head as node, node energy become equal to minimum energy the node will be consider as dead, because it lie below the threshold. So after each round pass the "I am alive "message to neighbour with the help of this information node can be predict how many neighbour are alive and predict the energy for current round and weight broadcast by nodes(remaining energy after current round).

In WBCHN weight function calculated with help of equation 2. WBCHN attempts to maintain load balancing. Maximum energy node selected as cluster head because cluster have to perform various task such as transmission and data aggregation.

Energy efficient Sleep awake aware protocol (EESAA) considers two types of node scheduling first one is "sleep" mode and the other one is "active" mode while we are considering only one interval communication. EESAA provided the pairing concept of nodes. Main Purpose of this protocol to avoid the redundant data.

When nodes are coupled, they sense the same data and send to Cluster Head. EESAA provide the pairing (coupled nodes) concept for increasing the total life time for a network on the basis of when two nodes coupled, at a time one node will be in active mode. EESAA tries to reduce the energy uses because when nodes are in Sleep-modes they can preserve their power by not contacting with the CHs [34].These protocols are based on homogenous network.

major target of this algorithm is to reduce the redundancy in data. Cluster head choose in first with help of LEACH. And afterwards energy of nodes will be different then we have for selecting CH after considering their energy. Deployment of nodes in network is random.

plan of a distributed energy-efficient clustering protocol for heterogeneous wireless sensor networks proposed by Li Qing et al [24] to enhances the scalability and network life time. And it gives some algorithm for minimizing the energy uses. It is called as DEEC. Cluster heads selection is based on the probability of ratio residual energy for each node and network average energy. And the nodes having more energy will have greater chances of becoming cluster head. So it reduces the energy consumption with the help total average energy for network. In every selection round global knowledge is not required by DEEC. It is multilevel heterogeneous protocol. DEEC provide the more scalability and more life time as comparison of stable election protocol (SEP) and LEACH. Its increases 15 % round then the stable election protocol for stability period.

	SPIN	**LEACH**	**Directed Diffusion**
Optimal Route	NO	NO	YES
Network Lifetime	Good	Very Good	Good
Resource Awareness	YES	YES	YES
Use Of Metadata	YES	NO	YES

Table 2.1 Comparison between Routing Protocols

Table 2.1 describing the characteristics of the routing protocol there are data centric routing and clustering technique and we can measure table clustering protocol providing the more lifetime and also providing the optimal route. In some case data centric routing protocol can be better as compare to clustering protocols.

We studied various clustering protocol some provides the various technique how we can stable our network more and how we can improve the life time of network. Heterogeneity provide more stable network as compare of homogenous network.

Clustering technique reduce the redundancy in data and clustering algorithm contains the various type of technique such as hierarchical, distributed, centralize. We focus on the cluster

properties which contain the cluster count, intra cluster topology, inter cluster topology and stability and cluster count. Extended HEED [36] contains variable cluster count and fixed intra cluster topology single hop and inter cluster topology contain the direct link between the cluster head and base station. Stability assumed in extended HEED. Cluster head capabilities define in extended HEED. Cluster head is stationary and aggregate the data. It is distributed methodology and selection of cluster head randomly and it saves energy.

Huang and Wu extended HEED on the basis node will not give up which did not hear from any cluster head (Orphaned nodes).In extended HEED we consider these nodes as cluster head and communicate directly to base station does not require re execute the algorithm. These modifications decrease the cluster head count.

Various clustering algorithm make great effort to construct minimum number of disjoint cluster. Youssef et al. [37] proposed that overlapping of cluster facilitate various applications such as inter cluster topology, localization of nodes and cluster head failure recovery. Youssef proposed MOCA (Multi hop Overlapping Clustering Algorithm).In MOCA each node has p probability to become a cluster head. Each cluster head broadcast message with in its radio range. This message forward k-hop away sensor nodes only. Cluster head receive request to join cluster by all sensor nodes which hear broadcast message. Node contains the ID of all cluster heads it heard from. Overlapping degree and number of cluster control by the probability p. MOCA proposed for overlapping degree and number of cluster. If number of cluster is appropriate then number of cluster head also is suitable for communication with base station. This maintains the overlapping degree and author selects the suitable the value of p to maintain the overlapping degree and particular cluster count.

Vaibhav V. Deshpande et al [38] proposed algorithm to make the cluster of cluster head in wireless sensor network. Intra cluster and intra cluster communication mange by cluster head. Make the cluster of cluster head is suitable way to improve the network life time. If cluster head fail we have to maintain the cluster again. Lots of energy consume by these activities. To avoid this extra energy consumption make cluster of cluster heads. In this cluster we choose the leader of cluster and leadership rotating among the cluster heads after number of preset round communication.

Tony Ducrocq et al [39] proposed new algorithm to optimize the network life time. Clustering provide efficient way to organize the network. Cluster head perform various tasks such as gathering of data, aggregation of data and send data to base station. So they exhaust

quickly. Cluster head selection in this algorithm on the basis of BLAC (a novel battery level aware clustering scheme family).For balance energy consumption cluster head responsibility taken by alternatively by each node. This balances the energy consumption to increase the network life time. Cluster head role rotating and each node taking the responsibility.

Wireless sensor network contains the huge number of sensor nodes with limited power. Clustering algorithm provide way to reduce energy consumption. Maryam Soleimani et al [40] propose new algorithm PDKC and it is based on knowledge of node deployment. This use the Gaussian probability distribution function to modelled the node location in place of GPS and other device. This algorithm enhance the network life time. In this algorithm we use the deployment information of nodes, nodes residual energy, degree of nodes and distance from base station for selection of cluster head and improve the network life time. This clustering algorithm improves the coverage region of network. PDKC (Power consumption based on Deployment Knowledge for Cluster based Wireless Sensor Network) improves the energy consumption.

Clustering algorithms helps to remove the redundancy in information, because cluster head perform the data aggregation. We have discuss various clustering algorithm such as distributive, centralize and hierarchal algorithm. Each clustering algorithm focus on clustering objectives to improves the network life time and how we can minimize the energy consumption.

In these figures we described the performance of our algorithm. Various parameters are considered to evaluate the correctness of algorithm. Stability period of our proposed algorithm is observed to be more than traditional algorithm and is observed to be around 2100 rounds. Proposed algorithm has a better “stable region” as compare of other algorithms. Energy efficient clustering and data aggregation has also increased the life time of the network. Main purpose of this algorithm is to maximize the life time of network. We have optimised the number of CHs in our algorithm which reduces the cost of construction of excessive clusters. By optimising the number of CHs we have reduced the energy used for communication. In figure 4.6 which demonstrates the cluster head count we can see there are balanced no. of cluster heads as compared to the LEACH, SEP and EESAA. We used multi hoping concept to reduce the lengthy transmission cost and increasing the stable region. In figure 4.X we observe lesser no of packets are sent to BS as compared to other algorithms because we are using multi hop concept so every cluster head transmitting the data to nearer

cluster head. Aggregation is also performed on cluster heads to remove the redundancy in the data packets received from the nodes in the clusters.

Overall proposed algorithm performed better in comparison to other algorithms and makes network more stable. EESAA algorithm is observed to perform data transmission till around 4110 rounds. Our algorithm has prolonged the network till around 6000 rounds and we can observe that our algorithm has highest lifetime as compared to other mentioned algorithms. Life time is an important factor because we cannot change sensor nodes. After 4110 rounds EESAA has only 10 nodes and they are not dying because of no transmissions. So energy is not dissipated by nodes and nodes are alive till the end but such network is useless. So we can say that these results show the enhance version of EESAA algorithm and improved the cluster head selection with optimal no. of CHs and multi-hop mode of communication.

Chapter 3 proposed approach

In this chapter we propose an energy aware routing algorithm which is a combination of energy aware protocols and multi-hop routing algorithms which is intra-cluster in nature. We can understand this process with the help of two different rounds. First round will be as set-up round, in this set-up round we will organise the clusters after that in second round, which is steady-phase. in this round there is a transmission for the data towards the base station. Node's Position which is generated will be assigned randomly and further it will be displayed. After the deployment of these nodes, each and every nodes need to find its neighbours and this can be done by using neighbour discovery protocol. After that we need to select the cluster head so by using cluster head selection protocol we can find the cluster head. Further these cluster heads sends or we can say broadcasts a message which is an advertisement message towards all the neighbours, with the help of this method we can form cluster of fixed size. Each and every nodes which are present in the clusters contains routing table , In these tables routing information of each nodes will be stored and these information are updated. There is a method for sharing same frequency channel known as DRAND (distributed randomized time slot assignment algorithm). It follows a method of dividing the signal into many time slots. All this data will be collected by cluster head and further this data is sent towards base station.

Basically we need to accomplish three important tasks. First one is, we need to programme all sensor nodes, then we need to programme the gateway also. After that data is collected from sensor nodes. At last we need to inform the manager of greenhouse about the information of gateway via a website and SMS.

Sensor's programming : it includes repeatedly measuring the light, humidity, and temperature. After collecting these it will transmits these aspects towards the gateway. There is a concern that we need to care about is that all these operations should be done in minimum energy. So there is a need to implement energy saving routing protocols for our sensor network.

After programming of sensor nodes there is a need to programme gateway also. This task itself needs to perform three basic tasks. First one ,we need to analyse the coming data from the nodes if there is any kind of error is present in that data then we need to fix that error. second task is to consolidate data. and final task we need to save all the collected data into as

single SQL database in the computer. This SQL database should be connected with the gateway. There is need of a web application which should provide user friendly interface for greenhouse manager. with the help of this interface manager will be able to look into the data about his greenhouse in no time. With this manager can also see the previous data and can compare all the data with the present knowledge.

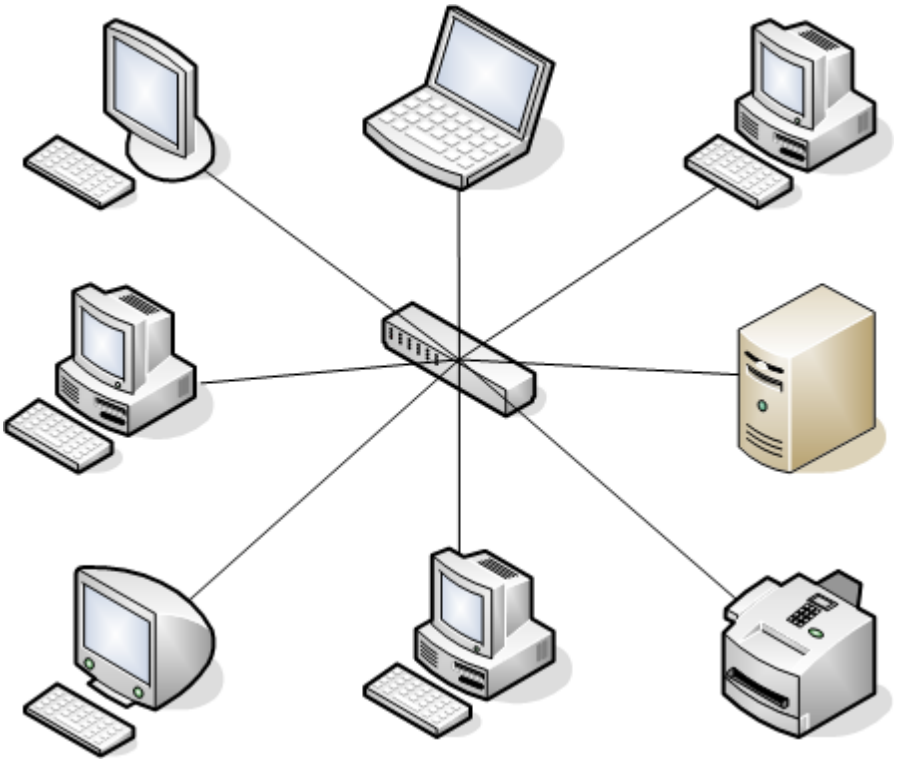

Figure: 3.1 Star topology

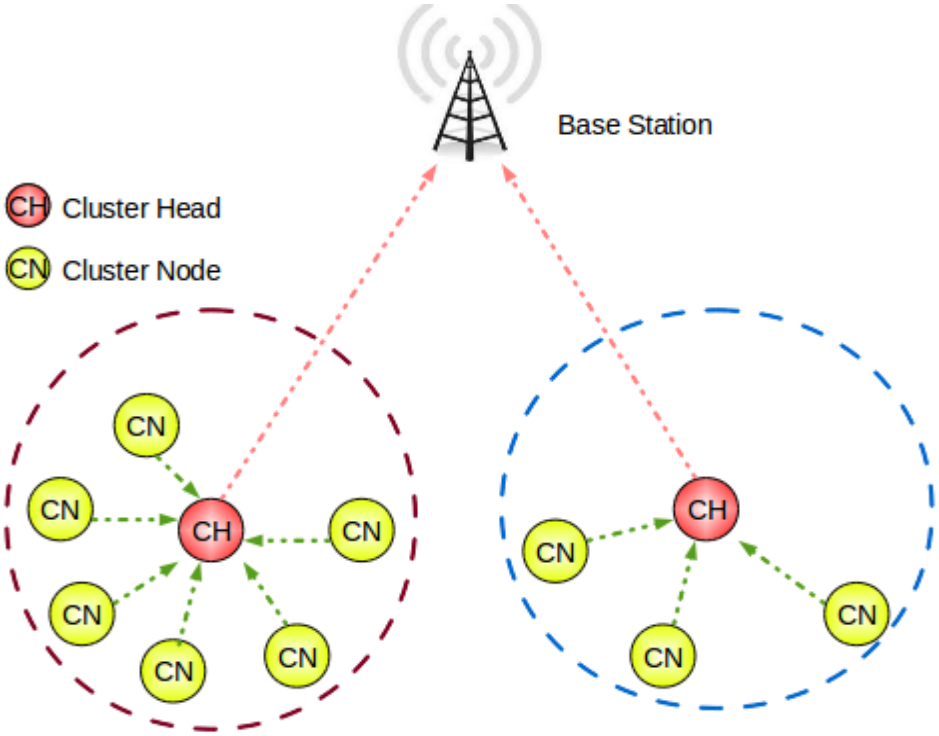

Fig 3.2 Leach protocol

3.1 Language Used

MATLAB

MATLAB stands for matrix laboratory. It is a software used to numerical computing and data visualization. It is developed at the university of new Mexico by computer programmer Cleve Moler.

Today MATLAB software is so advanced that we can integrate c++ in java wit Matlab. If you are trying to manipulates the data and wanted to add some data then it will easier in amtlab in case if you are better in c++ or fortran. Matlab firstly used by researchers in the field of control engineering and later on and later on it is used to reach numerical analysis and linear algebra and it is very famous among the scientists which are in the field of image processing.

MATLAB supports and includes all the aspects which are available in object-oriented programming like inheritance, packages , pass by value and pass by reference etc. MATLAB also have concepts like value classes if there is super class which can handle a base class. It also includes a concept known as reference class.

3.2 IMPLEMENTATION

Operation of LEACH algorithm can be done in many rounds. There are two phases are present for each round, first one is setup phase and the other one is steady phase. first we will are going to look into setup phase and after completion of this we will move on to the next phase which is steady phase. In the first phase we are going to build the clusters. In the steady phase data will be transferred towards base station. When we are in setup phase each node needs to know that whether there is a need of becoming the cluster head or no. for this purpose there is need of calculating the energy for that node. To decide this we need to check the random number and the value for that number should be in between 0 and 1. Further if threshold is greater than the selected number then this node can be used as a cluster head. There is a need of a simple question for selecting the threshold value. This question includes following terms like p is cluster head's probability, r is round which currently executing, 1/p is the collection of nodes which were is like a cluster heads for previous rounds. In the beginning all the nodes behave like cluster heads with p probability. As we know some nodes have less probability of becoming cluster head, but with the help of this method we can make any node as a cluster head. After becoming cluster head it needs to tell about its position with the help of advertising massage which is broadcasted by the cluster head. This message consists a node ID and a header which behaves like announcement message. All the nodes which are present in the network will save this message for further rounds. Each node will select its own cluster head on the basis of received signal's power. Each node will transmitts the membership request towards its corresponding cluster head. For all the stages radio transmitter should be for the whole time. There is a responsibility on Cluster head of receiving the signal from the nodes.

CH behaves like local control machine for handling the data flow among all the clusters. With the help of TDMA, cluster head propose a schedule and sends this towards the member nodes.

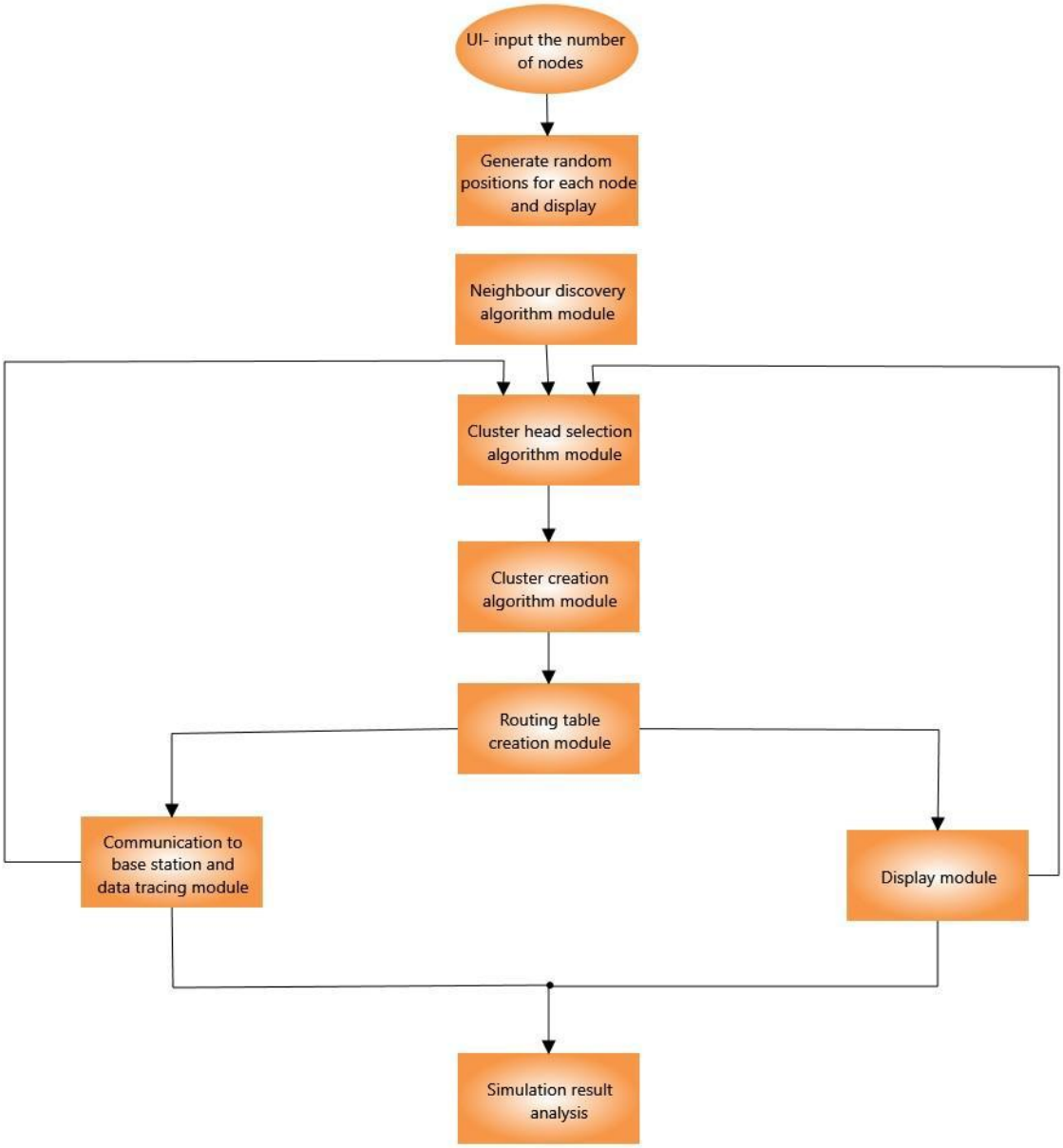

figure 3.3 Flow chart of proposed approach

3.2.1 Setup phase

Initially, just after node arrangement we need to apply neighbour discovery algorithm. There are so many methods to accomplish this like: ping, k of n approach, beacon messaging. After performing neighbour discovery , at the time clusters are about to created, each node needs to decides that whether they wants to be cluster head or not. This method is as same as used in leach.

In leach, it all depends on nodes that which nodes is taking which cluster head without centralized control. So there is no requirement of long-distance partnership from the base

station and we do not need the exact location of the nodes for creation of the distributed cluster.

Moreover, there is no need of global communication for setting up the clusters. We need to keep in mind that all the nodes have same frequency for becoming the cluster head in cluster formation protocol, here all the nodes have same energy in starting. Sensor needs to choose a number, r, from 0 to 1 .
Suppose threshold value is :

T(n) : T(n)= p/1-p ×(r mod p-1) …….(1)

if threshold value is greater than the random number , then the node will behave like cluster head. For calculating threshold value we will be looking for that formula which is able to find out the desired percentage for becoming the cluster head in previous rounds, here p will be as CH probability. After the selection of the cluster head , node will sends a advertisement message. In this message we will include node ID and as well as a header which is useful for differentiating this message from the normal message. After calculating the received signal's strength each node which is not a cluster head will select cluster for it's own. After selecting the cluster, each nodes needs to inform to belonging cluster head that node belongs to this cluster from now onwards.
nodes need to send any join-request towards the cluster head. The cluster head behaves like a local control for co-ordinating the data transfer.
There is a need for setting up the TDMA schedule after that there is a need of sending schedule towards the nodes .this is helpful for declaring that we don't have any collision. There is concept of turning off all the nodes in the network if they are not In working condition. This method can be useful in saving the energy.

3.2.2 Data Transmission Phase

After the creation of clusters, sensor nodes needs to send their data in their allotted time slot. knowing that they always some data for sending ,they sends it in fix time slots.
When any node gets the data from one any of its neighbours ,it will collect that data along with the its own data. For sending this collected data there is need of choosing the most appropriate path among all the paths.

Heuristic function is used for selecting paths,

$$h = K (Eavg/hmin * t)….(2)$$

here k= constant, Eavg = current path's energy, hmin= minimum hop number in current path, t= current path's traffic.

We will select the path whose heuristic value is highest. if any path's threshold<Emin then we will select that path. Else we will select second maximum value.

$$Emin = Eavg/const…..(3)$$

Constant's range is from 0 to 10. If there is no node whose Emin is more than the threshold energy than we will pick the node with highest lowest energy node.

3.2.3 Periodic Updates

As we know after some time all the routing paths and data of that paths will gets old. Because we calculate all the heuristic value with the help of these old values so it Leeds to inconsistent values finally. So we need to supply latest values to the heuristic function. Because of this we can increase the lifetime, accuracy and constancy of the network.

When operation is in processing then important knowledge about the network is exchanged. All the operations which are based on old values should be performed very carefully because we don't want to perform our system inefficiently.

Chapter 4 Simulation

4.1 Results

Here we are using MATLAB for simulating the result of LEACH and as well proposed approach. We are taking some parameters for evaluating the performances of both the algorithms.

- Round sequence number vs Number of total dead nodes at present.
- Round sequence number vs Average energy for each node.
- Round sequence number vs Number of total dead nodes at present(while we are varying number of total nodes).
- Round sequence number vs Average energy for each node(while we are varying number of total nodes).

For simplifying the solution for these algorithms there are some assumptions are performed. They are as follows:

1. Stating energy of each node is similar.
2. Nodes should be static.
3. Nodes should have restricted transmission energy.
4. Nodes should be distributed in homogeneous manner.
5. Nodes need to send data in every condition.

4.2 Network Parameters:

We are going to use these parameters for the simulation of our selected algorithms.

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Parameter	Value
Area	100*100
Nodes	200
Base station	(150,50)
Packet size	
Initial energy	0.1
Data Aggregation Energy	5*0.000000001
Alpha(a)	1
Maximum number of rounds	100
intermediate	1

Table 2– Radio parameters for simulation

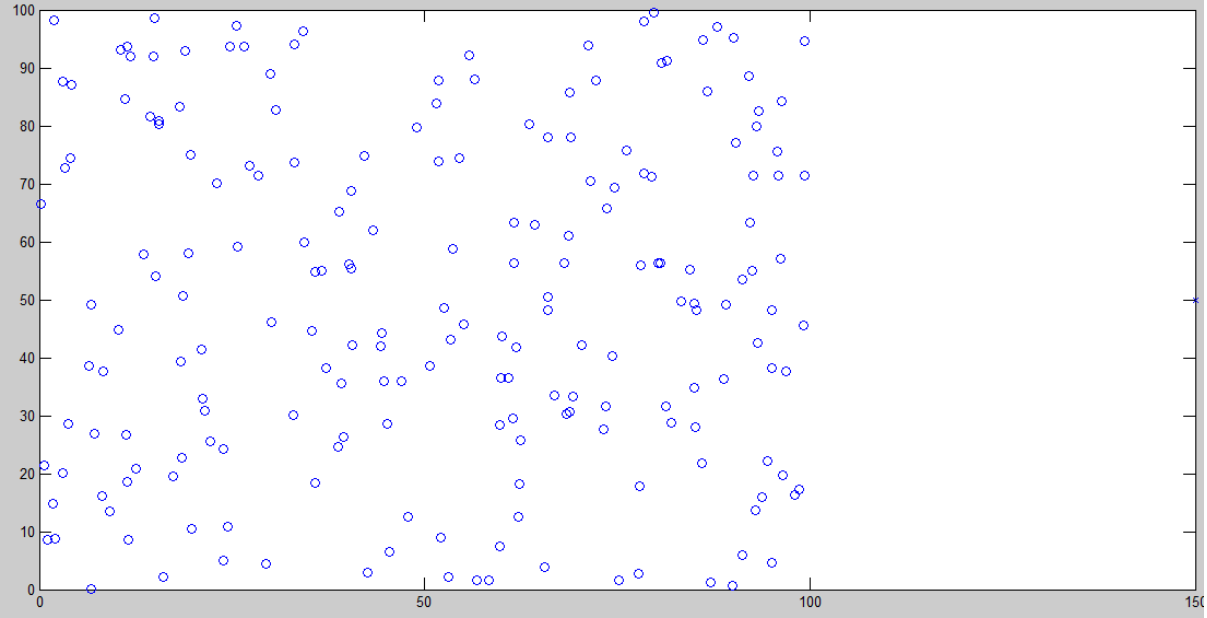

Fig. 4.1 deployment of the nodes in 100*100 and base station is at (150,50)

In network parameter we are using several assumptions for evaluating the performance of our proposed algorithm. We are taking 100 sensor nodes and uniformly deployed in network region.

Here I am going to take RED colour for LEACH protocol and BLUE colour for PROPOESED approach. In the following section I am going to compare our proposed algorithm with LEACH.

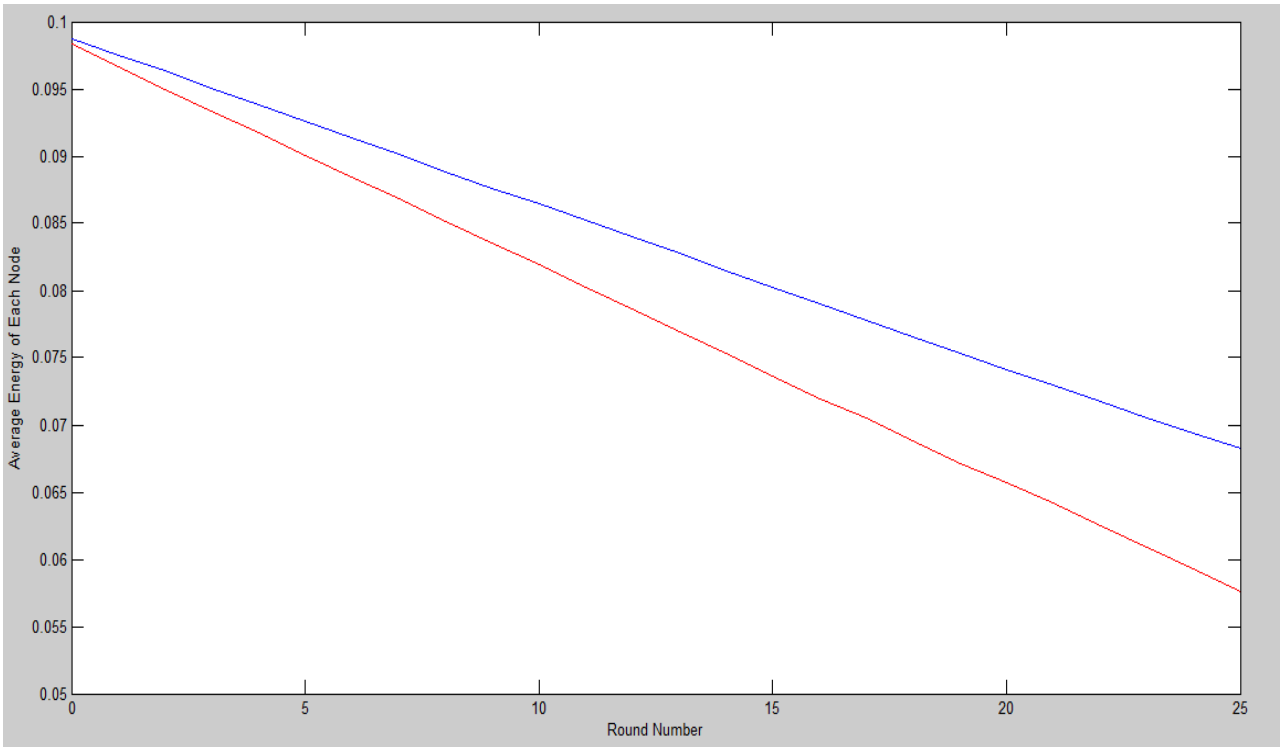

Fig. 4.2 Average energy of each nodes vs round number from 0 to 25.

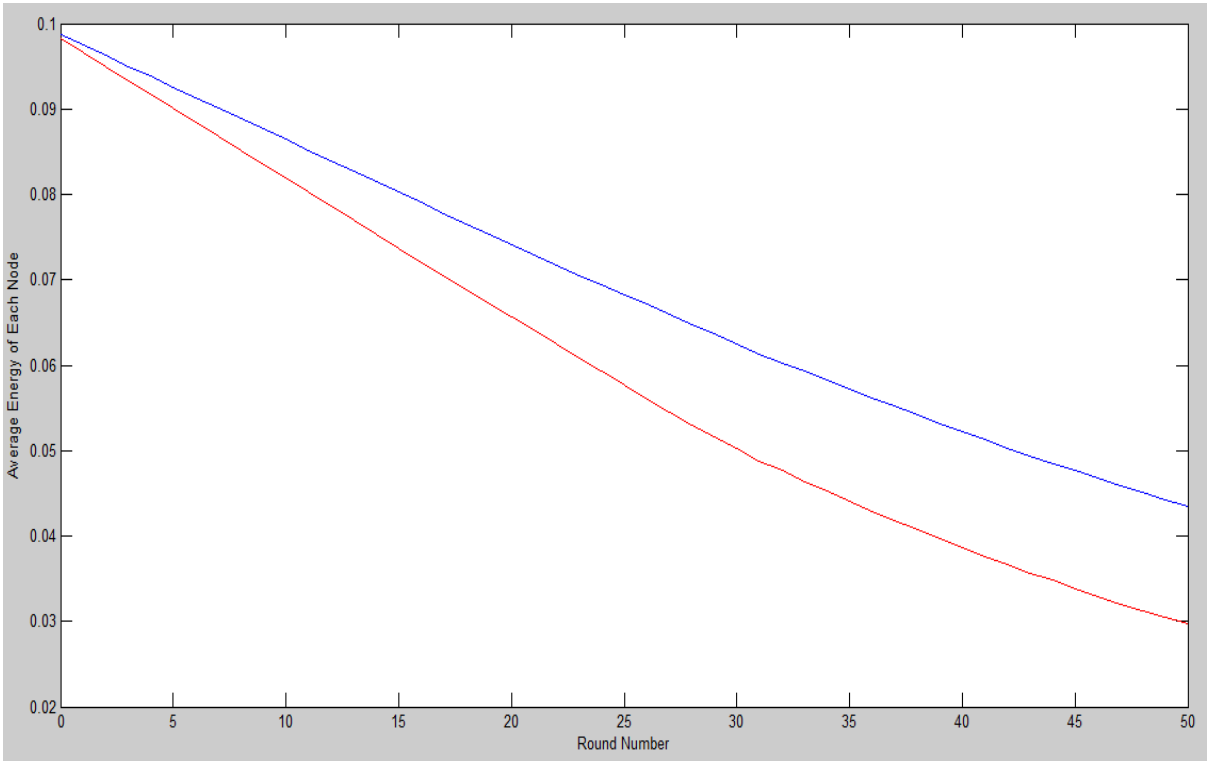

Fig. 4.3 Average energy of each nodes vs round number from 0 to 50

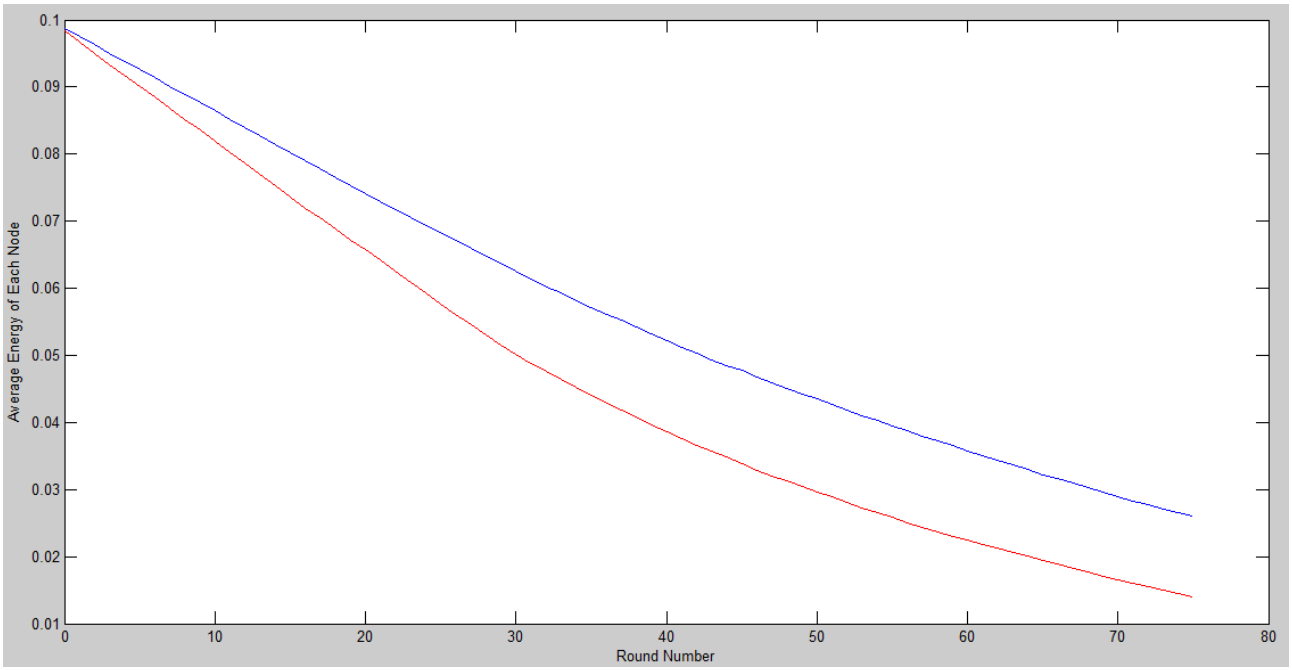

Fig. 4.4 Average energy of each nodes vs round number from 0 to 75.

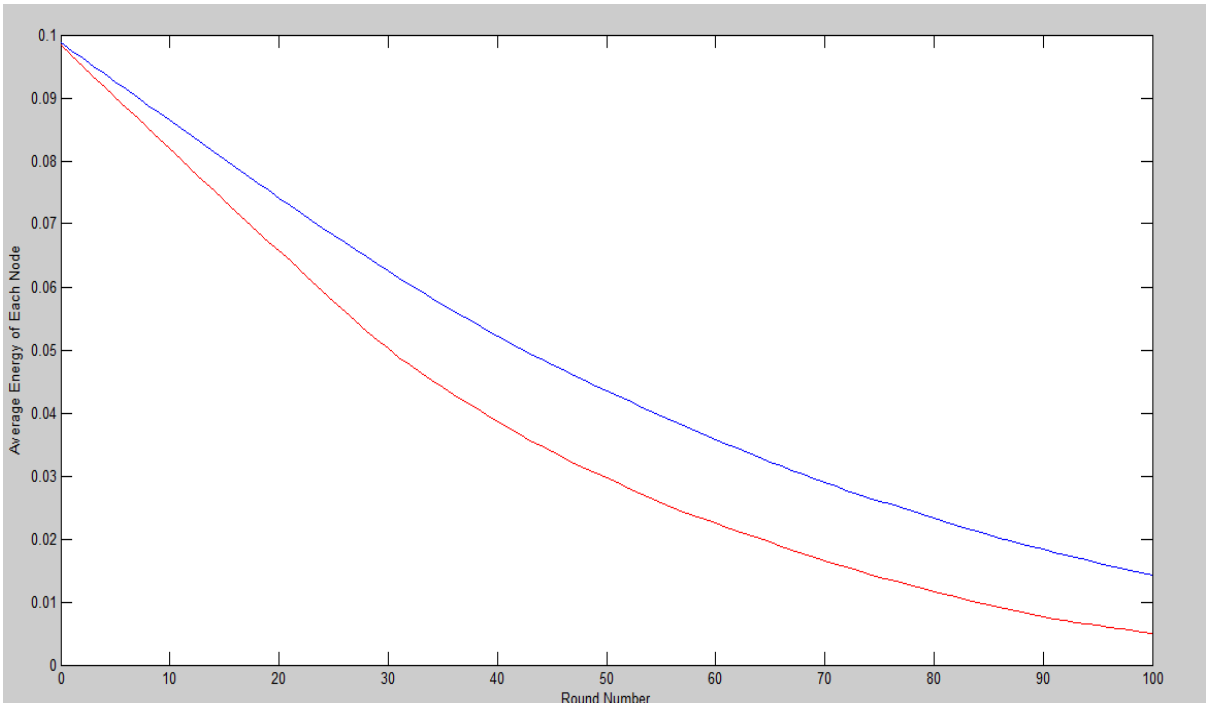

Fig. 4.5 Average energy of each nodes vs round number from 0 to 100.

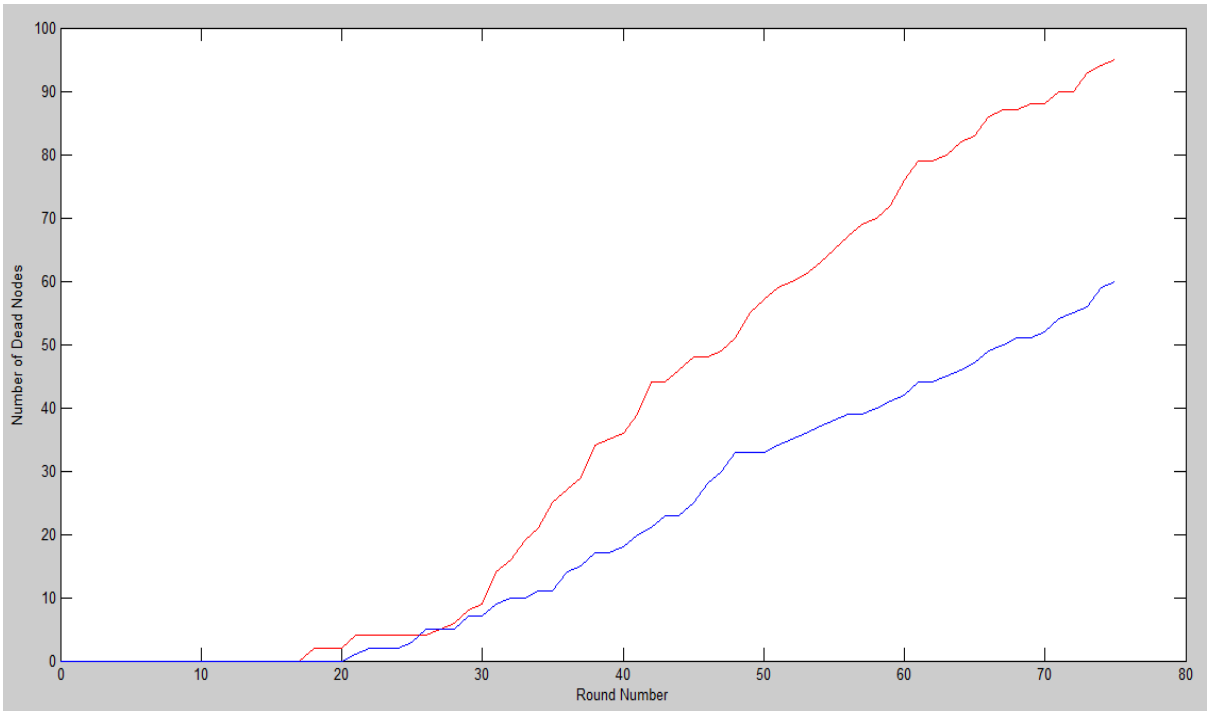

Fig. 4.6 Number of dead nodes vs Round number from 0 to 25.

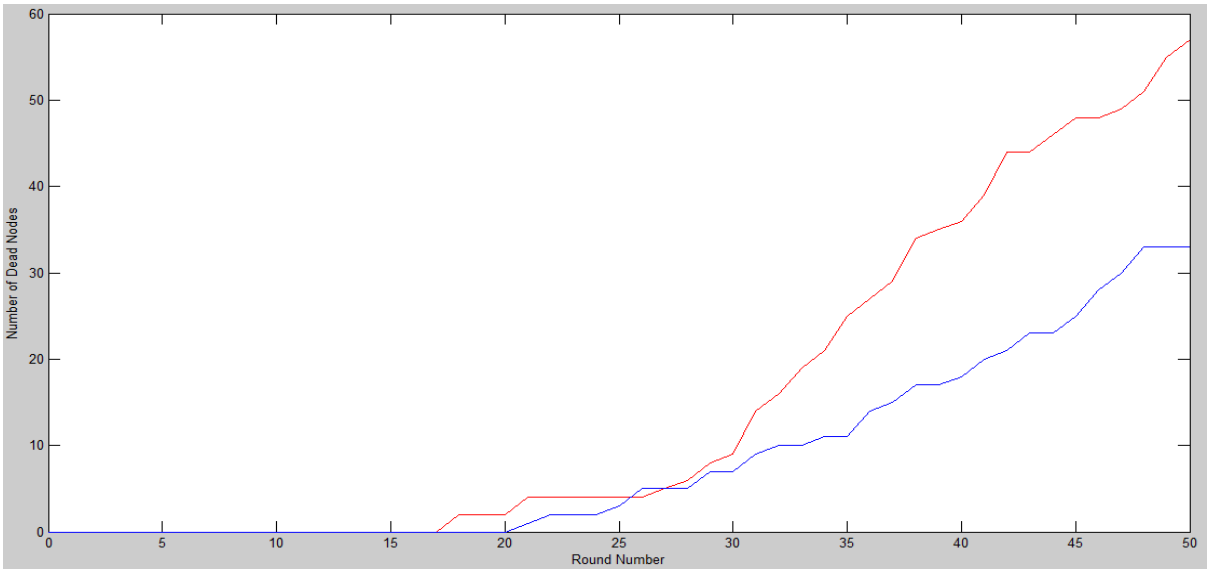

Fig. 4.7Number of dead nodes vs Round number from 0 to 50.

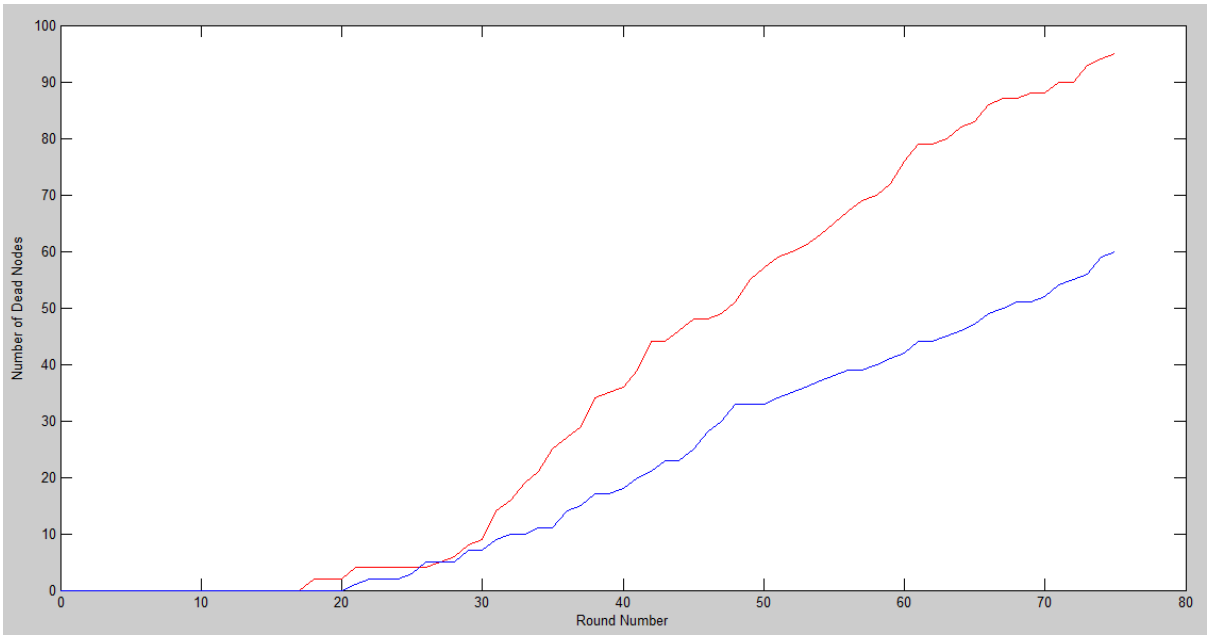

Fig. 4.8 Number of dead nodes vs Round number from 0 to 75.

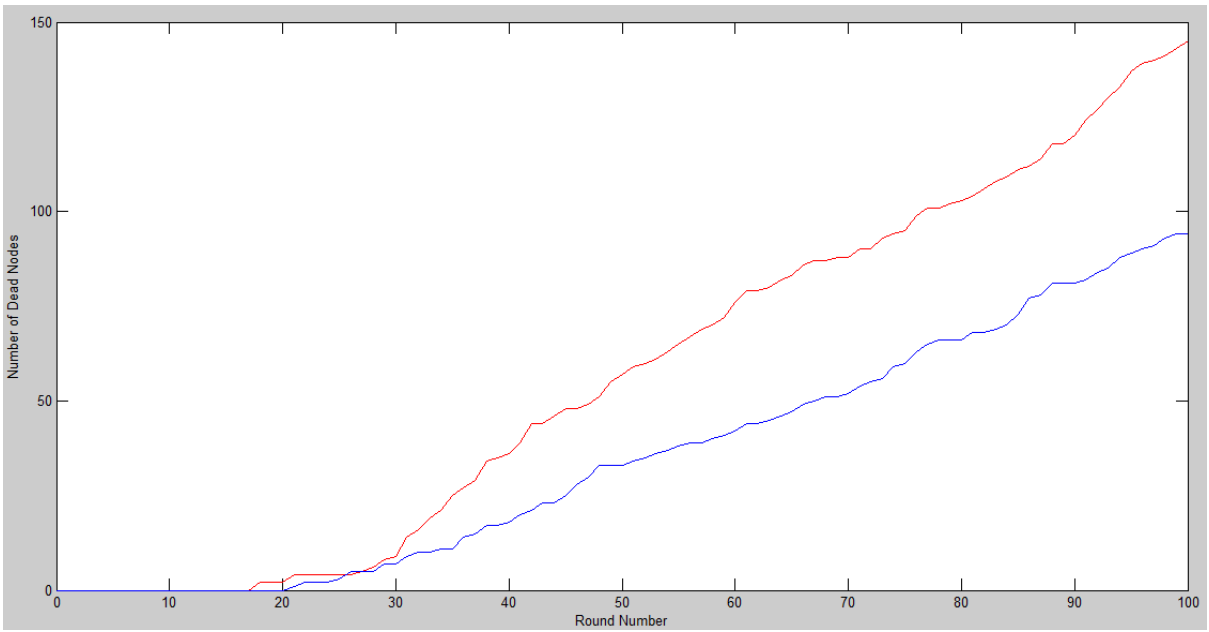

Fig. 4.9 Number of dead nodes vs Round number from 0 to 100.

4 .3 Analysis of Result

As we can see that, when time increase in figures from figure 4.1.1 to 4.1.9 according to the round's progress energy of nodes will decrease. Further it can be seen that whenever any node's energy reaches to zero that we can say that this node is no more functional and it can be considered as a dead node. In figures we can clearly see that the energy graph per node for the proposed algorithm is slightly better than the LEACH algorithm. Further after analysis of number of dead nodes are much lesser than the LEACH algorithm. So we can say that for a probability 0.2 proposed algorithm will behave efficiently than the LEACH algorithm.

After seeing all the figures it can be seen that for every probability level when number of total nodes increase propose protocol will work as compared to the LEACH algorithms in terms for average energy for each and every node. But when the number of nodes are less than LEACH is going to perform better than the proposed algorithm. From most of the cases in the figures it can be seen that first dead node is from the proposed approach.

When we compare our algorithm with LEACH than we can see that LEACH is taking more time for achieving its dead node but when we increase total nodes will lost their energy much faster than the proposed approach.

when we increase cluster head's probability and there is fixed set for nodes, than we can see that for proposed approach there is more gap in between of curves. This is happening if all nodes and even cluster head is too far from the base station then cluster head needs more energy for transmitting data towards base station because it have to travel more as compare to the closest nodes.

The main reason for performing better when we compare to the LEACH in most cases is our proposed algorithm performs inter cluster communication mechanism. with the help of this mechanism survival time of this algorithm increases. And leach use direst transmission of data towards base station.

Even LEACH is also using multi-hop communication but in proposed algorithm we are using multi path also with the multi-hop communication so this combination is making our proposed algorithm more efficient than the LEACH algorithm. After looking at all the aspects on which we are simulating our results we can say the proposed algorithm have better energy utilization

Chapter 5 Conclusion and future scope

There are so many application of wireless sensor network in different fields because they are usefull in many areas. So we need a specific way which can be helpful in achieving better use of these wireless sensor networks. As we know that power capacity of the batteries which are being used in WSN is limited. The critical challenge in WSN is how we are going to handle this limited power problem in batteries and design of the network.

Target of each network is WSN should be energy efficient while keeping all the nodes alive for longer period. In this thesis we propose an algorithm for achieving this goal for a certain limit. As we have already mentioned about the simulation results where I have compared two algorithms.

Detailed description about the algorithms is already mentioned in above topics. As I have compared both the algorithms in different environment with the help of MATLAB platform. So as a conclusion we can say that for small networks where nodes are present in less number LEACH will perform better as compared to other algorithms, but if we increase the number of nodes and heuristic probability for cluster head then we will go for our proposed approach where dead nodes will be lesser than the LEACH.

There is a possibility of improvement for this algorithm as we can minimize the cluster size. With the help of this this method we can also minimize the energy uses in previous algorithms.

Advantages:-

1. It outperforms all the conventional routing algorithms.
2. LEACH is totally distributed, there is no requirement of control information from base station.
3. There is no need of global knowledge about the network.

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Chapter 6 References

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