BLACK HOLE ATTACK DETECTION ON LEACH PROTOCOL IN WSN

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Under the Guidance of

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This thesis does not, to the best of my knowledge, contain part of my work which has been submitted for the award of my degree either of this university or any other university without proper citation.

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ABSTRACT

Wireless sensor network is one of the developing ranges of research in present situation. A Wireless sensor network comprises of geographically dispersed self-governing tiny sensor nodes with little battery life to screen and control over the physical parameters or ecological conditions, for example, temperature, sound, pressure, humidity and so on and this data is gone by the sensor nodes in the network to a next area. Amid transmission, the sensor nodes devour impressive measure of energy. There are numerous requirements on these sensor nodes, for example, constrained memory, restricted battery power, and constrained processing capacity. At the point when sensor nodes send the data to the base station (BS), routing protocols assumes critical part to convey the data at the BS. Low Energy Adaptive Clustering Hierarchy (LEACH) is the surely understood distributed and centralized clustering routing protocol. Wireless Sensor Networks are inclined to different attacks. Black hole a sort of Denial of Service attack is extremely hard to identify and protect. Black Hole attack happens, when a intruder catches and re-programs a set of nodes in the network to block the packets as opposed to sending them towards the base station in wireless sensor network. In this paper, we show the effect of black hole on LEACH protocol researched by the dynamic authors. Likewise I have proposed an algorithm for the identification and mitigation of the black hole attack.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL WSN LAYOUT

WSN stands for wireless sensor network. It has the ability of monitoring large areas, accessing remote places, real-time reacting, and relative ease of use. WSN is used in various fields such as in military activities like reconnaissance, surveillance and target acquisition, environmental activities such as forest fire prevention, geophysical activities such as volcano activity study, biomedical purposes such as health data monitoring or artificial retina or civil engineering such as structural health measurement [2]. Uses of WSN are increasing day by day without any kind of limitations. Different type of applications have different type of network bearing constraints and features but still most of the issues are common or same which makes them homogenous. The positions of the sensor node become most sensitive point while the process of deployment of nodes. But sometimes coverage area of networks creates an issue because it also directly depends upon the positions of the nodes. In sniper systems, a sensor network is placed to secure an area from the snipers. The network is designed according to the urban areas where snipers can easily hide and sound sensors are also installed in the network to detect the sound generated by the bullet. By fetching data collected by all these sensors, the location of the sniper can be estimated after applying space temporal data in an efficient manner. In some cases complete terrain coverage is must where the situations are critical so that the sensors can detect the bullet trajectory no matter what this trajectory is. But in some areas like biomedical sensors the coverage of the terrain is not important but in this situation interface with the patient and the safety of the system become of a critical. There are two other important concerns, in the first the WSN is deployed in a battlefield where the support and maintenance of WSN is not possible or a longer period of lifetime. It follows one of the rule of WSN which implies the energy saving and on other hand WSN as to operate secretly so that it cannot be detected by the enemy. This means that the number of sensor used must be low in order to reduce probability of one of them being

discovered. Excluding this these concerns are not unknown to the civilian purpose WSN because decreasing the number of sensors used and increasing the lifetime can directly effects the cost reduction of the network. Since many WSN include bulk of nodes and some of their features cannot be measured in a simple manner, the process of selecting the geographical positions of the nodes for an optimal resulting network -referred to as WSN layout problem can make it very complex. This problem recalls the unicost set covering problem also known as NP. Therefore, metaheuristics is a option to solve this problem. In most of the problems the focus is on to reduce the Energy consumption as well as nodes used in the network. The number of nodes can create a problem while covering the network. While displaying the network it have to face the various considerations. The coverage has to follow some rules or restrictions and highly coverage area is preferred. The reduction of sensor nodes is not for a specific purpose it is just to reduce the cost factor. The lifetime of a network depends upon the energy consumption so energy management is the most critical issue in the network.

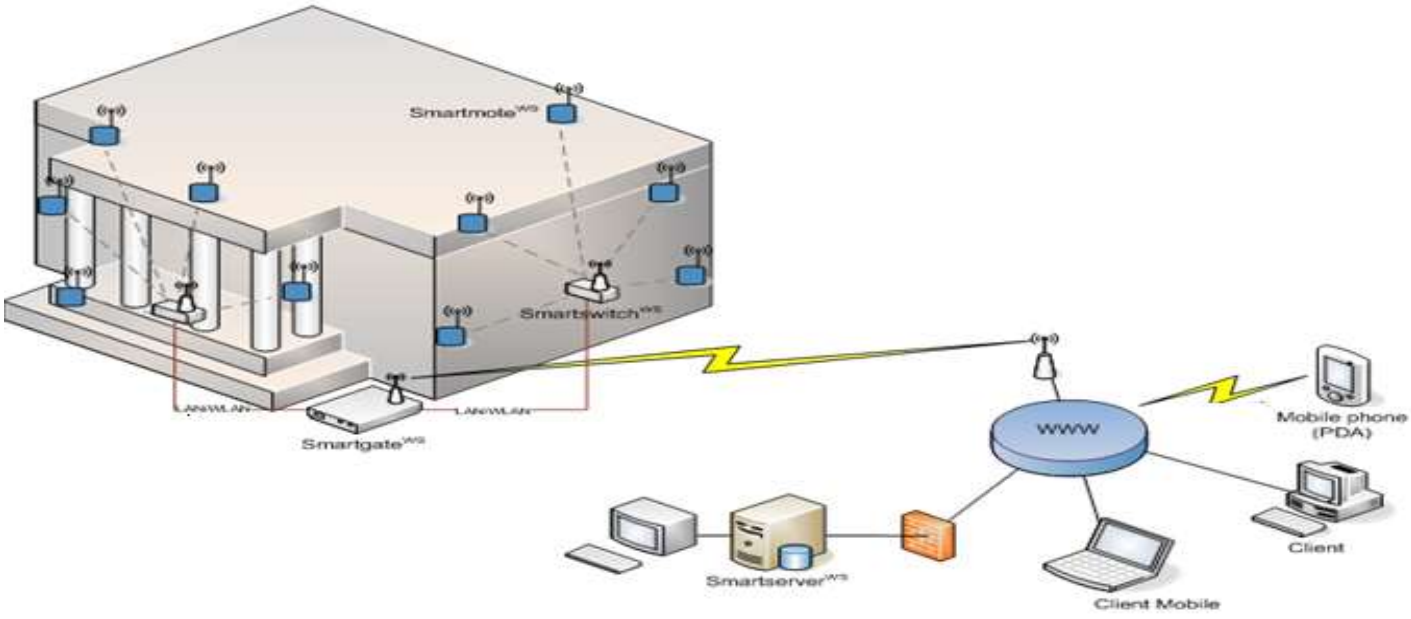

Figure 1.1 General Layout of WSN

1.2 ROLE OF ENERGY IN WIRELESS SENSOR NETWORKS

Power transmission and distribution substations includes some pivotal parts like circuit breakers and transformers that are continuously monitored in order to minimize the possibility of expensive and disruptive power outages(i.e. when power is supply is not available or equipment is closed) [1]. Due to the fast growth in trend of substation equipment and infrastructure, this becomes an serious issue for engineers and substations managers to reduce the possibility of expenses and power outages. Nowadays this kind of monitoring is done by using periodic physical inspections and real-time measurements with the help of exorbitant wired sensors. Due to the growth in the popularity of low power wireless sensor network , some companies also trying to find the advantages of large scale wireless sensors over low power sensors for this kind of applications [2]. Wireless sensor networks are tending to spread very quickly, easy to install, and in case of early detection of failure it provides a very efficient and cost effective solutions. It gives the output of an EPRI funded project on an experimental wireless sensor network for substation monitoring. This project of EPRI was contracted by The University of North Carolina (UNC) at Charlotte. The experimental WSN is also known as ParadiseNet and was installed on different phases and currently it contains 122 sensor nodes which measures the physical quantities of various subsystems within a substation. A base station collects the data from these nodes and transfers to the database at Charlotte through i9nternet connection. The main objective of this project was to check or test the capacity of the wireless sensors in a substation and to implement the main applications which are mandatory for sub station monitoring by using low power wireless sensor nodes and for design challenges to expand the network for overing the whole substation. Design of these mandatory components also represents the design issues for this network. It focuses on design in order to expand the number of nodes from 122 to 150 at least. The prominence is on energy and issues related to the lifetime of battery and also new discovered consideration of field data. There is a sampling scheme for increasing node time also available known as level crossing sampling, it transfers the sensors data only when it notice any alteration in sensors values by comparing it to the predetermined values. In recent years, the practical implementation of wireless sensor network has attracted lots of interests. Wireless sensor network is used in various fields such as industrial process monitoring , natural-disaster forecasting , habitat monitoring structural monitoring , and

climate and soil monitoring for use in agriculture. These examples indicate the capacity and cost-effectiveness of wireless sensors networks as compared to wired.

Many practical examples have been defines the various issues related to the installation of large-scale networks. Such issues include network architecture, coverage, and energy consumption, for instance, describes a network consisting of 557 solar-powered nodes covering some 50,000 square meters. This gateway contains seven gateways and a server. There is another example of large scale network in which there are 50-node mobile sensor network namely ZebraNet, and the 150-node habitat monitoring network.

There are another design issues also excepting scalability like development of general layout for industrial use and it reports the implementation in two different target applications. One of them is an oil platform in the North Sea and other is a semiconductor manufacturing plant. In another industrial implementation, a wireless sensor network was used to monitor the states of all motors located at a Boeing Company plant. In health monitoring, this work was also purposive to estimate energy costs.

1.2.1 ENERGY CONSUMPTION AND LIFETIME ISSUE

Energy consumption is the most important aspect for designing a efficient wireless sensor network. Finite electrical energy in each sensor node, is defines by the capacity of the onboard battery [1]. Due to size and cost, variations of solar radiance, and constraints imposed by the rechargeable battery, solar energy harvesting modules have to face a problem in the continuous power supply. Hence, all design related features of wireless sensor nodes must include facts regarding energy conservation. In this, the advantage of the low power (LP) operation mode of the XMesh routing protocol is that the nodes sleep for most of the time and wake up only 8 times in a second for a small period in order to detect activity. After detection, it keeps its radio on to receive the signal. Since radio transmission consumes high amount of energy and the average energy consumption mostly depends on the number of packets send and received by the node. Another parameters which effects the energy use are sensing and actuation current, which are important for some applications like vibration sensing and gas density sensing.

1.2.2 ENERGY MODEL

We use laboratory experiments to develop models for the average energy consumption for all applications Because of some parameters which effects the energy consumption in case of

wireless sensor networks. Particularly, experiments were conducted to estimate the energy consumption for various events takes place at the speck. For example consider a energy consumption in a mote during various events of the circuit-breaker monitoring application using the MDA300 and the SF6 gas density monitoring application using MDA320. For the purpose of better understanding of concept, these plots were obtained by using particular low data and route update intervals [2]. On the basis of events performed by the motes and above data, the average current consumption in a mote can be represented as follows:

$$I = \frac{I_{Rt}T_{Rt}}{T_{RUI}} + \frac{I_{Dt}T_{Dt}}{T_D} + N\left(\frac{I_{Rt}T_{Rt}}{T_{RUI}} + \frac{I_{Dr}T_{Dr}}{T_D}\right) + \frac{I_S T_S}{T_{Dt}} + 8I_p T_p$$

Table 1. Current measurements at various events observed by MICAz Mote

Event	**Current (mA)**	**Duration (ms)**
RU transmit/receive (R_t/R_r)	20	140
Data transmit/receive (D_t/D_r)	20	140
Processing (P)	8	3
Sensing (S):		
-Amb. Temp.	7.5	112
-Vibration/sound	9.5	7000
-Surface temp (MDA300)	16	25
-Surface temp (MDA320)	16	25
-SF6 density (MDA3200)	150	400

Table2. Drawn current and lifetime estimation for some applications using N=2 for experimentation.

Application	**T_{RUI} (s)**	**T_D (s)**	**Calculated current (mA)**	**Observed current (mA)**	**Expected lifetime (months)**
Ambient	60	60	0.486	0.495	14.2
Temp	7200	900	0.203	0.211	34.1
Vibration/	60	60	1.58	1.59	4.39
Sound	7200	900	0.276	0.288	25.2
Surface temp	60	60	0.478	0.481	14.5
(MDA300)	7200	900	0.205	0.219	34.21
Surface temp	60	60	0.97	1.079	7.09
(MDA320)	7200	900	0.70	0.821	9.87
SF6	60	60	2.107	2.17	3.29
Density	7200	900	0.854	0.87	8.13

Where;

- Ix and Tx stands for current drawn and the duration of the particular event x,
- N is the number of neighbors of the mote,
- TRUI and TD represent the RUI and data intervals, respectively.
- A complete list of events performed by the nodes for the different applications is shown in Table I. This model is validated by comparing the predicted values from Equation 1 with experimental results obtained in a 2-node network. The results are shown in Table II. The experimental results are according to the predefined values or parameters as shown in Table II (last column) are the expected lifetimes of the nodes using a 5000 mAH battery, is the battery used in the nodes in ParadiseNet. In spite of fact that the results in Table II are supportive, it must be noted that the current consumption in a node increases with N, the number of neighbors. The reason behind this is problem of overhearing, by which while receiving all packets, energy is wasted by the nodes.

Number of factors such as density, locations, and wireless transmission which are uncontrollable affects the average current consumption due to overhearing. With TRUI = 7200 s (2 hours) and TD = 900 s (15 minutes), the worst case current consumption in a node in a WSN of 150 nodes can be calculated by setting N = 150 in Equation 1, which gives a lifetime of 9 months for the vibration sensing nodes and a lifetime of 5 months for the SF6 density sensing nodes [2].

1.2.3 ENERGY CONSERVATION USING LEVEL CROSSING SAMPLING

For re-configuration of route, XMesh requires approximately 8 times the route update interval, all nodes in ParadiseNet were programmed with TRUI = 7200s in order to maintain the route re-configuration period below 24 hours. Thus, reduce the frequency of data packet transmissions to reduce the current consumption. Without having information regarding features of sensed signals like their bandwidths, it is difficult to measure the minimum fixed sampling rates for various monitoring application [2]. The sponsors defines the data sampling interval of TD = 900s. whereas generally the monitoring signals doesn't vary from one sample to another. So one can use a level-crossing sampling (LCS) scheme, in this the data is transmitted or transferred when it crosses the set of levels which are predetermined. LCS is a non-uniform sampling scheme which is suitable for transmitting the signals which are characterized by long inactivity period or bursty signals. It also abolishes the process of selecting a fixed uniform sampling rate, which is difficult In case of unknown signals. The choice of levels as well as the statistics of the signal has great impact on errors between and rearranged signals using sand the savings the large number of samples. The samples are saved in data packets and then these data packets are transferred using uniform LCS over a periodic sampling scheme. . These results were captured from data from an surrounded temperature sensing node in ParadiseNet. Even a C level-spacing provides nearly 75% savings in data transmissions for this application. Node is part of a an single cluster, cluster heads the distributed in a proper manner.

1.3 DEPLOYMENT OF NODES

With a rapid growth in wireless communication, integrated circuit, sensors and micro electro mechanical systems (MEMS) and so on, the information acquisition technology of sensors has been developed to the integration, MEMS and networking, so wireless sensor network becomes

increasingly mature [10]. It is contains a large number of tiny sensor nodes by using the radio communication, and it is done for collecting the sensors and to collect and maintain the real time information from the object which is detected in detection area of network and forward to the object that it requires. Therefore, the deployment of node can affect the full fledge network of wireless sensors. Good network node deployment decreases the redundancy of nodes and also protracts the service lifetime of the network. For example, In case of traffic warning system, the collection of all kinds of transportation information which affects the traffic control is the foundation of getting good control effect. Therefore, to collect the traffic information using wireless sensor network, it requires the coverage of sensor nodes deployment in such a way that it can use efficient and effective node deployment in order to achieve maximum coverage and provide efficient connectivity and energy saving performance. 3 nodes namely management node, single sensor node and sink node are required to create a road wireless sensor node deployment (As shown in figure below).

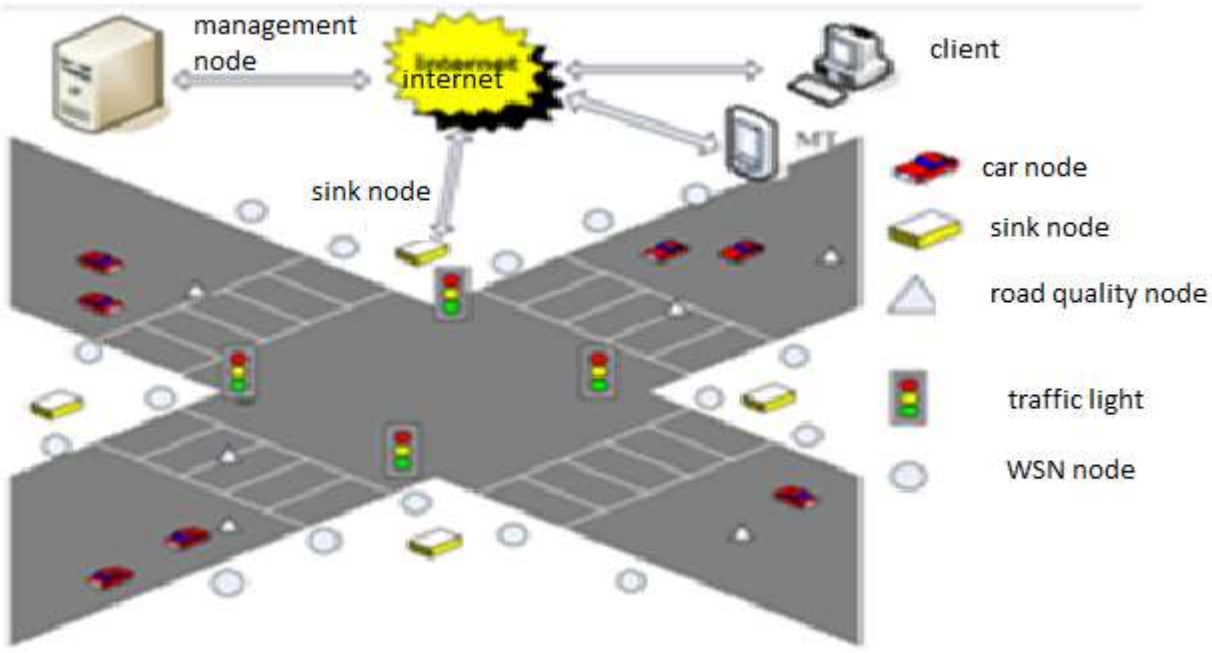

Figure 1.2. Example of a wireless network for intelligent traffic

The workings of these three nodes are as follows [10]:

- Management Node: It collects data from internet and stores the data in the database and maintains the records and provides the search services.
- Sink Node: It receives all kinds of traffic flow information, road information and people information, then perform data fusion on that information, and send the results to the management node.
- Single Sensor Node: It contains fixed nodes and vehicle nodes. Fixed nodes are buried in road to monitor the state of road and it is also buried in both sides of the road to gather other information related to the traffic.

The client and mobile terminals are required to perform the operations on gathered data. An integrated evaluation function is also used in some systems to achieve the sensor node deployment; it is based on coverage, energy conservation and connectivity, cording to the purpose of in some systems.

1.3.1 CLASSIFICATION OF NODE DEPLOYMENT

There are two types of node deployment as [10]

1. Static node deployment
2. Dynamic node deployment

1.3.1.1 STATIC NODE DEPLOYMENT:

In this Optimization technique is used to decide the best location and this location does not vary during lifetime of the network. Static deployment includes random deployment and deterministic deployment. In deterministic deployment first of all, the survey of area meshing is performed and then network node deployment takes place. In this sensor node deployment is based on target area to be covered. Reduction of network deployment cost and realizes the optimal allocation of spaces resources in wireless sensor networks can come into existence if sensor node deployment is done by using the maximum multi-overlapping domains of target points and the genetic algorithm. An approach is used to cover the targeted areas namely grid scan, according to this approach first of all area is divided into grids and then sensors are placed in the best grid located on the area. This Approach use the least nodes to achieve the target coverage, meet the required level of the whole coverage and come out with a better positions for node deployment. The

parameters like coverage quality evaluation are pre-defined. A new node deployment method is developed using the probabilistic detection model with false alarm rate. To select the sub-area for deployment Watershed algorithm is used. Then, to select the candidate positions for nodes the Delaunay triangulation is used. Then the nodes are placed in WSN network and purposed method can achieve better detection probability and coverage uniformity compared with some methods. To detect and measure the variations in temporal traffic patterns in large scale various methods of deployment node is used. In some areas like forest surveillance, earthquake observation and battlefield random deployment is used and a bulk of wireless sensor nodes is thrown in these areas to create a self-organized network. The self-organized algorithms wakes up some sensor node and make some sensor nodes to sleep. There is a mixed algorithm also used for visual sensor network. This algorithm used the virtual potential field and allows the sensor nodes top change their positions and varies the direction automatically within the detection area depending upon the directional sensing model. The algorithm could maximize the coverage rate throughout the detection area, after completing the coverage of multiple prior coverage of candidate locations which requires the higher quality requirements. On the basis of position distribution the nodes can also be deployed. To do this first of all create a model of WSN node distribution and then find the connection between percentage of coverage area and the nodes density of target area and at last look for the best range of nodes density to get the optimal deployment [10].

1.3.1.2 DYNAMIC DEPLOYMENT:

The Dynamic deployment can be used in deployment of robot. First of all, to create the sensor networks obtain the maximum performance, sensor nodes need automatically move to proper location, then start to work. In Random deployment, firstly, it randomly selects node and then use various optimization algorithms in order to achieve optimal deployment. Optimization algorithms are as Virtual force algorithm, virtual force oriented particles algorithm, simulated annealing algorithm, particle swarm optimization algorithm and simulated annealing genetic algorithm [10].

1.4 CLUSTERING

The use of wireless sensor networks is increased in last decades and at the same time the problem of energy constraints in terms of limited battery lifetime is arrived [26]. Since all the operations of the nodes depends upon the energy so it is very difficult to replace or recharge battery once a sensor node is installed. Failure of single node can affect the working of whole system. To save energy caused by communication follow the following steps[14]:

- To schedule the state of the nodes (i.e. transmitting, receiving, idle or sleep).
- · By using suitable clustering algorithm for network formation
- · By using optimal routing methods.

Energy consumption can only be minimized by having minimal activation of sleeping nodes. Every sensing node can be in active, idle and sleep modes for receiving and transmitting activities [20].

- In active mode , energy is consume while receiving and transmitting of data takes place,
- In idle mode , energy consumption rate is similar as active mode,
- In sleep mode, the radios of the nodes are closed in order to save energy, so this mode is totally energy saving mode.

The small amount of energy in a sensor node restricts the abilities of nodes such as processing, memory, storage, and communication; it may cause to limited lifetime of network. Clustering algorithms are more energy efficient than direct routing algorithm so it is another way of saving energy by using clustering algorithms instead of direct routing algorithms [20]. In clustering algorithms the clusters of nodes are created and each of the cluster is assigned with a cluster head (CH). In this topology, first of all sensor node sends the data to their respective Cluster Head and then these Cluster Heads forwards the data to the server of base station. Sensor nodes can communicate within their respective cluster only i.e. nodes can send or receives data within the limited range(within cluster only) therefore minimum amount of energy is consumed but when the data is transmitted from cluster heads to base station then energy consumption is high [26].

1.4.1 HARDWARE CONSTRAINTS

Sensor is a small device which is used for sensing its atmosphere in which it is installed and generate data on its basis.. A sensor node is also known as sensor mote. Sensor mote is part or component of large network of sensors [7]. The main role of sensor node in a wireless sensor network is to collect the data from its surroundings and to forward the data to the processor in the network. Sensors are used to sense its surroundings from the geographical area in which they are installed. Sensing units are created using two small units namely Sensors and Analog to Digital Converter (ADCs). Analog to Digital Converter is used to convert the analog signals into digital signals. Sensor produces the analog signals after sensing its surroundings so ADC is used to convert these signals into digital signals and then store these digital signals for further processing. Sensors are able to monitor temperature, humidity, vehicular movement, noise levels, etc. and also available in different forms such as seismic, low sampling rate magnetic, thermal, etc.

1.4.2 POWER SOURCE

Each sensor node is provided by the Power source so the lifetime of a sensor network is totally depends upon the power source of node. Energy can be stored by using batteries or alternative devices such as fuel cells or miniaturized heat engines, whereas energy-harvesting can be achieved by using solar power, vibrations, acoustic noise, and piezoelectric effects. The majority of the commercial and research platforms relies on batteries, which direct the node size.

1.4.3 COMMUNICATION ELEMENT

The communication element contains radio transmitter and a radio receiver. Both of these parts are mandatory for any sensor node to perform communication with other sensor nodes in the network. The transceiver unit of sensor nodes can be a passive or active optical device like smart dust nodes or a radio frequency (RF) device. . RF communication is most preferable device for most of the ongoing sensor network research projects, because the packets size is small and frequency re-use is high due to short communication distances.

1.4.3.1 PROCESSOR

The node contains microprocessor and some flash memory. Main role of the processing units is to make decisions and to handle collected data. It stores collected data in its memory until enough information has been collected, after a point the processing unit puts the data in data packages. Then these data packets are forwarded to the radio for broadcasting purpose. The brain also communicates with other nodes to maintain the most effective network.

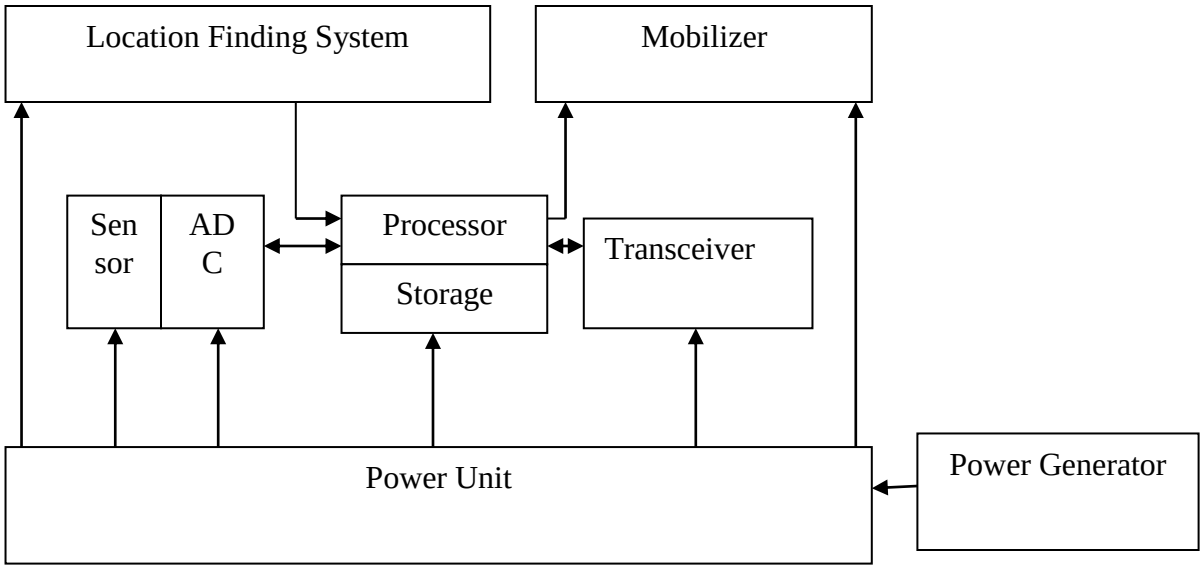

Figure 1.3 Diagram of sensor node

Radio transmitters and receivers are used by the sensor nodes for the purpose of effective communication. Radio transmitters and receivers makes a network of node that vary along with the variation in position of the nodes. To increase the performance they create a connection with each other but by using various topologies. These connections all lead to the cluster head, which transmits the information from each of the nodes present in cluster to whatever computer or PDA type device is used to collect and process the data. When the sensor nodes are arranged as one, they create a component of a machine with high computational power than any of the individual parts. These “machines” (made by sensor nodes) vary with respect to the condition and position such as broadcasting can be affected by high moisture and some other situations. Due to the variation in conditions some connections can become stronger as compare to the earlier strength

of the signals, and others nearly unworkable. The thinking stamina within the network allows the components to reorganize in such a way that all nodes will continue to be functional.

1.4.4 CLUSTER FORMATION

Phase 1: Potential cluster-head selection

First of all, each node broadcasts a discovery message containing the information like node ID, its Cluster ID, and estimated lifetime. If a node has a longest lifetime as compared to another nodes than it can play the role of cluster head itself [26]. After selection as cluster head the node can share this message to its neighboring nodes.

Phase 2: Gateway selection

- Primary Node: Primary node is that node which have direct path from more than one cluster.
- Secondary Node: secondary node is that node which is linked to a cluster head of another cluster through a member node of that cluster.

If a sensor node receives information from more than multiple potential cluster heads then it acknowledged that it is a Gateway and then decides the strength of the node with respect to its potential cluster head. This gateway node then transfers the information irrespective of its strength. In such condition two different messages to two different cluster-heads are forwarded [20].

Phase 3: Cluster-head selection and cluster formation

When a potential cluster head notifies that the strength of its gateway are strong then a potential cluster-head receives the information that all its gateways are strong then it choose a cluster head and forward the message to all its neighbors which has their own unique cluster id and hence a cluster is formed. . The re-clustering values are transferred to all clustered members by the cluster heads.

But when a cluster head receives the notification tht the one of its gateway has weak strength then it select itself as a cluster head and broadcast the message to all of its neighbors but reduce the value of the interval.

To minimize the energy consumption all the cluster members excepting cluster heads and

gateways switch themselves to their radio for period which is equal to their re-clustering interval. Whole of this process is performed after the formation of cluster [20] [26].

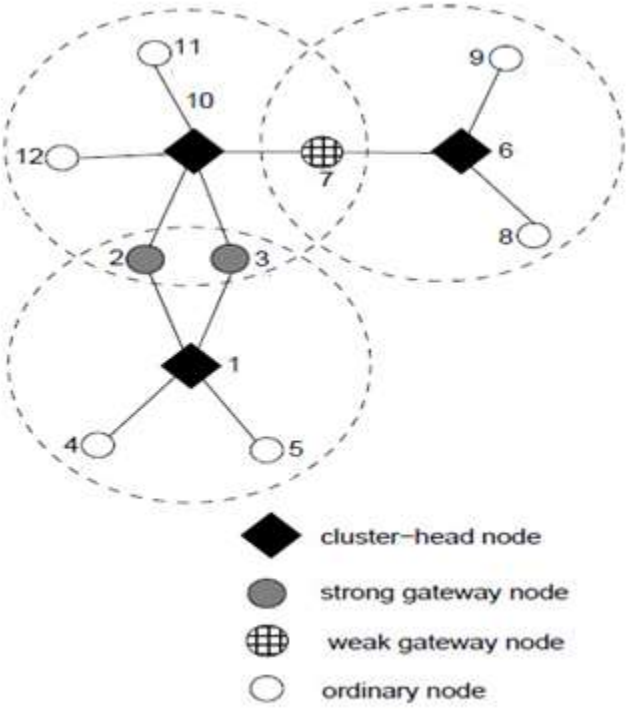

Figure 1.4 Cluster formations in WSN

Above figure explains the formation of cluster according to NEC. In the figure Node 2 and Node 3 are strong gateways and their remaining energy will allow them to survive the usual re-clustering interval (when = 0.50) while node 7 is a weak gateway since its remaining energy will not allow.

Example of NEC

Energy of each node is shown by the numerical values closed in the parenthesis. It to survive the re-clustering interval I if = 0.50.

In case of NEC, an alternative approach is used that hen cluster notifies that strength of its gateways are weak then it transfers a message along with their cluster Id, to all of its neighbors but with the reduced interval so that the node can survive for a long period. In case if it receives the reply from a neighbor node which has the same cluster id then it will use that neighbor as a link between cluster heads and itself so that it can perform operation for a long period and

increases the re-clustering interval [20]. Because Clustering is much expensive so the number of re-clustering should be as minimum as possible.

1.5 CLUSTERING PROTOCOLS

Clustering protocols are as follows:

- LEACH
- HEED
- TEEN
- DEEC
- PEGASIS

1.5.1 Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH stands for Low Energy Adaptive Clustering Hierarchy. Leach is a clustering protocol. It distributes the energy load equally among all the sensors in a network [11] [12]. Leach is a self-organized and adaptive protocol for networks. In LEACH, all the nodes contained in a local cluster and a single node among all of the nodes behaves like a cluster-head or base station. If the cluster heads were chosen a fixed throughout the system life time, as in conventional clustering algorithms, it is easy to see that the unlucky sensors chosen to be cluster-heads would die quickly, ending the useful lifetime of all nodes belonging to those clusters.

Therefore LEACH has a high energy cluster which is random so that it can move or rotate among all sensor nodes to drain the battery of single sensor. Leach also compress the size of data which is going to be transfer between cluster and base station, this process is known as local data fusion, LEACH performs local data fusion to “compress” the amount of data being sent from the clusters to the base station, and also decrease the energy consumption and increases the lifetime of system. Sensors select themselves as a local cluster-heads at any time with a certain possibilities [14]. Then these cluster heads send their status to other neighboring sensors within network. Each sensor node can select cluster by itself .Sensor nodes select only those cluster heads which consumes minimum communication energy. After choosing the cluster heads all the nodes have their own schedule assigned by the cluster head. This allows the less consumption of energy by disabling the radio components of each non-cluster-head node excepting the transmission time. Cluster heads collect all the data from its sensor nodes and then generate a

compressed form of data and then forward the compressed data to the base station. Hen base station is far away then it will be known as high energy transmission like as in our case. Less number of cluster heads effects the less number of sensor nodes because cluster head drains the battery of that node. Since the position of a cluster node is self elected at various time intervals but, if cluster nodes are not fixed then this energy can be distributed over the multiple nodes. Therefore the nodes can select themselves cluster-headset time with respect of time at which a new setoff nodes elect themselves as cluster-heads. The remaining amount of energy on a node will affect the choice of making of a cluster-head. Therefore the node having a large amount of remaining energy can be used as energy intensive function within a network [11] [16]. It is totally depends upon the choice of a node whether to be a cluster-head in an independent way with respect to other nodes in the network and there is no Each node makes its decision about whether to be a cluster-head independently of the other nodes in the network and thus no extra negotiation is required to select the cluster-heads. The number of clusters within a system can be defined by system itself also. Several parameters like topology follows by the network, relative cost of computation as compare to the communication can effect the number of clusters within a system. In example, LEACH protocol for random network shows that it uses the radio parameter and a computation cost of 5 nJ/bit/message to fuse 2000-bit messages while there is a change in the number of cluster-head nodes. With the change in number of cluster head nodes the energy consumption is also changed. 0 cluster-heads and 100% cluster heads are the similar as in direct communication. From this point, we can have information about the optimal number of cluster head nodes. If there are less number of cluster head nodes available in a network and in this case each node have to transmit the data very far to so it can lead to global energy Percent of nodes that are cluster heads Normalized energy consumption Direct Trans the system to be large. But if there are more cluster head nodes are available in the network then the nodes have no need tom transfer the data over the large distance because nodes can transfer the data the nearest located cluster-head node. Because there is large number of cluster heads that have to transfer the data to the base station over a long distance so the level of compression performed here is low in this case. It also shows that LEACH can achieve over a factor of 7 in energy consumption by considering the topology and other parameters used for system as compared to the direct communication with base station while using optimal number of cluster heads. LEACH is a energy saving protocol because it combines the loose compression with data routing. There is a

trade-off relationship between quality of output produced and level of compression achieved [14] [15]. In this case, some data from the individual signals is lost, but it leads to a reduction of the overall energy consumed by the system. In example it is explained that LEACH (with 5% of the nodes being cluster-heads) using MATLAB with the random network. Following figure shows the comparison between these algorithms as nJ/bit as the diameter of the network is increased.

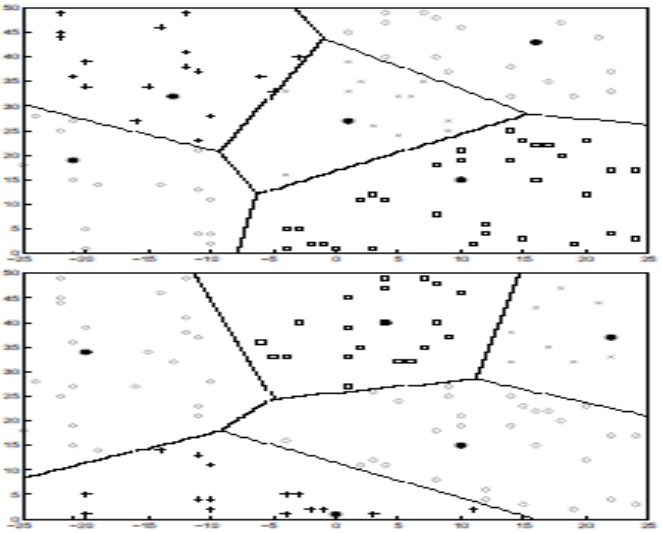

Figure 1.5 Cluster formation in LEACH using different diameter networks

In first figure, the plot shows that while comparing with direct communication, LEACH achieves between 7 xs and 8x reduction in energy and between 4 xs and 8x reduction in energy compared with MTE routing. In second figure, the plot shows the amount of energy used by LEACH as compared with direct communication and network diameter is increased and electronic energy is varies in case when LEACH is compared with MTE. This figure shows the amount of energy save by using LEACH with respect to the various parameters.

As mentioned that LEACH is a self-organized and adaptive protocol for sensor networks. It is use for random rotation of cluster heads in order to equal distribution of energy. LEACH based on two parameters or assumption [11] [14]:

1. Base station is fixed and located far away from the sensors,
2. Nodes in the network are homogeneous and energy-constrained.

The main aim of LEACH is to create a cluster of sensor nodes depends upon the strength of received signals and use local cluster heads to transfers the data to the base stations. The main

features of LEACH are as follows:

- Localized coordination and control for cluster set-up and operation.
- Randomized rotation of the cluster "base stations" or "cluster heads" and the corresponding clusters.
- Local compression to reduce global communication.

In LEACH, the operation is divided into fixed-length rounds, and each round starts with a setup phase followed by a steady-state phase [16]. The duration of each round is predefined. LEACH also suffers from the following drawbacks:

- It cannot be applied to time-constrained application as it results in a long latency.
- The nodes on the route a hot spot to the sink could drain their power fast. This problem is known as "hot spot" problem.
- The number of clusters may not be fixed every round.
- It cannot be applied to large sensor networks.

LEACH protocol will be proved a performance efficient performance protocol in case of Autonomic wireless sensor networks with stable and fixed homogeneous nodes [17]. Due to the advantages of LEACH such as reduced control messages, bandwidth reusability, enhanced resource allocation, improved power control and lest wastage of energy it is proved efficient for Autonomic Sensor Network which has mobile battery power nodes.

1.5.2 Power-Efficient Gathering in Sensor Information Systems (PEGASIS)

PEGASIS stands for Power-Efficient Gathering in Sensor Information Systems [27]. It is a chain-based power effective algorithm. It is based on following two parameters:

- Chaining,
- Data fusion

It works similarly LEACH. In PEGASIS, each node can act as a leader of the chain and chain is also constructed with the help of greedy algorithm and can install by the sensor nodes. PEGASIS is based on following assumptions [27]:

- Sensor nodes have global knowledge of the network,
- All the nodes are stationary

- Nodes have knowledge about the location of all other nodes.

PEGASIS performs data fusion in chain but data fusion is not performed at the end of the chain. PEGASIS has an advantage over LEACH that

- eliminates the use of dynamic clusters,
- minimize the difference between non-leader-nodes and leader nodes,
- limited number of transmissions,
- One transmission to the base station within a round.

PEGASIS also face some problems as LEACH suffers. One of the main disadvantages of PEGASIS is that it is not scalable so it cannot be used in case of wireless sensor networks due to the lack of knowledge regarding the nodes because of large number of nodes [13].

1.5.3 Hybrid Energy-Efficient Distributed Clustering (HEED)

HEED stands for Hybrid Energy-Efficient Distributed Clustering [6]. HEED does not contain any communication overhead so it did not facilitate the efficient distribution of cluster head nodes over the network. LEACH-C protocol is use to overcome this problem, it is a centralized approach but scalable to limited number of sensors only. Many clustering algorithms are available which creates more uniform clusters at the expense of overhead in cluster formation. One of the approaches is HEED which uses distributed algorithms which are easy and quick to convert. HEED uses a cluster formation algorithm, in which each node is assigned with a cluster head probability which is the function of their residual energy and also communication cost which is the function of neighbor proximity. Cluster head probability is used to decide that whether the sensor node is candidate for cluster head for this round or not. . Based on these advertisement messages, each sensor selects the candidate cluster head with the lowest "communication cost" (which could be the sensor itself) as its tentative cluster head [18]. This procedure continue till each sensor increases its cluster head probability at each iteration until the cluster head probability is one and the sensor declares itself a "final cluster head" for this round. The advantage of HEED is that there is no need to have the global knowledge regarding the nodes in a network, it terminates the processing at O(1) round or iteration, it considers that each node is part of a an single cluster, cluster heads the distributed in a proper manner.

1.5.4 Distributed Energy Efficient Clustering (DEEC)

DEEC stands for distributed energy efficient clustering. It is used for heterogeneous wireless sensor network. In this protocol the ratio between the remaining energy on each node and average energy on the network is calculated and its probability ratio is used to select the cluster-heads. The number of rotation on each node varies along with the variations in initial and remaining energy i.e. DEEC transforms the rotation on each node into energy [18]. The nodes which have high amount of residual energy and high initial energy is much suitable for cluster head candidate node as compare to the nodes with low energy. Therefore DEEC can extend the lifetime of the network by using heterogeneous aware clustering algorithms. DEEC can gain more effective messages as compare to the classical clustering algorithms. DEEC is more suitable for Multi-level heterogeneous networks [6].

1.5.5 Threshold sensitive Energy Efficient sensor Network (TEEN)

TEEN stands for Threshold sensitive Energy Efficient sensor Network protocol. It is used for reactive networks. It is an application which senses the temperature. It is more energy efficient protocol as compare to the conventional protocols [17]. To overcome the limitations of LEACH protocol the TEEN protocol is developed. It is the enhanced version of LEACH protocol. TEEN is not suitable for large scale networks because it lacks [6]:

- Randomly choosing cluster-heads before the events happened. It makes the sensors out of the event region gathering into clusters and transmitting data, causing unnecessary energy consumption and unbalance clusters.
- Choosing the cluster-heads without considering their residual energy. It may choose the sensors with less energy as the cluster-heads and then cause them premature death.

The cluster-heads transmit data to the sink node directly. Thus one-hop transmission

1.6 OUTLINE OF REPORT

- ✓ Chapter 1is introduction in which the basics of WSN and the related terms used in the LEACH is explained.
- ✓ Chapter 2 is terminology in which all the abbreviations used in the report is mentioned.

- ✓ Chapter 3 is review of literature and in this survey of papers are done which are related to my thesis.
- ✓ Chapter 4 is scope of study in which I have explained the importance of choosing my thesis topic and its use in the day to day life.
- ✓ Chapter 5 is objective of study in which I have pointed out the aim to be achieved from my paper.
- ✓ Chapter 6 is research methodology and in this I have explained the work which was carried out in my base paper then the problem formulation and finally the proposed out.
- ✓ Chapter 7 is result and discussion and here I have presented my result of my propsed work and its comparison with the base paper using MATLAB .
- ✓ Chapter 8 is conclusion and future scope in which I have concluded my paper and its future scope.

CHAPTER-2

TERMINOLOGY

WSN – Wireless Sensor Network

CH- Cluster Head

LEACH - Low Energy Adaptive Clustering Hierarchy

PEGASIS - Power-Efficient Gathering in Sensor Information Systems

HEED - Hybrid Energy-Efficient Distributed Clustering

DEEC - distributed energy clustering

TEEN -Threshold sensitive Energy Efficient sensor Network

CHAPTER 3

REVIEW OF LITERATURE

INTRODUCTION

Various researchers have worked to improve the energy efficiency and lifetime of network. Advancements in conventional techniques have been made for improvements and to achieve an upgraded system.. It is a sort of agreement in which input is collected by the cluster heads in the form of sensed data. The WSN is collection of small sensors and the network is divided into clusters which sense the data from its surroundings and a cluster head collects that data and apply compression techniques on collected data and then forward the compressed data to the base station. In WSN the lifetime of network totally depends upon the energy consumed by the sensor nodes. Many researchers discus the problem related to the clustering, energy dissipation, network cost. Some of the papers are studied and discussed as follows:

LITERATURE REVIEW

Buyanjargal, "An Energy Efficient Clustering Algorithm for Event-Driven Wireless Sensor Networks (EECED)" [4], In this paper author describes that, Wireless sensors networks are used in many area like environmental surveillance, intelligent building, health monitoring, intelligent transportations, etc. The WSN contains many small wireless device which have a limited amount of energy and memory and these small, autonomous devices are used to sense the data in its surroundings. It uses many energy efficient algorithms so each every part of the network can work efficiently since it is one of the most challenging issues related to the WSN. To overcome this problem or drawback many researchers develop the Energy Efficient cluster based protocols like LEACH, DEEC etc.. but no one focused on event driven WSN protocols whereas their main consideration is on continuous networks. The author also proposed an algorithm LEACH (Low Energy Adaptive Clustering Hierarchy) which is an energy efficient protocol used for WSN. the modified version of this protocol is named as ldquoenergy efficient clustering algorithm for Event-Driven Wireless Sensor Networks (EECED). The main aim of this protocol is to extend the lifetime of the network and it distribute energy equally on each node. In EECED the node with the more remaining energy is preferable candidate node for cluster-head. In this the Elector node is also used for selecting cluster head, the role of elector no

s to gather the data energy of nearest nodes Simulation is use to compare the performance of EECED algorithm with the LEACH protocol.

Yan Sun, "Energy-Efficient Routing Protocol in Event-Driven Wireless Sensor Networks" [29], in this paper it is explained by the author that, to perform routing is a difficult process in case of WSN. In last decade huge number of protocols was discovered. But author emphasise on Event-driven wireless sensor networks. An algorithm is used to improve the quality of data and decrease the power consumption of a network. In this algorithms, number of jaunts by sensor nodes when there is no task to perform and number of sampling frequency generated by sensor nodes is reduced to an extent and the positive feed-back scheme is used to alert the sensor nodes when an event occurs. This algorithm stores the data in packets and use negative-ACK to decrease the consumption of bandwidth.

Samer A. B. Awwad, "Cluster Based Routing Protocol for Mobile Nodes in Wireless Sensor Network" [23], In this paper it is described by the author that Strength of sensor nodes in WSN is an issue for transmission of packets and dissipation of energy. In some application both fixed and mobile nodes are used in the same network, whereas in some cases only mobile nodes are used. Loss of data packet is another issue in case of mobile sensor nodes. To solve this problem of lost data packet a cross layer design is implemented between medium access control (MAC) and network layers. Therefore a cluster based routing protocol is defined specifically for mobile sensor nodes (CBR-Mobile).This protocol is mobility and traffic control protocol. The sensor nodes which moves out of the cluster or don't have any data packet to transmit are allotted with a specific limited time slot reassigned to incoming sensor nodes within the cluster. Two types of database is used to gain the mobility and traffic control efficiently. According to this protocol data is based on the strength of the signals. Data transmission is done in a proper efficient manner. In CBR-Mobile protocol, cluster based routing and hybrid MAC protocol is combined together for mobility of sensor nodes. Two time schedules are used in this, first is Schedule timeslots which is for the transmission of data and another is contention timeslots which is used for transmission of join registration messages. The performance evaluation for this protocol is performed in MATLAB it is observed that it improves the ratio of packet transmission, energy consumption delay and fairness in mobile networks as compare to LEACH-Mobile and AODV protocols.

R. Rajeshwari, "Towards Energy Efficient Cluster Based Approach In Wireless Sensor Networks Using Mobile Sink" [20], in this paper author conveys that Sensor networks are combination of many sensor nodes. These sensor nodes sense the data from its surroundings and send that collected data to the base stations in the form of data packets. Because the lifetime of sensor node is based on the energy of battery, so it is mandatory to utilize the energy consumption by these nodes. And to reduce the battery consumption it is mandatory to reduce the traffic on each and every node along with the minimized number of transmitted data to the Base station. By using clustering approach scalability, reduced energy consumption and better performance of network can be obtained. In Clustering approach whole network is divided into small clusters and each cluster has its cluster head which is selected from the clusters itself. Cluster heads generate the aggregate form of data sensed by sensors locally. This technique reduces the size of the data by generation compressed form of data and this compressed data is forward to the base station for a proper sink of the network.

Arun K. Kumar, "Energy-Efficient Mobile Data Collection in Wireless Sensor Networks with Delay Reduction uses Wireless Communication" [1], in this author defines that the lifetime of sensor nodes depends upon the energy consumed by them So it is must to minimize the energy consumption for longer existence of the nodes in the network. This also affects the connectivity and coverage of the network. Energy consumption can be reduced to an extent by using Special Mobile Data collector to gather the information. The MDC gathers the data from the Sensor nodes and transmit it to the sink. There are various MDC available for various constraints and assumptions. But in all the models proposed, due to slow speed of mobile nodes, the data latency is usually high. There is a model used to reduce the data latency for collected mobile data. The delay can be reduced without affecting the MDC by using routing based clustering and data collection approach in a collective form or manner. After simulating this approach it is obtained that the packet delay is reduced to more than half of the delay in an existing approach.

Chu-Fu Wang, "A Network Lifetime Enhancement Method for Sink Relocation and Its Analysis in Wireless Sensor Networks" [5], in this paper author explains that with the advancement in recent trends of micro manufacturing technology also leads to the advancement in the of low-cost, low-power, multifunctional sensor nodes for wireless communication.

Diverse sensing applications have also become a reality as a result. These include environmental monitoring, intrusion detection, battlefield surveillance, and so on. How to increase the lifetime of the network, by managing the resources utilization in an optimum manner along with the process of sensing is an important issue in WSN. In a Wireless Sensor Network, multihopping is used to transmit the data to the base station. The lifetime of the network is affected mostly by those nodes which are near to the sinking point and these nodes consumes more energy and in this way the energy of the network will drained out earlier and it will leads to the shorten the lifetime of the network. To avoid excess consumption of energy Sink relocation is used because it avoids excess consumption of energy by the sensor nodes. A strategy known as EASR (Energy Awake Sink Location) is developed for mobile sinks in the network. This technique (EASR) uses the information of remaining battery energy on each node and manages the range of transmission for each and every node and relocates the scheme of sink. Some theoretical and numerical analyze are used to prove that the EASR method can enhance the network lifetime of the WSN significantly.

Shounak Chakraborty, "A Noble Approach for Self Leaming and Cluster based Routing Protocol with Power Efficiency in WSN" [26], in this author says that, Energy efficiency is the main consideration while developing routing protocol for a WSN. For a self learning, stable clustering power efficient routing protocol a statistical model is proposed. This model is known a statistical model because it uses various statistical functions like mean, variance and standard deviation to compress the data for transmitting it to the base station and a threshold value to generate an alarm in case of emergency. This technique utilize the statistical output of collected data and use it in the case of emergency that it automatically generates the alarm or alert to the base station about it. The algorithm also solves the problem of corresponding generation of both periodic and event driven data. A simulation is done to finalize the protocol in which it is obtained that this protocol leads to improved power efficiency.

Rui Chen, "An Event and Rule-driven Immune Clustering Routing Algorithm of Wireless Sensor Network with Mobile Sink" [21], in this author defines that an algorithm namely MSERDICR is a rule driven immune clustering technique which is used to reduce the energy consumption in a network for unexpected events and also provides a solution regarding the problem of Unbalanced distribution of the energy consumption. MSERDICR algorithm,

implements a biological immune system based mechanism for the dynamic clustering algorithms. In this algorithm, the network is divided into several virtual grids or clusters. After making the clusters and grids position of the sink node is adjusted by using the controlled mobile technique for remaining energy scan known as e-scan. This strategy can save the energy consumption to maximum level. The three parameters such as the moving range of the sink node, the size of the grid and the minimum energy standard of the grid, on the performance of the MSERDICR algorithm are analyzed in detail by using several simulations. It is proved that MSERDICR has best performance level in case of moving range of the sink node is one round around the event, the side length of a cluster is 10, and minimum energy standard of a cluster ia around 65% of the average energy inside the cluster as compare to the algorithms such as MSEERP, GAP and TDD.The lifetime of MSERDICR algorithm is superior to any other of them.

EZ-ZAIDI Asmaa, "Efficient data collection in wireless sensor networks using mobile sink" [7], in this author describes that Sensor nodes deployed in the locality of static sinks consumes maximum energy because of higher data relaying load. Hence it will lead to shorten of lifetime of Network and loss of data packets. To overcome this problem, the concept of mobile sink was introduced in several works. A technique which gathers data using mobile sinks that rotate around defined route and fetch data which is stored in various nodes.. To alleviate the problem of data delivery latency, rendezvous nodes move for a definite distance in parallel with the base station, in order to remain the longest possible within the sensing range, and upload the maximum amount of data. This technique also considers the priority of the data packets which are to be delivered. Most important or confidential data is routed first. This scheme manage equal balance between energy saving and data collection delay.

Priya Vyas, Manoj Chouhan, "**Survey on Clustering Techniques in Wireless Sensor Network" [18],** in this author proposed that WSN is a collection of small electronic devices namely sensors. Which can senses the computing and communicating data and can also work in each and every condition such as in the field of surveillance. Performance of sensor nodes depends upon the factor of power consumption But energy drained with a maximum speed due to unmonitored operation which are used by nodes to complete the communication with other nodes of different device. The main drawback of WSN is the energy consumption problem.

Communication protocol is used for optimal energy usage and to achieve real time functionality. With the use of clusters this problem can be solved to a limited extent. In this author explains the various clustering techniques used for WSN.

Ping Yang, "An Energy Effective Routing Algorithm for Event-driven Wireless Sensor Networks" [17], Event-driven wireless sensor networks are special networks that just need the sensors which detected the events gathering and sending data through a reasonable routing to the single information processing center called sink node, usually used in monitoring emergency events in many large scale severe environments. In order to achieve optimal battery consumption an efficient routing algorithm and effective message transmission techniques must be used so that the lifetime of the network can be enhanced. Author developed a real time based clustering algorithm which organizes the event detected by the sensors in the environment of the clusters. This technique considers all the parameters like remaining energy on the sensors, distance, event excited intensity and strength of received signals during the selection of cluster heads, clustering and developing routing path. After simulation it is observed that routing performed by this algorithm and network lifetime is 16% longer as compare to the TEEN algorithm.

Haitao Zhang and Cuiping Liu, "**A Review on Node Deployment of Wireless Sensor Network" [10],** In this author explains that Now a days WSN is applied in various fields and civilian applications such as vehicle tracking, habitat monitoring, forest surveillance, earthquake observation, biomedical or health care applications and building surveillance. The efficiency of WSN is based on the coverage provided by the sensor deployment techniques. Various kind of environment has various deployment requirements and optimization goals. Author firstly discuss the existing deployment techniques for nodes of WSN and then three performance indexes are analyzed in detail. At last main deployment model for WSN is presented.

Guillermo Molina, Enrique Alba et al., "**Optimal Sensor Network Layout Using Multi-Objective Metaheuristics" [9],** In this author describes that Wireless Sensor Networks (WSN) is a collection of small devices namely sensors and these sensors let the WSN to sense the data of monitor and large areas automatically without any human intercession. The coverage of terrain(Sensor fields)monitoring is mandatory for some WSN applications. The main consideration is to optimize the energy consumption and to minimize the number of nodes to extend the lifetime of the network and to reduce the network cost respectively. The process of

deploying sensor nodes with the consideration of these objectives is known as WSN layout problem. Author uses multi objective approach to achieve these objectives of reducing network cost and increasing lifetime of the network and coverage of sensor fields is considered as a constraint. Multi-objective optimization algorithms is used for this problem in which main objective is to achieve energy efficiency and number of nodes as independent optimization aim. After applying simulation it is observed that the efficiency of multi objective metaheuristic to solve this kind of problem and encourage further research on more realistic instances and more constrained scenarios.

Asis Nasipuri, Robert Cox, and James Conrad, "**Design Considerations for a Large-Scale Wireless Sensor Network for Substation Monitoring" [2],** In this author describes the design and deployment of a large scale wireless sensor network (WSN) for monitoring the health of power equipment in a substation. This sensor network contains 122 low power sensor nodes that that are expand over an area approximately 1000 × 400 feet in size and perform monitoring of equipment such as transformers, circuit breakers, and compressors. A multihop mesh network is used for communication by the sensor nodes, which uses a dynamic link quality based routing protocols. The main aim of this project is to develop such a WSN which can survive for a longer period and have low cost sensor nodes. Author analyzes the battery consumption by various nodes an developed a communication technique which We study the battery consumption in the network and present a transmission scheme that reduce the communication cost by allowing the sensor nodes that they can transmit the data of observed samples only when their values varies from those which are transmitted earlier. Result of simulation shows that the performance of the sensor network for several monitoring applications are presented.

Jianguo SHAN, Lei DONG, Xiaozhong LIAO, Liwei SHAO , Zhigang GAO, Yang GAO, "Research on Improved LEACH Protocol of Wireless Sensor Networks" [12], In this author compares the improved LEACH protocol with traditional LEACH protocols in order to check the efficiency of improved protocol. The energy factor and distance factor to the threshold T(n) is added by improved LEACH protocol. The multi-hop routing algorithm of cluster head is introduced too, it based on the hop count and the remaining energy. Simulation was done in MATLAB. The simulation results that the number of dead nodes is less then the number of dead

nodes in case of traditional one. Improved LEACH protocol balance the data load on the nodes and also results in maximum lifetime of the network.

Meena Malik, Dr. Yudhvir Singh, Anshu Arora, "Analysis of LEACH Protocol in Wireless Sensor Networks" [16], in this author explains that Wireless Sensor Network is a combination of small devices namely sensors. WSN is a de-centralized network. Due to the increase in use of WSN in several fields like biological, military, battlefields etc…. area of research is expanding continuously. Sensors depends upon the consumption of battery power , which can't be replaced or recharged. So the design of energy aware protocol is essential in respect to extend the network lifetime. LEACH is an energy efficient protocol used in WSn which saves the energy and in this way the lifetime of the network is extended automatically.Author represents the LEACH protocol in details. Comparison of various network parameters is done in the form of tables and graphs. The simulation work has been carried out by using own set of parameters and in the last of the paper conclusions is drawn.

Hunyao FU,Zhifang JIANG, Wei WEI and Ang WEI, "An Energy Balanced Algorithm of LEACH Protocol in WSN" [11], In this paper consideration of energy consumption is an important issue while designing an efficient network. Because energy is limited on each and every node.. As a typical representative of hierarchical routing protocols, LEACH Protocol has a vital role. In this author presents an improved LEACH algorithm which overcome the problem of uneven energy distribution on nodes and done by randomness of cluster head formation. Improved LEACH protocol evenly distributes the energy on the nodes and extends the lifetime of the network. After performing simulation in MATLAB, the simulation results indicate that improved LEACH has better results as compare to the LEACH protocol.

S Taruna, Megha R. Tiwari, "Event Driven Hierarchical Cluster based Routing Protocol for Wireless Sensor Network" [22], In today's era number of advance researches are performed in WSN it becomes a field of interest for scientists. A WSN is divided in the small cluster which consist of sensors, these sensors collects the data by sensing their surroundings and sends this data to the base stations or sink node. The important point is that the sensor's lifetime is depended on the energy consumed by them. The major fact that sensor nodes dies due to run out of energy quickly because of the small size of the sensor nodes has been a constraint and many energy efficient routing protocols have been developed for solve this problem and to

preserve the lifetime of the network. An Event Driven Hierarchical Cluster based Routing Protocol is define to solve the problem of energy consumption In Event driven energy protocol whenever an event id detected in the sensors then data related to that event is passes to the cluster which has higher remaining energy power and which is near to the sink node. In Simulation it is observed that event driven routing protocols enhances the lifetime of the network as compared to another protocols.

Shinichi Momma , "Power aware routing and clustering scheme for wireless sensor Networks" , In this author defines that WSN is is collection of nodes which are small;l sensors and energy is supplied to these nodes for their survival in the network. But for this power consumption must be decreased. To solve this author defines a method of clustering namely EACLE. In EACLE, after selecting the cluster head route is selected automatically. These two phase controls increase overheads and reduce the battery power, which leads to shorten the lifetime of wireless sensor networks. A method PARC is introduced which reduces the power consumption and load of the data on nodes .but the disadvantage of PARC is that in this the battery of those nodes which are around the sink nodes gets depleted in a very fast speed as compare to these nodes which are far away and result of this is that sink node is not able to get the relevant information..this fact is known as hot spot problem. To solve this problem PARC has an advanced version known as PARC+ in which only those nodes are selected as clusters heads which are near to the sink node. The result of this method is shown by simulating it in MATLAB.

Dhanashri V, Ambekar Amol D. Bhoi, R. D Kharadkar, "A Survey on Sensors Lifetime Enhancement Techniques in Wireless Sensor Networks" [6], in this author explains that from few years the WSN becomes most popular from users side and researchers side also it has applied in various fields like Environmental, healthcare, military and other commercial applications. Sensor nodes are battery powered so energy constraints on nodes are very strict. When battery gets discharged, sensor node will get disconnected from remaining network. This will result in exhausted life of the network and connection become disable due to which data gets lost. In some networks replacement and recharging of energy batteries is not possible. Therefore only those techniques of clustering should be applied on the network which manages the energy consumption and enhances the network lifetime. This also leads to the efficient data transmission.

R. Renuga Devi, "A Study on Classification of Energy Efficient Routing Protocols in Wireless Sensor Networks" [19], In this author conveys that the recent advancements in integrated circuit technology, micro-electro mechanical system technology, Ad hoc network routing protocol, distributed signal processing and embedded systems have enabled the development of low cost, low power, network enabled and multifunctional wireless sensor network environment. The major concern of all efficient WSN is optimal power consumption and maximum. Earlier WSN was used for monitoring and reporting events only but now it has variety of applications.. As every application has distinct requirement single Routing protocol is inefficient. We classify energy efficient routing protocols into three main schemes as data centric, hierarchical and location based routing. This comparison reveals the important design issues that need to be taken into consideration while designing and evaluating network protocol.

Kemal Akkaya, Mohamed Younis, "A survey on routing protocols for wireless sensor networks" [13], In this author defines that with the advancements in WSN many routing protocols are developed in order to reduce the power consumption, load of data and to enhance the lifetime of the network. This considerations can vary from network to network depends upon the kind of application and topology which is followed. In this author surveys recently used routing protocols and present a result. The author classifies three parameters such as data-centric, hierarchical and location-based Moreover, protocols using contemporary methodologies such as network flow and quality of service modeling are also discussed. The result is based on the conclusions of open research issues.

Sunita Rani, Er.Tarun Gulati, "AN IMPROVED PEGASIS PROTOCOL TO ENHANCE ENERGY UTILIZATION IN WSN" [27], In this author defines that Wireless sensor network is an ad hoc network. In WSN each senor node has limited amount of energy to consume each sensor is defined with limited energy. These wireless sensors sense and monitor the data from its surroundings physical or environmental condition such as temperature, sound, vibration at different location. And ten this collected data is transferred to the base station. In the process of transmission of data node consumes some amount of energy. The lifetime of the network depends upon the amount of energy consumed by the nodes..The protocols are used to minimize the delay in data transmission along with the reduced power consumption and extended lifetime of the network. Example is PEGASIS. PEGASIS follows a chain structure, every chain consist

of only one cluster head, it is in charge with every node's receiving and sending messages who belong to this chain, the cluster head consumes large energy and the times of every round increasing. In PEGASIS, saves the energy for WSN and increase the lifetime of the network. The proposed work is about to select the next neighboring node reliably. For considers the some parameters like Distance, Residual Energy and Response time. As the result simulates that PEGASIS leads to the reduction in energy consumption and extended lifetime of the network.

Sharath S.T, Veena N, "Quad Clustering Routing Protocol to Enhance the Stability in WSN" [24], In this author explains that WSN is huge network which is made up of small sensors which can efficiently sense the data from its surroundings. The main issue of the WSN is to develop Such a protocol for routing which increases the lifespan of the network and optimizes the power consumption. Most of the protocols focuses on decreasing the energy consumption and enhances the throughput and stability period of wireless sensor networks. For this purpose the modified version of Q-LEACH is developed. In this protocol, it is considered that the whole network is divided into four quadrants and each has equal number of sensor nodes, cluster-heads and sub-cluster heads. Result simulates by comparing the existing LEACH and Q-LEACH and it is observed that it has more efficiency as compare to earlier one.

B. Manzoor£, N. Javaid, "Q-LEACH: A New Routing Protocol for WSNs" [3] ,In this author explains that Wireless Sensor Networks (WSNs) gain the keen interest of the researchers due to their features.WSN can monitor the environment continuously which attracts the researchers to extend it as a vast platform. The main focus of WSNs is to enhance network life-time as much as one could, for efficient and optimal utilization of resources. Various protocols are developed to fulfill this purpose. Energy consumed by sensor nodes for monitoring the remote areas affects the lifetime of the network. In this author introduce the Quadrature-LEACH (Q-LEACH) for homogenous networks which enhances stability period, network life-time and throughput quiet significantly.

M. J. Handy, M. Haase, D. Timmermann, "Low Energy Adaptive Clustering Hierarchy with Deterministic Cluster-Head Selection" [15], In this author focuses on a parameters such as reducing the power consumption .for this purpose LEACH protocol is modified. The cluster head algorithm is extended by deterministic component. Lifetime of the network can be enhanced to 30% as depends upon the type of network. Three matrices can be used to define the

lifetime of a network FND (First Node Dies), HNA (Half of the Nodes Alive), and LND (Last Node Dies).

Lalita Yadav1, Ch. Sunitha, "Low Energy Adaptive Clustering Hierarchy in Wireless Sensor Network (LEACH)" [14], In this author defines the LEACH protocol. As WSN is a collection of small swhich are divided into clusters and each node consumes some energy in order to transmit data with cluster heads and sink node. Therefore the lifespan of network lies on the energy consumption of the nodes. Thus protocols are used to minimize the energy consumption and maximize the lifespan of the network. LEACH protocol is used to improve the energy consumption and extends the lifetime by maintaining a balance between these two parameters.

Georgios Smaragdakis Ibrahim Matta Azer Bestavros, "SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks" [8], In this paper the author concentrates on the effect of heterogeneity of hubs, as far as their vitality, in remote sensor arranges that are progressively bunched. In these systems a portion of the hubs get to be group heads, total the information of their bunch individuals and transmit it to the sink. The author accept that a rate of the number of inhabitants in sensor hubs is outfitted with extra vitality assets—this is a wellspring of heterogeneity which may come about because of the underlying setting or as the operation of the system develops. The likewise accept that the sensors are arbitrarily (consistently) conveyed and are not portable, the directions of the sink and the measurements of the sensor field are known. The author demonstrate that the conduct of such sensor systems turns out to be exceptionally flimsy once the primary hub passes on, particularly in the nearness of hub heterogeneity. Established bunching conventions accept that all the nodes are outfitted with the same measure of vitality and thus, they cannot exploit the nearness of hub heterogeneity. The author propose SEP, a heterogeneous-mindful convention to delay the time interim before the passing of the main hub (we allude to as security period), which is essential for some applications where the input from the sensor system must be dependable. SEP depends on weighted race probabilities of every hub to wind up cluster head as indicated by the remaining vitality in every hub. The author appears by recreation that SEP dependably drags out the dependability period contrasted with (and that the normal throughput is more prominent than) the one got utilizing current grouping conventions. The author closes by considering the affectability

of our SEP convention to heterogeneity parameters catching vitality awkwardness in the system. The author found that SEP yields longer security locale for higher estimations of additional vitality brought by all the more capable hubs.

CHAPTER 4

SCOPE OF STUDY

In black hole attack, the attacker nodes want to interrupt the node packets that utilize the routing protocol which establishes fake information that it has shortest path to the node. This is known as black hole attack. When malicious nodes are present between the communicating nodes of a network, it will perform any sorts of action with that packet that passes them. Users require safety on road in vehicular network and it could be done by implementing the VANET applications. Vehicular applications need security for example if attacker changes the content of safety applications then the users is directly affected. Attackers change their attacking behavior and they launch different attacks at different time. In this thesis, we can detect the attacks and mitigate the attackers by using the energy efficient LEACH protocol. We will develop such system to identify attacks in network with respect to eliminating the attack and updating the node information by making a table.

If we are controlling the attackers and mitigating the attacker then it would help us in saving number of human life. Also another effective solution is to proposed for DOS based attack (Black hole attack) which use the redundancy elimination mechanism consists of rate decreasing algorithm and state transition mechanism as its components.

CHAPTER 5

OBJECTIVE OF STUDY

The objectives of this research are:

- To detect the attacker node in the network using LEACH protocol.
- To mitigate the attacker node in the network using LEACH protocol.
- The nodes status information are updated in a table.
- Cluster Head (CH) selection equation will be improved with updated table.
- The network gets secured as the chances of getting malicious CH selection will be reduced by the proposed work.

CHAPTER 6

RESEARCH METHODOLOGY

Black hole attack

In Black Hole Attack, compromised node tries to pull in all the traffic from its encompassing nodes. The compromised node creates false directing data to neighboring nodes. This occupies all the traffic to the malicious node. Here, the malicious node publicizes that it has high remaining energy. By publicizing this, malevolent node gets to be CH at each round. All the nodes send packets to the malicious node as it goes about as a CH. The malicious node gathers all packets and does not forward to BS.

MODIFICATIONS IN LEACH

We consider that the attacker nodes are having high energy when contrasted with the ordinary nodes to have maximum lifetime amid network operation. We have utilized appropriated Energy Efficient Clustering, so that nodes with high starting energy and remaining energy in the further rounds will have a larger number of opportunities of becoming cluster head than the nodes with low energy nodes. Subsequently attacker node will have more opportunity to be the cluster head and gets more data and influence the network more. In our network there are two sorts of nodes attacker nodes and ordinary or normal nodes. Assume E_0 is the beginning energy of normal nodes than the energy of malicious node is considered as $E_0*(1+x)$. In this way total energy will be:-

$$E = (N1)*E_0+E_0*(1+x) \text{ ------ } (1)$$

Where N is the number of nodes in normal nodes ,

x is the number of nodes in malicious nodes.

CLUSTER HEAD SELECTION

Let n_i denotes the number of rounds then $P=\frac{1}{n_i}$ will be the average probability of a node I to be a CH during n_i rounds. If P_{opt} be the optimal probability of a normal node to be a CH then probability of malicious nodes will be:

$$P_{mal} = \frac{P_{opt}}{(1+x)} \text{ ------ (2)}$$

To calculate the threshold following formula is considered and from the formula it is clear that nodes having higher energy will be having more chance of becoming CH.

$$T(n) = \begin{cases} \dfrac{Pi}{1 - Pi * \left(\dfrac{r * \bmod 1}{Pi} \right)} \text{ if } n_i \in G \\ 0 \text{ otherwise } \} \text{ ---------(3)} \end{cases}$$

DETECTION TECHNIQUE

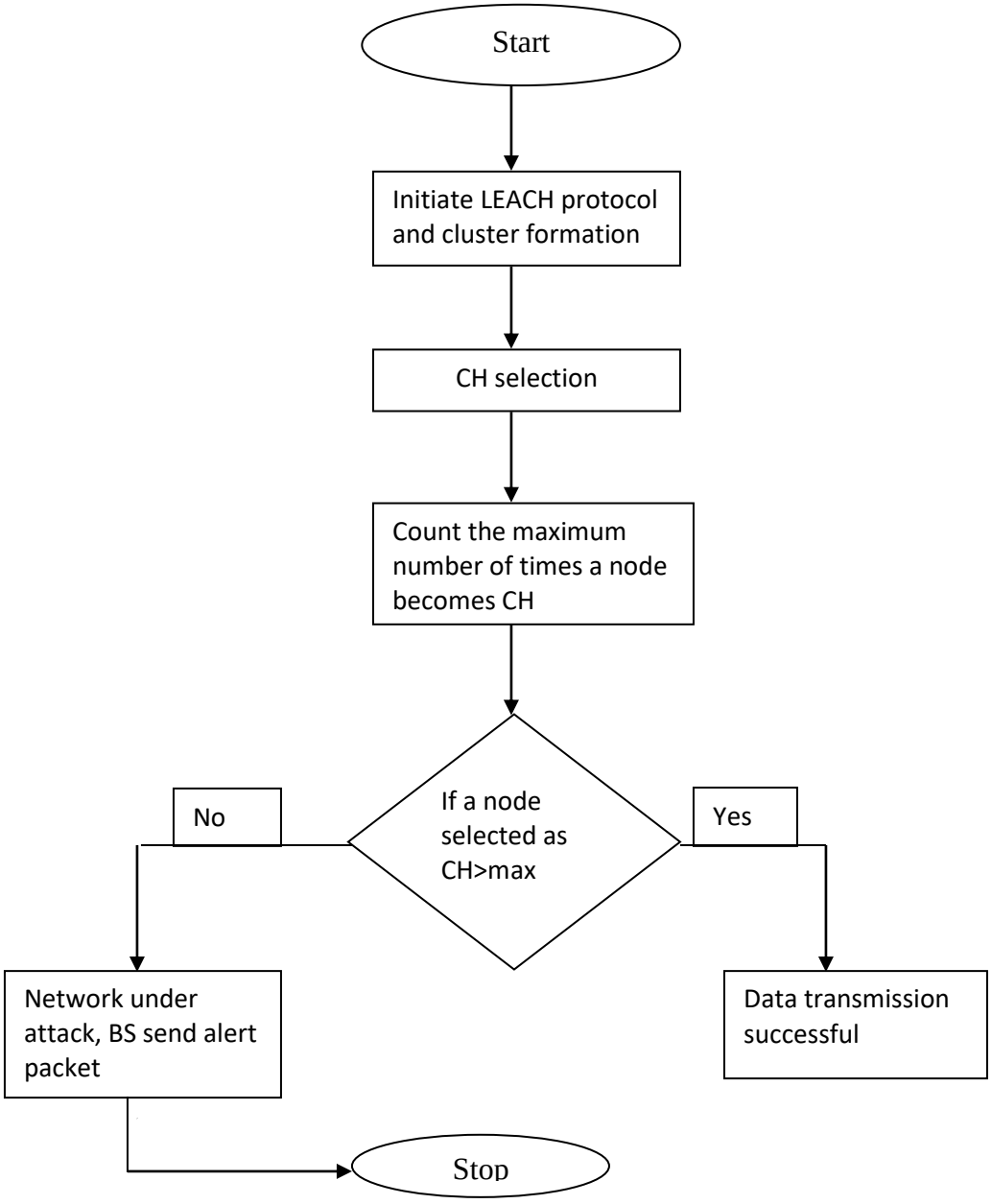

Figure 6.1 Flowchart of detection technique

PERFORMANCE METRICS

a) Packet delivery ratio:

The proportion of the quantity of conveyed information parcel to the goal and the aggregate number of bundles sent to the goal. This represents the level of conveyed information to the goal.

Packet delivery ratio = No: of packet receive / No: of packet sent

Where,

No: of packet sent = Packets dropped+ packets received

b) Throughput:

Throughput can be characterized as the quantity of bits effectively got through a system for each unit of time.

Throughput = number of bits received / Time

c) Remaining energy:

It can be characterized as the quantity of bits effectively got through a system for each unit of time.

Performance analysis of Black hole LEACH:

When no malicious hub arrives at base system in the network, base station gets measure of packet hub and output resulted are exhibited. It is watched that in case of malicious hub in the system number of information packet coming to base station diminishes .The impact of the Black Hole assault to the throughput. It is watched that impact of the attack is not huge if there ought to be an event of total remaining energy in the network, it is a direct result of the route that regardless of the way that the attacker is not sending the data to the base station but instead it is taking interest in each and every action in the network, which devours energy. The contrast is done by the amount of the nodes and the results.

PROBLEM FORMULATION

Wireless sensor network is one of the developing ranges of research in present situation. There are numerous requirements on these sensor nodes, for example, constrained memory, restricted battery power, and constrained processing capacity. Wireless Sensor Networks are inclined to different attacks. Black hole a sort of Denial of Service attack is extremely hard to identify and protect. These kinds of attacks are very effectible to the performance of the WSN which lead to many problems like data drop age, effect on security etc. Many researchers work on these attack oriented fields but their main focus was on detecting the attacks. As in the base paper the main work was done on detecting

the black hole attack in the LEACH protocol, No focus is on mitigating the effect or mitigating the node which is an attacker node. So there is need to propose a system which will work on detecting as well as mitigating the attacker node.

PROPOSED WORK

As in the problem it is discussed that no work or can say very little work is done on deciding the process that what is to do when a attacker node is detected in the network. So our proposed work will work on a proposal that will resolve the issue that is not considered in the base paper.

The proposed methodology will include the detection strategy on the basis of the tradition base papers working means the work will on that how many time the node is becoming a CH, if it is more than the max count it means it is an attacker node.

Now to mitigate the node that is attacker in the cluster the status of the nodes will be updated in the table of information which will give the values in form of 0 or 1.

Initially all nodes will be have a status of the 1, once node get detected as malicious node the status will be updated and the new CH selection will be done.

Also the CH selection equation will be enhanced with respect to present probability equation as presently the CH selection is on basis of below written equation :

$$T(n) = \begin{cases} \dfrac{Pi}{1 - Pi * \left(\dfrac{r * \bmod 1}{Pi} \right)} & \text{if ni } \varepsilon \text{ G} \\ 0 & \text{otherwise.} \end{cases}$$

Later on it will be updated by making it dependent on energy and distance also to enhance the energy efficiency. Also the Network get secured as chances of getting malicious CH selection will be reduced by the proposed methodology.

CHAPTER 7

RESULT AND DISCUSSION

EXPERIMENTAL RESULTS

This section represents the results that are obtained after implementing the proposed work and paper work. The implementation is done in MATLAB. There are some graphs in this section which proves the efficiency of proposed technique with respect to various aspects such as Throughput, and residual energy.

Initial step for the proposed technique is to setup a network. Below figure represents the number of nodes in the network where number of nodes are 100 and area is of 100 by 100.

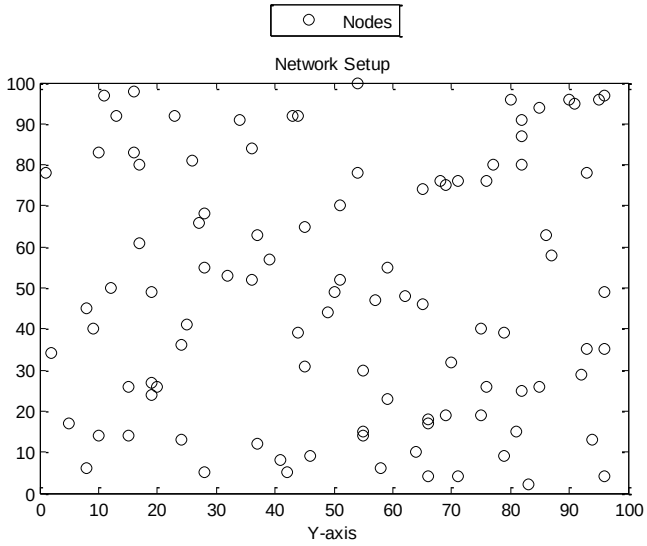

Figure 7.1 Network setup

Next step is to select a sink for the network which shows in the figure below where node with the green symbol represents the corresponding sink for the proposed technique.

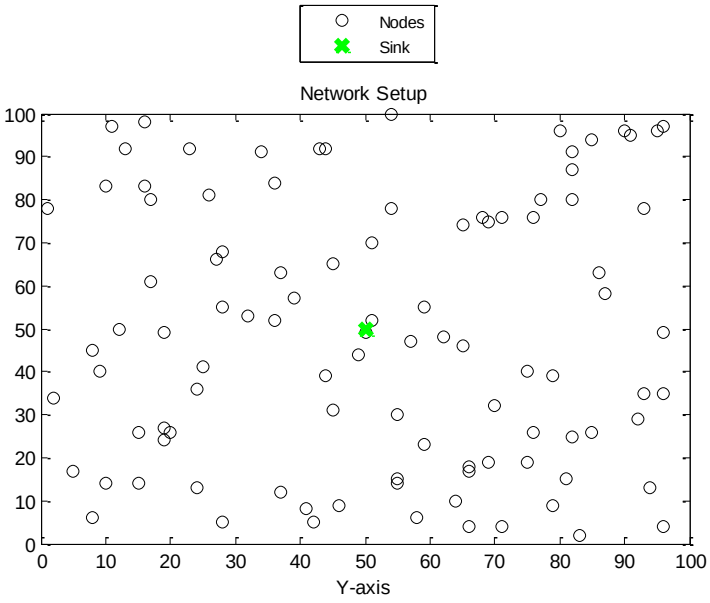

Figure 7.2 allocation of sink in the network

Below figure represents the nodes in the total defined area with the sink and the malicious nodes in the network. Malicious nodes are those nodes which are being corrupted by the attacks.

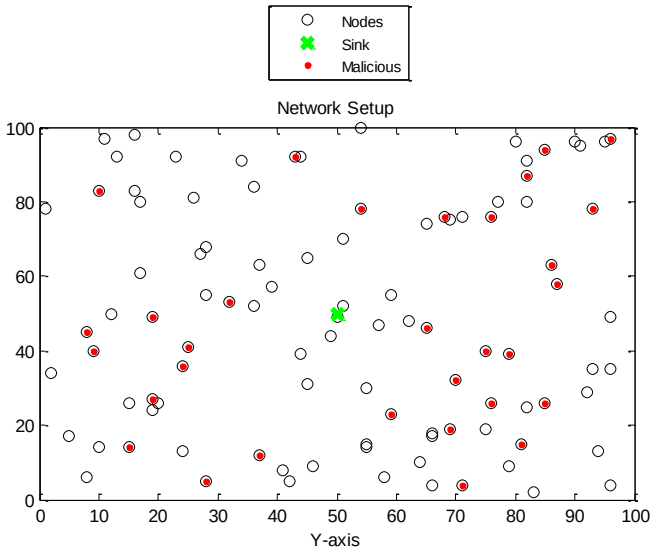

Figure 7.3 Malicious nodes in the network

In the below figure, cluster head has chosen from each clusters and these cluster heads will transfer the information from the nodes to the sink. Thus in each cluster, a cluster head is selected.

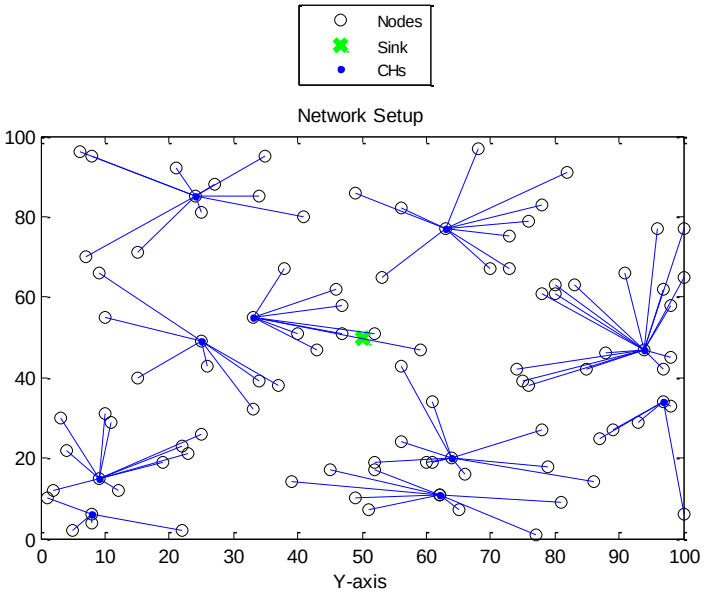

Figure 7.4 Selection and formation of cluster head in the network

In the figure below, proposed work's throughput has acquired in terms of simulation time. The through put of the network should be higher as it shows the rate of receiving of more packets at the destination. At different times intervals, throughput has changed and correspondingly has shown in the below figure.

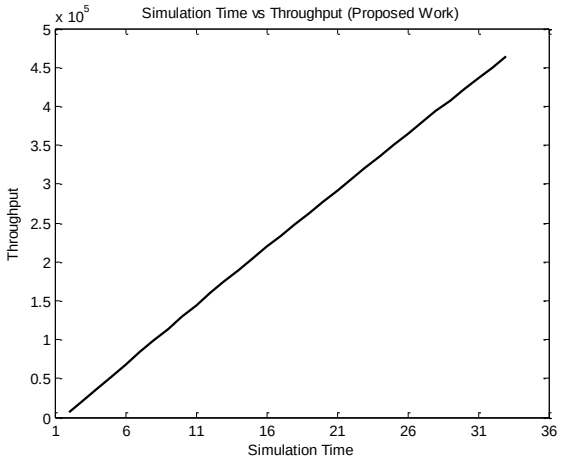

Figure 7.5 Throughput of the proposed work

Throughput of the paper has acquired in the below figure where it is not as stable as required. Simulation time has varied to evaluate the throughput in different aspects.

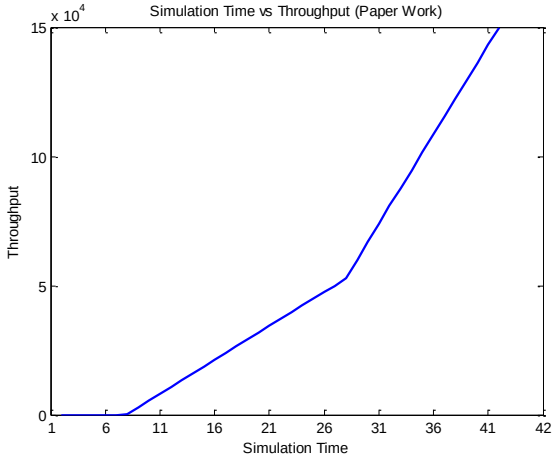

Figure 7.6 Throughput of the paper work.

Below figure shows the comparison graph of proposed and paper work in terms of throughput. It can be clearly shown that throughput of the proposed work is better as compared to the paper work. Throughput of the proposed work is efficient and more stable which concludes that the number of packets sent by the proposed work are higher in amount in comparison with the paper work where number of packets received at the destination are lesser in amount due to the lower and unstable throughput.

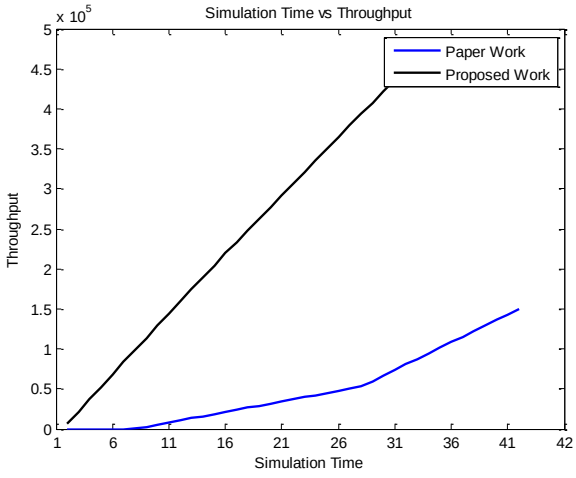

Figure 7.7 comparisons between proposed and paper work in terms of throughput

Figure 7.8 shows the residual energy of the paper work where it starts at a higher energy i.e. 60 joules but falls down to 30 joules instantly with the increasing the simulation time.

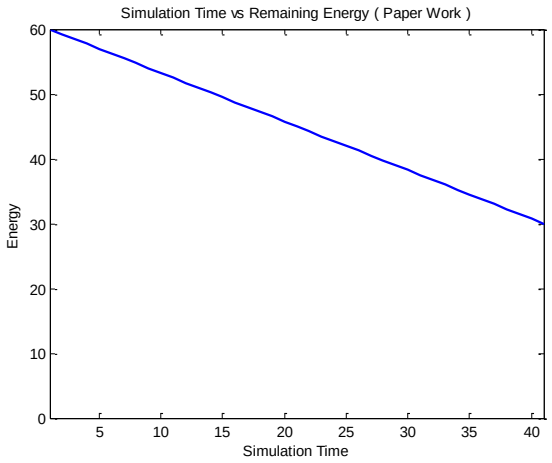

Figure 7.8 Residual energy of the nodes in paper work

Residual energy of the proposed work has shown in the below figure where it starts from the higher peak i.e. 60 joules and reducing the energy with the increase in simulation time. But it does not falls suddenly and maintains the stability in the network in comparison with the paper work.

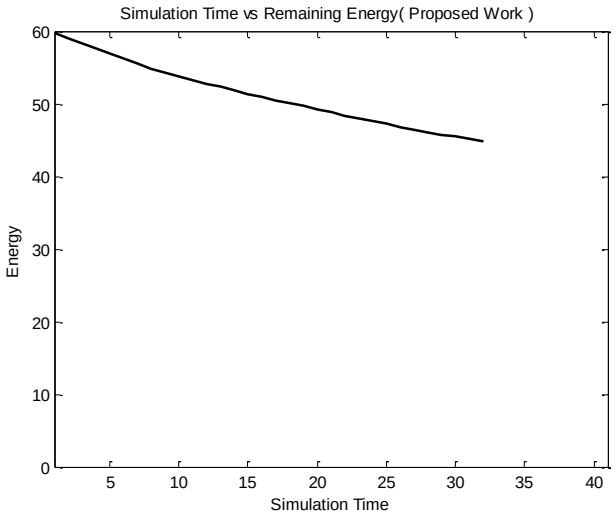

Figure 7.9 Residual energy of the proposed work

Figure 7.10 shows that proposed work achieves higher residual energy after the 40 time which are taken in this simulation work. Paper work also achieves the level of proposed work but it starts from higher level i.e. 60 joules at the beginning and in subsequent rounds it falls down to 30 joules.

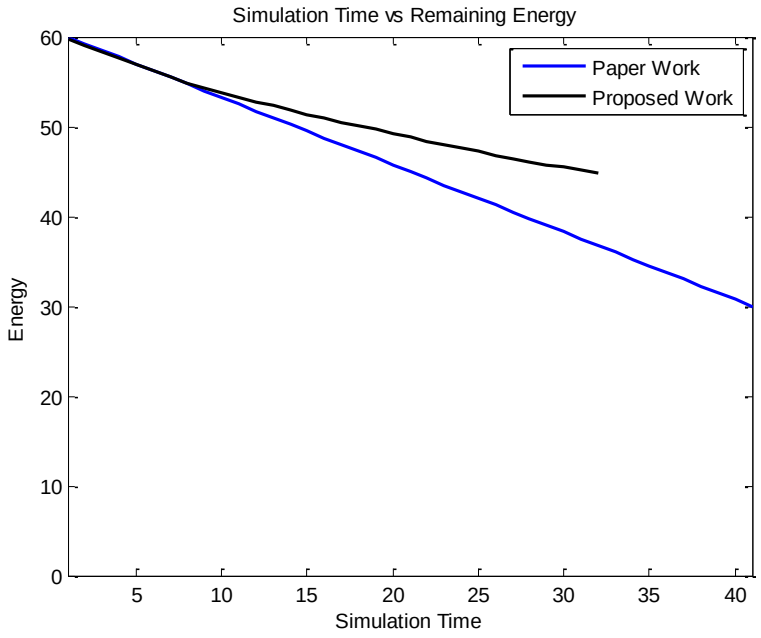

Figure 7.10 comparison between proposed and paper work in terms of residual energy

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

CONCLUSION

Clustering algorithm is an approach to enhance the network lifetime. Based on shortcomings of paper work, a method has proposed where comparison has performed in terms of throughput and residual energy of the nodes in the network. It has been concluded that the proposed work is better as compared to the paper work where throughput and residual energy are higher which means that more number of packets are received at the destination. Moreover, the stability of the proposed work is quite efficient with fewer variations in comparison with paper work. The experimental analysis shown the impact of the proposed in the network

FUTURE SCOPE

In future, Number of parameters can be enhanced to evaluate the performance of the proposed work in comparison with the base paper. By enhancing the parameters, impact of the proposed work over the paper work can be seen successfully.

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