To Evaluate and Improve RFID Protocol for Packet Collision Avoidance in Wireless Sensor Network

DISSERTATION -II Report

Submitted in final fulfillment of the

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(Lovely School of Science and Technology)

Lovely Professional University Punjab May 2015

Under the Guidance of

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(Asst. Professor)

By

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CERTIFICATE

This is to certify that the Project titled **"To evaluate and improve RFID protocol for packet collision avoidance in wireless sensor network"** that is being submitted by "Ramandeep Kaur" is in final fulfillment of the requirements for the award of MASTER OF TECHNOLOGY DEGREE, is a record of bonafide work done under my /our guidance. The contents of this Report, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.

Project Supervisor

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Lovely Professional University Punjab

Objective of the Project is satisfactory / unsatisfactory

Examiner I **Examiner II**

ACKNOWLEDGEMENT

“The successful completion of any task would be incomplete without accomplishing the people who made it all possible and whose constant guidance and encouragement secured us the success”

This seems to be fitting moment for me to express my heartfelt gratitude towards all those who helped me tirelessly and patiently in my Project work.

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By

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CERTIFICATE

This is to certify that Ramandeep Kaur bearing Registration No. 41200394 has completed objective formulation of project titled, **"To evaluate and improve RFID protocol for packet collision avoidance in wireless sensor network"** under my guidance and supervision. To the best of my knowledge, the present work is the result of her original investigation and study. No part of the project has ever been submitted for any other degree at any University.

The project is fit for submission and the partial fulfillment of the conditions for the award of degree of M.Tech in Electronics and Communication.

Signature of Supervisor
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DECLARATION

I Ramandeep Kaur, student of M.Tech under Department of Electronics and Communication of Lovely Professional University, Punjab, hereby declare that all the information furnished in this project report is based on my own intensive research and is genuine.

This report 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 consist no. of nodes spread in particular area where we need to monitor the changes going on there. S ensor node consists of sensors, memory, processor, actuators having ability to communicate. Sensor nodes permitted to communicate via a wireless medium. Wireless medium may be radio frequencies, infrared or any other mode without any wire connection. No of techniques already projected for energy saving, clustering also one of those. In Clustering, the clusters formed by grouping of nodes. The clusters head elected from time to time in such manner that cluster members could communicate with their cluster heads. These cluster heads received data from its members & send to base station. Multi-node clustering can also used. RFID is used in this clustering. To maintain a sufficient load on every node, cluster head need to rotate for energy balancing. The energy consumption can be reduced. In this network, all the sensor nodes should synchronized to avoid the packet collision. A master node need to deployed within sensor network that should synchronized with GPS. Master node controls the timing information to all sensor nodes so that all nodes synchronized to each other.

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ADOV	Ad hoc on Demand Distance Vector Routing Protocol
CH	Cluster Head
CP	Collection Period
CTS	Command to Send
EEHC	Energy-Efficient Hierarchical Clustering
GPS	Global Positioning System
HEED	Energy-Efficient Distributed Clustering
LEACH	Low Energy Adaptive Clustering Hierarchy
MAC	Multiple Access Control
NTP	Network Timing Protocol
P2P	Point to Point Communication
RFID	Radio Frequency Identification
RTS	Ready to Send
WSN	Wireless Sensor Network

CHAPTER-1

INTRODUCTION

1.1 Wireless Sensor Network

The recent developments to make a energy efficient Wireless Sensor Network, are providing new directions to use these networks in some of applications like industrial monitoring, surveillance, traffic controlling, habitat monitoring, crowd counting, cropping monitoring, etc. Use of these networks is continuously growing & attracts engineers to develop innovative and efficient thoughts in this field. No. of research in data routing, data compression and network aggregation has been projected in recent years.[1]

Wireless sensor network consist no. of nodes spread in particular area where we need to monitor the changes going on there. A sensor node generally consists of actuators, sensors, memory and a processor and they have ability to communicate. Sensor nodes permitted to communicate via a wireless medium. Wireless medium may be radio frequencies, infrared or any other mode without any wire connection. These nodes are deployed in a arbitrary fashion and they can communicate between themselves to create an ad-hoc system.

If node is not capable to communicate with other during direct link, i.e. they are away from reporting area of each other; the data can be send to the other node by using the nodes among them. This is called multi-hoping. To serve the requests all sensor nodes work in cooperative manner. There is peer to peer communication between the nodes wireless sensor networks cannot be centralized. So there is no need of prior infrastructure to manage the network. WSN provides flexibility of adding and removing the nodes while required. But this gives rise to lot of changes to deal with in the network topology like the network tree or updating the path etc. The sink word is used in WSN that collects data information. Hence we connect worldwide area via internet where information can be utilized within time constraints.[5]

The common problem occurs in using these networks is limited battery life. This happens due to that the expected size of a sensor node should be small and it means the components i.e. battery size, data storing memory and processors, should be small in size. So any

optimization in sensor networks should focus on optimizing energy conservation. In WSN a lot of sensed routing and data information has to be send which often have some time constraints so that the information can be collected earlier than any accident occurs, e.g. machinery monitoring, industrial monitoring, etc. In data communication process the uses of energy is more than the internal processing. So energy conservation in WSN need to be addressed.[6] sensing distribution allows the closer for placements the sensing nodes than a single sensor node would permit. Distributed sensing is done for finding the exact location if the location is unknown. Various sensor nodes are used to find out the environmental obstacles like line of sight constraints etc. In most of the cases, the area that have to be monitored does not have an existing infrastructure for either energy or communication. It becomes necessary for sensor nodes to live on small, fixed sources of power and communicate through a wireless communication channel. [7] Distributed processing capability is another requirement of sensor network. it is essential because communication is major consumer of power it means due to communication energy is more required than other operations. In centralized systems, various sensor nodes are used for communication over longer distance that leads to more energy deduction and some sensor nodes are used for other operations. It may be a excellent proposal to forward maximum information as possible to reduce the total number of bits transmitted.[8]

Physical world conditions, such as thermal, chemical, optical, mechanical and other measureable parameters these all are sensor monitor. These all are readily manner of industrial, commercial, public and consumer application. For deployment of sensors a user to do more with less, increased security, increased convenience, comfort through improved or automated processes. Organizations realize positive return on investment with sensor networks by [9]:

- Reducing energy usage
- Improving security
- Providing convenience
- Reducing labor expenses

Energy consumption can be reduced by building automation system, on average by between 5% and 15% more for which are poorly maintained and older buildings. To provide good data resolution across the environment, better device integration and use of control

strategies, only a sufficient number of sensors are needed, beyond most wired building sensor networks can provide.

Energy consumption in a sensor node can be recognized as “useful” or “wasteful” sources.

Useful energy consumption can be due to [10]

- Data transmitting or receiving
- Processing raised requests
- Forwarding raised queries log data to neighbor nodes.

Wasteful energy consumption can be due to

- Idle listening to the media
- Repeat transmission due to packet collisions
- Overhearing
- Generating/ handling control packets.

1.2 CHARACTERISTICS

There are two types of nodes :

1. Sensor nodes that having incomplete energy can judge their own remaining energy and have the equivalent structural design.
2. One Base Station (BS) without energy restriction is distant from the area of sensor nodes.

The characteristics of sensor node are given below:

- All sensor nodes are stationary that cannot move. Sensor nodes communicate with base station using multi-hop transmission technique or direct transmission.
- They sense area at fixed rate and constantly have data to send to the base station.
- Sensor nodes having capability to modify the transmission energy of transmitter according to the distance.
- The function of Cluster head is to collect data and Base Station receives compacted data.
- WSN lifetime is the total time before the first sensor node runs out of power.[11]

1.3 Sensor Network Architecture

In sensor network structural design, we can possibly deployed very large number of sensor nodes or devices. Sensor network consist of a sensor field, where the sensor nodes are deployed that is physical environment, which is shown in figure 1.1. Sensor nodes should have a low cost.

The inexpensive device can thus be projected to have practically limited computational and communication capabilities, considering the fact that sensing capabilities are also to be included in the appliance. There are many applications, where human involvement is not simple to retain the sensor node. This type of sensor nodes are operating on restricted battery power. Replacements of batteries are not easy process. Sensor nodes have a restricted power, so it should be designed in a way, that sensor nodes utilize this power in a efficient manner & automatically it goes to the power off mode when not in use.

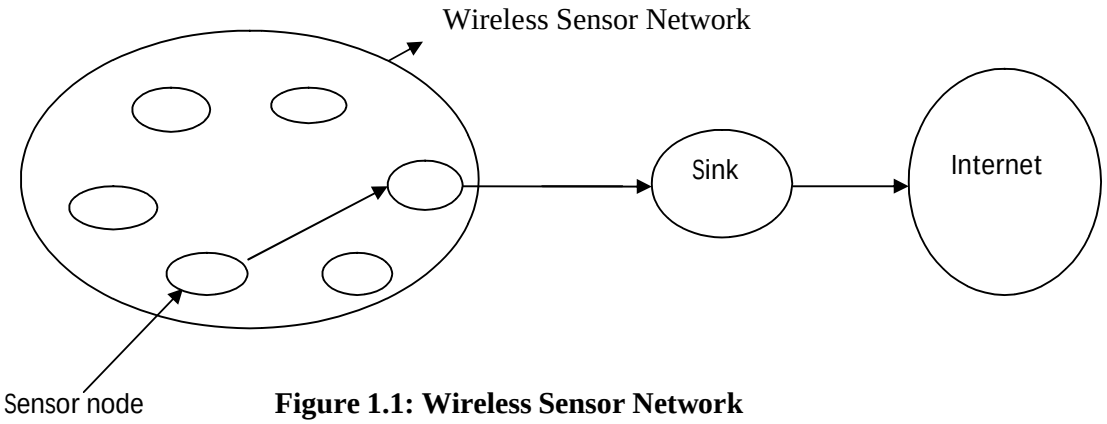

Figure 1.1: Wireless Sensor Network

For particular applications like disturbance detection, sensor nodes have advanced capabilities as compared to other nodes which are used in simple fields. Hence, sensor devices may be fabricated in millimeter sized devices on custom silicon for general purpose cell-phone-sized devices with advanced capabilities. Figure 1.1 shows simple sensor network structure where sensor nodes are deployed with limited capabilities in a sensor field.[12] The sensor nodes communicate with powerful base station. Base station connect sensor nodes with internet and a central manager forward the sensed data which is given by sensor nodes. All the sensor nodes will not able to communication directly with base station, so sensor nodes communicate with several nodes, which are connected to each other. May be sensor nodes are not in range of base station, due to limited communication range and so on. Base station or gateway may have other storage and processing capabilities that are useful for other applications. The base station in sensor network is a powerful unit.[13]

1.4 Structure of a Wireless Sensor Node

The internal structure of a sensor node has shown in figure 1.2. It having six parts,

- Power unit
- Sensing unit
- Processing unit
- Storage unit and timing synchronization
- Communication unit
- Medium access

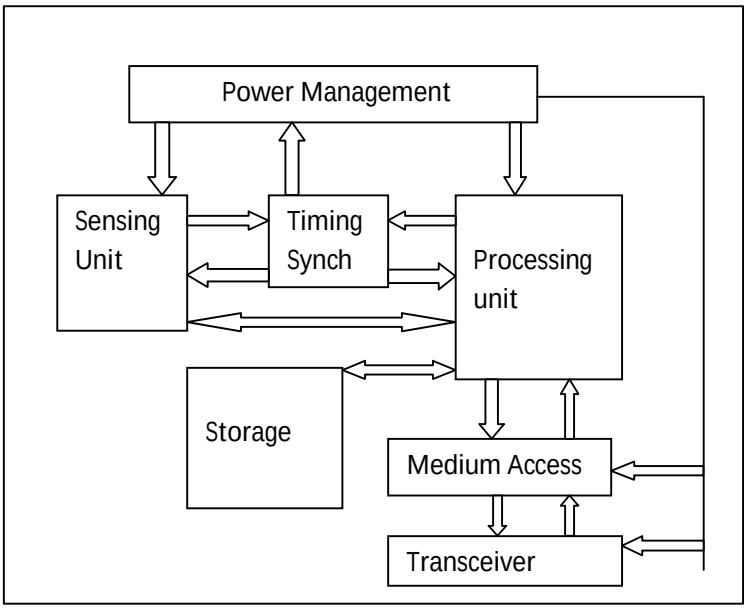

Figure 1.2: Structure diagram of a sensor node

- **Power management unit**: This unit or block is used to reduce the power utilization in the sensor node to the highest amount possible.
- **Transceiver:** This block is also known as communication unit. It supplies the communication channel which can be laser, optical or radio.
- **Processing unit:** This unit works with the storage unit, it is responsible for computing sensed data which is given by sensing unit. Processing unit has some internal RAM. The processing unit controls the communication with other nodes and working collaboratively with sensor nodes. It has RAM, microcontroller, operating system and timer that store, processes and executes the actions.

- **Sensing unit:** The main function of sensing unit is to sense the atmospheric conditions like humidity, pressure and temperature etc. basically it is grouping of sensors which generating the electric signal after sensing environment and converts analog signal to digital signal. Type of sensors used in a sensor node depends upon the application. More than one sensor can use in a sensing unit.

- **Storage and time synchronization: S**ensor classified as storage and time synchronization components. Generally, data storage on sensor device is equipped with flash memory. A medium access control unit works with the transceiver to access the mutual air interface. But not showing in fig. are potential external sensing units, the battery that actually powers the sensor device, the antenna, or other components, like those used for localizing a sensor.

1.5 Features of Sensor Networks

1.5.1 Lifetime: In a sensor network, nodes have limited battery power, so the life time of sensor nodes is less. Lifetime is more important in some more critical applications. Although, many times its assumed that the transmitted power associated with packet transmission accounts for the sensing, signal processing and even hardware operation in standby mode consume a consistent amount of power. In some applications, extra power is required for macro- scale actuation. At the physical layer routing and channel access protocols could be benefit to exchange the information. Lower radio duty cycles and dynamic scaling can be beneficial at physical layer for energy consumption. The loss of the sensor nodes due to battery depletion should avoided by using energy-efficient routing.

1.5.2 Flexibility: Sensor networks are dynamic in nature they can adapt the changes in nodes density and topology & these should be scalable. In a surveillance application, some of nodes may remain quiet as long as nothing happen. However, they must be able to respond in a special event that the network intends to study with some degree of granularity.[5] In a automatic recovery network filed, a number of sensing units may sleep as long as none of peer explodes, but they should operational quickly in the case of an enemy attack. In control application, respond time is very critical (sensor/actuator networks) in which the network is to provide a delay-guaranteed service.[17] In sensor network nodes are self configure and can easily adopt the different conditions. In

sensor network, failure of individual sensor node, the sensor network robust to change in their topology. Connectivity and coverage in sensor nodes always be guaranteed. Connectivity is achieved if each node is connected to base station directly or indirectly. To check the coverage of the network, to measure the quality of services is provide by network in particular area. Whole coverage is specificly important for surveillance applications.

1.5.3 Maintenance: Maintenance is very important in sensor networks. The sensor network is updated completely or partially in a wireless channel. Latest updation of all sensor nodes should be must, and the restrictions should be same on size of new code as in the case of wired programming

Packet loss definitely accounted for and should not obstruct correct reprogramming.[5] Code which is running in the nodes, should support the reprogramming as a small footprint, and modifying procedures should only cause a small disturbance in the normal working of the node.[5] The failures can occur due to many reasons like battery deterioration to volatile external events, either may self-dependent or spatially correlated. Fault tolerance is very crucial during maintenance, its rarely an alternative option in sensor network applications.[18] Independent configuring nodes allow operational process run efficiently without any human interaction, nodes should place in given specific geographical area. The nodes should capable to assess network deployment quality and indicate possibility of problem that may arise & adjust automatically during environmental changes by self configuration. [5] Time synchronous must to cooperate with all nodes in data fusion, sleep mode co-ordination, channel accessibility or security related communications.

1.5.4 Information gathering: Information gathering is related to network connection with device and coverage area. An attractive solution is the use of omnipresent mobile agents that arbitrarily move around to collect information or data bridge sensor nodes and access points, Mostly all data transmitted to base station, but this form of centralization data collection may reduce lifetime of a network.[15] Information transfer to a data sink causes irregular power consumption sequences that may overload nodes. Particularly nodes providing end links to base stations, which may restrict transmitting traffic receiving from other nodes, forming a narrow passage through the network. In sensing network clustering technique can used to transfer information. The cluster nodes transfer the information to cluster head & forward same information sinking. Cluster nodes team up the cluster, in a

cluster unit, 1 node is CH and rest are the related element of the cluster. After some data packets transmission, a steady energy utilization pattern may be achieved by intermittent re-clustering. Data idleness will be minimized, as combined process highly associated measurements [19] In some of applications queries raised that forward to sensing nodes. Our goal to collect specific information/data for a particular zone, where sensor nodes has deployed. In a network, sensor nodes should capable to protect its data as well as node itself from outside nodes. Main limitation of lower-end sensing node apparatus security is a major challenge.[20]

1.6 Applications of Wireless Sensor Network

There are many applications of WSN which are popular in WSN filed because of flexibility in problem resolving in different domains as mentioned under:-

1.6.1 Military Applications: In early stage, elemental knowledge of sensor networks was the used in defense application. Today wireless network using for military operations like control on stealth & monitoring the location, telephonic communications or telegraphic messages, data computation, intelligence, seismic activities or vibrations surveillance, thermal activities & evaders detections and targeting systems.

In a battle field, WSN process coding data and send extracted alarm or coded data to command centers, where commanding officer can takes the mandatory defense action. Moreover in rapid operations, patience in fault resolution & security of networks is very important. The sensor devices or nodes should provide following services [22]

- Monitoring army location, their equipments and missiles etc.
- Surveillance with help of Seismic sensors, motion sensor & thermal sensors
- Exploring the enemy force location
- Target for bombardment the battlefield area
- Loss assessment, due to battle damage
- Nuclear activities detection of enemy forces.

1.6.2. Health applications: Sensor networks are very useful in health care equipments. In hospitals lot of apparatus used built in sensor networks to monitor patient physiological information, which further support to control the medicine sequence. Further WSNs help to

monitor no of patients and doctors inside the hospital premises.[23]

Long-case nursing homes: this application helps on nursing care of old age peoples. In farm surveillance camera sensors, orientation or pressure sensors & some other sensors like detection of muscular activities etc are creating a very intricate network. They help to measure the unconsciousness, monitoring and dietary exercise etc. These applications can decrease personnel cost and fast the reaction of situation.[24]

1.6.3 Environmental Applications: At present, WSNs are also useful in ecological applications like surrounding monitoring, agriculture related research, fire control and traffic monitoring. By using sensor network in ecological area, there is no disruption to environment, also not strict as in enemy battle field.

Bush Fire Response: Environmental monitor and disaster response is lesser price distributed sensor network. An integrated network of sensors combining on the ground sensors monitoring local moisture levels, dampness, wind movement and direction, and long-lasting meteoric forecasting help to examine fire risk levels in focused regions as well as important information on possible fire direction. Such a network will provide important considerate of bushfire development and most importantly assist authorities in organizing a synchronized disaster response that will save lives and property by providing early warning for high risk areas. [2 5] Information gathered by sensor units could guide irrigation or harvesting to improve quality & removal of debris etc, providing wine producer owners a better return on their investment.[26]

1.6.4 Home Application: With increase of commercial application of sensor network, now it's so hard to improve housekeeping or monitoring other safety & security measures. [27]

When we come back home, door sensors detects you are at the front of door, the door will automatically open and after you enter into the home the door will close itself. All the switches of the room in which you are sitting or standing will automatically turned on like tube light, fan, air-condition. When you sit on sofa, the sensor which is deployed under the cushion detect your weight and on the table light and turned on TV. One sensor on TV set which sense our self that sitting in front of it.[28], similarly if we feel heat in atmosphere and reduce the temperature of the air condition, it will reduce the room temperature gradually. If we mounted any external sensor in room, that will indicate us the temperature maintained inside the room.[29][30] The air conditioner will work continuously until temperature

sensor not attain the desired temperature. The corridor lights, wash room and lobby lights all could be install with sensor control automatically for on/off.[31]

1.7 Challenges in WSN

There are some technical challenges in sensor networking as explained under:

- **Ad hoc deployment**: Many sensor nodes are developed in some regions where infrastructure not available. A distinctive way of equipping in a forest the sensor nodes spread down from an aeroplane. In this condition, it depends upon the nodes to identify its connectivity and distribution.[31]
- **Unattended operation:** In sensor network if sensor nodes deployed without any human interference, they can simply reconfigure them-self and accept the atmospheric changes, if occurred.[32]
- **Untethered**: In sensor networking, nodes not allied to any energy bank. There is limited energy units for sensor nodes, which can utilized during data processing and communication like power bank. So for optimized energy consumption, communication should be minimized where possible.[11]
- **Dynamic changes**: The sensor nodes self configurable because of its dynamic nature. Sensor nodes accept the changes easily while adding or removing any sensor node in network during any expansion of network or at stage while any failure occurred.
- **Fault tolerance:** The fault tolerance means to maintain the infrastructure in a form that if one node dies then it cannot affect the other nodes. The adaptive protocols are developed to maintain the other network unaffected.[33]
- **Security issues: T**hreats and attacks to breach the security of WSN are same as in wire connected network. In fact, wireless networks will weaker on security breach point of view generally as the non recommended broadcast medium is more vulnerable to security breaches in comparison of recommended broadcasting medium. The transmission nature of the wireless broadcasting is a normal participate for eavesdropping. Lot of security conflicts and fear of failure related to wireless ad hoc networks are also considered.[34]
- **Synchronization:** In a number of applications the information gain in all nodes sense logic as a whole and as a result needs to be synchronized. Time synchronization is an essential support in sensor nodes. The aim of time synchronization is to supply a regular

timescale for neighboring clocks of nodes in the network. A universal clock in a sensor network will help in processing data and observe the information appropriately and find the upcoming system behavior. This is not as insignificant as it could appear because delays are present at the time of transmission and there is no propagation clock to synchronize nodes. It is a most important challenge in WSN.[35]

- **Localization**: The localization of nodes using just the relative location of the sensors is also a major challenge in sensor nodes. It is most important and developers region in which several approaches have been made such as dominating received signal power indicators, upcoming time, time difference of coming signal, or angle of coming signal. Distributed algorithms plays a important role in increasing accuracy.[36]
- **Short Range Transmission:** In wireless sensor networks we have to consider the short range of transmission in order to decrease the overhearing. because in long range of transmission we need higher power due to the point to point transmission among the nodes to arrive at the destination which maximize the possibility of being eavesdropped.[37]
- **Energy utilization:** The energy utilization is a major challenge in WSN. The size of sensor nodes is small and the number of power source is limited. The sensor nodes are depending on the battery which is very difficult to replace due to the physical constraints. Because of this reason many of developers are focusing on the design of power alert algorithms and protocols. The main advantage of sensor network is low cost. Inadequate bandwidth of processor and less memory are two disputable constraints in sensor nodes, which will hide with the improvement of production techniques. However, the power constraint is not likely to be solved rapidly due to slow improvement in battery capacity. On the other hand the supervision nature of many sensor applications requires a long lifespan, it is an essential research matter to supply a form of energy efficient surveillance service for a geographic region.

1.8 Energy Consumption Issues in WSN

In the wireless sensor networks the main problem is limited battery life. The size of the nodes is small so constraints are there like battery size, processors, storage of data, these all are small as sensor nodes. So the main focus on optimizing energy utilization in wireless sensor networks.[38] . In WSN a lot of sensed routing and data information has to be sending which often have some time constraints so that the information can be collected earlier than any accident occurs, e.g. apparatus monitoring, manufacturing monitoring, etc. In data communication process the uses of energy is more than the internal processing. So energy saving in WSN required.[27]

In wireless sensor network there is node failure if power is lost. The network should be self adjusting and also have adjustable properties as necessary from time to time.[39] A bottleneck node may come across failure due to inadequate battery life. In this type of case protocol should be smart and have capability to handle these type of failures and keeps the network in ready state.

Generally sensor nodes depend on a battery with limited life, and their substitute is not possible due to some constraints. In addition the structural design and protocol of networks must be capable to scale up every number of nodes. [40] Since the battery lifetime can be extended if we manage to reduce the amount of communication, in the sensing subsystem energy utilization can be minimized by using low energy portion. In power supply subsystem it consists of a battery, the duration of a battery can be improved by minimizing the current drastically or switching off the device.

1.9 Clustering of Nodes

Clustering technique is used to save energy of the nodes. Through efficient network organization all the sensor nodes in network can be divided into small set is known as clusters. Cluster head is chosen from the clusters which having the highest energy. [40] Clustering gives two type of hierarchy. One is the higher tier and other one is lower tier. Cluster head form higher tier and instead of cluster head other node members came into the lower tier. The clustering involves grouping nodes and choosing cluster heads from time to time such that elements of a cluster can communicate with their CH and these cluster heads transfer collected information received from its neighbor clusters to a base station. The loss of energy is higher in cluster head because it transfer data at distant points compared to other elements of nodes.[23] The clustering method is used to minimize the

energy utilization. It reduces the packet collision and channel contention. It also increases the network throughput when load is at higher level. Clustering increases the lifespan of the sensor networks. Lifetime is the primary factor to evaluating the performance of the sensor networks.[41] The clustering approaches cannot directly apply to wireless sensor networks, because these networks has single deployment and operational features. Wireless sensor networks are established in ad hoc manner. In ad hoc networks nodes are not aware about their positions.[42] Hence, distributed clustering protocols that depend only on neighborhood information are preferred for wireless sensor networks. [43]

We know that in the WSN the nodes work on battery power which has limited energy. Due to the some unexpected failure of node, re-clustering is necessary as the cluster needs like remaining energy and node degree, this type of clustering is dynamic clustering. For data processing static parameters are needed like space between nodes and suppose that nodes are more dependable. When using clustering in sensor network, the workload on the cluster head is thus larger than for non-cluster heads. It can be changed in the sensor network during the lifetime, to distribute the work load and energy consumption.

- **Heterogeneous sensor networks:** There are two types of sensors. Those sensors which having more handing out capabilities and composite hardware. This type of sensors is used to generate some sort of spine within the wireless sensor network being fixed as the cluster head nodes and also serve as information collectors and handing out centers for data collected by other nodes.[43] Generally sensors, with lesser capabilities, used to essentially sense the chosen attributes in the zone. In homogeneous networks, all nodes carrying same features, hardware and handing out capabilities i.e., this is the case when the sensors are used in field of battle. In this type, each and every node turns into a cluster head. Moreover, the clusters head role can be rotated among the nodes in order to get better load stabilizing and more identical energy utilization.[44]
- **Homogeneous sensor networks:** To gain more flexibility and fast implementation meeting of the number of nodes in homogeneous sensor networks had done by distributed algorithm. Cluster head selection and creation process of cluster is more suitable approach. [43] Some approaches using hybrid techniques, where coordinator nodes or the base station is responsible to separate the entire network off-line and manage the cluster link. In wireless sensor network they are useful for special-purpose WSN applications where high-class connectivity and network separation is required.[43]

1.9.1 Clustering parameters

Before clustering formation, the clustering algorithms fulfill all conditions for clustering which are necessary for clustering in wireless sensor networks. There are some parameters which are important for whole clustering processor in WSNs, it give more detail about clustering formation. These clustering parameters are:

- **Clusters:** In randomized algorithms the cluster head selection and creation process direct to variable no. of clusters.[45] In some techniques, cluster heads are predefined and number of the cluster are also preset. For efficiency of total routing protocol the number of cluster is very critical parameter.
- **Intracluster communication:** one-hop communication is used in initial clustering techniques, where the cluster head and sensor nodes are communicating direct. For communication among the sensor nodes and cluster head multi-hop communication is needed in large number of sensor nodes and communication range is limited. So here cluster heads is bounded.[46]
- **Sensor nodes and cluster head mobility:** Suppose that nodes and cluster head are fixed, Normally we follow steady clusters with facilitated intercluster network management. If the nodes and cluster heads to be movable, in this case the cluster head and other members of that cluster are moveable. They all change their positions dynamically, dynamic changes will occur in the clusters, probably need to be continuously maintained of that clusters.[47].
- **Nodes types and roles:** In heterogeneous environment the cluster head has more capabilities than other nodes like more communication resources and computations. All the nodes have the similar capability as cluster head in homogenous area.
- **Cluster formation methodology:** In recent techniques, while cluster heads are normal sensor nodes and the efficiency of time is major design norm, clustering is divided into this manner that there will be no coordination between clusters. [4 8] O ne or more sensor nodes are coordinator nodes which are used to control the cluster members and to separate the entire network off-line.
- **Cluster-head selection:** In heterogeneous environments the head nodes of the cluster is pre assigned. Pre assigned nodes become the cluster head. In homogeneous area the cluster head are chosen from the established set of nodes either in completely random way or based on remaining energy, connectivity etc.[49]
- **Algorithm complexity**. Goal of primary design is the fast ending of the implemented protocol in most recent algorithms. The time complication or union rate of cluster design

projected these days is constant or just dependent on the number of cluster head. [3] In the previous protocols, however, the complexity depends on the maximum number of sensor nodes. [50]

- **Multiple levels:** Multiple level type of clustering is used to get better energy utilization. It can also provide better energy distribution. [51] Multiple level clustering is used when network is at large scale and inter-cluster head communication efficiency is of highly important so improvements are offered by multi-level clusters are under study.
- **Overlapping:** The sensor nodes are overlapped with in different clusters due to some reasons, either for improved routing capability and rapid cluster generation protocol implementation it is also a high importance clustering parameter. The majority of the protocols still attempt to have minimum overlap. It can also possible some of the protocols do not carry overlapping. [52]

1.9.2 Classification of Clustering Techniques

There are two major categories in wireless sensor networks that depending on cluster arrangement criteria and parameters used to choose the cluster head.[53]:

- Probabilistic clustering algorithms: Energy-Efficient Distributed Clustering (HEED), Energy-Efficient Hierarchical Clustering (EEHC), Low Energy Adaptive Clustering Hierarchy (LEACH), etc.
- Non probabilistic clustering algorithms: Node Proximity and Graph-Based Clustering Protocols, Weight-Based Clustering Protocols, Biologically Inspired Clustering Approaches.
- The grouping of nodes and selection of cluster head is important in clustering so that [23]
  - The family members of a cluster can transfer data with cluster head (CH) directly.
  - A cluster head can send data to the base station through other cluster head.
- There are many techniques that are used in clustering these are LEACH, and lot of improved version of Low Energy Adaptive Clustering Hierarchy like E-LEACH, LEACH-SM, Multi-hop-LEACH and so on. There are two stages for LEACH protocol. [14]:
- **Cluster set up stages:** in this stage each node describes whether they have capability to become a cluster head for the present case. To take the decision all nodes select a random number 0 or 1. A threshold value is fixed, if the number of the node is less than threshold value, then the node becomes a cluster head for present case.
- **Steady state:** The network will move in the stable state when the cluster head allot time slots to its family members using Time division multiple access mode. This state divided into frame, where nodes send their information to the cluster head at most once per frame during their allocated transmission slot.[14]

There are some deficiencies in selection of cluster head node in LEACH such as

- Some time large size of clusters and tiny clusters may available in the network at the same time.
- Wrong election of cluster head while the nodes have unusual energy.
- The members of cluster nodes diminish energy after cluster head was dead.
- The algorithm does not acquire the location of nodes.
- Avoid remaining energy, geographical area and other data, which causes cluster head node failure drastically.[16]

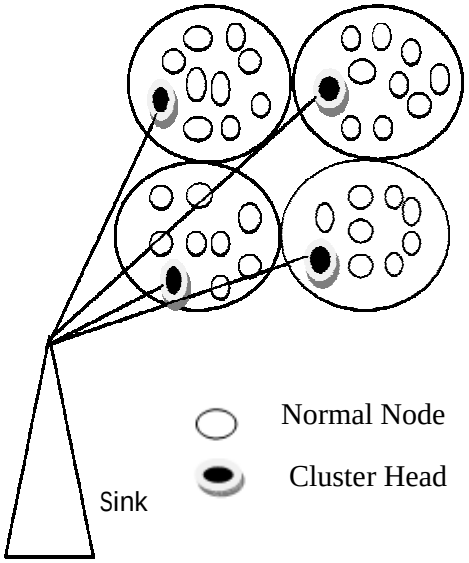

Figure 1.3: single hop with clustering

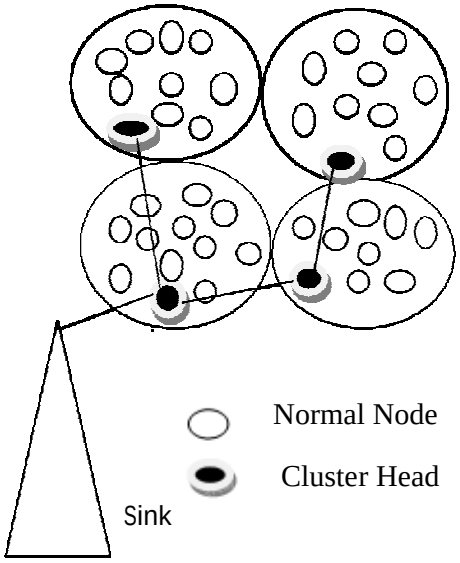

Figure 1.4: multi hop with clustering

The clustering is given in above figures. Figure 1.3 shows that single-hop clustering and figure 1.4 multi-hop clustering. In the above figure 1.3 and figure 1.4 the LEACH is divided into three clusters. Black node is the cluster head which represent the cluster. All the white nodes are the members of the cluster but it's not cluster head. In clustering the cluster head is changed in a random manner by any cluster protocol. To changing the cluster head between each cluster nodes is to distribute the network load. In this way performance of the entire network is improved and can be achieved lower energy consumption.

1.9.3. Disadvantages of the Low Energy Adaptive Clustering Hierarchy Protocol

LEACH protocol has some problems as compared to the plane multi-hop routing and static routing, because it prolongs network lifetime. In this protocol the cluster head is elected randomly, so all the nodes cannot be cluster head. The division of cluster heads cannot be ensured. In clustering all the nodes have same right to become cluster head with high energy or low energy. Therefore, those nodes with less residual energy may be selected as the cluster heads which will result that these nodes may end first.[54] Low Energy Adaptive Clustering Hierarchy cannot be used in large-scale WSNs for the limit effective communication range of the sensor nodes, because in single hop

the cluster head transfer information with the base station.[54]

1.9.4 Need of clustering

- **Load balancing**: The cluster heads requires extensive energy consumption to aggregate information from element of nodes and to pass on the collected information to base station which can be sited far away from the network. Therefore, by revolving the function of cluster heads, the load can be shared uniformly between all the nodes in the network.[6]
- **Optimal no. of cluster heads**: In some techniques, the cluster head is determined a priori. Completing the best possible number of heads guaranteed the minimum power loss in the network and therefore, reduce power utilization in order to make longer network lifetime[6].
- **Maximum network lifetime:** Sensors are resource constraint and dependent on their batteries as source of energy, therefore, the lifetime becomes important consideration in sensor network topology design.[6]

1.10 RFID Protocol:

RFID is radio frequency identification based on radio frequency. It has automatic identification skills. There are usually two types of RFID according to the power source: active RFID and passive RFID. Active RFID is less advantageous than passive RFID in terms of its tag cost, size, and battery management, but more advantages in term of sensing nature, its nature, sensing rate ad sensing distance. RFID is developed so that physical information can be stored and sensed for a long time to improve quality of the system in addition of basic functions.

RFID is self organized technology which is based on the radio frequency. RFID is divided into two categories:-

1) Active RFID
2) Passive RFID

Active RFID/WSN will be performing the availability of tag-to-tag communication. Active RFID is less advantage than passive due to its tags size, cost, battery management but less advantage in the form of sensing rate, stability, and sensing distance. Active RFID save the energy of tag operate on the tag ID period and data collection period. The active RFID tag uses the radio module to deliver the stored physical information to the reader. RFID provides

the point-to-multipoint (P2MP) Communication structure where the reader controls the tags. To minimize the energy utilization of the tag, the reader controls the power that the radio module consumes by making the tag operate in the active and sleep periods. The reader transmits a collection command to multiple tags, which deliver the ID to the reader via contention. Data collection period, the reader collects the data on the tags that are sensed from the tag ID collection period using their IDs, via the point-to-point (P2P) method.

The active period is separated into tag identification period and data collection period. The id period is called contention period. A reader can be transmitting a command to multiple tags which also deliver id to reader via contention. In the data collection period, the reader collects the data on the tags that are sensed from the tag ID collection period using their IDs, via the point-to-point (P2P) method. Then the sleep command turns off the radio module of the tag from which the data have been collected. This is called the collection period (CP). The reader repeats this process until all the tags within its communication range are collected.

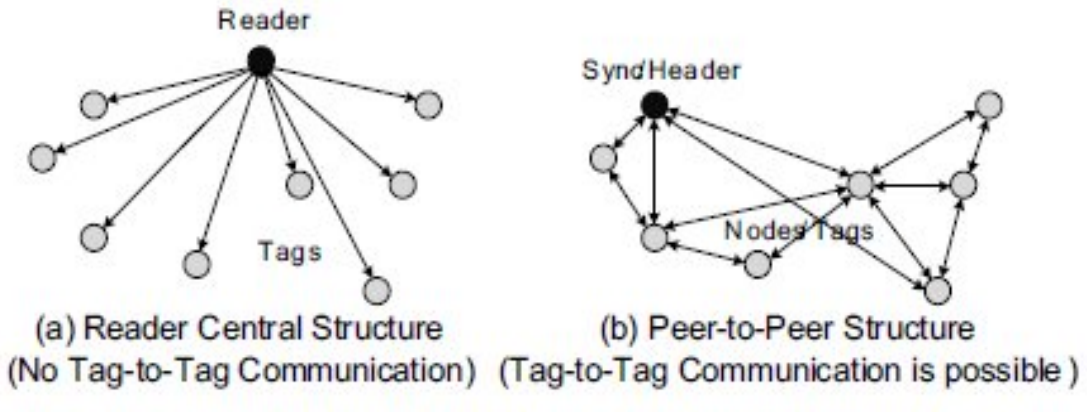

Figure 1.5 communication structure of (a) RFID (b) WSN [32]

these methods are not easy to apply, however, because their communication structures differ from those of the active RFID system. The MAC of the active RFID has a reader central communication structure, wherein the reader controls the communication of all the tags. The MAC of WSN has a peer-to-peer communication structure, wherein all nodes control their own communication processes. If all the nodes have to control their own communication processes in WSN, the communication channel must always be in the carrier sensing and the medium must be occupied via RTS/CTS. The occupation of the medium is only for the Tx and Rx nodes, and the rest cannot communicate. If the tags in the active RFID system use

carrier sensing, all the tags must conduct carrier sensing as many times as the number of tags to transmit their IDs. This creates tag collection delay, which is an additional source of energy consumption. This may lead to the loss of the basic characteristic of the RFID system that collects tags.

CHAPTER-2

LITERATURE REVIEW

Chae-Seok Lee et al. [32], purposed Reservation Aloha for No Overhearing that is used to inform the tag of its effective communication for eliminate overhearing problem. large of energy is reduced due to overhearing is many times larger than consumed effective communication. to eliminate this problem author purpose algorithm (RANO). A tag has information about the time and duration of communication advance because it maintain active mode for kept the sleep mode due to other transmission period. RANO Protocol save the 60 times energy than another protocol.

LI Jian-qi et al. [33], proposed improved clustering routing algorithm which priority to energy efficiency. First, generate cluster head by random competition in the nodes which have advantage in energy; next determine the internal structure of clusters by calculating dynamically tightness coefficient of each cluster, after that, optimize transmission path between cluster heads through improved multi-objective particle swarm algorithm.

Yu Wang et al. [34], proposed energy efficient and delay tolerant cooperative transmission algorithm which show simulations validate that EDTCT outperforms the store-wait forward way no matter in E2E sleep latency and E2E energy consumption. In particular, our plan is adaptive to dense network and it works capably in low-duty-cycled WSNs.

Degan Zhang et al. [35], proposed a method forward aware factor (FAF-EBRM).this method is used for the next hop node selected according to the forward energy density and link weight .The FAF-EBRM compared with LEACH and EEUC. The proposed method balance the energy reduction, function lifetime and provide good quality of service . reduces the probability of successive node breakdown.

Nicolas Gouvy et al. [36], proposed PAMAL (PATH MERGING ALGORITHM) new geographies routing algorithm for mobile node .the proposed first routing protocol which is located and uses paths crossing to adjust the topology to reduce network traffic in this way while still optimize energy efficiency. The protocol makes the intersection to move away

from the destination, getting closer to the sources, allowing higher data aggregation and energy saving. It improves the network life time 37% than exiting.

Peyman Neamatollahi et al. [37], proposed hybrid clustering approach a cluster head reduce of its power, it ultimately informs all other nodes and clustering is used to beginning of the future case. Clustering is performed on requirement. To elaborate the efficiency of plan, HEED (Hybrid Energy Efficient Distributed) hybrid clustering algorithm is used as baseline example. It is also called distributed clustering protocol. Results explain that HCA is just about 30% more efficient in terms of network life span than the other protocol. The major cause is that the clustering is executed on requirement.

Maciej Nikodem et al. [14], focus on the theoretical aspects of clustering in wireless sensor networks, as a result to develop network lifespan. We examine whether clustering itself (without data aggregation) can improve network lifespan in particular application when compared with the network having no clusters. We use integer linear program to analyze one dimensional and two dimensional networks, taking into account capabilities of real- life nodes. Our results prove that clustering itself cannot develop network lifespan so further techniques and means are necessary to be used in synergy with clustering.

Dahlila P. Dahnil, et al. [6], presents a relative study of clustering methods and cluster feature of a single criterion cluster heads selection and cluster construction in Wireless Sensor Networks. The LEACH, HEED and power-based LEACH protocols are simulated and their performance are compared in terms of the number of cluster size, cluster head generated, cluster head division, scalability and coverage. The results of these protocols represent how the cluster pattern helps to extend the network lifespan. We investigate scalability aspects in the occurrence of advanced nodes in the network and its effect on the network lifespan. We proposed to investigate A HEED and AE-LEACH protocols, a new move toward the cluster heads selection that improved network lifespan. The simulation graph shows that having little bit of advanced nodes in the network gives major progress in network lifespan as compared with having other identical nodes in the network.

Ewa Hansen, et al. [8], discussed that WSNs became important for development of energy efficient infrastructure. They initiate the smallest amount of separation distance among cluster heads in a cluster based network, improved network lifespan by reducing the energy

utilization. They use simulation to find how much energy is utilized by sensor network in sorting out the cluster heads. They also discussed the effect of energy utilization for a given lowest separation distance among cluster heads. They showed that wireless sensor network could better performed when they introduce minimum separation distance between cluster heads. It is checked by comparing the number of message was acknowledged by the base station.

T. Shankar, et al. [28], discussed, in the WSN the election of cluster head done using neural network for energy efficiently used by sensor nodes. In cluster based routing, special nodes called cluster heads form a wireless backbone to the sink. The cluster heads assemble the information from sensing nodes and promote data to their sink. In homogeneous networks all nodes have same capabilities. Cluster nodes have more resources than other nodes in heterogeneous networks. Energy saving in these approaches can be obtained by cluster pattern, cluster-head selection, data collection at the cluster-head nodes to minimize information redundancy and thus save energy. In the cluster each node became a head for a limited instance in this way they saved energy of each node.

Matthias R. Brust, et al. [38], discussed hierarchal network is created by clustering techniques is called clusters. In a cluster all sensor nodes select the cluster head. To elect the cluster head in WSN and in ad hoc network is main issue due to their dynamic nature. They proposed a topological criterion for robust cluster head element selection, flexible to irregular node functionality and failure as well as for efficient information distribution. This technique is to avoid the border nodes to select the cluster head because they can move to other cluster anytime and again re-clustering will occur and again elect a new cluster head. This is totally wastage of time and more energy consuming. They performed experiments together for static topologies as well as for cases in the existence.

Arun K. Somani, et al. [2], discussed a disseminated, light mass, scalable cluster algorithm for clustering in wireless sensor networks. The area where the sensors are deployed at random here clustering algorithms are appropriate. There is no necessity of the same size in terms of the number of nodes in a cluster for disseminated clusters. The size is located by the radius of the radio range. In the cluster arrangement one node could bond the one cluster at a time. The cluster head can transfer data to other nodes indirect or direct. The cluster head

can communicate to the BS through an overlay network and intermediates node in between. They analyzed that the performance of algorithm using simulation. Results show that very few nodes (less than 5%) are not able to link a cluster or stay orphan; many are isolated due to random deployment and communication range limitation.

Ebin Deni Raj [7], In this paper they discussed the Gateway Switch Routing protocol uses a topology management where whole nodes arranged in combination of nodes that should ensure belief in cluster head which selected by assigned algorithm. They refer some algorithms that help us to optimize energy utilization while arranging cluster head in WSN that is LEACH. Here many factors like power efficiency, sill, concentration, load maintaining, scalability and distance on which in selection of cluster head based. Algorithms refer for load balancing decrease broadcasting expenses to a large extent. Also they discussed with another reference which focus on a concentration and Distance based Cluster Head. A Power proficient Algorithm for Cluster-Head Selection in WSNs, is dissipation of energy. Their analysis on algorithms resulted a differed algorithm known as EDR LEACH.

Vinay Kumar, et al. [30], In this paper they discussed in wireless sensor networks to maximize the lifetime of the sensor network, for the data transfer the path is selected in such a way in which the energy consumption is minimized in that path. To support high scalability and better data aggregation, sensor nodes are often grouped into clusters. Clusters create hierarchical wireless sensor network, the sensor nodes utilization their limited resources in efficient way and thus extends network lifetime. They presented taxonomy of energy efficient clustering algorithms in WSNs, and also presented timeline and description of LEACH and Its descendant in WSNs.

Limin Meng, et al. [39], discussed that in wireless sensor networks one of the most important factor is energy. Clustering algorithms are used to obtain long lifetime. WSN should meet various requirements for quality of service (Qos). Accordingly, this paper they presented an energy aware Qos routing algorithm for WSN, which can also run efficiently with best-effort traffic. their work had been differs from existing algorithms in two ways: (1) improve the first order energy consumption model with dynamic clustering; (2) use clustering to build the multi-objectives programming model to support Qos. They compared their work with some typical route algorithms that showed algorithm is robust and effective.

V veillance, widespread environmental sampling, security and health monitoring.[11]

CHAPTER 3

3.1 Problem Formulation:

The wireless sensor network, being a microelectronic circuit, can equip with a inadequate power. In some application scenarios, the replacement or recharge of energy resources might be impossible. The lifetime of sensor nodes strongly depend on lifetime of the battery. If the sensor nodes may get expire due to incomplete battery then the probability of network breakage maximize and if there is requirement to gather data of that particular region we cannot get that data. The data can be humidity, pressure and temperature etc. Each node performs the dual role of data inventor and information router in a multi-hop ad hoc sensor network. The faulty nodes can cause important topological changes and might need rerouting of packets and restructuring of the network. Hence, energy maintenance takes on additional importance.

No of techniques already projected for energy saving, clustering also one of those. In Clustering, the clusters formed by grouping of nodes. The clusters head elected from time to time in such manner that cluster members could communicate with their cluster heads. These cluster heads received data from its members & send to base station. Multi-node clustering can also used. RFID is used in this clustering. To maintain a sufficient load on every node, cluster head need to rotate for energy balancing so that energy consumption can be reduced.

In the present work whole network is distributed in clusters. The cluster heads can communicate to each other by using the Destination Sequenced Distance Vector (DSDV) routing algorithm. All the members of the cluster give their information to the cluster head and cluster head forward it to the further cluster head until the data do not reach its destination. In the whole network the path between cluster heads is fixed. The path cannot be changed until all the sensor nodes do not die means their battery goes to down. In this case some intermediate nodes will die earlier than other nodes. Then the path is break down between source and destination. Here due to path breakage the packet loss increases, the packet do not reach at the destination. Packet retransmission is also increases the whole network becomes useless. A new network is configured for complete the communication. To configure the new network again become the clusters and cluster heads it takes too much time and consume energy may be the network do not complete the

communication. It is totally wastage of network resources like bandwidth, nodes battery, time, etc. figure 3.1 shows the network when intermediate nodes will die earlier than other nodes so it increases the packet loss and packet retransmission. In this figure all black nodes are the cluster heads of each cluster. Here S is the source nodes and D is the destination nodes respectively. Between the source and destination a fixed path is established that is cluster 1 to cluster 2 to cluster 4. In this figure the data is transferred from source to cluster head of cluster 1 and cluster head 1 promote the data to cluster head 2. Cluster head 2 forward the data to cluster head 4, now data goes to the midway node between the cluster head and the destination.

The intermediate node sends data to the destination.

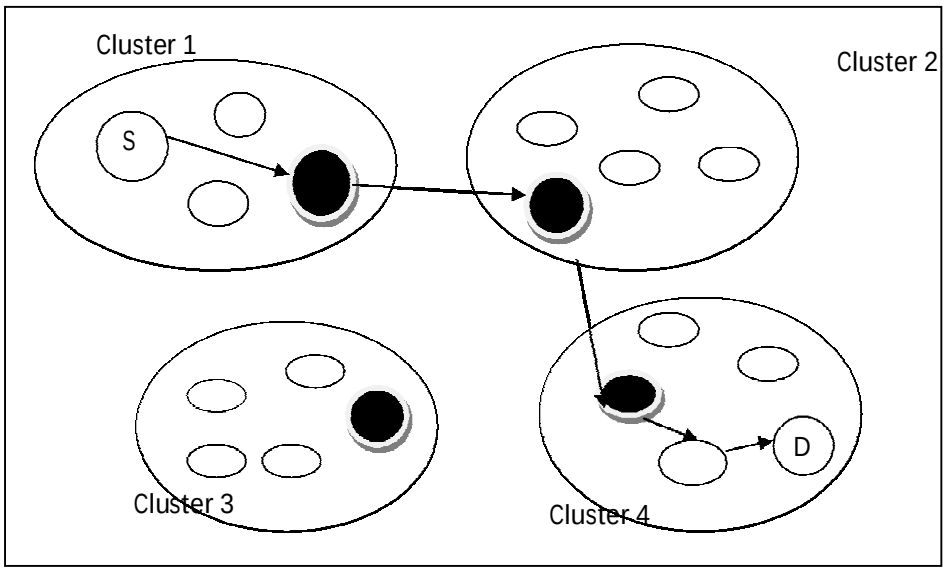

Figure 3.1: simple network with pre-established path

In figure 3.2 shows, that the cluster head 2 goes down, it cannot receive the data from cluster head 1 because its lifetime or battery is not more. Here the packets are losses and it does not reach to its destination because there is no other path established between source and destination. In this network further communication cannot take place. We have to need configure the new sensor network with full charged nodes so the communication takes place between source and destination. To configure the new sensor network it is repeats the whole process and it waste the network resources.

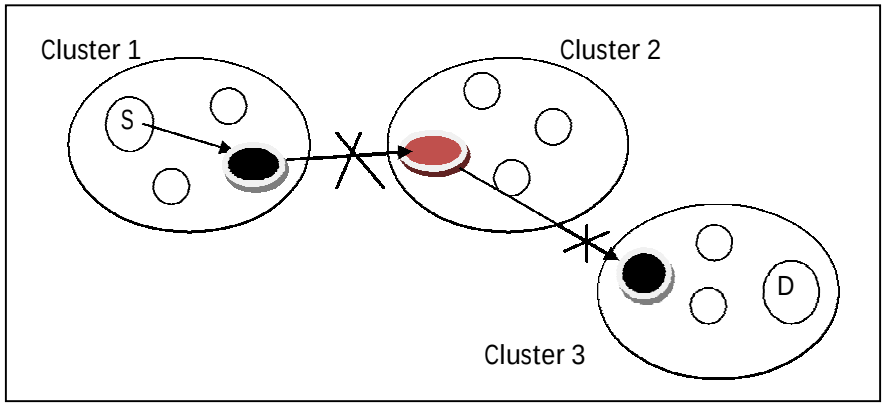

Figure 3.2: a network with die nodes and loss of packets

In the current work the sensor nodes are not synchronous to each other. The packet collision occurs due to the difference of time. Again the packet loss and packets do not arrive at their destination. Figure 3.3 shows the whole situation of sensor network without synchronous of sensor nodes. There are two nodes for source and two nodes for destination are shown in the figure. Source and destination followed the same path for communication. The source of Cluster 1 send data to destination of cluster 4 and the source of cluster 3 send the data to destination of cluster 2. Here the clock synchronous is absent between the sensor nodes.

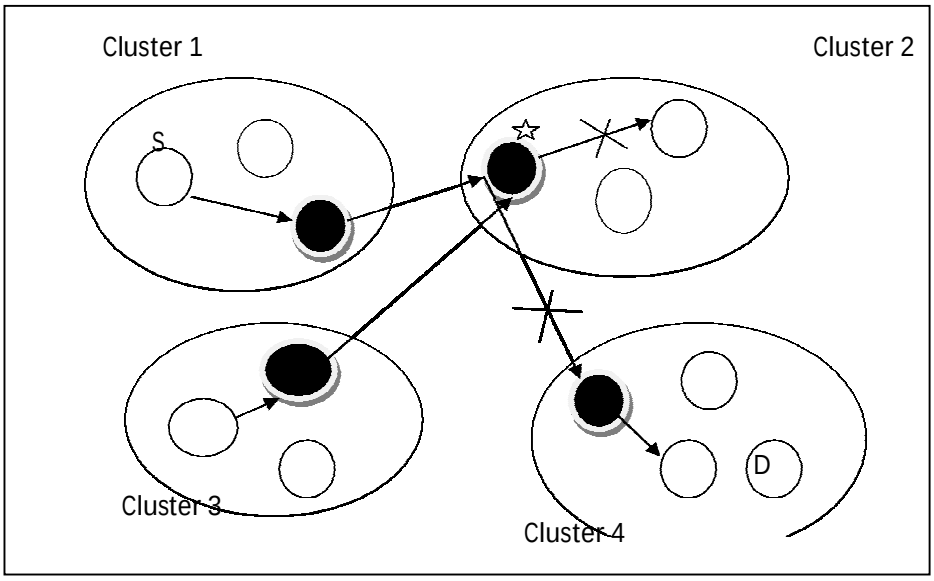

Figure 3.3: A network without synchronous nodes and packet collision

The source of Cluster 1 and cluster 2 send their information to their respective cluster heads. Now their cluster heads forward the information to next cluster head according to the routes.

Here both sources have same route for transfer their data. When the data reaches to the cluster 2's head from both sources at same time here data packets are collide to each other, the data packets are loosed and it do not reach to their respective destinations. The packet re-transmission is necessary to complete the communication.

3.2 Methodology

Firstly we set up the sensor network with unlimited sensor nodes. All the sensor nodes grouped into clusters. According to the sensor nodes these clusters are formed. Each node has a cluster head. Cluster heads are elected by selection algorithm. The node which having maximum energy is chosen as cluster head. All the nodes forward their data to cluster heads and further it forward the data to their respective destinations. For broadcasting, track is searched by AODV protocol. The track is build among transmitter and receiver. Ad hoc On-Demand Distance Vector routing protocol find out the dynamic path. After finding the path, the transmission takes place.

All the sensor nodes should be synchronized with cluster head to avoid the packet collision. There is a sink available at the network. After that there are clusters having cluster head and node in it. First of all, one cluster head will deliver message to the sink. After receiving message sink will minus transmission delay from the message and calculate its current time. Now sink will deliver information to the same cluster head. Now again this cluster head will minus transmission delay from the message and calculate its time. Now we have final delay that is transmission delay of sink– transmission delay of cluster head. Finally, cluster head will set its clock according to the current timing after deducting delay. This process will continue until all the cluster head gets the similar clock. Same process will be applicable to the clock synchronization between cluster head and the node in a cluster.

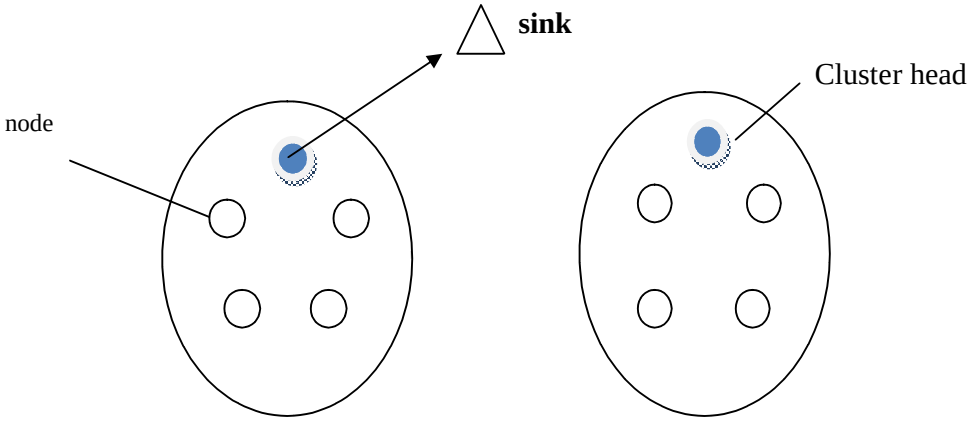

Fig. 3.4 Cluster head deliver message to the sink

In fig. 3.4, cluster head delivers clock message to the sink for synchronization.

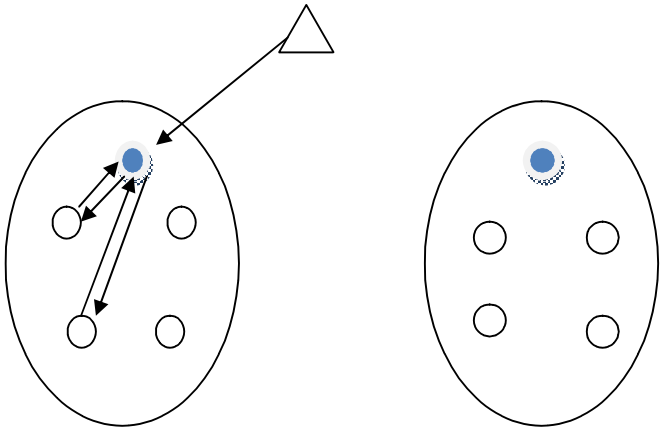

Fig.3.5 Sink sends message to cluster head and for other nodes

In figure. 3.5 sink sends message to cluster head. After receiving message from sink cluster head will minus its delay from the message. For the final clock timing cluster head will calculate final delay and deduct it from the timing. The remaining time will the final time for clock setting. All the other nodes also set their clock by sending data to the cluster head first. Cluster head will calculate time by deducting transmission delay and send message back to node. Now node will calculate time by deducting transmission delay from the message. Again calculate final delay and minus it from the current time. The remaining time will be final time and node sets its clock according to it.

3.3 Algorithm

Base station :

broadcast (Sync_start, level=0)

if receive (Sync_req) then

send (Sync_ack , T1, T2, T3)

Neighbor cluster nodes :

receive (Sync_start , level)

if (level = null) then

{

level++;

wait for short time ;

send (Sync_req, level, T1) ;

```
receive( Sync_ack);
{
record ( T1, T2, T3, T4);
d = ( (T2 -T1) - (T4 -T3) ) / 2;
calculate (d, )
Sync( d, )
}
Broadcast(Sync_start,node=0)
If node(reciver Sync)
{
Clusterhead send(ping)
{
If(Node receive Ping)
{
Send(Ack)
{
Wait for random time
{
Node record(d and d1)
{
IF(d1==d)
{
Node adjust its clock to d
}

Else

{

Reply with Ok message

}
```

3.4 Flow Chart for synchronization

The flow chart of the proposed work is as given. First of all the sensor nodes are deployed in the fixed size region. Then clustering of the sensor nodes is done. By using the bully algorithm the cluster head is selected means that the nodes which have the highest energy that will be the cluster head. The virtual paths are selected between the cluster heads. The shortest path is selected by using the reactive AODV protocol. Here to avoid the collision the NTP protocol is used the clock is synchronized on each cluster head. RFID is used for The master node synchronizes the clock through the GPS (Global Positioning System). The packet loss is avoided by using this technique.

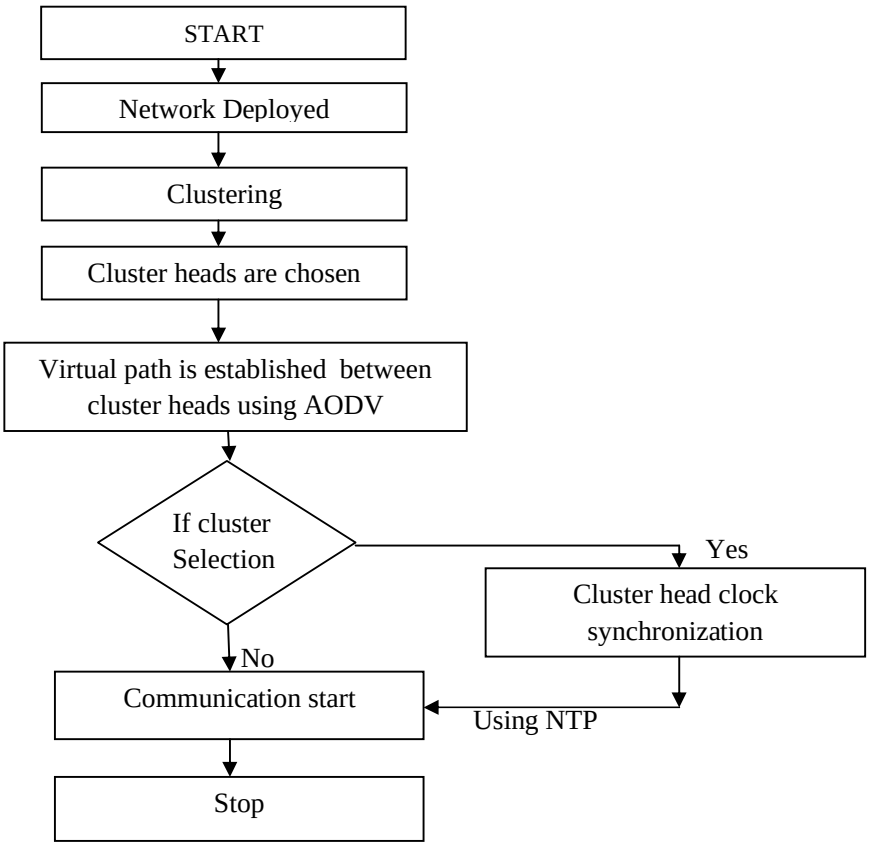

Figure 3.6: flow diagram of synchronization process

CHAPTER-4

4.1 Problem implementation

4.1.1 Network Deployment: The network is deployed with finite number of nodes. The deployed network contains the sensor nodes. The network is deployed at the distant places. The sensor nodes are having the capability to sense the environmental conditions. Each of the sensor nodes have the capability to communicate with every node and the sink which further transmits the data through the internet. Each of sensor nodes contains the sensors which are used for sensing the weather conditions like temperature, pressure, moisture etc.

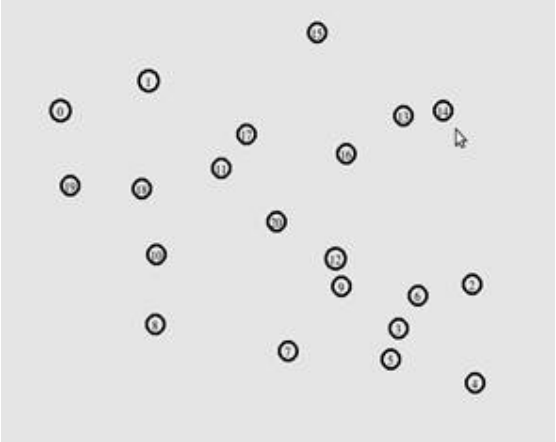

Figure 4.1: Network Deployment

4.1.2 Election for cluster formation: The whole network is separated into the fixed size of clusters. Every node exchanges its location with the corresponding node. These clusters have the capability to communicate with every cluster through single hop or multi- hop method. But to minimize the energy utilization the multi-hop communication is used.

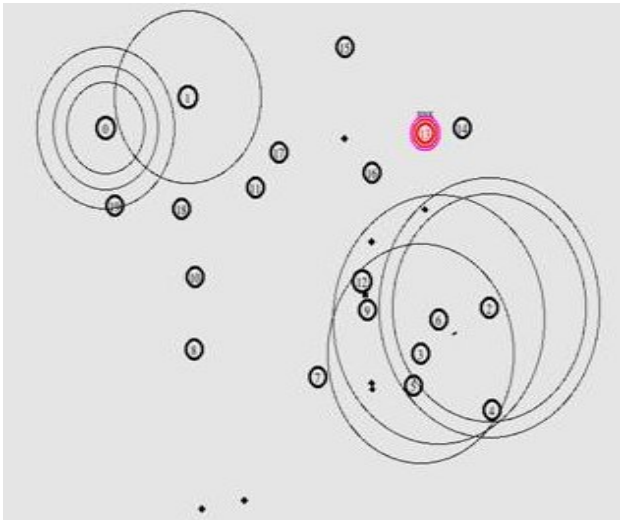

Figure 4.2: Election for cluster formation

4.1.3 Sink Deployment: The sink is deployed in the network to get data from every cluster through the cluster heads. It is deployed in the network for broadcasting the sensed data to the internet.

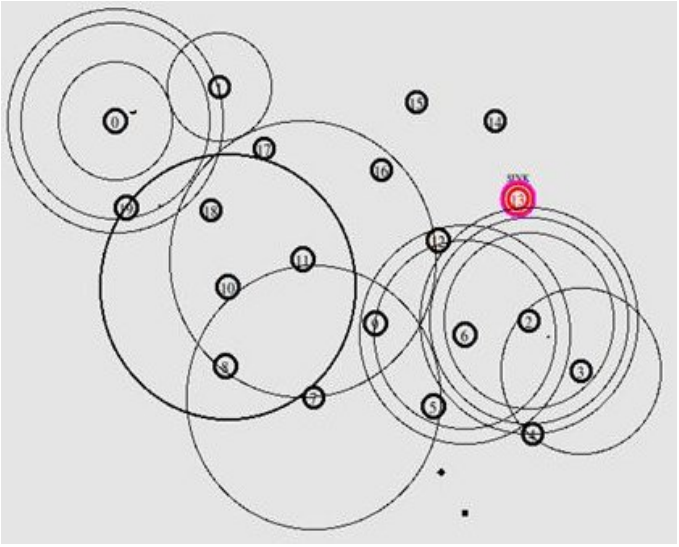

Figure 4.3: Sink Deployment

4.1.4 Cluster formation: The approach of location based clustering is followed and clusters are formed in the network. Here every five nodes form the clusters and there are four clusters.

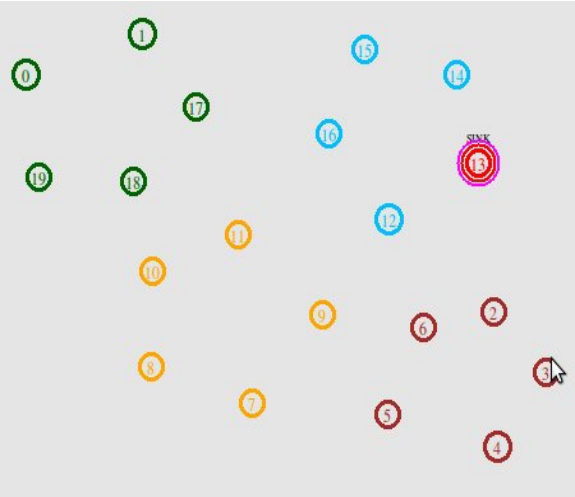

Figure 4.4 cluster formation

4.1.5 Cluster Head selection: When whole network is separated into the finite size clusters. The cluster heads are chosen, the cluster heads are selected on the basis of ID. Every node has equal battery when these are deployed. Every node presents its resources to its corresponding node, which are within the cluster. The cluster heads are elected to broadcast the information to the sink to reduce the energy consumption.

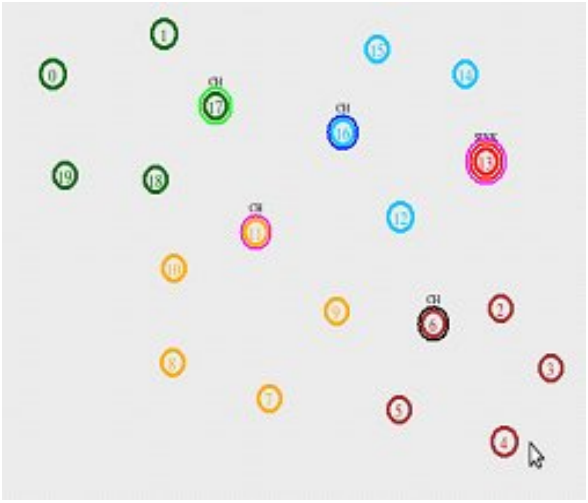

Figure 4.5: cluster head selection

4.1.6 Intracluster communication starts from source 1: The communication is from starts from the one cluster head to other cluster head. The fixed path is defined between the two cluster heads with using DSDV protocol. Cluster head delivers the data to the destination. The source 1 provides the data to the sink.

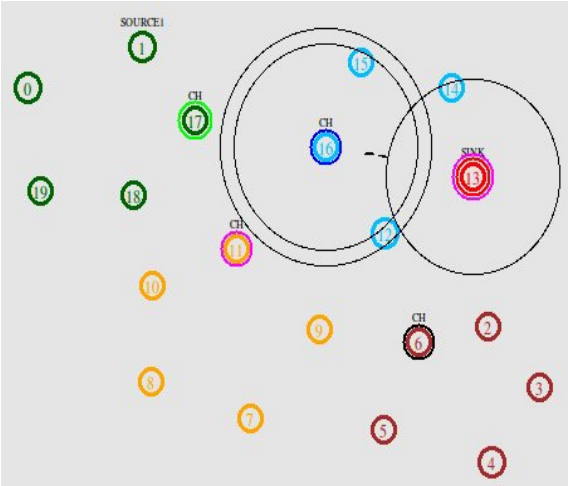

Figure 4.6: Intracluster communication from source 1

4.1.7 Intracluster communication starts from source 2: The communication starts from source 2 to another cluster head and is dependable for delivering the data to the sink. Here source 1 and source 2 transfer the data to the sink through the cluster heads.

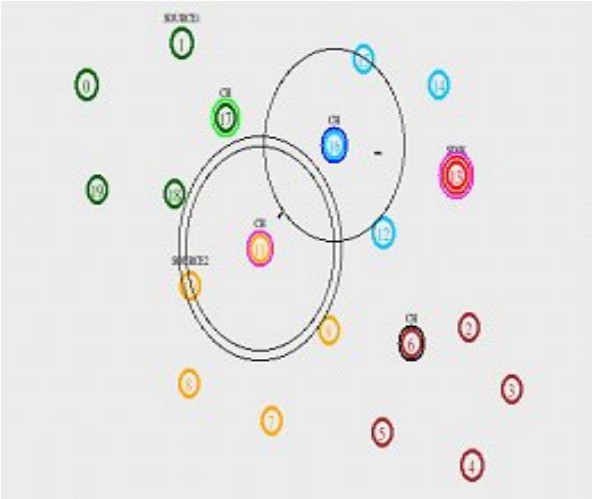

Figure 4.7: Intracluster communication from source 2

4.1.8 Collision of packets: The fixed path creates the problem because there is possibility that two nodes have same path. The RFID is used for channel sensing. The clocks of the cluster heads are mismatch, due to this problem the packet collision takes place and throughput of the network decreased and energy uses increases and overall network life time reduces.

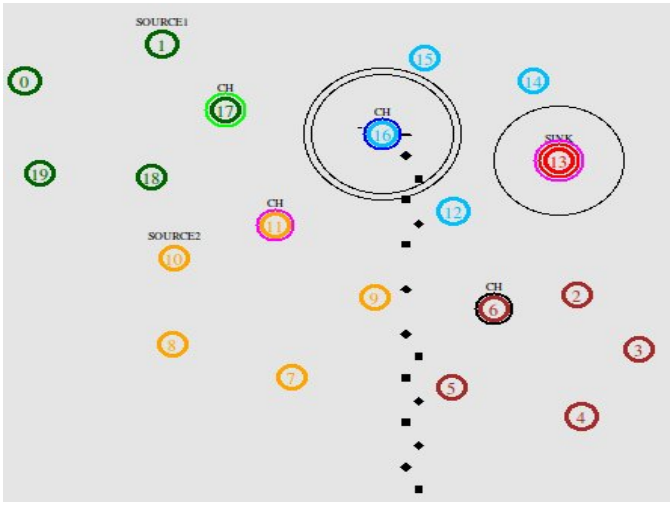

Figure 4.8: Packet Collision

4.2 Solution Implementation:

4.2.1 Network deployment: The network is deployed with the fixed number nodes and sensor nodes responsible for sensing the environment conditions like pressure, temperature, moist etc. every sensor node contains the sensors inside it which senses the environmental conditions. This is then converted into electrical signals and then the processing takes place and the data is then send to the sink.

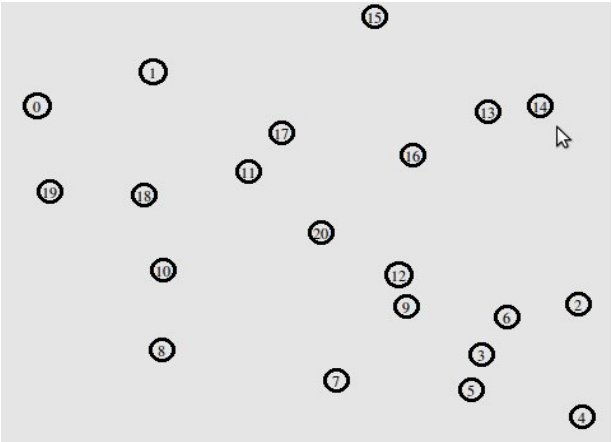

Figure 4.9: Network deployed

4.2.2 Election for cluster: Network is divided into the fixed size clusters using the location based clustering. These clusters are elected to transfer the information further to the sink. The clustering is a superior technique to reduce the energy utilization of the sensor nodes. The multi-hop clustering is mostly used in the sensor networks.

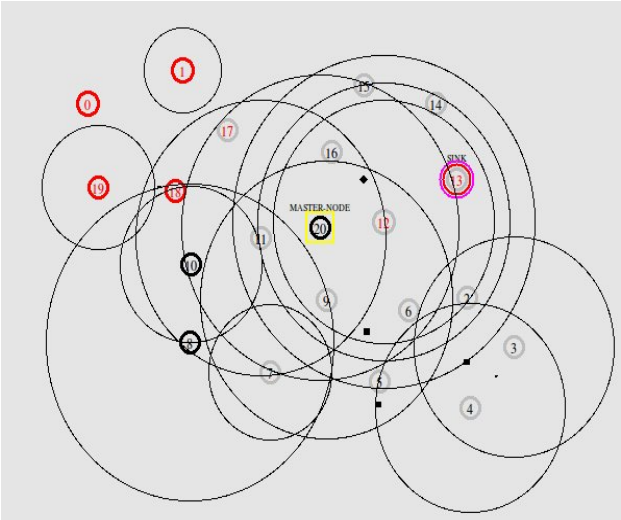

Figure 4.10 Election for cluster

4.2.3: Master node deployed: The master node is arranged in the network and master node synchronizes its clock using Global Positioning System (GPS). The clustering process continues. The master node synchronizes the network. It does not take part in the communication purposes. All the network synchronizes according to the master node.

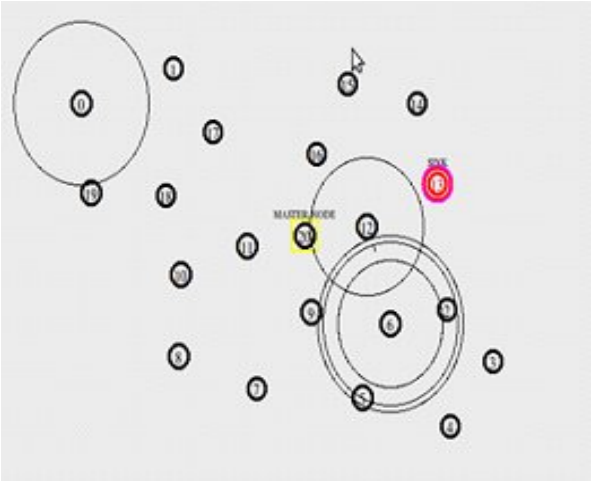

Figure 4.11: Master node deployed

4.2.4 Cluster formation: The network is divided into fixed size clusters and the global positioning system is used to synchronize the clock. The clusters are created in the hexagonal shape because this covers the network more appropriately. There are four clusters and every cluster have the five nodes in the hexagonal shape.

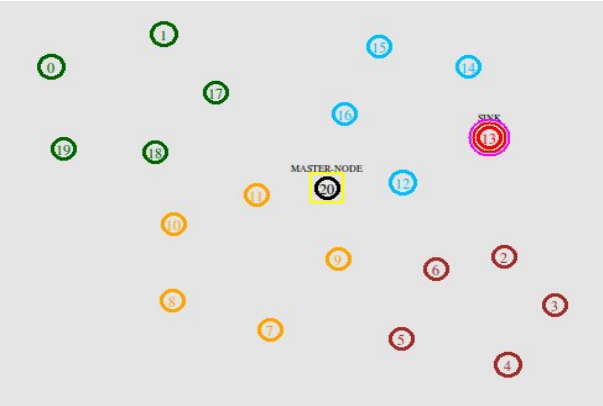

Figure 4.12: Cluster formation

4.2.5 Election for cluster head: The cluster heads are formed in each cluster. The cluster heads are formed with election algorithm. Every node is presents its resources to its corresponding nodes. The nodes which are having higher no. of resources is elected as cluster head. The cluster head is elected the basis of election algorithm (bully algorithm). It means that the node which is having the more battery is elected as a cluster head. If node is having more battery power then there are lesser chances of the change in network topology and the number of election procedures can also be reduced and the battery consumption is also reduced.

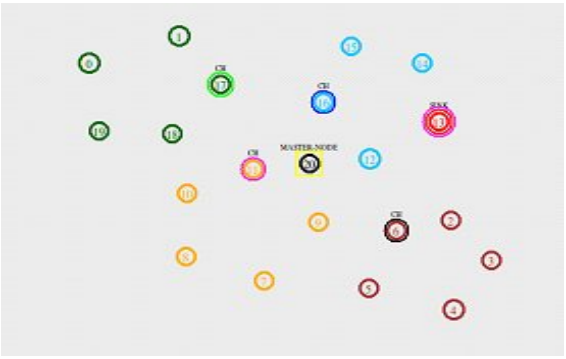

Figure 4.13: Election for cluster head

4.2.6 Synchronization of CH with master node: Cluster head in each cluster synchronizing its clock with the master node. The master node synchronizes its clock according to the Global Positioning System (GPS)

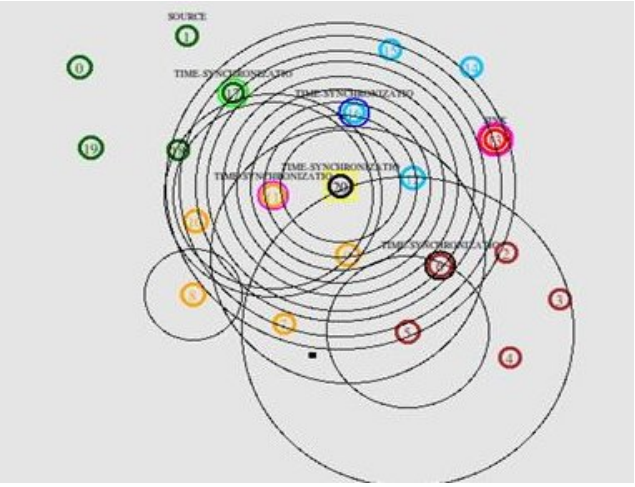

Figure 4.14: Synchronization

4.2.7 Virtual Path Establishment: The virtual path is established between source and sink through cluster heads. The reactive routing protocol AODV is used for path establishment. The source node sends route request packets to the cluster heads. The cluster heads which is having path to destination will reply back with the route reply packets.

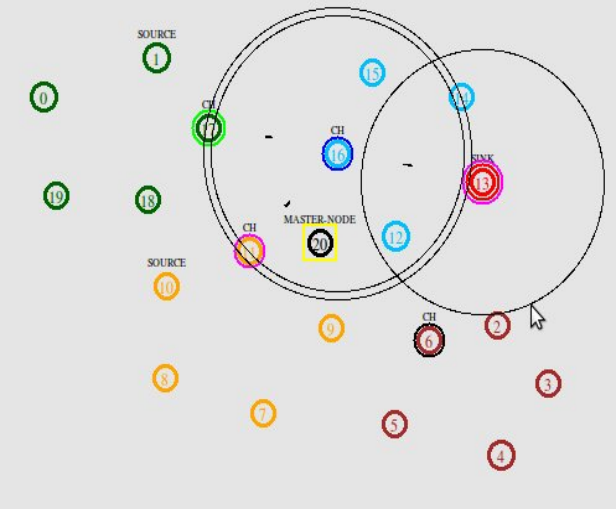

Figure 4.15: Virtual Path Establishment

4.2.8 Intracluster communication: When the path is recognized between source of node and destination of the node. The communication starts. The communication starts from source 1 to another cluster head. Also the communication starts from the source 2 towards the cluster head. And the network is synchronized according to the master node. Now there is no collision between the nodes.

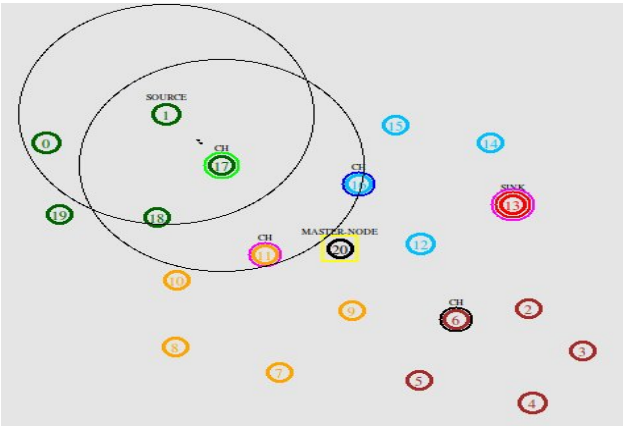

Figure 4.16: Intracluster communication

4.2.9 Channel sensing: RFID protocol is used to sense the channel and when cluster heads clocks are synchronized, the efficiency of the slotted ALOHA increased. By using the master node which is using the network time protocol (NTP). And the efficiency of the network increases. If collision is not present between the packets then no need to put the packets again. The most of the energy is utilized in the communication. If the broadcasting reduced for repeative transmission of data packets then the battery consumption of nodes can also be minimized. Hence there is a less power utilization.

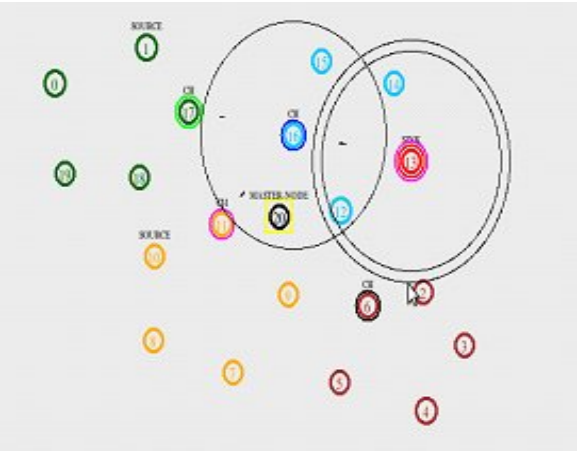

Figure 4.17: Channel sensing

CHAPTER-5

5.1 Simulation Results

5.1.1 Energy Graph: In the below figure, energy consumption of previous and new technique is shown. The red lines show the energy of previous technique. The green line shows the energy consumption in the new proposed technique. The clocks in the previous technique are not synchronized and fixed path are from source to destination. Due to these two reasons retransmission of the packet are required when packet loss is there in the network. In the new technique clocks are synchronized with master clock. The virtual is established between source and destination. The energy consumption is reduced as shown in red line. This graph show that proposed technique is efficient than the existing technique.

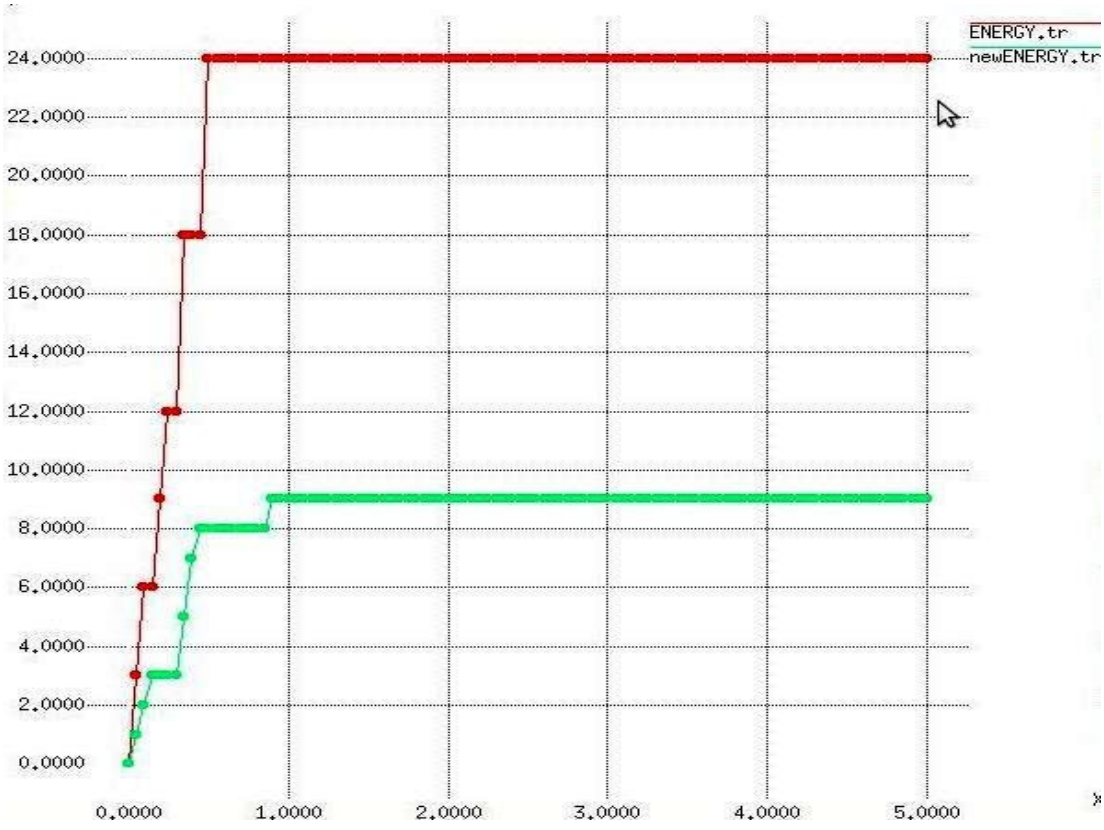

Figure 5.1: Energy graph without synchronization

And with synchronization

5.1.2 Throughput Graph: The figure illustrated the throughput of the new and previous technique. The red line shows the throughput of the previous technique. The throughput of new technique is shown in green line. The efficiency of network is improved with the clock synchronization. The throughput of the network is enhanced through the use of new proposed technique because the loss of packet is minimized in the network.

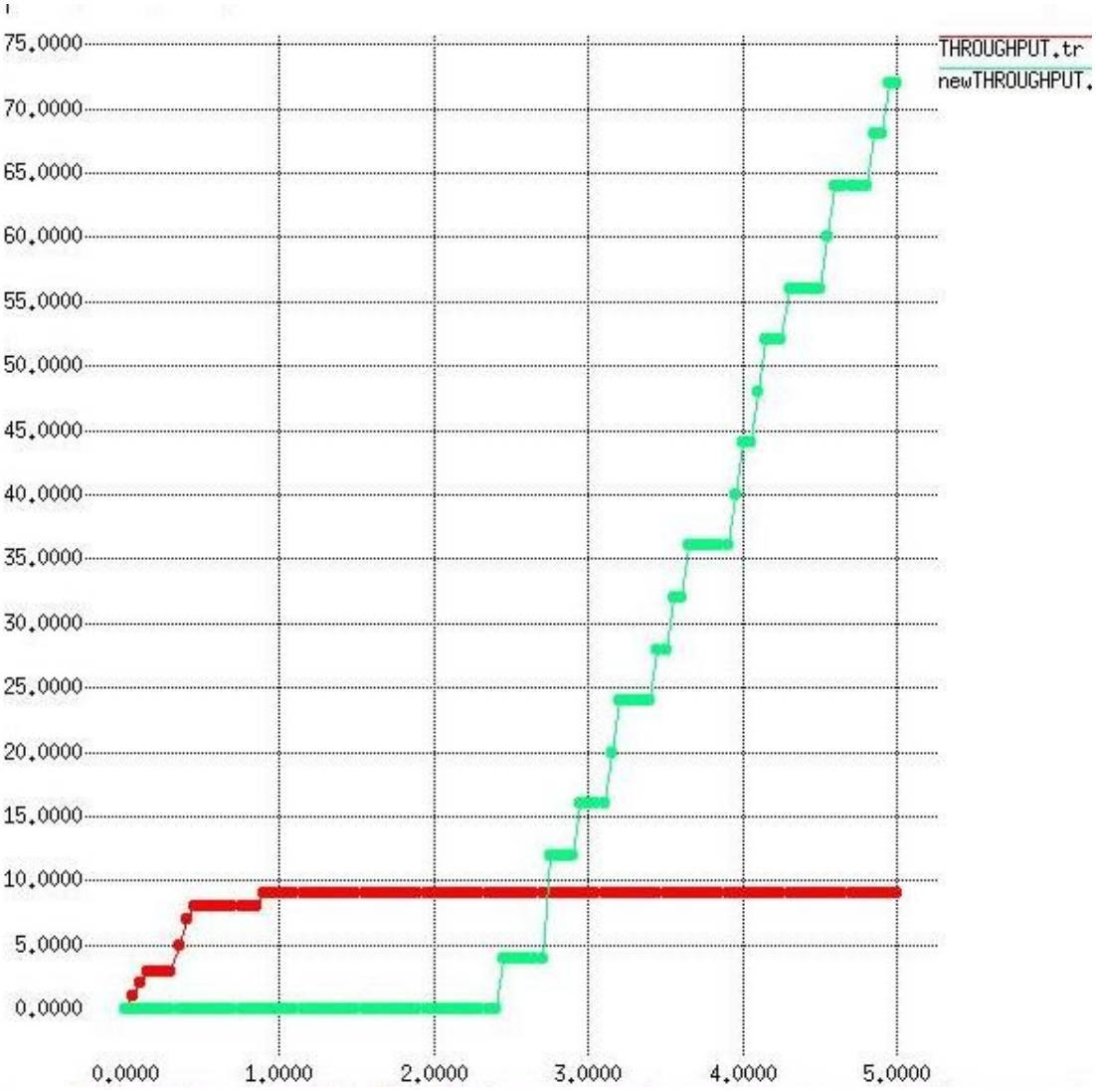

Figure 5.2: Throughput Graph without synchronization

And with synchronization

5.1.3 Packet Loss Graph: The packet loss graphs are shown in the figure. The packet loss is more in previous technique. Clocks of the cluster heads are not timely synchronized in the previous technique. This is the reason that the loss of packet is more in the previous technique. The packet loss in the new technique is reduced, because the clocks of the cluster heads are matched with the master clock.

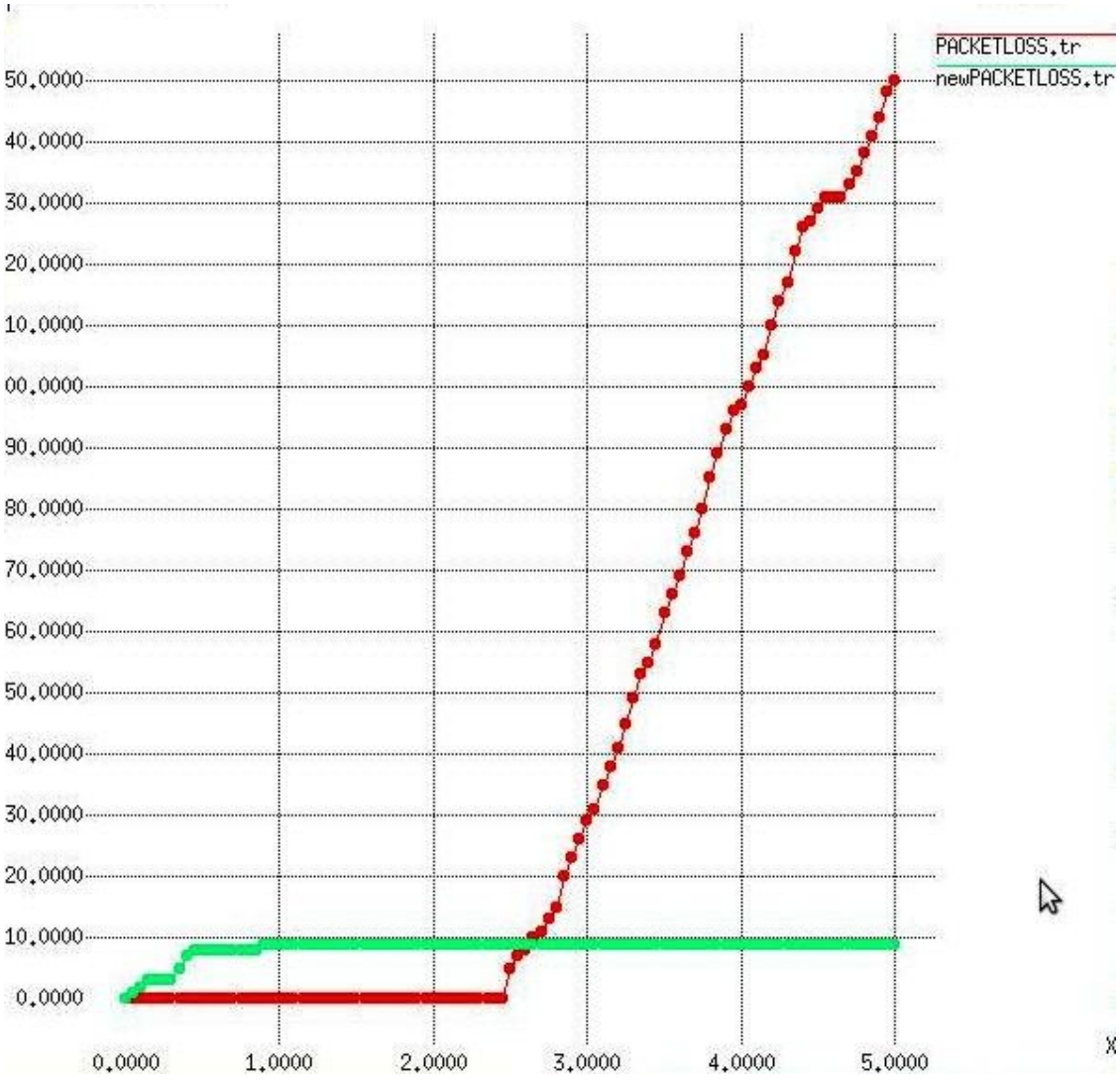

Figure 5.3: Packet Loss Graph without synchronization and with synchronization

CHAPTER-6

Conclusion

In WSNs there is a problem of power consumption. First of all the sensor nodes are divided into the fixed size of area. Then clustering of the sensor nodes is done. By using the HEED protocol the cluster head is selected means that node which has the maximum energy that will be cluster head. The virtual paths are selected between the cluster heads. The shortest path is selected by using the reactive AODV protocol. If the nodes are not synchronized then the energy consumption is high due to retransmission of data and throughput is low due to collision of packets which results in loss of no. of packets and delay increases due to collision and retransmission of packets. In present work, to avoid the collision the NTP protocol is used and the clock is synchronized on each cluster head. RFID is used for the channel sensing to avoid the collisions. The master node synchronizes the clock through the GPS (Global Positioning System). The energy and throughput is reduced which results less loss of packets therefore, delays is decreasing with synchronization of nodes.

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