Chapter 1

Introduction

Wireless Sensor Network:

A Wireless Sensor Network (WSN) is a subset of Ad-hoc network (Figure1.1). There are many restrictions of WSNs as compared to Ad-Hoc network in terms of its sensor node's capability of memory storage, processing and the available energy source. WSNs are generally assumed to be energy controlled because sensor nodes operate with small capacity Direct Current source or may be placed in such a way that substitute of its energy source is not possible. Even though sensor networks are subset of ad-hoc networks, the protocols designed for this networks cannot be used in sensor network due to the reasons cited as follows [1]:

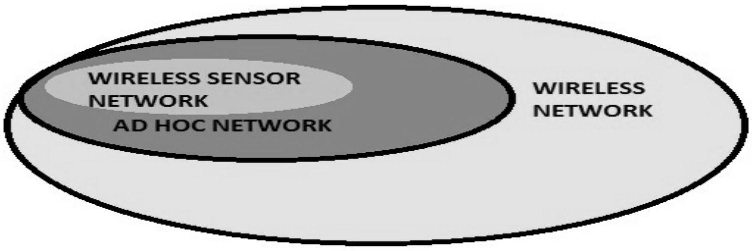

Figure 1.1: WSNs as Subset of Wireless Network

Hrituparna Paul, Priyanka Sarkar, Prodipto Das, "WSNs Performance Analysis through Ad-Hoc Routing Protocols using Qualnet", Eighth International Conference on Communication Networks (ICCN-2014) July 25th to 27th, 2014, Bangalore, INDIA,. ICCN 2014, **Elsevier, pp**. 114–119. ISBN: 9789351072539.##

a. The number of nodes in a sensor network is very large compared to ad-hoc networks. Thus sensor networks require different and more scalable solutions.

b. In comparison to ad-hoc networks, sensor nodes have limited power supply and recharging of power is impractical considering the large number of nodes and the environment in which they are deployed. Therefore energy consumption in WSN is an important metric to be considered.

A WSN consists of spatially dispersed autonomous sensors nodes to cooperatively monitor physical or environmental conditions. After being deployed in an ad-hoc fashion the nodes can communicate wirelessly and have the power of self organization. A WSN [3] may consist of hundreds or even thousands of nodes. Source nodes transmit their data to destination nodes through intermediate nodes. This destination node is connected to a central gateway, also known as BS. Central gateway provides a connection to the wired world where the data can be collected, processed, and analyzed.

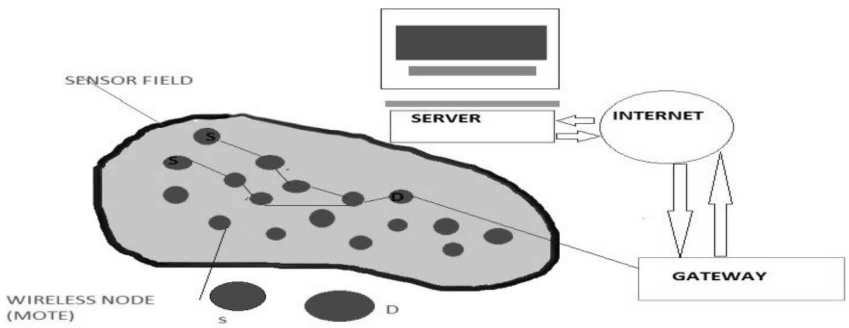

Figure 1.2: A Wireless Sensor Network

The WSN consist of two main components:

a. Sensor Nodes and
b. Base Station (Central Gateway)

Sensor Nodes:

Sensors nodes are typically built of few sensors and a mote unit as shown in Figure1.3. A Sensor is a device which senses the information and passes it on to mote. Sensors have various typical applications such as it can be used to measure the changes in physical environmental parameters like temperature, pressure, humidity, sound, vibration and changes in the health parameter of person e.g. blood pressure and heartbeat. MEMS based sensors have found good use in sensor nodes. A mote consists of processor, memory, battery, A/D converter for connecting to a sensor and a radio transceiver for forming an ad-hoc network. A mote and sensor mutually form a Sensor Node. A sensor network is a wireless ad-hoc network of sensor nodes. Each sensor node can support a multi-hop routing algorithm and function as forwarder for relaying data packets to a base station (BS)

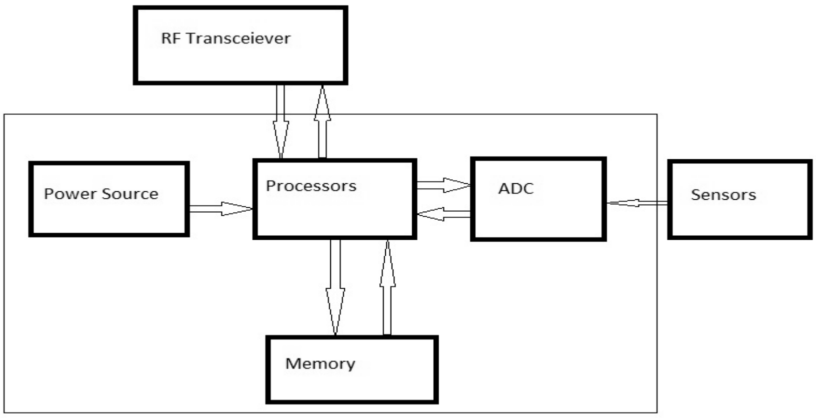

Figure 1.3: Block diagram of Sensor Node

Typically, a sensor node is a small device that includes four basic components: a sensing subsystem for data acquisition from the physical surrounding environment, a processing subsystem for local data processing and storage, a wireless communication subsystem for data transmission and a power supply subsystem which consists of a battery with a limited energy budget. Moreover, various supplementary components can also be incorporated into the sensor node depending on the application. These components include a power generator, a mobilizer and a location finding system. The general hardware architecture of a sensor node [2] is depicted in Figure 1.4 and the components are explained as follows:

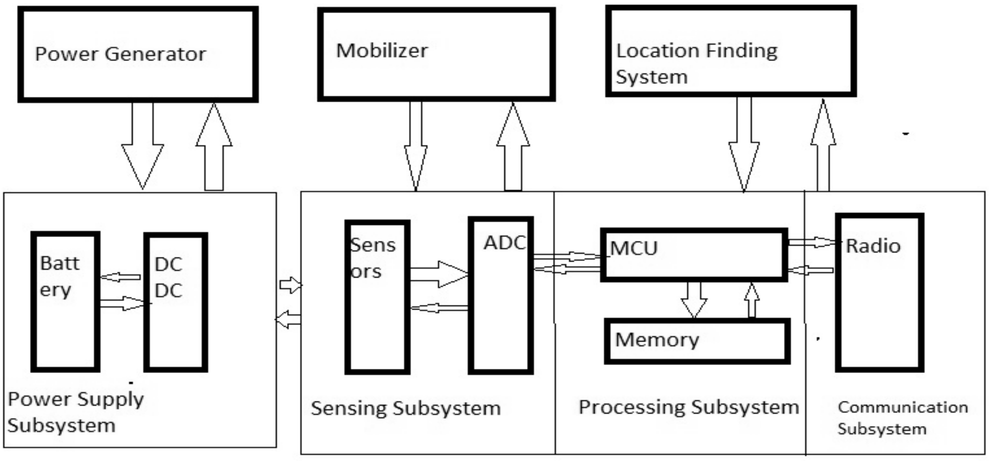

Figure 1.4: Hardware Architecture of a Sensor Node

Sensing Subsystem: It includes several sensing units, which provide information gathering capabilities from the physical world. Each sensor unit has the responsibility of gathering information of certain type, such as temperature, humidity, or light and is usually composed of two sub units: a sensor and an analog-to-digital converter (ADC). The analog signals that are produced by the sensor are converted to digital signals by the ADC and fed into the processing unit.

Processing Unit: The processing unit is the main controller of the wireless sensor node, through which every other component is managed. The processing unit may consist of an on-board memory or may be associated with a small storage unit included into the embedded board. The processing unit is used to manage the procedures that enable the sensor node to perform sensing operations, run associated algorithms, and collaborate with other nodes through wireless communication.

Communication Unit: Communication between any two nodes is performed by radio (transceiver) units. A communication unit performs the necessary procedures to convert bits to be transmitted into radio signal (RF) and recovers them at the other end.

Power Unit: Power Unit is one of the most important components of a wireless sensor node. Usually battery power is used, but other possible energy sources can also be used. Each component in the wireless sensor node is powered through the power unit and the limited capacity of this unit requires energy efficient operation of the tasks performed by each component.

Location finding system: Most of the sensor network applications, sensing tasks, and routing techniques need knowledge of the physical location of a node. This system may consist of a GPS (Global Positioning System) module or a software module that implements localization algorithms.

Mobilizer: If sensor nodes are to be moved so that it can carry out the assigned tasks a mobilizer may sometimes be needed. Mobility support requires extensive energy resources and should be provided efficiently. The mobilizer controls the movement of the sensor node.

Power Generator: While battery power is mostly used in sensor nodes, there are various applications where longer network lifetime is essential in that case an additional power generator can be used.

The main concern for the operation of WSNs is the energy consumption. For most applications, as nodes may be deployed in a hostile or impractical environment, it could be impossible or inconvenient to recharge the battery. On the other hand, the sensor network should have a lifetime long enough to fulfill the application requirements. In many cases a lifetime of the order of several months or even years may be required. Among the components described above, the radio unit is the most important part of sensor nodes due to the reason that it consumes much energy and provides connectivity to the rest of the network.

Base Station:

A BS links the sensor network to another network. It consists of a processor, radio board, antenna and USB interface board. It is pre-programmed with low-power mesh networking software for communication with wireless sensor nodes. As all the sensor nodes handover their data to the BS for processing and decision making so deployment of the BS in a WSN is very important. There are various factors such as energy conservation, coverage of sensor nodes and reliability issues that are taken care of during deployment of BS in sensor network. Generally BSs are assumed static in nature but in some scenarios they are assumed to be mobile to collect the data from sensor nodes. The Crossbow sensor node and BS [3] are shown in Figure 1.5 and Figure 1.6 respectively.

Figure 1.5: A Sensor Node

Figure 1.6: A Base Station Node

Energy Consumption Model:

Understanding and knowledge of cluster is important before discussing the energy consumption model. Clustering is a process of assembling or grouping nodes using an algorithm to perform certain tasks efficiently as per the requirements. Based on certain criteria clustering can also be used to divide the topology into sub-regions e.g. whole area should be covered, minimum energy consumption, maximum lifetime etc.

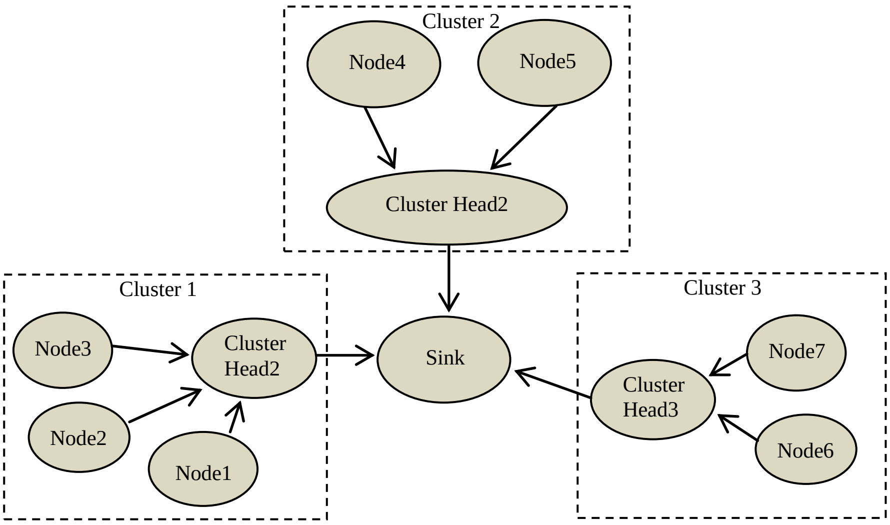

Figure 1.7: Clustering in WSN

In WSNs, CHs are selected from all the nodes. Each node chooses the nearest CH for forwarding packets to BS. All the nodes attached to CH, form the cluster.

Challenging Factors:

There are some challenging factors which are important and have to be taken in notice while designing routing protocols. These include energy consumption, node deployment, scalability, coverage, location awareness, the nature of the nodes, the complexity of the control overhead messages, Quality of Service (QoS) and application. A short discussion is provided for these metrics as follows:

i. Energy Consumption: The main goal of routing protocols is to distribute data among the sensors and sink in an efficient way. Each sensor node consumes energy in sensing, processing, receiving and transmitting information. Data transmission is the most energy consuming task among all the above mentioned task. Since, the sensor nodes have limited energy resources, energy depletion of some nodes results in great topology and network connectivity changes, reorganization of the network and finding new routes. Due to the above reason, there is a need to design routing protocols that can accommodate the tradeoff between energy consumption optimization and accuracy.

ii. Node deployment: Node deployment is very application dependent. Moreover, it influences the energy consumption, coverage, delay, lifetime and the throughput of the network. Node deployment can be manual, randomized or non-uniform. In the first strategy, the nodes have the location deterministically in order to meet the required performance objectives. In manual node deployment, the coverage of the area is satisfied with careful choice of node density. Although, this is a good solution when the nodes are expensive or their operations are influenced by their position (e.g. in underwater application), it is not appropriate for ruthless environments. A good solution for this kind of environment in which the sensor nodes are scattered in the environment randomly is Random deployment.

iii. Scalability: The number of the nodes that are deployed in the field may vary from tens to thousands. To work efficiently with this enormous number of nodes the routing protocol should be scalable when the number of nodes is extensive, it is infeasible that each node maintains global knowledge of network topology. Therefore, scalable routing protocols should be fully spreaded in order to work efficiently with a limited knowledge about the network topology

iv. Coverage: In some cases depending on the application, the sensor networks have to support continuous coverage of the area; the network should be able to provide the data from anywhere at any time in order to fulfill the requirement of application.

v. Location awareness: Some routing protocols require the location information of sensor nodes can be achieved via a Global Positioning System (GPS) or positioning algorithm. Due to this it results in increasing the overhead messages and energy consumption.

vi. Nature of nodes: In WSN, the nodes that are scattered over the environment that can be either homogeneous or heterogeneous which is very application dependent. When the nodes are homogeneous, they have the same capabilities, such as transmission range, battery life, processing power or speed of movement. The heterogeneous nodes have different capabilities, such as different initial energy.

vii. Control messages: The overhead of the control messages exchanged for finding new routes and maintaining existing routes should be kept to the minimum. The control packets can reduce the throughput of the network due to collision with data packets and consume bandwidth

viii. QoS: The routing protocols should also have the ability to provide a certain level of QoS that is required by the application. The QoS parameters can be bandwidth, delivery delay, jitter, and throughput

ix. Application: The routing protocols have the characteristics that they are very application specific. The design of new routing protocols is affected by various factors such as the environmental conditions, network topology and the requirements of the application.

Applications of WSNs:

One of the earliest deployments of a large sensor network was carried out in the summer of 2002 on Great Duck Island [4] to enable non-intrusive and non-disruptive monitoring of sensitive wildlife and habitats. The Island is home to Leaches Storm Petrels that nest in separate patches within three different habitat types. A sensor network of 32 nodes was deployed for monitoring the micro-climate in and around the nesting burrows and the data made available to the researchers over the Internet. Sensor networks have been applied to structural health monitoring of mechanical systems like studying vibrations on the BriMon [5].

WSNs for health care have emerged in the recent years. SMART [6] is an integrated wireless system for monitoring unattended patients. A sophisticated wireless sensor node was employed for monitoring patients with Parkinsons Disease [7]. An in-depth clinical trial was carried out to assess the feasibility of a reliable patient monitoring system using

WSNs [8]. MediSN [9] is a sensor network multi-hop system for monitoring patients' vital signs in hospitals and disaster events.

WSNs have motivated a large number of researchers in the field of precision agriculture. It can play an important part in the handling and management of water resources for irrigation, in understanding the changes in the crops to assess the optimum point for harvesting, in estimating fertilizer requirements and to predict crop performance more accurately. The capacity of WSN devices to collect measured values in broad ranges of soil and environmental conditions has been demonstrated [10]. The developed system helped to successfully monitor a crop of ecological cabbage for the entire growing season with the required precision. The growing conditions of vegetables in a green house were examined by monitoring temperature in the green house, soil temperature, dew point, humidity and light intensity [11].

Real-time tilt monitoring of landslide prone slopes by sensor networks will provide immediate notification of landslide activity, potentially saving lives and property. A sensor network using a collection of instruments is proposed to detect ground movements and collectively estimate the displacements of sensor nodes embedded in a hill under observation [12]. Real-time monitoring of landslide using sensor networks is also discussed in [13]. AMRITA University of India has deployed India's first landslide detection system using WSNs at Munnar, Idukki, Kerala, India. [14]. There are other successful systems developed for various applications like automatic people counting, ZebraNet for tracking zebra movements, volcano monitoring [15] and understanding micro-climates in redwood canopies.

1.1 Motivation:

The vast number of solutions that have driven the research community over the years made WSN phenomenon a reality. However, their explosion has so far been limited to the research community with just a minimum number of commercial applications. The major challenge for the proliferation of WSNs is energy. Extremely energy efficient solutions are required for each aspect of it's design to deliver the potential advantages of the WSN phenomenon. Therefore, in both existing and future solutions for WSNs, energy-efficiency is the major challenge. Routing protocols for sensor networks should try to minimize energy consumption in order to maximize the network life time. Among the many routing protocols that have been developed for WSNs, the cluster-based protocols claims more energy-efficiency compared to others [16]. These classes of protocols are most suitable for applications like habitat monitoring which require continuous stream of sensed data. The most interesting research issue regarding cluster based protocols is how to form the clusters so that the energy consumption is optimized.

Clustering is one of the basic approaches for designing energy efficient, robust and highly scalable sensor networks. Clustered organization dramatically reduces the communication overhead, thereby minimizing energy consumption and interference among the sensor nodes. Moreover, by aggregating the sensor's data at a designated node called CH, the total amount of data to the BS can be reduced, saving energy and bandwidth resources. Since most of the clustering protocols are based on local properties, clusters generated by these protocols are often not optimal. In this backdrop, the question how to create load balanced energy-efficient cluster assumes greater significance. Each clustering algorithm is composed of two phases namely, the setup phase and steady state phase. The major issue in these algorithms is the CH selection. Many approaches based on different criteria are suggested by researchers [17, 18]. Many clustering algorithms require re-clustering after a round of the protocol operation, causing extra energy consumption [19, 20]. It is worth to investigate a way to reduce this extra energy consumption.

In static networks, the mobility of sensors, users and the monitored phenomenon is totally ignored. It is interesting to note that several applications of sensor networks are inherently mobile [21]. So, the next evolutionary step for sensor network is to handle mobility in all its forms. One motivating example could be a network of environmental monitoring sensors, mounted on vehicles used to monitor current pollution levels in a city. In this example, the sensors are moving, the sensed phenomenon is moving and the users of the network move as well. Many protocols for WSNs proposed in the literature assume that nodes are static. The effect of mobility on the performance of these protocols is of prime importance in designing of mobile WSNs. Mobility of nodes can lead to disconnection of cluster members from their CHs causing data loss. In a given mobility scenario, one can ask for an appropriate mechanism to select the CH so that the data packets reach the BS successfully.

The vision of sensor web is to have worldwide integrated sensor network that may provide the functionalities similar to those available through the Internet. Various types of web-resident sensors, instruments, image devices, and repositories of sensor data should be made discoverable, accessible, and controllable via the World Wide Web. However, the effort needed to develop such applications is enormous due to the fundamental characteristics of sensor networks. Service Oriented Architecture (SOA) has been considered as a felicitous candidate for developing open, efficient, inter-operable and scalable sensor network applications [22]. The node sensing capability is presented as an in-network service and presented as a modular discoverable service. Also, the application developers compose services into applications and into other services. It is desired to use the framework based on SOA to develop an application which deliver the sensor data to the end user in a flexible way.

Recent advances in technology have witnessed an increasing in using WSNs in many applications, including environmental monitoring and military field surveillance [16]. Unlike general purpose data communication networks, WSNs are typically designed for a specific domain of applications. In these applications, hundreds to thousands of low cost sensors are deployed and periodically report physical information such as temperature, pressure, humidity, light, and chemical activities. Many WSNs applications require only the aggregated value at certain region. In this case, sensors in different positions in a certain region can collaborate to aggregate their data and more efficiently report their information. Data aggregation reduces the communication overhead in the network, leads to meaningful energy savings. In order to support such data aggregation or network topology control, nodes can be partitioned into a number of small groups called clusters. Clustering has been considered as an effective approach for organizing the network into a connected hierarchy. Besides achieving energy efficiency, a well designed clustering mechanism can reduce packet collisions between nodes so that it results in better network throughput under high load conditions. Many localization algorithms [17, 18] and clustering approaches [19-22, 14, 15] for WSNs have been proposed. Each cluster has a coordinator, referred to as a CH, and a number of member nodes (MNs). The MNs report sensing data to the respective CHs. The CHs not only perform sensing the environments, but also collect the data from MNs and relay the aggregated data to a sink through gateways (GWs) [19] or other CHs [21, 22].Clustering in WSNs causes several issues, such as ensuring connectivity and scheduling inter-cluster communications.

In this work, we propose a location-aware Cluster Based Routing (LACBRP) algorithm to handle these problems. It is one of the clustering approaches used to minimize the energy dissipation [23]. It provides balance in the energy consumption and prolongs network life-time. Here in this work, by knowing [24] the location of a sensor node, cluster the sensor nodes based on the highest energy and least distance. In that group of nodes, one node is select as a CH. This is to avoid communication over head between the sensor nodes. Clustering of nodes shows that the network is more stable and efficient. This increases the overall network lifetime and reduces traffic of the network. Each node in a cluster can directly communicate with their CH. The CH can forward the sensed information to the BS through other CHs. There is 1-hop communication between a node and the CH. Further, CHs can communicate with each other or directly to the BS, and there is multi-hop communication between the BS and the CH.

Our Proposed Algorithm uses three phases in WSNs. In the first phase, the location information of each sensor node is computed by using the localization algorithm such as Trilateration, Triangulation etc; in the second phase, the sensor nodes are clustered to minimize the residual energy and maximize the network performance then the CH is elected based on the minimum distance between the cluster node's and the centroid; in the third phase, Routing takes place between the CH and the cluster members and also between the CH and the BS.

1.2 Objective:

The main objective of the work reported in this thesis is to design and develop Energy efficient routing schemes for static WSNs. A routing scheme is said to be energy efficient if it ensures both low average energy consumption over time and smaller standard deviation of energy consumption of sensor nodes. Such a scheme should aim for one or more aspect of the following: Minimizing the total energy spent in the network, minimizing the number of data transmissions, maximizing the number of alive nodes over time or balancing the energy dissipation among the sensor nodes in the network. It is very difficult to achieve all these goals at the same time. The WSN design often employs some approaches as energy-aware techniques, data aggregation, clustering and multi-hop communication to extend the network life time. Moreover, when mobility is added as an extra dimension to WSNs, it is also important that the scheme should ensure successful data transmission from node to BS.

Rather than the designing of an Energy Efficient Reliable Location Aware Cluster Based Routing Algorithm we also simulate this algorithm in NS-2.35 simulator. This Simulation work is done using Routing Parameters like Energy Consumption Value, Latency Value, PDR Value and Residual Energy Value.

We also discussed in detail and did an analytical study of three prominent cluster based routing protocols and their advantages and disadvantages are highlighted. The routing protocols are followed:

LEACH: Low Energy Adaptive Clustering Hierarchy proposed by Heinzelman et al. [19] is one of the well -known cluster-based routing algorithm. LEACH is a self-organized and adaptive clustering protocol that uses randomization in order to distribute energy equally among the network.

BSP: The objective of this Base Station Positioning Routing Algorithm is to minimise the overall energy consumption in a WSN and find such a BS location .Considering some nodes to be far enough to use a different path loss model for their signals to the BS, here proposed algorithm considers two categories of nodes and hence two different path loss models based on their distance from the BS. The optimal location of a BS can be analysed with respect to minimum energy expenditure or maximum lifetime of a sensor network.

BEC: Energy-Balanced Routing Method Based on Forward-Aware Factor algorithm quantify the forward transmission area, define forward energy density, which constitutes forward-aware factor with link weight, and propose a new energy-balance routing protocol based on forward-aware factor (FAF-EBRM). Thus balances the energy consumption, prolongs the function lifetime.

We also simulate these three cluster based routing protocols i.e. LEACH, BSP and BEC in NS-2.35 simulator using Routing Parameters like Energy Consumption Value, Latency Value, PDR Value and Residual Energy Value.
And then compare these three based routing protocols i.e. LEACH, BSP and BEC using Routing Parameters like Energy Consumption Value, Latency Value, PDR Value and Residual Energy Value in NS-2.35.

1.3 Methodology:

Recent advances in radio and embedded systems have enabled the proliferation of WSNs. They are extensively being used in different environments to perform various monitoring tasks such as search, rescue, disaster relief, target tracking and a number of tasks in smart environments. In many such tasks, node localization is inherently one of the system parameters. Node localization is required to report the origin of events, assist group querying of sensors, routing and to answer questions on the network coverage. So, one of the fundamental challenges in WSN is node localization and energy consumption technique.
In the beginning, research work on communication networks involved both experimentation and mathematical modeling to prove feasibility and to establish bounds on expected performance of computer networks. However recently the computer networks have gone through a rapid revolution and have become too complicated for mathematical analysis. Computer-based simulation plays a significant role in the research work to help the researchers and network designers to understand the behavior and performance of the networks and its protocols. Computer simulation is often used to test

the planned capacity of networks and to meet customer requirements. In addition, simulation is also used to explore a wide range of potential protocol designs through rapid evaluation and iteration [23]. However, different simulators require variable time, memory and computation power for evaluating proposed protocols/techniques. In this modern era of technology, the advancement and development specifically associated with network simulators make them a significant tool for enhancing fundamental understanding in the field of next generation wireless network technologies, worldwide. Network simulators provide consent to investigators and developers to test diverse scenarios with an ease that are very tricky, intricate or expensive to simulate in real world. These are proven to be incredibly effective and efficient in developing basic knowledge by analyzing distinct layers of the hypothetical as well as real-life objects. It is of the most important to test a newly proposed protocol in a real-world before actual placement.

Several routing protocols for sensor networks have been developed and currently widely. To achieve the multipurpose properties, our proposed protocol will be tested by running over AODV. Another famous routing protocol i.e. LEACH, BSP and BEC protocol may also be involved in the experiment. The standard MAC protocol will be used as a link layer.

In some situations, a user may access sensor networks via the internet to see sensory data or use such services provided by an application. Finally, visualized and animated results are required in order to nicely understand protocol behaviors.

There currently exist a vast number of simulators for networks. A survey conducted by Mishra [24] lists a total of 42 different network simulators. Different Routing protocols such as LEACH, BSP [25], BEC [26] etc simulated using these simulator. Many network simulators are currently available such as TOSSIM [27, 28, 29], OMNeT++ [30, 31, 32], NS2 [33], OPNET [34, 35], GloMoSim [36], J-Sim [37], SENS [38, 39], SENSE [40, 41],

The Network Simulator – ns-2:

Amongst the existing network simulators, ns-2 [42] is an open-source, discrete-event simulator and is one of the most widely used tools in the networking research community. It was developed within the VINT project in 1995 which attempted to provide an efficient simulation tool to facilitate new protocol design [43]. Current ns-2 users come from several universities and research communities. It also provides much useful information on its website [44] such as downloading and installation guides, examples, tutorials and on-line manuals, development help, and mailing lists. Moreover, ns-2 includes an application module named Network Animator (nam) to provide a visualisation result. Energy consumption and depletion are essential data for operational lifetime analysis; battery and power model have been included to reflect the current energy level of mobile node.

Statistics says about 70% education purposes use ns2. It is open source, discreet event simulators for computer networks. NS2 code comprises of OTCL and C++. OTCL is an interpreter used to execute the commands. NS2 follows two levels of hierarchy namely C++ Hierarchy and the interpreted OTCL, which is one to one correspondence. Two languages are linked because to achieve efficiency. C++ Hierarchy allows faster execution and to achieve efficiency. This gives detailed description, definition and operation of protocols, packets and processing time. On the other hand OTCL enables user to define network topology, protocols, applications that user tend to simulate. OTCL can make use of compiled C++ Object through an OTCL linkage [1]. OTCL Linkage creates a matching between OTCL and C++ Objects. Whenever a tcl file is executed it produces two outputs or two files namely trace file and namfile. Trace file differs for both wired and wireless scenario. It defines the event discreet simulators. It records the data for each millisecond and gives an output regarding packets send, received, dropped, initial energy of nodes, consumption of energy for transmitting, receiving, idle power, sleep power. It denotes the traffic model, simulation packets, packet size, and mac address.

Nam file is a visual graphical window which shows the node movements, radio range, and packet transfer including time. Trace file can be given input to a new scenario file called NS- VISUAL TRACE ANALYZER [45].

Apart from ns2, tcl code can be generated using four most important network tools like

1. nscript
2. NSG JAR File
3. Mannasim generate
4. TCL 830.exe

The above tools are user graphic tool to generate tcl node. The drag and drop components like Node, link, traffic, applications, parameters are predefined. NSG Jar file is a java applet file which has inbuilt java code for nodes, links, application, agent and parameters. As explained different drop-down boxes with options to create nodes , agents , link and parameters like range , energy , Link layer , antenna can be modified. nscript and Mannasim are similar like NSGJAR and drawback for those three tools is that we can't add any new protocols, C++ Code into the files. NS2 can be executed only in Linux platform and windows needs Cygwin platform. To execute ns2 in windows environment we need a special tool called TCL 830.Exe, nam.exe and ns.exe. It enables to run the tcl command in windows command prompt. Again the main drawback of the tool, we can't include C++ Codes. The above tools are not simulators, but just an alternative and easy solution to generate tcl codes. For adding new routing protocols, modifying existing protocol we should stick to ns versions like ns2.29, 2.34 2.35. TCL codes were created by John Ousterout.

Although ns-2 is a powerful network simulator, some researchers claimed it has some drawbacks for simulating WSNs [3, 28]. An object-oriented design in ns-2 may introduce some unnecessary interdependence between modules which may lead to difficulties in a new protocol addition [3]. Finally, ns-2 has been developing for about 10 years; it has quite a large and expanding infrastructure which leads to a steep learning curve for a novice user.

1.4 Major Contribution:

WSNs offer the opportunity to apply computer science concepts to obtaining measurements in challenging environmental field settings. It has unlimited potential for numerous application areas including environmental, health-care, military, transportation, entertainment, home automation, traffic control crisis management, homeland defense, and smart spaces.

There are several schemes to study WSNs. Analytical study seems to be difficult because of the high varying characteristics of a network. A small-scale testbed in a lab and full-scale deployment may be costly because the price of a sensor is quite high. Further, a large number of sensors will be in an experiment because a sensor is prone to failure and easily runs out of energy. Network simulation is considered to be cost-effective way to gain a preliminary result with some limitations.

In our work, a detail simulation survey of the different clustering algorithms considering Energy Consumption Value, Latency Value, Packet Delivery ratio and Residual energy are being presented for energy constrained WSNs. Simulation results are discussed to describe the effect of CH selection and the size of the cluster based on the parameters like Energy Consumption Value, Latency Value, Packet Delivery ratio and Residual energy.
In our experiments, the existing protocols will be evaluated by using ns-2. The various strengths and weaknesses of each protocol will be concluded. The obtained results will help in designing the new protocol. Applying the Energy Efficient Protocol will bring about several interesting issues such as energy consumption which should be investigated.

The experimental study will be based on comparison amongst existing protocols. Three protocols including LEACH, BSP and BEC will be run over routing protocols (AODV) included in the ns-2. By stating the required routing protocol in a command script, differences in output could then be observed.

1.5 Thesis Organization:

This thesis will organize in the following structure.

Chapter 2 describe about review of literature

Chapter 3 is a systematic survey on existing routing protocols for static and mobile WSNs. LEACH protocol and various schemes based on this single protocol in the literature are also given. Then Simulation work is done using Routing Parameters like Energy Consumption Value, Latency Value, PDR Value and Residual Energy Value in ns-2.

Chapter 4 discusses the Base Station Positioning Routing Algorithm of basic routing schemes. An analytical study and simulation work is done in ns-2.

Chapter 5 discusses the Energy Balanced Routing Algorithm basic routing schemes. An analytical study and simulation work is done in ns-2.

Chapter 6

Provides detail about the proposed routing scheme i.e. Location aware cluster based routing scheme is implemented and describes the algorithm used which included system architecture and detailed design of various phases involved in this proposed work.

Chapter 7 Deals with the performance evaluation and describes the results.

Chapter 8 Deals with the conclusion and scope of future work.