"Performance Analysis of Wireless Sensor Networks"

A PROJECT

Submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION

Under the supervision of

Mr. Alok Kumar

(Assistant Professor)

By

Amit Kumar Tiwari (141026)

Aman Singh (141063)

Shreya Gupta (141065)

to

Jaypee University of Information Technology

Waknaghat, Solan -173234

Himachal Pradesh, INDIA

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"PERFORMANCE ANALYSIS OF WIRELESS SENSOR NETWORKS"** in partial fulfilment of the requirements for the award of the degree of B.Tech in Electronics and Communication Engineering and submitted to the Department of Electronics and Communication Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Amit Kumar Tiwari (141026), Aman Singh (141063) and Shreya Gupta (141065)** during the period from August 2017 to May 2018 under the supervision of **Mr. Alok Kumar**, Department of Electronics and Communication Engineering, Jaypee University of Information Technology, Waknaghat.

Amit Kumar Tiwari	Aman Singh	Shreya Gupta
(141026)	(141063)	(141065)

The above statement made is correct to the best of our knowledge.

Mr. Alok Kumar

Assistant Professor

Electronics and Communication Engineering

Jaypee University of Information Technology, Waknaghat, India

Dated:

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"If words are to be symbol of undiluted feelings and token of gratitude then let the words play the heralding role of expressing my gratitude".

A successful project is a fruitful culmination of the efforts of many people. A project is therefore incomplete if one fails to acknowledge all those individuals who have been instrumental in successful completion of the same.

When writing this acknowledgment, we must definitely mention that we have been extremely fortunate to have **Mr. ALOK KUMAR** as our project guide. We greatly acknowledge his profound knowledge and advice in each and every stage of our project, sacrificing his valuable time for us.

At last we are thankful to all those who are directly or indirectly related to this project.

Thank You

Amit Kumar Tiwari (141026) Aman Singh (141063) Shreya Gupta (141065)

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ABSTRACT

Wireless sensors are extremely dispersed networks of various sensing devices, randomly deployed for sensing the physical world. Sensor nodes are generally operated with limited power supply. The energy consumption during the data transmission from a sensor node to destination raises as an essential issue in developing satisfactory sensor networks over a wireless medium as well as implementation of efficient routing protocols.

Even after 16 years of existence, low energy adaptive clustering hierarchy (LEACH) protocol continues to be gaining the eye of the research department operating within the space of wireless sensor network (WSN). The importance of these protocols can be visualized. Numerous and diverse modifications in the LEACH protocol have been made till date by the researchers. LEACH protocols are implemented successfully from single hop networks to multi-hop network scenarios. In depth work has already been done associated with LEACH and it's a decent plan for a brand new analysis within the field of WSN to travel through LEACH and its variants over the years.

In this project, we have implemented an enhanced cluster algorithm called E-LEACH to strengthen the hierarchy based routing protocol and have compared performance parameters of different routing protocols namely Dynamic Source Routing (DSR), Destination-Sequenced Distance Vector (DSDV) and Ad Hoc On-Demand Distance Vector (AODV) using NS-2 simulator

MOTIVATION

A wireless sensing element network (WSN) may be an assortment of huge numbers of sensing element nodes with restricted sensing, computing and communication capabilities. These sensors are unit deployed over an oversized space with one or quite a one Base Station (BS). WSN has wide application potentialities, like temperature, pressure, humidness and home ground watching, disaster management, military intelligence operation, forest fire-tracking, security police investigation and lots of others. In most eventualities, sensing element nodes are units indiscriminately deployed with restricted battery power. The choice of routing techniques is certainly a crucial issue for the economical delivery of detected information from its supply to the destination. The routing strategy employed in these kind of networks ought to guarantee minimum energy consumption as battery replacement in sensors is quite difficult. Plenty of energy efficient routing protocols are planned and developed for WSN, counting on their applications. Planning a routing protocol is choked with challenges, principally restricted power, low information measure, low process power, no typical addressing theme, process overheads and organization of the sensing element nodes [1].

The typical configuration of such a device node during a WSN includes single or multiple sensing components, an information processor, communication parts and an influence supply. Normally, the sensing components perform measurements associated with the conditions existing at its close surroundings. These measurements square measure remodelled into corresponding electrical signals and square measure processed by the info processor. A device node makes use of its communication parts so as to transmit the info, over a wireless channel, to a base station (a sink node). By utilising such a configuration, device nodes in such WSNs have resource constraints like restricted energy, low storage capability, and weak computing ability. Thus, associated economical energy saving protocol is needed to prolong the network lifespan [2].

LIST OF FIGURES

CHAPTER 1

WIRELESS SENSOR NETWORKS

INTRODUCTION

Due to recent furtherance in microelectronics technologies, wireless sensor networks (WSNs) became a substantial segment of day to day life. It is because of depletion in the cost of sensor equipment's, enhancing the deployment at next level. WSNs have a significant number of sensor nodes in small sizes having sensing devices, antennas, and battery-driven node. WSNs have potential to monitor the external surroundings. WSNs includes sizable amount of sensor nodes that are tiny, low priced and battery operated. WSNs are mainly employed in miscellaneous applications such as defence surveillance, border immunity, weather observance, surroundings observance, healthcare monitoring, etc. These applications consumed less energy and need directly information from surroundings. WSNs networks are placed in the rough atmosphere. Therefore, it's quite impossible to charge or switch the sensor nodes battery, so it's important to design communication protocols such that energy supply is employed effectively and therefore, minimize the delay between networks [8].

Sensor nodes sense the surroundings, gather the info from its external environment and forward it to the base station (BS). Out of the 3 tasks transmission of data takes a great deal of limited power of a sensor node, so the data transmission is our main concern. We have to attenuate the transmission price to avoid wastage of battery power.

Wireless sensor networks consist of thousands of sensing nodes that are arbitrarily installed in surroundings. In a sensor network, there's a BS (base station) that is placed a long way from the sensing field. Sensor nodes send the observed information to the BS. Plenty of energy is consumed in sending the sensed data directly to the Base station. So, it's fascinating to develop some protocols for reducing energy consumption and enhance the network lifetime. These two are major key challenges in the implementation of WSN [8].

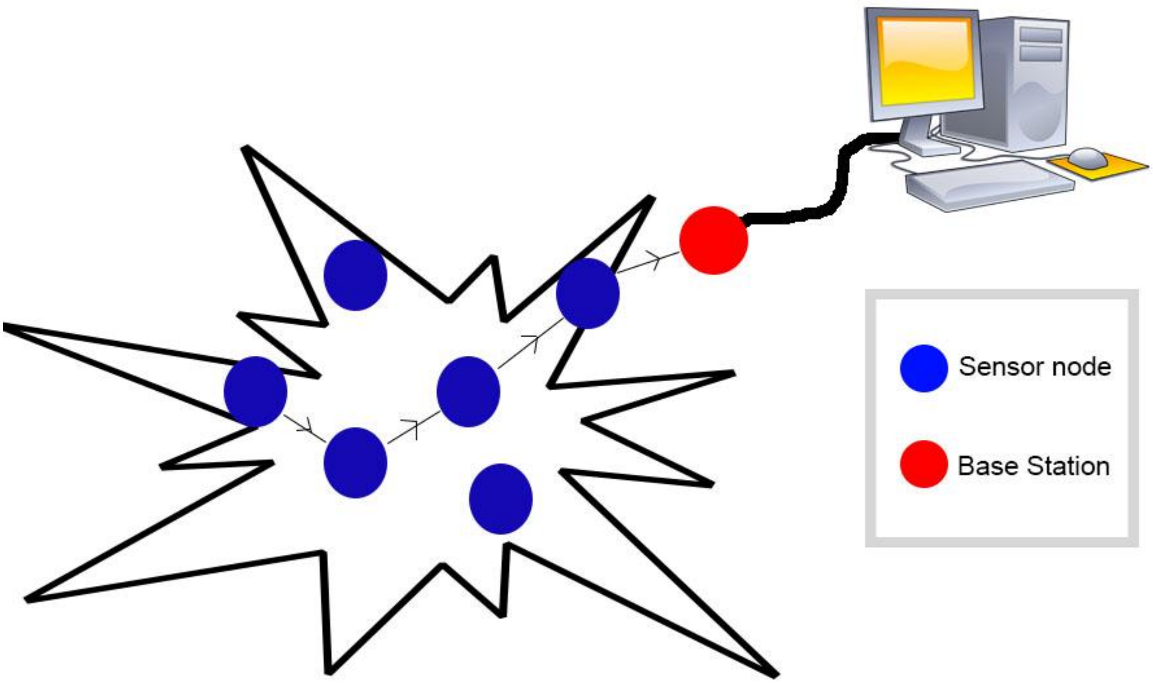

Figure 1.1: A typical architecture of wireless sensor networks

1.1 Architecture of Sensor Node

Basically, there are five main components of typical sensing node.

Controller: All the important information is processed by controlling unit.

Memory: Some memory to store program and intermediate payloads

Sensors: This is the real connecting link to the physical world; these devices manage the physical parameters of the setting.

Communication: Cluster of nodes forming a network that need tools for data transmission over a wireless medium.

Power supply: There is limited power supply is out there, up to few extents energy is provided by the battery and other is energy harvesting (for ex: Solar cells)

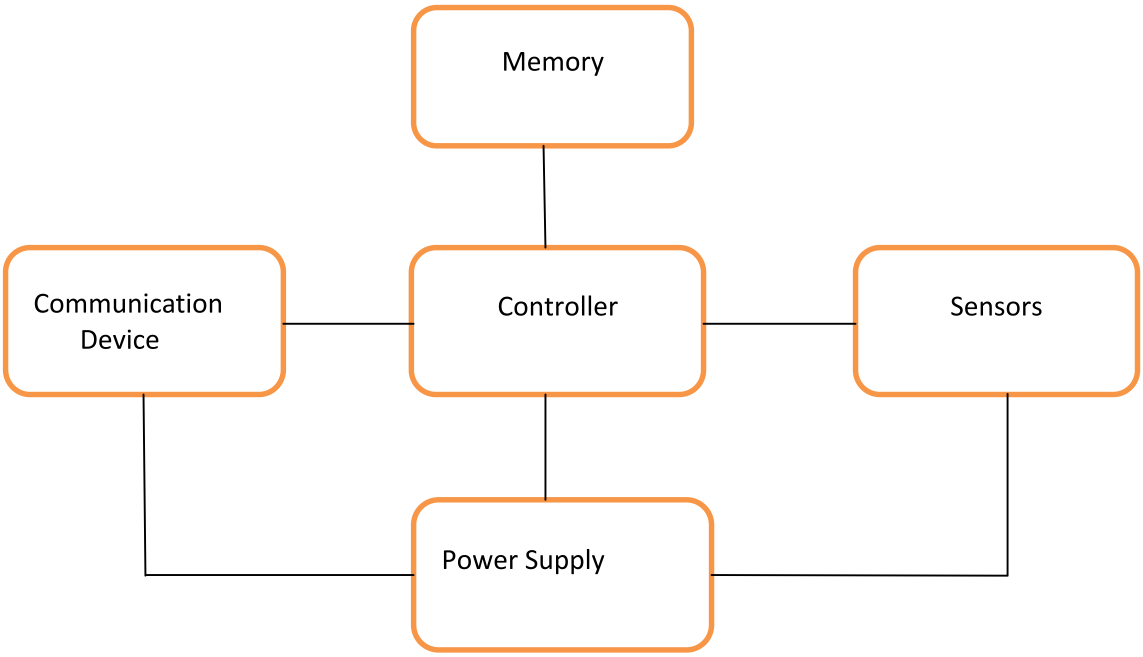

Figure 1.2: Block diagram of typical WSN

1.2 Application of WSNs

Wireless sensor networks could comprise various different kinds of sensing devices like the low rate, seismic, magnetic, thermal, visual, infrared, radar, and acoustic, those are smart enough to watch a large vary of close things. For continues event detection, event ID, event detection management, etc sensor nodes can be implemented. Various applications of WSNs in the main embody health, military, environmental, home, business areas [8].

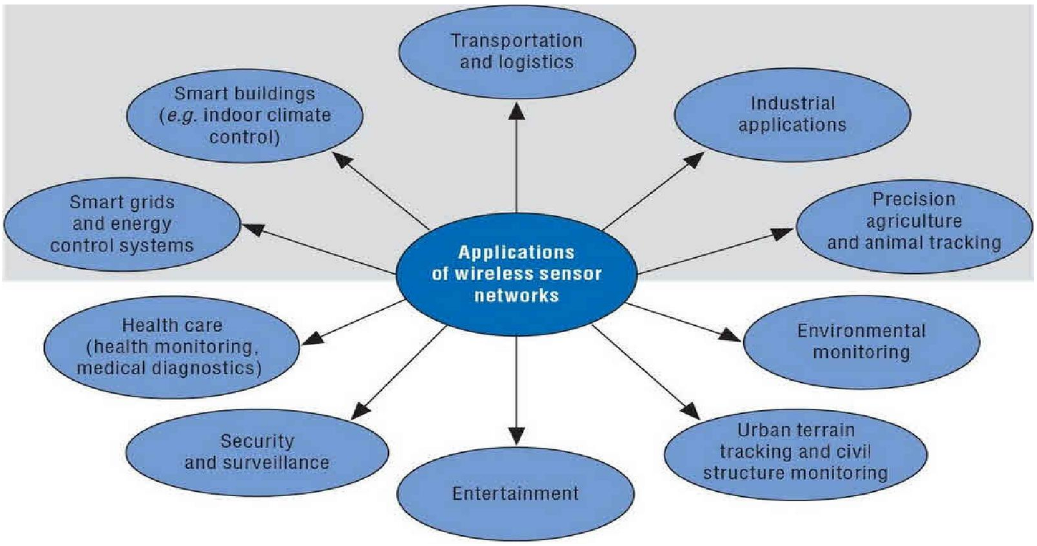

Figure 1.3: Application of Wireless Sensor Networks

1.3 Challenges in WSN

Wireless sensor networks have tremendous potential as a result of they'll increase our ability to see and provides wireless interaction with the physical world. It has potential to gather huge number of random information and data aggregation. Sensors can be placed wherever it's quite impossible to deploy information source and power connectivity and can be accessed remotely. To extract the total ability of sensor networks, we should initially address the unusual challenges of these networks and ensuing technical problems also.

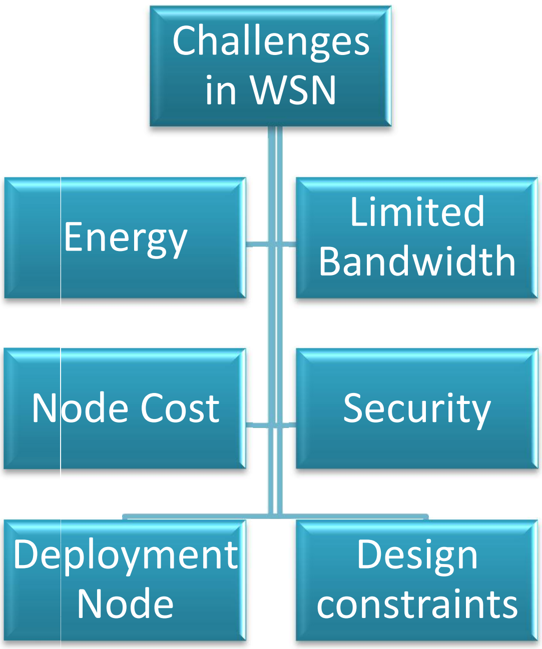

Figure 1.4: Challenges in WSNs.

1.3.1 Energy

One of the most important design challenges in WSN is "Energy efficiency". Power consumption can be classified mainly into three domains sensing, transmission, and data processing, optimization is necessary at each stage. The sensor network lifetime usually exhibits a powerful dependency on their energy source. The limitation is that sensor nodes are operated with limited energy. Also, batteries can be either replaced or recharged when depleted [9].

1.3.2 Bandwidth Limitation

During the transmission process less power is consumed in data gathering as compared with transmitting it.Now a day, wireless data transmission is restricted to a data rate in the range of 10–100 Kbps. Message exchanges among sensors directly affected by limited bandwidth and synchronization is not possible without message exchange. Sensor networks often operate in a various wireless communication ranges like radio, infrared, or optical [9].

1.3.3 Node Cost

A large number of sensor nodes comprise to form a sensor network. The cost of a single node affects the financial budgeting of overall sensor networks. Depending upon the application, requirements of sensors and their cost can be determined [9].

1.3.4 Node Deployment

To reduce the complexity of problems proper node deployment is necessary. Special techniques are required for deployment of a huge number of nodes in restricted surroundings. There are two types of deployment techniques: (i) Dynamic deployment (ii) Static Deployment. In dynamic deployment, nodes are apparently deployed whereas in the static deployment, nodes are placed in fixed locations in an optimized manner [9].

1.3.5 Designing Constraint

WSN have both restrictions on software as well as hardware configuration models, various type of limitations can affect the designing of wireless sensor networks. The main objective of wireless sensors is to create more effective, efficient and compact devices at low expense [9].

1.3.6 Security

One of the difficulties in WSNs is to furnish high-security necessities with obliged resources. Numerous WSNs gather delicate data. The security necessities in WSNs are involved node confidentiality and information secrecy. To recognize both reliable and inconsistent node from a security stance, the sending sensors must pass through node confirmation examination by their relating base station. As a result, sensor systems require new encryption/decryption of data.

1.4 Scope of WSN

In future, these networks are going to be all over so as to form future technologies/environment/infrastructure as sensible as attainable. This includes:

- Medical care
- Smart homes thorough sensors
- Environment monitoring, security, IoT, etc.

The main convenience of WSN is the ability to be applied in any field and in any kind of environment. WSN deals with various kind of interconnection of nodes to form a network for exchange of data. Different types of protocols are developed and implemented at various layers, mostly routing and clustering protocols depending upon the application. It is one of the fundamental building blocks of IoT.

1.5 Basics of Routing Technique

WSNs are generally used for monitoring purposes. The main purpose of WSN is data aggregation from source and forwarded it to destination. However, high amount energy is required by nodes to transmit data from source to sink, leads to drain nodes power quickly. Therefore, it is sometimes necessary that the nodes are cooperated to ensure transmission between remote nodes with the BS. Similarly, data are propagated through intermediate nodes by maintaining a route to the BS. Routing protocols are important for maintaining and discovering the routes between wireless networks [3].

On the basis of deployment of sensor nodes and their working, routing protocols can be classified into three main categories.

1.5.1 Direct Communication

Any node can send data straightforwardly to the Base Station (BS). Applying these routing techniques in an expansive system may deplete the vitality of sensor nodes rapidly. Its adaptability is little. E.g. SPIN.

1.5.2 Flat

In this protocol, if any sensor device tries to send data then initially node will search for a route to the BS and afterward transmits the information. Along these lines, nodes around the BS may deplete their vitality rapidly. Its adaptability is normal. E.g.: Rumor routing

1.5.3 Clustering

As per the clustering routing protocols, a group of nodes forms clusters and each cluster has a cluster head (CH). Nodes in a cluster send their data to their relating CHs, and these cluster head directly communicates with the BS. E.g.: TEEN.

CHAPTER 2

ENERGY EFFICIENT TECHNIQUES

INTRODUCTION

The first and frequently most significant style challenge for a WSN is energy efficiency. Power consumption will be allotted in three useful domains: sensing, communication, and processing, every of which needs optimization. The sensing element node period generally exhibits a powerful dependency on battery life. The constraint most frequently related to sensing element network style is that sensing element nodes operate with restricted energy budgets.

Typically, sensors are units supercharged through batteries that should be either replaced or recharged once depleted. A detector node ought to be able to operate for non-reversible batteries till either the battery are replaced or its mission time has passed. The sort of application decides the length of the mission time.

The design of prolonged wireless detector networks (WSNs) could be a terribly unfavourable issue. On the other hand, energy-constrained sensors are units expected to run autonomously for long periods. However, it's going to be cost prohibitive to interchange exhausted batteries or may be not possible in hostile environments. On the opposite hand, in contrast to alternative networks, WSNs are unit designed for specific applications that vary from small size aid police work arrangements to environment observance on large scale. Thus, any WSN distribution has got to fulfil a collection of specifications that differs from one application to a different. A bunch of analysis work has been conducted so as to propose comprehensive and all-encompassing solutions to the energy-reducing obstacle. Various analysescover many areas going from physical layer optimization to network layer solutions. Therefore, it's harsh for the WSN architect to pick the economical solutions that ought to be thought of the design of application-specific WSN design [3].

Wireless device networks are the trend of past few years and that they received vital attraction from researchers, thanks to their in depth applications in several areas. For increasing the network period the energy consumption of individual device nodes should be reduced. For prolonging the network period, many techniques, that scale back the energy consumption of device nodes, are chiefly thought about while doing our work. We tend to classify the energy economical techniques into seven categories supported energy waste in

WSN, particularly duty sport, knowledge handling, reliable routing protocol and overhead reduction, mobility, quick communication and energy economical forwarding theme, topology management and energy potency supported QoS. We tend to conclude with a quick description on future analysis activities that we tend to propose to undertake [3].

2.1 TYPES OF ENERGY EFFCIENT METHODS

Five main classes of energy efficient techniques can be identified, namely, data reduction, protocol overhead reduction, energy efficient routing, duty cycling and topology control.

2.1.1 Data reduction

In WSN, information reduction forces the device nodes to prevent sending the information once it is assured about recreating the longer term data at the device sink depending upon the prevailing, past and proximity observations thereby protecting the energy resources used for transmission of information. It centers its focus on reducing the number of input information created, processed and transmitted. Information compression and information aggregation are essential examples of such methods. In wireless device networks (WSNs), thanks to the restriction of scarce energy, it remains associate open challenge the way to schedule the information communications between the device nodes and also the sink to scale back power usage with the aim of increasing the network lifespan. Information reduction is usually the primary step to tackle a knowledge set, as a result it facilitates in extracting its distinctive options. Typically, knowledge reduction techniques are used for data processing of massive knowledge warehouses. A standard thanks to facilitate knowledge reduction in WSN is by deploying, adaptation and prediction mechanism at the supply and also the destination thus on adapt to the dynamical pattern of the info and to predict it. The higher than mechanism is economical in protecting the communication resources concerned because it needs the supply to relay solely a set of the particular knowledge. Moreover, since the radio transmission at the node consumes a lot of quantity of energy than the other operation at the node , knowledge reduction becomes an attractive choice to conserve the restricted energy resources of WSN. Data reduction in WSN could be a difficult method as knowledge exists within the type of continuous stream (infinitely massive knowledge set) wherever the variation and prediction should be performed on-line i.e. at a given instance of your time, not all the data is accessible for process. Typically, the abstraction and temporal relations among the information sources in WSN are exploited to attain truthful data reduction rates. Abstraction and temporal characteristics of WSN facilitate in adapting the setting then predicting it thereby leading to knowledge reduction [3].

2.1.2 Protocol overhead reduction

The method targets on extending protocol potency by reducing the overhead. Completely different methods exist. Sending periods of messages are counted on the steadiness of the network, or on the space to the supply of the transmitted data. A lot of usually, a cross-layering approach can alter an improvement of the communication protocols taking under consideration the application needs. Another technique, optimized flooding will considerably make its contribution to scale back the overhead [3].

2.1.3 Energy efficient routing

Routing protocols ought to be made with the aim of increasing network period of time by reducing the energy consumed to a minimum level by the end-to-end transmission and avoiding nodes with low residual energy. Some protocols are time serving, taking advantage of node quality or the published nature of wireless communications to cut back the energy consumed by a transmission to the sink. Others use geographical coordinates of nodes to create a route towards the destination, in some others a hierarchy of nodes is build to alter routing and scale back its overhead. Finally, information central protocols send information solely to interested nodes so as to spare useless transmissions.

Ideally, we might just like the sensing element network to perform its practicality as long as attainable. Optimum routing in energy unnatural networks isn't much possible (because it needs future knowledge). However, we are able to soften our necessities towards a statistically optimum theme, which maximizes the network practicality thought of overall attainable future activity. A theme is energy economical (in distinction to 'energy optimum') once it's statistically optimal and causative (i.e. takes solely past and gift into account). In most sensible police investigation or observation applications, we have a tendency to don't wish any coverage gaps to develop. We have a tendency to so outline the time period we wish to maximize because the worst-case time till a node breaks down, rather than the common time over all eventualities is just too computationally intensive, even for simulations. It's so actually impossible as a tenet to base sensible schemes on [14].

2.1.4 Duty cycling

This method means that the fraction of your time nodes is unit active throughout their time period. Nodes active/sleep plan ought to be coordinated and accommodated to specific application needs. These techniques are additionally divided. High graininess techniques specialize in choosing active nodes among all sensors deployed within the network. Low graininess techniques handle shift off (respectively on) the radio of active nodes once the communication is not needed (respectively once a communication involving this node might occur). They are extremely relating to the medium access protocol. Although a decade of productive analysis has been conducted in low power wireless networks, the duty-cycled turnout capability, –defined because the most rate in terms of variety of nodes, n, and their duty cycles, ψ,– isn't simply computed, and strategies for its estimation haven't received abundant attention[14].

2.1.5 Topology control

Topology management may be a method utilized in distributed computing to change the underlying network (modeled as a graph) to cut back the value of distributed algorithms if run over the new ensuing graphs. It is a general method in distributed algorithms. As an example, a (minimum) spanning tree is employed as a backbone to cut back the value of broadcast from O(m) to O(n), wherever m and n square measure the quantity of edges and vertices within the graph, severally. The term "topology control" is employed largely by the wireless spontaneous and device networks analysis community. The most aim of topology management during this domain is to save lots of energy, cut back interference between nodes and extend period of time of the network.

It targets its focus on reducing energy usage by setting transmission power whereas maintaining network property. A replacement reduced topology is formed supported native info. In WSNs the most supply of energy is that of the battery and also the power of it is very restricted. Once the detector nodes square measure are allotted within the harsh atmosphere, their recharging and switching is quite impossible. So it's advisable to utilize the battery power effectively. Keeping this in mind several energy efficient protocols are projected till date.

2.1.6 Lifetime

It's fascinating to prolong the period of time of the network as the sensors square measure are not accessible once deployed.

2.1.7 Network size

Most of the applications require bigger networks because of the fact that they cover additional areas and thus monitor additional events.

2.1.8 Minimize errors

A network with errors uses resources to come up with incomplete information. At the detector level, it means that the watching of the atmosphere is broken and lots of events could also be lost. In sending the information to the sink, it means that packet loss is high; in each case, the data of the atmosphere is unfinished and thus the collected information isn't reliable. In alternative words, a reliable collective event-to-sink is important in WSNs. These needs demand the subsequent criteria in communication protocols: Lower energy consumption: as an instantaneous effect of the need for extended lifetime of the sensors, the communication between these sensors (and sink) should slowly consume the offered energy, as the majority of a sensor's energy is consumed in communication. Matched with multi-hop communication: generally, the direct communication of the sensors with the sink is avoided (as energy usage is proportional to the sq. of distance); instead, it's most well-liked that sensors use alternative sensors as hops to speak [14].

2.1.9 Scalability

The communication protocol should be such that it can be relied upon in terms of creating and keeping property among sensors. This protocol should perform as traditional once the dimensions of the network become greater.

2.1.10 Reliability

Reliable information transmission in term of packet loss is one in every of the most concerns to produce a higher extent of capability in watching and management systems. Therefore, using energy-efficient communication techniques, taking into consideration multi-hop ability, measurability and responsibility is very much required. As an instantaneous result, the period of time of the network are made better.

CHAPTER 3

CLUSTERING PROTOCOL IN WSN

INTRODUCTION

Leach is among the first researched and developed clustering protocol for WSN's. It was found in the year 2002. Its main objective is to make the network more efficient in terms of energy by rotation based CH selection using a random number. Its architecture is shown in Figure 3.1

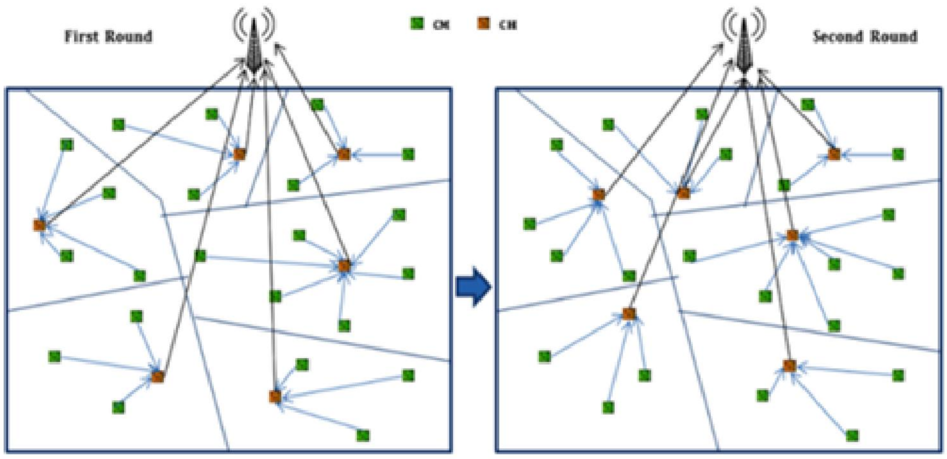

Figure 3.1: LEACH protocol architecture

LEACH action contains number of rounds where each round is isolated into two phases: Set-up state and the Steady state. In Step-up organize, CH race, game plan of gathering and undertaking of a TDMA (Time Division Multiple Access) booked by the CH for part center points are perform. In CH decision, each center point appreciate a CH choice process by making an irregular need an incentive in the vicinity of 0 and 1. In case the made number isn't as much as an edge regard *Th(n)* by then that center point transforms into the gathering head. Breaking point regard i.e. *Th(n)* is figured using Eq-3.1[1].

$$Th(n) = \begin{cases} D/(1 - D * (p \bmod 1/D) & : \text{if } n \in S \\ 0 & : \text{otherwise} \end{cases} \qquad (3.1)$$

where D is the desired level of sensor nodes to end up CH's among all sensor center points, p implies the present round and S is the plan of sensor center points that did not appreciated CH race in past 1/D rounds. A hub that structures into the CH in round p can't appreciate the accompanying 1/D rounds. Along these lines each one of the nodes gets proportionate chance to wind up the CH and imperativeness decline among the sensor nodes is passed on reliably. Once a hub is picked as the CH, it conveys a notice message to each and every other hub.

Dependent upon the got flag quality of the advancement message, sensor nodes join a CH for the current round and send a join message to this CH. By making another notice message in light of Equation 1, CHs rotate in each round with a particular ultimate objective to consistently suitable the imperativeness stack in the sensor nodes. After the course of action of the bundle, Each CH makes a TDMA arrangement and transmits these timetables to their people inside the gathering. The TDMA design avoids the crash of data sent by part nodes and gifts the part nodes to go into rest mode. The set-up arrange is done if every sensor node knows its TDMA design. The reliable state organize takes after the set-up-arrange.

Figure 3.2 : Objectives of LEACH

Dependent upon the got signal nature of the headway message, sensor nodes join a CH for the current round and send a join message to this CH. By influencing another notice to message in light of Equation 1, CHs pivot in each round with a specific extreme goal to reliably reasonable the significance stack in the sensor nodes. After the strategy of the package, Each CH makes a TDMA course of action and transmits these timetables to their kin inside the social occasion. The TDMA configuration keeps away from the crash of information sent by part nodes and blessings the part nodes to go into rest mode. The set-up mastermind is done if each sensor node knows its TDMA plan. The solid state compose takes after the set-up-arrange [2].

3.1 ADVANTAGES OF LEACH

LEACH is a completely conveyed directing convention in nature. Thus, it doesn't require any worldwide data. The basic favoured point of view of LEACH joins the going with:

1) Bunching used by LEACH tradition actualizes less correspondence between sensor nodes and the BS, which grows the framework lifetime.

2) CH reduces related data locally by applying data add up to technique which diminishes the basic measure of vitality usage.

3) Allocation of TDMA system by the CH to part nodes empowers the part nodes to go into rest mode. This expects intra group impacts and enhances the battery lifetime of sensor nodes.

4) LEACH tradition offers ascend to chance to every sensor node to twist up the CH in any occasion once and to wind up a section node usually all through its lifetime. This randomized turn of the CH updates the framework lifetime [1].

3.2 Disadvantages of LEACH

On the other hand, there exist a few impediments in LEACH which are as per the following:

1) In each round the CH is picked subjectively and the likelihood of turning into the CH is the same for every sensor node. In the wake of completing of a few adjusts, the likelihood of sensor nodes with high vitality and additionally low vitality turning into the CH is the same. In the event that the sensor node with less vitality is picked as the CH, at that point it passes on rapidly. In this manner, strength of the system is influenced and lifetime of the system debases.

2) LEACH does not ensure the position and number of CHs in each round. Arrangement of groups in fundamental LEACH is irregular and prompts unequal conveyance of bunches in the system. Further, in a few bunches the situation of the CH might be amidst the groups, and in a few groups the situation of the CH might be close to the limits of the bunches.

Accordingly, intra bunch correspondence in such a situation prompts higher vitality scattering and abatements the general execution of the sensor arrange.

3) LEACH takes after single hop correspondence between the CH and the BS. At the point when the detecting region is past a specific separation, CHs which are far from the BS spend more energy contrasted with CHs which are close to the BS. This prompts uneven energy dissemination which at last debases the lifetime of the sensor organize [2].

3.3 IMPLEMENTATION

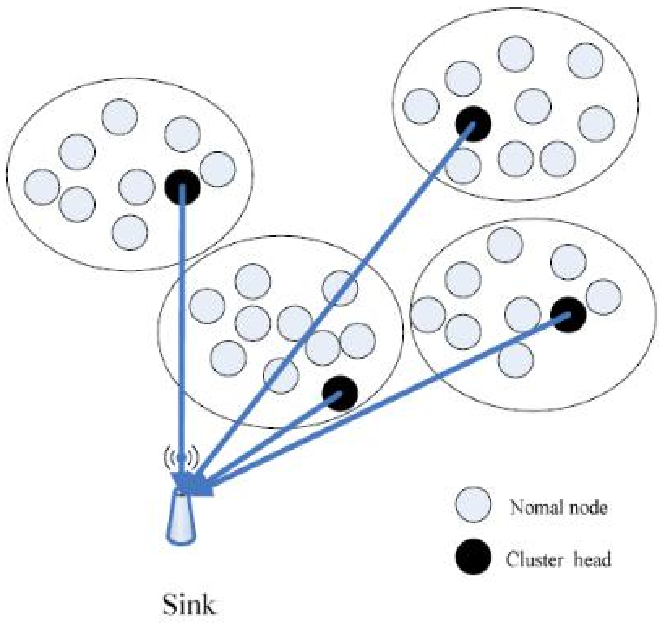

Figure 3.3: Clustering in LEACH

Step1: Initialize the various parameters

Description	Symbol	Value
Number of nodes	N	100
The initial node energy	$E_{initial}$	0.5J
Energy consumed by the amplifier to transmit at a short distance	E_{fs}	10pJ/bit/m^2
Energy consumed by the amplifier to transmit at a	E_{mp}	0.0013pJ/bit/m^4

longer distance		
Energy consumed in the electronics circuit to transmit or receive the signal	E_{elec}	50pJ/bit
Data packet	K	4000bits
Bits Control packet	L_{ctrl}	100 bits
Data aggregation energy	E_{da}	5pJ/bit/report
Maximum number of rounds	R_{max}	2000
The cluster probability of LEACH	p	0.05
The Sensing area	$M \times M$	100m×100m

Step2: Computation of d_o ($sqrt(E_{fs}/E_{mp})$)

Step3: Creation of the random sensor network

Step4: Random election of normal node

Step5: Initialize the iteration

Step6: Initialize the dead nodes=0, Checking if there is any dead nodes

Step7: Election of Cluster Head

Formula:

$$T(n) = \begin{cases} P/(1 - P * (r \bmod 1/p) & : \text{ if } n \in G \\ 0 & : \text{ otherwise} \end{cases}$$

Step8: Calculation of energy dissipated distance

if (distance>d_o)

((ETX+EDA)(4000) + E_{mp}*4000*(distance*distance*distance*distance))*

if (distance<=d_o)

((ETX+EDA)(4000) + E_{fs}*4000*(distance * distance))*

Step9: Plot the graph of Random normal nodes, Cluster Head, Energy Dissipation.

3.4 OUTPUT

3.4.1 Random normal nodes

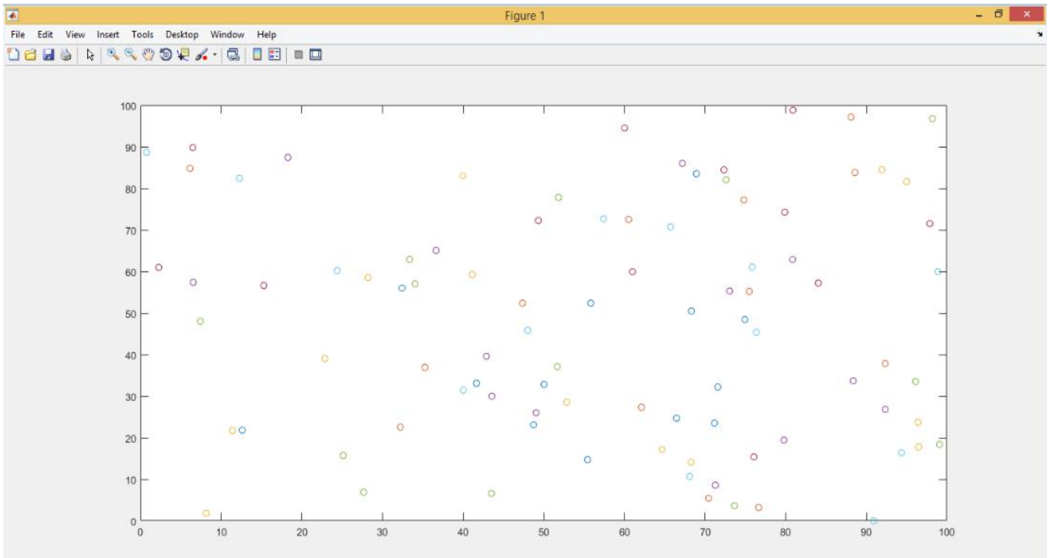

Figure 3.4: 100m x 100m

3.4.2 Cluster Head formation

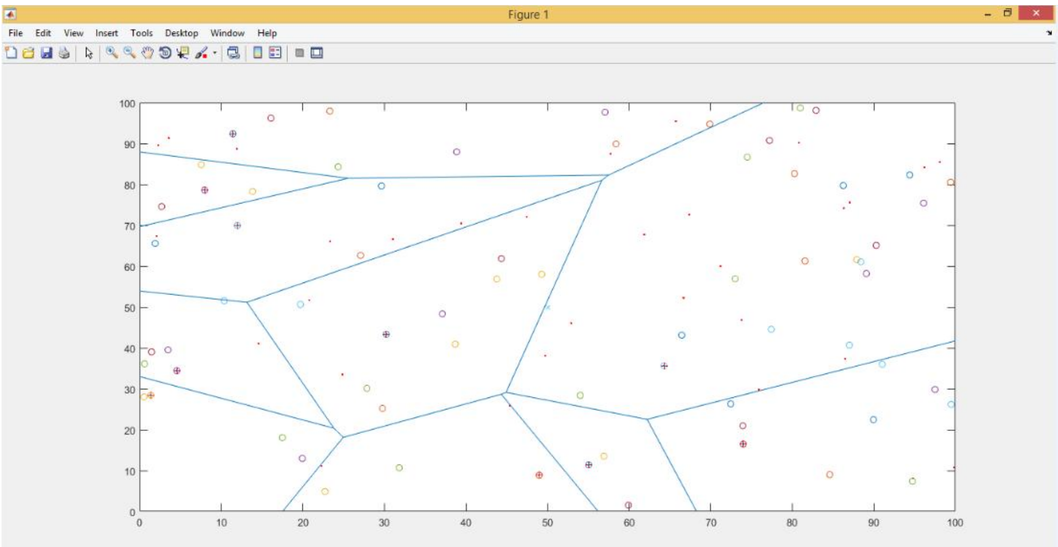

Figure 3.5: 100m x 100m

3.4.3 Energy Dissipation

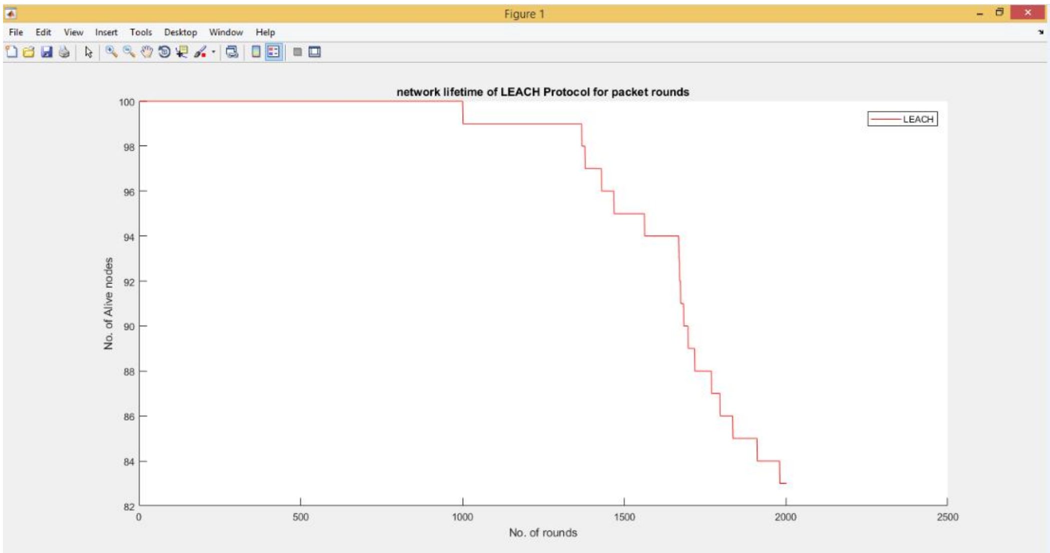

Figure 3.6: Number of alive nodes vs. number of rounds

CHAPTER 4

IMPROVEMENT OF LEACH PROTOCOL FOR WSN

4.1 THE PROPOSED PROTOCOL

We have actualized another convention called E-LEACH in view of LEACH convention to adjust the energy utilization of sensor nodes to tackle the over-burden energy utilization issue. The E-LEACH embrace the same round idea as specified in the first LEACH. In various leveled steering conventions, the quantity of group heads is a key factor that impacts the execution of coordinating traditions. If the amount of gathering heads is less, each bundle rush toward cover greater area, this will lead the issue that some pack people get far from their gathering heads and use significantly more vitality. As the correspondence between amass heads and the base station needs fundamentally more vitality than normal hubs, the over the best number of bundle heads will grow the essentialness usage of the whole framework and curtail the framework lifetime. In like manner, it is imperative to pick perfect bunch head to make the vitality use slightest. In the E-LEACH we use the base intersection tree between bundle heads, pick the gathering head which has greatest outstanding imperativeness as the root hub.Figure 4.1 delineates the design of E-LEACH[2].

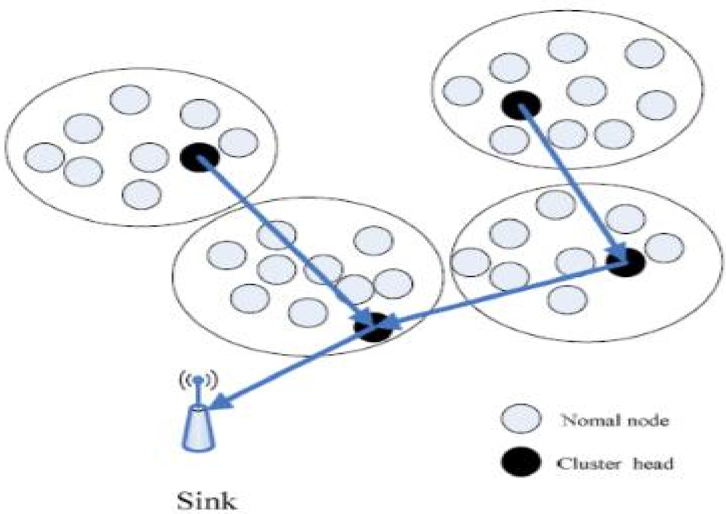

Figure 4.1: Clustering in E-LEACH

4.1.1 Selection of cluster head

The arbitrary determination calculation for LEACH effortlessly prompts the disparity of the put away energy of sensor nodes, in this way the utilization of framework energy is expanded. To guarantee that the energy load is consistently disseminated all through the system, the extra parameters including the residual energy and the consumed energy for transmitting information are connected to advance the procedure of cluster head determination. The principle thought of the enhanced cluster head determination calculation is to stay away from the lower remaining energy nodes and higher devoured energy nodes to be group head. Another T(n) is characterized in condition 4.1 [2]:

$$T_{new}(n) = \begin{cases} \frac{Phead}{1-Phead\ P_{head}(r*mod(1/\ Phead))} * \frac{Ecurrent}{Einitial}, & if\ n€G; \\ 0, & else \end{cases} \qquad (4.1)$$

Where the $E_{current}$ is the leftover energy of nodes at the r round, $E_{initial}$ is the underlying energy of nodes. By utilizing T_{new}(n), the likelihood for low leftover energy nodes being bunch head is significantly diminished and the likelihood for high remaining energy nodes being cluster head is expanded.

$$P_{head}=\sqrt{\frac{N}{2\pi}}\sqrt{\frac{Efs}{Emp}}\frac{M}{d^2_{toBS*N}} \qquad (4.2)$$

In the E-LEACH, the estimation of P_{head} is powerfully figured by the equation (4.2).Then, sensor node is haphazardly allocated a number in the vicinity of 0 and 1, if estimation of the number is not as much as $T_{new}(n)$, the sensor node is chosen as the bunch head at the current round. In the E-LEACH convention, the round time $T_{current}$ is characterized toward the start of the round $R_{current}$. It relies upon the ideal bunch estimate, as opposed to utilizing a steady round time T for each round in the system life. At that point we can characterize the current round time $T_{current}$ as takes after:

$$T_{current} = NF_{avg}*(M_{min}*\sigma + \lambda) \qquad (4.3)$$

Where, NF_{avg} is the average number of frames for a cluster with size

$1/P_{head}.M_{min}*\sigma+\lambda$ is the frame time of a cluster which has the minimum size (the minimum number of nodes M_{min}).

Subsequent to characterizing the round time $T_{current}$ for the current round, the base station sends the group data and the changed $T_{current}$ to all nodes in the system, in this way every node can decide its bunch and its vacancy in the TDMA plan [2].

4.1.2 Steady-state Phase

In the relentless state stage, every node sends the gathered data amid its own particular TDMA schedule vacancy. The group head sends the last information to the sink by the base spreading over tree. In the wake of accepting data of all the bunch heads, the base station investigation the datum and exchange those to the best man machine correspondence interface. As indicated by ID and data power of node sending, the bunch heads communicate the data to the system, and prepare for the following round.

4.2 OUTPUT

4.2.1 Random nodes deployment

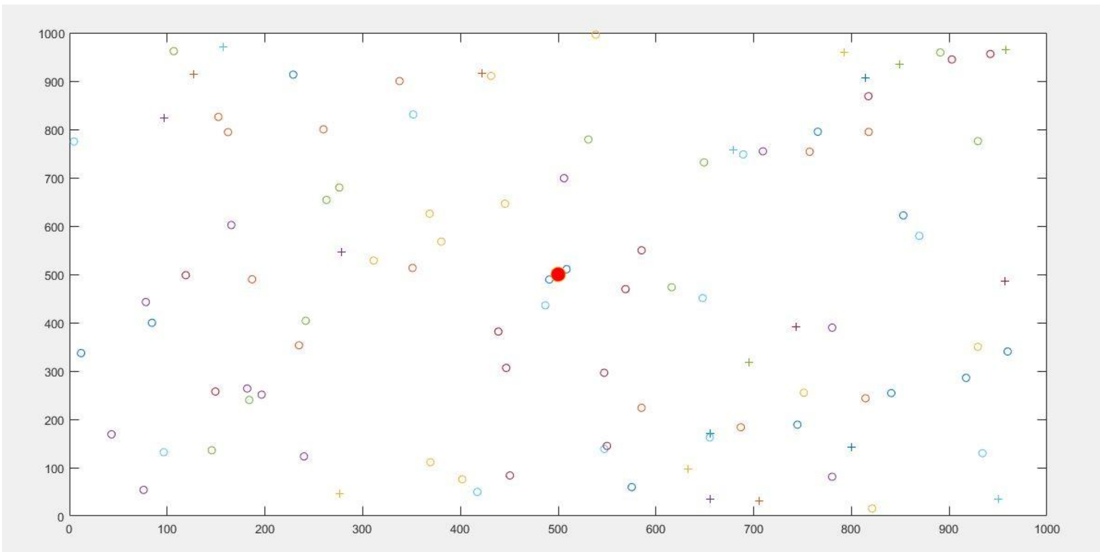

Figure 4.2: 1000m x 1000m

4.2.2Comparison of Network Lifetime of nodes between LEACH protocol and E-LEACH protocol

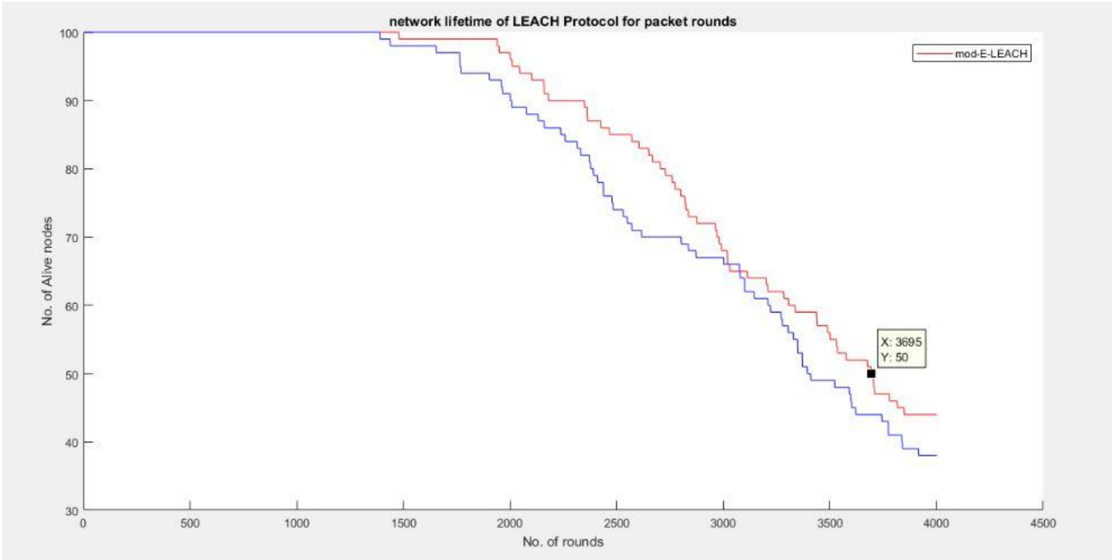

Figure 4.3: Number of alive nodes vs. number of rounds

CHAPTER 5

ROUTING PROTOCOLS

5.1 DYNAMIC SOURCE ROUTING

Dynamic Source Routing (DSR) is a basic and efficient protocol used for the wireless networks. It is specially used in multi-hop wireless ad hoc networks with mobile nodes. It is dynamic in nature and there is no requirement of existing administration or infrastructure networks, making networks as “self-organizing” and “self-configuring”. System nodes (PCs) participate to exchange of data with each other for allowing transmission over different "hops" between nodes not specifically inside the wireless communication within the scope of each other. As nodes in the system move about or join or leave the system, all the routing is naturally decided and kept up by the DSR routing protocol as the source of interference changes. The subsequent system topology is dynamics in nature and continuously evolving with the amount of intermediate hops required to reach any destination is dynamic in nature. It works with mobile telephone and networks with up to around 200 nodes. Every source in DSR determines the routes to be utilized as a part of transmitting the packet to the chosen target [14].

DSR has two components named as Route Discovery and Route Maintenance. Route Discovery means to determine the path for transmitting the packet from a source to target. Route Maintenance guarantees that the transmission way stays ideal and loop-free as the conditions of network changed.

5.1.1 Working

When the node A (source) wants to transmit data to node B (destination), but node A doesn’t know the route of node B then node A initiates a Route Discovery. Node A surges Route Request (RREQ), every RREQ consists of Sender and destination addresses and unique request created from sender.

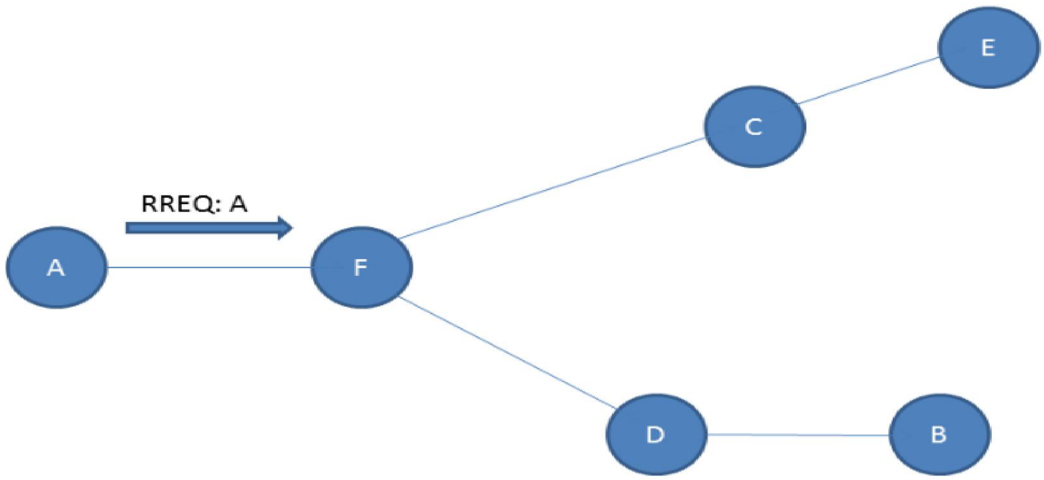

Figure 5.1: Node *A* needs a route to node *B* through RREQ broadcast. Node *F* receives data and there is no direct route to node *B* then adds its address and rebroadcast it.

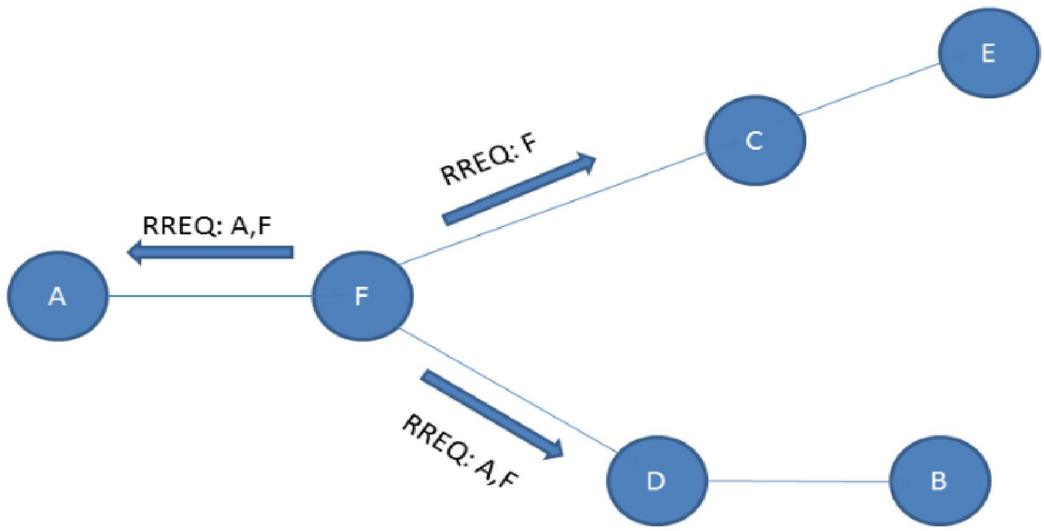

Figure 5.2: Node *C* accept packets, add its address and rebroadcast as there is no direct route to node *B*. Similarly, Node *D* receives packets and Rebroadcast it

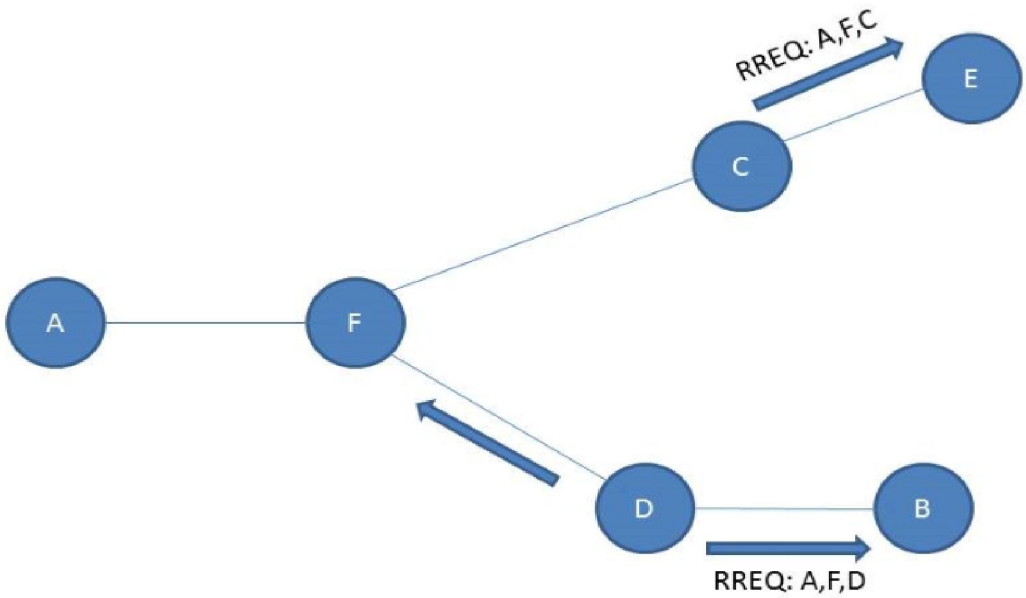

Figure 5.3: Node *E* accepts packets from Node *C*, there is no route to *B*, stop broadcasting. Node *D* gets a route to node *B,* adds its address and unicast RREQ to Node *B*.

5.2 DESTINATION-SEQUENCED DISTANCE VECTOR

The Destination-Sequenced Distance Vector (DSDV) convention might be a table-driven directing convention supported by the upgraded variant of more seasoned Bellman-Ford steering guideline. DSDV is predicated on the Routing information convention (RDP). With RDP, a directing table having all the possible goals is held by a hub inside the system and in this way, the assortment of bounces to each goal. DSDV has furthermore upheld distance vector routing and along these lines utilizes the connections in both the headings. It gives only one course to a source/goal attempt, which is a genuine constraint of this convention. Destination-Sequenced Distance-Vector Routing (DSDV) might be a table-driven steering subject for unconstrained versatile systems bolstered by the Bellman-Ford run the show. It had been further enhanced and detailed by Perkins and Bhagwat in1994. The most commitment of the lead was to disentangle the directing circle disadvantage. Each section inside the directing table contains a succession assortment, the grouping numbers are unit regularly, however, there is a connection introduce there. The sum is produced by the goal, and along these lines the anode must send resulting refresh with this assortment. Steering data is appropriated between nodes by causation full dumps some of the time and little dynamic updates a ton of regularly[13].

An ad hoc network may be assortment of mobile nodes forming a second network while not fastened configuration of a communication network. In a network of such kind, every node behaves as each router and host at the same time, and might move out or take part the network freely. The instantly created network doesn't have any base infrastructures as utilized in the standard networks, however it's compatible with the standard networks. DSDV may be a modification of the standard Bellman-Ford routing rule. It addresses the drawbacks associated with the poor iteration properties of RDP within the face broken links. The modification custom-made in DSDV makes it a additional appropriate routing protocol for unintentional networks.

Ad hoc arranges to differ extensively from normal systems inside the dynamic topology of interconnections and programmed administration for fitting the system. From a diagram hypothesis reason for reading, an ad-hoc system could be a chart G(N, E(t)), that makes out of a gathering of hubs N, and a gathering of edges E(t). Each versatile host is a hub of the diagram. Each edge of the set E(t) is made by two hubs at interims the administration fluctuate, it is unidirectional or bi-directional. E(t) changes with time on the grounds that the portable hubs inside the unconstrained system unreservedly move around.

The topology of the unconstrained system is discretionary whenever. With the alteration of the topology of an ad-hoc organize, the hubs inside the system must be constrained to refresh their steering information mechanically and in a split second. Steering conventions in parcel exchanged systems generally utilize either distance-vector or link-state directing rule.

Both of them enable a bunch to search out consecutive hop to succeed in the destination via the "shortest path". The metric of the shortest path could be a variety of hops, time delay in milliseconds, total variety of packets queued on the trail, or one thing similar. Such shortest path protocols are with success employed in several dynamic packet switched networks. In essence, any such protocol can even be employed in impromptu networks. The most drawbacks of each link state and distance-vector protocol are that they take too long to converge and have a high message quality. Owing to the restricted information measure of wireless links in a poster hoc network, message quality should be unbroken low. Additionally, the rapidly dynamical topology needs that the steering conventions should be created to meet this fundamental theory. The Distance sequenced distance vector (DSDV) convention is related degree adaptation of the traditional Bellman-Ford directing conventions.

It's particularly focused for the extemporaneous systems. It addresses the enduring circles and count to time everlasting issues of the standard separation vector directing conventions [12].

5.2.1 ROUTING TABLES

The routing table's structure for this protocol is quite easy. Every table entry encompasses a sequence variety that's incremented each timean associate degree updated message is sent by a node. Routing table's square measure are sporadically updated once the configuration of the communication network changes and square measure propagated throughout the network to stay consistent data throughout the network. Two routing tables are maintained by every DSDV node: One is there for forwarding packets and the other is for advertising progressive routing packets.

The routing data sent sporadically by a node contains a replacement sequence variety, the destination address, the quantity of hops to the destination node, and therefore the sequence variety of the destination. Once the configuration of the communication network changes, a detection node sends associate degree update packet to its neighboring nodes [10]. On receipt of associate degree update packet from a neighboring node, a node takes the knowledge from the packet and updates its routing table as follows:

5.2.2 PROCESS ALGORITHM

1) If the new address contains a higher succession go, the course with the upper arrangement run is picked by the hub and the past grouping range is disposed of.

2) A course with the littlest sum cost is chosen, when the approaching arrangement assortment is much the same as the one happening to the overall course.

3) All the measurements looked over the new steering information are increased.

4) This technique keeps on continuing going till every one of the hubs are refreshed. In the event that there are copy refreshed parcels, the hub thinks about keeping the one with the minimum cost metric and disposes of the rest of. Just in the event of a broken connection, an estimation of the metric with a fresh out of the box new arrangement range(incremented) is allocated there to ensure that the succession scope of that metric is generally bigger than or up to the grouping scope of that hub. The bundle overhead of the DSDV convention will

build the whole scope of hubs inside the ad-hoc arrange. This reality makes DSDV fitting for modest systems. In monstrous ad-hoc arranges, the quality rate thus the overhead increment, making the system insecure to the reason that refreshed parcels won't achieve nodes on time [10].

Goal sequenced remove vector steering (DSDV) is custom-made from the traditional Routing Data Protocol (RDP) to extemporaneous systems directing. It adds a spic and span property, arrangement goes, to each course table passage of the traditional RIP. Misusing the newly supplemental arrangement go, the versatile hubs will recognize stale course information from the new and in this way stop the development of routing loops.

5.2.3 SELECTION OF ROUTE

If thenew info is received by the router, then it uses the most recent sequence variety. If the sequence variety is that the same because the one already within the table, the route with the higher metric is employed. Stale entries are those unit entries that haven't been updated for a jiffy. Such entries are additional because of the routes exploitation of these nodes as next hops are unit deleted [10].

5.2.4 ADVANTAGES

The availability of ways to any or all destinations the in the network invariably shows that less delay is needed within the path came upon method. The method of progressive update with sequence variety labels marks the present wired network protocols flexible to Ad-hoc wireless networks. Therefore, all accessible wired network protocol will be helpful to unplanned wireless networks with less modification [7].

5.2.5 DISADVANTAGES

DSDV needs an everyday update of its routing tables that consumes battery power and a little quantity of information measure even once the network is not in use. Whenever the configuration of the network changes, a replacement sequence range is critical before the network re-converges; therefore, DSDV isn't appropriate for extremely dynamic or massive scale networks. (As altogether distance-vector protocols, this doesn't perturb traffic in regions of the network that don't seem to be involved by the topology modification)[7]

5.2.6 INFLUENCE

While DSDV itself doesn't seem to be abundantly used nowadays, different protocols have used similar techniques. The known sequenced distance vector protocol is AODV, which, by virtue of being a reactive protocol, will use easier sequencing heuristics. Babel is a trial at creating DSDV a lot of sturdy, a lot of economical and a lot of wide applicable whereas staying among the framework of proactive protocols.

5.3 AD HOC ON-DEMAND DISTANCE VECTOR

An Ad Hoc On-Demand Distance Vector (AODV) is a steering convention expected for remote and versatile ad hoc organizes. This convention build up courses to goal on request and backings similarly unicast and multicast directing. The AODV convention was as one created by Nokia Research Center, the University of California, Santa Barbara and the University of Cincinnati in 1991[8].

The AODV convention creates courses between hubs if and just on the off chance that they are recognized by source hubs. AODV is in this way considered an on-request calculation and doesn't make any additional movement for correspondence crosswise over connections. The courses are kept up as long as they are basic for the sources. Additionally they frame trees to interface multicast gather individuals. AODV makes utilization of grouping numbers to ensure course freshness. They are self-beginning and circle free other than scaling to different versatile hubs [8].

In AODV, systems are in rest mode until the point when associations are built up. System hubs that require associations, broadcast a demand for association. The rest of the AODV hub advances the message and follow the hub that asked for an association. In this manner, they make a progression of here and now courses back to the asking for hub.

5.3.1 Main features of AODV protocol

- This convention is both an on-request and a table-driven convention.

- The parcel measure in AODV is uniform dissimilar to DSR. Not at all like DSDV, there is no requirement for framework wide broadcasts because of neighborhood changes.
- AODV underpins multicasting and unicasting inside a uniform system.
- Each course has a lifetime after which the course terminates in the event that it isn't utilized.
- A course is kept up just when it is utilized and consequently old and terminated courses are never utilized.
- Unlike DSR, AODV keeps up just a single course between a source-goal combine.

5.3.2 LIFETIME

- A lifetime is related with the section in the course table.

- This is a critical element of AODV. In the event that a course passage isn't utilized inside the predefined lifetime, it is erased.

- A course is kept up just when it is utilized. A course that is unused for quite a while is thought to be steady [7].

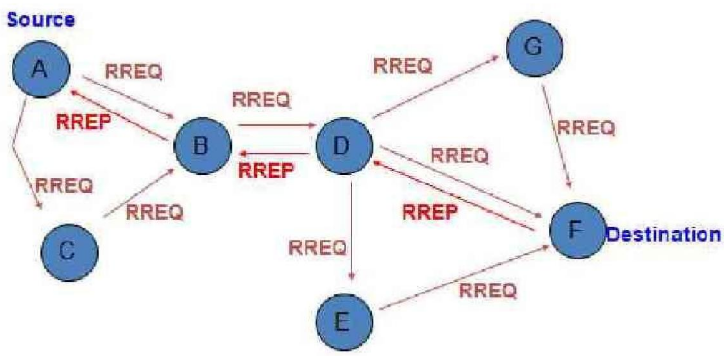

Figure 5.4: An example of AODV routing protocol

CHAPTER-6

OUTPUT AND RESULT

6.1 DYNAMIC SOURCE ROUTING

6.1.1 OUTPUT

For number of nodes=500

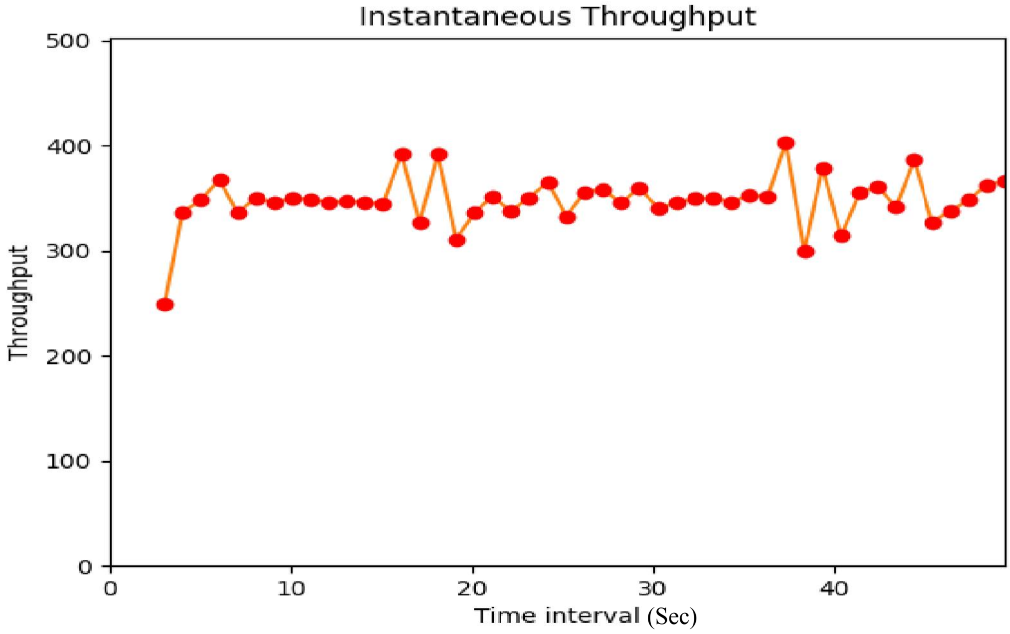

Figure 6.1: Throughput vs. Time Interval

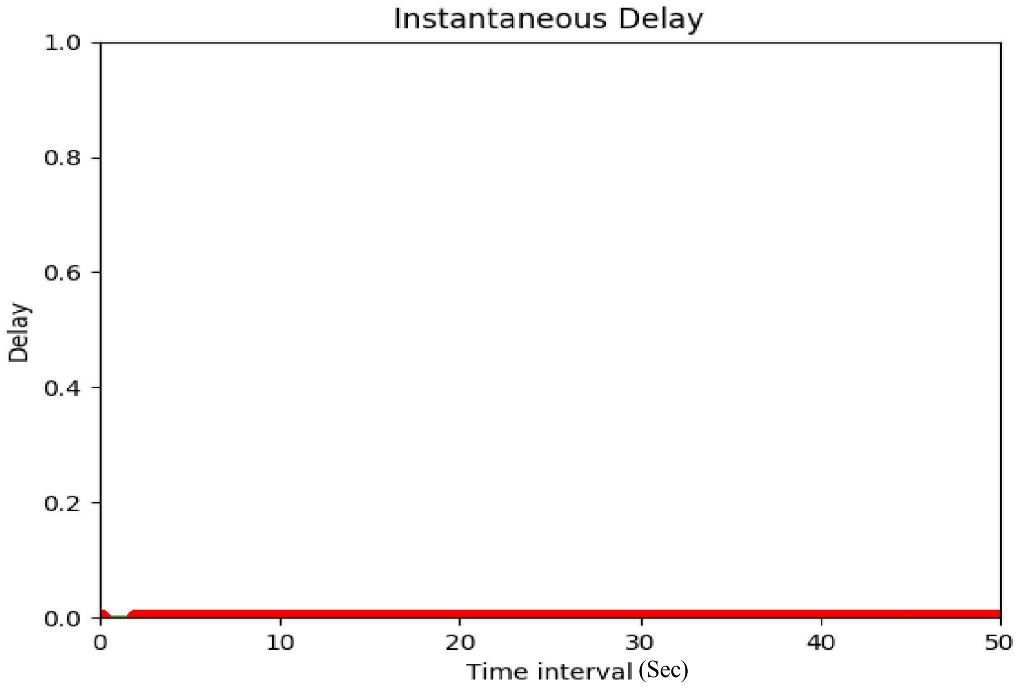

Figure 6.2: Delay vs. Time Interval

6.1.2 RESULTS:

--Average throughput--

StartTime: 2

StopTime: 49

ReceivedPkts: 3858

AvgTput[kbps]: 347.139

--Average Delay--
AvgDelay[ms] overall: 0

Packet Delivery Ratio
GeneratedPackets = 54.27

ReceivedPackets = 3858

Packet Delivery Ratio = 7108.9

Total Dropped Packets = 0

6.1.2 OUTPUT

For number of nodes=1000

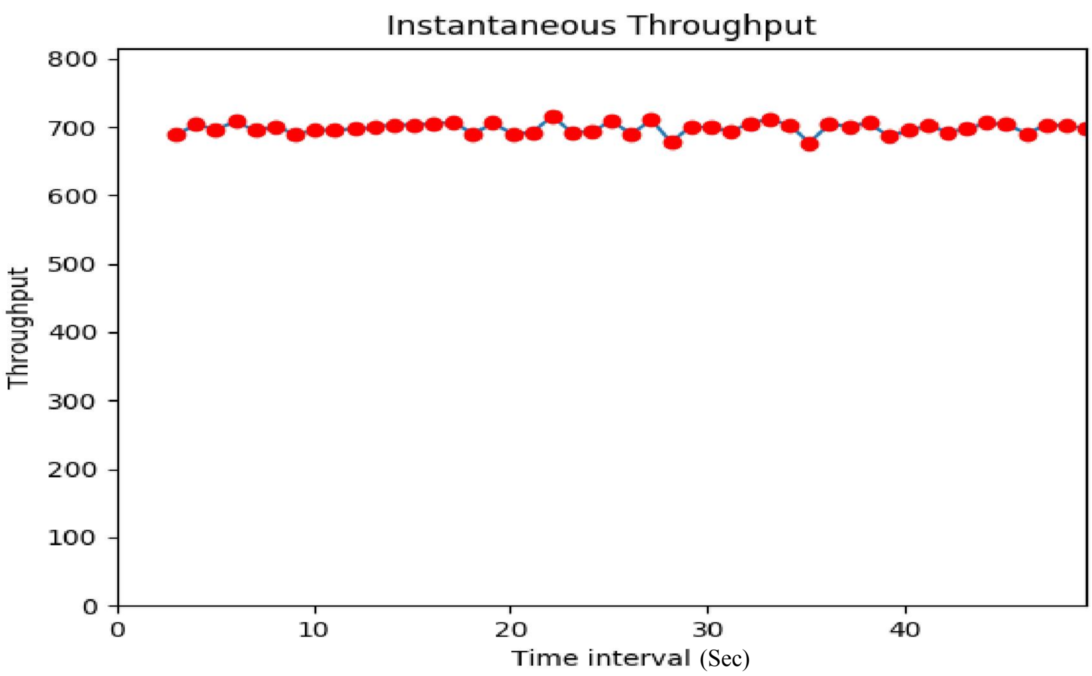

Figure 6.3: Throughput vs. Time Interval

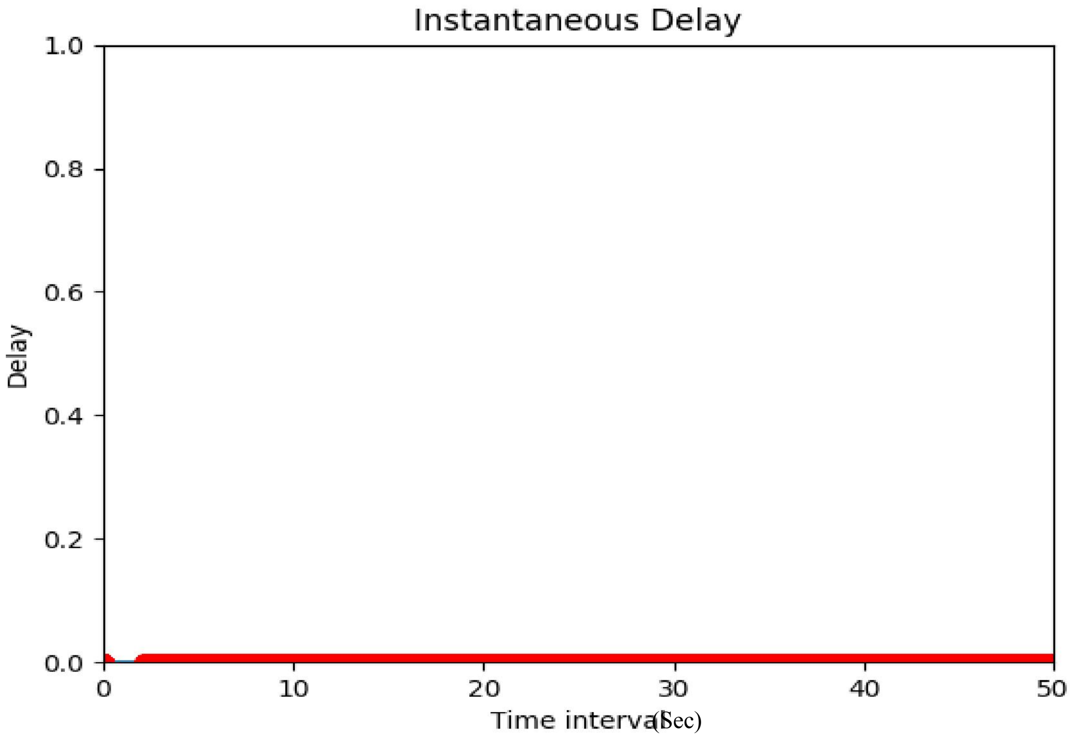

Figure 6.4: Delay vs. Time Interval

6.1.4 RESULTS:

--Average throughput—

StartTime: 2

StopTime: 49

ReceivedPkts: 7753

AvgTput[kbps]: 698.393

--Average Delay—
AvgDelay[ms] overall: 0

Packet Delivery Ratio
GeneratedPackets = 206.13

ReceivedPackets = 7753

Packet Delivery Ratio = 3761.22

6.2 DESTINATION-SEQUENCED DISTANCE VECTOR

6.2.1 OUTPUT

For number of nodes=500

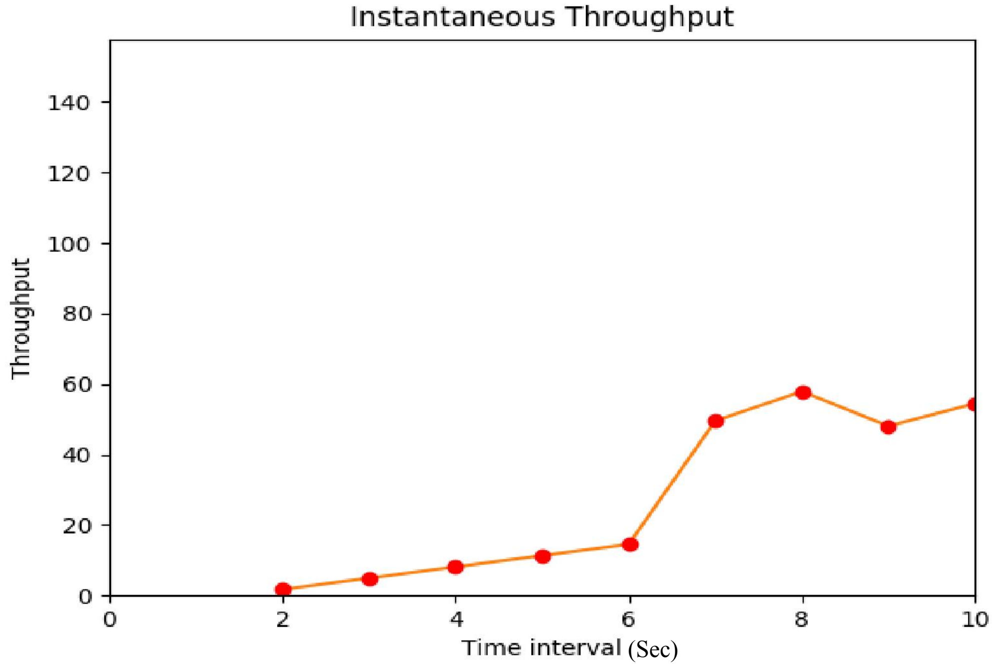

Figure 6.5: Throughput vs. Time Interval

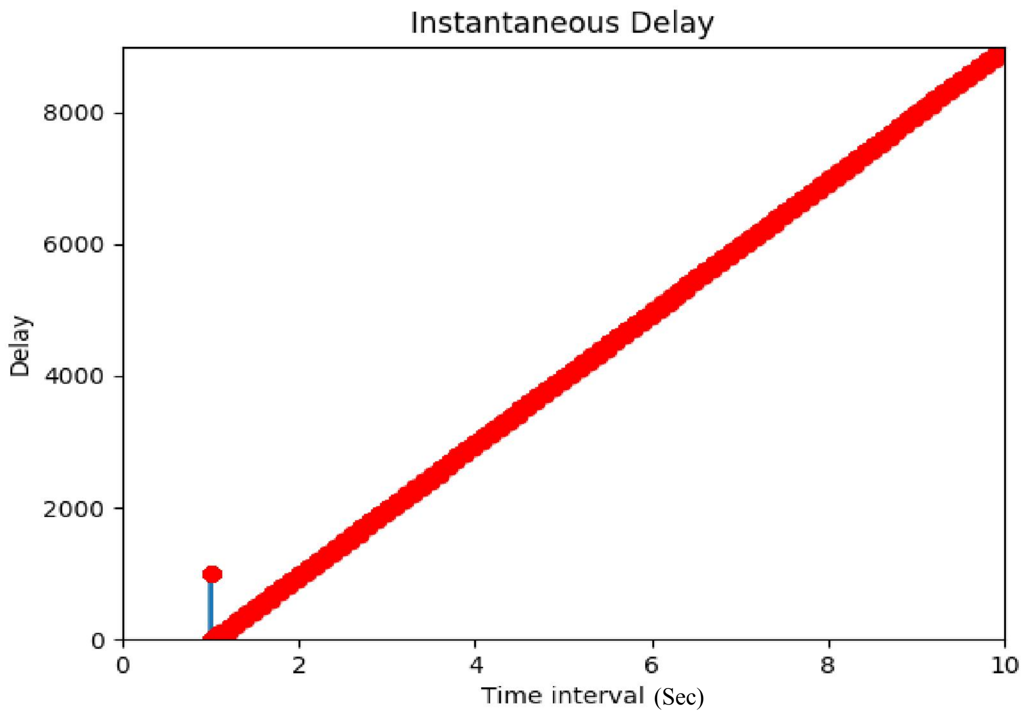

Figure 6.6: Delay vs. Time Interval

6.2.2 RESULTS

--Average throughput--

StartTime: 1

StopTime: 10

ReceivedPkts: 18611

AvgTput[kbps]: 27.9582

--Instantaneous throughput--

2	1.68
3	4.88
4	8.08
5	11.28
6	14.48
7	49.536
8	57.84
9	48
10	54.4

-Average Delay--

AvgDelay[ms] overall: 8955.32

Packet Delivery Ratio

GeneratedPackets = 1

ReceivedPackets = 18611

Packet Delivery Ratio = 1861100

6.2.3 OUTPUT
For number of nodes=1000

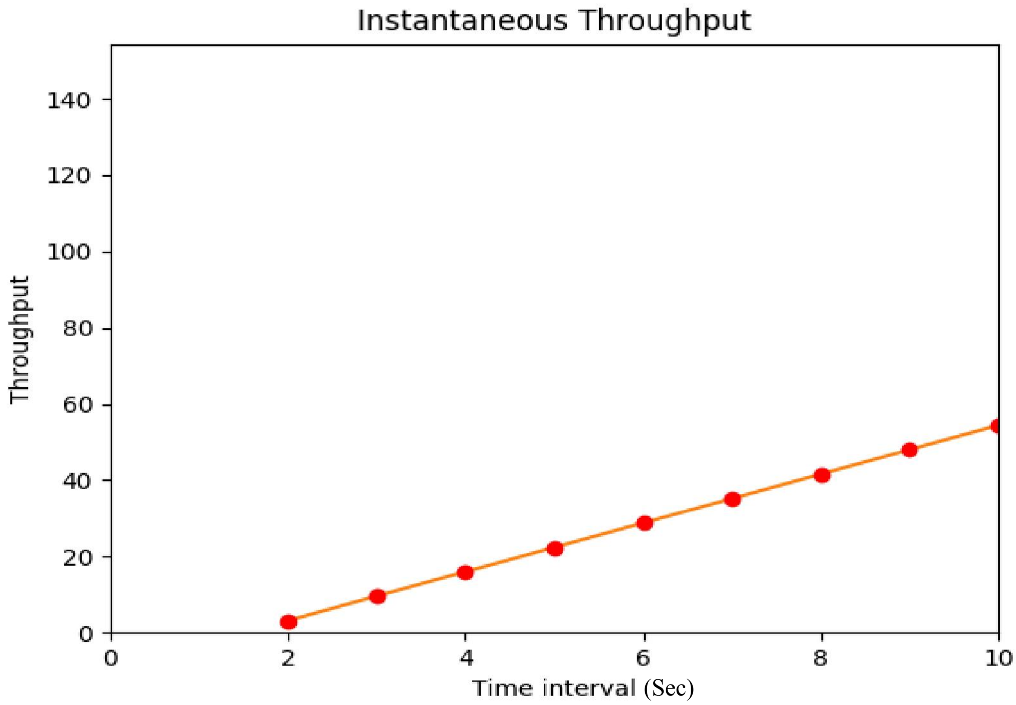

Figure 6.7: Throughput vs. Time Interval

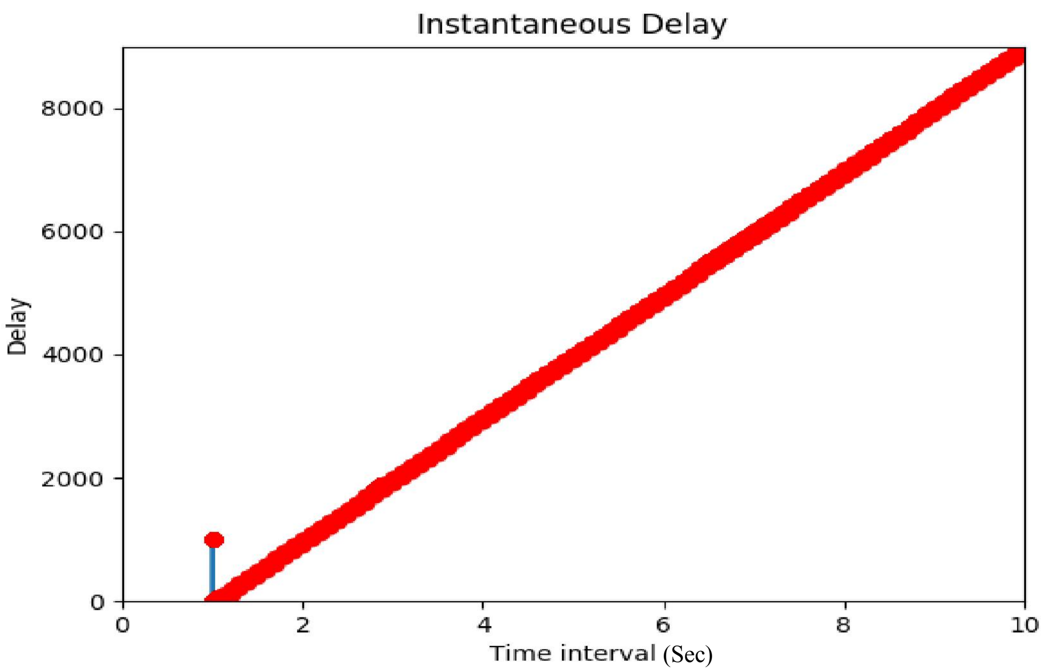

Figure 6.8: Delay vs. Time Interval

6.2.4 RESULTS

-Average throughput--

StartTime: 1

StopTime: 10

ReceivedPkts: 12949

AvgTput[kbps]: 28.9609

--Instantaneous throughput--

2	3.2
3	9.6
4	16
5	22.4
6	28.8
7	35.2
8	41.6
9	48
10	54.4

--Average Delay--
avgDelay[ms] overall: 8955.12

Packet Delivery Ratio
GeneratedPackets = 1

ReceivedPackets = 12949

Packet Delivery Ratio = 1294900

6.3 AD HOC ON-DEMAND DISTANCE VECTOR

6.3.1 OUTPUT

For number of nodes=500

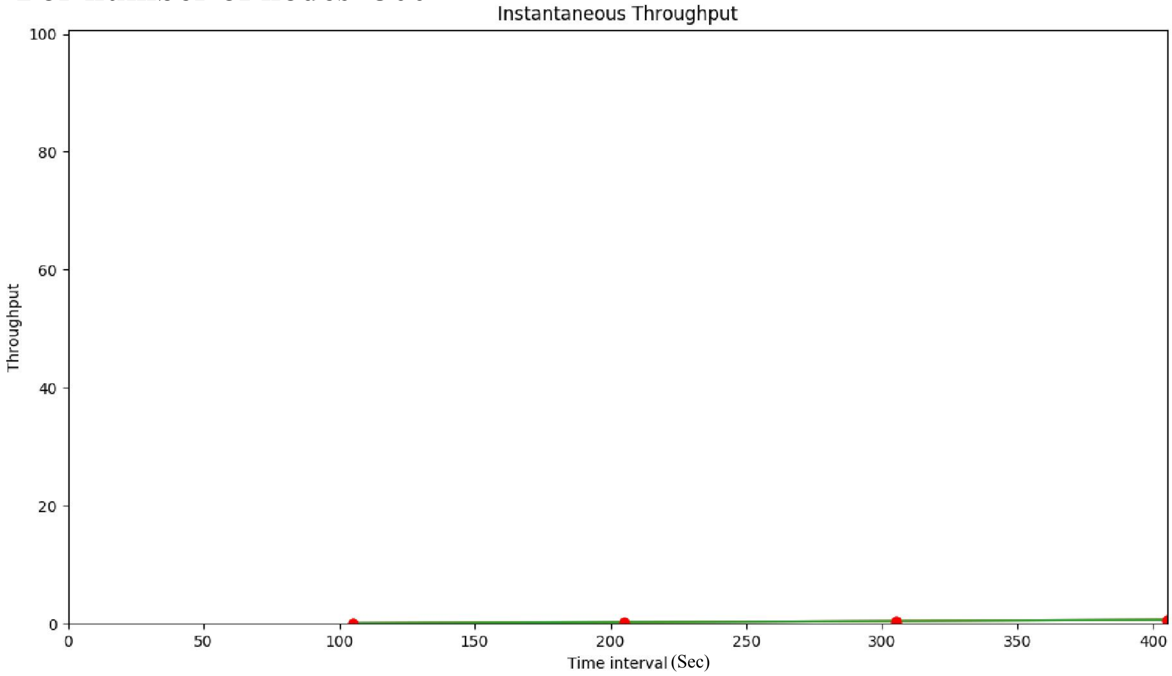

Figure 6.9: Throughput vs. Time Interval

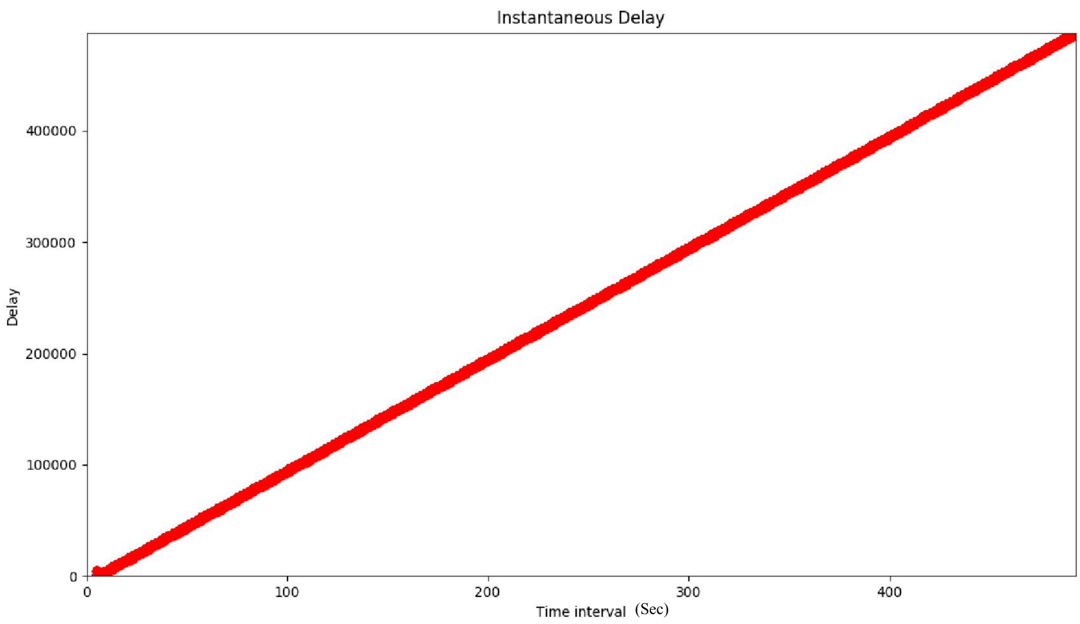

Figure 6.10: Delay vs. Time Interval

6.3.2 RESULTS

--Average throughput--

StartTime: 5

StopTime: 498

ReceivedPkts: 21136

AvgTput[kbps]: 0.484927

--Instantaneous throughput--

105	0.102
205	0.302
305	0.502
405	0.702

--Average Delay--

AvgDelay[ms] overall: 490551

Packet Delivery Ratio

GeneratedPackets = 2

ReceivedPackets = 21136

Packet Delivery Ratio = 1056800

Total Dropped Packets = 0

Average residual energy :116.261311

6.3.3 OUTPUT
For number of nodes=1000

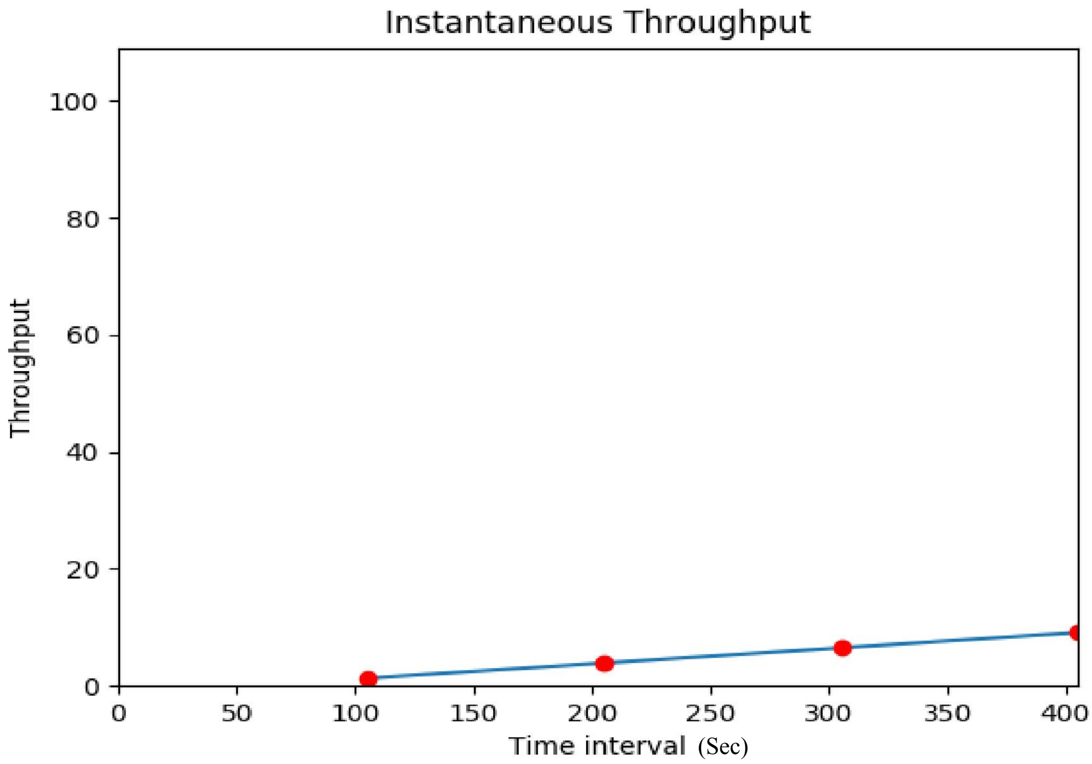

Figure 6.11: Throughput vs. Time Interval

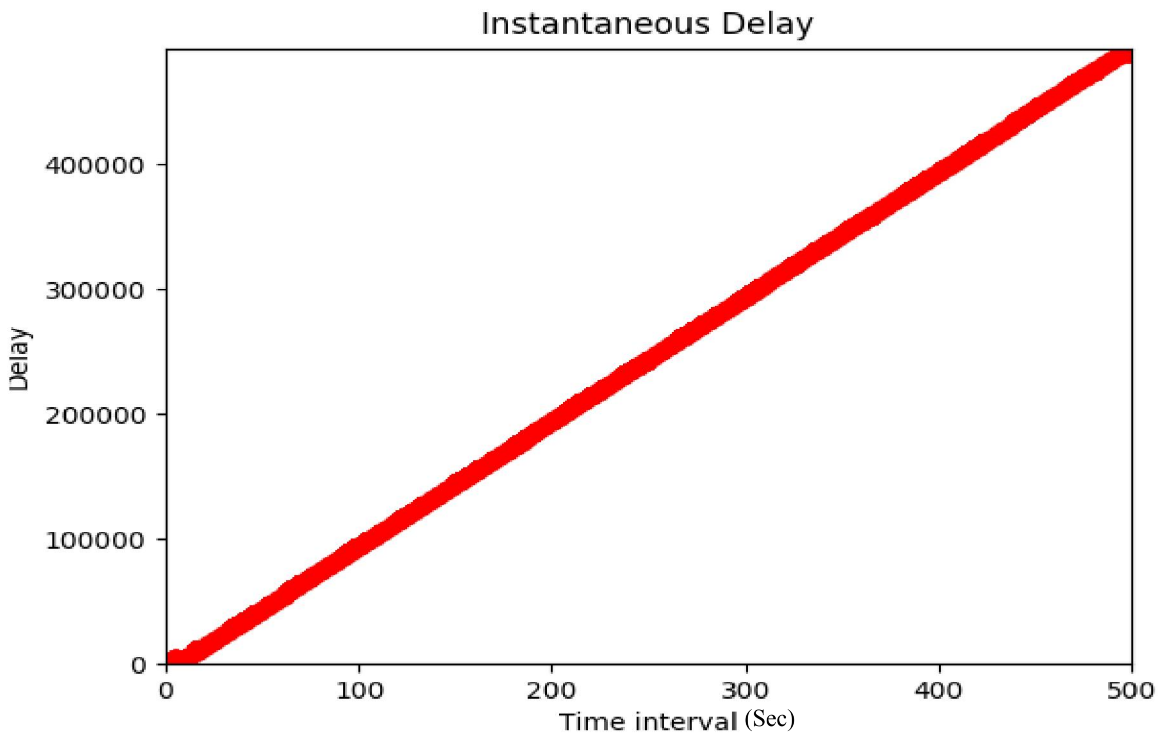

Figure 6.12: Delay vs. Time Interval

6.3.4 RESULTS

--Average throughput--

StartTime: 5

StopTime: 493

ReceivedPkts: 8241

AvgTput[kbps]: 6.36914

--Instantaneous throughput--

105	1.278
205	3.878
305	6.478
405	9.078

--Average Delay--

AvgDelay[ms] overall: 488030

Packet Delivery Ratio

GeneratedPackets = 275

ReceivedPackets = 8241

Packet Delivery Ratio = 2996.73

Total Dropped Packets = 0

Average residual energy :101.996804

CONCLUSION

Wireless Sensor Networks have potential to overcome challenging activities and fulfil the demands for extending network lifetime, enhancing the activeness, scalability, and autonomous processes. Through the implementation of Clustering protocol LEACH and E-LEACH, we concluded that E-LEACH provided better results in terms of energy efficiency.

For further detailed performance analysis we extended our research work towards routing protocols in which we have implemented various routing protocols like Dynamic Source Routing (DSR), Destination-Sequenced Distance Vector (DSDV) and Ad Hoc On-Demand Distance Vector (AODV) using NS-2 simulator and compared the outputs.

On comparing these three routing protocols we found that DSR is better than the other protocols in terms of average throughput and average packet received for number of nodes equal to 500 and 1000.

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Name: Amit Kr. Tiwari, Aman Singh, Shreya Gupta Department: ECE

Enrolment No. 141026, 141063, 141065 Registration No. ____________

Phone No. 9805055664 Email ID. amansingh271095@gmail.com

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