International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

||Volume 8, Issue 7, July 2020||

Development of A-Leach Protocol for WSN

Kamakshi, Princy, Kirti Bhatia, Shalini Bhadola, Rohini Sharma

PG Student, Dept. of C.S., Sat Kabir Institute of Technology and Management, Bahadurgarh, Haryana, India

Assistant Professor, Dept. of C.S., Sat Kabir Institute of Technology and Management, Bahadurgarh, Haryana, India

Assistant Professor, Dept. of C.S., Sat Kabir Institute of Technology and Management, Bahadurgarh, Haryana, India

Assistant Professor, Dept. of C.S., Sat Kabir Institute of Technology and Management, Bahadurgarh, Haryana, India

Assistant Professor, Dept. of C.S., GPGCW, Rohtak, Haryana, India

ABSTRACT: The Wireless sensor networks (WSN) are becoming popular as an emergent requirement for manhood. Although, these networks are developing vary rapidly but, they can be used in approximately all aspects of the life. There is a need of more research to be conducted in a standard way. In this work, we have carried out cluster based routing for WSN. We have studied LEACH, PEGASIS, SPIN and GAF in detail. Also, we have amended one of the most well-known WSN's routing protocols LEACH and developed the Amended LEACH (A-LEACH) by initiating effective cluster head substitution method and different transmission energy requirements. In comparison to the LEACH, the proposed A-LEACH, performs better in terms of several parameters like cluster head setup, throughput and permanence phase of network. Subsequently we have set a value of energy for cluster heads known as delta. We have also made a comparison of popular energy efficient protocols for WSNs.

KEYWORDS: Energy Harvesting for WSN; LEACH; Permanence Phase

I. INTRODUCTION

A WSN contains spatially disseminated sovereign sensors to accommodatingly observe real or ecological circumstances (see Fig. 1)[1]. The sensors link wirelessly and regularly self-organized subsequently staying planned in an ad-hoc style. A sensor-net can include many numbers of nodes, even in thousands. Source nodes convey their information to destination nodes via relay sensors. The destination node has been associated to a central gateway (known as BS).The BSoffers a linking to the outside world where the data may be composed, handled, and examined.

The WSN has achieved ample popularity, as it is being utilized in every other industry, because of the technical advancements in processor, low power consumption and cross-layer design. The varied applications of a WSN include area monitoring, health care monitoring, earth sensing, air pollution monitoring, water quality monitoring, machine health monitoring, data logging, threat prevention etc. Sensor nodes are employed for the measurement of the ecological traits like temperature, compression, moisture, noise, vibration, placement etc.

The main components of WSN are as follows:

A. *Sensor Node/Mote*: Sensor nodes are normally made of some sensors and mote component like revealed in Fig.2. A Sensor perceives the info and passes it on to node circuit. These are naturally employed to evaluate the variations in physical ecological factors such as hotness, compression, moisture, noise, trembling and variations in the health aspects of a human, for instance BP and heart-rate. A mote contains CPU, storage, power cell, ADC circuit for linking to a sensor and a transceiver for creating an ad-hoc infrastructure. A WSN is a wireless ad-hoc network of sensors. Every sensor may assist a multi-node routing procedure and works as relay node for communicatingmessages to the BS. It is proficient of performing data processing, congregation and cooperating with extra linked sensors of the network.

B. *Power Block*: Every sensor mote is equipped with battery power. Battery is an vital component of the sensor node. If the battery has enough energy, sensor can very well perform its functions. A wireless sensor mote is often deployed in an inaccessible location, it is hard and inconvenient to replace its battery. A sensor mote consumes more power in communication than processing. There are various types of batteries available like, chargeable and non-chargeable. Some sensors are capable of refurbishing their energy through vibration, solar energy and temperate difference [2].

C. *Relay Node:* It is an intermediate sensor employed to communicate with the neighbouring sensors. It is employed to upsurge the reliability of the network. A rely node is a distinct kind of ground device that does not have process sensor or control apparatus and as such does not interface with the process. Normally, these sensors are resource packed devices which are equipped with great excellence handling competences, superior transmission powers and battery lifetime.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

||Volume 8, Issue 7, July 2020||

D. *Cluster Head (CH)*: It is highly able sensing node employed to make combination and accumulation of data in network. According to the necessities and usages of the system, there can be more than one CH in a cluster. An individual CH processor is approximately 5-9 MHz, consisting of 512 KB of primary memory, flash and possibly GHz of radio frequency. It is supposed to be extremely consistent, safe as well as reliable by every other node of the WSN.

E. *Gateway*:It is a boundary among WSN and outdoor infrastructures. Contrary to the sensor mote and CH, this node is utmost authoritative in context of memory and data, the CPU employed transmission and receiving scope and the likelihood of extension via exterior storage.

F. *Base Station (BS):*A BS contacts the WSN to different network. It comprises of a CPU, radio mother-board, antennas and interface for USB. It has been pre-programmed with low-energy mesh network software so that it can communicate with wireless sensor motes. Installation of the BS in a WSN is quite significant because all the sensors transfer their data to the BS for managing and decision building. Preservation of energy, coverage of sensor nodes and consistency matters are considered during deployment of BS in WSN. Normally BS are supposed to be stationary in character however in few situations they are assumed to be moveable for the gathering of the information from nodes.

II. RELATED WORK

The WSN is a disseminated pool of supply restrained small nodes competent of working with nominal user presence [3]. Quick progress in micro electromechanical systems (MEMS) machinery has delivered tiny sized, low-energy, and price sensor motes which have the ability to perceive numerous variety of substantial as well as atmosphere circumstances. The WSN enhances the capability of peoples to observe and regulate physical sites from faraway places [4]. As every sensor node is capable of working individually without any central management, stoppage of few sensors does not disturb working of entire network [4]. Contrary to other types of networks, the WSN is more consistent and protected. Every node is furnished with one or more low power-driven sensors, a CPU, storage, an energy resource, a radio, and an actuator [6].

.

III. ENERGY HARVESTING FOR WSN

The devices that use battery cannot be used for longer duration and if battery is used as the only source of power, then it may not be able to fulfill the design objectives such as optimization of energy, optimization of cost, long lasting, etc. simultaneously. These issues are solved by implementation of proper energy harvesting techniques in the wireless transmission networks. Energy harvesting provides a sustainable medium to make the wireless sensor devices sustainable and long-lasting. Energy harvesting consists of mainly two categories or sources and these are as follows:

1. Manually generated energy sources
2. Renewable Energy Sources.
   - Renewable energy source: The energy sources that are available in the physical environment itself and don't need any external influence by humans are called renewable energy sources. Instances of these sources are solar, wind, tidal, geothermal and RF energy, etc.
   - Human generated energy sources: The energy that is generated from human beings and their movements. Examples of the human generated energy sources are body heat, heel strikes, breath, finger motion, etc.

Due to the latest advancements in energy harvesting technologies, these sources have facilitated the wireless sensor devices with energy saving solutions for the rising issues in the WSNs, and should be considered as the effective substitute to upsurge the enactment of the devices making use of wireless sensors and also increase their average lifetime.

IV. WORKING OF LEACH PROTOCOL

The present attention in WSNs causes the occurrence of various applications centered protocols of which LEACH is the maximum ambitious and extensively employed method. It may be defined as a mixture of a cluster oriented design and multi-node transmitting. The expression cluster oriented means sensors using the LEACH protocol work on the basis of CHs and members of clusters. This routing is employed for cluster transmission with CHs and BS. According to experiments the multi-hop routing put away fewer powers when likened to straight communication.

The sensors detect data, combined them and transmit in the form of packets to the BS from a distant region through the radio broadcast method. Throughout this procedure, many challenging problems happen, like collision of data and the aggregation of data. LEACH is sufficient to lessen the data aggregation problems by means of a native data fusion which works by compressing the quantity of data which is composed by the CH afore it transmits it to the BS. Each sensor builds a self-maintained network by allocating the function of a CH at least one time. The CH is mainly liable

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

||Volume 8, Issue 7, July 2020||

for transmitting the data. It attempts to equilibrium the power depletion in the WSN and augments the lifespan of the network through improvement of the lifespan of the nodes. There are two stages of operations which take place in the LEACH (figure 3).

. *A. Set up Stage:*Figure 4 shows parts of setup phase of LEACH protocol. In this stage, each node in a network cluster itself into a zone by transmitting with each other via short MSG. In the network, at an instance of time one sensor acts as a CH and transmits short messages inside the network to all the other residual nodes. The nodes pick to connect those clusters or zones which are designed by the CHs, conditional to the power of the signal of the messages transmitted by the CHs. The nodes which are keen to join a specific CH or area reply to the CHs by communicating a return signal representing their approval to link. Therefore the set-up stage finishes in this manner. The CH can select the optimum number of cluster members which it is able to manage or entails.Prior entering in the steady-state stage, specific aspects are deliberated, like the topology of the network and the comparative costs of calculation vs. the transmission. A TDMA Program has been applied to every cluster member of the cluster group to convey packets to the head, and then to the CH to the sink.

B. Steady State Stage: Once a CH is picked for a region, each member off that area transmits the accumulated or identified information in their allocated TDMA periods to the CH which transfer this composed data in a compacted form to the sink and finishes the second phase, known as Steady State Phase. As soon as this phase completes, the data transmits to the sink, the complete procedure finishes and a fresh hunt starts for the formation of CHs for a zone and fresh cluster-member arrangement starts. Concisely, we can say that a fresh set-up stage and steady setup stage begins with the completion of data communication towards the BS. This alternate assortment of CHs within the area, that is performed by the sensors in a self-regulating manner assists in decreasing or reducing the utilization of battery.It is possible that each sensor is not very near to the CH; therefore the quantity of power which is consumed by the remoter sensor is non-equivalent to the quantity of power consumed by the nearby mote. For the sake of minimizing it, formation of CH or the role of CH is accomplished by a rotation among all the sensors in the cluster. At several intervals, LEACH reduces universal power consumption by allocating the burden of the network to each sensor or members of thecluster. All heads communicates the info to the sink in a compressed format. All the CHs cannot be nearby to the sink, they convey the compacted data to the adjacent CHs and in this manner, a multi-node routing WSN can be designed. LEACH performs the randomized alternation of the CH in sake of saving the high battery which is wasted during transmission of data to the BS. This alternation is performed for all the motes, as a result there is no shortage of the energy or battery of a sensor.Let us take into account a random sensor network in which there are no or complete number of CHs are present, the total power consumed by the CHs and their member is equivalent to the power which is consumed in a straight transmission. It proves that if there are an optimum number of CHs in the WSN which operates in conveying the composed data from their particular members. Better results can be achieved by saving of energy consumption.

V. PROPOSED METHOD

Our method is partially inspired from the LEACH protocol. In LEACH the CH changes in all rounds. But in Amended LEACH Protocol for WSN (A-LEACH) the cluster head does not change at every round. We set a level of energy (delta) for each CH. If the battery of the CH is more than delta than it remains as the CH else another node is set as a CH. This solution helps in less wastage of energy as less number of routing packets will flow in the network.Moreover there are three types of transmission: inter, intra and cluster to sink node transmission.Inter cluster transmission is performed within the cluster members. Intra cluster transmission is done between cluster heads.Finally, the collected data has been send towards sink node by all the cluster heads.Our proposed protocol have a mixed strategy, it transmit data directly as well as through CHs towards the BS. There are some terms which are used in the proposed protocols as follows:

- Permanence Phase: It the interval between the beginnings of network starts functioning and till the expiry of first sensor.
- Impermanence Phase: It the interval between the expiry of first sensor and the expiry of last sensor.
- Throughput: Amount of whole data transferred in the WSN during its operation like transfer of data from sensors to CHs or from CHs to the BS or from sensors to straight BS.
- Lifespan: Duration of functioning of WSN.
- Aggregation of Data: In sake of reducing energy consumption, similar type of data is aggregated and transmitted further.

VI. NETWORK CONFIGURATION

We take into account a sensor network as energy-harvesting sensor network where N number of sensors and a BS are placed in a geographical zone. These sensor motes are installed arbitrarily in a given rectangular region.Least amplification power is different for inter-cluster or intra-cluster or towards transmission to sink.For all kinds of

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

||Volume 8, Issue 7, July 2020||

transmissions, amplification energy is set same for LEACH. The low level energy for intra cluster communication with regard to CH towards BS transmission cause saving of energy. Furthermore, different energy levels also decrease the ratio of packet loss, crashes or intrusion for another signal. For this perspective, we adopt that, at maximum, a cluster can span into a zone of 10X10m2 in a region of 100X100m2. Energy which is sufficient to convey at maximum ends of a field of 100X100m2 should be reduced much for intra-cluster communiqué. When a node becomes a CH, it uses excessive energy magnification and in subsequent cycle, if it becomes a member of the cluster, routing protocol shifts it to low energy level. Lastly, soft and hard threshold methods were also employed in A-LEACH and produce better outcomes.

VII. ENERGY CONSUMPTION MODEL

We have taken into account the first order radio energy model for energy consumption estimation of the protocol. A node consumes radio electronic power (E_{elec}) to operate and amplification power (ε_{amp}) to transmit a packet [10]. The aggregate energy (E_{tx}) disbursed in the broadcast of a packet through a path of *s* transitional sensors, is expressed by equations:

$$E_t(|\dots|) = lb(E_{elec} + \varepsilon_{amp} * d^{\lambda}_{|\cdot|}) \quad (1)$$

Energy consumption in receiving a packet is given by:

$$E_r = lbE_{elec} \quad (2)$$

The distance factor is considered zero for receiving a packet. Let E_{DA} be the energy disbursed in data aggregation, then the energy disbursed in aggregating *M* messages is given by:

$$E_{Agg}(M, lb) = M \cdot lb \cdot E_{DA} \quad (3)$$

Here we assume that the complete energy parameters are used for RF based communication model. In order to transmit a single bit data, the energy consumed by RF unit can be expressed as

$$e_{RF}(d) = \begin{cases} \epsilon_{mp} d^4, & d_0 < d \\ \epsilon_{fs} d^2, & 1 < d \leq d_0 \\ \epsilon_{fs}, & d \leq 1 \end{cases} \quad (4)$$

Where ϵ_{mp} and ϵ_{fs} denotes the energy (J) constants for multi-path and free-space channel model. On the other hand, sensor node performs several other tasks during communication such as modulation, channel coding and spreading etc. which consumese_{elec} quantity of energy. Hence, the energy disbursed by a cluster-member to convey a packet can be articulated as:

$$\mathbb{E}_n^{\overline{CH}} = P_L(e_{RF}(d_{mn}) + e_{elec}) \quad (5)$$

Let us consider that $E_n^r(i)$ and E_n^h denotes the residual energy and harvesting energy respectively of node n for the current i^{th} frame. At this stage, a cluster member node n can transmit the data if it has sufficient energy for the transmission. This relation is given as:

$$\mathbb{E}_n^r \geq \mathbb{E}_n^{\overline{CH}} \quad (6)$$

That means, if the cluster member node's residual energy is equal or more, then it can transmit the packet to other CHs. If enough energy is not available, then the sensor node waits until the enough energy is accumulated. The enduring energy of the sensor n may be expressed as:

$$\mathbb{E}_n^r(i+1) = \mathbb{E}_n^r(i) + \mathbb{E}_n^h(i) - \mathbb{E}_n^{\overline{CH}} I_A \quad (7)$$

Where $A = \mathbb{E}_n^r(i) \geq \mathbb{E}_n^{\overline{CH}}$ is an indicator function which is set to 1 if $\mathbb{E}_n^r(i) \geq \mathbb{E}_n^{\overline{CH}}$otherwise $A = 0$.

In general, if any node doesn't have thee enough energy for packet transmission then it doesn't participate in communication and the energy consumption for that particular node remains zero. On other hand, if the node is having sufficient energy then the energy consumption for that CH node can be computed as:

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

||Volume 8, Issue 7, July 2020||

$$\mathbb{E}_m^{CH}(i) = I_{Tx_m}(i) \times \left(P_L \sum_{k=1}^{k_m-1} I_{Tx_k}(i)\,(e_{da} + e_{elec}) + P_L e_{da} I_{k_m>1} + e_n\right) \quad (8)$$

Where the first term represents the power requirement for transmitting the packet to the sink node, second term represents the power disbursed for receiving the data from its cluster member, and the third term represents the power disbursed for data aggregation. $k_m$denotes number of sensors in the cluster, e_{da} denotes the data aggregation energy consumption and $e_n = P_L(e_{RF}(d_n) + e_{elec})$ is the least essential energy for node n to convey the packet directly to the BS.

Once the energy conditions are satisfied then the sensor node transmits the packet and all packets are received at the CH node where data aggregation process is implemented and the energy level of the CH node is measured for transmitting the packet to the sink node i.e. $\mathbb{E}_m^r(i) \geq E_m^{CH}(i)$that means residual energy is more than the required energy for packet transmission hence the CH node m can convey the packet to the next hop, the remaining energy can be expressed as:

$$\mathbb{E}_m^r(i+1) = \mathbb{E}_m^r(i) + \mathbb{E}_m^h(i) - \mathbb{E}_n^{CH}(i) I_{E_m^r}(i) \geq E_n^{CH}(i) \quad (9)$$

Based on this modeling, we consider some assumptions which are as follows:

- Every node is furnished by a battery which has enough storage capacity for data processing and transmission

The entire data packet which has arrived at the CH node, aggregated into one packet and transmitted to the sink node.

VIII. MECHANISM FOR CLUSTER HEAD

We have used LEACH protocol [10] mechanism to choose CHs among the sensor motes. In the clustering setup phase, nodes within an area, choose themselves as the cluster heads in distinctive cycles. The number of CHs (k) in a round is given by:

$$\sum_{i=1}^{N} P_i = k \quad (10)$$

And the likelihood of a node $N_i$to be selected as a CH at round r is expressed as:

$$P(N_i) = \begin{cases} \frac{k}{N - k*(r \bmod N/k)} & : \ 1 \ if \ N_i \in S \\ 0 & : \ otherwise \end{cases} \quad (11)$$

Where S, is the set of non-cluster heads in current (r *mod* N/k) rounds. The value of $P(N_i)$ is one, if node N_i is not designated as a cluster head in latest rounds else $P(N_i)$ is zero.

The value of (r *mod* N/k) decides the total number of motes elected as the CHs in recent cycles. Whole number of sensors which are qualified to be a head at present round r is expressed as:

$$T(r) = N - k * (r \bmod N/k) \quad (12)$$

This ensures the uniform energy depletion in complete set of sensors after every cycle. The selected CHs in each zone transmits an ADV control packet to their adjacent motes in their area. To evade collision, CH implements the TDMA [10] amongst its member motes for data communication.

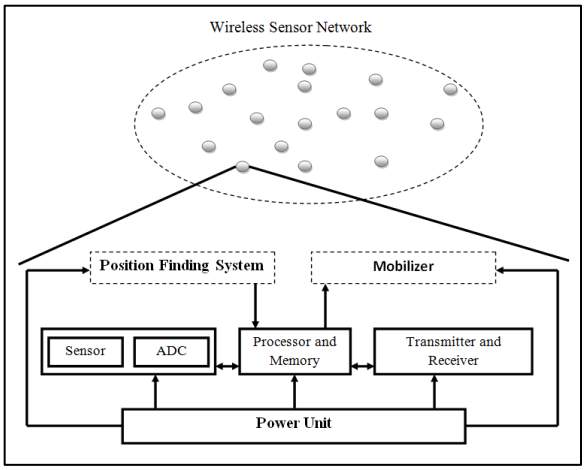

Fig.1.Modules of WSN

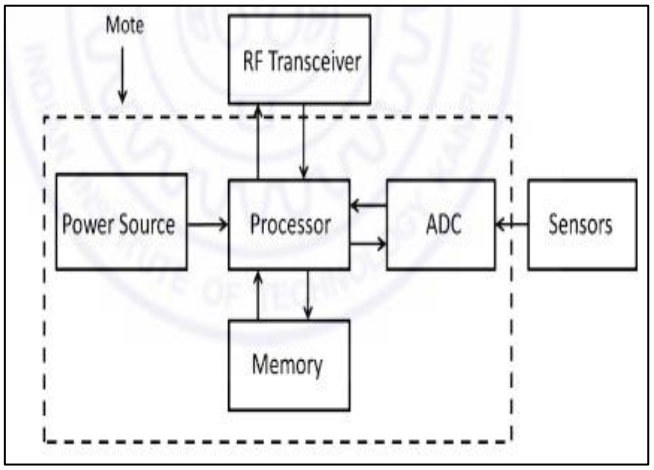

Fig. 2.Pictorial Depiction of Sensor Node

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

||Volume 8, Issue 7, July 2020||

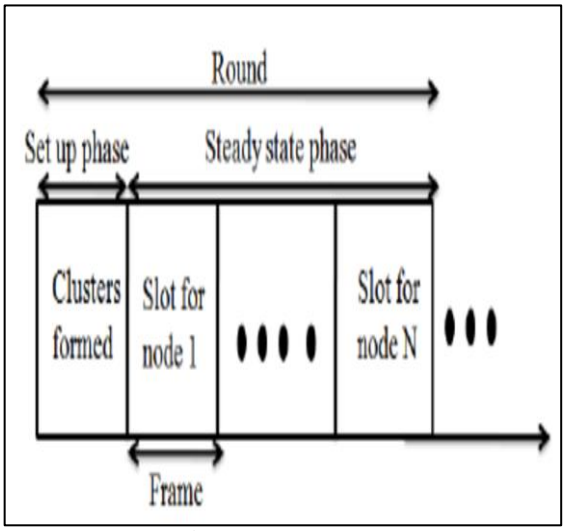

Fig. 3.Phases of LEACH Protocol

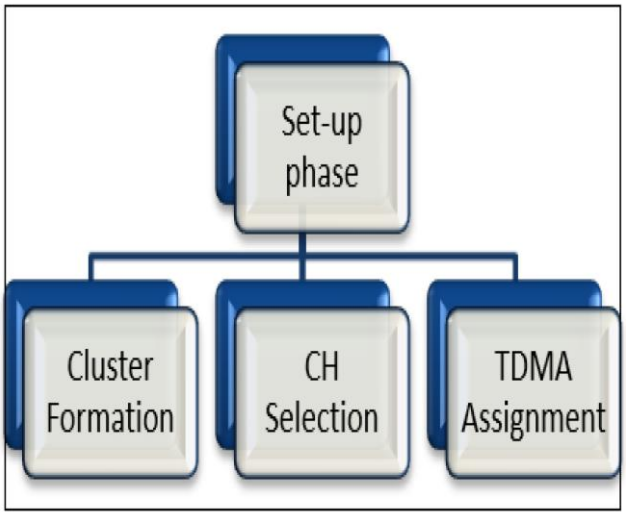

Fig 4.Set Up stage of LEACH protocol

IX. RESULTS AND DISCUSSION

We have considered a 100 X 100 m2 area of WSN which is needed to be monitored. Total 100 number of nodes have been disseminated in the field. We have carried out the experiments in a MATLAB bases environment. Table 3 show the parameters used in experimentations.At each round, normal sensor nodes of each region forward data to their gateway node/ CH node and similarly nodes in the sink region convey their data packets to the BS. In the cluster regions, the cluster members convey data to their head and then it do aggregation of data. Next, all the cluster heads transmit data to the gateway of their area, the node combined data received from all the cluster heads and from the normal nodes in its gateway region. Moreover, if the distance of any CH is lesser to the sink than the gateway node in its region. The cluster head is substituted only if its power is less than a threshold value.

Figure 6 exhibits the Permanence Phase in terms of alive nodes till the end of the network. More the number of alive nodes more are the permanence phase. Figure 7 shows the throughput of the WSN. Figure 8 displays the number of heads per round in the network. Figure 9 displays packets sent to cluster head per round.

Table 4.1: Parameters and their Values

Parameters	Value
$\mathbf{E_{init}}$	0.5 J
$\boldsymbol{E_{elec}}$	5 nJ/bit
$\mathbf{E_{fs}}$	10 pJ/bits m^2
$\mathbf{E_{mp}}$	0.0013 pJ/bit/m^4
$\mathbf{E_{DA}}$	5 pJ/bit
Initial energy of advanced nodes	E_{init} (1+β)

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

||Volume 8, Issue 7, July 2020||

Fig. 5 exhibits a MATLAB figure of proposed network.

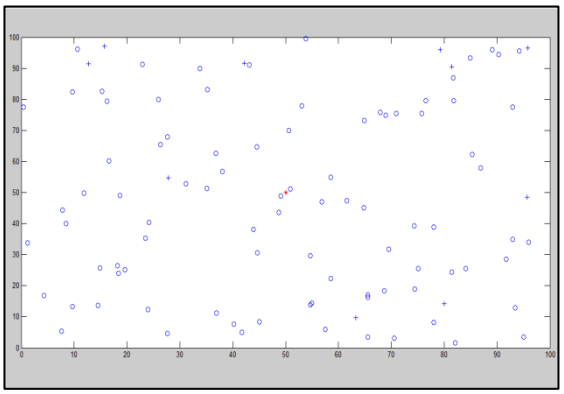

Fig 5.Sensors and Base station in 100 X 100 WSN

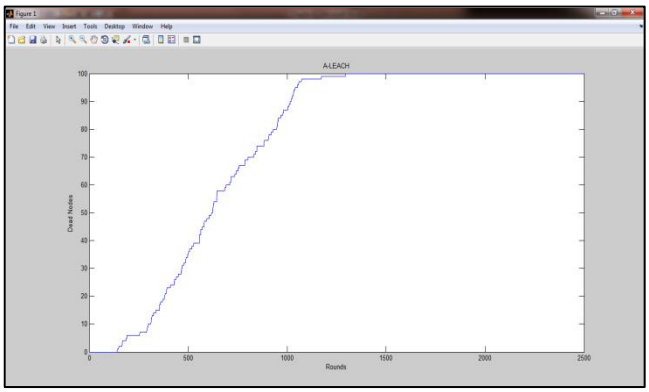

Fig 6. Permanence Phase

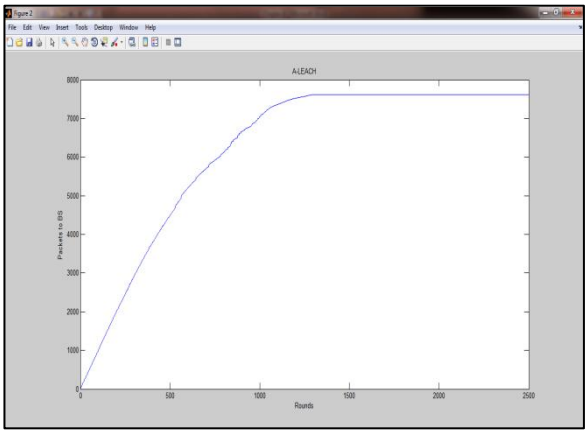

Fig 6.Throughput of WSN

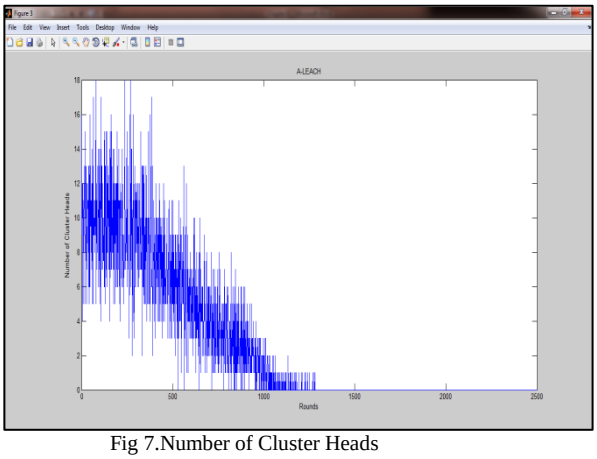

Fig 7.Number of Cluster Heads

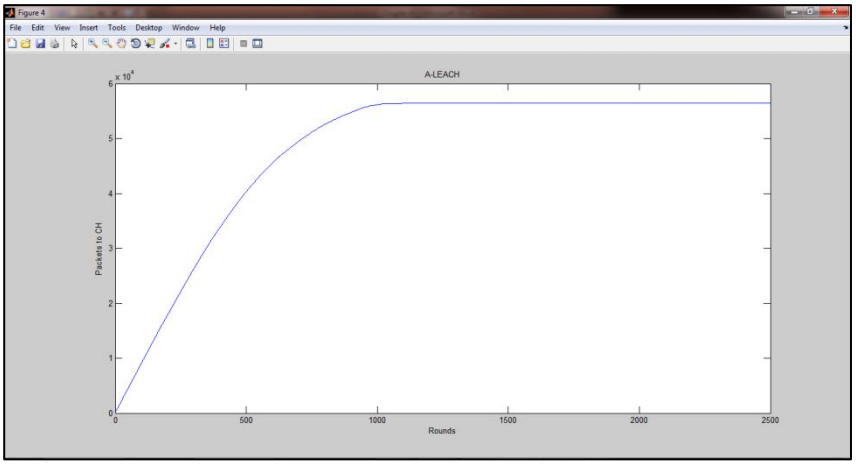

Fig 8.Packets send to Cluster Heads

X. CONCLUSION AND FUTURE WORK

Hereby, we represent a concise analysis on advent of cluster according to routing in WSNs. We have also projected A-LEACH, a fresh modification of LEACH which may be exploited in different cluster based routing protocols for energy proficiency. A-LEACH cause least energy consumption in network through effectual cluster head substitution after every cycle and double transmitting energy levels for intra-cluster and CH to sink transmission.In A-EACH, if the energy of a CH falls under a specific threshold, it can be replaced by another node to minimize the load of routing protocol. Henceforth, replacement procedure of CH includes residual energy of cluster head at the beginning of every

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

||Volume 8, Issue 7, July 2020||

cycle. Additionally, soft and hard thresholds have been applied on A-LEACH to provide a comparative analysis on enactments of these protocols taking into consideration throughput and energy consumption

REFERENCES

1. Akyildiz, I.F., Su, W., Sankarasubramaniam, Y. and Cayirci, E. (2002). Wireless sensor networks: a survey. Journal of Computer Networks, 38, 393-422.
2. Sinha, A. and Chandrakasan, A.N. "Dynamic power management in wireless sensor networks," IEEE Design & Test of Computers, vol. 18, issue. 2, pp. 62-74, 2002.
3. Hooda, S., Bhatia, K.., Sharma, R. (2016). Nodes Deployment Strategies for Sensor Networks: An Investigation. International Research Journal of Engineering and Technology, 3(4), pp. 2499- 2500.
4. Sharma, R. and Lobiyal, D.K. (2018). Intelligent Water Drop Based Coverage- Connectivity and Lifespan Maximization Protocol for Wireless Sensor Networks. Recent Patents on Computer Science, 10.2174/1872121126661805210829 55, 2018.
5. Sharma, R. (2015). Energy Holes Avoiding Techniques in Sensor Networks: A survey. International Journal of Engineering Trends and Technology, 20(4), pp. 204-208, 2015.
6. Chhillar, P., Bhatia, K., Sharma, R. (2016). Swarm Intelligence Inspired Energy Efficient Routing Protocols for Sensor Networks: An Investigation. International Research Journal of Engineering and Technology, 3(5), pp. 623-630.

BIOGRAPHY

Kamakshi is a Master of technology student in the Sat Kabir Institute of Technology and Management, Bahadurgarh, Haryana, India.