2nd International Conference on Emerging Trends in Materials, Computing and Communication Technologies
International Journal of Scientific Research inScience, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)

Enhanced Energy Efficient Routing in Wireless Sensor Network Using Modified Trust Based Leach Protocol

J. Sugan[1], Dr. R. Isaac Sajan[2], M. Joselin Kavitha[3], Dr. V. Bibin Christopher[4], Dr. J. Jasper[4]

[1]Assistant Professor, Department of Information Technology, Ponjesly College of Engineering, Nagercoil, Tamil Nadu, India

[2]Associate Professor, Department of CSE, Ponjesly College of Engineering, Nagercoil, Tamil Nadu, India

[3]Assistant Professor, Department of ECE, Marthandam College of Engineering & Technology, Nagercoil, Tamil Nadu, India

[4]Professor, Department of EEE, Ponjesly College of Engineering, Nagercoil, Tamil Nadu, India

ABSTRACT

Wireless sensor network could be a set of freelance transducers with communication infrastructure for recording and observance of different locations. The observance parameters are energy, temperature, humidity, pressure, direction and speed of the node in the WSN. The main challenges of WSN square measure potency, efficiency, quality,responsibility, robustness, privacy and security. Many researchers are addressing these difficult tasks of WSN however not with eachparameter. In this paper, we have projected toreinforce the lifetime of sensor in wireless sensor network that makes it reliable moreover as energy economical using Modified trust based LEACH Protocol. The new cluster technique, responsibilitysuggests that to stop the crashes of cluster head node and potency suggests that to require care concerning election of cluster head. Simulation result clearly suggest that Modified trust based LEACH protocol using Trust have performed well when compared with existing LEACH protocols.

Keywords: Energy Efficiency, Cluster Head Selection, Energy Efficient Clustering, Efficient Routing.

I. INTRODUCTION

In recent years WSN is an emerging area. WSN is associate interconnection of devices in wirelessly. The WSN has been employed in varied areas like military and civilian application. Sensor nodes are arbitrarily deployed inan surroundings and sense the real world. These sensor nodes square measure having restricted capability such tiny electromagnetic unit, tiny memory, low computation and low processing. The necessary parameter of sensor is lifetime. The sensor nodes square measure generates a vast quantity of information. Sensor nodes send the perceivedinformation to base station to additional operation. This sensor nodes square measure sorted

usually into cluster.Sensors square measure won't to monitor the real world atmosphere and transmit the perceived information to base station.

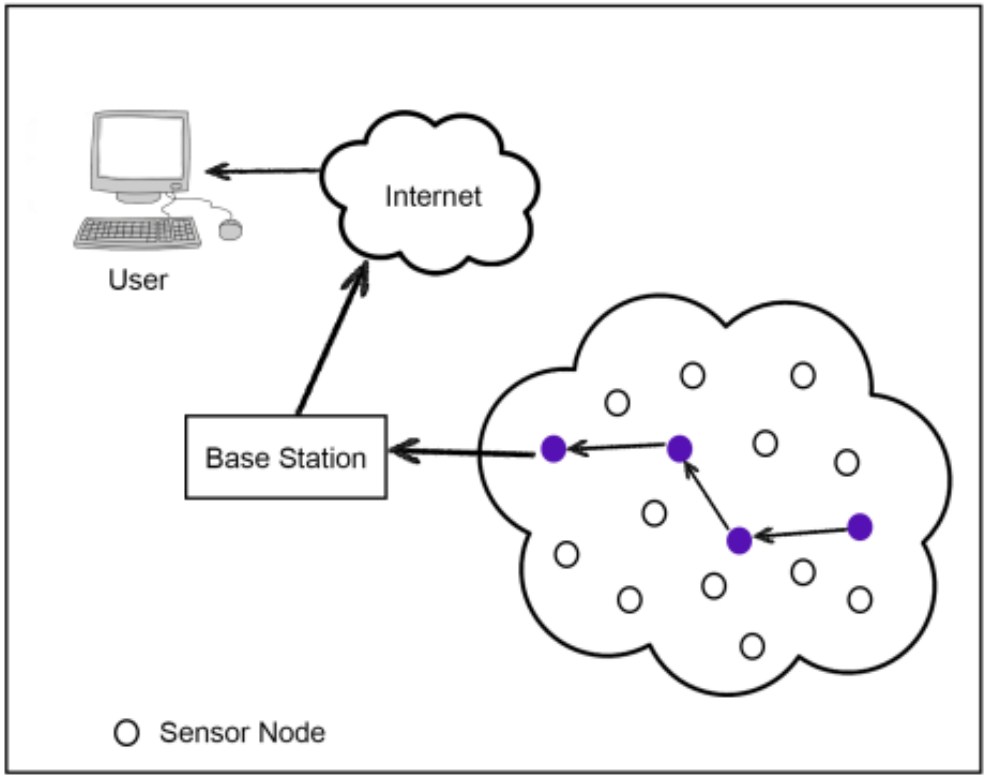

Fig 1. WSN Structure

If each and every sensor starts to speak and interact in knowledge transmission within the network the great data congestion and collision are practiced. The clustering is method to overcome these problems. WSN have some algorithms to solve these routing problems. Some of routing algorithms are try to increase the network lifetime and reduce the energy consumption. The routing algorithms are LEACH, HEED, DEEC, SEP, LCA, TASC, etc. These algorithms have the goals to extend the network energy and supply quantifiability.

In clustering concept every cluster contains a organizer mentioned as a cluster head and a variety of member nodes. The WSN contain 2 kinds of communication like inter-cluster communication among the nodes during a same cluster and also the intra-cluster communication among the nodes during a totally different cluster. However the intra clustering reduces the battery emptying of a node.

II. RELATED WORK

A. Cluster Head Selection

There are many routing protocols developed in WSN. The design of routing protocols must consider many characteristics of sensor node. Power consumption is one amongst the foremost vital factors.

In Low Energy Adaptive Clustering Hierarchy (LEACH) [3], it is a hierarchical protocol with the cluster techniques. LEACH protocol comprises of two stages: First, The Setup Phase: In the setup stage, the groups are coordinated and the cluster heads are chosen. In each cycle, a stochastic calculation is utilized by each node to

decide if it will end up being a group head. If a node becomes a cluster head once, it cannot become a cluster head once more for P rounds, where P is the desired percentage of cluster heads. The Steady State Phase: inside the steady state stage, the data is shipped off the base station. The time of the steady state stage is longer than the time of the setup stage to constrict overhead. Filter is a convention that will in general decrease energy utilization in a WSN. In any case, LEACH utilizes single-jump steering during which each sensor node communicates data to the cluster head or the sink.

Accordingly, it isn't recommended for networks that are conveyed in huge locales. In the paper [1], Gateway and Cluster Head Election using Fuzzy Logic in heterogeneous wireless sensor networks (GCHE-FL), it uses election fuzzy logic in two stage for evaluating probabilistic gateway and cluster head. In the first stage, the selected nodes are considered based on their energy and proximity. Here, two fuzzy parameters are considered as efficiency and Cluster Distance. Efficiency can be calculated by the ratio between residual energy and average energy. Cluster Distance is the sum of distances of all nodes within the cluster.

By using the above mentioned techniques each node send the collected information to their cluster head. Then the cluster head after collecting all data is send to the base station through closed gateway. Some assumptions are considered in this protocol like the WSNs applicable for heterogeneous sensor networks, the distance calculated by using radio signal of the nodes, the nodes are static after deployment and the base station will be positioned such that it can cover the entire area of wireless sensor networks. The initialization phase, the probability is assigned to each node of becoming cluster head. Within the communication range, the least cast node is selected as a tentative cluster.

In the paper [4], the cluster head selected based upon connectivity of the node. Here, cluster head selection Technique improves network life time, network coverage based on active sensing region. Active sensing region can be calculated with the ratio of active sensing coverage and maximum sensing region. Typically, the nodes are deployed for various applications in dynamic manner. As a consequence, the overlapping regions of the sensor node are increasing the actual area to be covered. The sensor device having large quantum value is selected as cluster head.

B. Energy-Efficient Clustering

The algorithm discussed for energy efficient clustering in [5] is the energy efficient cluster with the help of removing the cluster reforming process after each round. The cluster head is rotated among the members in the same cluster. This improved the life time of the network as well. In the same paper author discussed another algorithm say REC+, in which the chain cluster based protocol is used to maximize the reliability of multi-hop network. Here, cluster head selection and the shape of the cluster are to be covered by each cluster, which does not necessary provided error controlling approaches required. These approaches improve the performance and reduce the cluster forming process. From the result, it has shown comparatively more reliability in some applications in terms of energy efficiency. Here, the aim is to place a cluster head in the best place to maximize the reliability of the node. The cluster will not be reformed frequently until or unless a huge change in the network occurs.

In [7], the author described energy efficient Clustering Protocol for a purely deterministic node. It shows more energy efficiency than the existing protocol in dynamic self-organized network. Here, cluster head selection is

based upon residual energy for each node. The threshold function is completely discarded due to the uncertainties in the cluster head and underutilization of the potential for lifetime maximization. Here the set-up phase of LEACH is modified trust to improve the efficiency of energy.

C. cluster back up approaches

In [8], the author described selection of the cluster head based on Fuzzy logic. All the data communication Responsibility depends on Cluster head. The cluster formation is considered as single place of disappointment. In the event that the cluster head neglect to do his work, the cluster individuals to discuss straightforwardly with the base station. This increases the power consumption of the network and reduces life of the network. In this paper we, focus on two aspects first one is selection criteria of cluster head and second one is cluster back up approach as in fig. (1).

It introduced FCA-BS based on fuzzy logic for cluster head. The cluster backup approach is recently considered by the researchers for the cluster head selection. With the help of residual energy the backup node can be selected and it improves the lifetime as well as save the energy. Cluster head will be decided as per the maximum score of the node. Here the backup nodes have dual duties, the node is collecting the information and as a backup node for cluster head.

D. Reliability

Reliability [9] of the system can be measured based on probability or various functioning on sub component [10]. It can be evaluated in certain condition and for a mentioned interval of time for instance, we can measure backup node as a subcomponent during cluster formation. The energy requirement also minimizes as cluster reformation is reduced.

In this context cluster head is more reliable in our proposed approach, and this will extend the life time of the network. Reliability analysis plays a crucial role to identify the drawback of existing in communication networks [11] as well as to provide prevention for the future. It can be used to improve the performance of the network and to depend on the system to take decision.

Reliability Models assessment can be utilized in the designphase of the system. It improves development, operation andmaintenance. FT and RBD are the two base model forproviding reliability and availability estimates. It works inearly design phase as well as at later stage also. Here, thesystem models associated more detailed specification toimprove the performance of pervious existing models. Fordesigning this Markov chain [12] is used as a powerful tool indesign phase. As a result the updated system model functionsas more beneficial to estimate and maintenance. Byconsidering reliability model it reduces the cast of the systemelements as well as life time of the model also increases.

III. SYSTEM MODEL

Modified trust based LEACH is proposed to reduce the node and network failures and to maximize the network lifetime. As in LEACH, the network is partitioned into clusters and cluster heads are selected to transmit data from cluster members to the base station. As in LEACH-C, the clustering algorithm used is simulated annealing,

for finding the optimal clusters for partitioning the network. The base station is responsible for electing the cluster heads[14]. Unlike LEACH-C, in Modified trustbased LEACH, the base station not only elects the cluster head, also elects next heads for each cluster.

The figure 2shows the Modified trustbased LEACH topology. The network is partitioned into small clusters. Each cluster has one cluster head, few next heads and few sensor nodes. The base station can be either inside the sensing area or outside the sensing area.

ALGORITHM FOR M-LEACH

1. BS requests all the nodes to send their energy and site information.
2. BS elects the nodes that are square measure nearer to that as Cluster-heads (CH)
3. Simulated Annealing is employed to partition the network into clusters
4. Threshold price (Tj) for each cluster is that the magnitude relation of Current residual energy (Re) to variety of nodes in that cluster.
5. Based on Tj, the BS elects few next heads (NH) for every cluster.
6. For the primary round, the elected CH will act as the CH for the cluster.
7. Information gathering and information forwarding is done by the CH. One round is completed.
8. For the second round, if Re (CH)> Tj, BS elects the same CH for this round.
9. If Re (CH) < Tj, BS elects the NH1 for this round.
10. If there is no Re (CH or NH) > Tj, BS does re-clustering.

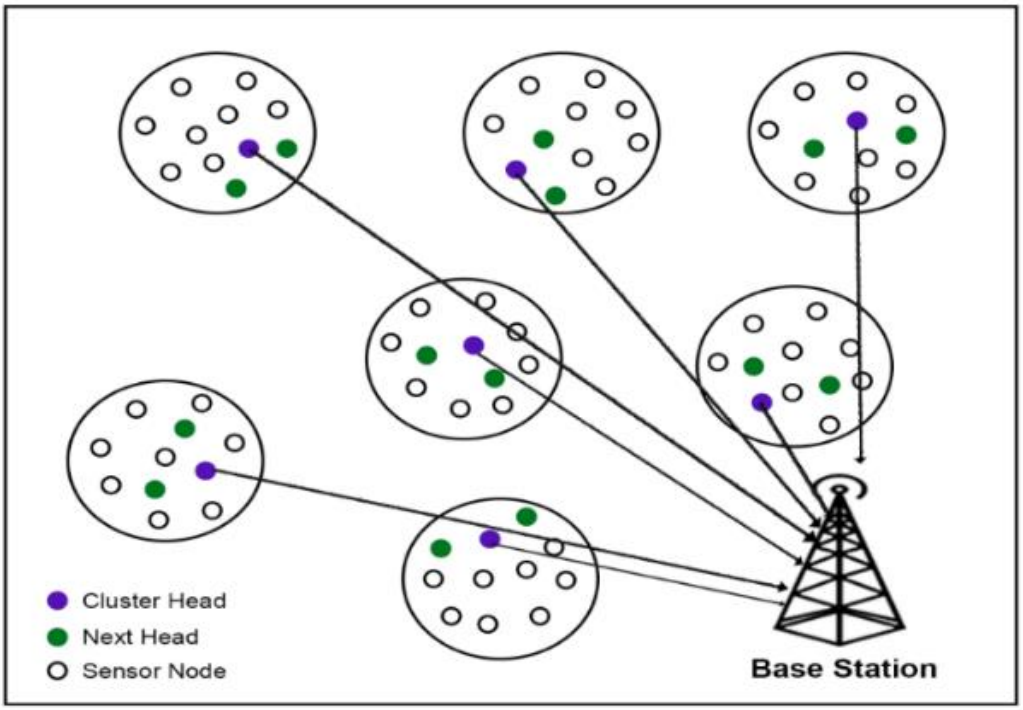

Fig 2. Topology of Modified trust based LEACH

The operation of Modified trust based LEACH is described in the following sections. In Modified trust based LEACH, there are three Phases:

- Setup phase
- Steady state phase
- Re-clustering phase

A. Setup Phase

In set-up phase, all the nodes in the network send their location and energy to base station. Each node is assumed to have GPS receiver to send their location information. Initially, all the nodes have equal energy. The nodes which respond first and are closer to the base station are selected as cluster heads (CHs) nodes. By using these CHs, base station forms the cluster using simulated annealing algorithm [12,13]. This algorithm helps to reduce the amount of energy spent by a non-cluster head node to transmit data.

After the clusters are formed, the base station calculates the energy for normal nodes to find the next heads (NHs) for each cluster. Based on the threshold value the NHs is elected. The threshold value (Tj) is computed using the equation (1),

$$Tj = \frac{1}{m}\sum_{i=1}^{M} Ei(t) \quad (1)$$

Where, m represents the number of sensors in the cluster, Ei(t) denotes the current energy of a node, i=1,2,……M. The base station elects the next heads for each cluster using the threshold value, and the nodes which are having more energy than the threshold is elected as the next heads[15]. The nodes which are equal or less than the threshold value cannot become cluster head for this cluster until next re-clustering takes place.

After the CHs and NHs are elected, the base station sends the CH identity (IDs) and the NH IDs to all the nodes. If the ID matches with its own ID, the node assumes itself to be the CHs and NHs. In every cluster, the CH node sends the advertisement message (ADV) to their cluster members, including the next heads. Once the ADV message is received by the cluster members they send join request message (JOIN) to CH.

B. Steady State Phase

In steady state phase, upon receiving the JOIN message, the CH sends TDMA schedule to its cluster members for transmitting data. According to the received TDMA schedule, nodes send information to the CHs. The CHs has to perform the following functions are Data gathering and Data forwarding. Once the information is gathered, the CH will forward the information to the base station using the CDMA schedule. This indicates the completion of one round.

Normally, in LEACH and LEACH-C, the second round can begin with re-clustering and new CH election. In Modified trustbased LEACH, the base station would check the residual energy of the elected cluster heads. If the residual energy of the present CH is still greater than the threshold value, the same CH will be continue to be the cluster head for the next round and the steady state process takes place.

C. Re-Clustering Phase

If the residual energy of the current CH is lesser than the threshold value, the NH1, with higher energy than the threshold will be elected as CH. Then this NH1 can act as CH for the present round, and it repeats an

equivalent method as done by the previous CH. If all the next heads repeats the above process and there are no nodes which have the residual energy above the threshold value, the re-clustering phase is initiated by the base station.

D. Fault tolerance in Modified trust based LEACH

Once the data transmission is completed, in LEACH and LEACH-C, the re-clustering is done, irrespective of the residual energy of the current CH and the cluster members [4, 8]. But in Modified trustbased LEACH, in order to avoid node failure due to energy depletion, the nodes that are below the threshold will never get a chance to become a CH, which will prevent these nodes to perform intense network operations such as data gathering, aggregation, forwarding, etc.,. The node failure in a network mainly occurs due to low energy nodes, which will contribute to loss of data and as a result, leads to the network failure.

In Modified trustbased LEACH, faults are reduced to a greater extent by reducing the energy consumed for frequent re-clustering and cluster head election. Since most of the nodes in LEACH and LEACH-C are involved in the operation of clustering and communication with the new CH, the energy spent for sensing operation is reduced. But in Modified trustbased LEACH, since this election and re-clustering does not occur frequently, the nodes get involved in their intended functions and communication overheads are reduced.

IV. RESULTS

In this section, the performance of Modified trustbased LEACH is analyzed and simulated using Matlab R2007b. The performance is compared with LEACH and AODV protocol in terms of Network lifetime, Throughput, Packet delivery ratio and Delay.

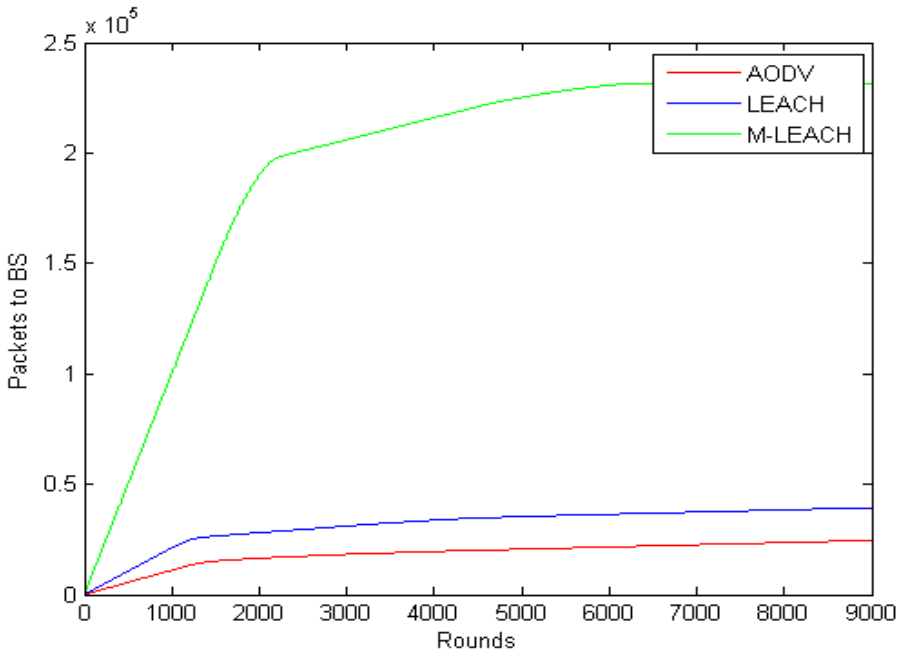

Fig 3. Packets to Base Station

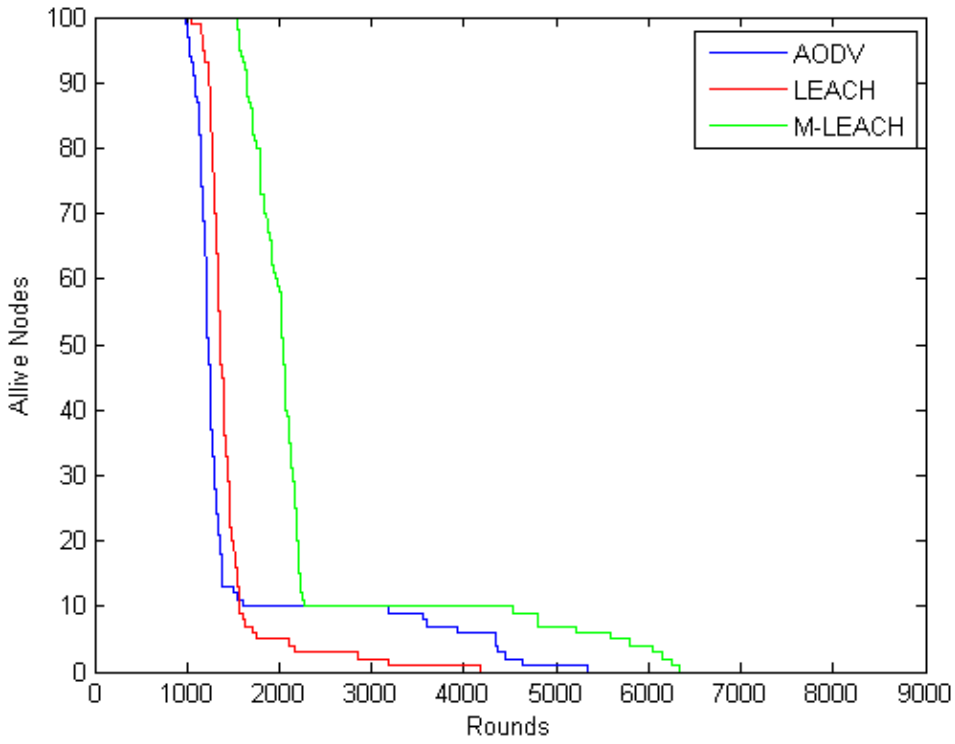

Fig 4. Alive nodes

A. Working Environment

In this section we provide an illustration of proposed protocol algorithm capabilities using Matlab R2007b simulator compare its performance with LEACH and AODV. The parameters employed in the simulation are summarized within the Table1.

Parameters	Values
Network Grid	(0,0)x(100,100)
Base Station	(50,50)
εelec	50 nJ/bit
εfriss amp	10pJ/bit/m2
εtwo ray amp	0.0013pJ/bit/m4
d0	87 m
Initial energy per node	0.2 J
Number of nodes	100, 200
P	0.05

Table 1: Simulation Parameter

B. Simulation Result

During a round, every member sends just one data packet to its individual cluster-head. At the end of each round, each cluster-head aggregates all data packets received from its members into one packet and sends it to the base station.

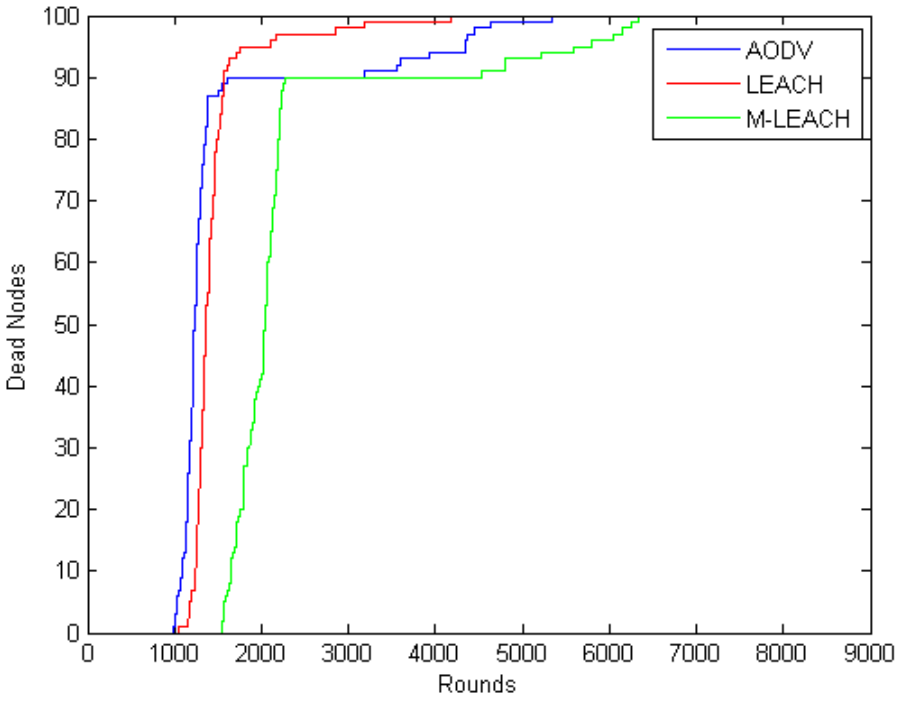

Fig 5. Dead Nodes

V. CONCLUSION

Energy efficiency is the most significant issue in wireless sensor networks. Energy efficient routing algorithms are used to maximize the network lifetime period. In this paper, Modified trust based LEACH algorithm is proposed, which reduces the failure of the cluster head due to the energy depletion. Simulated annealing is used for partitioning the network into optimal clusters.Thesignificantfeatureofthisproposedalgorithmisthe election of next heads. The election of next heads along with cluster head prevents the death of cluster head due to fast energy depletion. Another important feature of this proposed algorithm is that, re-clustering of network is not done after completion of one round. Nodes lose more energy in the operation of re-clustering. To prevent this, a threshold value is calculated. Unlike LEACH and LEACH-C, this algorithm maintains the network connectivity and increases the reliability of data transmission. As a result the network lifetime is increased. The QoS parameters such as throughput, delay, packet delivery ratio and network lifetime of Modified trustbased LEACH outperforms AODV and LEACHprotocol.

VI. REFERENCES

[1]. Zaib Ullah, Leonardo Mostarda, Roberto Gagliardi, Diletta Cacciagrano, Flavio Corradini “A comparison of HEED based clustering algorithmsintroducing ER-HEED,” IEEE 30th International Conference on Advanced Information Networking and Applications, 2016.

[2]. W. R. Heinzelman, A. P. Chandrakasan, and H. Balakrishnan "An application-specific protocol architecture for wireless microsensor networks," IEEE Transactions on Wireless Communications, vol. 1, no.4, pp. 660–670, October 2002.

[3]. MadhuPatil, Chirag Sharma "Energy Efficient Cluster Head Selection to Enhance Network Connectivity for Wireless Sensor Network," IEEE International Conference On Recent Trends In Electronics Information Communication Technology, May 20-21, 2016, India.

[4]. Heewook Shin, Sangman Moh, and Ilyong Chung "Energy-Efficient Clustering with One Time Setup for Wireless Sensor Networks," Fourth International Conference on Computational Intelligence, Communication Systems and Networks, 2012.

[5]. Zahra Taghikhaki, Nirvana Meratnia, Paul J.M. Havinga "A Reliable and Energy-efficient Chain-cluster Based Routing Protocol for Wireless Sensor Networks," IEEE ISSNIP, 2013.

[6]. Sunil Kumar Soni, Gagandeep Kaur"Performance Analysis of Four Layer Clustering Network using Enhanced Deterministic Energy- Efficient Clustering Protocol in Wireless Sensor Network," Fifth International Conference on Advanced Computing & Communication Technologies, 2015.

[7]. Ejaz Hussain, Xiong Zhang, Li Chao, Sadique Ahmed Bugti "Fuzzy based smart selection of cluster head with backup support in wireless sensor network," Computing and Networking Technology (ICCNT), 2012 8th International Conference on, 2012.

[8]. Waqar Ahmeda, Osman Hasana, Usman Perveza, Junaid Qadir "Reliability Modeling and Analysis of Communication Networks," Journal of Network and Computer Applications, Volume 78, 15 January 2017, Pages 191–215.

[9]. A. Villemeur, Reliability, Availability, Maintainability, and Safety Assessment:Assessment, hardware, software, and human factors, Vol. 2, Wiley, 1992..

[10]. F. Altiparmak, B. Dengiz, A. E. Smith, A general neural network model for estimating telecommunications network reliability, Transactions on Reliability 58 (1) (2009).

[11]. S. Bernardi, J. Merseguer, D. Petriu, Dependability analysis techniques, in: Model-Driven Dependability Assessment of Software Systems, Springer, 2013, pp. 73-90.

[12]. Isaac Sajan, R, Jasper, J. Trust-based secure routing and the prevention of vampire attack in wireless ad hoc sensor network. Int J Commun Syst. 2020; 33:e4341. https://doi.org/10.1002/dac.4341

[13]. Isaac Sajan R, Jasper J,A secure routing scheme to mitigate attack in wireless adhoc sensor network, Computers & Security, Volume 103, 2021, 102197, ISSN 0167-4048, https://doi.org/10.1016/j.cose.2021.102197.

[14]. R. Isaac Sajan, J. Jasper and E. Arun,Surveying the Effect of Vampire Attack in Wireless Ad-hoc Sensor Networks, International Journal of Control Theory and Applications 8(5),2015, 2051-2061.

[15]. Isaac Sajan R & Jasper J, An Efficient Approach to Detect DoS Attacks in Wireless Ad hoc Sensor Network, Journal International Journal of Scientific Research and Engineering Development, Volume 3, Issue 6, 2020, pp-270-274.