RESEARCHERID
THOMSON REUTERS

[Prasad, 5(8): August 2018] ISSN 2348 – 8034
DOI- 10.5281/zenodo.2566000 Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

AN OPTIMIZED SOLUTION FOR MEASURES OF NETWORK LIFE TIME AND ENERGY CONSUMPTION USING IMPROVED ENERGY EFFICIENT LEACH PROTOCOL IN MANET

Prasad A.Y*[1] & DR R. Balakrishna[2]

*[1]Assistant Professor, Dept CSE, ACS College of Engineering, Bangalore-560074, India
[2]Principal, Rajarajeshwari College of Engineering, Bangalore-560074, India

ABSTRACT

The different advancements in the wireless communication led to the network with sensors connected. The node restricted with the power in the WSN is a major constraint. The node action to sense the data and forwarding to the sink needs efficient battery usage for increasing the network lifetime. So, in this research work the primary objective is to improve the network lifetime. In this paper the LEACH protocol is simulated using NS2 simulator for a fixed size network of 1000 m X 1000 m with 150 nodes for a data packet of 812 transmitted for 10 (dimension) and the simulation is carried out for 30 (dimension). The simulation observed parameters are packet delivery ratio, energy consumption, and throughput. The overall residual energy obtained is 202.213 for simulation time of 30.

Keywords: *LEACH, Cluster Head, TDMA, Network Lifetime, MANET.*

I. INTRODUCTION

The widely accepted technology is Mobile Ad-hoc Network (MANET). It finds wide spread applications in industry and academics throughout the world. It contains basically a more number of low powers, low cost and many operational capability wireless sensor nodes along with sensing, communication also computational capability [1, 2, 3]. In the WSN the sensor node communication occur in a short distance through a medium of wireless and work together to achieve a collect job. It finds applications in industries, monitoring activity, military surveillance and others [4]. The main objective of MANET is the capacity of every sensor node is restricted and the total power of the whole network is adequate for the project under consideration.

The wireless sensors are self-organising network with battery operated and estimated to operate for a longer period of time. The energy constraints of several numbers of organised sensors require optimized protocol for implementing different network control and to manage function like localization of node, synchronization and network security.

1.1 Key factors of MANET routing protocol design

The chief methodological task of wireless sensor network is to sense, communicate and control functions when computing power, storage space, and energy resource and nodes communication capability are extremely restricted. The MANET routing protocol main objective is to make an effective path of energy from a consistent data progressing mechanism and for realizing the network full life cycle. The MANET structure possess the chief factors which affect the routing protocol proposal like network dynamic, data sending mode, network topology, node type and path selection. The diversity of MANET routing protocol makes it challenging to assess which protocol is superior. The energy effectiveness, life cycle, reliability, fault tolerance, scalability and delay are the indexes needed to assess the routing protocol for MANET to be effective.

The MANET protocols can be commonly categorized into five types: QoS-based routing protocol, position-based routing protocol, flooding routing protocol, data-oriented routing protocol and hierarchical routing protocol.

1.2 Hierarchical routing protocol

Low-Energy Adaptive Clustering Hierarchy protocol (LEACH) [5, 6] is the principal hierarchical routing protocol. Most succeeding hierarchical routing protocols were developed after LEACH. The selection of cluster head node is done randomly and uniformly share the MANET relay communication service for uniformly consume the nodes energy in the sensor network and enhance the network life cycle. The LEACH protocol two phases are preparation and data transmission. At the first phase, cluster head is chosen form a node at random. It broadcasts the messages to the neighbouring nodes and remaining nodes choses a particular cluster to link. The cluster head sends information to the sink node also the cluster member's only send information within the cluster.

When associated with collective multi-hop routing protocol then static cluster algorithm, LEACH can enhance the network life cycle by 15%. The protocol Leach adopts that every node can directly link with the cluster head nods as well as sink nodes, it does not relate to use of a big observing variety besides the dynamic cluster takes further above the topology variation and a big broadcasting quantity.

II. LITERATURE REVIEW

The E-Leach protocol is considered, which is an improved form the leach protocol that is inclined by cluster head selection of energy factor. In leach protocol the node converts to unworkable after 541st round where as aimed at E-Leach the node dies afterwards 1116 round. LEACH is one amongst the several other clustering based protocols to select the best CH node. The author proposed an improved version of LEACH protocol where the selection of CH is done based on the probability grounded threshold value where it is prejudiced by remaining energy of candidate CH node and average preliminary energy of whole network. The selection of CH node is extremely reliable on energy factor [7].

The clustering algorithm LEACH-CCH intended at refining wireless sensor network lifetime. LEACH-CCH decreases the energy used during the expensive data transmission. LEACH-CCH rises the network lifetime. Initial energy given to each node is 0.5J in leach as well as in LEACH-CCH. LEACH-CCH retained 80% of alive nodes for 8.2% lengthier than Leach. LEACH-CCH attains an enhancement of 0.44mJ per data message communicated to the cluster head [8].

The design the routing protocols for WSN, the goal of minimum energy consumption grasps its highest importance since energy assets are limited. The principal objective of the routing protocol scheme is to preserve the sensors in action for as stretched as possible, thus network's lifetime is extended. The sensors energy consumption is controlled by data transmission and reception [9].

Mian Ahmad Jan et al. [10] discussed a brief review of Cluster-Based Hierarchical routing protocols that how protocols establish nodes into clusters. Different clustering protocols characteristics like selection algorithm and transmission mode for cluster head is discussed. M.Usha et al. [11] delivered the relative examination of LEACH and its successors based on measurement parameter like hop count, reliability and mobility. The author [12] discussed about classification of algorithms related to energy efficient clustering in WSNs and also presented the timeline and description of LEACH and its descendants. P.Manimala et al. [13] discussed about diverse hierarchical protocols established after LEACH along with their pros and cons.

III. LEACH PROTOCOL

Low-Energy Adaptive Cluster Head Protocol has a hierarchical network structure where the nodes are self-organized into clusters and lead by the CH. All nodes have rights to act as CH therefore the Probability function is used in election of CH. The CH receives the data from the cluster nodes and forwards the data to the BS. The energy consumption of CH is high when compare to the member nodes. To avoid the dead of CH, the periodic CH election and network reconstruction according to the selected CH are necessary metrics.

The cluster reconstruction is a circular process. It consists of two phases: i) Set-up Phase and ii) Transmission phase.

ISSN 2348 – 8034
DOI- 10.5281/zenodo.2566000
Impact Factor- 5.070

In Set-up Phase, the cluster-head selection is processed randomly. Random selection of CH ensures the reduction of energy consumption for a data transmission between CH and BS [16]. CH broadcasts a packet to all nodes informing that the node is going to act as CH. According to the signal strength of the node, it is decided to join to the CH to act as a member of the cluster by sending the join message. Every node should join to any of the cluster and the node which is not joined to any cluster will act as independent CH. After the formation of cluster, the TDMA adopting is done in order to distribute channels within cluster nodes.

The election process of CH is processed as: every node selects a random value from 0 to 1. Threshold is calculated for the total network and the nodes which have less value than the threshold value can act as CH. The threshold function is given in (1):

$$T(n) = \{0, \frac{p}{1-p*\left(r\, mod \frac{1}{p}\right)}, n \in G \quad (1)$$

P is the cluster head's percentage in all nodes, r is the current round number and G is the collection of nodes which is not act as CH in the last 1/p rounds. In transmission phase, the sensor nodes send the collected data to the cluster head from the given time slot using TDMA. Fig.2 shows the clustering in LEACH [17].

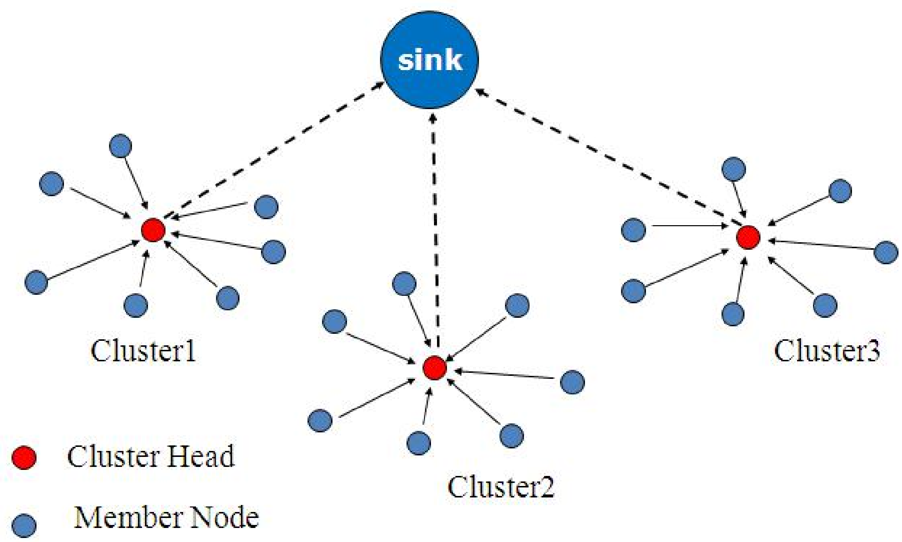

Figure 2: Clustering in LEACH Protocol

The data fusion is done and CH sends the data to BS. Reselection of CH is processed in next rounds.

Some flaws were identified in LEACH

i) The number of member nodes are not unique for each CH therefore the CH size may vary and the energy of each CH also differs according to the size varies. This will drain the energy of CH easily.

ii) The nodes with low residual energy also have the same priority to become CH. By the selection of node with low-energy the node may die first and it leads to high percentage of dead nodes in every rounds.

IV. PROPOSED METHODOLOGY

The "Improved Energy efficient LEACH(IEE-LEACH)" trails the same method as applied in LEACH in the beginning round to select the CH and members. In the succeeding round, the IEE-LEACH trails specific parameters in the process of selection **[18]** they are node residual energy, to determine the distance amongst the BS and node, to determine the distance amongst the node and its neighbors finally to calculate the neighboring nodes numbers.

Residual Energy of the node

In a WSN, the battery power consumed by the nodes is of primary concern since it affects the network lifetime. The collected data are directly forwarded to the CH or BS by sensor nodes. The member data received by CH is combined and forwards it to BS. The power consumption is more in CH. So residual energy consumed node is selected as CH regularly. The node residual energy is given by (2),

$$Residual\,energy = \frac{E_{present}}{E_{max}} \quad (2)$$

The distance between BS and node

The CH collects the data sent by the member nodes, gathers it and moves the data to BS. For longer distance data travelling more power is consumed [18]. The shorter distance amongst the BS and CH enhances the lifetime of network. Therefore, the distance amongst BS and node is given in (3).

$$Distancee_{node-BS} = \left[1 - \frac{D_{BS}}{D_{Intermediate\,Node}}\right] \quad (3)$$

Where the D_{BS} represents the distance amongst each node and BS. $D_{intermediate\ node}$ is the distance of the intermediate node to BS.

The distance between node and its neighboring nodes

Data transmission is the direct effect in the energy and distance, where the closer members save energy in transferring of data to the node. The following equation gives a score value based on the distance between the node and its neighbors. The equation is calculated in (4).

$$Distancee_{n-CH-Maxn} = \left[1 - \frac{\sum_{i=1}^{N} \mathrm{D}_{n-CH}}{NX\, D_{CH-Maxn}}\right] \quad (4)$$

Where D_{n-CH} denotes distance between the ith node and CH and $D_{CH-Maxn}$ denotes distance between the CH and its longest neighbor node and N denotes the number of nodes. The minimum distance between the node and neighbors gives a preference is selection of node.

The number of Neighboring Nodes

The cluster nodes number on every cluster needs to fix the balance for enhancing the network lifetime. So, it is necessary to fix the cluster member threshold to calculate the node with higher cluster member nearest to the threshold value which is probable to be selected as CH. This is calculated in (5).

$$Total_{nig-n} = \left[1 - \frac{(T_{nig} - threshold^2)}{threshold^2}\right] \quad (5)$$

Where counting signifies number of neighboring nodes of every node and threshold signifies the optimal number of neighbors for each node. Sometimes, $Total_{nig-n}$ may equals 1, when the number of neighboring nodes is equivalent to the optimal number of neighbors.

The threshold function is considered as in (6).

$$Threshold = \frac{Total\,number\,of\,nodes}{optimal\,number\,of\,cluster} \quad (6)$$

Finally, all the four equations are united to form an Energy Efficient Function (EEF) to select CH is as calculated in (7).

$$SF = \sum_{i=1}^{4} SP_i = \left[\frac{E_{present}}{E_{max}}\right] + \left[1 - \frac{D_{BS}}{D_{Intermediate\,Node}}\right] + 1 - \left[1 - \frac{\sum_{i=1}^{N} \mathrm{D}_{n-CH}}{NX\, D_{CH-Maxn}}\right] + \left[1 - \frac{(T_{nig} - threshold^2)}{threshold^2}\right] \quad (7)$$

The four parameters discussed above with LEACH probability function separately for finding the fitness function is primarily applied to find the node fitness in order to become CH. Each parameter is assigned with weights dynamically agreeing to the functions effect magnitude to reduce the energy consumption to enhance the lifetime of network. The functions are joined separately with LEACH probability function to know the parameter effect. The weights are varied agreeing to the parameters effect in reducing the energy.

Also, every node transmits an advertisement node information (ADV) packet which comprises node location, and node ID to its one-hop neighbors and generates a neighborhood table to store the neighbor node's ID, location and distance of the node from the neighbor node. A counter is used to count the number of ADV packets. Then by score functions network each node score value is calculated. The score function combines the fitness function and weighs. Next the score value is calculated, every node broadcast the score value called Advertisement Nodes Score (ANS), which comprises the considered score value and the probability of the node to elect as CH.

After getting the ANS Packet, every node estimates a function to categorize the neighbors into two groups as the nodes having high score value than the identified node score value and as the nodes holding low score value than the identified score value of a node. The high score nodes uses a RCR function to show the comparative preference to elect as CH. Then the identified node broadcasts Relative CH Rank Advertisement (RCRA) message to all nodes which have greater score value than the identified node. Centred on the RCRA message from high score group the SRCR is considered to classify the preference for the identified node to act as CH.

The SRCR is broadcasted to the low score value group from the specified node where the specified node collects the same from the high score value group. By the SRCR received by the specified node, the node chooses it CH when the low score group value nodes were not selected the specified node as CH.

The selection of CH is done when the SRCR messages are collected form the neighbors, RCR high value nodes and nodes possessing highest value. The CH waiting time to publish the CH amongst two neighbors is known as reverse SRCR. The higher SRCR node and high priority between neighbor node waits for a lesser time period known as T_w in comparison to other nodes. CH waiting for join the cluster member nodes for a specific time is T_w. The nodes possessing smaller SRCR also needed to wait Tw to get the CHs message. At last, nearest CH is selected after the CH message and sends the message to join.

If for a node, the messages from any CHs are doesn't reache on time Tw, then the node attends the join message of the neighbors and joins to CH of the nearby neighbor. There is a lesser amount of likelihood to get a similar SRCR value for more than a node, then in that case the CH which is nearer to BS is selected as CH and other nodes will join to it.

To evade the single cluster where there are no nodes on it, the CH with no members select the nearby CH which is having greater SRCR value and join as a member or else the node remains as a single node cluster. Whenever the node is elected as CH then the election message with decision is sent to CH based on the node ID. At last each node use the score function to calculates the score value using the below equation (8).

$$SF = \sum_{i=1}^{4} W_i * SP_i = W_1\left[\frac{E_{present}}{E_{max}}\right] + W_2\left[1 - \frac{D_{BS}}{D_{Intermediate\,Node}}\right] + 1 - W_3\left[1 - \frac{\sum_{i=1}^{N} \mathrm{D}_{n-CH}}{NX\, D_{CH-Maxn}}\right] + W_4\left[1 - \frac{(T_{nig} - threshold^2)}{threshold^2}\right] \tag{8}$$

The data transmission of clusters is processed by CH as of all time and the energy utilization of this node is always higher than the energy utilization of the member nodes. Therefore, the CH needs a special care by proposing multi power levels [25]. Here the two different nodes, member node and CH have two different power amplification signals is proposed. Minimum power amplification is enough for member nodes to send the data to the CH but the CH needs more power in order to send the data to BS which is somewhat far away to CH.

The power amplification is set to minimum to all sensor nodes in the very beginning. Whenever the node receives the election message with decision to elect as CH then the power amplification is changed to high level till the node act as CH. The power level is set back to normal/minimum in a sudden of a node changes from CH to member. Till the announcement of CH node remains with same power and also whenever the next round is processed there also all the node is set to minimum power including CH. This is done by the routing protocol.

Therefore, the power amplification will not disturb the usual LEACH except adding the maximum power to CH after the election. The multi power amplification also reduces packet drop ratio and collision and saves energy.

Therefore, the residual energy of node is redefined as (9).

$$Residual\,energy = \begin{Bmatrix} H_P\left(\frac{E_{present}}{E_{max}}\right) & node = CH \\ L_P\left(\frac{E_{present}}{E_{max}}\right) & node = member\,node \end{Bmatrix} \quad (9)$$

Where, HP denotes the High Power amplification which will be activate when the node is act as CH and LP denotes the Low Power amplification which is normal active to all nodes.

V. SIMULATION RESULTS AND ANALYSIS

a) Packet Delivery Ratio

Figure 3 shows comparison of the performance factor the packet delivery ratio against the number of nodes for the proposed IEE-LEACH and LEACH protocols. The Simulation results show that Packet Delivery Ratio is high in IEE-LEACH protocol compared to LEACH protocol. The packet delivery ratio is measured with different number of nodes by simulating by considering different number of uneven nodes (10, 25, 50, 75, 100 and 150) with different pause times. From the obtained simulation results, the work performs that at minimum number of nodes the PDR variation is slightly varying between LEACH and IEE-LEACH protocols where as the number of nodes increased the PDR tends to increase. IEE-LEACH protocol performance improves approximately by 1.317%. By increase in the number of nodes and reducing the time slots the possibility of the data loss may occur. This is overcome by partially in terms of PDR by IEE-LEACH protocol than LEACH protocol.

Table 1.1: Measures of Packet Delivery Ratio LEACH vs IEE-LEACH Protocol

Number of Nodes	Packet Delivery Ratio	
	LEACH	IEE-LEACH
10	0.7214	0.7244
25	0.7121	0.7256
50	0.7302	0.7398
75	0.7403	0.7416
100	0.7412	0.7423
150	0.7592	0.7602

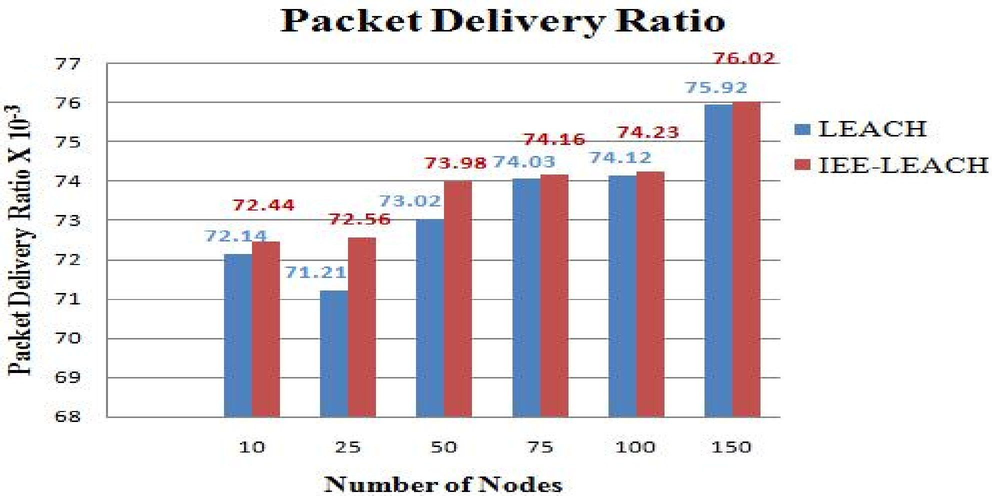

Figure 3: Comparison of Packet Delivery Ratio vs number of Nodes

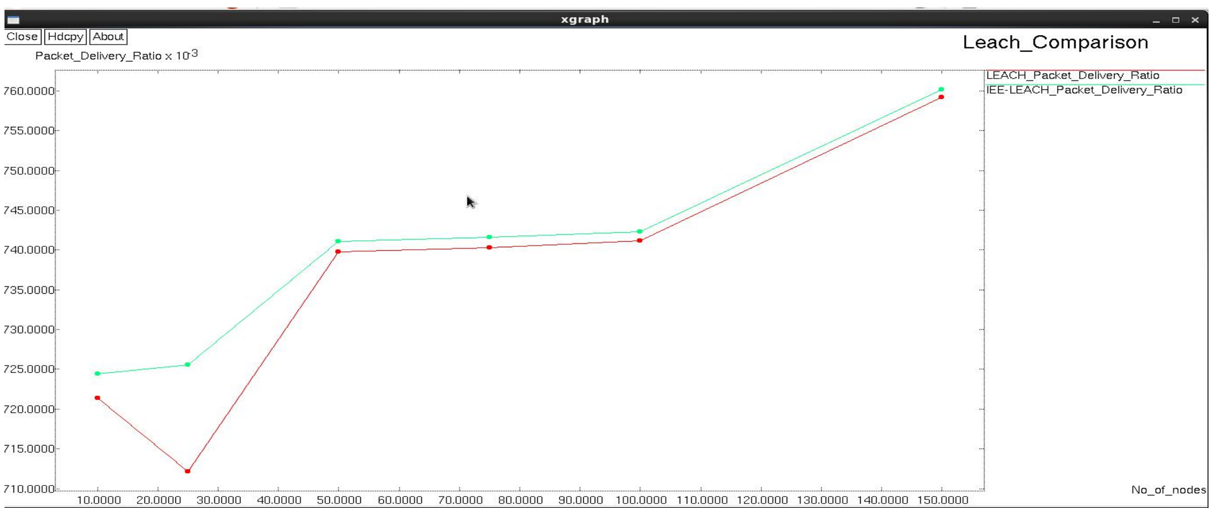

***Figure 4: Packet Delivery Ratio of Leach and** IEE-LEACH*

b) Energy Consumption

The simulation results of energy consumption using NS2 tool from 10 to 100 numbers of nodes are shown in figure 5. Initially energy consumption gradually increases as the number of nodes increases from 10 to 150. The energy consumption of IEE-LEACH protocol is decreased up to 72.10. So, the results show that energy consumption is improved in this proposed IEE-LEACH protocol by 5.03% compared to LEACH protocol. The simulation results of energy consumption are obtained using NS2 tool is shown in figure 6.

Table 1.2: Measure of Energy Consumption LEACH vs IEE-LEACH Protocols

Number of nodes	Energy Consumption	
	LEACH	IEE-LEACH
10	58.01	56.12
25	61.11	60.03
50	62.35	61.11
75	68.90	67.12
100	72.11	68.98
150	75.92	72.10

DOI- 10.5281/zenodo.2566000
ISSN 2348 – 8034
Impact Factor- 5.070

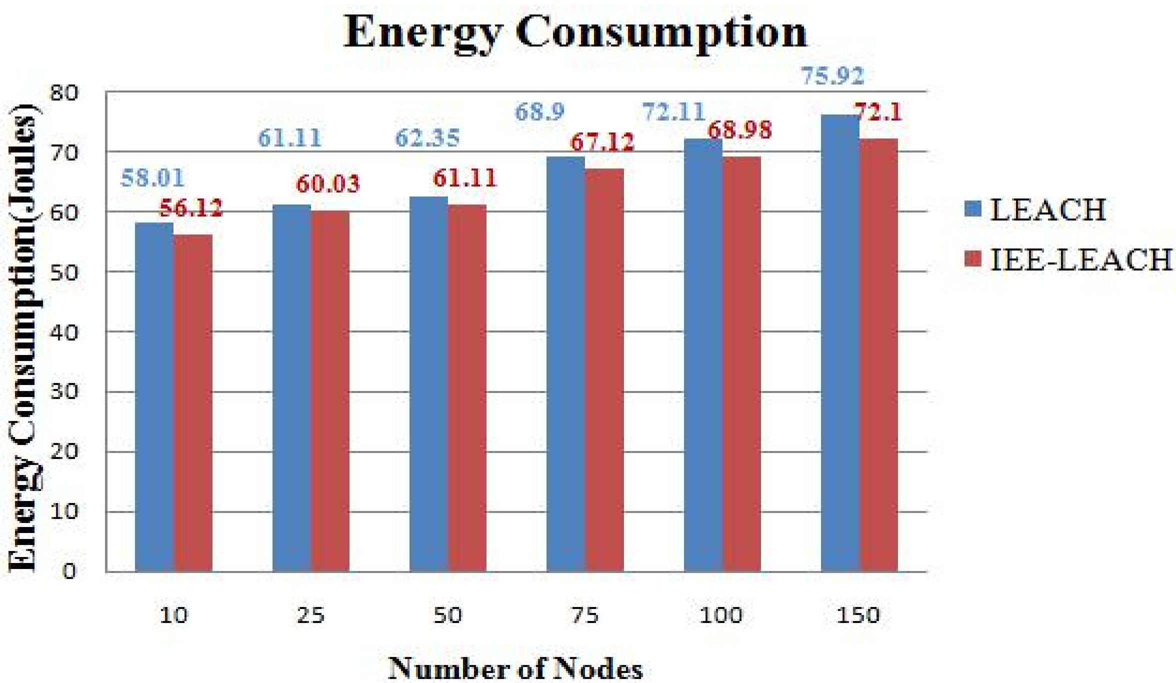

Figure 5: Energy consumption vs Number of Nodes

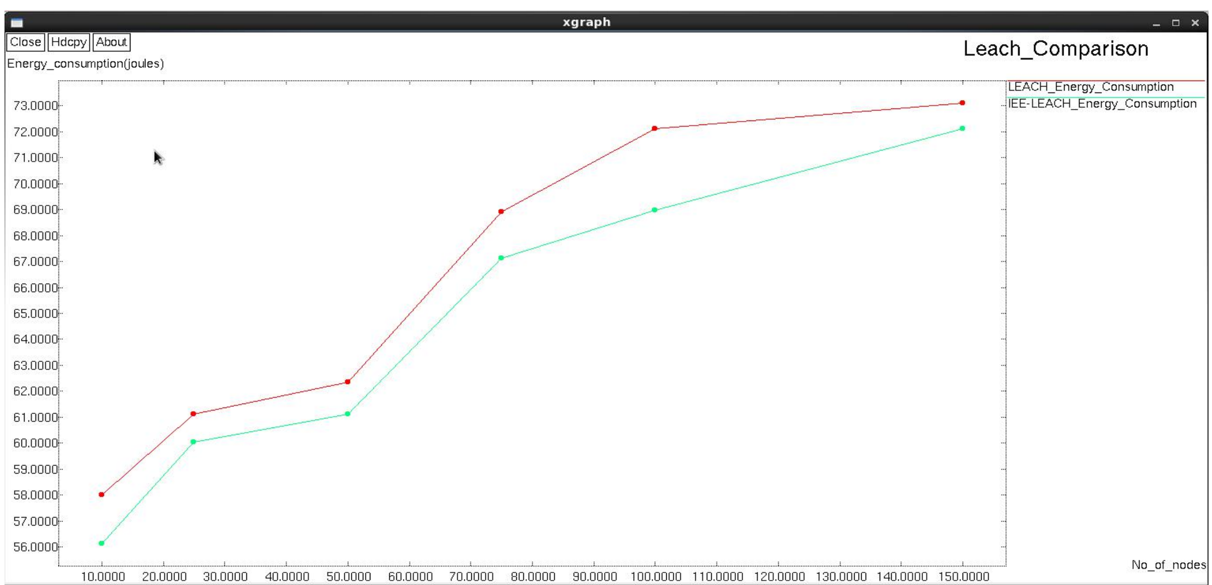

Figure 6: Energy consumption of Leach and IEE-LEACH Protocol

c) Throughput

Figure 7 shows simulation results obtained for throughput using NS2 tool from 10 to 150 numbers of nodes. Initially throughput remains till 75 numbers of nodes beyond that the throughput drastically increases by an averages of 17.482% in the proposed IEE-LEACH protocol compared to LEACH protocol. Throughput of IEE-LEACH protocol is increased up to 35.12 as a number of nodes reaches to 150.

Table 1.3: Measure of Throughput LEACH vs IEE-LEACH Protocols

Number of nodes	Throughput	
	LEACH	IEE-LEACH
10	25.01	27.17
25	26.12	27.19
50	26.20	28.45
75	26.35	28.43
100	28.11	32.03
150	28.98	35.12

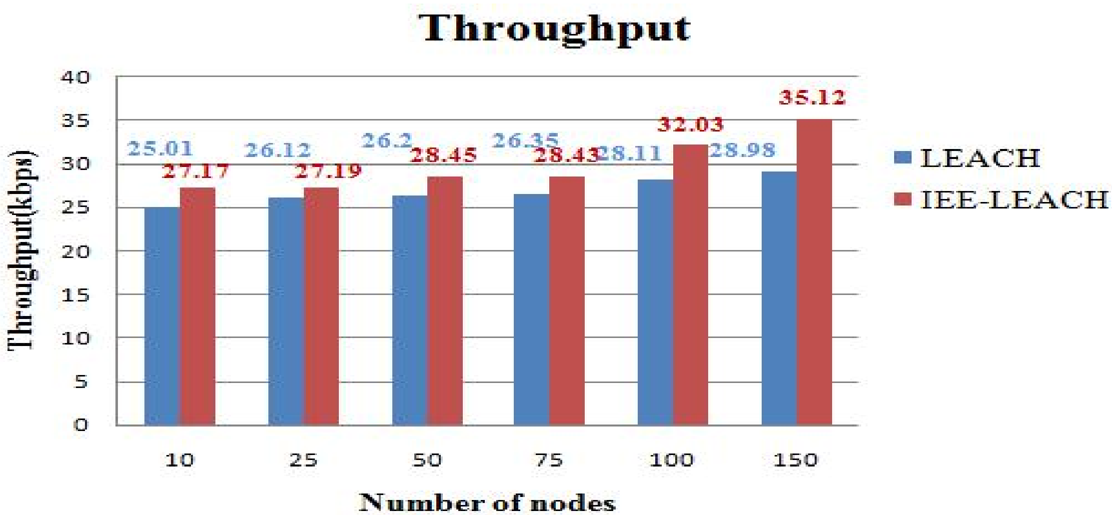

Figure 7: Throughput vs Number of Nodes

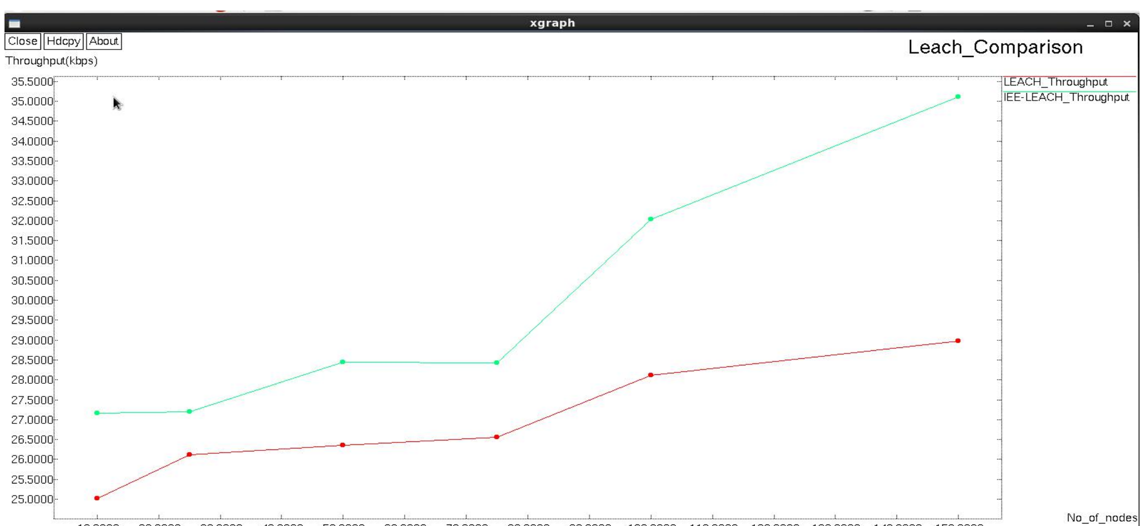

Figure 8: the Throughput Demonstrating the Efficiency of the Network between Leach and IEE-LEACH

VI. CONCLUSION

The LEACH protocol is implemented with NS2 simulation tool for the parameters of packet delivery ratio, energy consumption and throughput. The improved protocol of LEACH is considered for 150 nodes. The PDR by 1.317%, energy consumption by 5.03%, throughput by 35.12 compared to the LEACH protocol. The total residual energy attained is 202.213 for simulation time of 30. The IEE-LEACH may be implemented for different parameters and the energy consumption can be reduced with increased network lifetime.

REFERENCES

1. *"21 ideas for the 21st century", Business Week, Aug. 30 1999, pp. 78-167.*
2. *S.K. Singh, M.P. Singh, and D.K. Singh, "A survey of Energy-Efficient Hierarchical Cluster-based Routing in Wireless Sensor Networks", International Journal of Advanced Networking and Application (IJANA), Sept.–Oct. 2010, vol. 02, issue 02, pp. 570–580.*
3. *S.K. Singh, M.P. Singh, and D.K. Singh, "Energy-efficient Homogeneous Clustering Algorithm for Wireless Sensor Network", International Journal of Wireless & Mobile Networks (IJWMN), Aug. 2010, vol. 2, no. 3, pp. 49-61.*
4. *Jun Zheng and Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", a book published by A John & Sons, Inc, and IEEEE, 2009.*
5. *Shio Kumar Singh 1, M P Singh 2, and D K Singh 3, Routing Protocols in Wireless Sensor Networks – A Survey, International Journal of Computer Science & Engineering Survey (IJCSES) Vol.1, No.2, November 2010.*
6. *Z. Xuedan, D. Yuhan; L. Xiaokang, "Adaptive energy-harvesting aware clustering routing protocol for Wireless Sensor Networks," 2012 7th International ICST Conference on Communications and Networking in China, CHINACOM 2012 - Proceedings, pp. 742-747.*
7. *REF: Lei An 1, Aihua Li 1, Ling Pang2, Guangdong He1, Analysis and Comparison of Routing Protocol of Wireless Sensor Network, IJOE – Volume 12, Issue 10, 2016.*
8. *EiP-Leach: Energy influenced probability based leach protocol for wireless sensor network, Anup Kumar M.Bongale, IEEE 2017.*
9. *Jun. Corn, J.W. Bruce ,Clustering Algorithm for improved network lifetime of mobile wireless sensor network , ,IEEE 2017.*
10. *Y.Chung and D. Kim, "Self-Organization Routing Protocol Supporting Mobile Nodes for Wireless Sensor Network," in First International Multi-Symposiums on Computer and Computational Sciences, 2006.*
11. *V.Kumar, S.Jain, and S. Tiwari, "Energy Efficient Clustering Algorithms in Wireless Sensor Networks: A Survey," International Journal of Computer Science Issues (IJCSI), vol. 8, issue 5, no. 2, pp. 259-268, September 2011.*
12. *M.Ahmad Jan and M.Khan, "A Survey of Cluster-based Hierarchical Routing Protocols," IRACST – International Journal of Computer Networks and Wireless Communications (IJCNWC),vol.3, no.2, pp. 138-143, April 2013.*
13. *P.Manimala and R.Senthamilselvi, "A Survey on Leach-Energy Based Routing Protocol," International Journal of Emerging Technology and Advanced Engineering (IJETAE), vol.3, issue 12, pp. 657-660, December 2013.*
14. *M.Usha and Dr.N.Sankarram, "A Survey on Energy Efficient Hierarchical (Leach) Clustering Algorithms in Wireless Sensor Network," International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE), Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14), vol.2, special issue 1, pp. 601-609, March 2014.*
15. *HeenaDhawan, SandeepWaraich, A Comparative Study on LEACH Routing Protocol and its Variants in Wireless Sensor Networks: A Survey, International Journal of Computer Applications (0975 – 8887) Volume 95– No.8, June 2014.*
16. *ParulKansal, DeepaliKAnsal, ArunBalodi,"Compression of Various Routing Protocol in Wireless Sensor Networks", International Journal of Computer Applications Volume 5-No. 11(August 2010)*

[*Prasad, 5*(8): August 2018] ISSN 2348 – 8034
DOI- 10.5281/zenodo.2566000 Impact Factor- 5.070
17. *M. BaniYassein, A. AL-zou'bi, Y. Khamayseh, W. Mardini, "Improvement on LEACH Protocol of Wireless Sensor Networks", International Journal of Digital Content Technology and its Applications Volume 3- No. 2 (June 2009).*
18. *Reenkamal Kaur Gill1, Priya Chawla2 and Monika Sachdeva3,Study of LEACH Routing Protocol,for Wireless Sensor Networks,International Conference on Communication, Computing & Systems (ICCCS–2014).*