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Development of Robust and Efficient Routing Scheme for The Extended Network Lifetime in Wireless Sensor Networks

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Abstract: WSN is made up of a wide amount of small power units called nodes that execute sensing, information collection, computing, compression, transmission operations. Much emphasis has recently been placed on improvements in WSNs by developing new methods and methods for attaining energy efficiency and improving lifetime. Since the network is restricted in terms of power, energy, and computing capacities, these need to be addressed effectively. In WSNs sensor nodes with inadequate battery capacity are positioned in wireless sensor networks, therefore use of energy is a key concern in a WSNs. Efficient use of energy has therefore become a fascinating study area in WSNs. The Clustering and gateway approaches remains the effective way to improve the WSNs lifetime. In this paper we proposed the hierarchical routing scheme is in the function of limiting the energy consumption of the network and extend the lifetime of network. In which we generate some nodes from the deployment of sensor nodes as a gateway node in the last section of the routing protocol.

Keywords: Cluster formation, Cluster head nodes, Energy Consumption, Gateway nodes, Hierarchical Routing protocols, LEACH, Leader Nodes, PEGASIS, Wireless Sensor Networks, Two-level routing scheme, Three-level routing scheme.

I. INTRODUCTION

A Wireless Sensor Network (WSNs) includes an oversized collection of densely deployed sensor nodes which have limited capacity for energy and processing. The Wireless Sensor Network includes randomly deployed sensors. Available nodes (sensors) are responsible for sensing data from the surrounding area, collecting data from neighboring nodes (if it is a Cluster Head), processing the data collected and finally sending the data (packages) to the sink [1]. Analysis of the energy-efficient routing protocol can be executed to standardize the parameter used. There are a number of energy-efficient routing protocols available. Several routing approaches were projected to increase the network's lifespan. Among these protocols hierarchical routing within which the network is divided into small groups and a node referred to as (Cluster Head: CH) monitors and controls every cluster. A CH is responsible for information transmission the information collected by its cluster nodes and can compress the data before it's sent to the base station. However, WSNs suffers from extensive constraints such as limited memory, very little computational capacity, not rechargeable and limited battery, security and a global addressing for all sensor nodes was founded. Most research in the WSN domain focuses on maximizing the lifetime of the networks and the sensor network's overall working time. Different types of energy-efficient routing strategies are suggested to improve and maintain networks lifetime. WSN routing protocol design depends on a broad range of variables, such as data reporting (event driven, time driven, query driven), node distribution strategy (non-deterministic and deterministic node distribution), node nature (heterogeneous and homogeneous), network dynamics (stationary and mobile), connectivity, transmission media, coverage area, deployment environment (unattended and unattended) [2]. Routing is more difficult due to the limited sensor hubs battery limit. Because of their constrained battery capacity, memory and processing capability and accessible bandwidth, some of the sensor nodes engaged may not operate correctly, irrespective of network size and operation. The requirement for a routing protocols with the ability to exchange data along lengthy paths is therefore considerably more difficult, to boost the energy efficiency as well as the lifetime of sensor nodes [3]. The goal of this paper is to prolong the lifetime of a sensor network for a given fixed amount of energy. Based on a three-level hierarchical routing, this paper has proposed a clustering approach by considering it is the fixed group based routing protocol for wireless sensor networks. In this research work, the gateway nodes will be deployed near the base station. The data from all groups will be delivered to gateway nodes which forward it to base station. Our simulation results show that the proposed approach clearly improves the network lifetime and is more efficient than other existing approach.

II. LITREATURE SURVEY

LEACH-protocol is one among the primary hierarchical protocols introduced for WSNs and a lot of application protocols have been designed supported it Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol [4] using a pure stochastic model to periodically select CHs and switch CHs to manage energy consumption. However, in some cases it is possible to select inefficient CHs. Since LEACH depends on a probabilistic model only, some cluster heads may be close to each other and may be located at the edge of WSNs.

The energy efficiency could not be maximized by these inefficient cluster heads. In addition, the distribution of CHs is not uniform, so some sensor nodes need to transfer data over a longer distance. Appropriate selection of cluster heads can significantly reduce energy consumption and extend network lifetime. Fuzzy three level clustering [5] method in this routing protocol based on Super Cluster Head Election using Fuzzy Logic in Three Levels (SCHFTL) is proposed, in which a super cluster head is elected among the cluster heads. The super cluster head election is performed based on a fuzzy description in three levels using Mamdani inference engine. Because of this approach exponentially growing in the size of the fuzzy logic rule-base. As sensor nodes have limited memory, storing large rule-bases could be a decrease lifetime of network.

An improved gateway based energy aware multi hop routing in [6] this base station is considered to be located outside the network area. The sensors are randomly distributed and based on threshold levels area divided into six parts. The sensor nodes below the threshold are in direct communication with the gateway node while those above the threshold level use clustering hierarchy similar to those proposed in LEACH for communication. But stability period and throughput per round ratios were very poor in this technique.

LEACH-T [7] in which layer based routing protocol for extend network lifetime and decreases power consumption among the network. In every layer has its own cluster head. First layer of CHs gathers data from sensor nodes in its clusters. The second layer gathers data from CHs. And the third layer of CHs is taken up if the distance between second layer and sink nodes is vast. Limitation for this protocol is less number of packet deliver to base station and overall lifetime of network. Two layer clustering [8] is one in all the clustering mechanisms employed in the communication between sensor nodes to attain energy efficiency. The sensing data is transmitted to the top of the layer1cluster then to the bottom station layer-2 from the layer-0 sensor nodes. By employing a distributed algorithmic program, two-layer algorithm forms clusters wherever nodes create autonomous selections. For the achieving better network lifetime and reducing energy consumption we propose a hierarchical routing protocol in which at the last phase of routing protocol we deploy some gateway nodes in the network nodes are able to transmit their packet over long distance. Moreover, in our proposed routing technique there has no limitation on the number of gateway nodes it is based upon network size. If the user has small region of area, then can use less number of gateway nodes on the other hand if the user has extended the area then we deploy more number of gateway nodes according to network size because our main goal is to extended lifetime of network.

III. PRELIMINARIES AND PROBLEM DEFINATION

In WSNs sensor nodes with inadequate battery capacity are positioned in wireless sensor networks, therefore use of energy is a key concern in a WSNs. Efficient use of energy has therefore become a fascinating study area in WSNs. In the Wireless Sensor Network (WSN) multi-hop, nodes adjacent to Base Station (BS) need to bring traffic from other network nodes, which easily depletes their energy and causes an energy hole in the network. In addition, energy consumption between many nodes is not stabilized because of the "non-uniform" distribution of nodes and it causes some node to drain their energy quicker than other nodes in the network [11]. In WSN, this energy hole problem plays a crucial role factor in lowering the network's relatively short time as data cannot be sent to the BS by other sensor nodes even though the network's remaining energy stays high. These facilities the loss of a big quantity of energy and the lifespan of the network will die soon.

A. Energy Consumption Model

A typical sensor node comprises three basic units: sensing unit, processing unit, and transceivers. First order radio model [3] is adopted for proposed scheme. In this radio model, the electronics energy E_{elec} = 50nJ/bit to operate the transmitter or receiver circuit. The transmitter amplifier ϵ_{amp}=
5nJ/bit/message. It utilizes both channel models of the free space with d^2 power loss and multipath fading with d^4 power loss. The radios have power control and can expend the minimum required energy to reach the intended recipients. The radios can be turned off to avoid receiving unintended transmission. Thus, to transmit a K-bit message a distance d using this radio model, the radio expends: if $d < d_0$ than $E_{tr}(K,d)$ will be

$$E_{tr}(K,d) = K * E_{elec} + k * \epsilon_{fs} * d^2$$

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if $d > d_0$ than $E_{tr}(K,d)$ will be

$$E_{tr}(K,d) = K * E_{elec} + k * \epsilon_{mp} * d^4$$

And to receive this message, the radio expends:

$$Erx(K) = K * Eelec$$

where E_{elec} is the unit energy dissipation for transmitter electronics or receiver electronics. $_{fs}$ the amplifier energy in the free space model while ϵ_{mp} is the one in the multipath model and d_0 is the threshold and defined as

$$d_0 = \sqrt{\epsilon_{fs}/\epsilon_{mp}}$$

B. Network Assumptions for proposed approach

1. Base station is positioned in the center of sensing region and after deployment it is stationary.
2. The Base Station (BS) has the location information for each node and gateway node location information.
3. Sensor nodes are spread in a 2-dimensional space and after deployment cannot be recharged.
4. Nodes are randomly distributed in the network and after deployment they are stationary.
5.Nodes provide the same capabilities and are heterogeneous. Every node has varying values of energy.
6. Nodes of the leader can send information to nodes of the gateway.
7. All nodes have gateway node location data.
8. In the same sensor field, gateway nodes are scattered randomly.
9. Gateway nodes have the information of location of BS.
10. Gateway nodes have extensive battery energy, making it possible to recharge their batteries.
11. There are only two duties for gateway nodes, one is receiving information from cluster heads and the other is transmitting information to BS.
12. The communication connections are symmetrical so that by using the same transmission energy, two nodes can interact with each other.
13. A gateway node can connect to various head nodes of the cluster in one moment.
14. The proposed protocol connects in one time more than one cluster head.
15. Each node has a probability p in the first round to become the head of the cluster.
16. The Cluster head compresses data.
17. Energy of transmission depends on the distance (source to destination) and data size.
18. Each no de can aggregate the data and the energy consumed in aggregation is EDA (nJ/bit). In data aggregation scheme, no des only retransmit only the average of the received data. It is also as summed that the sensed data is highly correlated so the no des always aggregate the data gathered from its neighbor into a single length-fixed packet.

IV. PROPOSED ROUTING SCHEME

The Clustering approach remains the effective way to improve the WSNs lifetime. The hierarchical routing scheme is suggested in the function of limiting the energy consumption of the network. In propose hierarchical routing protocol in which we generate some nodes from the deployment of sensor nodes as a gateway node in the last section of the routing protocol to mitigate the transmission distance between cluster head and sink. Furthermore, the deployed gateway nodes show support for exhausted network energy sources. The gateway node procedure to obtain aggregated data from cluster heads via leader nodes and fuse this information to the base station. The information is transmitted to the cluster head mostly through the use of leader nodes. Close to the gateway, sensor nodes can transmit information straight to gateway nodes. All cluster heads will pass the message to the gateway node at one moment and, if one gateway node stops, another nearest gateway node can be used for transmitting information. Furthermore, in our algorithm there is no constraint on the number of gateway nodes it is based on network size. If the user has a small area then uses less number of gateway nodes, if the user has extended the area, then we will deploy more gateway nodes according to network size. The proposed analysis work begins with an extensive literature study of wireless sensor networks energy-efficient routing protocol. The model of energy consumption is developed based on the software specification of the nodes, and parameters such as network lifetime, first node dead, ten percent nodes dead, half nodes dead, last node dead, throughput, packet delivery ratio, energy consumption are calculated. In terms of these performance parameters, a corresponding analysis of current routing protocols is performed.

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A. Working of Proposed Routing Protocol

In the clustering techniques, cluster heads are selected from the normal sensors which may expire rapidly due to fast energy diminution for such an additional workload. For the achieving better network lifetime and we propose a hierarchical routing protocol in which at the last phase of routing protocol from deploying sensor nodes we make some nodes as a gateway node so that it will reduce transmission distance between cluster head and sink by making some nodes as a gateway node in the network area. gateways nodes, which are equipped with superfluous energy and larger communication range than the normal sensor nodes. In this start with the deployment of network area (160 X 160 m2) and divide and deploy the sensor nodes in both the coordinates randomly. After that for the formation of cluster head node and leader nodes we have apply respective algorithm. The three level hierarchical routing scheme is proposed in the work to reduce energy consumption of the network. In this section, three level routing technique is presented in details.

Level 1: Election of cluster heads
Level 2: Election of Leader nodes
Level 3: Election of gateway node

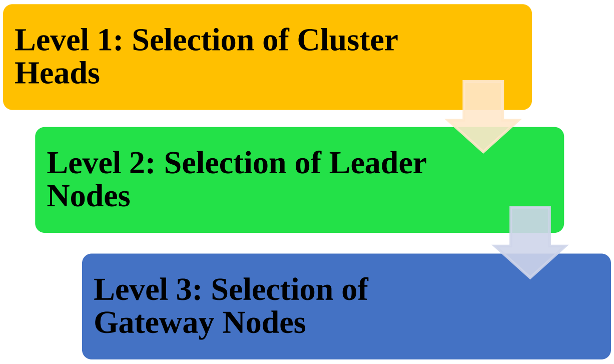

Figure 1: Hierarchy of proposed three level routing scheme

Level 1: Selection of Cluster Heads

In this method, cluster head formation is based on the positioning of base station at the middle of the network. The message is pushed across the network stating that it is perfectly feasible to choose an efficient cluster head. The base station predicts the network's signal strength. The sensor nodes also carry their remaining energy that covers a major part in being selected as the head of the cluster. The radius of each cluster is extrapolated and that cluster is constituted by the sensor nodes lying within the cluster radius. From the nodes above the threshold value, the cluster head can be allocated. Following equation satisfy the threshold value.

$$RCH = Rmin * \frac{[1 + dbs - dbsmin]}{[dbsMax - dbsmi\,n]} \quad \ldots\ldots\ldots\ldots(1)$$

Here, the radius of cluster is denoted by Rmin, the node's distance from base station is denoted by dBS and the minimum distance from base station is denoted by dBSmin. Further, the maximum distance from base station is denoted by dBSmax.

$$F_{CH\text{-}Value} = a * N_{deg} + \frac{b}{MSDdeg} + \frac{c}{dBS} \quad \ldots\ldots(2)$$

Here, the number of neighbor nodes of specific node is denoted by Ndeg. The mean distance of all nodes in network is denoted by MSDdeg. The three threshold values used here are a, b and c which give 1 as total. Random values from 0 to 1 are generated by the sensor nodes of the network. When the condition given in Eq. 3 is satisfied, the sensor node will be satisfied as cluster head.

$$K(i) > F_{CH\text{-}Value} \quad \ldots\ldots(3)$$

The K(i) is the random value generated by the sensor node individually.

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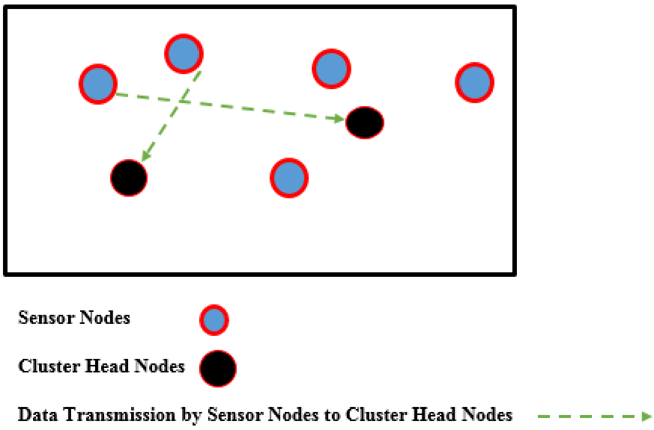

Figure 2: Data transmission from sensor nodes to cluster head nodes

Level 2: Selection of Leader Nodes

The formation and allotment of leader nodes in the network is the second phase of proposed technique. The nodes that are not chosen as cluster heads can be chosen as leader nodes. With the help of those leader nodes, the information is gathered from sensor nodes and handed to the cluster head. The Eq. (1) given below selects the volunteer leader node.

$$F_{LN\text{-}Value} = x * M_{deg} + \frac{y}{KLN} \qquad \ldots\ldots\ldots(1)$$

The numbers of nodes that can be volunteered as being chosen as leader nodes are represented by Mdeg. The numbers of nodes that fall under defined radius are denoted by KLN. Two constants with a total of 1 are marked with x and y. The nodes that are employed to be elect as leader nodes can turn out a random range from 0 to 1. The nodes which are selected as leader nodes satisfy below condition

$$K(i) > F_{LN\text{-}Value} \qquad \ldots\ldots\ldots\ldots\ldots(2)$$

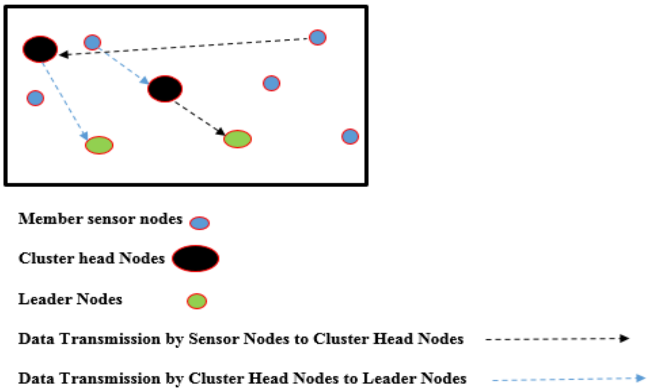

Figure 3: Data transmission from cluster head nodes to leader nodes

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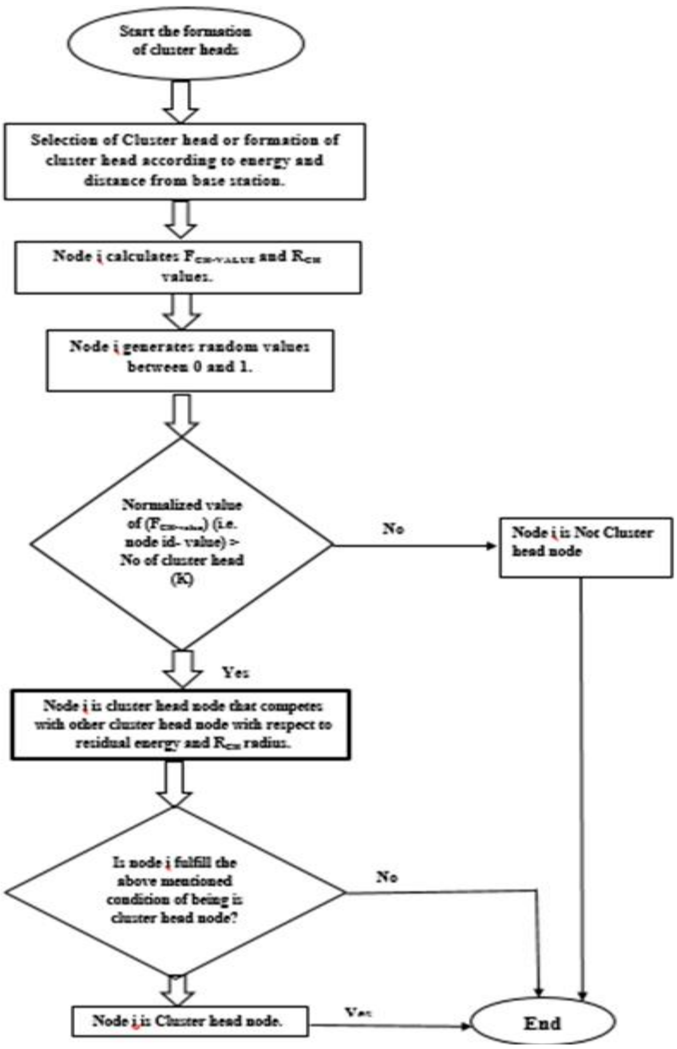

Figure 4: Flow chart for selection of cluster head

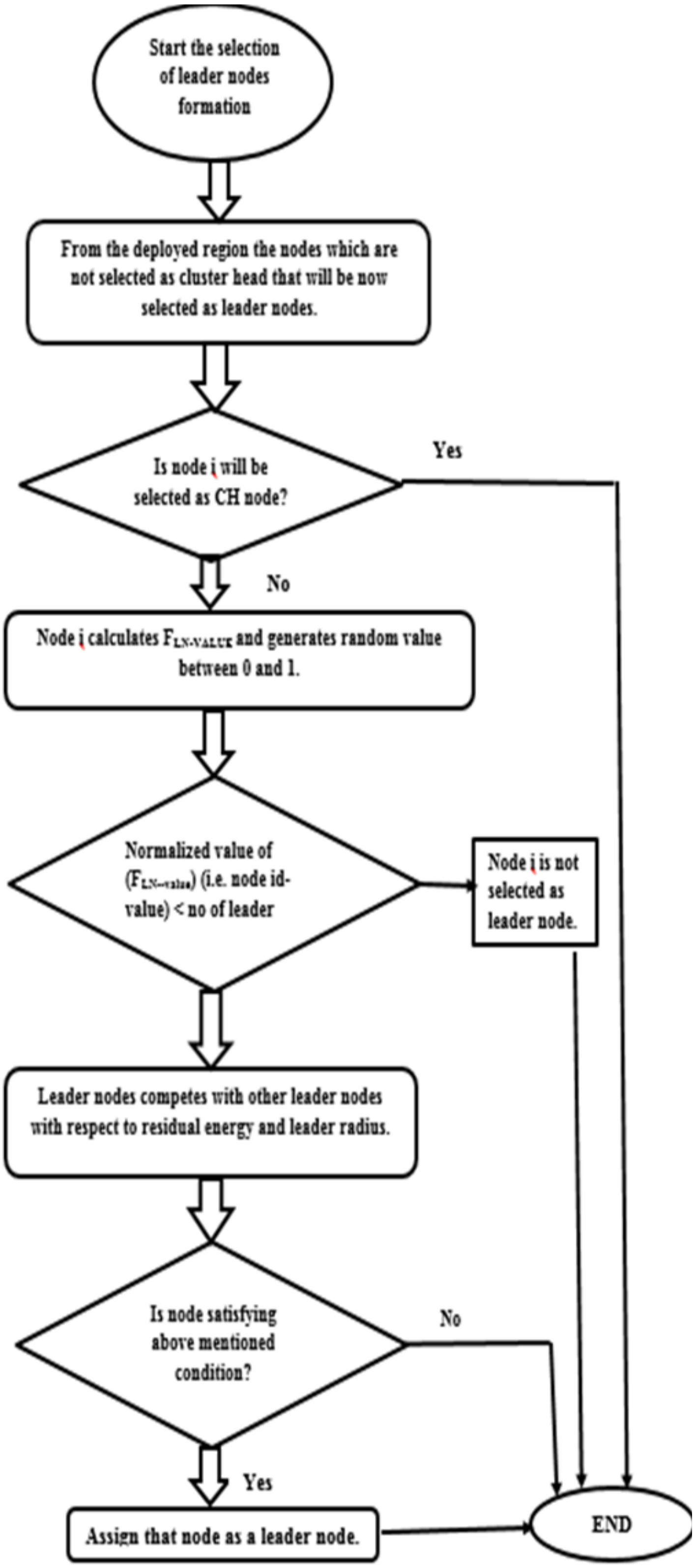

Figure 5: Flow chart for selection of leader nodes

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Level 3: Selection of Gateway Nodes

Cluster heads are chosen from the ordinary sensors in the clustering methods, which can expire quickly owing to a rapid decrease in energy for such an extra workload. Some authors have therefore indicated the use of some exceptional nodes called gateways or relay nodes, fitted with superfluous energy and a wider variety of connectivity than ordinary sensor nodes. The gateway nodes arrangement is that the final section of the proposed protocol. gateway nodes are the complementary nodes that are deployed to strengthen the lifetime of the network. The deployment of gateway nodes depends on the network area. The heads of the cluster distribute information to the nodes of the leader. Information is transmitted to gateway nodes via leader nodes. This info is redirected to base station by the gateway node. The base station is taking information from the nearby gateway node and therefore the leader node is transmission the data to the closest gateway node. With the Euclidean distance, the distance between the nodes is calculated.

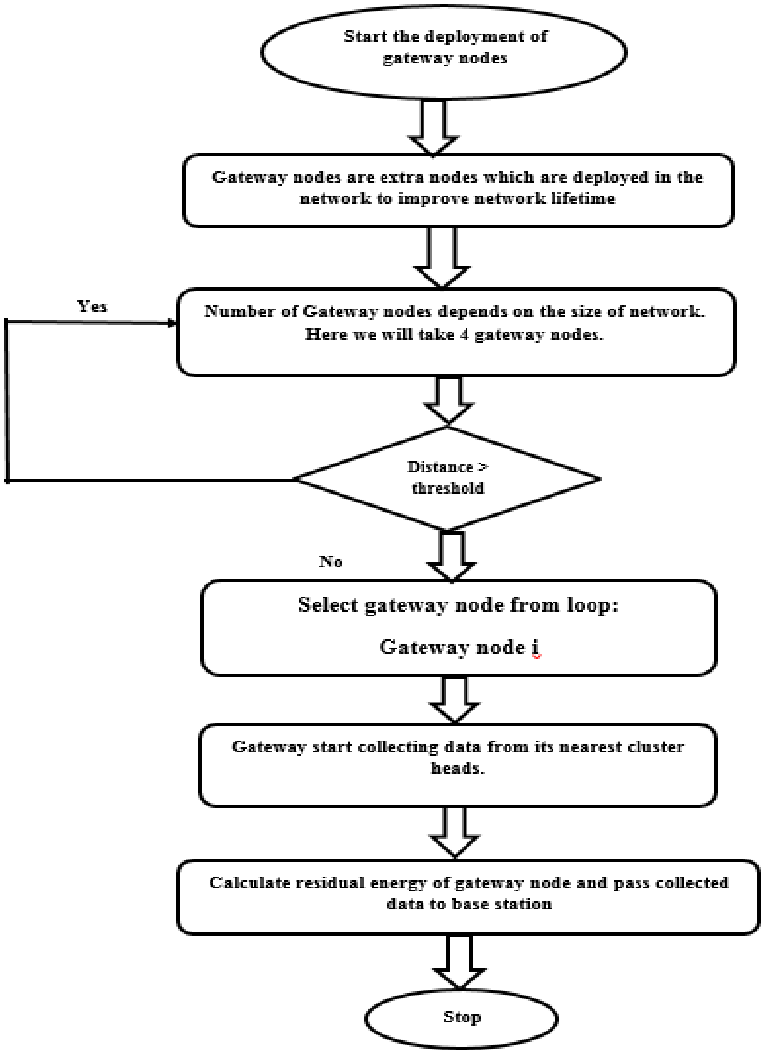

Figure 6: Gateway nodes deployment flow chart

V. PERFORMANCE EVALUATION

In this portion, to analyses our proposed strategy, we demonstrate the outcomes of experimental simulations. The primary problem we are interested in this paper is how to lengthen the lifetime of a sensor network by using different hierarchical clustering solutions for an assigned fixed quantity of energy. In addition to comparing with as the suggested method is based on three-layer hierarchy, which is an extensive work from previous two-layer clustering, the work in this paper is also compared to two-layer clustering methods to provide a detailed comparison. In addition, proposed approach also compared with some existing routing approach LEACH [4], PEGASIS [9], Two-level routing approach [10] and with existing three level routing approach [5].

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Table 1: Simulation Parameters

Simulation Parameter	**Values**
Node deployment area	160 x 160
No of nodes	100
Initial energy	(1) 0.5 joule (2) 1 Joule (3) 2 Joule (4) 3 Joule
Relative position of base station	(80, 80)
Energy for Data Aggregation (*EDA*	5 nJ/bit/message
Free Space (*fs*)	10 pJ/bit/*m*2
Multi-path Fading (*mp*)	0.0013 pJ/bit/*m*4
Packet Size	4000 bit
Total number of rounds	(1) For 0.5 joule, Number of rounds= 2000 (2) For 1 Joule, Number of Rounds= 4000 (3) For 2 Joule, Number of Rounds= 7000 (4) For 3 Joule, Number of Rounds= 10000
Transmitter energy (E_{TX})	50 nj/bit
Receiver energy (E_{RX})	50 nj/bit

A. Simulation Results

Simulation is done in MATLAB 2019a environment to evaluate the performance of proposed scheme with three popular protocols LEACH, PEGSIS, Two level hierarchical routing protocol. By using the simulation result with different simulation scenarios three level routing protocol is compared with previous protocol. In this simulation system Base station is unvarying its position and located at the center of network. Base station is located at (80,80) coordinate position and all sensor nodes have different energies and are deployed over the network in 160 X 160 region. Simulation parameter is showing in table 1. Heterogeneous sensor network is assumed in which all sensor nodes are having equal sensing and processing capabilities initially.

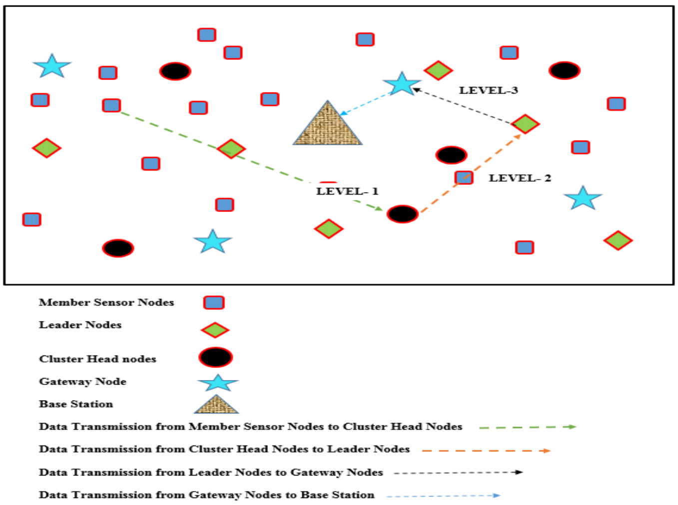

Figure 7: Basic Network Topology

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Each node has initial energy of 0.5 Joule,1 joule, 2 Joule, 3 Joule and length of data message is 4000 bits. Each sensor node has location information and no mobility is taken in account means nodes are static in nature. In proposed scheme data is passed through multi-hop approach. We considered multiple scenarios to evaluate the efficiency of the suggested protocol i.e. number of nodes, initial energy, area. In this proposed scheme the number of gateway nodes relies on the size of network.

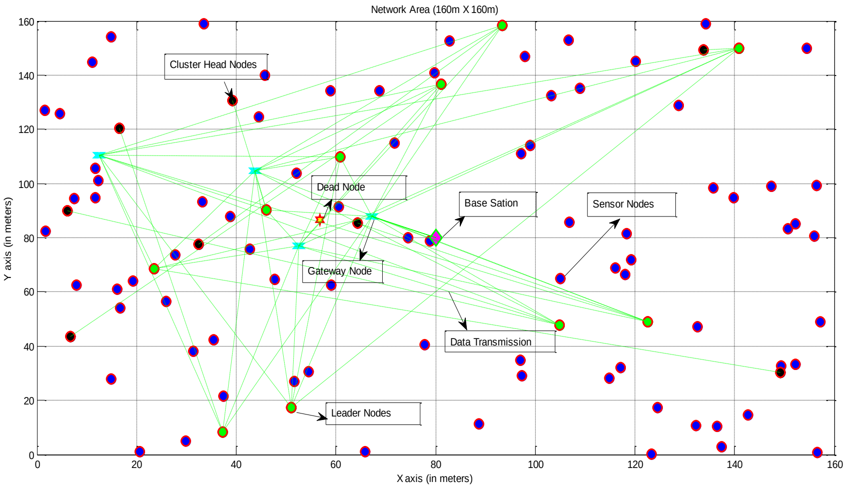

Figure 8: Network model for proposed approach in MATLAB

The performance of the protocol is measured in terms of

- First node dead (FND) or Stability period
- 10 % Nodes dead
- Half Nodes dead
- Packet delivery ratio (PDR)
- Throughput.

1. Network Lifetime

Network lifetime is measured using three metrics: First Node Dies (FND), Half of the Nodes Alive (HNA) (or Half of the nodes die (HND)) and Last Node Dies (LND). LND refers to the time when 90% of the total nodes die.

FND (First Node dead) or Stability Period

The time interval between the early stages of network operation until the death of the first sensor node is described. The first dead node emerges later, higher the period of stability [10]. In below figure 10 and 11 we can see that the First node dead in LEACH and PEGASIS in the initial energy 0.5 Joule will be at 185 and 276 round. LEACH is basic hierarchical routing protocol in this nodes are randomly distributed. Due to this dynamic clustering includes additional overhead [4]. Network robustness will be affected. PEGASIS Because of the chain logic and greedy approach in PEGASIS, sensor nodes can send their data with too much delay. In two level routing algorithm or existing three level fuzzy approach because of low energy nodes will be selected as cluster head because of random selection and in fuzzy rule base information is collected repeatedly. In our proposed routing scheme three level energy efficient hierarchical routing scheme by the use of extra nodes i.e. gateway nodes procedure it will be energy efficient it will reduce the data transmission distance and provide better lifetime. In below table shows the comparison with some existing routing approaches. From table 2. we say that our proposed protocol works better in terms of stability period.

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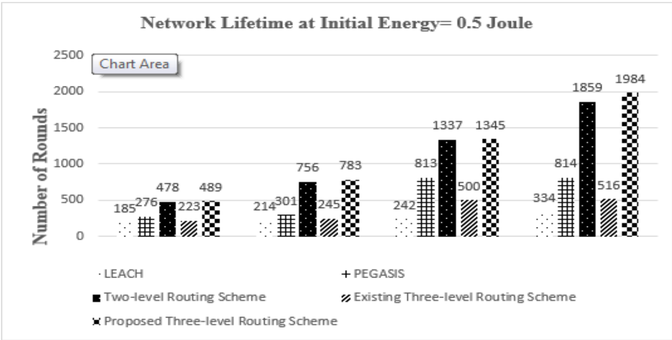

Figure 9: Network lifetime at initial energy 0.5 Joule for different routing scheme

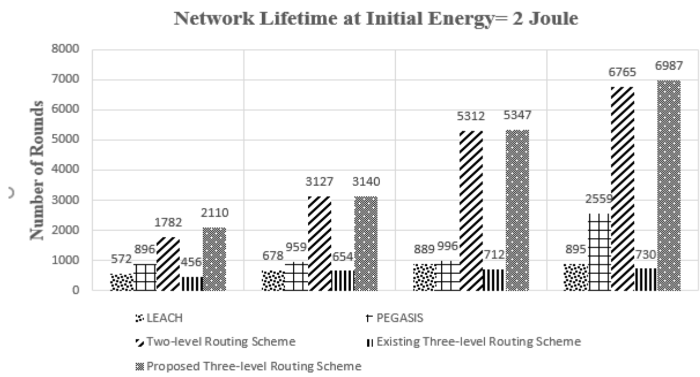

Figure 10: Network lifetime at initial energy 2 Joule for different routing scheme

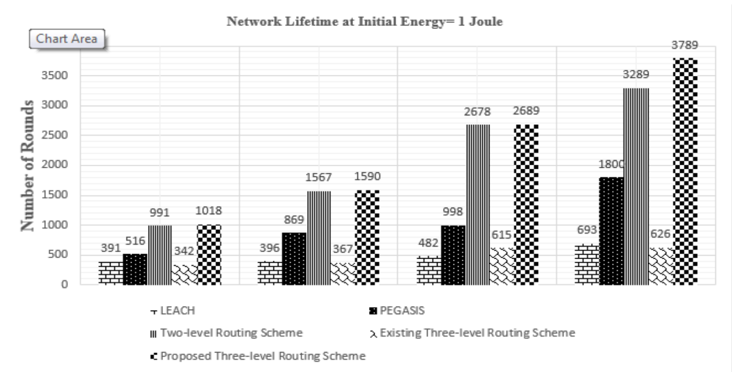

Figure 11: Network lifetime at initial energy 1 Joule for different routing scheme

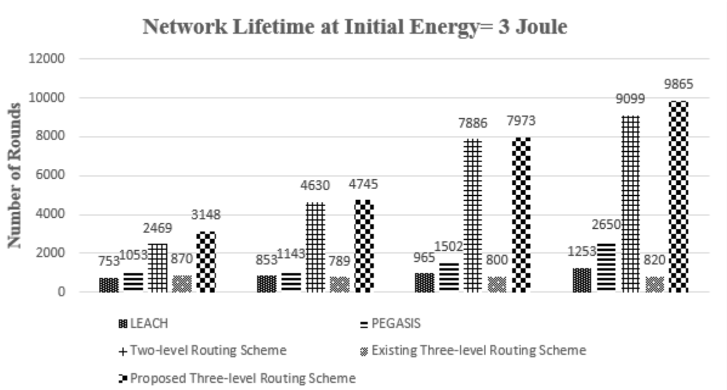

Figure 12: Network lifetime at initial energy 3 Joule for different routing scheme

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Table 2: Comparison of Network lifetime for various initial energy between different routing scheme

Initial Energy	**Routing algorithms**	**First node Dead**		**10 % nodes Dead**		**Half Nodes dead**		**Last node dead**	
0.5 Joule		Rounds	Time(Sec)	Rounds	Time(Sec)	Rounds	Time(Sec)	Rounds	Time(Sec)
	LEACH[4]	185	4.003	214	5.074	242	5.353	354	6.464
	PEGASIS [5]	276	26.65	301	29.311	813	31.456	814	36.784
	Two-level Routing Scheme [10]	478	444.958	756	734.89	1337	638.42	1859	1206.72
	Existing Three-level Routing scheme [5]	223	506.78	245	510.89	600	514.456	516	525.901
	Proposed Three Level Routing scheme	489	641.696	783	727.857	1345	738.247	1984	1008.789
1 joule	LEACH	391	4.521	396	4.789	482	4.952	693	6.414
	PEGASIS	516	26.989	869	29.678	998	31.558	1800	48.035
	Two-level Routing Scheme	991	708.89	1567	808.923	2678	823.987	3289	1477.66
	Existing Three-level Routing scheme	342	507.78	367	515.89	615	516.891	626	517.789
	Proposed Three Level Routing scheme	1018	727.857	1590	1026.74	2689	1127.345	3789	1206.51
2 Joule	LEACH	572	6.004	678	6.112	889	6.2718	895	10.915
	PEGASIS	896	27.690	959	29.99	996	33.789	2559	57.819
	Two-level Routing Scheme	1782	2001.23	3127	1391.652	5312	1406.341	6765	1450.71
	Existing Three-level Routing scheme	456	510.89	654	520.67	712	522.891	730	530.981
	Proposed Three Level Routing scheme	2110	738.978	3140	3236.45	5347	3578.981	6987	3768.90
3 Joule	LEACH	753	6.598	853	8.024	965	9.876	1253	13.95
	PEGASIS	1053	27.00	1143	30.323	1502	34.898	2650	129.428
	Two-level Routing Scheme	2469	2023.78	4630	1456.781	7886	1491.891	9099	1459.89
	Existing Three-level Routing scheme	870	512.78	789	539.89	800	525.891	820	535.98
	Proposed Three Level Routing scheme	3148	1864.026	4745	3267.897	7973	3654.78	9865	3976.891

Proposed scheme performs better in terms of stability period of network by 62.16 % from LEACH, 43.55 % by PEGASIS at 0.5 initial energy, 2.24 % by two-level routing scheme at initial energy 0.5 joule, 54.39 % by existing three level routing scheme at initial energy 0.5 joule. We also measure the time for the first node dead in the respective routing protocols. From table 2 we can see that in the LEACH, PEGASIS, Two-level routing scheme and existing three-level routing scheme our proposed protocol will be work more in the network lifetime, in our proposed routing protocol time for first node dead at 0.5 energy value it will be 224.91 sec, for 1 joule energy it will be 727.857 sec, for 2 joule energy it will be 738.978 sec, for 3 joule energy it will be 1864.026 sec. From the results we can see that our protocol will be extend in the network lifetime.

Ten Percent Nodes Dead

The number of dead nodes specifies the level of the network lifetime. If it is high in most time of the simulation process, the network lifetime is low; and vice versa. Following table 2. shows the 10 % nodes dead at following rounds. Overall comparison shows that proposed approach better than existing techniques.

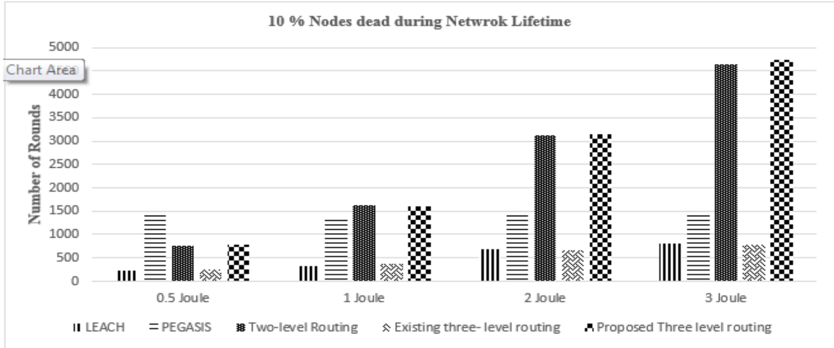

Figure: 13 Performance evaluation in terms of ten percent nodes dead during network lifetime

Half Nodes dead (HND)

It is denoted when sensor nodes have consumed half of their complete energy, i.e. they are partly dead and partly alive (i.e. energy will remain between half and zero. These partly alive nodes can still be part of network activity, thus increasing the network's lifetime. Increase the amount of half-dead nodes, improve network lifetime. From table 2. and graphs 14 we explain that in our proposed protocol better in terms of network lifetime as fifty percent of node die in our protocol at round 7973 which is far better than other existing protocols.

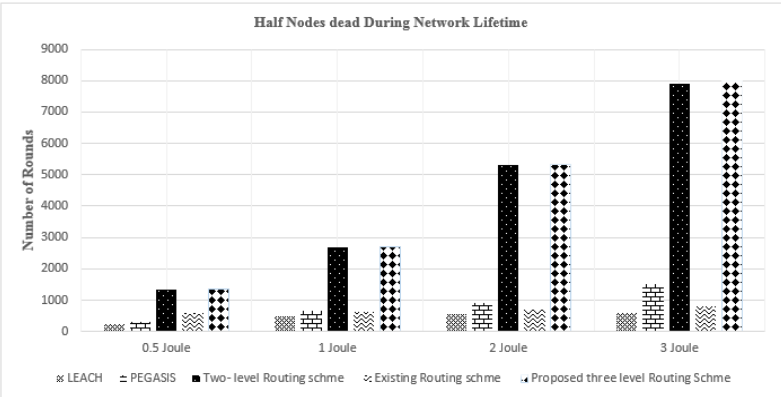

Figure: 14 Performance evaluation in terms of half nodes dead during network lifetime

Last Node Dead (LND)

LND refers to the time when the last node of the network dies or the 90% of the nodes died. From the following table 2 we see that proposed protocol performs better in terms of last node dead in the lifetime of network. In our proposed protocol for the initial energy 3 joule last node dead will be at 9865 round which is far better than existing routing schemes.

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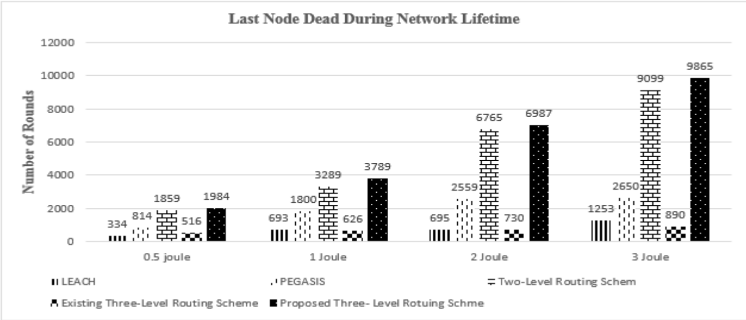

Figure: 15 Performance evaluation in terms of Last nodes dead or all nodes dead during network lifetime

2. Packet Delivery Ratio

The packet delivery ratio is specified as the amount of data packets that the destinations receive to those generated by the sources. Mathematically, it can be defined as

$$PDR = S1 \div S2$$

Mathematically, S1 is the sum of data packets received by each destination and S2 is the sum of data packets generated by each source. From figure 17, 18 and 19 we can see that in our proposed technique there will be high Packet delivery ratio as compared with others routing algorithms. In our proposed three level energy efficient routing scheme the PDR at 3 Joule is 7.989 % and in other existing routing technique i.e. in Two-level the PDR will be 7.67 % and existing three level approach it will be 6.78 %.

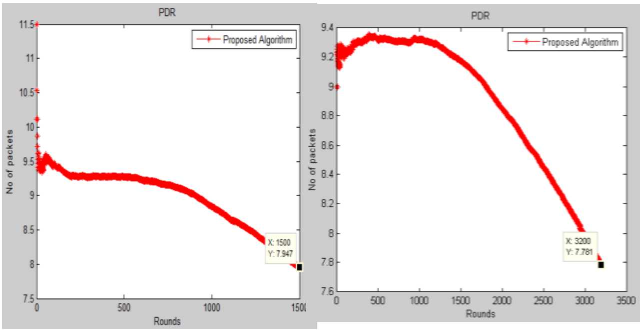

Figure 16: Proposed three-level routing protocol PDR performance in MATLAB figure window at different value of initial energy PDR at initial energy= 0.5 Joule PDR= 7.947 %
PDR at initial energy= 1 Joule, PDR=7.781 %

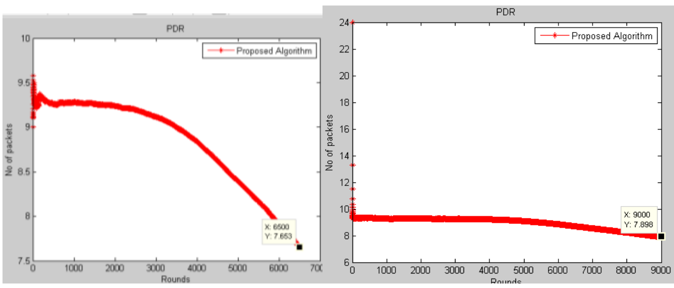

Figure 17: Proposed three-level routing protocol PDR performance in MATLAB figure window at different value of initial energy
PDR at initial energy= 2 Joule, PDR=7.653 %
PDR at initial energy= 3 Joule, PDR=7.898 %

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Figure: 18 Performance evaluation in terms packet delivery ratio

Table 3: Comparison of Packet Delivery Ratio at different initial energy from different routing algorithms

Initial energy	**Routing Algorithm**	**Packet Delivery Ratio (%)**
0.5 Joule	Two-level Routing Scheme [10]	7.24
	Existing Three-level Routing scheme [5]	6.13
	Proposed Three Level Routing scheme	7.947
1 joule	Two-level Routing Scheme	7.53
	Existing Three-level Routing scheme	6.12
	Proposed Three Level Routing scheme	7.781
2 Joule	Two-level Routing Scheme	7.02
	Existing Three-level Routing scheme	5.98
	Proposed Three Level Routing scheme	7.653
3 Joule	Two-level Routing Scheme	7.67
	Existing Three-level Routing scheme	6.78
	Proposed Three Level Routing scheme	7.898

3. Throughput

Throughput is represented in terms of packets sent from nodes to cluster head and from cluster heads to base station. As the network operation continues to progress, nodes begin to die. The transmission of packets from nodes to base station also reduces with reducing nodes. from figure 20,21 and 22 it shows that proposed routing scheme is better in terms of throughput analysis. Enhancement of throughput will be due to addition of gateway nodes in network the network lifetime will be improved.

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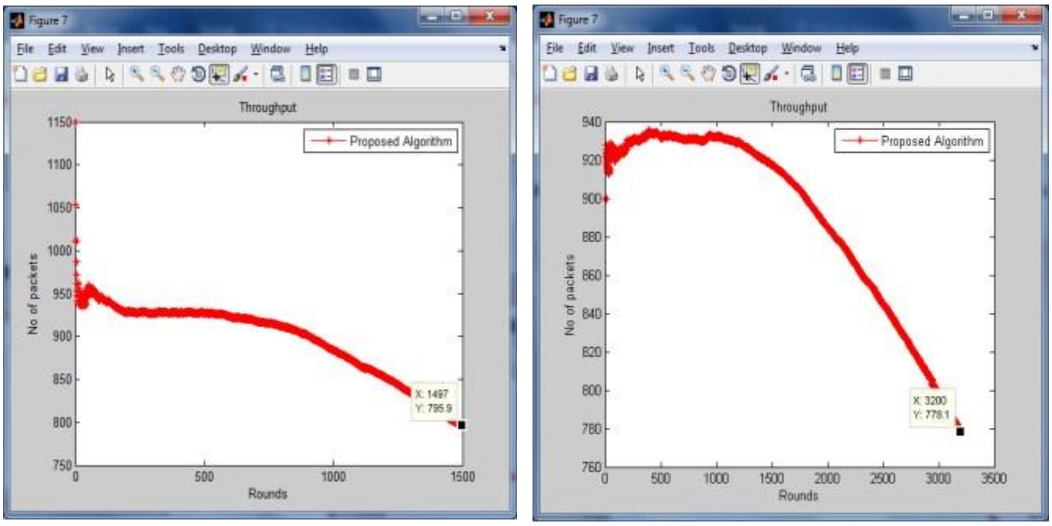

Figure 19: Proposed three-level routing protocol throughput performance in MATLAB figure window at different value of initial energy
Throughput initial energy= 0.5 Joule, Value =795.9
Throughput initial energy= 1 Joule, Value=778.1

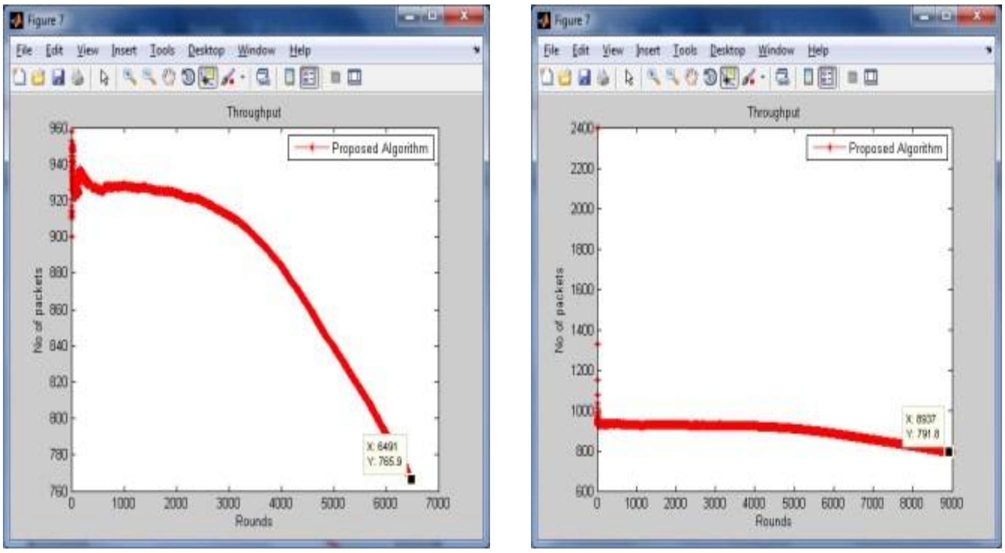

Figure 20: Proposed three-level routing protocol throughput performance in MATLAB figure window at different value of initial energy
Throughput initial energy= 2, Joule, Value =765.9
Throughput initial energy= 3, Joule, Value=791.8

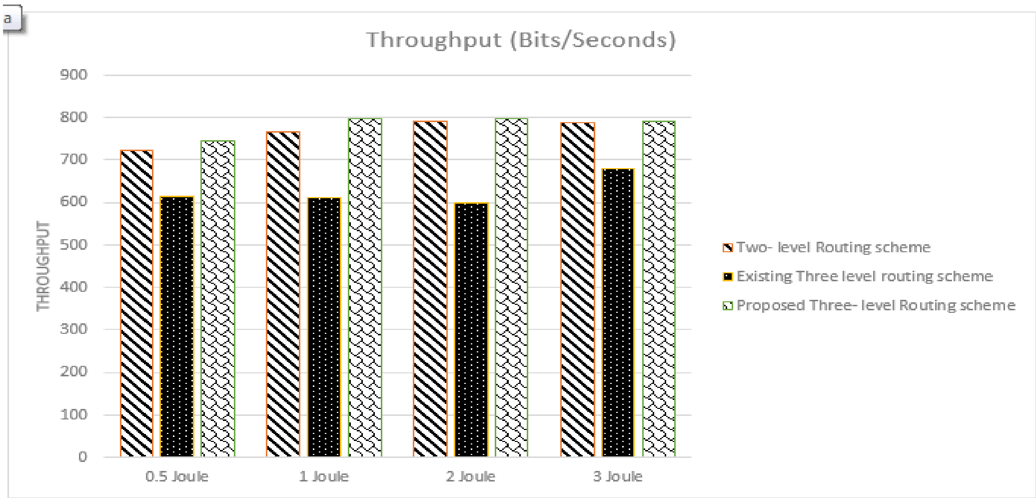

Figure 21: Performance evaluation in terms throughput during network lifetime

Table 4: Comparison of Throughput at different values of initial energy from different routing algorithms

Initial energy	Routing Algorithm	Throughput
0.5 Joule	Two-level Routing Scheme [10]	724.39
	Existing Three-level Routing scheme [5]	613.78
	Proposed Three Level Routing scheme	795.9
1 joule	Two-level Routing Scheme	767.9
	Existing Three-level Routing scheme	612.3
	Proposed Three Level Routing scheme	778.1
2 joule	Two-level Routing Scheme	792.1
	Existing Three-level Routing scheme	598.1
	Proposed Three Level Routing scheme	765.9
3 Joule	Two-level Routing Scheme	787.1
	Existing Three-level Routing scheme	678.43
	Proposed Three-level routing scheme	791.8

IV. CONCLUSION

From all these results, we can conclude that proposed hierarchical routing protocol is energy efficient and outperforms in comparison with existing LEACH, PEGAISIS, Two-level routing scheme and existing three level routing approaches. It is based on a clustering and gateway selecting approach. The network performance is best in terms of stability period (First node dead), 10 % node dead, Half nodes dead, Last node dead, throughput and packet delivery ratio. The proposed routing protocol is powerful in terms of longer network lifetime.

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