

# MESSCH PROTOCOL AN ENERGY EFFICIENT ROUTING PROTOCOL FOR WSN

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## Abstract

The rapid development in the diversified sensor based devices with the communicating module through unguided media has led the researchers to extend their research works in Wireless Sensor Network (WSN). The WSN contains large number of nodes that can be deployed in an area to monitor and then the nodes send their sense data somehow to the base station or Sink Node. The nodes run on button cell (3 volt) and are deployed in varied environments, so to maximize their operability and lifetime of the whole WSN network; the routing is an important issue. In this paper I have developed and analysed Maximum Energy Selection Static Clustering Hierarchy (MESSCH), Protocol architecture for WSN. The proposed protocol inherits the traits of an Energy Efficient there by increasing the network lifetime and minimizing the latency of the network. MESSCH is an static clustering hierarchy protocol where the cluster heads are rotated among the nodes in the respective cluster there by uniformly Expending the Energy among all the nodes. The proposed MESSCH protocol is simulated in the MatLab and is analysed accordingly which shows that the life time of the network increased compared to the LEACH protocol.

**Keywords:** Lifetime, Latency, Static Clustering Hierarchy Routing, Wireless Sensor Network.

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## I. INTRODUCTION

The growth of Wireless Sensor Network was initiated by Military and Defence Applications. The rapid progress in MEMS which is followed by NEMS has bigger role in the development of WSN and the applications of WSN is not restricted to only military and defence applications. The sensor nodes are low battery powered and have limited resources and due to their cheap production with the advancement in technology, they are used for health care, surveillance, monitoring & tracking etc.. There are two variants[1] of WSN, which are classified on the basis of the types of sensor nodes that are deployed in an environment. The two categories are Heterogeneous Wireless Sensor Network [2] where we used advanced nodes with more energy than the normal nodes and Homogeneous Wireless Sensor Network [3] where we used only one kind of nodes i.e with same energy. The research in wireless sensor network is done mainly in Network and MAC layer which focuses on optimization of Energy and localization of node.

In order to analyze the MESSCH protocol I have used the following performance metrics:

- Energy Consumption:** The sensor node's energy is dissipated by sending the sense data to the sink node and to come up with an energy optimized protocol it's important to evaluate this metric.
- Network Lifetime:** Since in heterogeneous WSN the sensor nodes are with different power resources and to develop an efficient routing protocol its important to analyze the Network Lifetime metric.
- Latency:** The latency of the network should be low or minimized overall, so I check this metric also.

## II. BACKGROUND

Since the nodes are battery powered and have limited resources so to maximize the lifetime of the network its utmost important to keep the micro sensor nodes in sleep mode when their operation is not required. Clare *et al.* had developed the time division multiple access (TDMA) [4] Medium Access Layer and using this technique the sensor nodes can be kept in sleep mode and can be brought onto wake up mode when their round comes. The sensor nodes transfer the sense data to the cluster head (CH) so the CH has heavy sense data and since the CH itself is restricted by power and resource constraint so it's crucial to diffuse or aggregate the sense data there by reducing the bulk of data send to the base station or sink node. Intanagonwivat *et al.* had developed the directed diffusion protocol which emphasize on data driven technique there by achieving low energy routing [5].

The research to develop the energy efficient routing protocol for WSN where the CH are chosen in such a manner that will aid in increasing the lifetime of the network. In WSN the nodes are deployed in uneven order so to sense the environment effectively it's important that the nodes should be deployed in such a manner that every parts under the deployed area should be covered. In MESSCH the CH are rotated on the basis of maximum residual energy in the cluster and the nodes are deployed in a manner so as to cover all the parts of the area.

The first order radio model[6] is used for the calculation of energy consumption by the radio signal in the Wireless Sensor Network (WSN).

### ATHE FIRST ORDER RADIO MODEL

The micro sensor node senses the environment and transmits the sense data to the CH and due to which the energy is depleted by the node. To transmit the packet of size 'n' bits energy depleted is:

$$E_{Tx}(n, r) = E_{tc}(n) + E_{amp}(n, r) \tag{1}$$

Here 'E<sub>Tx</sub>' is the transmitter energy, 'r' is the distance between the sender and receiver, 'E<sub>tc</sub>' is the energy that radio circuit needs to spend in order to process 'n' bits, 'E<sub>amp</sub>' is the amplification energy.

The equation (1) can be further expanded as follows:

$$E_{Tx}(n, r) = E_{tc}(n) + E_{amp}(n, r) = n \cdot E_{trans} + n \cdot \epsilon_{amp} \cdot r^\gamma \tag{2}$$

Where 'E<sub>trans</sub>' is the transmission energy for single bit & ε<sub>amp</sub> is the transceiver energy dissipation & 'γ' is the Path loss (PL) component.

Path loss component (γ) is dependent on medium of propagation and the PL value falls in the set of {2,4} where first value is used for free space propagation and the 2<sup>nd</sup> value in the set is used for multi path propagation when there are some obstacles in the path of propagation.

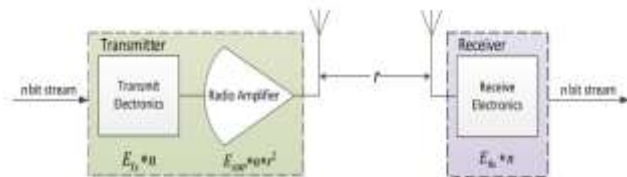


Fig. 1. Radio model for the transmission of n bits of inform [7]

After the transmission by the sensor node the packets are received by the CH and to receive the packet of 'n' bits the following energy is spent:

$$E_{Rx}(n) = R_{rc}(n) = n \cdot E_{recv} \tag{3}$$

Here 'E<sub>Rx</sub>' is the energy spent on receiving the packet, 'E<sub>recv</sub>' is the energy depletion for receiving the single bit.

### III. MESSCH PROTOCOL

The Maximum Energy Selection Static Clustering Hierarchy (MESSCH) is a routing protocol which has been developed after analyzing the traditional clustering routing protocol. MESSCH is based on static clustering where the nodes are deployed on the random manner but in a precise way compared to the traditional protocols over an area. Two types of clusters are formed in MESSCH protocol:

- *Intra Cluster:* The intra cluster is formed by the association of sensor node with a Cluster Head (CH).
- *Inter Cluster:* The inter cluster is formed by the association of CH with the SN(Sink Node).

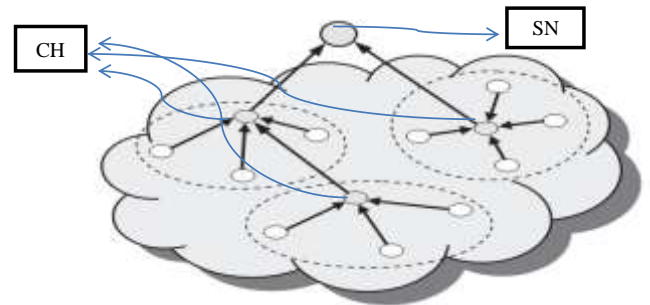


Diagram: WSN N/W with sensor node, CH & SN.

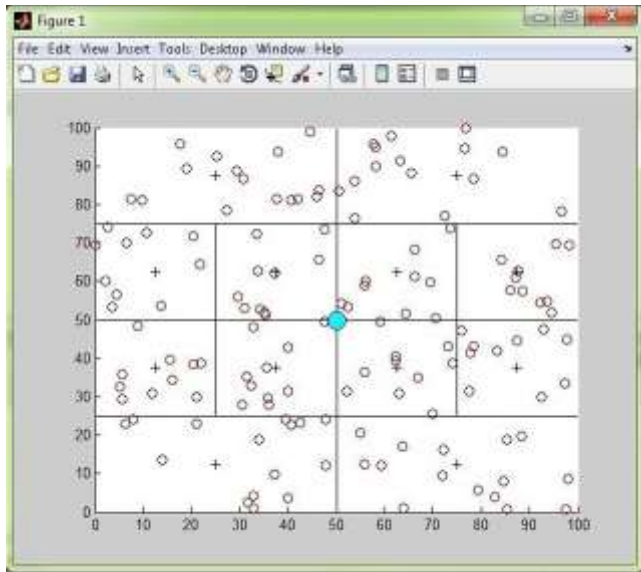
All the sensor nodes in the WSN except the CH sense the environment and the sense data is transmitted by the sensor node to the CH. The CH after receiving the packet does not immediately transmit the packet to the SN, instead it aggregates the receive packet where 'E<sub>ag</sub>' energy is spent for aggregation of the packet.

In MESSCH the area to be sense is broken down evenly logically so that the sensor nodes can be deployed randomly. It appears that the sensor nodes are deployed randomly but when compared to other traditional dynamic clustering protocol then it's clear that the nodes are deployed precisely in a smaller sub-sectional area of the main area. Before deploying the nodes, area to be sense is broken down evenly into smaller sub-sectional area in the geometric shape of either rectangle or square. The given area can be broken down evenly by the following mathematical method (Algorithm 1):

- I. Bisecting the whole sense area logically in the horizontal manner and vertical manner.
- II. After the first step is over again apply the same former method onto each bisected sub-sectional area.
- III. After the second step is over the whole sense area is logically broken down into twelve (12) sub area.

The MESSCH protocol emphasize on precisely plotting the advance node which are sensor nodes but with higher Energy levels compared to the normal nodes. After analyzing the Diagram [1] it's clear that the Advanced node should be plotted on the center of each region, so that the distance from the advanced node to the sink node is optimized and moreover all the nodes in the cluster will have average distance from the normal node to the advanced node if the advanced node is selected as Cluster Head somehow mathematically.

By applying the Algorithm 1, I have come out with the following logical area Diagram 1.



**Diagram 1:** Logical sub sectional area of the main sense area.

So to maximize the lifetime of the network in this paper I am focusing on giving importance to the residual energy of the sensor node for the selection of the Cluster Head (CH). In MESSCH protocol since we are deploying advanced node at the center of each region so advanced node for each cluster is mathematically gets selected for few rounds in the operation of the network until its Energy starts to dissipates and its energy level falls in the category of normal node.

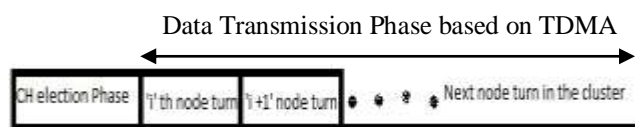
The MESSCH is a self-organized & Self Adaptive protocol where the operation is based on the rounds and each round starts with the following stages:

a) **Announcement Phase:** In this phase all the nodes in the cluster contend for the election of the cluster head based on the residual energy and the node having maximum energy in the cluster of a region gets selected as the CH for each round.

b) **Data Transmission Phase:** In MESSCH the clusters are static so after the election of the CH the non Cluster head sensor nodes wait for their turn to transmit the sense data to the CH. In this phase the TDMA is used so that the non CH sensor node can put themselves in the sleep mode when their turn doesn't arrive.

This phase is similar to the "Steady State Phase" of LEACH protocol but in MESSCH since the clusters are static so the numbers of non CH sensor nodes are fixed.

The MESSCH protocol process is:



**Diagram 2:** MESSCH Protocol Phase

The CH during the operation of MESSCH routing protocol loses its energy rapidly compared to non CH sensor nodes in the cluster due to the following reasons:

- In **intra cluster** operations the CH energy is depleted due to 'E<sub>Rx</sub>' as shown in equation (3).
- In **inter cluster** activity the CH node energy is spent on 'E<sub>da</sub>' which is the Aggregation energy for aggregating the sense data before transmitting the data to the SN. In addition to 'E<sub>da</sub>' energy the CH expends the energy in the form of 'E<sub>Tx</sub>' as shown in equation (2).

As already discussed the 'E<sub>Tx</sub>' energy is dependent on the path loss component and due to which the Threshold distance 'd<sub>0</sub> = √(E<sub>fs</sub>/E<sub>mp</sub>)' is calculated where 'E<sub>fs</sub>' is the amplification co-efficient of free space and 'E<sub>mp</sub>' is the amplification co-efficient for multi path. If the distance between the CH to the BS is less than or equal to 'd<sub>0</sub>' then the free space component is considered and in this case the γ=2 else multi path component is considered which is γ=4.

In MESSCH since the clusters are static so the total number of elected CH is fixed, this is also equal to the total number of regions or sub sectional logical areas. The CH after receiving the packet transmits the aggregated packet to the Sink node by exploiting the technique of CDMA which is allocated by the Sink Node or Base Station at each round upon the selection of the Cluster Head.

#### IV. SIMULATION OF MESSCH Protocol

To simulate the MESSCH protocol I have used MatLab R2009a and in the simulation I have tried to analyze the MESSCH protocol there by evaluating the performance metric as discussed earlier. I have also compared the graph of MESSCH & LEACH protocol during the simulation to come to a conclusion regarding the performance of my proposed developed algorithm.

#### A SIMULATION PARAMETER

The following parameters are considered for simulation:

- a) The sensor nodes are randomly deployed so as to ease the deployment process but are precisely deployed so as to increase the coverage of sensing area.
- b) I have considered the Heterogeneous WSN where two kinds of nodes exist:
  - Normal nodes: These are the nodes having initial energy E<sub>0</sub>.
  - Advanced Node: These are the nodes having α times more energy than E<sub>0</sub>.
- c) After applying the Algorithm 1 which is proposed earlier in this paper, I have come out with 12 regions out of which 4 rectangular regions & 8 square regions are formed.
- d) Each rectangular region contains more number of sensor nodes compared to the square region.
- e) The rectangular region is deployed with 15 normal nodes & 1 advanced node.
- f) The Square region is deployed with 10 normal nodes and 1 advanced node.
- g) The advanced nodes are placed at the center of each region.
- h) The Sink Node or BS is plotted at the center of the area

The other specific parameters are listed in the Table 1.

Parameter	Parameter
EDA=5 nJ/Bit	Packet Size:4000 Bits
Rmax= 1300.	Advanced Node=12.
$\alpha= 50\%$ of $E_0$ .	$E_{mp}=0.0013$ pJ/Bit/m <sup>4</sup>
Normal node= 140.	$E_{mp}= 0.0013$ pJ/Bit/m <sup>4</sup>
Area=100 * 100 m <sup>2</sup>	$E_{Tx}= 50$ nJ/Bit.
SN= (50,50)at Center	$E_{Rx}= 50$ nJ/Bit.
$E_0=0.5$ J	$E_{is}= 10$ pJ/Bit/m <sup>2</sup>
P= 10 % of N.	N= 152 i.e (140 + 12=152)

.Table 1: Simulation Parameters.

### B EVALUATION OF SIMULATION

After the deployment of the sensor nodes I have come out with figure 1.

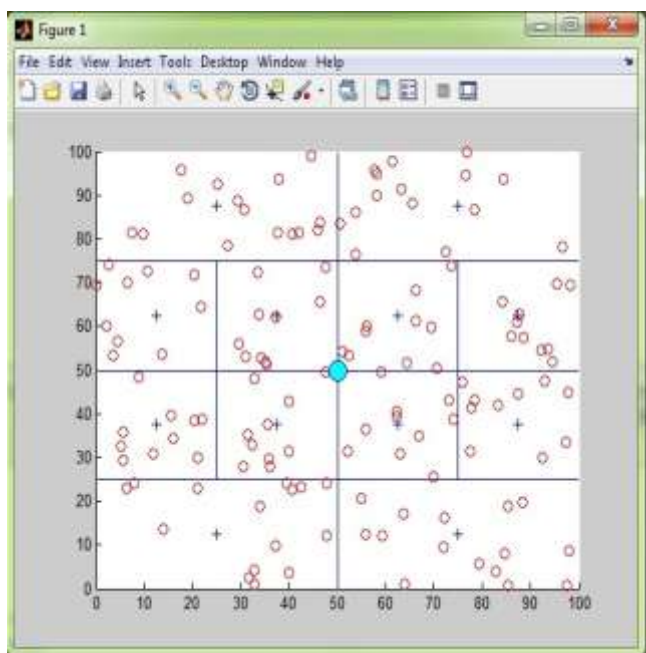


Figure 1. Sensor Nodes Deployment with SN & Advanced Node

The figure (1) shows the normal sensor nodes with small 'bubbles' and advanced nodes with '+' symbol and sink node is at the center of the area.

To evaluate the Network life time performance metric I have plotted the parameters on to a graph and have come out with the following graph (figure 2)

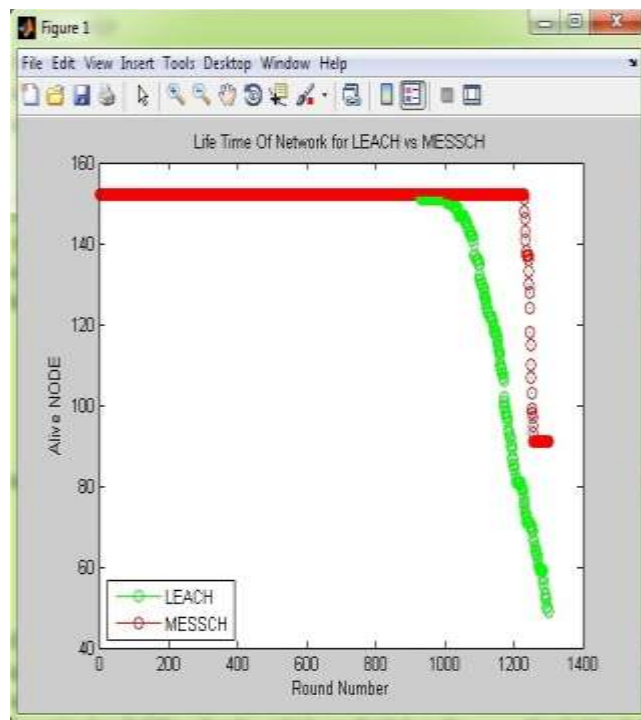


Figure.2. Alive Node (Life Time of the N/W)

In the figure 3 I have plotted the pie graph for both LEACH & MESSCH protocol.

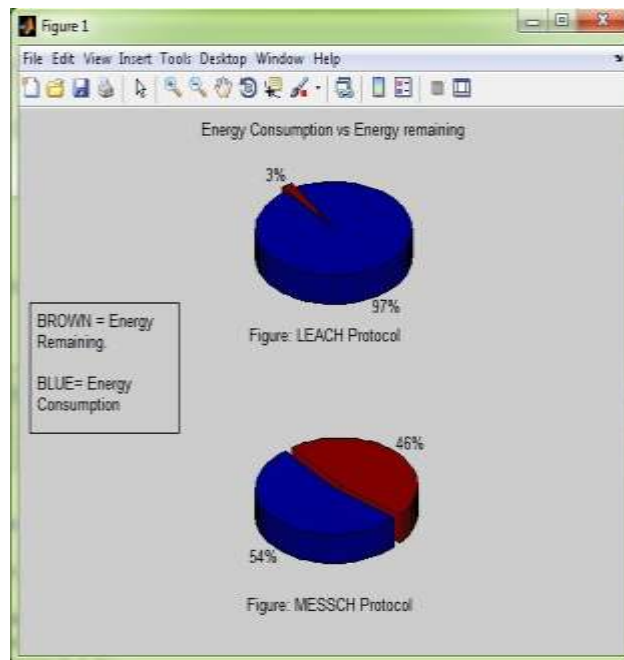


Figure 3. Energy Consumption plotting (pie graph)

The following figure 4 shows the packets transmitted to the CH from the non CH sensor nodes.

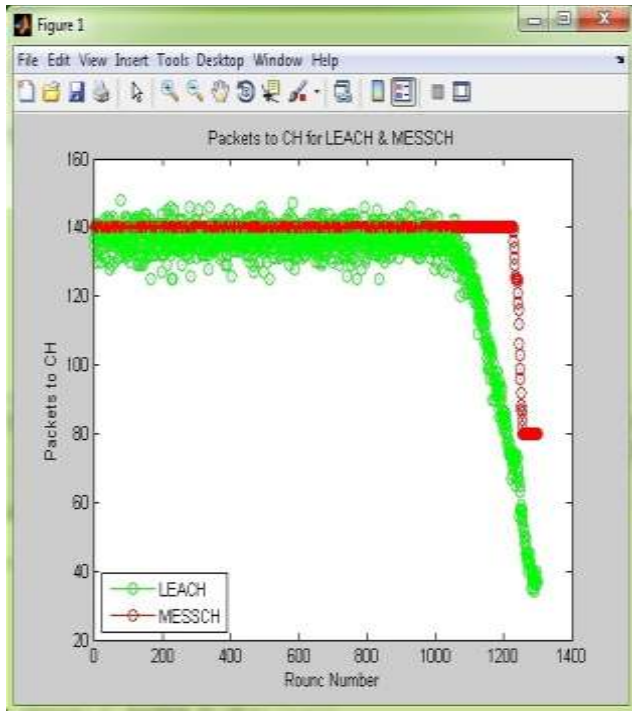


Figure 4. Line graph for packets to CH from non CH

The figure 5 shows the packets transmitted by the CH to the sink node or base station.

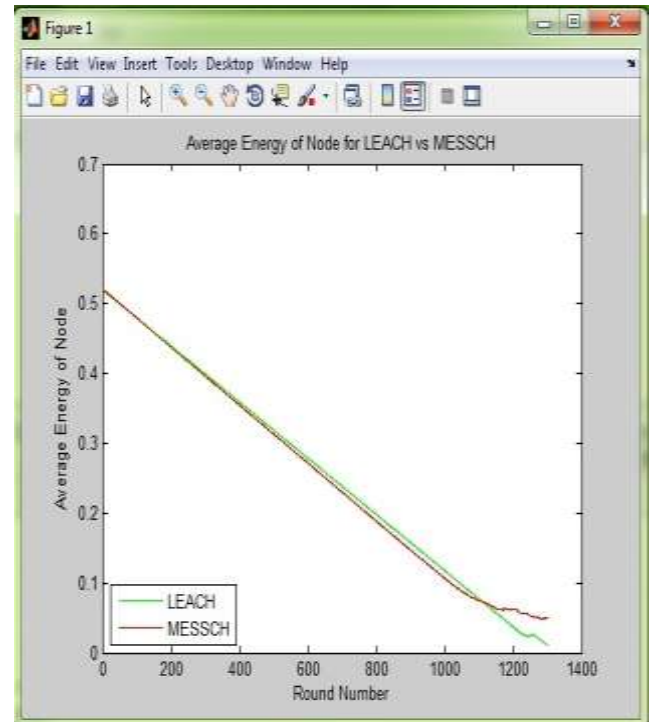


Figure 6. Average Energy of the sensor nodes

When we run the simulation for 1300 and then the final state of the Network is depicted in figure 7.

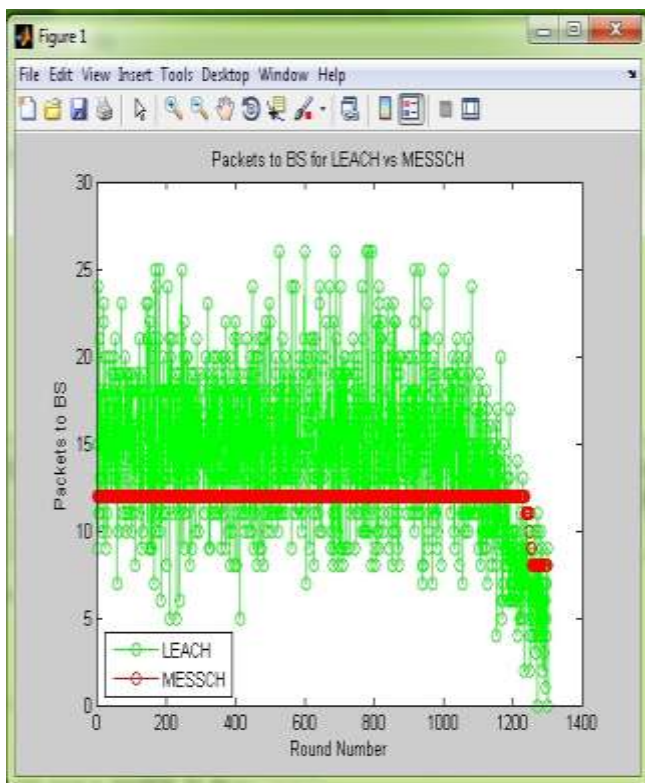


Figure 5. Line Graph for packets to BS from CH

After running the simulation for 1300 rounds I have come out with the figure 6

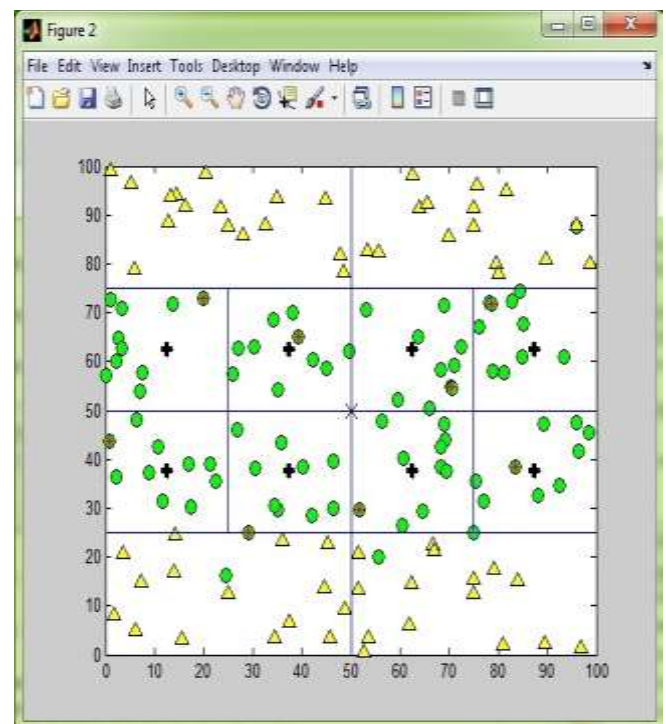


Figure 7. Final State of the Network.

## V. CONCLUSION

On the basis of the simulation I have come out with the following conclusions which are listed below:

- i) In figure 2, its notice that up to round number 1231 all the nodes were alive where as in LEACH after round number 931 the nodes started to drain all of its energy there by becoming dead nodes.  
So, I can conclude that the **network was stable up to round number 1231 in MESSCH (94.69 %)** compared to **931 in LEACH (71.61 %)**.  
So the proposed algorithm MESSCH is much better compared to LEACH.
- ii) From figure 3, it's notice that after running the simulation for 1300, the remaining energy was **46 % for MESSCH** where as its only **3 % for LEACH** protocol.  
So , I can conclude that **MESSCH is power efficient compared to LEACH** there by making huge percentage differences in terms of remaining energy of the network.
- iii) From figure 4, its clear that after round number **1000 in LEACH** the packets from sensor nodes to CH tend to decline compared to round number **1200 for MESSCH**.  
So the proposed **MESSCH protocol was able to sense the environment more compared to LEACH**.
- iv) Figure {4,5} made me to conclude that the number of **CH is more in LEACH** compared to **only 12 for MESSCH** protocol and it's **better if the CH numbers can be reduced** there by making those nodes to sense the environment instead of acting as the cluster head for the network.  
So **MESSCH is better compared to LEACH there by making the nodes more usable** instead of acting as the CH for the Network.
- v) **LEACH does not consider the residual energy while selecting the CH**, and it might be possible that sometimes chosen CH might drain all of it's energy before transmitting the packet to the SN there by increasing the latency of the Network where as in **MESSCH the CH are chosen based on the maximum residual energy**.  
So **MESSCH reduces or minimizes the latency of the Network**.
- vi) **LEACH is a probabilistic** algorithm whereas **MESSCH is developed removing the probability** feature.
- vii) The proposed **MESSCH protocol efficiently uses the advanced node thereby making them to serve as CH** for few rounds during the initial operation of the Network.  
So **MESSCH is better adhering to the heterogeneous WSN feature**.

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## BIOGRAPHY



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