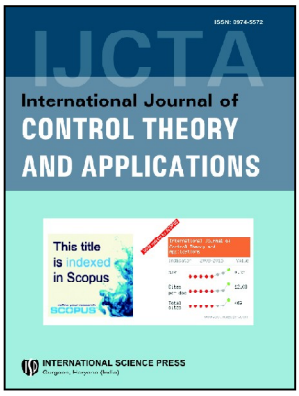

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Reduce Overlapping Sensing Area Based WSN Network Life Time Enhancement Protocol Based BAT Optimization

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Abstract: WSN is major field among researchers to get better and enhanced life time for network, one of the main fields is to calculate route for routing more precisely and accurately to get better results. Now researchers are moving towards routing mechanism in order to distribute the load between the sensor nodes and gateway(s). In recent works researches are using the number of sensors present for the particular sensor node to route data to the base station. In this paper be will solve the problem of energy consumption related to the wireless sensor networks. BAT Algorithm optimization technique is used for the management of the energy efficiency. The performance is than compared with the other algorithms like, LEACH, Zone and EZone. Be will we using MATLAB for the extensive simulation to check the effectiveness of the algorithm. The founded result is quite better as compared to the other algorithms in every aspect like Total number of alive nodes and Total system energy.

Keywords: Wireless Sensor Network, Routing and BAT Algorithm.

I. INTRODUCTION

Sensor network is a structure that constitute of computing, sensing, and communication elements that equip user with the capability to observe and act in response to the occurrence or happening of the particular area. Wireless sensor network are spatially distributed sensors over some area and pass their data about the condition of the area or some other information to the main location. These sensors help us to study the environmental conditions such as temperature, sounds, etc. without our physical presence over that area. It acts as the bridge between the virtual and real world. The user usually belongs to the governmental, civil, industrial entity and commercial. Nodes are scattered in the environment like a biological system, the physical world or an information technology (IT) framework.

WSN has different application in different fields like Wireless Sensor Network plays a very significant role in military applications. In the military applications, WSN can be utilize or used in many purpose like in remote area it will keep on monitoring the activities of the militants and leads to the protection of forces. [1] These networks facilitate identification of rival's force, the detection of rival's movement, investigating their enemy movement and the progress in the work is possible only through the utilization of appropriate sensors. Also in

Environmental Applications like ALERT (Automated Local Evaluation in Real-Time [2]) is the first familiar wireless sensor network that was deployed in real world. ALERT offer information about the water level and real-time rainfall to calculate approximately the possibility of prospective flooding. It also helps in health care monitoring, pollution control etc.

Due to a range of wireless network constraints, it becomes very challenging for WSNs to design the routing protocols according to that. WSN'S has various design issues such as central processing unit, limited memory, bandwidth and battery power etc,. So in order to transfer the data from the sensors nodes to sink less energy should be use so that the lifetime of the network is increased because once the nodes are deployed then it's very difficult to make any changes.

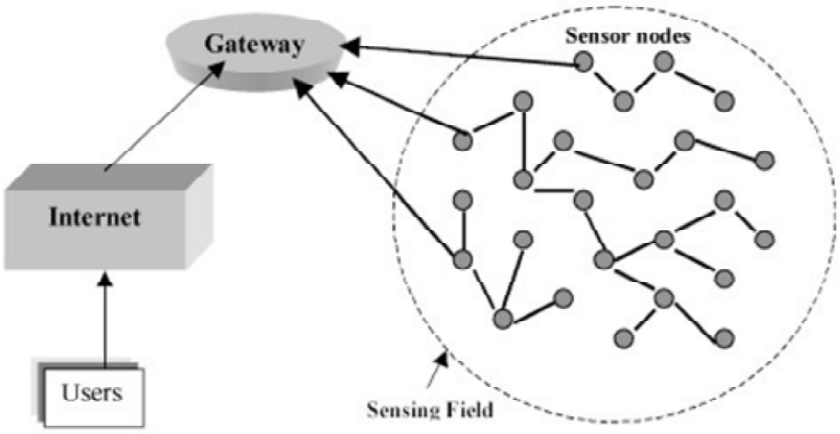

Figure 1: Wireless Sensor Network

In this figure we can see that the each node is capable of capturing information from its nearby area by using their battery energy and can communicate with each other, also capable of transferring the captured information from the sensing area to the nearby gateway.

In this paper we will focus on the deployment of the strategic WSNs like the deployment of the nodes is done randomly over the areas and the gateway is placed on the outside of those areas. In the absence of human the network operation must be reliable and should use minimum energy and cover the maximum area for the information. A main challenge is that how to deploy the strategic WSNs with the limited battery energy of each nodes. Due to this the service of the network is affected. To increase the lifetime of the network, those techniques should be used having efficient routing mechanism in order to increase the energy efficiency between sensors and gateway.

(A) Motivations and Contributions

Different traditional load balancing algorithms are discussed in literature. In this paper we will discuss about the drawbacks of these traditional algorithms on the performance and the lifetime of the Wireless Sensor Network because these traditional algorithms has not taken into consideration the most important factor which is energy efficiency schemes which are required to extend the lifetime of the network. In this paper our aim is to provide better network service life by incorporating an energy efficient load balancing techniques with the routing algorithm.

In order to achieve better performance load balancing techniques must be taken into account. This can be explained on the basis of the maximum time for which the nodes perform. The topology is controlled for the live nodes when the concentration of dead nodes keeps on increasing so that the uniform coverage of the interested

area is achieved. We have considered an additional gateway node and has observed improvement in performance of the network.

Our work in this paper is summarized as following:

- Survey of existing load balancing routing algorithm in WSNs. In addition of the additional gateway the improvement in performance is also identified. The studied algorithms are: 1) Low Energy Adaptive Clustering Hierarchy (LEACH), 2) Zone Routing and 3) EZone Routing.
- We will develop a WSN routing algorithm which must be energy efficient that uses a second cluster head for the transfer of information and results in improvement of performance as compare to the other algorithms. We refer this algorithm as proposed BAT algorithm.
- Shows that how the energy is saved and how this affects the coverage over the area.
- Most of the network the node die randomly fast because of this number of times trials are performed. This technique select the second cluster head for the transfer of the information so that the load on the main cluster head is reduced. This is energy efficient technique.

The remainder of this paper is as. In section II discuss about the implementation of WSN. Dissection of various traditional algorithms along with the proposed algorithm is described in section III. In section IV the results simulations and analysis in done. Finally in section V paper is concluded.

II. WSNPROTOCOL STACKS IMPLIMENTATION

According to our study be will implement each algorithm for single as well as multi-gateway.

Physical layer: Our WSN consists of 100 sensors nodes which are distributed over 50m × 50m grid and the gateway (also for multi gateway) is placed at 100m from grid. We utilize a first order power amplifier and sensor model [3], [4], [5]. This model assigns an energy cost-per-bit to collect, transmit and receive information. In order to identify the information required for the transmission of one bit of information over a certain area between the nodes it takes into account the direct and multi-path wireless signal propagation and signal-to-noise ratio is guaranteed at the receiving point. We have used the first order radio energy model which relates the expected energy required to send and receive an L-bit message over distance d and taking into account the direct and multi-path propagations.

The energy symbol and other parameters are introduced in [5] Table 1. The employment of these parameters is done at physical layer simulation. We assume that every node is within wireless transmission of the gateway and also means that in the WSN each node is within communication range to any other node present in the system.

Table 1
Radio Energy Dissipation Parameters [4]

Constant	*Value*
Transmit and Receive Electronics, Eelec	50 nJ/bit
Transmit Amplifier, free space propagation, “fs	10pJ/bit/m2
Transmit Amplifier, multi-path propagation, _m	0.0013pJ/bit/m4

1) MAC layer: Time-Division Multiple Access (TDMA) is assigned to each node in WSN. It assigns a timeslot for each round. The information is transferred to the gateway during this timeslot. The simulation at MAC layer starts at round zero and ends when last node dies. In WSN each and every

node sends a packet of L-bit from the application layer to the gateway during each round. We don't deal with how the TDMA assignments take place; we are concern with only how the packet is transferred from the node to the gateway.

2) *Network Layer*: Number of routing algorithms are applied in this layer, some are described in [6], [7], [8], [9], [10]. Several traditional algorithms are applied and routing algorithm are established as observed. We have proposed an energy efficient routing algorithm BAT. Following are the algorithms we implemented:

   a) *LEACH*: A network clustering algorithms for WSNs [11], [3].

   b) *Zone*: Clustering algorithm used for the partition of the network into zones and determine the routing from the nodes to the gateway using cluster head (CH) present in each zone [12].

   c) *EZone*: Implementation of EZone routing is described in [12], and routing algorithm is described in [13].

   d) *Proposed BAT*: Energy efficient algorithm implemented in this paper. BAT is described in [b], except in proposed BAT we elect the second cluster head, based upon the second highest energy and transfer the information to that cluster head (CH) which has highest energy in all clusters and minimum distance from gateway and is described in detail in Section III.

3) *Transport layer*: The strategy implemented by the transport layer is similar to that of the modern days internet using User Datagram Protocol (UDP). UDP is a connectionless oriented protocol in which the source node has no acknowledgement about the reaching of message to the destination. So his is applicable for WSNs because it prevents the energy level because no energy is use for the feedback transmissions.

4) *Application layer*: It implements 1) use of traffic generator, and 2) use of a data aggregation technique. A 2000 bit of data message is generated for each round transmission to the gateway by the traffic generator. For clustering algorithms data aggregation is used and data aggregation can be performed by the cluster head (CH) only. All messages from the different nodes is received by the cluster head (CH) in the cluster. Then messages are compressed into one 2000 bit message including the CH's sensor message, and the compressed message is transmit to the gateway for each round.

III. ROUTING ALGORITHMS FOR LOAD BALANCING: TRADITIONAL VS EZONE

Four routing algorithms will we discussed in this section as followed: LEACH, Zone, EZone and Proposed BAT.

A. Traditional Routing Algorithms: LEACH, Zone and EZone.

a) *LEACH*: Heinzelman, et.al [14] introduces Low Energy Adaptive Clustering Hierarchy (LEACH) for sensor network and considered as a hierarchical clustering algorithm, LEACH assembles the deployed nodes in the network and grouping them into small clusters and one among the nodes are elected as cluster head. Each node in the clusters first senses their destination point i.e. target and then transmit the appropriate information to their associated cluster head. Then the cluster head aggregates the data and compresses it that result in reduction in size of the appropriate data received from its non cluster nodes and transmit it to the destination i.e. base station. The nodes elected as the cluster head consume more energy in comparison to the other nodes as it is mandatory to transmit data to the base station. It may be possible that the location of base station is far away from the network. For this reason LEACH believes to choose cluster head by randomly selected it among the nodes for each round. And this helps in load balancing of the energy consumption in the network.

b) *Zone*: Zone clustering is used less as compare to the LEACH. But it can be used for the tactical network, because by using it we can state that how the zones are distinguished for the network.

c) *EZone*: In EZone CH is chosen randomly of each cluster. The clustering algorithm used for the partition of the zones is energy efficient in EZone as compare to that of LEACH because the distance to transmit from the nodes to CH is less. In EZone election of the CH is as followed: the CH chosen is the node with the highest energy then the energy depletion rates of the node is minimized with the battery level in any zone depleting at a uniform rate. In EZone instead of choosing the CH randomly, the node with the highest energy is chosen as CH.

d) *BAT*: Bat algorithm used the advantages of the other algorithms and combined with the characteristics of Bat echolocation. The Bat algorithm was also developed based upon the following three idealized rules:

- Objects distance are always perfectly sensed by the echolocation system of bats and the background obstacles run in darkness.
- Bats random velocity $v_{i,}$ fixed frequency f_{min} at position x_i and varying wavelength λ and loudness from A_0 to A_{min} to search for its prey. They can frequently change the emitted pulses wavelength and adjust the pulse emission rate $\gamma\varepsilon$ [0,1], based on the bat's target.
- We considered the loudness changes from a maximum (A_0) to a minimum loudness (A_{min}).

In this paper first the network is partition into specific zones and then the CH is chosen based upon the energy level of the nodes. The node with the highest energy is chosen as CH of that zone. Then the second CH is chosen. The second CH is that node which has the second highest energy level that of CH. Firstly all the data from the individual nodes is transmit to the CH of the zone then the information collected at the CH is transmit to the second CH so that the energy of the main CH is saved because the CH of the zone has to collect the information and also has to compressed that information into 2000 bit of message and further has to transmit that message to the gateway, in this way lot of energy of the node is consumed. So in order to preserve this energy the second CH is chosen so that the CH transmit the data to the second CH and second CH transmit the message to that node which is finally chosen based upon the distance from the gateway and with the highest power. In this pattern from each zone one node is selected which has least distance from the gateway and energy is high as compare to other second CH's then all the other CH's transmit the data to that node and finally that node transmit the message to the gateway. In this way less energy is consumed.

IV. SIMULATIONS AND RESULT ANALYSIS

In the simulation process sensors and gateways are distributed on a Cartesian grid with axes x-axis and y-axis. In our simulation and analysis process we have involve a grid of 100 sensors. And each sensor's x and y coordinate is modeled as a uniformly distributed random variable between 0 and 50 meters (m). In single gateway the simulation of gateway is positioned at (x; y) = (25m, -100m), while in the simulation of multi-gateway the gateway is employed at (x1; y1)=(25m, -100m) and (x2; y2)=(25m, 150m).

Fig. 2. Shows the single WSN graphically. Multi-gateway is same as that of the single gateway except that of there is an addition of the gateway employed on top of the network topology positioned at (25m, 150m).

Zoning arrangement is shown in the figure which is only used for zone related algorithms; while no use of the vertical zone partitions is make by the other algorithms. The representations of the nodes are done by the outline circle of blue colour and the gateways are represented by solid green. The field zone and the perimeter are shown with red colour lines. The starting energy of all nodes is 0.5J, the energy of the gateways are assumed unlimited. Two application layer policy is being employed, 1) constant bit rate generator (CBR) and 2) data aggregation application. At each round the CBR allows the node to send message of an L=2000 bit to the

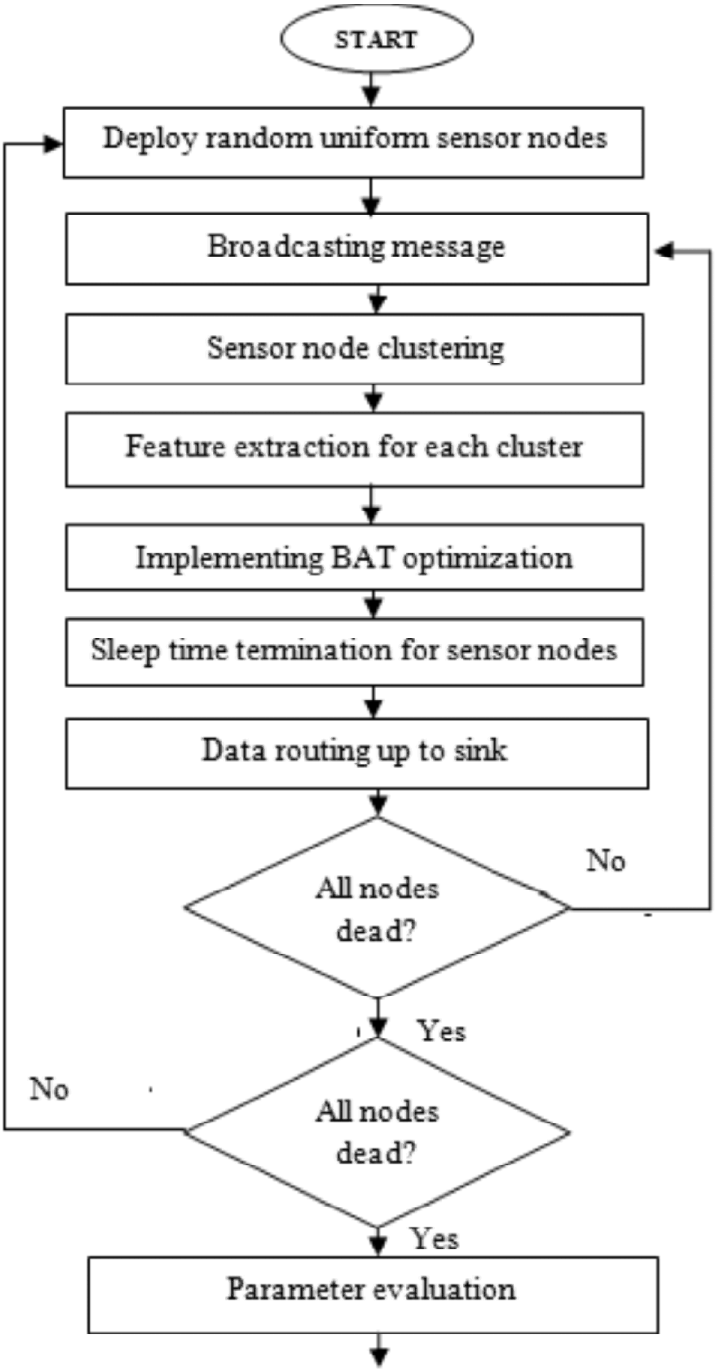

Figure 2: Proposed BAT Optimization

gateway. The contents of the message are not considered. However, the focus is that the message is produced so that the energy which is depleted during routing algorithm is observed.

Data aggregation is used by clustering mechanism only in our scenario. We must account for the energy which is used by the data aggregation for the compression of the signal. The CH perform the data aggregation and EDA [15], is used to account for the energy which is used to compress messages into one final L=2000 bit message.

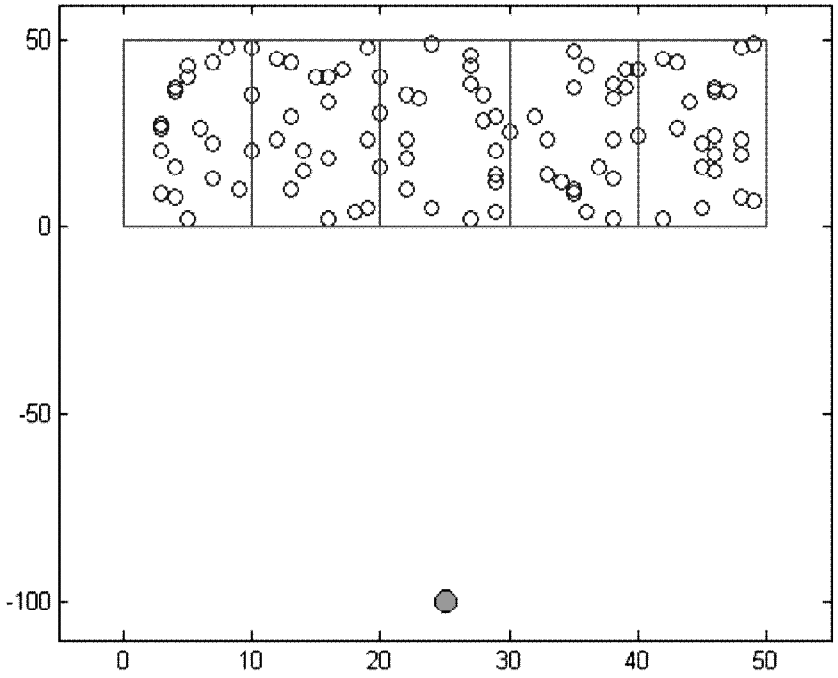

Figure 2: Arrangement of single gateway WSN topology simulated in Matlab

Data aggregation constant (EDA = 5nJ/bit) is used in our simulation which results in an aggregation cost of EDA × L [15].

(A) Comparisons of Algorithms based on Energy Consumption

During each transmission rounds total WSN energy level is plotted for all traditional algorithms and proposed one (Fig. 3).

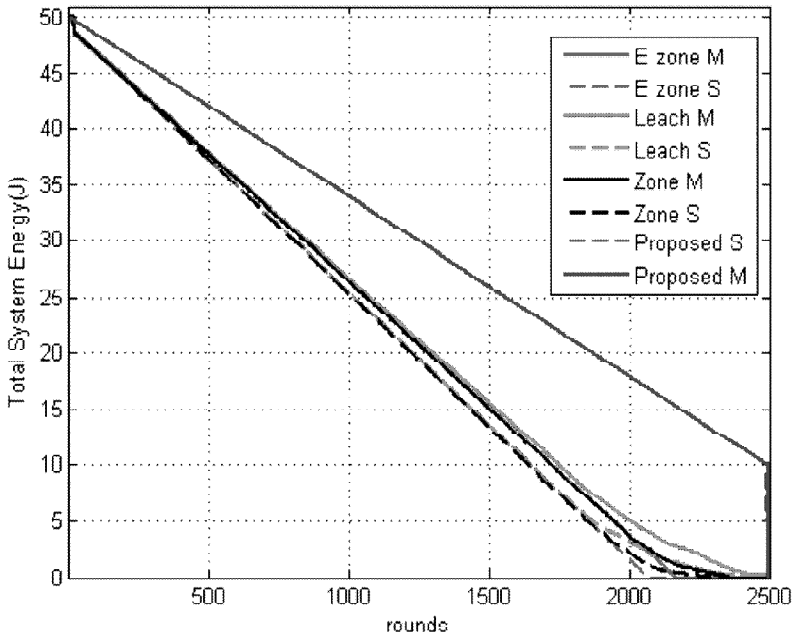

Figure 3: Total system energy (J) versus rounds of all algorithms

Number of alive nodes for each round (Fig.4). Through these graphs we had geographically observed that how nodes die throughout the simulation. S is referred to single gateway and M to multi-gateway scenario.

The LEACH algorithm outperformed the zone clustering algorithm which results into the high energy for long range transmission and also helps in data aggregation by CHs. Generally there is no difference between the single and multi gateway energy depletion rates and are illustrated in Fig. 3.

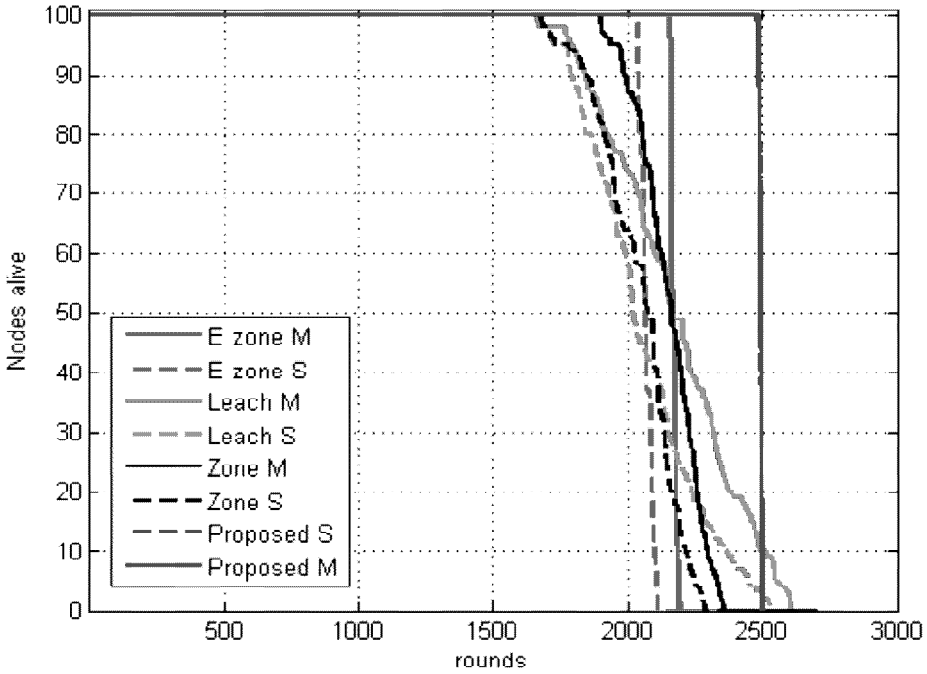

Figure 4: Total number of alive nodes versus transmission rounds

The different algorithms minimized the variance in energy of the WSN, and our proposed BAT algorithm provided better energy efficient zone routing algorithms. Our algorithm provide the better results in energy saving and also live of nodes. BAT algorithm outperformed all other algorithms in perspective of the node die out as well. Whereas pattern is created by the other algorithms for node die out. In other algorithms expect EZone the nodes die out in an unfavorable style. But in EZone when the first node die than all other nodes die out immediately. Same case is with our algorithm also but the difference is that the time of our first node die out is later than that of EZone. That leads us to better energy efficient algorithm.

In Table II the impact of the multi-gateway is shown. In the table the rounds and distribution of the nodes when 10%, 50% and 80% of the nodes die out are shown and the graphical representation is shown in fig 4. The table shows the depletion of the network from 100 percent to 20 percent (when 80% of the nodes are dead). The table also illustrate that how the impact of multi-gateway occurs and shows the difference between the different algorithms and there performance.

V. CONCLUSION

In our paper we have shown that how the selection of second cluster head helps in the improvement of the network lifetime and in addition of the multi-gateway leads to the better coverage and extend WSN service life and also the single gateway provides the good results. Our proposed BAT algorithm provide better opportunity for the improvement of the WSN lifetime. As the first node die out later so it is energy efficient and also provide better WSN service life. Also leads to less variance in energy and helps in load balancing.

Table II
Overall Algorithm Die Out Statistics with A Comparison Between Single and Multigateway Network Configurations

Protocol	*Metric*	*Single-gateway*	*Multi-gateway*	*% Increase*
LEACH	First Node Dead	1642	1633	-1
	10% Nodes Dead	1760	1805	3
	50% Nodes Dead	1990	2112	6
	80% Nodes Dead	2182	2327	7
Zone	First Node Dead	1649	1862	13
	10% Nodes Dead	1821	1964	8
	50% Nodes Dead	2022	2117	5
	80% Nodes Dead	2140	2215	4
EZone	First Node Dead	2003	2116	6
	10% Nodes Dead	3007	2119	6
	50% Nodes Dead	2026	2126	5
	80% Nodes Dead	2051	2134	4
Proposed BAT	First Node Dead	2482	2484	0.08
	10% Nodes Dead	2487	2486	-0.04
	50% Nodes Dead	2493	2492	-0.04
	80% Nodes Dead	2495	2496	0.04

REFERENCE

[1] Ms. Sunita, Jyaoti Malik, Suman Mor; — *Comprehensive Study of Applications of Wireless Sensor Network* ; IJARCSSE Vol. 2, Issue 11, pp. 56-60 Nov. 2012.

[2] T. He, S. Krishnamurthy, J. A. Stankovic, T. Abdelzaher, L. Luo, R. Stoleru, T. Yan, L. Gu, J. Hui, B. Krogh, — *An energy-efficient Surveillance system using wireless sensor networks* , MobiSys'04,Boston, MA, 2004.

[3] W.R Heinzelman, A. 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.

[4] I. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "Wireless sensor networks: A survey," Computer Networks, vol. 38, no. 4, pp. 393–422, March 2002.

[5] "Tinyos," http://www.tinyos.net

[6] J. Hao and H. Mouftah, "Routing protocols for duty cycled wireless sensor networks: A survey," IEEE Communications Magazine, vol. 50, no. 12, pp. 116–123, December 2012.

[7] C. Cirstea, "Energy efficient routing protocols for wireless sensor networks: A survey," in Proc. of IEEE SIITME, 2011, pp. 277–282.

[8] A.A. Abbasi and M. Younis, "A survey on clustering algorithms for wireless sensor networks," Computer Communications, vol. 30, no. 14-15, pp. 2826–2841, 2007.

[9] K. Akkaya and M. Younis, "A survey on routing protocols for wireless sensor networks," Ad Hoc Networks, vol. 3, no. 3, pp. 325–349, 2005.

[10] D. Goyal and M.R. Tripathy, "Routing protocols in wireless sensor networks: A survey," in Proc. of IEEE ACCT, 2012, pp. 474–480.

[11] W.R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energyefficient communication protocol for wireless microsensor networks," in Proc. of HICSS, 2000, pp. 1–10.

[12] S.K. Singh, M.P. Singh, and D.K. Singh, "Energy efficient homogenous clustering algorithm for wireles sensor networks," International Journal of Wireless Mobile Networks, vol. 2, no. 3, pp. 49–61, 2010.

[13] Kevin A. White," Energy Efficient Cross Layer Load Balancing in Tactical Multigateway Wireless Sensor Networks," 2015 IEEE International Multi-Disciplinary Conference on Cognitive Methods in Situation Awareness and Decision Support (CogSIMA).

[14] Wendi Rabiner Heinzelman, Anantha Ch, and Hari Balakrishnan. *Energy-efficient communication protocol for wireless microsensor networks*. pages 3005–3014, 2000.

[15] Y. Guo, F. Hong, Z. Guo, and Z. Jin, "Eda: Event-oriented data aggregation in sensor networks," in Proc. of IEEE IPCCC, 2009, pp. 25–32. 2015 IEEE International Multi-Disciplinary Conference on Cognitive Methods in Situation Awareness and Decision Support (CogSIMA) 199.