# STRATEGIC NODE SCHEDULING IN VIEW OF ENERGY OPTIMIZATION FOR WIRELESS SENSOR NETWORK

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***ABSTRACT***
*Wireless sensor network having a very vast application area where the sensor nodes can sense, control, analyze, evaluate, move and send the data and receive it according to application. The main limitation of sensor node is their battery power. Sensor nodes can cover more application area but due to limited energy they are restricted to some areas. In the proposed work we have suggested some scheduling policy through which the energy can be utilized efficiently through which lifetime of the network can be increased. In this approach all the nodes does not work concurrently but consecutively in which scheduling of nodes with the reduction in transmission reduces the overall energy of the sensor node.*

***KEYWORDS:*** *Wireless Sensor Network, scheduling, Cluster, Energy resource.*

## I. INTRODUCTION

As there is rapid growth in wireless techniques and the inexpensive and less human interaction features of wireless micro- sensors makes them as the part of our daily life. Wireless sensor network consist of large number of tiny sensor nodes. Each sensor node can sense, compute and communicate the gathered and computed data to the head of the cluster or the cluster head can send it to base station. All the sensor nodes are deployed in some predefined area in a predefined manner or in some applications they can be deployed without predefining the manner or by uncontrolled manner in which they are deployed. Deployment of sensor node totally depends on the application for which they are used. Authors of paper [3] have suggested nodes deployment methods. First is controlled node deployment which is usually pursued for indoor applications such as health monitoring of large buildings, range finders , imaging and video sensors. For such applications hand placed sensor nodes are one of the best node deployment technique.

Another technique for node deployment is Random node distribution as suggested by author [3] in which randomized placement becomes the only way to deploy nodes. For example nodes deployed through helicopter in some disaster area to sense the behaviours of area objects (target), causes of disaster, forest fire detection etc where deterministic deployment is infeasible. Generally what work the sensors perform is totally depend on the application in which sensor nodes are used as they can be health care system , battle field surveillance system, environment monitoring system etc .figure 1 shows the basic structure of sensor nodes in a predetermined area which are collectively form clusters based on their transmission range. Figure 1 show three clusters having number of node sending and receiving data from the cluster head and cluster head after analysis send it to the base station for further processing.

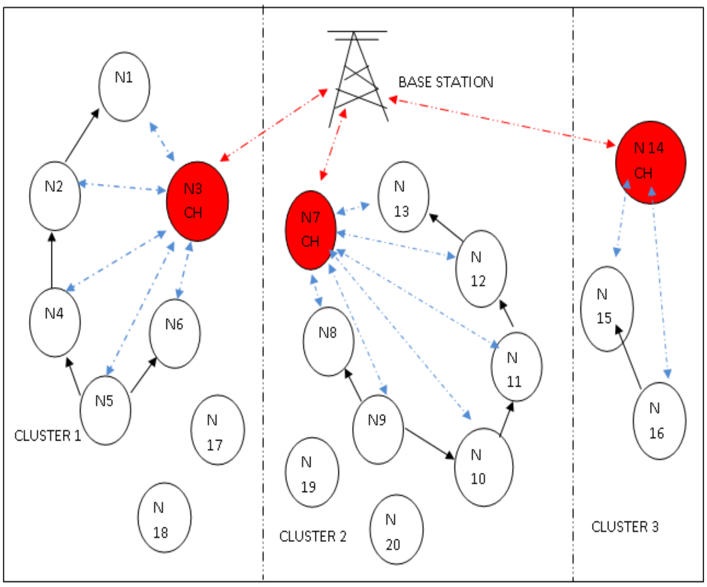


**Figure 1:-** Basic structure of cluster based sensor nodes controlled by base station.

The main advantages of sensor nodes are that they can be operate in harsh environment without human interaction. They have built-in mechanism to collect the data from surrounding and transmit through its onboard radio. Because of their short life span and possibility of damage and failure of nodes , the sensor nodes are deployed in large amount in hundreds or can say in thousand [1]. The sensor nodes collectively can form a network in an ad-hoc manner. Forming such a large group of nodes and manage them is very tedious task. How do they coordinate, control and organize in such a way that they collectively can produce a result which is useful or can meet the requirement and specifications of the application.

Number of sensor nodes can join and make a cluster and work collectively to overcome the situations like limited amount of energy, overloading some nodes, crashing of nodes etc. author of [5] has proposed novel clustering algorithm which set up non-overlapping clusters and number of cluster members decided based on the capacity of cluster head to handle the nodes or can be restricted by some pre defined threshold value for cluster members. It also performs rotation of cluster head. In the proposed algorithm when the system activates only then it forms the cluster as to reduce the computation and the communications cost as well as the messages exchanged.

Energy play the major role in wireless sensors as the sensors are deployed in remote areas where charging of batteries or change the batteries could not be possible so the energy utilization or consumption should be proper as to increase the lifespain of the network.

In this paper we have suggested some scheduling approach to reduce the energy consumption by the nodes for sensing and transferring sense data to the cluster head. The proposed algorithm partitions the network into different clusters based on:

(i) Cluster is formed based on transmission range of the nodes.

(ii) The size of cluster i.e. number of sensor nodes in a cluster. Also define a threshold number of sensor nodes that a cluster can regroup. This is totally depending on the capacity and energy of the cluster head to handle traffics.

(iii) The distance between the nodes of the cluster should be proper as to reduce the interference as well as energy consumption and increase transmission range and communication quality of network.

(iv) The position where cluster head should be deployed / elected / determine so that CH can maintain link with both the sink and cluster members without wasting much energy in transmission. The clusters of sensors must not be overlapped.

(v) Lastly the energy level of the network as when the nodes are grouped, initially energy of cluster member will be same and as time passes it will start losing the energy depend on the state of node.

Cluster energy should be handled in such a way so that network lifetime can be increase. As soon as the network is divided into clusters, the cluster Head is elected for each cluster. Cluster head gathers all the sense data from cluster members and analyze and compute according to requirement of application. In the proposed approach cluster head selection is pre determined. Here cluster formed based on transmission range of the nodes. In this approach some different techniques are combined to form one approach which can reduce the energy consumption of the network as a whole.

The proposed (strategic node scheduling) approach can be used for the application where there are large number of nodes are deployed or where data from some nodes are acceptable if some nodes are in sleep mode and not sending the data. So the cluster head or base station can manage or work based on that limited amount of data, it can be possible only where there is no drastic change in data sense by all the nodes in the cluster.

In the next section, literature review is discussed, in this, what the different issues of WSN are discussed first. The related work in this area and the open issues in WSN are discussed later.

The proposed approach is discussed in the third section. In this the basic assumptions are discussed first. After that the clustering of nodes, scheduling of nodes, and related algorithm, etc. are discussed.

In the last sections the detail description of modules of the proposed approach is discussed and related experimental result shown. It gives details about, the experimental setups, simulation tool. Later the discussion on the obtained results is presented in this chapter.

Lastly discusses about the conclusion of the work carried out and the scope for future research in the area.

## II. RELATED WORK

Energy of the node is very important aspect in wireless sensor network. Number of researches and work has been made in area of energy utilization by the sensors or different parts of sensors, it can be say as energy consumption by the hardware of the sensor nodes and another areas for reducing energy through proper scheduling, routing, mobility, clustering approach and many more areas where the researchers have suggest the proper utilization of energy to increase the life span of the network. Firstly it is very important to know how much energy is required for transmission and reception and keep track on remaining energy.

Author in paper [6] have shown the energy model for hybrid sensor network and suggest some formulas to predict the energy consumption by the cluster head or cluster node. Two algorithm Subtract Clustering and Fuzzy C mean Clustering use to form the clusters whereas in paper [7] author also consider that clustering is an effective topology control approach and can increase network lifetime. Author suggested EECS which is Energy Efficient Clustering Scheme where cluster head selected based on node's residual energy in independent manner. Paper also suggests distance based method for load balancing among cluster head. This EECS suits for applications which require periodic data gathering.

Paper [8] also put forward reducing energy through clustering but it also provide controlled traffic flow with minimal data loss and also reduced data redundancy. This approach is distributed so it will reduce the overhead of the sink. S. V. Manisekaran has proposed an approach which comprises of two phases first is cluster formation phase and another is adaptive sleep duty cycle phase. The rate of sending data and the similarity of data between the nodes are the two factors of this approach. In the first phase, the rate of data generation and similarity between data series is analyzed by the sink and based on that analysis clusters formed. The cluster heads are selected based on the connectivity and residual energy. In the sleep duty cycle phase, a minimum threshold is decided and the data generation rates of cluster members are compared with this threshold value. If the nodes have lower rate than the threshold level, they have allotted a sleep duty cycle for some definite period.

Now we also survey the other aspects to increase network lifetime by using energy efficiently through avoiding retransmissions, idle listening, and overhearing, controlling redundancy of data transmission or by proper scheduling of nodes and transmission. If these aspects take into account the energy can be saved at maximum.

One of the approaches is the sleep and wake scheduling or can say ON/OFF of the nodes in the network. Researchers have shown that sleep/ wake is the efficient approach, there are number of algorithms and protocols have been developed to implement this approach as the author in paper [9] have used *Virtual Backbone Scheduling* (VBS), in which some redundant nodes are turn off their radio to save energy and some nodes turn on their radio to forward messages, which forms a backbone. This technique saves energy as at the same time some nodes are in sleep so it will definitely prolong network lifetime. This technique does not affect the quality of communication because only those nodes will turn off which send the same or redundant data to the sink. Network energy consumption is evenly distributed as the VBS algorithm schedules multiple overlapped backbones so that the energy of all sensor nodes can be fully utilized.

In paper[10] Barbara Hohlt have introduce distributed power management protocol named Flexible Power Scheduling (FPS) for reducing power consumption using slotted time division scheme as well as power management for making nodes ON/OFF. FPS implements a tree based topology with an adaptive slotted communication schedule to route packets, synchronize with neighbours, and schedule radio on/off times. The paper also manage fluctuating network load or traffic load by using supply and demand based protocol.

To increase longevity of the sensor network sleep / wake scheduling is used but it comes at cost of increased message delivery latency, packet loss and poor reliability because a forwarding node has to wait until its next-hop neighbour awakens and ready to receive the message. In paper [11] author suggest a novel class of wakeup methods called multi-parent techniques in which assigning number of forwarding parents to each node having different wake up schedules. This method uses cross-layer approach and exploits the existence of multiple paths between the nodes in the network. This approach can increase the network lifetime while reducing the message delay constraints. In the sleep /wake scheduling some sensor nodes allow to sleep for specific period of time but the problems arise is how to decide which sensor nodes put into sleep mode while maintaining sufficient sensing coverage.

Author of paper [12] proposed a Balanced-energy Scheduling (BS) scheme. This scheme distributes the energy load among all the nodes in the cluster evenly. Two related sleep scheduling schemes, the Distance-based Scheduling (DS) scheme where probability of a node goes in to sleep depend on the distance between the sensor and its cluster head and node which is farther away from cluster head have higher probability to put into sleep and the second scheme is Randomized Scheduling (RS) in which nodes are selected randomly to put them into sleep mode. Simulation results in paper shows that BS scheme extends the network lifetime similarly while maintaining network coverage. Author also shows that the proposed BS scheme extends the network lifetime by a factor of 1.5 and 0.7 compared with the RS and DS schemes, respectively

## III. PROPOSED APPROACH

In this strategic node scheduling approach the number of sensor nodes are deployed and cluster are formed according to the transmission range. Some of energy efficient techniques based on some area of sensor network are analyzed such as sleep /wake node scheduling, routing techniques, transmission scheduling and all the approach is performed only in one area but the proposed approach is prepared, considering the other area collectively can reduce the energy consumption as a whole to increase the network lifetime.

### 3.1 Initial Assumptions

We make the following assumption for our approach.

a) Number of sensor nodes are deployed in a specific area where data from all the cluster members are not necessary to make assumptions or sufficient number of nodes are deployed so that some nodes when go to sleep mode, it will not degrade the performance of overall network.

b) Clusters are created based on the transmission range and number of members in cluster is predefined.

c) Sensor network is static in nature, so all the nodes belong to the same cluster will remain the member of the cluster.

d) Wake node transmits and losses its energy during transmission, but sleep nodes also losses some amount of energy while sleeping.

e) Total amount of energy consumed by a node $E_c = S_s + T_s + I_s$

$S_s$ (sleep state) is sleep time energy discharge.

$T_s$ (Transmission state) transmission energy.

$I_s$ (idle state) when node is awake and not in transmission state as well as not in sleep state.

f) From [12], the average energy consumption per second of the active nodes is:-

$$E_{active}(x) = \lambda k_1[\max(x_{min},x)]^{\gamma} + k_2$$

In the above equation k1 is the constant value of energy consumption for transmission of packet and k2 is the idle/receive energy consumption per second, xmin is the minimum transmission range corresponding to the minimum allowable transmission energy.
The max function indicates that, even if the distance between a sensor node and the cluster head is smaller than xmin, the sensor needs to spend the energy that corresponds to xmin for its transmission.
g) Initial modes of sensor nodes are sleep, wake and dead modes. Initially all sensor nodes set to sleep mode
h) Variables used:-

Ncm =no. of cluster member.
Ns = no. of sensor nodes.
CH = cluster head.
Nc = number of clusters.
p_value = previous value.
c_value = current value.

### 3.2 Scheduling algorithms for improving energy consumption

**Algorithm for Module 1**

1. Start
2. Identify node deployment area (A).
3. Identify number of sensor nodes to deploy in a given area (Ns).
4. Elect fixed number of Cluster Head (CH).
5. Sensor nodes are divided into clusters called cluster members based on transmission range (Nc).
6. For all the Clusters (C) repeat step 7 to 13
7. Set number of cluster member (Ncm) to n.
8. Set MODE of 'n' i.e. n[mode]= WAKE
9. Start sensing and send the data to Cluster Head (CH).
10. If battery of node decrease to 0 then set n=DEAD
11. set n = n-1
12. Repeat step 6 to 11 while n [battery] = 0 or n=DEAD.
13. If no other node is remaining in the cluster then shift to the next cluster i.e. set C=C+1

**Algorithm for Module 2**

1. Start
2. Max_timer = 50 seconds
3. Variables = p_value, c_value
4. In the current cluster, node n.
5. Sensor node set the timer to 0.
6. Sense data and set to p_value
7. If current sense data similar to previous sense data c_value = p_value then,
8. Do not transmit sense data to CH
9. Else
10. Set c_value to p_value
11. Send the sense data to CH
12. Repeat step 5 till timer equals to max_timer
13. Send the p_value to CH
14. Reset timer
15. Repeat step 3 to 8 for every node in cluster.

## IV. DESCRIPTION AND ANALYSIS

### 4.1 Module 1

In the proposed approach the strategic node scheduling for energy optimization are planned in three modules. In the first module the numbers of sensor nodes are deployed and numbers of clusters are formed where cluster head for each cluster are selected. Initially all the cluster members have the same energy level and all are in sleep mode. The algorithm DSR is used for selecting the cluster member to transmit the sense data to cluster head. Firstly the node wake and then start sensing and transmitting .When the node losses all its energy, it will become dead and the next node closer to head will start transmit to cluster head. This process will work until all the nodes in the cluster become dead. If all the nodes in the cluster will become dead, nodes of the next cluster will start sensing and transmitting. Sensor node may switch into 3 modes i.e. sleep, wake and dead modes, according situation and status of the battery of the sensor nodes as shown in the figure 2. Energy consumption is reduced as the nodes are switching from sleep to wake one by one as all the nodes are not working simultaneously the lifetime of network increases.

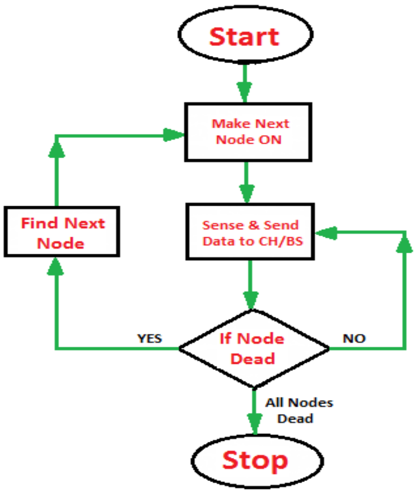


**Figure 2:** Sensor Node status are divided into 3 modes

### 4.2 Module 2

In this module the way to reduce the energy consumption is through the reduction in redundant data. In this the threshold value of sensor node for sending data to cluster head or sink node is defined. The threshold value can be last send value to head by the node. The sense data is first compared by the sending node itself and if data is similar to the threshold value, data will be rejected and if the value is greater than threshold, then it is send by the node, otherwise wait for new value this process goes until the defined time after that the sense data will be send.

Transmitting the data takes more energy than receiving and sleeping as well as sensing the data. When the same sense data is transmitted again and again to the head or sink node it is totally waste of energy so to decease the consumption of energy the transmission of same data will be reduced in some extent by the sending node. The figure 3 shows the sensing of a specific area temperature by number of nodes if node 1 sense 32 degree temperature in some part of area again and again it will send the data when it sense it first after that all time it senses again it discarded it until it gets the new sense data. The working is similar to all the other nodes.

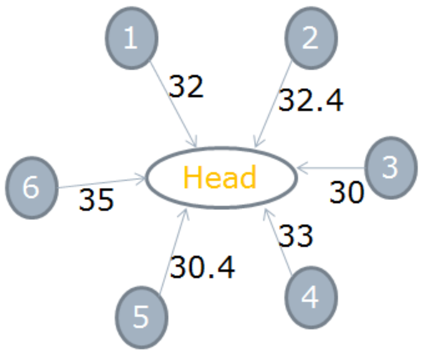


**Figure 3:-** Reduction in redundant data

There is also provision for Highest Priority Data in which If there is a drastic change in the sensing data or there is some important data sensed by the sensor node, then it will be sent to sink node on highest Priority or immediately.

### 4.3 Module 3

Reliability & Efficiency of the network can be increased Alternate sensor node can be made available if any node fails. If any node in the routing path fails, it can be replaced by another node, hence reduces path failure and if any node is overloaded, load can be shared by other nodes, hence improves the efficiency and effectiveness of the network.

## V. EXPERIMENTAL SETUP

We consider that region of interest is predefined; we developed the code for square shape region. The type of node deployment of the sensor nodes is deterministic.
To show the actual working of the scheduling of nodes in the WSN, different simulation software can be used. Network simulator-2 (NS-2) is one of the network simulators which can be used to show such kind of simulations. We have used NS-2, version 2.33 for the implementation of our approach. The simulations executed in NS-2 using a Pentium IV computer with 1.86 GHz CPU and 1 GB RAM. NS-2 can be installed either in a UNIX (or Linux) or Windows (2000 and XP) environment. For the Windows environment, it is necessary to install a UNIX emulator, such as Cygwin, prior to the installation of the NS-2 software. One disadvantage of performing simulations in the Windows environment is the issue of software stability. Moreover, most third party software extensions, which are available as contributed codes to NS-2, are neither available nor well supported for the Windows platform.

### 5.1 Simulation Tool NS-2

Ns-2 is a packet-level simulator and essentially a centric discrete event scheduler to schedule the events such as packet and timer expiration. Centric event scheduler cannot accurately emulate “events handled at the same time” in real world, that is, events are handled one by one. However, this is not a serious problem in most network simulations, because the events here are often transitory.
Because of the simplicity and modularity of ns-2 network simulator, it has gained an enormous popularity among participants of the research community. It is an object-oriented, discrete event-driven network simulator developed at UC Berkeley and USC ISI as part of the VINT project. It is a very useful tool for conducting networks simulations involving local and wide area networks, but its functionality has grown during recent years to include wireless networks and ad-hoc networking as well. It allows simulation scripts, also called simulation scenarios, to be easily written in a script-like programming language, OTcl. More complex functionality is done in C++ code that either comes with ns-2 or is supplied by the user. This flexibility makes it easy to enhance the simulation environment as needed. Most common parts are already built-in, such as wired nodes, mobile nodes, links, queues, agents (protocols) and applications.
Most network components can be configured in detail, and models for traffic patterns and errors can be applied to a simulation to increase its reality. There even exists an emulation feature, allowing the simulator to interact with a real network. Simulations in ns-2 can be logged to trace files, which include detailed information about packets in the simulation and allow for post-run processing with some analysis tool. Some of the existing ad-hoc routing protocols are pre-built in NS-2, for example, AODV, DSR, DSDV and TORA. It is also possible to let ns-2 generate a special trace file that can be used by NAM (Network Animator), a visualization tool that is part of the ns-2 distribution. This allows simulations to be replayed on screen, which can be useful for complex simulations.

## VI. SIMULATION RESULT

In this section, we present simulation results to point up the performance advantage of our optimal scheduling algorithm. We simulate a wireless sensor network with 20 nodes deployed randomly over a 10-by-10 area with a given distribution. We assume that the transmission range from each node i is a disc with radius 1.5, so if the distance between node j and node i is less than 1.5, then j belongs to cluster Ci. Approximation battery ranges are set in JL. Battery consumption in Sleep mode is considered as 0.001 JL, for Sense / Work mode is 0.1 JL, and for transmitting data is 0.1 JL.

We also assume that the power consumption ratio is identical for all nodes i. in figure 4 the result shows that all the nodes are initially in sleep mode showing green in colour. Firstly the cluster head of all clusters are selected i.e. 16,17,18,19 and according to the DSR algorithm the nodes nearest to the head which is 0,1,2,3 wakes and start sensing and transmitting to the cluster head after some time the nodes decreases its energy and become dead and turn into red. All the nodes which are in sleep mode also lose its energy in some extent. In figure 5 numbers of nodes becomes dead and cluster head also losses most of its energy and green colour turn into yellow.

Figure 6 shows the energy graph of node 0 and 15. Node 0 wakes first and transmits and node 15 is last node which awakes in the sensor network. The life of node 15 is more than all the other nodes it is the last node of network. Figure 7 shows the energy graph of all the nodes in a cluster. 0, 4,8,12 where the node 0 wakes first and transmits after that 4 then 8 and 12 node awake and transmit. The node 12 start transmitting last but it will loss energy while sleeping but slowly than wake node shown in graph that the yellow bar decreases constantly.

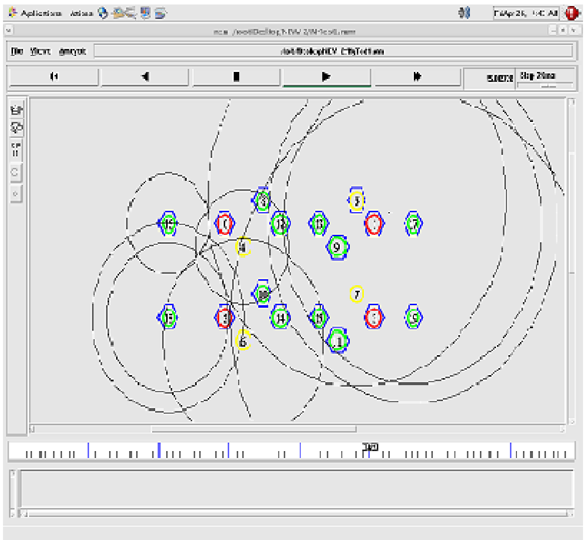

**Figure 5:** Intermediate Simulation showing some nodes are dead, some sending data

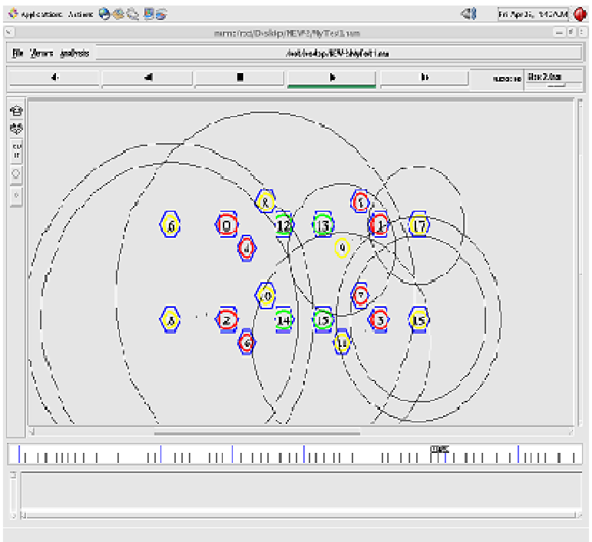

**Figure 6:** Intermediate Simulation showing some more nodes dead and some still working

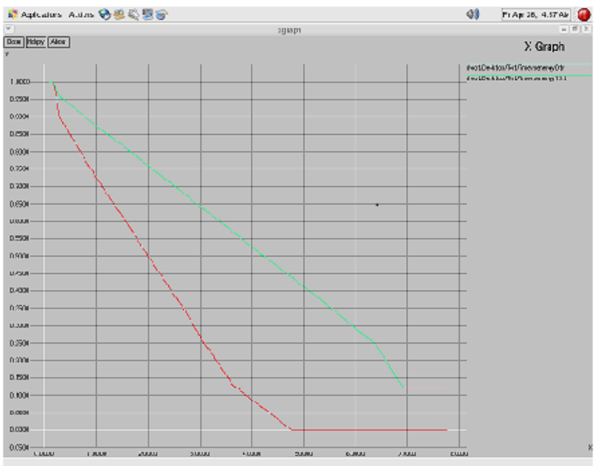


**Figure 6:** Graph shows energy of node 0 and 15

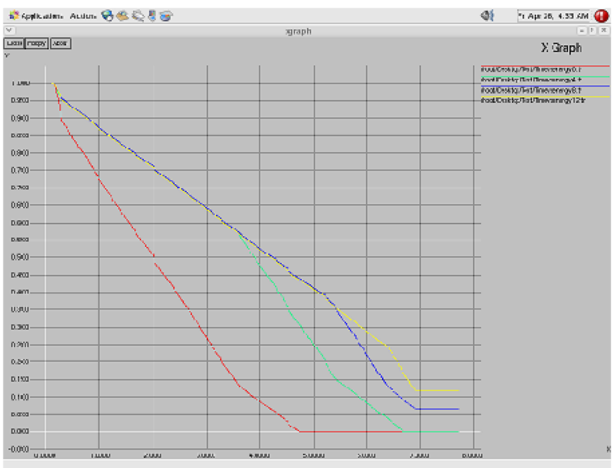


**Figure 7:** Graph shows energy level of nodes in a cluster

# VII. CONCLUSION & FUTURE SCOPE

In this paper we have presented scheduling algorithm having 3 modules providing efficient energy consumption. The goal of the proposed approach is to reduce energy consumption by switching nodes in sleep/wake modes and also avoiding unnecessary message transmissions by reducing redundant data by the node and also reduce the load of node or network. A combination of these techniques would lead to better results ensuring the prolongation of the lifetime of the WSN. These techniques may also conserve energy of nodes to work for long time by making some nodes active & standby mode depending on certain condition. Sensor nodes may do scheduling of themselves to work according to situations, circumstances and works efficiently, effectively in complex situations. These energy efficient technique may improves operation time of sensor nodes as the work load are reduced and transmission overload is also reduced by eliminating redundant data packets resulting reduction of network traffic and efficiently usage of network bandwidth. It also reduce the data analysis of the head node or sink in the network while the work of cluster member increases by maintaining the last send data and comparing it with current sense data through which more reliable data routing & reliable network can be obtained.

In this work we have considered deterministic node deployment; we can further extend the work using non-deterministic node deployment. Here, we have considered fixed region of interest i.e. square region, we can extend the work for the region of any shape. The nodes considered here are static in nature; in future it can be extended for the mobile nodes. In this work fixed number of nodes is deployed in different parts of the region, it can be extended by deploying random numbers of nodes in the different parts of the region of interest. Here each node is directly communicating with the cluster heads and the cluster heads are communicating directly to the sink, this can be augmented, the nodes should communicate with each other and by proper routing the data should be sent to the cluster heads and the cluster heads should first of all communicate with each other and through proper routing they should communicate to the sink node, because practically, it is not always possible that the cluster head and sinks are at one-hope distance.

Another scope is as follows:-

1) Highest Priority of data: - The If there is a drastic change in the sensing data or there is some important data sensed by the sensor node, then it will be sent to sink node on highest priority

2) Reliability & Efficiency of the network: - Alternate sensor node can be made available if any node fails. If any node in the routing path fails, it can be replaced by another node, hence reduces path failure.

3) Reduce network load: - If any node is overloaded, load can be shared by other nodes, hence improves the efficiency and effectiveness of the network.

# REFERENCES

[1] Ameer Ahmed Abbasi, Mohamed Younis "A survey on clustering algorithms for wireless sensor networks", Computer Communications 30 (2007) 2826–2841.

[2] Yazeed Al-Obaisat, Robin Braun "On Wireless Sensor Networks: Architectures, Protocols, Applications, and Management", 2007.

[3] Mohamed Younis, Kemal Akkaya "Strategies and techniques for node placement in wireless sensor networks: A survey" Ad Hoc Networks 6 (2008) 621–655.

[4] Ossama Younis, Marwan Krunz, and Srinivasan Ramasubramanian "Node Clustering in Wireless Sensor Networks: Recent Developments and Deployment Challenges" 0890-8044, IEEE Network, May/June 2006.

[5] O. Moussaoui, A. Ksentini, M Naimi and M. Gueroui "A novel clustering algorithm for efficient energy saving in Wireless Sensor Networks" Proceedings of the Seventh IEEE International Symposium on Computer Networks (ISCN' 06), 2006.

[6] Malka N. Halgamuge, Siddeswara Mayura Guru and Andrew Jennings "Energy Efficient Cluster Formation in Wireless Sensor Networks" IEEE, 2003.

[7] Mao YE, Chengfa LI, Guihai CHEN and Jie WU "An Energy Efficient Clustering Scheme in Wireless Sensor Networks", Ad Hoc & Sensor Wireless Networks, Vol. 3, pp. 99-119.

[8] S.V.Manisekaran , R.Venkatesan "An Adaptive Distributed Power Efficient Clustering Algorithm for Wireless Sensor Networks" American Journal of Scientific Research ISSN 1450-223X Issue 10 (2010), pp. 50-63, EuroJournals Publishing, Inc. 2010.

[9] Yaxiong Zhao, Jie Wu, Feng Li, And Sanglu Lu, “On Maximizing The Lifetime Of Wireless Sensor Networks Using Virtual Backbone Scheduling” Transaction On Parallel And Distributed Processing, Vol. X, No. X, 2011.

[10] Barbara Hohlt, Lance Dohert, Eric Brewer “Flexible Power Scheduling for Sensor Networks” IPSN’04, April 26–27, ACM, 2004, Berkeley, California, USA.

[11] Abtin Keshavarzian, abtin.keshavarzian ,Lakshmi Venkatraman “Wakeup Scheduling in Wireless Sensor Networks” MobiHoc'06, ACM, May 2006, Florence, Italy.

[12] Jing Deng, Yunghsiang S. Han, Wendi B. Heinzelman, Pramod K. Varshney “Balanced-energy sleep scheduling scheme for high-density cluster-based sensor networks” Computer Communications 28 (2005) 1631–1642.

[13] Yingwei Y and Georgios B. Giannakis, “Energy-Efficient Scheduling for Wireless Sensor Networks” IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 53, NO. 8, AUGUST 2005.

[14] M. Athanassoulis, I. Alagiannis and S. Hadjiefthymiades, “Energy Efficiency in Wireless Sensor Networks: A Utility-Based Architecture” Presented at: European Wireless 2007, Paris, April 1-4, 2007, Published in: 13th European Wireless 2007.

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