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# Energy Efficient Scheduling in Wireless Sensor Networks Based on Residual Energy Levels of Sensor Nodes

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***Abstract:*:** The maximum amount of sensor energy is consumed during communication. To prolong the Network Lifetime of a Wireless Sensor Network (WSN), there is a need of optimum utilization of sensor energy. Scheduling in MAC layer plays an important role in the design of WSN to avoid collision and conserve more energy. Distributed energy aware MAC protocol (DE-MAC) is one such efficient MAC Protocol that addresses the energy management problems in WSN. This paper proposes an extension of DE-MAC technique by allocating varying time slots to the nodes based on their residual Energy level. Energy of all the nodes is exchanged at regular intervals and accordingly the nodes with lesser energy are allocated lesser time-slots for transmission and are made to sleep more. Simulation results for Average residual energy, Throughput and Packet delivery ratio are compared with DE-MAC for performance analysis.

***Index Terms – WSN, Scheduling, Network Lifetime, Sensor Energy, MAC Protocol.***

## I. INTRODUCTION

WSNs sometimes called as Wireless Sensor and Actuator Networks are spatially distributed autonomous sensors used to monitor physical and environmental conditions, such as temperature, sound, pressure etc. and to cooperatively pass their data through the network to other locations. The development of WSN was motivated by military applications and today such networks are used in many industrial and consumer applications such as industrial process monitoring and control, machine health monitoring and so on. To avoid data collision on a shared medium several MAC protocols have been developed with Scheduling playing a major role in the design of WSN. In TDMA based MAC protocol, time is divided into slots and every node is allocated time-slots in a Time-frame, to allow the transmissions only during the assigned time. Generally TDMA based MAC protocols allocate equal number of slots to all the nodes. In any network, there exist some critical nodes with lower energy level. Such nodes are to be identified and allocated less number of transmission slots and make them sleep more. This concept helps in achieving load balancing in the network conserving more energy to prolong the Network Lifetime [1].

Energy management being a critical issue, we come across some energy efficient TDMA MAC protocols such as Power aware clustered TDMA(PACT), Traffic-adaptive medium access(TRAMA), On-demand TDMA Scheduling(ODS), Light weight medium access protocol(LMAC), Energy efficient and self- organized TDMA MAC protocol by wake up (TDMA-w). DE-MAC is one such energy efficient distributed energy-aware MAC protocol that uses TDMA features for avoiding collision, idle listening and overhearing. This protocol treats the nodes with lower energy in a different manner which is identified by initializing an election process. Such nodes are called winners and are made to sleep more than their neighbors [2]. Our paper proposes a similar technique with an extension by varying time-slots for transmission and sleep, based on the levels of residual energy of every node. This technique conserves the energy of critical nodes and thereby prolongs the Network Lifetime. Rest of the paper is organized as follows. Section 2 provides a review of MAC protocols and some of the related work. Section 3I explains the proposed Energy efficient Scheduling. Section 4 provides Algorithm and performance analysis with graphs. Finally we conclude the paper in Section 5.

## II. REVIEW OF MAC PROTOCOLS AND RELATED WORK

Contention based and Scheduled based protocols are the two categories of MAC protocols for WSN. In contention based MAC protocols there exists a common channel for all the nodes to transmit the data. With a single shared medium, probability of collision is very high and hence every node needs to listen to the channel before transmission. The Energy consumption is high because these protocols use idle listening and overhearing to avoid collisions. In Scheduled based TDMA protocols, fixed time slots are allocated to every node to access the common channel without any collisions or interference. Scalability, Adaptability and Time synchronization are the limitations of TDMA protocols [2]. Further TDMA MAC protocols can be classified as centralized and distributed protocols. In centralized TDMA Protocols, the base station or the central coordinator allocates the time-slots to all the nodes in the Network. Some of the centralized TDMA based protocols are: Bit-map–assisted MAC (BMA) protocol, Self-organized TDMA protocol (SOTP), Event driven TDMA protocol(ED-TDMA) and Mobility tolerant TDMA based protocol. Unlike the centralized protocols, in Distributed TDMA based MAC protocols, there is no centralized coordinator. Scheduling in distributed protocol takes place locally in a distributed manner by the nodes themselves. These Protocols are more Energy Efficient and some of them are briefly discussed below.

In [3], every node is made to turn on and off its radio by tuning the frequency as per the requirements to different bands. The nodes establish scheduling with different time slots maintained by the superframe to communicate without any centralized base station. In [4] the authors use clustering and backbone technique to save energy by rotating the role of cluster heads and gateways. Duty cycle of the nodes is used to turn off the radios. This protocol prolongs the Network Lifetime by conserving the energy but overhead due to clustering is seen as the limitation. Paper [4] presents a collision free, energy efficient protocol with improved performance in Throughput, Latency and Fairness. Neighbor protocol(NP), Schedule exchange protocol(SEP) and Adaptive Election Algorithm(AEA) are the components used to reduce collision and improve sleep time to conserve energy and increase Throughput.

The Authors of paper [6] propose two variants of TDMA MAC protocols, the first being the Busy tone on-demand scheduling (BTODS) and the second being on-demand Scheduling(ODS). This protocol provides an efficient way of delivering the sensed data to Sink and also reduce the Energy consumption. In both the variants nodes are allowed to identify slots without interference to the ongoing flows in their setup. In [7] the authors design Energy efficient protocol that considers the properties of Physical layer. Distributed algorithm is used to allocate the Time-slots. Main aim of this algorithm is to reduce the number of transceivers so that the sleep time of the nodes keeps changing with the amount of Network traffic. TDMA-W [8] is a self-organized, collision free, Energy efficient protocol with simple maintenance. Two slots are assigned to every node, one being send slot(s- slot)and another wakeup slot(w-slot). In w-slot the channel is being sensed and in s-slot transmission takes place. Nodes destined listen to the transmission while other neighboring nodes switch off their RF circuits to conserve energy.

## III. PROPOSED ENERGY EFFICIENT SCHEDULING

The main objective of the proposed work is to conserve energy by making the lower energy nodes to sleep more based on varying energy levels that are identified with the exchange of residual energy. A WSN is created with $N_N$ nodes, where $N_N$ represents the number of nodes that are randomly deployed. At the outset energy of every node in the network has maximum value ($E_{max}$) and any one of the node is randomly chosen as Sink node. Initially every node in the network is assigned with five slots for data transmission. Nodes transmit the data in their allocated slots. At every fixed interval of time, there is an exchange of energy value among the nodes in Self organized manner. Average energy of all nodes is computed and is considered as the threshold energy $T_E$. Let $S_E$ represents the sum of residual energy of all nodes after the exchange of energy. Threshold energy is given by

$$T_E = S_E / N_N \quad (1)$$

The residual energy of every node represented by $E[(N_N)]$ is compared with the threshold energy $T_E$ and accordingly the transmission slots are varied based on the Energy levels. We assign time-slots for different energy levels as shown in the Table1 below. In the first level, all the nodes initially possess maximum energy and are assigned five slots each.

**Table1:** Time-slots based on Energy level

| Level | Energy | Time slots |
|---|---|---|
| I | $E[(N_N)] = E_{max}$ | 5 |
| II | $E[(N_N)] > T_E$ | 4 |
| III | $T_E > E[(N_N)] > T_E/2$ | 3 |
| IV | $E[(N_N)] < T_E/2$ | 2 |

After every fixed interval of time there is an exchange of energy among nodes. The residual energy of every node is is represented by $E[(N_N)]$ is compared with threshold energy $T_E$. If

$$E[(N_N)] > T_E \qquad (2)$$

The transmission time-slots of the nodes are reduced to four slots and the node goes to sleep in the fifth slot. If the energy of the node $E[(N_N)]$ is

$$T_E > E[(N_N)] > T_E / \qquad (3)$$

The transmission time-slots of the node is reduced to three slots. Similarly, if the Energy of the node $E[(N_N)]$ is

$$E[(N_N)] < T_E/ \qquad (4)$$

The transmission time-slots of the node is now reduced to two slots. All the nodes now transmit the data as per the new schedule and goes to sleep during the remaining time-slots. This ensures the efficient utilization of energy, prolonging the Network Lifetime, which is an essential requirement of any WSN.

The network scenario with nodes of different time slots after the exchange of energy is as shown in Fig 1 below.

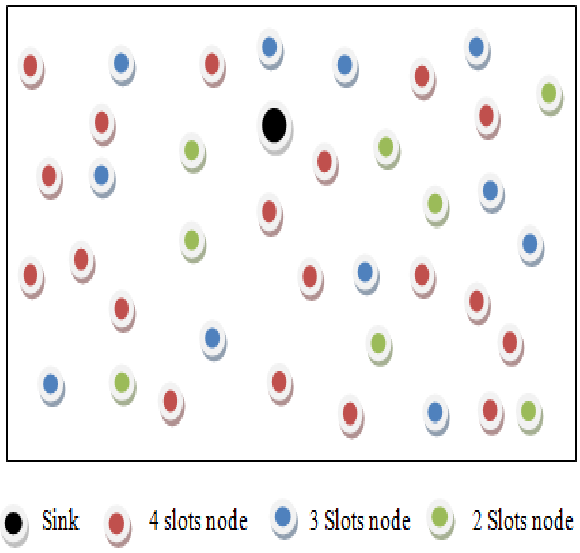


**Fig. 1**: Network after the exchange of energy

# IV. SIMULATION RESULTS AND PERFORMANCE ANALYSIS

Simulation was carried out using NS2Network simulator with a Network created of fifty nodes in an area 1000x1000 sq. meters. The initial Energy of the nodes is hundred joules. Exchange of residual energy takes place in a self-organized manner at every fixed interval. The steps of execution of simulation are represented in the form of flow diagram as shown in Fig 2.

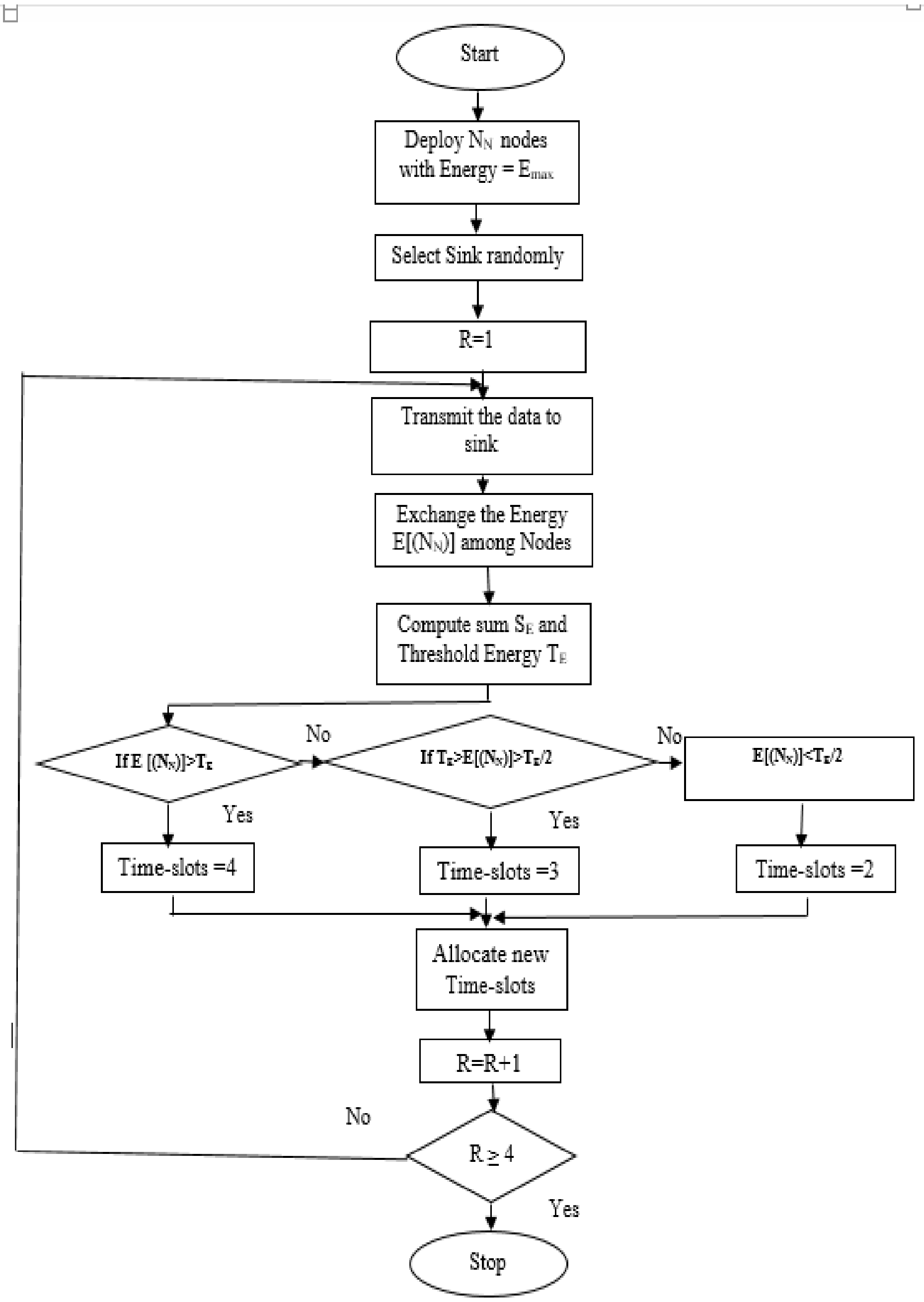


**Fig. 2:** Flow diagram of the proposed Algorithm

Result analysis of the proposed algorithm is carried out comparing it with the DE-MAC protocol for performance metrics of Energy, Throughput and Packet delivery ratio. In DE-MAC the nodes conduct a local election process based on energy of neighboring nodes. A node with the least energy is declared as winner assigning more slots to sleep and other nodes as losers to reduce their sleep slots by a constant factor. Our proposed algorithm performs a similar exchange of energy among the nodes and Threshold energy is computed. We identify three levels of Energy, and allocate varying time-slots for transmission of data in accordance with the different Energy levels instead by a constant factor as in DE-MAC. Graphs below show improvement over DE-MAC in all the three metrics: Average residual Energy, Throughput and Packet delivery ratio as shown in the Fig 3, Fig 4 and Fig 5 respectively. This Energy efficient Scheduling based on residual energy levels of sensor nodes enhances the Network lifetime of a WSN.

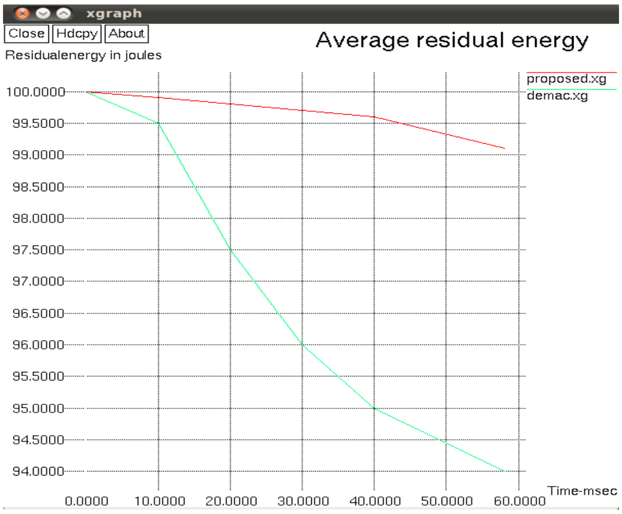


**Fig3:** Average Residual Energy vs Time

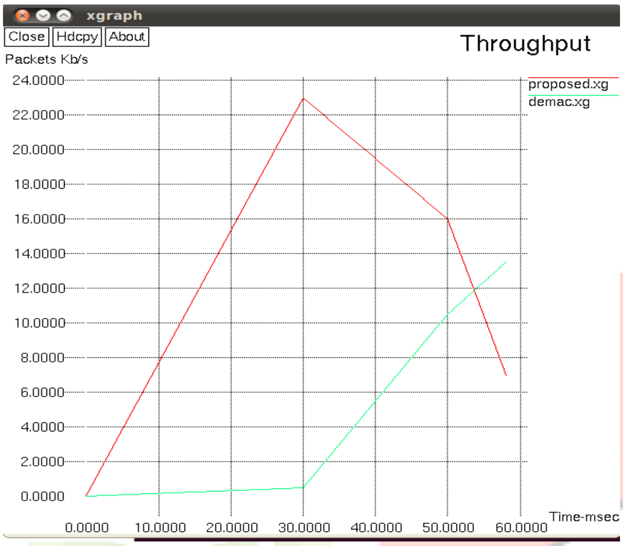


**Fig 4:** Throughput vs Time

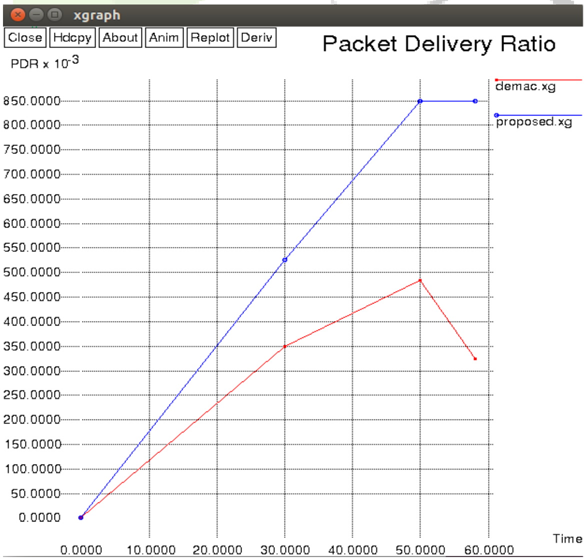


**Fig 5:** Packet Delivery Ratio vs Time

## V. CONCLUSION

Energy efficiency being the highest priority in the design of WSN, this paper proposes an optimum utilization of Energy in Sensor nodes. Critical nodes with less residual energy are forced to sleep more than their counterpart nodes. Threshold Energy is computed and accordingly three levels are identified to allocate varying time-slots for transmission of data. The simulation results are compared with DE-MAC protocol to show the improvement. Further this work can be extended by sharing the energy data to the Network layer for Routing purpose with a cross layer approach.

**REFERENCES**

[1] Jennifer Yick, Biswanth Mukherjee, DipakGhosal, "Wireless Sensor network: survey". Computer networks (2008), 52, pp. 2292-2330.

[2] Pijuskumar pal, Punyashachatterji,"A survey on TDMA-based MAC protocols for Wireless sensor network" IJETAE, ISSN 2250- 2459, vol. 4, issue 6, 2014.

[3] Wang, Y., Henning, Li, X and Hunter, "SOTP: A Self organized TDMA protocol for Wireless Sensor Networks", IEEE conference on Electrical and Computer Engineering. 1108-1111, 2006.

[4] Pie, G. and Chien, C., "Low power TDMA in large Wireless Sensor Networks", Military Communication Conference 2001, IEEE Communications for Network centric operations: Creating the Information source, 347-351.

[5] Rajendran, V., Obraczka and Garcia-Luna-Aceves, "Energy-efficient, collision-free medium access control for Wireless Sensor Networks", in Proceedings of 1st ACM conference on EmbededNetworked Sensor System(SenSys '03), Los Angeles, CA, 181-192.

[6] Miller, M. J. and Vaidya, N. H., "On-Demand TDMA Scheduling for Energy Conservation in Sensor Networks", Technical Report, 2004.

[7] Hoesel, L.F.W van and Havinga, "A Lightweight Medium Access Protocol(LMAC) for Wireless Sensor Networks, Proc. INSS Conf, June 2004.

[8] Chen, Z., and Khokar, " Self-organization and Energy efficient TDMA MAC protocol by wakeup for Wireless Sensor Networks", 1st Annual IEEE communication Society Conference on Sensor and Ad Hoc Communications and Networks(IEEE SECON '04), 335-341, 2004.

[9] VidyaHonguntikar, G. S. Biradar, "Frog based Routing Algorithm to Enhance the Network Lifetime of Wireless Sensor Networks", International Journal of Computer Networks and Information Security, MECS Publishers, vol 8, 9-15,2017.