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Minimizing Energy Hole Problem Comparisons in Some Hierarchical WSN Routing Protocols

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----------ABSTRACT----------

This paper study the efficient use of energy as a challenging task of designing these protocols. The energy holes are created due to non-uniform node distribution in the network when quickly drain the energy in a few nodes. It is studies removing energy holes by using sleep and awake mechanism for sensor nodes to save energy. This approach finds the maximum distance nodes to calculate the maximum energy for data. It intends to enumerate the dead nodes transmission, alive nodes, throughput, overhead and packet delivery ratio consumed by the entire network and affected by the network area changes. lastly, a brief performance analysis of Low Energy Adaptive Clustering Hierarchy (LEACH), Distributed Energy-Efficient Clustering (DEEC), Threshold sensitive Energy Efficient sensor Network protocol (TEEN) and Stable Election Protocol (SEP) is carried out considering metrics of the previous characteristics of wireless sensor network.

Keywords: dead nodes, alive nodes, throughput, overhead, packet delivery ratio, protocols, WSN.

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1- Introduction

A wireless sensor network (WSN) is a collection of tiny sensor nodes with non-rechargeable batteries for processing the data which includes signal processing, embedded computing, communication and connectivity and transmit the data to sink node through intermediate nodes present in the network. Wireless Sensor Networks have self-organized nodes with logical interconnection. The major challenge of wireless Sensor Networks with respect to characteristics and required mechanisms [1][2][3] are **Fault tolerance, Network Lifetime, Scalability, Quality of Services (QoS)** which includes **packet delivery ratio, reliability, delays and so on**. WSN plays a vital role in many applications like military for surveillance, Intrusion, Monitoring and Targeting, Health monitoring, Industries, Natural disaster detections, Environmental Monitoring like Pollution, Habitat and Forest Fires, Agricultural for Crop, Pesticides and Water Monitoring.

The lifetime of the network can be analyzed with the available node energy while transmitting a data from source to destination. But the batteries used in WSN neither be not recharged nor be replaced. So it is necessary to improve the lifetime time of the network for better performance. Based on the structure of sensor networks, routing can be classified as flat, hierarchical and location based routing [4]. Among all, one of the most energy efficient, more scalability, and minimal use of resource constrain is hierarchical routing protocol [5]. For the past few decades, researchers developed many new Hierarchical routing protocols to improve the network lifetime by minimizing the node energy consumption [6]. In this paper, we analyzed and compared the performance of LEACH-GA over LEACH and LEACH-C to have improved network lifetime.

2- Related Work

As a result, the sensor network will disconnect having sufficient energy left unused [7]. Various schemes have been proposed to address the Energy Hole Problem (EHP). In [7], authors present a model for balanced density control to avoid energy holes. They use equivalent sensing radius and pixel based transmission schemes for balanced energy consumption. By activating different energy layered nodes in non-uniform distribution the energy holes problem is mitigated effectively.

In [3], authors purpose a Voronoi diagram-based distribution model for sensor deployment. In this model, each node calculates its Voronoi polygon to detect coverage hole and move towards a better position for maximum coverage in the field.

In [4], authors discuss the Corona-based sensor network model for balanced energy depletion due to many to one communication in multihop sensor networks. They use mobile sensors to heal the coverage hole created due to large data re-laying near the sink. In [8], authors purpose a multiple sink model to divide the network load near the sink to avoid the energy hole. Decision of a multiple sink is based on the amount of data loads in sensor networks.

In [5], authors discuss the distributed localization problem, Optimal Geographic Density Control (OGDC)

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for full coverage as well as connectivity. They prove that if communication range is twice the sensing range then complete coverage implies connectivity.

Tang and Xu [3], discuss how to optimize the network lifetime and data collection at the same time. Large amount of data is given to the sink by nearby nodes and less data from the nodes that are far away from the sink in the previous study. For this a rate allocation algorithm Lexicographical Max-Min (LMM) for data gathering is proposed to maximize the data-gathering amount and maximize the network lifetime under balance data gathering condition.

M.B. Rasheed et al. [9] proposed Energy-efficient Hole Removing Mechanism (E-HORM) technique. This technique removes the energy holes. They use also sleep and awake mechanism for sensor nodes to save energy. This approach finds the maximum distance nodes to calculate the maximum energy for data transmission.

3- Simulation and results

The WSN are contained 300 nodes that are deployed randomly. In the center of the field the sink is located. Sensor nodes transmission ranges are adjustable according to the distance from the sink. The nodes that are need to send the data packets to the sink its follow a cycle time. Sensor nodes which selected in each round to work and the rests of nodes are set to sleep mode to save energy. This mechanism is called sleep-wake process [9]. We have been implemented this mechanism and also we have been used the same mathematical model in some cluster-based protocols which LEACH [10,11,12] and TEEN [13] are homogenous protocols and DEEC [14] and SEP [15] are heterogeneous protocols. The modify of using Energy-efficient Hole Removing Mechanism (E-HORM) technique for these protocols the iLEACH and iTEEN are homogenous protocols, iDEEC and iSEP are heterogeneous protocols used in our simulation.

Table 1: list of simulation parameters

S. No.	*Parameters*	*Values*
1	Network Area	300*300, 500*500
2	Number of Nodes	300
3	Cluster head probability	0.3
4	Energy for each node	0.5
5	transmiter energy	50*0.000000001
6	reciever energy	50*0.000000001
7	Aggregation Energy	5*0.000000001
8	amplification energy	0.0013*0.000000000001
9	Number of Rounds	5000
10	Hard Threshold	100
11	Soft Threshold	2

3.1-Simulation with area 300×300

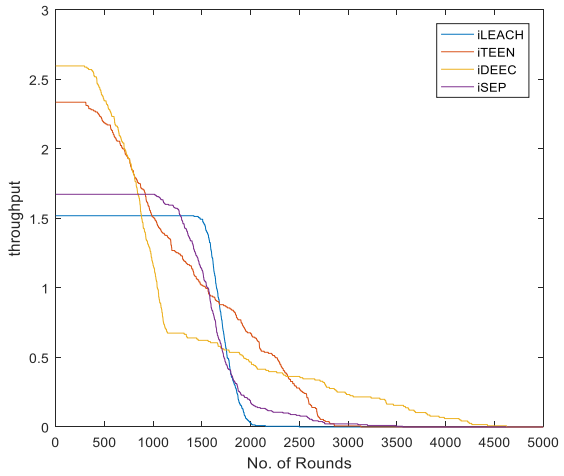

Figure 1: Shows the throughput for protocols with 300X300 area network.

Network **throughput** "is the amount of data moved successfully from one place to another in a given time period".

All protocols throughput decreased with increased number of rounds. But Throughput of iDEEC is the maximum other than protocols and iLEACH is the second maximum put when reached 500 rounds we found that iTEEN exceeds than iLEACH. iSEP protocol throughput is less than other protocols.

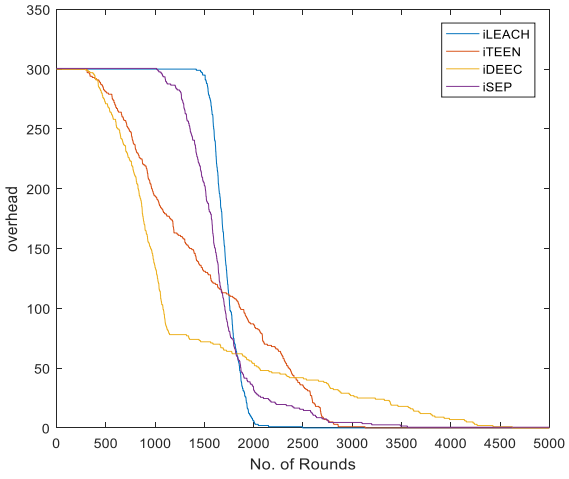

Figure 2: Shows the overhead for protocols with 300X300 area network.

Also overhead which mean "routing and data packets have to share the same network bandwidth most of times and hence routing packets are considered to be overhead in the network" [4] of all protocols decreased with increasing number of rounds but Overhead of iLEACH protocol is less other

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than protocols and iDEEC have maximum overhead. iTEEN protocol overhead exceeds than iSEP in 1100 rounds and they reached the same over head when reached 2500 rounds.

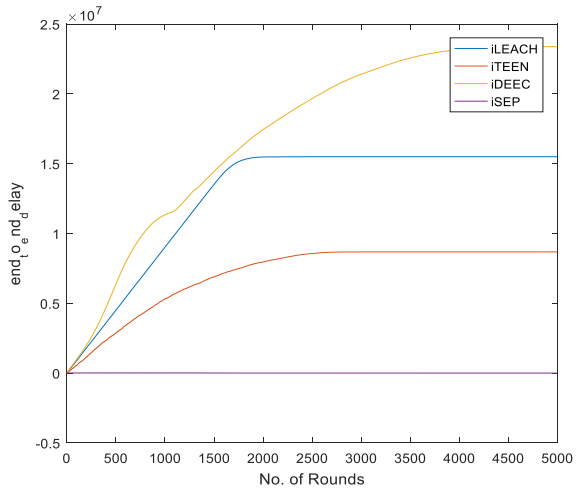

Figure 3: Depicts the end to end delay for protocols with 300X300 area network.

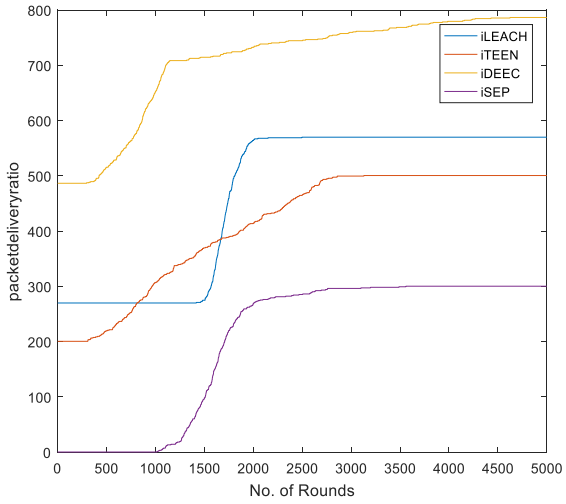

Figure 4: Depicts the packet delivery ratio for protocols with 300X300 area network.

All packet delivery ratio increased with increasing number of rounds. Packet delivery ratio of iLEACH exceeds than others and reaches the maximum in 1500 rounds after that are stable. iTEEN and iDEEC exceeds in the same manner and reaches the maximum in 2000 rounds. iSEP protocol packet delivery ratio less than others and also reaches the maximum in 1500 rounds after that increased little to reach 2500 round and be stable after that.

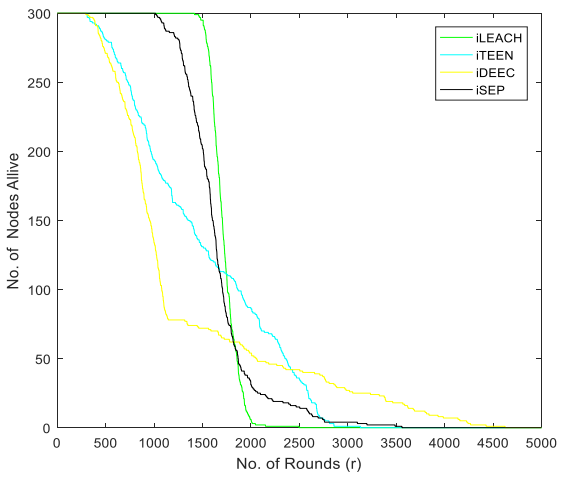

Figure 5: Shows the number of alive nodes for protocols with 300X300 area network.

Network lifetime decreased with increasing number of rounds iLEACH protocol life time less than other protocols until 1500 rounds. iSEP protocol exceeds than iTEEN and by increasing number of rounds iTEEN exceeds than iSEP in 1000 rounds and exceeds than iDEEC when reaches 1500 and less from it when reaches 2100 rounds. Network life time still 3250 rounds of network.

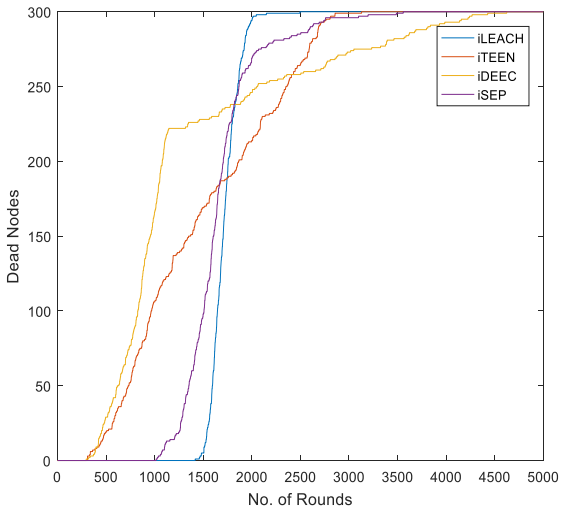

Figure 6: Shows the number of dead nodes for protocols with 300X300 area network.

All dead nodes exceed with increasing number of round. Dead nodes number of iLEACH less than other protocols. iLEACH protocol dead nodes number reaches maximum in 1500 rounds and the other protocols dead nodes number reach maximum in 3000 rounds.

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3.2- Simulation with area 500×500

All protocols throughput decreased with increased number of rounds.

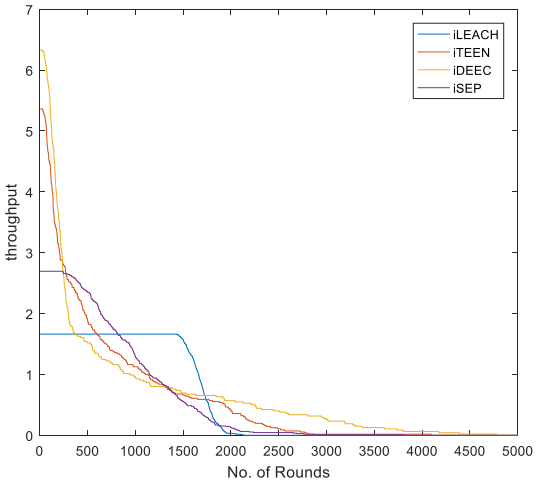

Figure 7: Shows the throughput of protocols with 500X500 area network.

But Throughput of iLEACH is the maximum other than protocols and iTEEN is the second maximum put when reached 500 rounds we found that iDEEC less than previous protocols. iSEP protocol throughput is less than other protocols. Throughput of protocols increased with decreased cluster head probability.

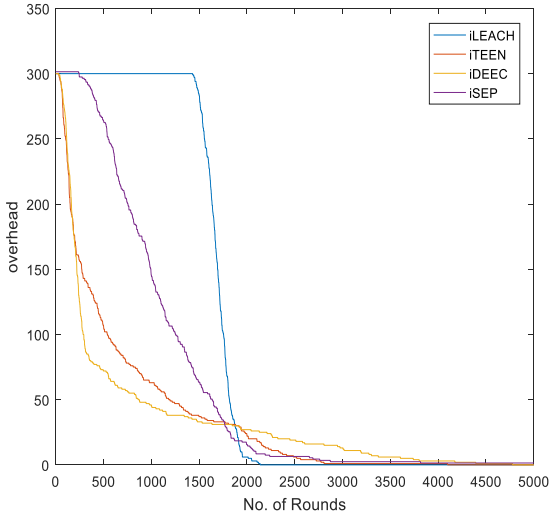

Figure 8: Depicts the overhead of protocols with 500X500 area network.

Also overhead of all protocols decreased with increasing number of rounds but Overhead of iLEACH protocol is less other than protocols and iDEEC have maximum overhead. iSEP protocol overhead exceeds than iTEEN until reached 1100 rounds and iDEEC and iSEP reached the same over head when reached 2500 rounds. But overhead of iTEEN reaches to 3500 rounds.

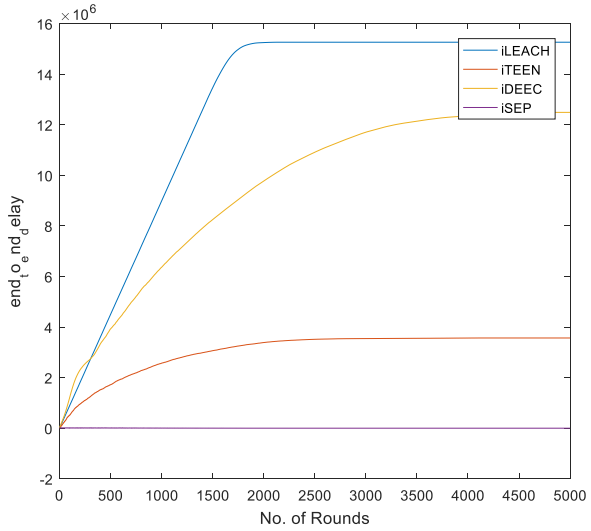

Figure 9: Shows the end to end delay of protocols with 500X500 area network.

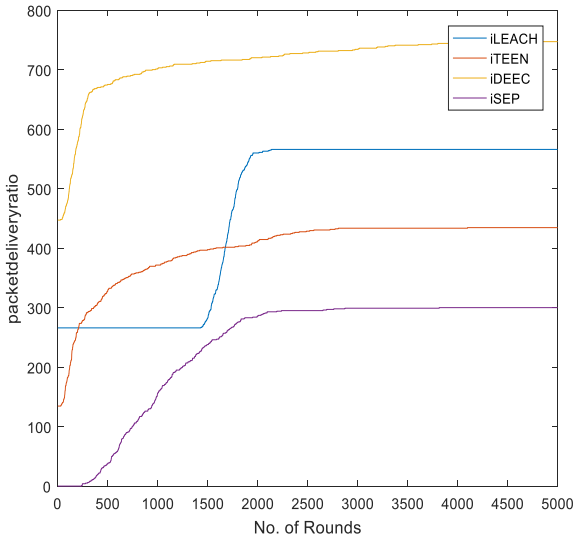

Figure 10: Shows the packet delivery ratio of protocols with 500X500 area network.

All packet delivery ratio increased with increasing number of rounds. Packet delivery ratio of iDEEC exceeds than others and reaches the maximum in 400 rounds after that iLEACH exceeds than iDEEC until 1500 rounds iDEEC exceeds than other protocols. iTEEN and SEP exceeds in the same manner and reaches the maximum in 1500 rounds. iSEP protocol packet delivery ratio less than others and also reaches the maximum in 1500 rounds than iTEEN and be stable after that. Also the

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manner of protocols that has been observed is different with changing decreasing cluster head probability.

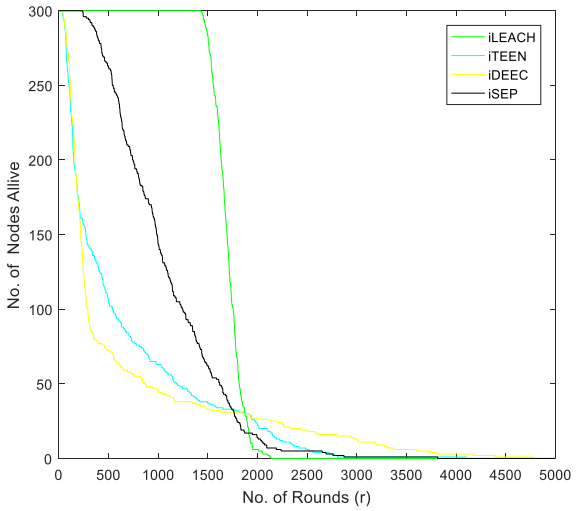

Figure 11: Depicts the alive nodes number of protocols with 500X500 area network.

Network lifetime decreased with increasing number of rounds. iLEACH protocol lifetime less than other protocols. iSEP and iDEEC protocols life time exceeds than iTEEN and by increasing number of rounds iTEEN and iDEEC life time exceeds than SEP in 1200 rounds. Network lifetime of iLEACH decreased with decreased cluster head probability but other protocols lifetime iTEEN, iDEEC and iSEP increased with decreased cluster head probability.

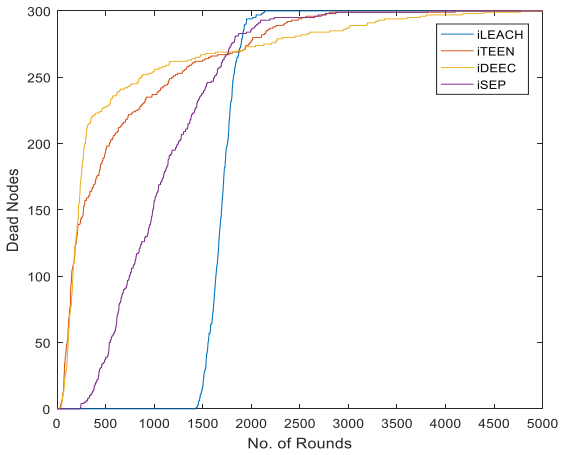

Figure 12: Depicts the dead nodes number of protocols with 500X500 area network.

All dead nodes exceed with increasing number of round. Dead nodes number of iLEACH less than other protocols. iLEACH protocol dead nodes number reaches maximum in 1000 rounds and the other iDEEC and iSEP protocols dead nodes number reach maximum in 2500 rounds. But in iTEEN protocol dead nodes number reaches the maximum in 3500 rounds. We observed also that the dead nodes numbers are different with changing cluster head probability.

5- Conclusion

In this article, we focus on energy hole problem and energy consumption in LEACH, TEEN as homogenous protocols, DEEC and SEP as heterogeneous protocols. We discussed the creation of energy holes in homogeneous and heterogeneous routing protocols. Due to random deployment in these protocols, there exists the probability of energy holes. Sleep and awake mechanism to remove energy holes in WSNs is proposed. We investigated that after this proposed scheme, a better energy consumption is achieved. This work clearly gives the results in terms of network lifetime and stability period. Sensor nodes consume balance energy, and hence maximize the network lifetime. This paper clearly points out how we can remove the energy holes problem in WSNs, and other re-searchers can also easily purpose a new protocol according to deployment techniques, which avoid the energy holes. Simulation results show that the results of our scheme perform better than previous schemes in terms of network life time and stability period.

Future Contribution

In future many other techniques should be developed which should focus on improving the network performance. So that the lifetime as well as the performance of the wireless senor networks could be improved and extended to be applied in internet of things applications. The hierarchical routing protocols have been affected in its performance as well as cluster head probability changes and the different parameters that have been used proved that. The adaptability of the protocols can be checked out and they even can be made more flexible to all kinds of applications in industrial internet of things also.

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