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# A Novel Method for Improving the Throughput in High Data Rate WSNs

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**Abstract:** Energy efficiency and throughput are main concerns while designing routing protocols for wireless sensor networks (WSNs). However, most of the existing schemes are either improving energy efficiency or improving throughput. Low Energy Adaptive Clustering Hierarchy (LEACH) is one of the major hierarchical routing protocols for WSNs to minimize the energy consumption. In order to minimize the energy consumption, in this work we have introduced access points in the network in between cluster head and base station. The QoS parameters such as throughput, packet delivery ratio, delay and energy consumption are metrics used to measure the performance of energy efficient reliable routing protocol and proposed three tier architecture. Simulation results show that three tier architecture outperforms the energy efficient reliable routing protocol and m-leach protocol.

**Keywords:** Wireless Sensor Networks, Energy Consumption, LEACH.

## I. INTRODUCTION

Growth of Micro-Electro Mechanical system (MEMS) and wireless technology enables development of small and cheap wireless sensor nodes. Wireless sensors are widely deployed in many difficult situations such as battle fields, nature disaster monitoring, agriculture monitoring, and architecture structure monitoring. Due to small size of wireless sensor, they have limited in battery energy power, communication capabilities, computational power, and memory.
Wireless sensor network (WSN) are different from traditional wireless networks. In traditional wireless network, data are requested from a specific source, but in WSN, information propagates from source to base station (BS) without specific request. Research aspects in WSN range from data dissemination, query processing, media access control, communication protocol to network topology. In this work, we propose a novel communication protocol to reduce energy dissipation of wireless sensors around the base station, and to extend lifetime of sensor nodes.

If the node is not able to communicate with other through direct link, i.e. they are out of coverage area of each other. The data can be sent to the other node by using the nodes in between them. This property is referred as multi-hoping. A network with clustering is divided into several clusters. Within each cluster, one of the sensor nodes is elected as a cluster head (CH) and with the rest being cluster members. All sensor nodes work cooperatively to serve the requests. Cluster head collects the data locally from the cluster members and transmits the aggregated data either directly or via multi-hop transmission to the sink. Since the cluster heads spend more energy than the non-cluster heads so to distribute the workload of the cluster heads among the wireless sensor nodes their role is rotated among all nodes in order to equalize energy consumption.
Generally WSNs are not centralized one as there is peer-to-peer communication between the nodes. So there is no requirement of prior established infrastructure to deploy the network. WSN gives flexibility of adding nodes and removing the nodes as required. But this gives rise to many drastic changes to deal with in the network topology such as updating the path, or the network tree, etc.

## II. RELATED WORK

In the wired networks, the design emphasis has been on maximizing throughput and minimizing delay. However, in wireless networks, apart from these two design objectives, there are two more dominating design issues. These are energy constraints and signal interference, which have attracted most attention from the researchers in the past decade. These have become important issues along with the growing popularity of the wireless consumer devices. Due to the unattended nature of the sensor nodes in the WSN applications, the energy efficiency issue has become extremely important.

In the literature, several protocols for energy efficient[1] data transmission and need of multipath routing[2]-[3] protocols have been proposed for WSN. In which main concentration on minimizing the energy consumption and also how much efficient of the multipath routing in the WSN. Based on the key feature of the multipath routing we have introduced this three tier architecture for minimizing the energy consumption as well as improving the Throughput in WSN. Key point to introduce the proposed architecture is energy consumption of the short distanced nodes is less compared with the long distanced nodes. Different routing techniques[2] are present in WSN for data packet transmission. Different routing protocols for WSN in [3]. Need of the multipath routing is explained in[7],[8]. Energy efficiency can be attained by clustering are studied in[4],[5].

LEACH protocol prolongs the lifetime of the network, but it does not consider the issue of reliable data delivery. Moreover, the protocol does not consider mobility of the sensor nodes and the BS. The modified LEACH (MLEACH) is an extension of the LEACH protocol, which can handle mobility of sensor nodes. However, M-LEACH, again, does not consider mobility in the BS. LEACH is also enhanced in order to support mobile sensor nodes. In [32], node mobility in the WSN is supported by adding membership declaration to the LEACH protocol. It declares the membership of a cluster as they move and confirms whether sensor nodes are able to communicate with a specific CH node. Significantly energy efficiency can be also achieved at the software level. Tactful design of routing mechanisms, which is a network layer issue of the communication protocol stack, may lead to acceptable level of energy saving along with reliable routing service. Network-layer energy efficiency related studies are available in the literature, specifically for static sensor net-works. Most of the proposed routing protocols for WSN do not consider mobile sensor nodes and mobile BS. Very limited work for mobile sensor networks is available. When the mobility is introduced in the sensor nodes, the topology becomes very dynamic, and the task of finding out the stable routes (i.e., reliable and long living) under such circumstances becomes challenging. Moreover, it is infeasible for the WSN nodes to cope up with the overhead of maintaining routing tables mainly due to onboard memory constraints. Therefore, different table-driven routing protocols for wireless networks are not directly applicable to WSN.

## III. PROPOSED ALGORITHM

A. System Design and Protocol Overview

We have proposed three tier architecture for minimizing the energy consumption and to improve the throughput in wireless sensor networks. In this architecture we have introduced access points (AP) in the network. These access points are placed in between cluster head(CH) and base station(BS).Main use of these access points(AP) are to minimize the energy consumption because access points use less energy and these are intelligently scheduled for dormant state which is a low power state. Those nodes are scheduled for dormant state, whose services are not required at a particular instant in time. At a later stage, these nodes may perform state transition and again become active while needed. The state transition is dictated by the BS. This saves significant amount of energy at the nodes. Thus, the battery lives of the sensor nodes get prolonged. Thus we can reduce the energy consumption over a period of time in the network. After the deployment of the sensor nodes, the BS creates groups of different sensor nodes in order to form clusters. Each cluster contains a CH node. The BS selects a set of suitable sensor nodes from each cluster, which can act as CH at a later stage. This set of nodes is also called CH panel. The cluster members i.e., the sensor nodes, forward data to the respective CH node. The CH nodes do the data aggregation to remove redundancy and then forward the aggregated data toward the AP. The AP nodes do several cluster management tasks that include mobility monitoring also. Other cluster management tasks are, for example, collecting location information of cluster members regularly and communicating this location information to the BS. They also remain ready to act as intermediate hop in presence of faults in some CH nodes. Therefore, the AP nodes are also called cluster management nodes. The CH nodes do not transmit data directly to the BS, unless it is the nearest one to the BS. The communication pattern or the route for the CH nodes is determined by the BS and distributed to the respective CH nodes. Fig. 1 depicts the overall organization of the sensor network system. It is assumed that the BS has an idea about the expected number of data packets (i.e., the volume of data) to be arrived in it during a specified time interval. Therefore, the BS keeps on monitoring the actual volume of data arrived from different clusters in the network. If the BS observes less arrival of data packets from some clusters in comparison with a pre-specified threshold level, then it informs the respective CH nodes to check their connectivity with their cluster members. The CH considers this as feedback from the BS and accordingly checks the current connectivity with its cluster members. If the connectivity status of the cluster members with the respective CH is very poor, the BS decides to shift the charge of cluster headship to another suitable member from within the CH panel.

Role of CH Node: The CH node is responsible for gathering sensed data from the cluster members, aggregate those and forward toward the AP either directly or in a multihop fashion. This part of data forwarding will take place according to the communication pattern or the route distributed by the BS.

CH-BS Network Creation: Since the location information of each of the CH nodes is available with the BS, the BS computes different alternate multihop routes for each of the CH node. These routes are computed considering the CH nodes only, which are spread throughout the sensor network. Considering all the CH nodes in the field,

The proposed protocol is organised in three phases
1.Set-up phase
2.Steady state phase
3. Re-clustering phase

1. Setup Phase: In set-up phase, all the nodes in the network send their location and energy to base station.

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Each node is assumed to have GPS receiver to send their location information. Initially, all the nodes have equal energy. The nodes which respond first and are closer to the base station are selected as cluster heads (CHs) nodes. By using these CHs, base station forms the cluster using simulated annealing algorithm. This algorithm helps to reduce the amount of energy spent by a non cluster head node to transmit data. After the clusters are formed, the base station calculates the energy for normal nodes to find the next heads (NHs) for each cluster. Based on the threshold value the NHs is elected. The threshold value (Tj) is computed using the equation

$$T_j = \frac{1}{m}\sum_{i=1}^{m} E_i(t)$$

where, m represents the number of sensors in the cluster

The base station elects the next heads for each cluster using the threshold value, and the nodes which are having more energy than the threshold is elected as the next heads. The nodes which are equal or less than the threshold value cannot become cluster head for this cluster until next reclustering takes place. After the CHs and NHs are elected, the base station sends the CH identity (IDs) and the NH IDs to all the nodes. If the ID matches with its own ID, the node assumes itself to be the CHs and NHs. In every cluster, the CH node sends the advertisement message (ADV) to their cluster members, including the next heads. Once the ADV message is received by the cluster members they send join request message (JOIN) to CH.

2. Steady State Phase: In steady state phase, upon receiving the JOIN message, the CH sends TDMA schedule to its cluster members for transmitting data. According to the received TDMA schedule, nodes send information to the CHs. The CHs has to perform the following functions are Data gathering and Data forwarding. Once the data is gathered, the CH will forward the data to the base station using the CDMA schedule. This indicates the completion of one round. Normally, in LEACH and LEACH-C, the second round will start with re-clustering and new CH election. In Modified LEACH, the base station would check the residual energy of the elected cluster heads. If the residual energy of the present CH is still greater than the threshold value, the same CH will be continue to be the cluster head for the next round and the steady state process takes place.

3. Re-clustering Phase: If the residual energy of the present CH is lesser then the threshold value, the NH1, with higher energy than the threshold will be elected as CH. Then this NH1 will act as CH for the current round, and it repeats the same process as done by the previous CH. If all the next heads repeats the above process and there are no nodes which have the residual energy above the threshold value, the re-clustering phase is initiated by the base station.

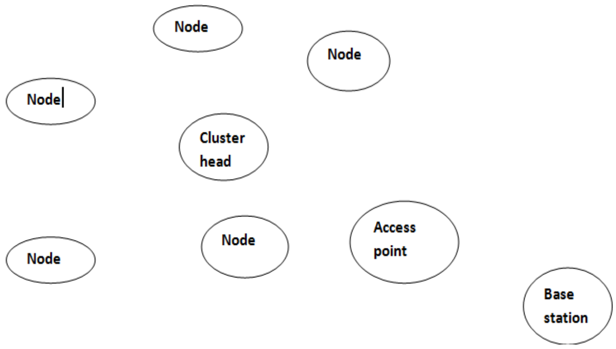


Fig. 1:Architecture of the proposed protocol

Proposed protocol is explained with the above architecture, after the deployment of the nodes base station creates total network into some partition this is called as cluster. In each of the cluster one cluster head is elected by the base station based on the energy level and neighbors of the node. Communication pattern is from normal nodes to cluster head aggregated for redundancy of any data and then access points finally to the base station.

## IV. RESULTS

A. Simulation Setup:

This section describes about simulation through NS2 tool. In this, a random network deployed in an area of 500 X 500 m. The number of nodes is set as 50. Initially the nodes are placed randomly in the specified area. The sink is assumed to be situated 100 meters away from the above specified area. The initial energy of all the nodes assumed as 90 joules. In our simulation, the channel capacity of mobile hosts is set to the same value: 0.9 Mbps. We use the distributed coordination function (DCF) of IEEE 802.11 for wireless LANs as the MAC layer protocol. The simulated traffic is CBR with UDP source and sink. All experimental results presented in this section are averages of five runs on different randomly chosen scenarios. Table I summarizes the simulation parameters used.

B. Performance Metrics:

Throughput: It is ratio between the actual numbers of packets transmitted by the nodes in the system to the numbers of successfully delivered packets at the Sink. A protocol with higher throughput is desirable. Throughput is a measure of successful delivery of packets at the Sink and alternately it is also termed as Successful Delivery Ratio (SDR).

Average Energy Consumption: It is average (i.e., per node) of the total energy expenditure in the network system over a period to time. This energy expenditure includes all kinds of sources for energy consumption such as communication (control as well as data), computing, sensing, idle listening etc.

Average end-to-end delay: The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations. A protocol with less delay is preferred.

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Average Packet Delivery Ratio: It is the ratio of the number of packets received successfully and the total number of packets transmitted. A protocol with high PDR is desirable.

C.Simulation results:

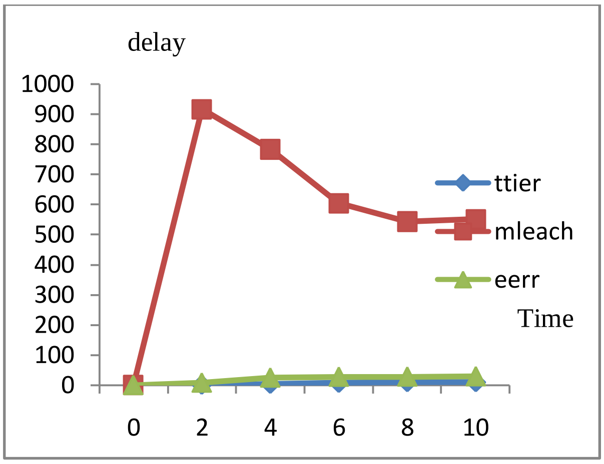


Fig.2:Delay comparision of different routing protocols

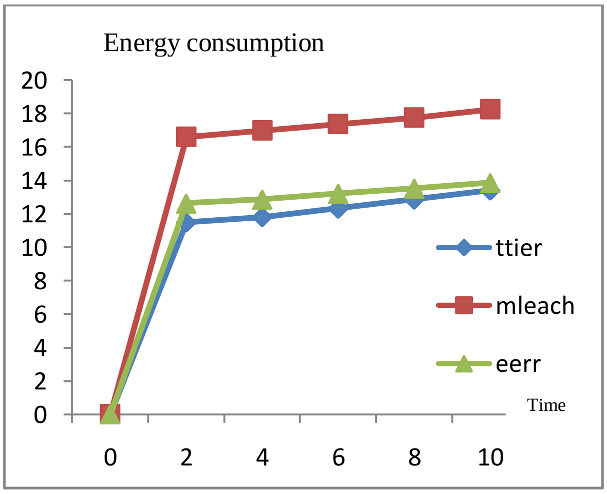


Fig.3: Energy consumption comparison of different routing protocols

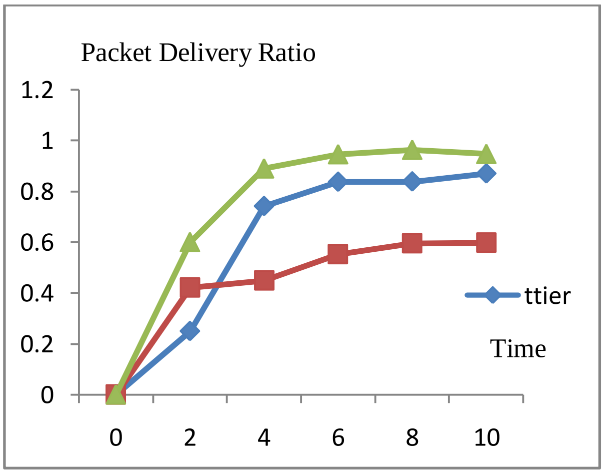


Fig.4: Packet Delivery Ratio comparison of different routing protocols

Fig 2 gives the description about the delay of the various routing protocols at different simulation times. On x-axis simulation time was taken and on y-axis delay is considered. For the sake of identification introduced different colours for different routing protocols. As the simulation time increases delay also increased for all the protocols but for the proposed (ttier) architecture has been improved for the proposed protocol.

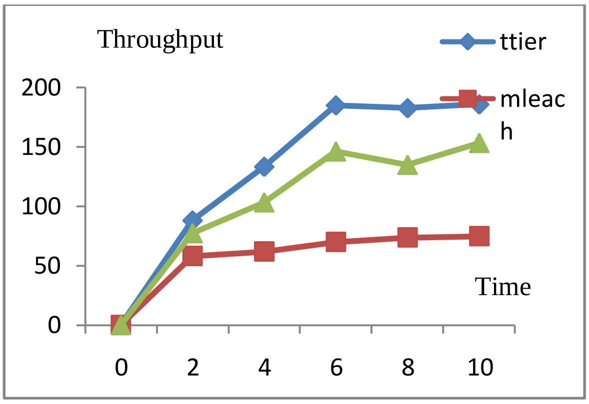


Fig. 5: Throughput comparision of different routing protocols

Fig 3 describes about the energy consumption (joules) of the nodes versus simulation time. Energy consumption has been increasing with the time. Specially for the proposed (tteir) architecture is better compared to all the protocols shown in the graph.

Fig 4 gives information about packet delivery ratio; it is the ratio of the number of packets received to the number of packets send. Time goes on PDR is increasing but for this parameter is not been improved with the proposed protocol.

Fig 5 is about throughput versus simulation time, finally the parameter throughput has been increased as the time increases. For the proposed protocol (ttier), throughput

TABLE I PARAMETERS USED FOR SIMULATION

| | |
|---|---|
| SIMULATOR | Network Simulator 2 |
| NUMBER OF NODES | 50 |
| AREA | 500m x 500m |
| COMMUNICATION RANGE | 250m |
| INTERFACE TYPE | Phy/WirelessPhy |
| MAC TYPE | 802.11 |
| QUEUE TYPE | Droptail/Priority Queue |
| QUEUE LENGTH | 200 Packets |
| ANTENNA TYPE | Omni Antenna |
| PROPAGATION TYPE | TwoRayGround |
| TRANSPORT AGENT | UDP |
| APPLICATION AGENT | CBR |

| | |
|---|---|
| INITIAL ENERGY | 90 Joules |
| TRANSMISSION POWER | 0.3watts |
| RECEPTION POWER | 0.1watts |
| SIMULATION TIME | 10seconds |

## V. CONCLUSION

In this paper we have proposed a novel method for improving Throughput in high data rate wireless sensor networks (WSNs).This protocol is cluster based. In each cluster one cluster head (CH) and remaining nodes are cluster members. We have introduced Access Points in between the cluster head (CH) and base station (BS) which minimizes the energy consumption by nodes in the network. We analyze the performance of the proposed protocol through simulations and compare with M-LEACH & $E^2R^2$.The proposed protocol outperforms M-LEACH & $E^2R^2$ in terms of throughput, delay and energy consumption. In the proposed protocol, the throughput improvement is 21% on average over $E^2R^2$.

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## BIOGRAPHIES

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