ADAPTIVE LOW-POWER LISTENING PROTOCOLS FOR WIRELESS SENSOR NETWORKS IN NOISY ENVIRONMENTS

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Abstract— *Wireless sensor network(WSN) has important application such as remote ecological monitoring and target tracking. This has been enabled by the availability, particularly in recent years, of sensors that are smaller in size and smart. These sensors are equipped with wireless interfaces with which they can communicate with one another to form a network. Wireless sensor network consists of sensor nodes with sensing and communication capabilities are sensor node are generally battery powered devices, the critical aspects to face concern how to reduce the energy consumption of nodes, so that the network lifetime can be improved to reasonable times.*

Keywords- *Cluster Wireless Sensor Network, LEACH,Packet Delivery Ratio,System PEGASIS, Residual Energy*.

I. INTRODUCTION

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. WSNs measure environmental conditions like temperature, sound, pollution levels, humidity, wind, and so on. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine .

Over the past few years ,duty cycling[1],[2] and low power listening (LPL)[3]-[5]have been greatly explored for energy saving in wireless sensor network (WSNs). According to recent extensive surveys[1],[6],[7].LPL with duty cycling is one of the most popular energy efficient techniques for MAC protocols in constrained WSNs. The technique is used widely in real WSN deployments and in the default MAC protocol of TinyOS[8] and Contiki [9],the two common OS frameworks for constrained WSNs.

A theoretical framework incorporating LPL temporal parameters with the false wakeup rate and the data rate. We then formulate an energy consumption minimization problem of LPL in noisy environments and address the problem by a simplified and practical approach. Based on the theoretical framework, we design an efficient adaptive protocol for LPL (APL) in noisy environments.

II. PROPOSED MODEL

Duty-cycled MAC protocols for WSNs can generally be categorized into synchronous and asynchronous schemes. In the synchronous scheme[2],[3], MAC procedures work under an assumption of time synchronization among nodes. By synchronizing nodes active time together, synchronous MAC protocols are normally designed to optimize the packet delivery latency. In this scheme, a node is required to exchange timing information periodically with neighbour nodes for time synchronization. High energy consumption and synchronized precision requirement are two remaining challenges for resource-constrained sensor nodes using synchronous MAC protocols.

Asynchronous MAC protocols [1],[2],[4],[6] have been proposed to address the above mentioned limitation . In the asynchronous scheme, the communication among nodes is enabled by LPL ,thus eliminating the overhead for time synchronization. In particular , the sender transmits preambles to explicitly alert other nodes about its packet transmission. Other nodes,including the receiver,periodically samples the channel for activity detection. If any channel activity is detected, the node wake up in order to receive packets. Extensive survey for LPL-related MAC protocols can be found in [1],[6],[7], and [8],and our previous work [10]

In MIX-MAC [14], Merlin and Heinzleman propose to improve energy efficiency by switching among various duty cycling protocols for different scenarios . In [5] and [6], heuristic methods are used propose to improve energy efficiency by adapting LPL based on the number of descendants and successfully received packets. ASLEEP focuses on adapting sleep schedules of nodes to match the network demand of periodic data acquisition applications by forming a staggered topology.In [9], Ning and cassandras of propose to adapt sleep time based on objectives and constraints of the network while in[8], a desired sampling period is used as input information for adapting . recently, several protocols are proposed to adjust LPL parameters based on traffic patterns in [1],although the study is not designed environment, which is investigated for tuning LPL temporal parameters, a new method is proposed to improve energy efficiency by adjusting CCA thresholds. In the literature, there is still a lack of a practical study on the impact of false wakeups to the performance of LPL in noisy environment, which as investigated in this paper.

1. **Cluster wireless sensor network:**
   WSN base station always needs to generate an aggregated value to the end users and the aggregation of the data to be forwarded can also help in reducing the transmission overhead and the energy consumption. To support the data aggregation in the network the nodes can be accommodated in the small groups called the Clusters.

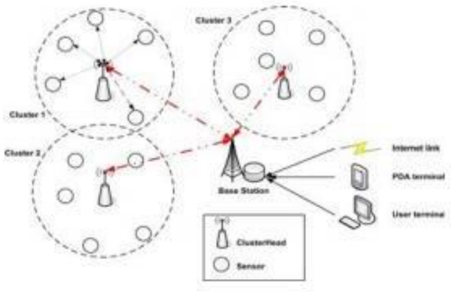
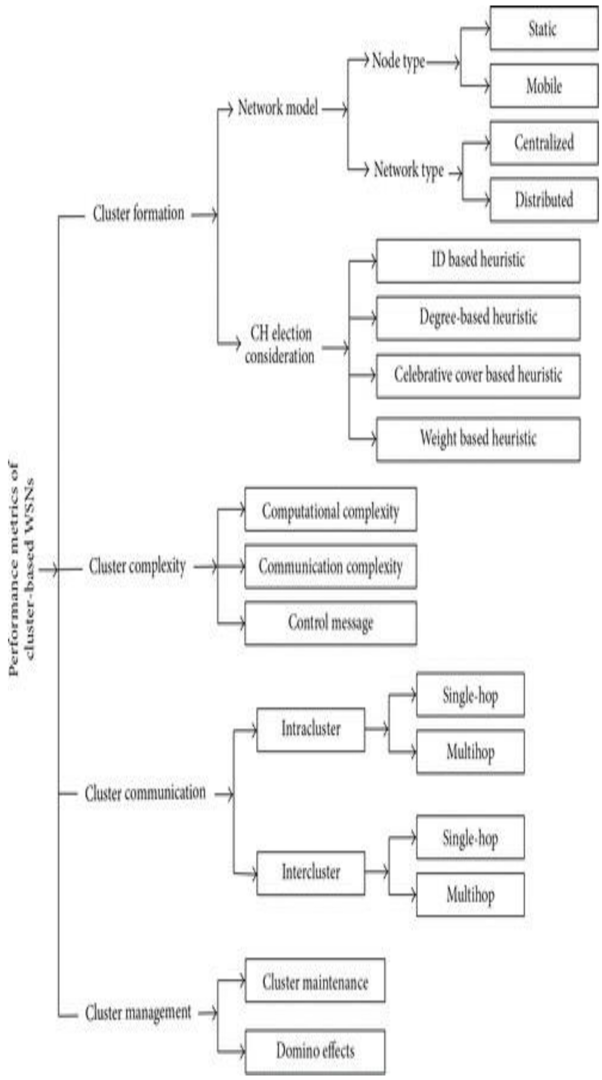


Fig 1: Performance metrics of cluster based wireless sensor network

In this section, a set of performance metrics are enumerated which can be used to categorize and differentiate cluster-based WSN algorithms. One of the benefits of clustering is to make network scalable in situation when sensor nodes' number is huge. Nevertheless, there are downsides of using a cluster-based network, such as higher cost overhead during network construction as compared to flat sensor network. Cost of clustering is an important parameter to authenticate the effectiveness of the scheme. Moreover, it also refers to the improvement of network structure in terms of network scalability. Cost of the clustering schemes in this paper is evaluated qualitatively and quantitatively.

a) **Node Type.** A node can be of two types, either mobile node or stationary node. In the former way, CHs, MNs, or GWs or all three can be mobile. Therefore, mobile node (CH or MN) changes its position dynamically in terms of other nodes. A challenging problem in such scenario is to retain cluster for long time and to overcome problems associated with packet loss. On the other hand, in stationary nodes, CHs, MNs, and GWs are the static nodes that do not change their positions in terms of other nodes

b) **Network Type.** In WSN, cluster formation is either distributed or centralized. In centralized technique, a base station or CH needs universal information about the sensor network. In the distributed technique, a node becomes either CH or member node without the entire network information.



2. LEACH

LEACH stands for Low Energy Adaptive Clustering Hierarchy which is the first protocol of hierarchical routing which proposed data fusion, it is of milestone significance in clustering routing protocol.

All the nodes in a network organize themselves into local cluster, with one node acting as the cluster head. All non-cluster head node transmit their data to the cluster head, while the CH node receive data from all the cluster members or leaf nodes, perform signal processing functions on the data aggregation and transmit data to the remote base station. Therefore, being a cluster head node is much more energy intensive than being a non-cluster head node. Thus, when a cluster head node dies, all the nodes that belong to the cluster lose communication. The problem of LEACH protocol is balance the energy consumption, network energy consumption.

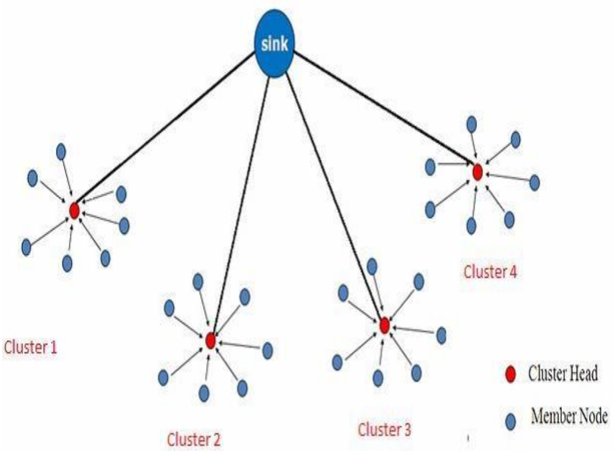


Fig :2 LEACH protocol

LEACH incorporates randomized rotation of the high-energy cluster-head position such that it rotates among the sensors in order to avoid draining the battery of any one sensor in the network. In this way, the energy load associated with being a cluster-head is evenly distributed among the nodes. Since the cluster-head node knows all the cluster members, it can create a TDMA schedule that tells each node exactly when to transmit its data. In addition, using a TDMA schedule for data transfer prevents intra-cluster collisions. The operation of LEACH is divided into rounds. Each round begins with a set-up phase when the clusters are organized, followed by a steady-state phase where several frames of data are transferred from the nodes to the cluster-head and onto the base station.

In the set-up phase, the clusters are arranged and cluster-heads are chosen. In the first round, each node selects a random number between 0 and 1 and compares it to the threshold T(n) given in (4) and if the number is less than a threshold, the node becomes a cluster head.

$$T(n) = \frac{P}{1 - P * (r \bmod \frac{1}{P})} \quad if n \in G, \quad 0 \quad otherwise$$

Where p is the desired percentage of cluster heads, r is the current round, G is the set of nodes that have not been cluster heads in the last 1/p rounds In each round, selected cluster-heads broadcast an advertisement message to all the nodes in the network, informing their new status. After receiving this message, each of the non-cluster-head nodes can determine to which cluster they belong to based on the strength of the received signal. Then, according to the number of nodes in a given cluster, that cluster's cluster-head generates a TDMA (Time Division Multiple Access) schedule, and broadcasts a transmission time window to its CHs.

3. SYSTEM PEGASIS:

System PEGASIS is another hierarchical routing protocol which considered as an improvement over LEACH. PEGASIS stands for Power - Efficient GAthering in Sensor Information System. In PEGASIS, The primary idea is having each node to receive from and transmit to adjacent neighbors and then each node will take its turn later to be the chain leader.

The nodes in PEGASIS are organized to form a chain either by the sensors themselves using a greedy algorithm starting from the randomly chosen node, usually the farthest nodes from the sink, or by having the sink construct the chain and transmits these information to the rest of sensors. In PEGASIS, the data aggregation is performed at every node on the chain except the end nodes in the chain and the network topology is assumed to be known. PEGASIS performs better than LEACH because it reduces the consumed energy in its phases. In its local gathering stage, the summation of distances among transmitting nodes is less than transmitting to a CH in LEACH.

4. PERFORMANACE EVALUATION:

Fig 3 represents the packet delivery ratio plot measured for total simulated time of about 15 seconds. The proposed algorithm generates the maximum PDR of 58.24% at 12th sec and the PDR value is stable to the end of the simulation. Existing system generated the maximum PDR of 56 % at 10th second which is lesser than the propose algorithm.

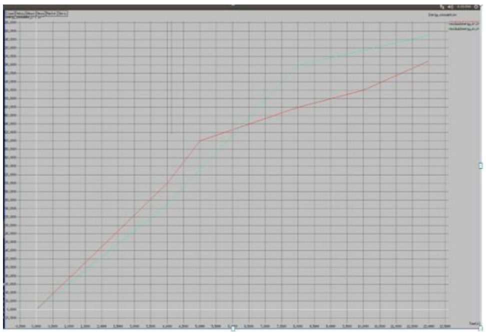


Fig 3: Packet Delivery Ratio

Fig 4 represents Residual energy is the total power consumed by the network during the simulation period. The Proposed algorithm consumed maximum power of about 580 joules and the existing algorithm consumes maximum power of 660 joules. Decrease in consumption of power increases the lifetime of the network.

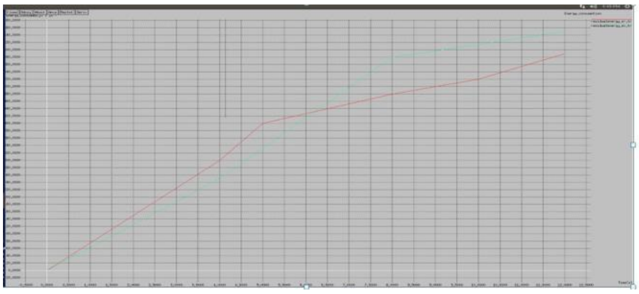


Fig 4: Residual Energy

Fig 5 represents End to end delay is the measure of time taken by the packet to reach the destination node from the sender node. Increase in delay affects the throughput of the network. The proposed algorithm generates network delay of about 1.7 seconds and the delay is stable after 260ms. The delay in existing system is not stable increasing gradually through out the simulation. This indicates the unstability of the existing system.

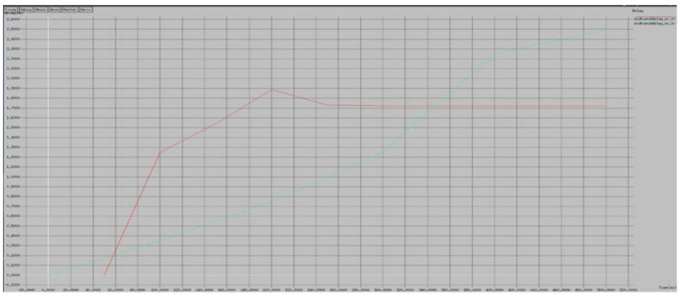


Fig 5: End to end delay

Fig 6 represents Packet loss ratio measures the amount packets dropped during the transmission of packets between the sender and receiver node in unidirectional format. Increase in packet loss ratio increases delay in the network. The proposed method generates packet loss ratio of 0.9% and existing system generates the maximum loss ratio of 1%.

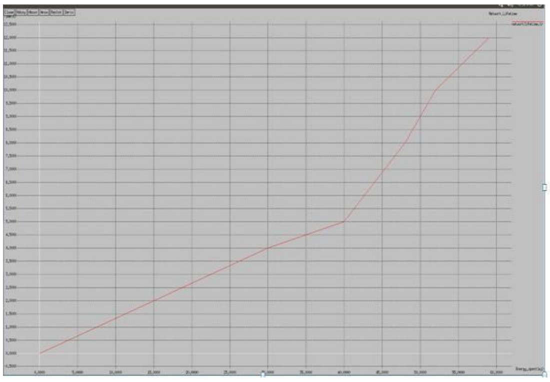


Fig 6: Packet Loss Ratio

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