Performance Analysis of Efficient Energy Management in Routing Protocol for Mobile Wireless Sensor Network

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***Abstract*— Wireless Sensor Networks (WSN) are promising and very appealing technology applied to different applications. Nodes(sensors) of a wireless sensor networks (WSNs) are powered by exhaustible batteries with limited life span and generally they are non-rechargeable. As the deployment of these WSNs occurs in harsh areas generally inaccessible and sometimes hostile, the replacement of depleted batteries is not feasible, so nodes must therefore ensure their mission with their unique initial strict energy budget. This constraint makes the energy resource the most decisive and of critical importance in the WSNs. The routing protocols have to pay much attention in this context of energy conservation. Cluster based routing protocols have significant impact on the energy dissipation and life time of wireless sensor networks (WSN). In this paper the proposed technique PEGASIS-MAEM(PEGASIS- Mobile average energy based) protocol for Multi hop network will be achieved by combining LEACH-MAE[1] based protocol with PEGASIS-MH[2]] protocol. This novel technique overcomes the pitfalls in present protocols and gives better mobile average energy based Cluster Head selection. All the simulations are carried out in NS2 simulator. Simulation results shows that our proposed protocol PEGASIS-MAEM outperforms compared to the other protocols.**

***Keywords*- Mobile Wireless Sensor Network, NS2, LEACH-MAE, PEGASIS-MH, RWP.**

I. INTRODUCTION

Wireless Sensor Network is promising and emerging technology used in a wide variety of applications. For example in Industrial areas, home networks, hospitals, weather forecasting, underwater disaster management, habitat monitoring etc. These all applications are monitored by using sensor nodes deployed statically. However these networks suffer from some limitations like energy resource, connectivity, outer attacks etc. In this scenario of deployment it is impossible to replace the batteries since the deployment environment is hostile and inaccessible as it has hundreds and thousands of nodes. Then it is necessary to design an efficient routing protocol to efficiently manage the energy supplied by batteries. Since these batteries are exhaustible and non rechargeable, we have to focus mainly on power consumption reduction. This will increase the network life time. A network will be efficient if it has more number of nodes alive for more time. If the node dies then there will be a link breakage which will cause the loss of information. This can be solved if we deploy higher number of nodes which will increase the lifetime of the network.

To address these situations 1st protocol designed is LEACH [4] (Low Energy Adaptive Clustering Hierarchy) protocol. This protocol is based on cluster head selections. Initially all nodes are divided into clusters and then cluster heads are selected for each cluster. All nodes transmit their data to the cluster heads and then cluster head transmit the data to the base station by preserving the energy radiation and reducing the power consumption. This protocol is an efficient protocol in routing. But this protocol supports only static nodes. This protocol doesn't support mobility of the nodes. Therefore LEACH protocol is modified to LEACH-M[3] protocol for mobile nodes. Again that protocol is modified to LEACH-MAE [1] (LEACH-Mobile Average Energy) in which cluster head selection is purely based on received signal strength of a sensor node.

Another protocol which can address this problem is PEGASIS [5] (Power Efficient Gathering In Sensor Information System). This protocol is based on the chain based approach. This protocol is an improvement of leach protocol. This protocol avoids the formation of cluster heads and allows single node to transmit the data to the base station hop by hop. In this protocol it every node finds its nearest neighbor and transmits data to that node. It is then modified to PEGASIS-MH (Multi Hop) which combines the clustering and chaining routing methods (figure 1). In the proposed paper we are modifying the PEGASIS protocol to support mobility of the nodes.

In this paper the mobility of the nodes is defined in the RWP (Random Way Point) model. RWP model provides random destinations to all nodes and provides flexibility of pause time. It also assigns random coordinates to all nodes. In this simulation we used different speeds for the nodes and simulated in NS2. During whole simulation time all nodes are mobile with zero pause time.

Remaining paper is organized as follows: section 2 describes about the LEACH protocol its evolution and its modification to adapt the mobility. Section 3 describes about the PEGASIS protocol its extension and the proposed PEGASIS-MAEM protocol for mobile wireless sensor network. Section 4 provides the simulation scenario and simulation parameters followed by simulation results carried out in NS2 Finally section 5 concludes our work.

II. LEACH PROTOCOL

A. *LEACH*

Low Energy Adaptive Clustering Hierarchy protocol is a cluster based protocol. In this protocol all nodes are divided into clusters and then cluster heads are selected. Here nodes transmit data to respective cluster head and then cluster head aggregates the total data received and then transmits the data to the base station. Here total number of cluster heads selected must be 5% to 15% of the total number of nodes [8] then we will have low energy consumption. It consists of two phases of cluster head election *Set up phase and Steady state phase*. In the *Set up phase* each node chooses a random number between 0 and 1. If the number is less than the threshold probability, node is elected as cluster head for the current round. In *Steady state phase* after the formation of clusters each cluster head assigns a TDMA schedule to every node which specifies the transmission time to the node during which the node has to transmit the data. LEACH is modified to LEACH-M to support mobility of the nodes.

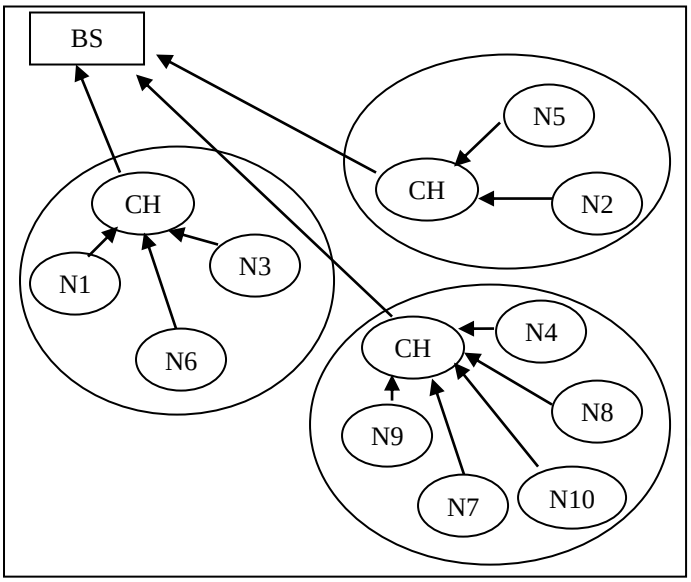

Fig1: LEACH Protocol Architecture

B. *LEACH-MAE*

LEACH-MAE is the extension for the protocol LEACH-M. LEACH-M is modified to LEACH-MAE in which the cluster head election is purely based on the residual energy of the nodes. Every node is mobile and get checked after every round whether the nodes moved out from the cluster and then again it forms the cluster and elects the cluster heads. It also elects its cluster head in two phases *Set up phase* and *Steady state phase* in the same manner as in LEACH protocol (figure2). By conducting a brief study on comparison of LEACH and PEGASIS protocol for static nodes we found that PEGASIS protocol is more efficient than LEACH protocol. This is what is intended to our proposal to adopt, combining the residual energy based cluster election with this protocol to simulate in mobile environment. The proposed protocol elects the cluster heads purely based on received signal strength. The proposed protocol mainly focuses on energy reduction and distribution of energy consumption on every node.

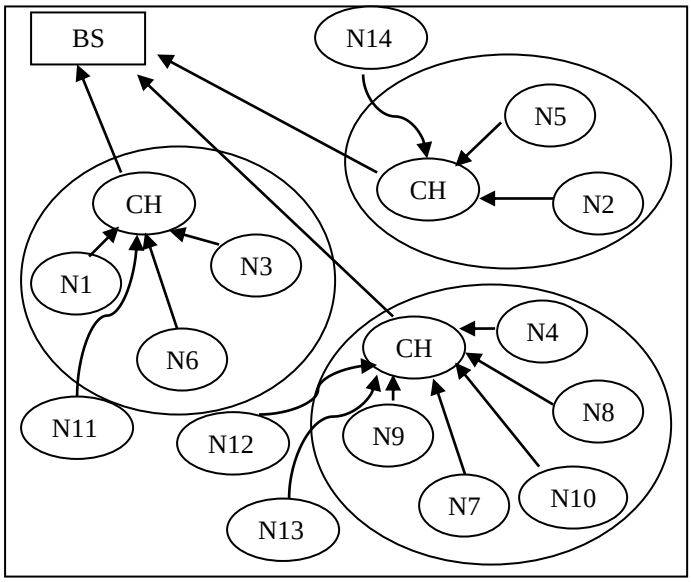

Fig2: LEACH-MAE Protocol Architecture

III. PEGASIS PROTOCOL

Power Efficient GAthering in System Information System (PEGASIS) protocol is based on the chain based approach. In this the hierarchical organization of nodes belonging to the same cluster in the form of chain allows improving and regulating the dissipation of energy, which allows reducing the load on cluster head. In this protocol nodes only communicate with their nearest neighbor and not directly with cluster heads which saves more energy (figure 3).

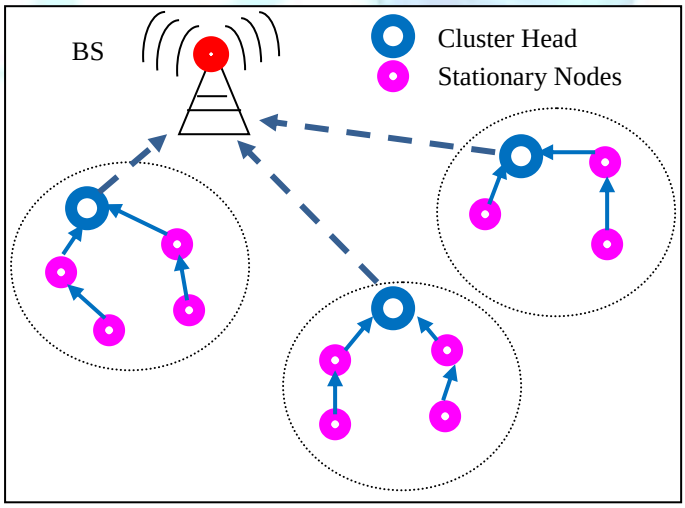

Fig3: Hierarchical PEGASIS

A. *PEGASIS-MH*

This protocol is the extension for the well known protocol PEGASIS. This protocol follows chains and cluster formation. Here nodes are divided into clusters and cluster heads are elected. These nodes forms inter and intra multi-hop routing among nodes in which a node transmits data to its nearest neighbor node up to cluster head and then transmits the data from one cluster head to other nearest cluster head up to base

station. This formation reduces load on cluster heads and increases the network lifetime. The inter cluster multi-hop routing also minimizes the energy consumption and increases network lifetime.

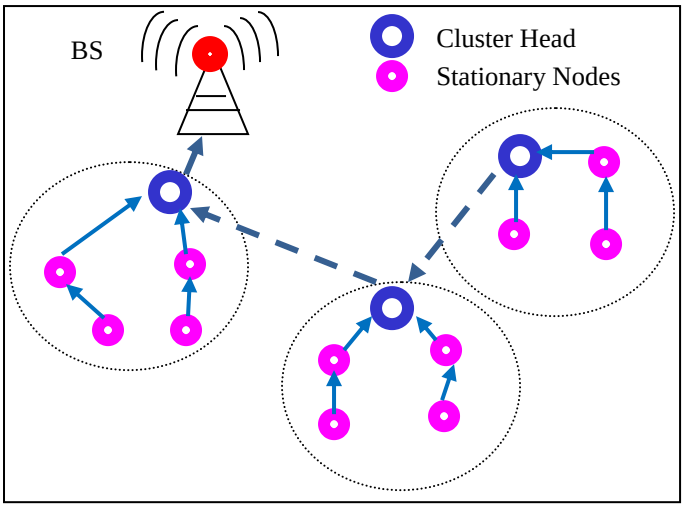

Fig4: PEGASIS-MH Protocol

This protocol uses hop by hop data transmission from peer to peer which increases the data transmission delay.

B. Proposed PEGASIS-MAEM

After conducting a brief study on above protocols we are going to simulate and combine the above protocols for Mobile Wireless Sensor Networks. Here we are going to elect cluster heads purely based on residual energy of the nodes. This protocol avoids inter cluster multi-hop networking. Data is transferred from node to cluster through intermediate nodes and the directly to the base station. This will minimize the delay due to inter cluster multi-hop formation.

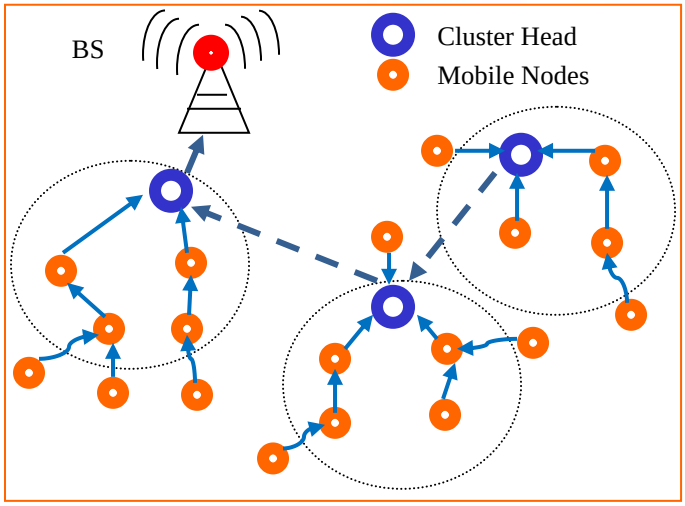

Fig5: PEGASIS-MAEM Protocol

This protocol supports mobility of the nodes. Here simulations are carried out for mobile nodes with different speed in different scenarios. Here these nodes use RWP Model for mobility.

C. RWP(Random WayPoint Mobility Model)

In MWSN nodes are mobile and have different speeds for different scenarios and hve pause time and acceleration. The mobility models have great impact on the performance of routing protocols. It is important to choose a simple mobility model. RWP is a widely used in WSN. In this a model node has random destinations and can move independently without restrictions and has constant speed throughout e move. The node has some pause time in which nodes stops for some time and then again chooses another destination and move.

D. PEGASIS-MAEM protocol steps

Here the first block is the announcement phase, second block cluster formation phase, third one is intra cluster tree formation phase and fourth one is the data communication phase.

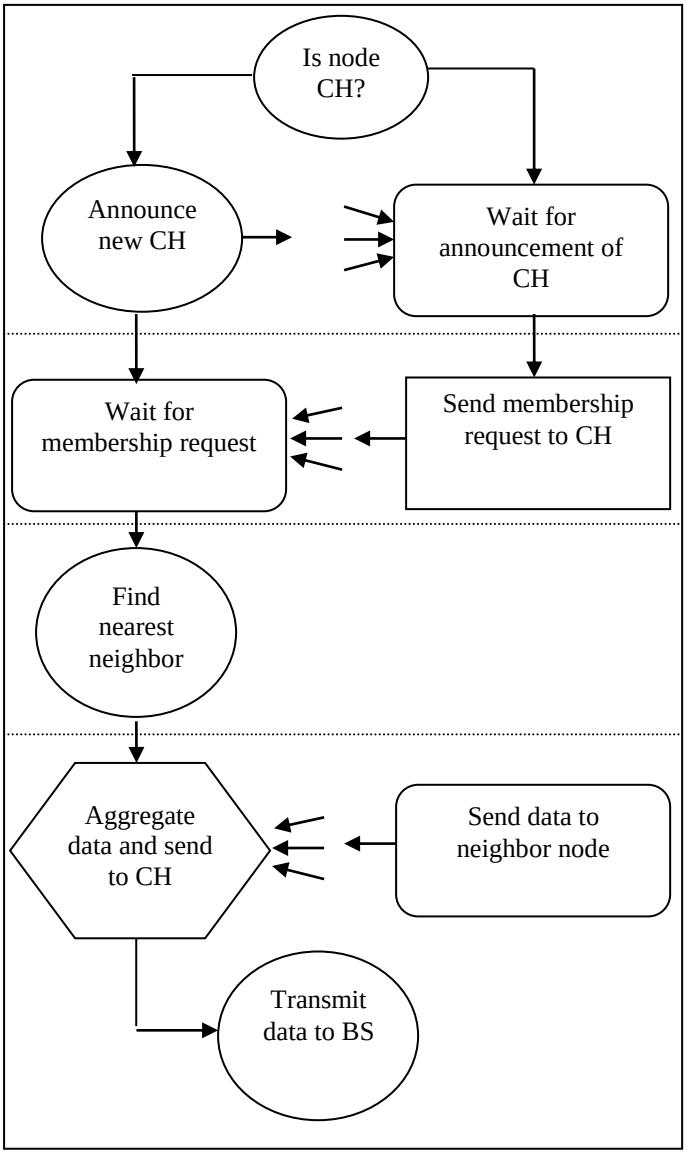

Fig6: PEGASIS-MAEM protocol steps

IV. SIMULATION AND PERFORMANCE ANALYSIS

In this section the simulation parameters are shown. These are as follows:

A. *Performance metrics*

These protocols mainly focus of network lifetime. So here we used two performance metrics to dhow the energy consumption of the network.

- Energy consumption of all nodes.
- Number of alive nodes.

B. *Simulation parameters*

Here we have shown all the parameters used in simulation to analyze the performance of the proposed routing protocol. Here base station is fixed.

The proposed protocol is tested for different speeds of mobile sensor nodes in different scenarios. For comparison of results we used the following parameters as shown in the table:

Table 1: Simulation parameters

Parameters	Description
Antenna model	Omni directional
Channel type	Wireless channel
Radio propagation model	Two ray ground
Interface queue type	Droptail/priQueue
Link Layer type	LL
Communication model	Bidirectional
IFQ length	50 packets
Simulation time	200secs
Field size	100*100
No. of nodes	100
BS position	(75m,150m)

The simulation of the proposed protocol is carried out in two speeds 20m/s and 40m/s. The pause time is 0sec.

C. *Simulation Results*

The simulation results are carried out on three protocols LEACH-M, LEACH-MAE, PEGASIS-MAEM.

The simulation parameters stated above are used to analyze the behavior and performance of the proposed protocol in mobile wireless Environment.

1. *Energy consumption Vs Time*

Here to estimate the energy consumption we used two speeds of mobile wireless sensors. First one is 20m/s and second one is 40 m/s as shown in fig7 (a) and fig7 (b).

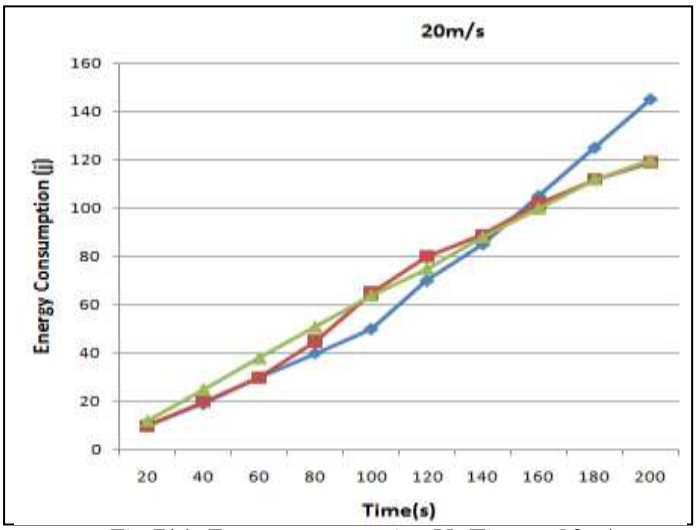

Fig 7(a): Energy consumption Vs Time at 20m/s

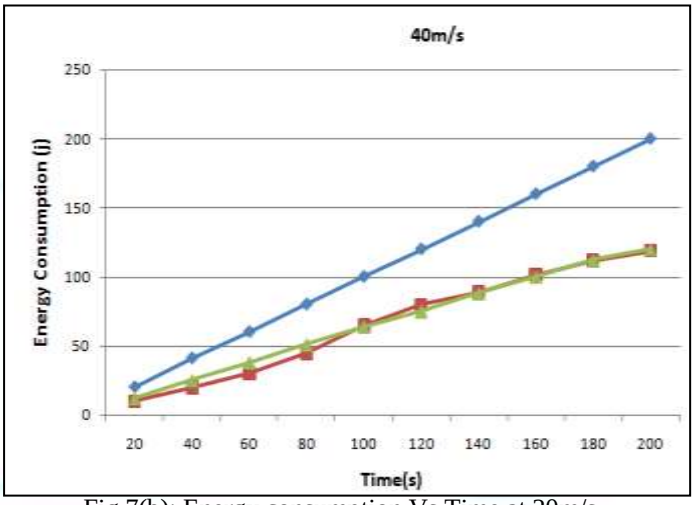

Fig 7(b): Energy consumption Vs Time at 20m/s

2. *No. of Alive nodes Vs Time*

The number of nodes alive in a network plays an important role in WSN. For every network to survive, it must have maximum number of alive nodes for a long time.

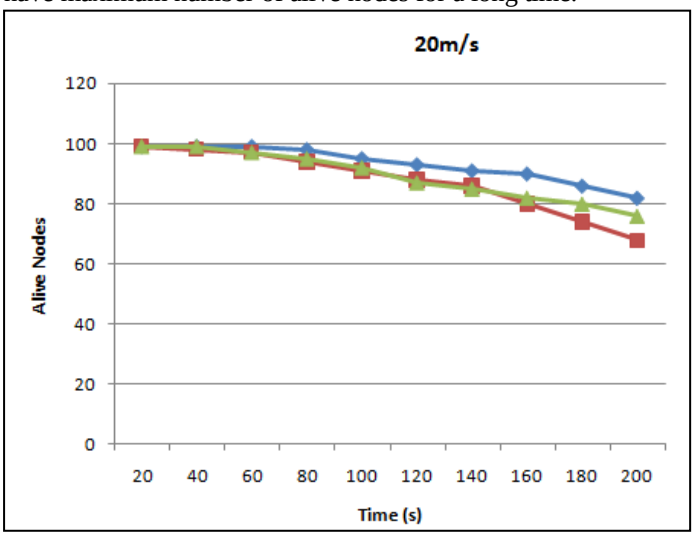

Fig 8(a):No. of Alive nodes Vs Time at 20m/s

The simulation is carred out for two different speeds. First one is 20m/s and second one 40m/s. Here three protocols are compared. from the above results it can be seen that the proposed protocol PEGASIS-MAEM outperforms compared to the other protocols. Proposed protocol has more number of alive nodes than other protocols in both the speeds. Energy consumption is nearly constant for both speeds and nearly equal to the other protocols.

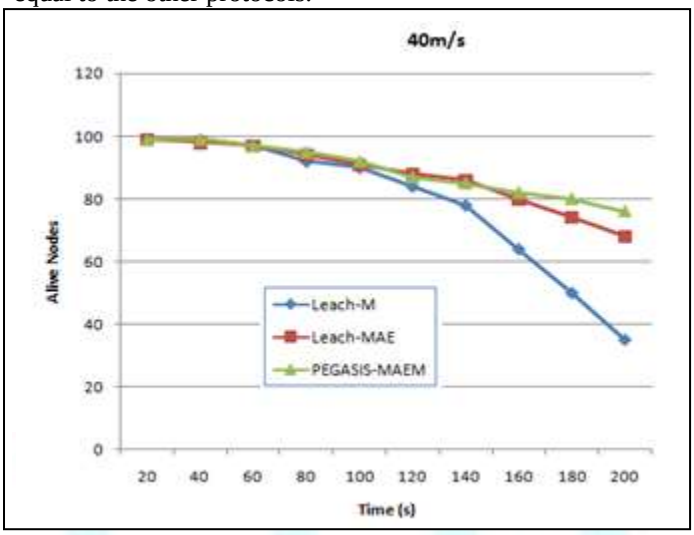

Fig 8(b): No. of alive nodes Vs Time at 40m/s

CONCLUSION

This paper presents the performance analysis of PEGASIS-MAEM for Mobile wireless sensor networks. Here energy resources have been focused. Comparison of simulation results proved that this protocol consumes less energy with minimum data loss and has more network life time.

As protocols are never be perfect and complete, Link breakage and fault tolerance would be our future work

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