A Novel Hybrid PEGASIS-MM Protocolfor Mobile Adhoc Wireless Sensor Networks

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Abstract - WSN (Wireless Sensor Networks) are most widely used in recent years for information gathering from our surroundings. These networks use tiny sensors which use non-rechargeable batteries and are inaccessible. So these sensors must work under strict energy budget. So the routing protocols must ensure less energy consumption. There are cluster based routing protocols like LEACH and PEGASIS which works great for stationary nodes. This paper appertains PEGASIS protocol in Multi hop network for mobile WSN. All the simulations are performed in NS2.34 and accomplished results are compared with LEACH-MAE protocol and endow that the suggested PEGASIS-MM protocol shows improved results than other protocols.

Keywords:mobileWSN; LEACH;LEACH-M; LEACH-MAE;PEGASIS; PEGASIS-MM; NS2.34.

I. INTRODUCTION

Advancement in technology made human life more comfortable and easy. WSN (Wireless Sensor Network) is one of those easiest way of gathering information from our surroundings. These networks consist of the sensor nodes which monitor the required area continuously and provide us the required information. That information is forwarded to base station. In general commonly used sensors are temperature sensors, flow sensors and pressure sensors. Earlier sensors used are of hefty and are operated by rechargeable batteries. But in recent times technological advances made the size of the sensor nodes very small. The price of sensor nodes also became modest. Presently we are using MEMS (Micro Electro Mechanical Sensors) and NEMS (Nano Electro Mechanical Sensors) as sensor nodes which are miniature in size and are of reasonable price. These Sensor nodes are operated by non-rechargeable batteries. The sensor nodes comprise of very low initial energy budget and should be designed such that sensors will complete their mission with in the lifetimeAs these networks are wireless the deployment of the sensors is easy as compared to wired networks. Deployment must be done by considering the area. Sensors must cover the whole area. This deployment is the case of stationary nodes. These nodes are fixed and never change their position. Forming the clusters, selecting the cluster head and data transfer is easier in stationary nodes since they have different configurations and transfer the data within their allotted time slot. They can configure their clusters and cluster heads according to the time schedule with less energy consumption. Alternatively, mobile nodes are continuously moving randomly. Forming clusters and allocating the time schedule becomes complex in case of mobile nodes. Mobile sensor nodes result in less PDR (packet delivery ratio) because their continuous movement break the links formed previously which results in dropping of more number of packets. After assignment of TDMA schedule the forward or backward movement of node results link breakage and the loss of data transfer link.

In general, we have TDMA schedule, scheduled to reconfigure the sensors in 20seconds. For every 20 seconds all the sensors are again reconfigured by forming new clusters and selecting new cluster heads. An increase in the frequency of this reconfiguration of sensors increases the PDR (Packet Delivery Ratio). This means that by decreasing the time of TDMA schedule it will increase the PDR. Generally all sensors are configured with different routing protocols depending on the application and based on strict initial energy budget to transfer the data to base station. Routing protocol based on cluster formation is one of the arrangements which shows potential towards decreasing the energy consumption. In cluster based routing protocol all nodes are divided into clusters and elects a cluster head among the cluster. Here nodes use intermediate nodes like cluster heads to transfer the data to base Station and they do not have direct link to the base station. The best proven protocols in case of cluster based routing are LEACH and PEGASIS. These protocols works fine for stationary nodes. But in case of mobile nodes the scenario is fully different.

In this proposed protocol PEGASIS-MM, PEGASIS protocol is modified and simulated with more frequent TDMA schedules. The mobility to the nodes is provided by RWP (Random Way Point) model which shows the mobile scenario of nodes with different speeds. In RWP model all nodes have random destinations so that the resulting mobile scenario will be perfect.

The persisting paper is classified as follows: Section 2 elaborates about LEACH protocol and its extension to LEACH-M[3](Mobile nodes) and LEACH-MAE[1](Mobile Average Energy based routing protocol) to adapt the mobility of nodes. Section 3 explains about PEGASIS protocol and proposed PEGASIS-MM protocol for Mobile Wireless Sensor Network. Section 4 provides the simulation scenario and simulation parameters followed by simulation results carried out in NS2.34. Finally, section 5 concludes our work.

II. LEACH PROTOCOL

A. *LEACH*

LEACH[4](Low Energy Adaptive Clustering Hierarchy)protocol is initially suggested by W R Heinzelman etal. It explains how the energy consumption can be reduced using this protocol in WSN. This protocol adopts node clustering and election of cluster head. In this routing protocol the basic idea is the work load on distribution over the other nodes of the network. In basic LEACH protocol (fig1) cluster formation is divided into two phases.

Set-up phase: Here each round begins with setup phase and in this phase based on probability function, each node decides whether it is to be or not be cluster head. A random number between 0 and 1 is chosen by each node of the cluster and the node is elected as cluster head for current iteration if the number is less than the threshold probability R(n)[3] .

$$R(n) = \begin{cases} \dfrac{L}{N - L * (i \bmod \frac{N}{L})} & n \epsilon G \\ 0 & Otherwise \end{cases}$$

Where L is the percentage of Cluster Heads, i is current iteration, N is the total number of nodes and G is the group of nodes that have not been cluster head for past N/L iterations. After election of cluster head a status message is broadcasted to all sensor nodes and then each sensor node chooses its cluster head based on received signal strength.

Steady state phase: The second phase is the steady state phase which begins after cluster formation. In steady state phase Cluster Head assigns TDMA schedule for its cluster nodes and the nodes will initiate data transfer within its allotted time slot. This allows the network to turn on radio only while data transmission which results in the reduction of energy consumption in the network. After receiving the data from nodes CH performs aggregation of the data and transmits the data to the BS.

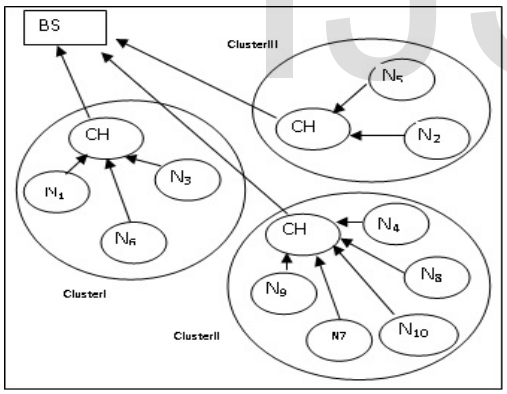


Fig1: Basic LEACH Protocol

LEACH protocol is scheduled for stationary nodes and mobility of nodes is not supported. It is then reformed to LEACH -M protocol in which mobility of nodes is promoted. LEACH-M is then modified to LEACH-MAE.

B. *LEACH-MAE*

In LEACH-MAE protocol(fig2) election of CH depends on residual energy(r_e) of the nodes. Among the all nodes of the cluster the node having higher residual energy(r_e)energy is elected as CH for the current iteration. The CH election is random at the starting point. This LEACH-MAE protocol also employs similar phases as that of LEACH for cluster head election. This protocol is designed for mobile nodes. But in case of stationary nodes depending upon the survey over these protocols, it is observed that PEGASIS protocol is more effective compared to LEACH protocol .

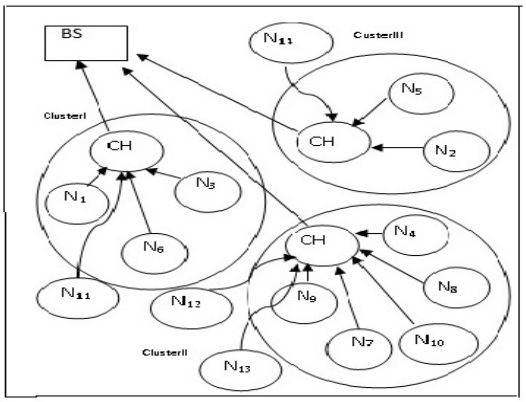


Fig2: LEACH-MAE Protocol

III. PEGASIS PROTOCOL

PEGASIS[5,6,7](Power Efficient GAthering in Sensor Information System) is also a cluster based approach of routing protocols in which data transfer data from nodes to BS takes place in the form of chain through in between nodes. In Pegasis protocol nodes does not interact directly to CH's, but the nodes transmit data through the intermediate nodes. So the workload is distributed by all the nodes of the cluster in the form of aggregation there by reducing the workload on the CH. In this way there will be reduced energy consumption in this protocol. The two phases of the PEGASIS protocol (fig3) are the initialization phase and transmission phase .The cluster head election is done in initialization phase similar to that of LEACH protocol. Here the number of cluster heads are denoted by N and is fixed, unchanged during all iterations. The energy loss will be minimum only when the percentage of number of cluster heads is between 5% to 15% of the total number of nodes .

Initially at the starting point of each iteration at time t the CH's are elected according to their probabilities $R_i(t)$ determined as below:-

$$R_i(t) = \begin{cases} \dfrac{N}{G} & (Energy\ Homogeneous\ nodes) \\ \dfrac{R_e}{Te} & (Energy\ Heterogenious\ nodes) \end{cases}$$

Where N is number of CHs, G is the group of nodes that have not been elected as cluster head till then, R_e Residual energy of the nodes and T_e total energy of the nodes.

During each iteration, a random number between 0 and 1 is generated by each node i and if the generated number is smaller than $R_i(t)$ then that node will be elected as cluster head for current iteration. TDMA schedules are allotted to the nodes of the clusters in transmission phase and the data transmission starts to take place.

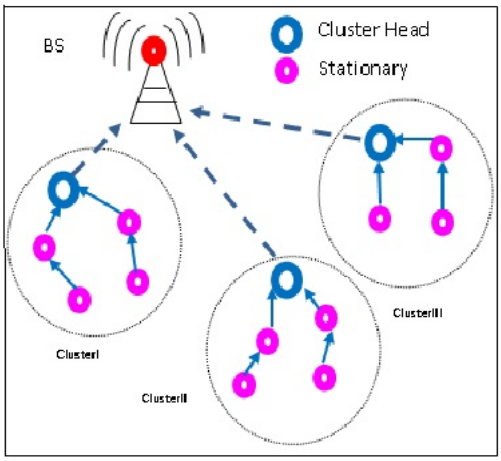


Fig3: Hierarchical PEGASIS

PEGASIS-MH[2](Multi-Hop) protocol is developed from PEGASIS protocol in which cluster heads transfer the data through intermediate cluster head nodes to the Base Station and the CH's do not have direct access to the base station. In PEGASIS-MH protocol multi hop delay is increased because of inter and intra cluster multi hop networking. So in proposed protocol in order to decrease multi hop delay, inter cluster multi hop networking is avoided for mobile WSN.

A. Proposed PEGASIS-MM protocol

The proposed protocol PEGASIS-MM(Multihop for Mobile WSN)(fig4) is the enhanced version of PEGASIS protocol and imported the node mobility. Here the inter cluster multi-hop networking is avoided by keeping intra cluster multi-hop networking. This protocol also employs two phases same as PEGASIS protocol. They are initialization and transmission phases. In this protocol data transfer to CH takes place through intermediate nodes in a multi hop way. Every node finds its nearest neighbor node and transfers its data to that node. This continues until it reaches to CH and then finally CH transmits the data to BS.The mobility to the nodes is provided by Random Way Point model with continuous random movement of nodes and zero pause time.

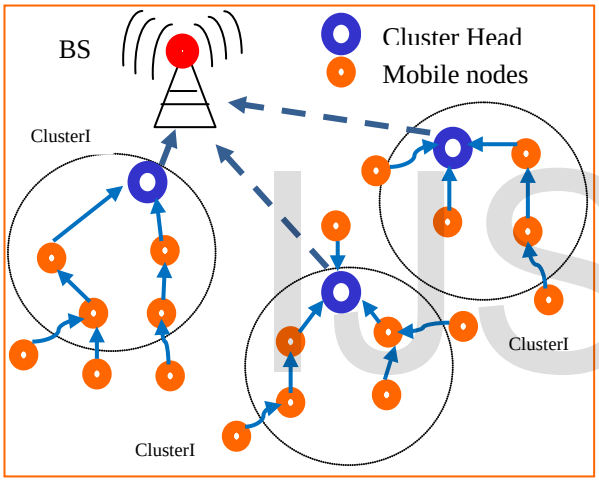


Fig4: PEGASIS-MM Protocol

B. PEGASIS-MM Protocol procedure

In this first block represents election of CH, second block shows formation of clusters, third block shows finding nearest neighbor, fourth block represents transmission of data.

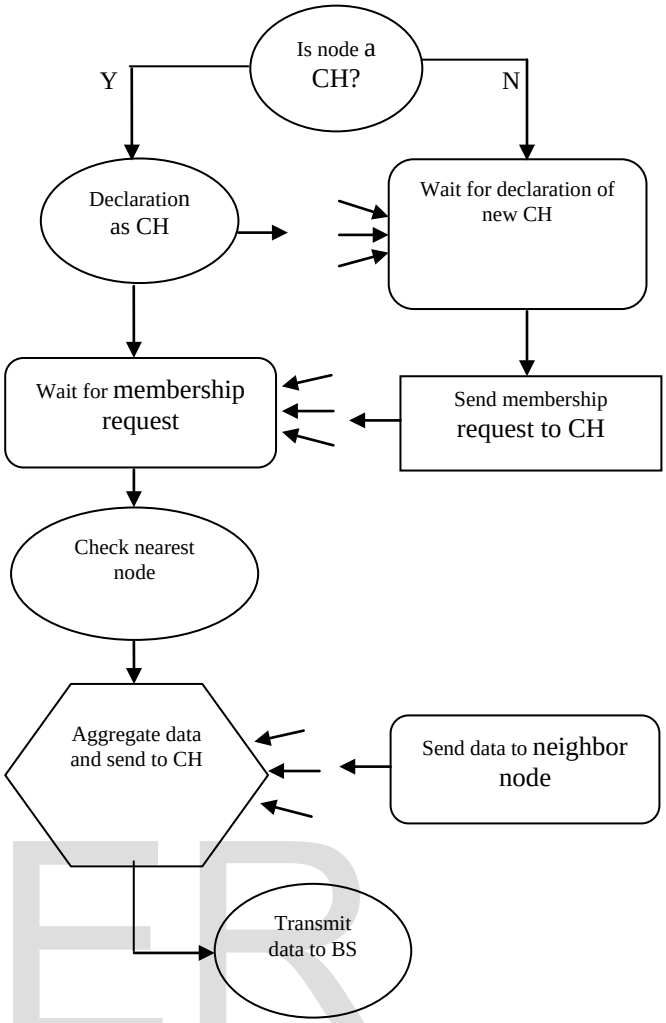


Fig5: PEGASIS-MM procedure flowchart

C. RWP(Random WayPoint Model)

The mobility models have a great intrusion on the performance of routing protocols. RWP model is simple and most widely used mobility model compared to Random Direction Model. Mobile nodes moves with different speeds, acceleration and they may have pause time too. In RWP model all nodes have random destinations and constant speed throughout the movement. Here nodes can have pause time or can have zero pause time.

IV. SIMULATION PARAMETERs AND RESULTS

This section shows the simulation parameters used in the simulation. NS2.34 is used for whole simulation.

A. Performance Criteria:

Eenergy consumption is the main factor to be considered during protocol design in Wireless sensor networks and another factor to be considered is the lifetime of the network. The above protocols focuses on these two issues. To show this we had taken the below performance criterion:

- Energy consumption of the Network.
- Number of Alive nodes.

B. Simulation Parameters:

Parameters	Description
Antenna model	Omni directional
Channel type	Wireless channel
Radio propagation model	Two ray ground
Interface queue type	Drop tail/priQueue

Link Layer type	LL
Communication model	Bidirectional
IFQ length	50 packets
Number of nodes	100
Field size	100*100
Base Station position	(75m,150m)
Simulation time in seconds	200secs
Round time	10secs

Simulation of the proposed protocol is carried out with two different speeds of nodes:20m/s and 40m/s and have zero pause time. Here for every 10 seconds new iteration starts and new CHs are elected. This method provides every node to reconfigure its neighbor nodes for every 10 seconds and minimizes the probability of link breakages.

C. Simulation Results

Simulation is carried out on two protocols LEACH-MAE and PEGASIS-MM and results are obtained for two speeds of mobile nodes 20m/s and 40m/s.The simulation results are shown in the below figures:

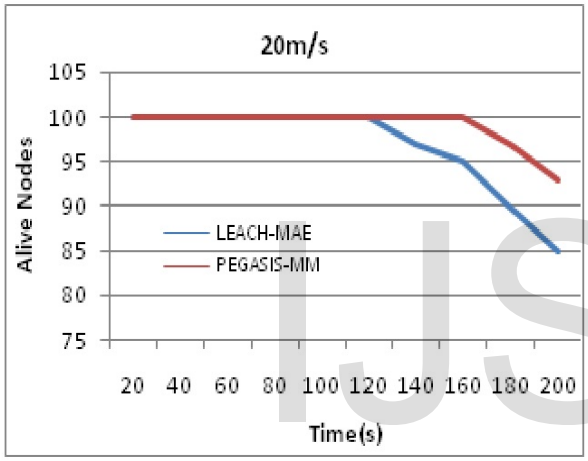


Fig6 (a): Alive nodes for 20m/s

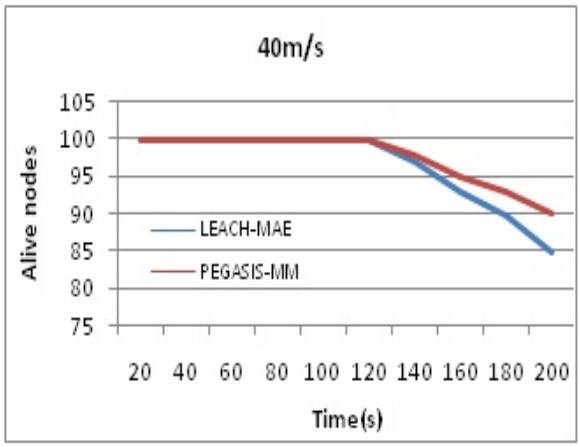


Fig6 (b): Alive nodes for 40m/s

1. Number of Alive nodes Vs Time

Above results shows the number of alive nodes Vs time for 20m/s[fig6(a)] and 40m/s[fig6(b)]

2. Energy consumption Vs Time

Energy consumption of the network is also found by simulating with two speeds 20m/s[fig7(a)] and 40m/s[fig7(b)].

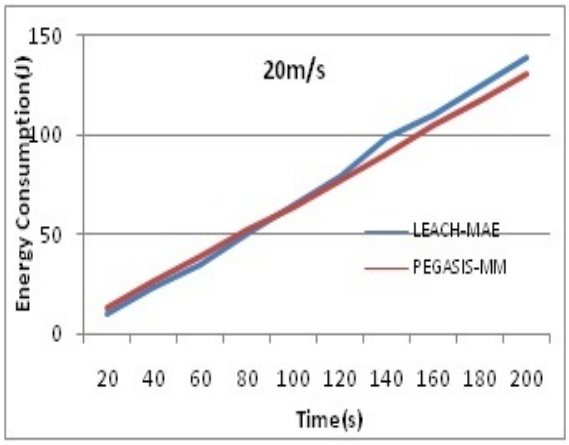
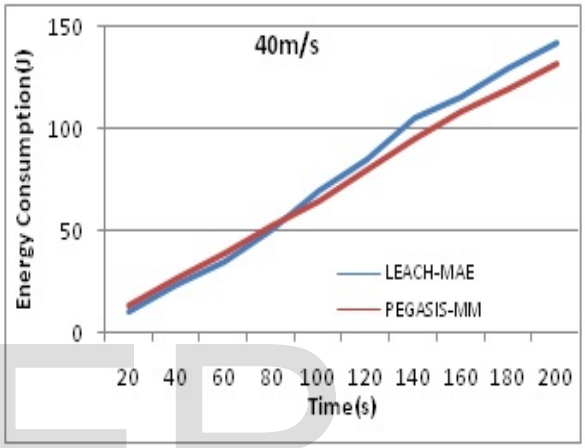


Fig7 (a): Energy consumption for 20m/s



Energy consumption of the network shows the time of functioning of the network.

With increase in speed of nodes link breakages will be more and energy consumption becomes more. Figure7(b)shows with increase in speed of nodes energy consumption is also increased

CONCLUSION

This paper presents the performance of PEGASIS-MM protocol for Mobile WSN. In this papersimulation results are mainly focused on energy consumption and network lifetime. Comparison of simulation results proved that the PEGASIS-MM protocol consumes less energy as compared to the LEACH-MAE. This protocol has less data loss and more network life time.

As protocols are never be perfect and complete, fault tolerance and link breakage will be our future work.

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Fig7 (b): Energy consumption for 40m/s