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PEGASIS-MM A NOVEL HYBRID PROTOCOL FOR AD HOC MOBILE WIRELESS SENSOR NETWORKS

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Abstract

In recent years, wireless sensor networks, often known as WSNs, have become increasingly popular for their application in information collection from the environment. These networks make use of minuscule sensors that run on batteries that cannot be recharged and are unreachable. Consequently, a stringent energy budget is required for these sensors to function properly. Therefore, the routing protocols need to assure a lower amount of overall energy consumption. There are protocols that are built on clusters, such as LEACH and PEGASIS, that perform exceptionally well for nodes that are stationary. This paper discusses the PEGASIS protocol used in multi-hop networks for mobile wireless sensor networks (WSN). All of the simulations are run in NS2.34, and the results are compared with those obtained from the LEACH-MAE protocol. The findings indicate that the suggested PEGASIS-MM protocol exhibits improved outcomes compared to those obtained from other protocols.

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

I. INTRODUCTION

The development of technology has brought about improvements in the quality and convenience of life for humans. WSN, which stands for "wireless sensor network," is one of the simplest ways to collect data from the environment around us. These networks are made up of sensor nodes that keep a constant watch over the designated territory and relay the necessary information to us when requested. That information will now be transmitted to the base station. Temperature sensors, flow sensors, and pressure sensors are the three types of sensors that are utilized most frequently. The earlier sensors that were employed are somewhat cumbersome and are powered by batteries that can be recharged. But in recent times technological advancements have made it possible to significantly reduce the size of the sensor nodes. The cost of sensor nodes decreased to a more reasonable level. At the moment, we are utilizing MEMS (Micro Electro Mechanical Sensors) and NEMS (Nano Electro Mechanical Sensors) as sensor nodes. Both of these sensor types are extremely small in size and are available at affordable prices. These Sensor nodes utilize batteries that are not capable of being recharged. The sensor nodes have a very limited initial energy budget, and they need to be designed in such a way that they can finish their mission within their lifetime. Because these networks are wireless, it is far simpler to install the sensors than it would be to do so with cable networks. When deploying, it is necessary to take into account the surrounding surroundings. The entire region needs to be monitored by the sensors. In this deployment, the nodes have been left in a stationary position. These nodes are always in the same place since their position is fixed. Stationary nodes make the process of forming clusters, selecting the cluster head, and transferring data much simpler because these nodes may be configured in a variety of ways and are able to complete these tasks within the specified time slot. They will be able to reduce their overall energy consumption by configuring their clusters and cluster heads in accordance with the timetable. On the other hand, mobile nodes are always moving in a random direction. When mobile nodes are involved, forming clusters and distributing the time schedule can be a challenging endeavor. Mobile sensor nodes have a lower PDR (packet delivery ratio) than fixed sensor nodes because the continuous movement of mobile sensor nodes breaks the linkages that were previously formed, which causes a greater amount of packets to be dropped. Following the assignment of the TDMA schedule, link breakage and the loss of the data transfer link will occur whenever a node moves in either the forward or backward direction[1].

In general, we make use of a TDMA schedule, which is set to change the sensors every 20 seconds. Every 20 seconds, all of the sensors undergo another round of reconfiguration, during which new clusters are formed and new cluster heads are chosen. An increase in the frequency with which these sensors are reconfigured results in a rise in the PDR (Packet Delivery Ratio). This indicates that the PDR can be increased by reducing the amount of time that the TDMA schedule takes up. In general, each sensor must be setup with a unique set of routing protocols in order to send data to the base station[2]. These protocols vary depending on the application, and they must adhere to a stringent initial energy budget. One of the arrangements that has the ability to reduce energy consumption is a routing protocol that is based on the construction of clusters. A cluster-based routing protocol organizes all of the nodes into clusters and then chooses one of the nodes inside the cluster to serve as the cluster head. Nodes in this configuration do not have a direct link to the base station; instead, they send the data to the base station through intermediate nodes such as cluster heads. LEACH and PEGASIS are the best proven protocols to use in the event that cluster-based routing is used. These protocols function quite well for nodes that are stationary. On the other hand, things play out very differently when mobile nodes are involved.

In the new protocol that has been proposed, known as PEGASIS-MM, the PEGASIS protocol is altered and simulated to use TDMA schedules that occur more frequently. The Random Way Point (RWP) model, which illustrates the mobile situation of nodes moving at varying speeds, is responsible for providing mobility to the nodes. In the RWP model, every node is assigned a random destination, and this ensures that the mobile scenario that is generated will be flawless[3].

The remaining paper can be broken down into the following categories: In Section 2, we go into further detail on the LEACH protocol, as well as its extension to LEACHM (Mobile nodes) and LEACH-MAE [1] (Mobile Average Energy based routing protocol), which are both designed to accommodate the mobility of nodes. In Section 3, the PEGASIS protocol and the proposed PEGASIS-MM protocol for Mobile Wireless Sensor Network are broken down and explained. Following the description of the simulation scenario and the simulation parameters in Section 4, the results of the simulation run in NS2.34 are presented. The conclusion of our effort can be found in section 5.

II.LEACH PROTOCOL

A. LEACH

W. R. Heinzelman and colleagues were the ones who came up with the idea for the LEACH [4] (Low Energy Adaptive Clustering Hierarchy) protocol. It provides an explanation of how the energy consumption of WSN can be decreased by employing this protocol. The clustering of nodes and the democratic selection of a cluster leader are both incorporated into this protocol. The fundamental concept behind this routing system is the distribution of the work load across the various nodes that make up the network. The LEACH protocol in its most fundamental form (fig. 1) divides the process of cluster formation into two parts.

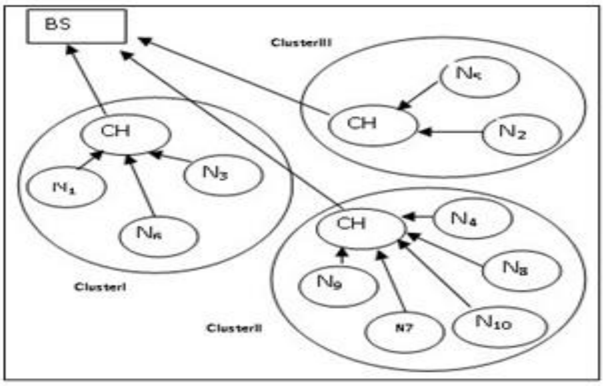

Fig1: Basic LEACH Protocol

Set-up phase: In this scenario, the first step of each round is the setup phase. During this phase, a probability function is used to determine whether or not a node will serve as the cluster head for the next round. Each node in the cluster picks a random number between 0 and 1, and if that number is lower than the threshold probability R(n), the node is elected as the head of the cluster for the current iteration

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

Where G is the group of nodes that have not been the cluster head for the last N/L iterations, L is the proportion of Cluster Heads, I is the current iteration, N is the total number of nodes, and Following the election of the cluster head, a status message is sent to all sensor nodes, and each sensor node subsequently chooses its own cluster head based on the received signal strength.

Steady state phase: The second phase, also known as the steady state phase, is the phase that starts following the cluster formation phase. Within the steady state phase, the Cluster Head will assign the TDMA schedule for its cluster nodes, and the nodes will commence data transfer during their allowed time slots. Because of this, the network is able to switch on the radio only while it is transmitting data, which results in a reduction in the amount of energy that is consumed by the network. After collecting the information from the nodes, the CH performs an aggregate operation on the data before sending it on to the BS.

The LEACH protocol is planned to only run on stationary nodes; it does not support running it on mobile nodes. Following that, it is transformed into the LEACH -M protocol, which encourages the mobility of nodes. After then, LEACH-M is altered to become LEACH-MAE.

B. LEACH-MAE

The election of CH in the LEACH-MAE protocol (fig. 2) is contingent on the residual energy (re) of the nodes. The node within the cluster that possesses the greatest amount of residual energy (re)energy is the one that is chosen to serve as CH for the current iteration. The election for CH begins with a random selection of candidates. This LEACH-MAE protocol also uses phases that are comparable to those used by LEACH for the election of the cluster head. The mobile nodes are the focus of this protocol's architecture. On the other hand, relying on the survey conducted over these protocols, it was discovered that the PEGASIS protocol is more effective than the LEACH protocol when it comes to the case of stationary nodes.

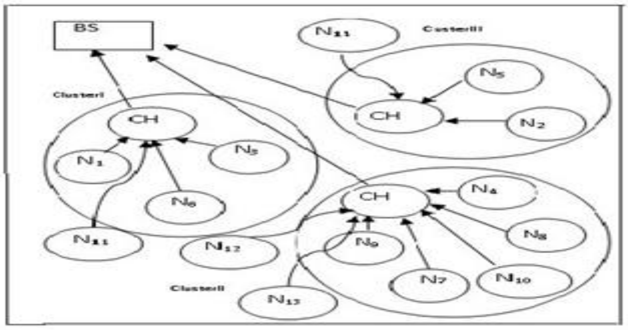

Fig2: LEACH-MAE Protocol

III. PEGASIS PROTOCOL

PEGASIS[5,6,7], which stands for Power Efficient GAthering in Sensor Information System, is another example of a cluster-based approach to routing protocols. In this protocol, the transfer of data from nodes to BS occurs in the form of a chain that passes via nodes in between. Nodes in the Pegasis protocol do not connect directly with CHs; rather, the nodes transmit data by way of intermediate nodes. As a result, the workload is aggregated across all of the nodes in the cluster, which in turn decreases the amount of work that needs to be done by the CH. In this manner, there will be a reduction in the amount of energy that is consumed by this program. The initialization phase and the transmission phase of the PEGASIS protocol (fig3) are the two phases that make up the protocol. In a manner analogous to that of the LEACH protocol, the election of the cluster head takes place during the initialization phase. In this case, the number of cluster heads is indicated by the letter N, and it remains constant throughout all of the iterations. Only when the percentage of the total number of cluster heads is between 5% and 15% of the total number of nodes will the energy loss be at its lowest possible level.

The CHs are chosen at the beginning of each iteration, which occurs at time t, based on the probability associated with each candidate. Ri(t) was calculated as follows:

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

Where N represents the total number of CHs, G represents the group of nodes that have not yet been chosen as the cluster head till that point, and Both the nodes' residual energy and their total energy are referred to as "Re" and "Te," respectively.

Where N is the number of CHs, G represents the group of nodes that have not been elected as cluster head until then, Re represents the residual energy of the nodes, and Te represents the total energy of the nodes.

Each node I will generate a random number between 0 and 1 during each iteration, and if that number is lower than Ri(t), then that node will be elected as the cluster head for the current iteration. If the generated number is equal to or greater than Ri(t), then the node will not be elected as the cluster head. During the phase of transmission, TDMA schedules are distributed to the nodes of the clusters, and the actual process of data transmission then gets underway [8-12].

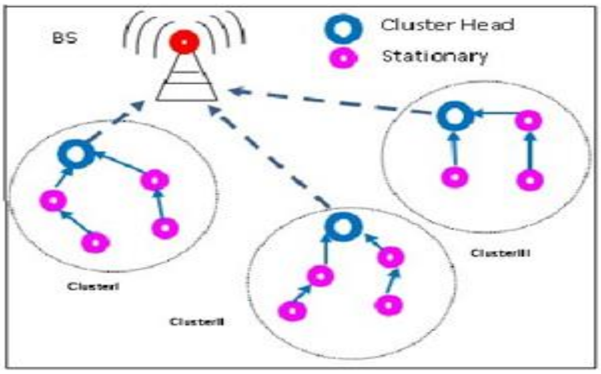

Fig3: Hierarchical PEGASIS

In the PEGASIS-MH [2] (multi-Hop) protocol, which was evolved from the PEGASIS protocol, the cluster heads transport the data to the Base Station via intermediary cluster head nodes. The CHs do not have direct access to the Base Station. Because of inter and intra cluster multi hop networking, the PEGASIS-MH protocol's multi hop time is enhanced. Therefore, the suggested protocol for mobile WSN avoids utilizing inter cluster multi hop networking in order to cut down on the latency caused by multiple hops.

A. Proposed PEGASIS-MM protocol

The upgraded version of the PEGASIS protocol is called PEGASIS-MM (Multi-hop for Mobile WSN), and it was incorporated into the proposed protocol PEGASIS-MM (Multi-hop for Mobile WSN) (fig4). By maintaining multi-hop networking within the cluster itself, the need for multi-hop networking between clusters can be eliminated. The two stages that are used in the PEGASIS protocol are likewise used in this protocol. Initialization and transmission are the two processes that make up this phase. In this protocol, data is transferred to CH in a manner that involves multiple hops and involves the use of intermediate nodes. Every node searches for its closest neighbor node and sends its data to that node once it has located it. This continues until it reaches CH, at which point CH sends the data on to BS. After that, the process repeats itself. The Random Way Point model, which features continuous random movement of nodes and no halt period, is the one responsible for providing mobility to the nodes[13-16].

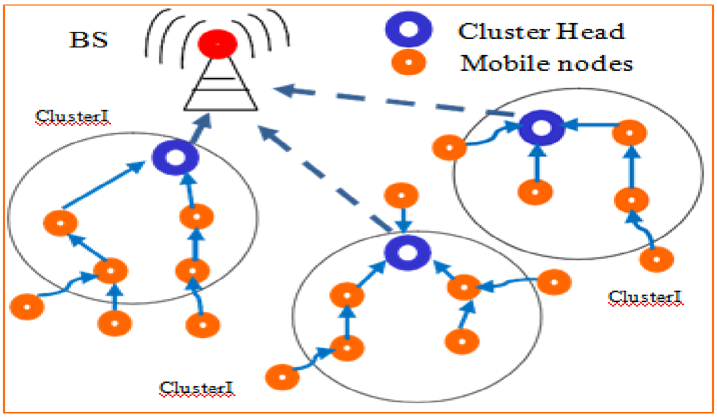

Fig4: PEGASIS-MM Protocol

B. PEGASIS-MM Protocol procedure

This first block illustrates the process of selecting the CH, the second block demonstrates the formation of clusters, the third block illustrates the process of locating the nearest neighbor, and the fourth block illustrates the transmission of data.

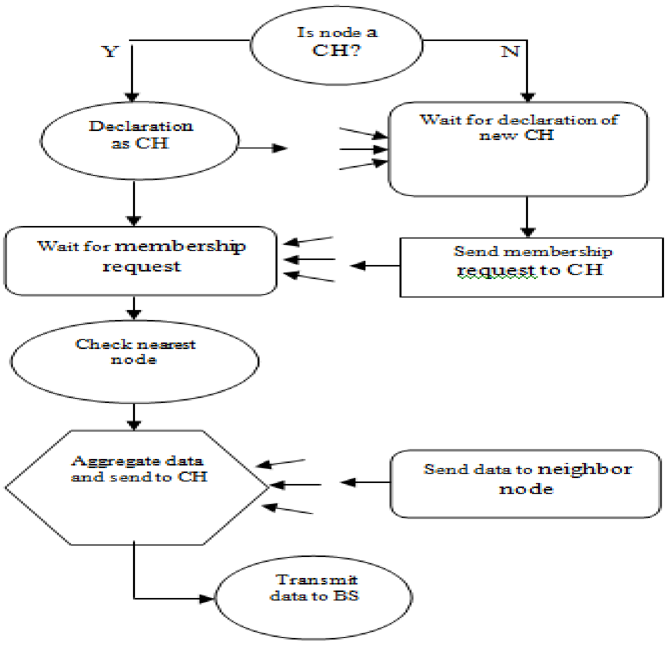

Fig5: PEGASIS-MM procedure flowchart

C. RWP (Random WayPoint Model)

The mobility models have a significant impact on the way in which the routing protocols are carried out. When compared to the Random Direction Model, the RWP model is one of the simplest and most extensively used mobility models. Mobile nodes can travel at a variety of speeds, accelerate at varying rates, and in some cases even pause temporarily. In the RWP model, every node travels to an unpredictable location while maintaining a consistent speed throughout the process. In this case, pause time may be present on nodes, or there may be no pause time at all.

IV. SIMULATION PARAMETERS AND RESULTS

In this part, the simulation parameters that were utilized in the simulation will be shown. NS2.34 is utilized for the entirety of the simulation.

A. Performance Criteria:

Energy consumption is the most important aspect that must be considered during the protocol design phase of wireless sensor networks. The lifetime of the network is another important component that must be taken into consideration. The focus of the methods described above is on these two problems. In order to demonstrate this, we used the performance criterion that is listed below:

- 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

The simulation of the proposed protocol is run with two distinct speeds of nodes—20 meters per second and 40 meters per second—and there is no rest period. Here, a brand new iteration begins around every ten seconds, and new CHs are chosen. This technique allows each node to reconfigure its neighbor nodes once every ten seconds and reduces the likelihood that a link will become broken.

C. Simulation Results

Simulation is performed on both the LEACH-MAE and PEGASIS-MM protocols, and results are achieved for 20 m/s and 40 m/s mobile node speeds. The results of the simulation are presented in the following figures:

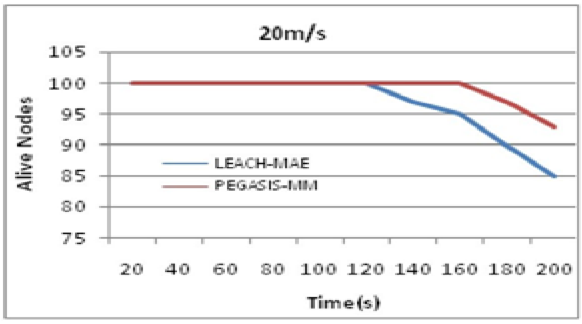

Fig6 (a): Alive nodes for 20m/s

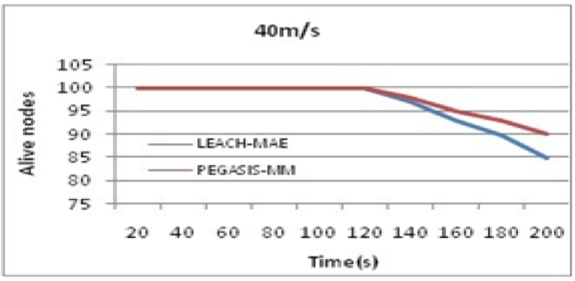

Fig6 (b): Alive nodes for 40m/s

1. Number of Alive nodes Vs Time

The data presented above demonstrate, for 20m/s [fig 6(a)] and 40m/s [fig6(b)], the correlation between the number of living nodes and the passage of time.

2. Energy consumption Vs Time

The amount of energy that is used by the network can also be determined by simulating it at two different speeds: 20 meters per second and 40 meters per second.

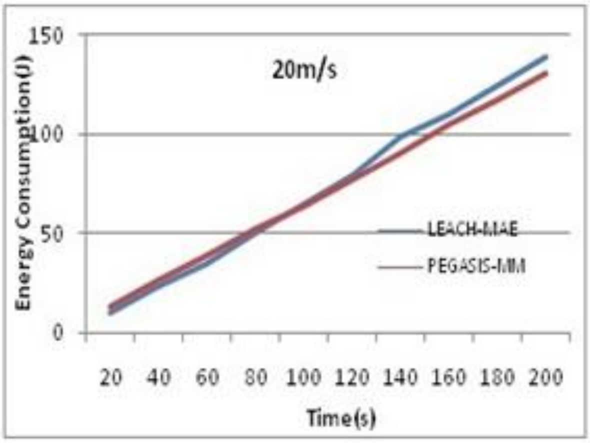

Fig7 (a): Energy consumption for 20m/s

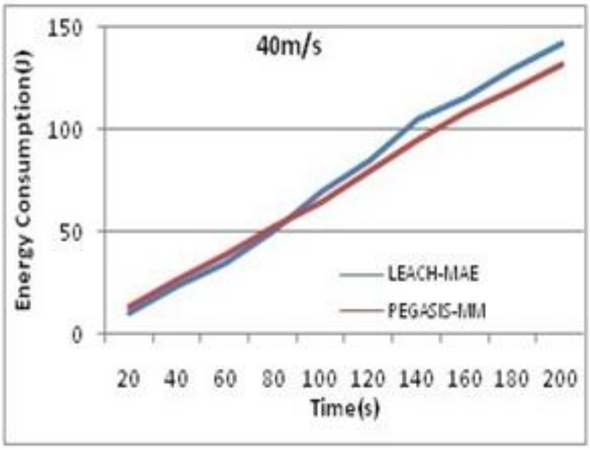

Fig7 (b): Energy consumption for 40m/s

The amount of energy that the network uses during its operation can be used to estimate how long it has been operational. As the speed of the nodes increases, there will be an increase in the number of connection breakages, and the amount of energy that is consumed will also grows. Figure 7(b) demonstrates that an increase in the speed of the nodes results in an increase in the amount of energy that is consumed.

V.CONCLUSION

The performance of the PEGASIS-MM protocol for Mobile WSN is presented here in this study. The results of this simulation are primarily focused on energy consumption and network lifetime throughout this study. A comparison of the results of the two simulations demonstrated that the PEGASIS-MM technique had a lower overall energy need than the LEACH-MAE. This protocol reduces the amount of data that is lost and increases the lifespan of the network.Due to the fact that protocols can never be flawless and comprehensive, our work in the future will focus on fault tolerance and link breakdown.

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