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An optimization based Power-Efficient Gathering in Sensor Information Systems (PEGASIS) for Wireless Sensor Network

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Abstract: Routing is the major challenge for sensor networks. It presents the trade- off between efficiency as well as responsiveness. There are various protocols exist in this category. In this work, we have analysed Power Efficient Gathering in Sensor Information System (PEGASIS) hierarchical protocol for routing with the protocols on the basis of total energy consumed, sensors lifetime and provides a comparison with traditional methods. The optimization method used in the proposed work is ABC (Artificial Bee Colony). Utilization of PEGASS is done as it is considered as a redirecting method and allows good routing. This method employs some sort of greedy approach beginning from the actual furthermost node and each of the sensor nodes form some sort of string just like composition. The proposed work has been designed and implemented in WSN by using PEGASIS routing protocol. In this work, the performance analysis of the network with the scenarios consisting 50 nodes moving with the speed of the 5-10m/s within the area (1000X1000) m2 has been done in regards to the parameters packet delivery ratio, Throughput, End-to-End Delay, and Energy consumption.

Keywords: WSN (wireless sensor network), PEGASIS (Power Efficient Gathering in Sensor Information System), ABC (artificial Bee colony) and MATLAB.

I. INTRODUCTION

A Wireless Sensor Network (WSN) is a wireless network consists of devices being spatially distributed by utilizing sensors for monitor physical or environmental conditions. WSN is constructed with nodes that are utilized for observing the surrounds, namely, humidity, temperature, pressure, vibration, sound, and position etc. These nodes could be utilized in various real-time applications for performing variety of tasks like a discovery of neighbour node, smart detecting, data processing and storage, target tracking, data collection, synchronization, node localization, monitor and controlling, and efficient routing within the base station and nodes. Wireless sensor network can be categorized by utilizing:

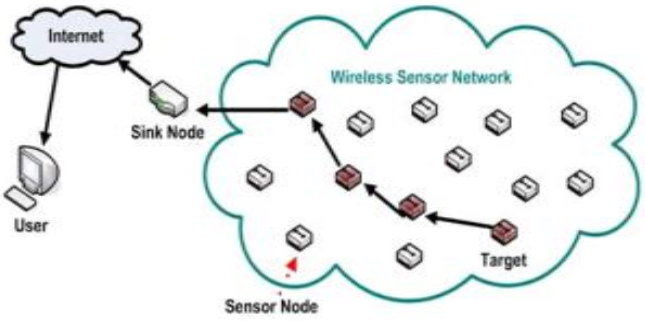

Fig. 1 Wireless Sensor Network

1. Transmission media based networks just like wired sites (communication takes place by means of wires) in addition to Wi-Fi sites (communication takes place wirelessly).
2. System Sizing primarily based sites just like MAN, personal computer community in addition to WAN [1] Fig. 1 shows the classifications of wireless sensor networks and is defined below:
Sensing unit: Sensing unit comprises of a sensor and ADCs (Analog to digital converters) that transfers analog signal obtained by sensor to digital signal. It basically converts the physical phenomenon into electrical signal.
Processing unit: Processing unit comprises of microcontroller or microprocessor that control sensors, communication protocols execution with processing of signals algorithms on the collected sensor data.

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Transmission Unit: It takes the information from CPU and later transfers that to the end user in the outside world.
Power Unit: In WSN, battery power is consider as the main source of energy. The battery power is supplied to sensor node by power units [2].

II. PEGASIS

PEGASIS is a redirecting method when a chain primarily based method is usually followed. This method employs some sort of greedy approach beginning from the actual furthermost node and each of the sensor nodes form some sort of string just like composition. It functions for the process that many node will probably transfer in order to and acquire via it's in close proximity neighbourhood nodes. There's a leading light in the string which is in charge of transmitting in the collective facts towards sink node [38].

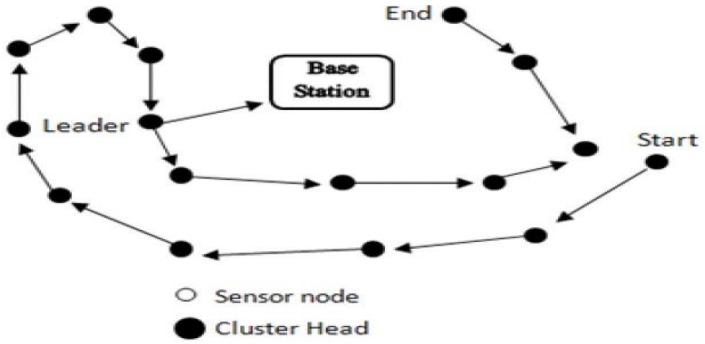

Fig. 2 PEGASIS

III. ABC (ARTIFICIAL BEE COLONY)

In the ABC model, the colony consists of three groups of bees: employed bees, onlookers and scouts. It is assumed that there is only one artificial employed bee for each food source. In other words, the number of employed bees in the colony is equal to the number of food sources around the hive. Employed bees go to their food source and come back to hive and dance on this area .The employed bee whose food source has been abandoned becomes a scout and starts to search for finding a new food source. Onlookers watch the dances of employed bees and choose food sources depending on dances.

IV. OBJECTIVES

The objectives are declared below:
1. To study research papers related to WSN using PEGASIS protocol and ABC algorithm.
2. To implement Wireless Sensor Network by deploying number of nodes in the designed network.
3. Utilize ABC Algorithm within each sensor node to develop the network performance efficiently in terms of broadcasting the messages so that node will consume less energy using PEGASIS protocol.
4. Set the best possible values of the fitness function.
5. Measure the performance metrics of network like Throughput, delay, energy consumption and packet delivery ratio.

V. LITERATURE SURVEY

A. Razaque et.al, 2016 [2], proposed a PEGASIS- LEACH named as _-Leach, protocol which is the improvement of PEGASIS and LEACH protocols. To transfer data within the WSN an energy efficient algorithm has been used by P-LEACH protocol. For efficient energy P-LEACH protocol, has been simulated in NS-2 and MATLAB environment. For simulation 100 sensor nodes formed a network in 600m *600m rectangular area. Unlimited data with 5 J of energy has been transmitted from one node to the other node. The node that used limited reserve during the simulation causes depletion and the node that exhausted reserve energy considered as dead node. A comparison with simple PEGASSIS and LEACH protocol along with P- LEACH protocol has been performed. It has been concluded that P-LEACH protocol perform well than these two protocols in case f energy consumption and dead nodes.
Hetal Rana et.al, 2014 [31], described the area of Wireless Sensor Networks which was one of the fast rising and up-and-coming field in the scientific and engineering world. It is an ad-hoc network that consists of small nodes with sense, compute and communicate wireless ability these sensor nodes are thickly deployed in the sensor field environments. The environment could be an Information Technological structure, a physical world, or a biological system. The major objective of WSN is to sense the crucial information from the environment depending on the type of

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application for which it is deploy and send this information to its Base Station so that it can take corrective actions. These Sensor Nodes speak with each other via various Routing Protocols. Protocols in wireless sensor networks are broadly classified as Flat, Hierarchical and Location Based routing protocols. This document presented a hierarchical routing protocol, Power Efficient Gathering in Sensor Information Systems and a comparative study on various versions of PEGASIS protocols.

W. Wu et al, 2014 [32], has explained the concept of Mobile Adhoc Network (MANET) with respect to clustering. The author has proposed a new algorithm in OLSR network. Varied numbers of simulations are performed for several nodes and variable nodes velocity. The simulation has been done to calculate with and without the clustering interval. The work has given improvement with the performance and number of elected cluster heads.

Sunita Rani et.al, 2012[33], presented a Wireless sensor node deploy into the network to monitor the physical or ecological condition such as temperature, sound, vibration at different location. Each node together the information than transmit to the base station. The data was transport over the network .Each sensor consume some energy in receiving data, sending data. The lifetime of the network depend how much energy spent in each spread. The behavior of protocol plays the important role, which could minimize the delay while donation high energy efficiency and long span of network lifetime. One of such protocol is PEGASIS, it is based on the chain arrangement, every chain have only one cluster head, it is in charge with every note's in receipt of and sending messages who belong to this chain, the cluster head consumes large energy and the times of every round rising. In PEGASIS, it take the advantage of sending data to it the closet fellow citizen, it save the battery for WSN and increase the lifetime of the network. The future work is about to select the next neighboring node reliably. For this it will combine few parameters such as Distance, Residual Energy and Response time. The future system will increase the overall statement and increase the network life.

M. M. Chandane et.al, 2013 [34], proposed a re-enactment model for WSN. Writing study has been done on energy-aware routing procedures, in which, the aforementioned was found in the Minimum Total Transmission Power Routing and Minimum Battery Cost Routing Protocol, most extensively catches exchange offs of energy proficiency in addition to and system lifetime individually. Proposed re-enactment model was actualized utilizing Qualnet 4.5 and connected to MTPR and MBCR to dissect its execution. Through this study, they establish a framework for further research take a shot at improvements in augmenting the system lifetime of WSN. Trial result demonstrated that there is dependably an exchange off between energy productivity and system lifetime.

VI. PROBLEM STATEMENT

Despite the wealth of research studies conducted separately on Ad hoc network. MANET has lot of wide application in many areas like in a military environment, preservation of security; latency, reliability, intentional jamming, and recovery from failure are significant concerns. Military networks are designed to maintain a low probability of intercept and/or a low probability of detection. We have discussed about many disadvantages of Reactive, Proactive & hybrid routing protocols so there is scope of improvement in this. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where routing is an essential design issue. The focus, however, has been given to the routing protocols which might differ depending on the application and network architecture. Routing in WSNs is very challenging due to the inherent characteristics that distinguish these networks from other wireless networks like mobile ad hoc networks or cellular networks. First, due to the relatively large number of sensor nodes, it is not possible to build a global addressing scheme for the deployment of a large number of sensor nodes as the overhead of ID maintenance is high. Thus, traditional IP-based protocols may not be applied to WSNs. Furthermore, sensor nodes are deployed in an ad-hoc manner. So, in proposed work routing problem will be solved using ABC routing protocol on PEGASIS protocol. The whole simulation is done in MATLAB 2010a environment using various parameters i.e.

• Packet delivery Ratio (PDR)

It is defined as the ratio of the number of packets delivered successfully to the destination as compared to the total number of packets transmitted from the base station (Source).

• Energy consumed

It measures the instantaneous amount of energy being consumed in the network per round. This is simply the energy difference from the beginning till the end of a round. It is defined mathematically as below:

$$\text{Energy Consumption} = \sum_{i=0}^{n-1} (\text{Energy\_consumed\_by\_node(i)})$$

• Throughput

Throughput is defined as the ratio of the total packets received at the receiver node to the to the time it takes the receiver to receive the last packet generated by the source.

•End to end delay

End-to-end delay refers to the time taken for a packet data to be transmitted across a network from source node to destination node. So, in network, we use those routes in which the probability of end to end delay is less, so

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performance of the propose work is better. In the mathematical term, we can say that the end to end delay is the total amount of time which is elapsed during the transmission of packet data.

$D_{end\text{-}end} = D_{trans} + D_{prop} + D_{proc}$

Where $D_{end\text{-}end}$= End-To-End Delay, D_{trans}= Transmission Delay, D_{prop}= Propagation Delay, D_{proc}= Processing Delay

Throughput= $\frac{\sum \text{Packtssent}}{\text{Totaldata packets}}$

VII. METHODOLOGY USED

In this section, the proposed methodology is described for WSN Network. The procedure of proposed work using PEGASSIS routing protocol with ABC optimization is given for the WSN Network.

Step1: Design and develop a network area for the simulation of propose work in WSN with the help of height and width of network.
Step 2: Define N number of nodes in the network area for simulation work.
Step 3: Define the source and destination node from the N number of nodes.
Step 4: Assume pre-defined energy. If energy is greater than average energy then denote node with letter A otherwise with letter N.
Step 5: For energy saving PEGASSIS protocol is used.
Step 6: Get number of nodes in the box and take their energy value. Calculate energy of each block and also defined failed and dead node.
Step 7: Apply PEGASSIS routing protocol for discovering the routes. After discovering the routes analyze the performance parameters.
Step 8: If QOS are less then apply ABC algorithm with required objective function.
Step 9: Route is discovered by using cluster head.
Step10: Calculate performance metrics parameters.

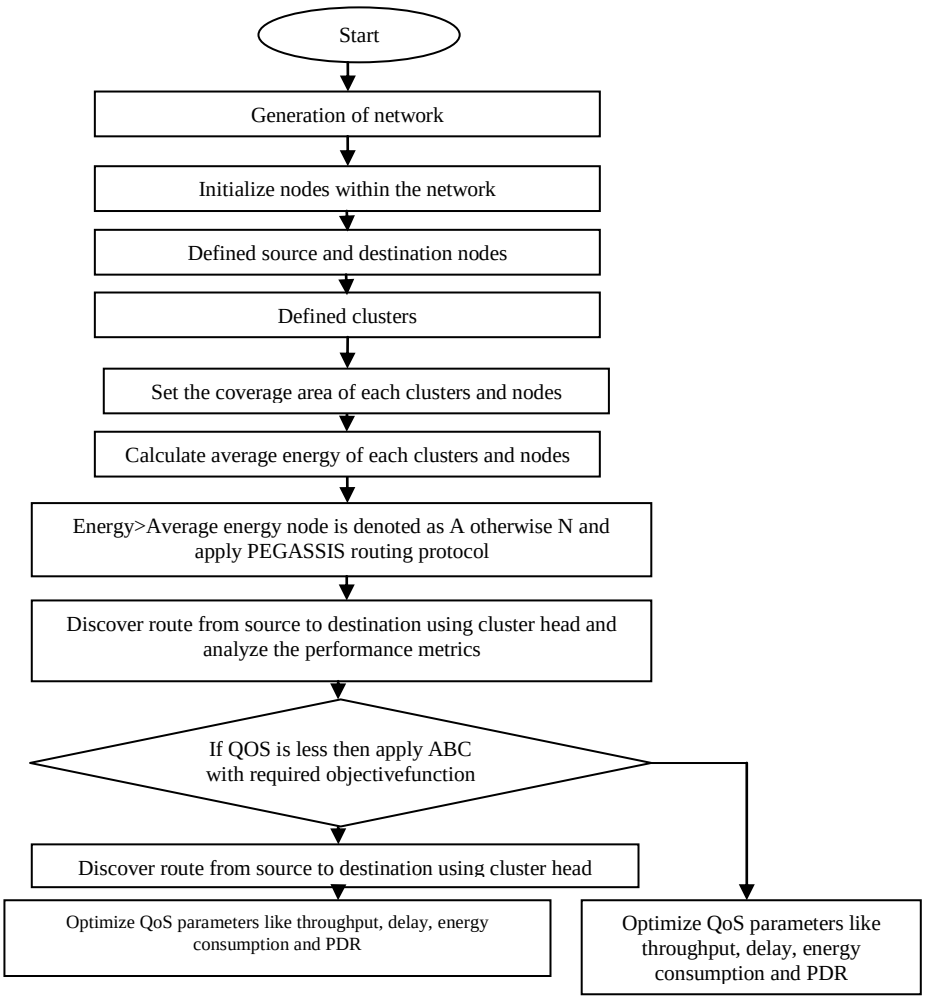

Fig 3 flowchart of proposed work

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VIII RESULT AND DISCUSSION

Table I Network Requirements

Number of nodes	50-100
Area	1000-1000 meters
Simulation Tool	Matlab
Authentication Parameter	Energy Consumption
Evaluation Parameter	Throughput , Error Rate, PDR, Delay

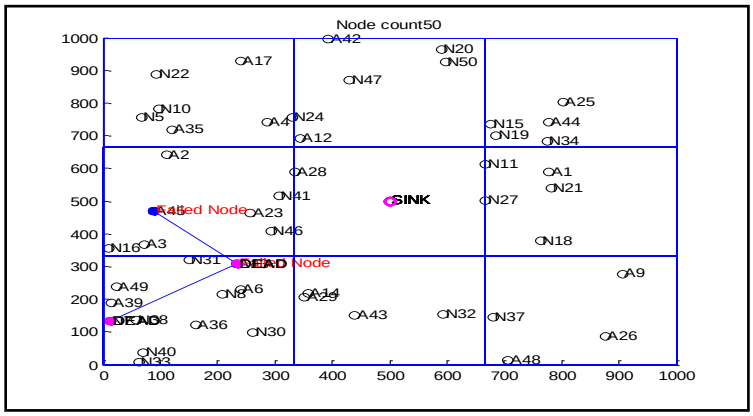

Fig. 4 network area

Here, we formulated the following results in MATLAB with 50-100 nodes. As shown in the figure the network area is in square form having length=1000 along y-axis and width =1000 along x-axis. The node with pink color depict dead node, blue color node indicate failed node red color node is the sink node. There are 50 total numbers of nodes that we have considered in the proposed work. Here, nodes are divided into two types; denoted by A and N. When the energy is >average then node is denoted by 'A' else, 'N'.

Table II Energy consumption with proposed work and previous work

Number of rounds	**Existing work LEACH (without optimization)**	**Proposed work OLSR with ABC optimization algorithm**
1	1.8	0.27
2	2.5	0.24
3	3.25	0.08
4	3.7	0.03
5	3.8	0.15

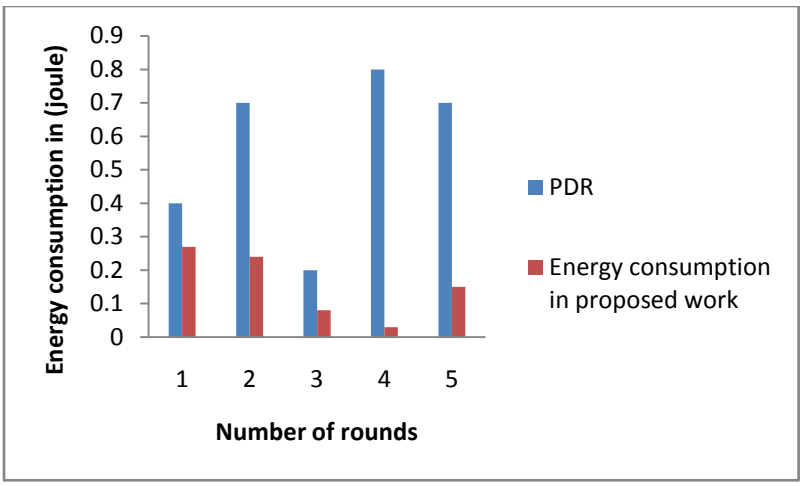

Fig. 5 Comparison of Energy consumption with existing and proposed work

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In the figure above, blue line indicates the value of energy consumption obtained for the existing work when only PEGGASIS protocol was used. Red line indicates the energy consumed by the sensor nodes when PEGGAIS protocol along with ABC algorithm has been used. From the figure above, we concluded that when optimization algorithm was applied to the network the energy consumption gets reduced which is better for any mobile network.

Table III comparison of throughput with existing and proposed work

No. of iterations	Throughput for the existing work	Throughput for the proposed work
1	50	65
2	0	88
3	80	87
4	0	90
5	0	98

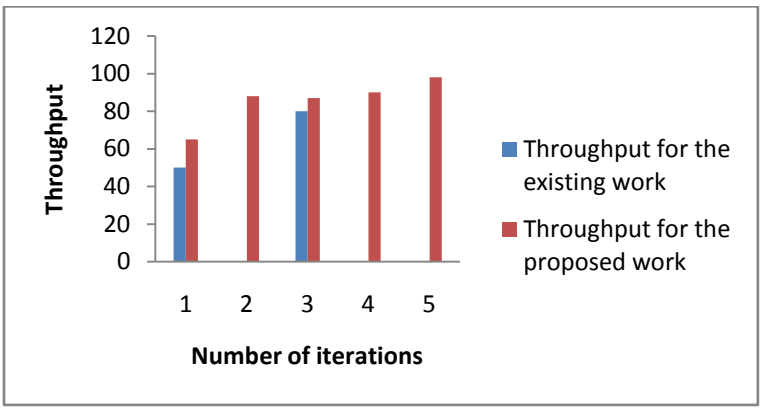

Fig. 6 Throughput with existing and proposed work

In the above figure, x-axis represents number of rounds, whereas, along y-axis it represents throughput with distortion. The proposed work is simulated for five number of iterations and the value of throughput obtained when no algorithm is applied or when attack occurs in the network are illustrated in table 5.3. The average value of throughput when distortion occurs is 26 %, which is very less, whereas with improvement throughput increased and become 85.6 %.

Table IV PDR values for existing and proposed work

No. of iterations	Existing PDR	Proposed PDR
1	0.5	0.4
2	1.2	0.7
3	0.2	0.2
4	1.5	0.8
5	1.3	0.7

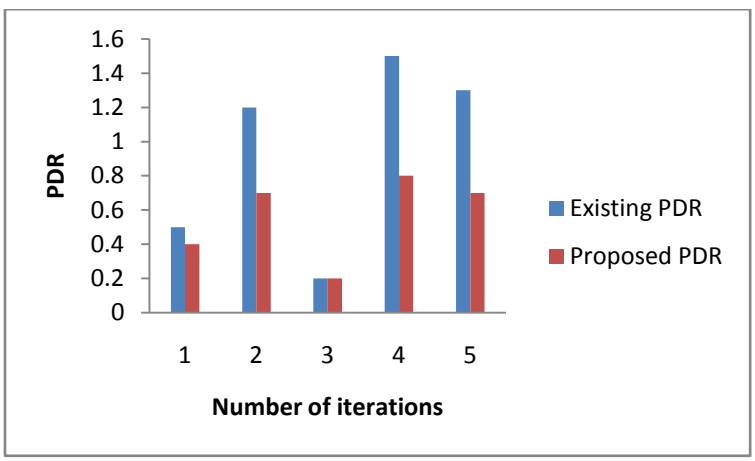

Fig.7 PDR values for proposed and existing work

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The above figure depicted the graph obtained for packet delivery ratio (PDR) when no algorithm is applied. The average value obtained for PDR is .94 whereas, for the proposed work average PDR is .56.

Table V Delay values for the proposed and existing work

No. of iterations	Delay for existing work	Delay for proposed work
1	4.5	4.5
2	3.5	3.2
3	0.5	0.2
4	5	4.5
5	2.6	2.3

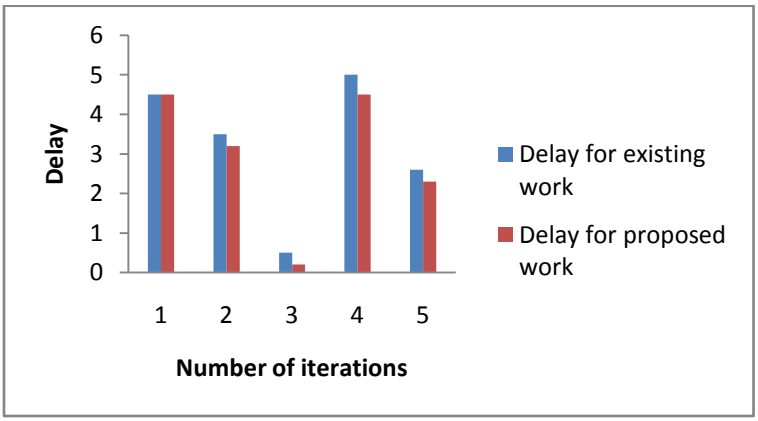

Fig.8 Delay for proposed and existing work

The above graph shows the value of delay w.r.t number of iterations. The values obtained for delay after simulations are illustrated in table above. The average value for the proposed work is 2.94 whereas for the existing work average value is 3.22.

IX. CONCLUSION

In this research, Power-Efficient Gathering in Sensor Information Systems (PEGASIS), which is optimal for data gathering application in sensor network, will be used. The basic idea in PEGASIS is to execute a chain between the sensor nodes so that each node would receive from and transfers to a close neighbour. ABC (Artificial Bee Colony Algorithm) will be used in each sensor node for developing the efficiency of the network performance by means of broadcasting for less utilization of energy by using PEGASIS protocol.

The main problem occurs in the WSN network is the designing of an efficient energy- based routing algorithm, because energy of sensor is limits. For this purpose we use PEGASSIS routing protocol, which is based on two parameters that are distance and residual energy. The PEGASIS protocol forms a chain of the sensor nodes, starting from the farthest node to the sink node. The nearest node send the packets to the neighboring node and so on until all the nodes are included in the process. During this process the load of energy is evenly distributed among the nodes.

The performance metrics of the network will be measured by parameters, namely, Throughput, packet delivery ratio, Delay and energy consumption. The average values obtained for throughput, PDR, Energy consumption and Delay when PEGGASIS protocol and ABC algorithm has been applied are 85.6%, .56, .152 and 2.9 msec. It is concluded that the energy consumption is very less when PEGGASIS protocol and ABC optimization algorithm as been applied.

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