International Journal of Inventive Engineering and Sciences (IJIES)
ISSN: 2319–9598, Volume-3 Issue-4, March 2015

Enhancement of Energy Efficient Protocol for Wireless Sensor Network with Improved Communication

Nibedita Priyadarshini Mohapatra, Adyasa Mohanty, Prajna Parimita Pradhan, Sasmita Kumari Sahu

Abstract-Wireless sensor network (wsn) is now the center of attraction for most of the research peoples due to its wide range of applications in almost every field. Where human intervention is impossible, wsn was reachable. It has lots of challenges and issues; we wish to solve the energy budget and also try to provide an improved communication in wireless sensor network. Here we proposed an energy efficient model for wsn which was an enhanced energy efficient routing and clustering approach. This model improves the lifetime of the network with enhanced energy efficiency and improved communication. Here we compare our model with existing protocol and by the simulation results we can say our model performs better than the existing model. Here we also propose a Energy saving data gathering method for wsn with less energy consumption and faster data transmission. The simulation results reflect the idea very well.

Index Terms— sensor network, clustering, routing, energy efficient

I. INTRODUCTION

Wireless sensor network is the first choice for most of research peoples due to its huge range of applications in different flavors. It gives 24*7 hours service, anytime and anywhere. So the sensor nodes have to be more energy efficient and timely work done method. In complex time critical application, the need of improved energy efficient routing technique is an important issue. At the same time we have to design a model with lower energy budget and also increase the network life time to a significant level.

As we all know that most of the sensor nodes deployed in hazardous area so the sensor nodes cannot be recharge like mobile devices. Thus we have to design a energy saving routing technique with improved communication method. Sensor node equipped with low energy, so energy depletion takes place quickly with more data transmission.

Manuscript Received on March 2015.

Nibedita Priyadarshini Mohapatra, Department of Computer Science and Engineering, National Institute of Science and Technology, Berhampur, India.

Adyasa Mohanth, B.Tech. Final year, Department of Computer Science and Engineering, National Institute of Science and Technology, Berhampur, India.

Prajna Parimita Pradhan, **B.Tech**. Final year, Department of Computer Science and Engineering, National Institute of Science and Technology, Berhampur, India.

Sasmita Kumari Sahu, B.Tech. Final year, Department of Computer Science and Engineering, National Institute of Science and Technology, Berhampur, India.

Here we try to reduce the complexity of inter cluster communication. At the beginning we have to invest little more and overall network energy consumption will be reduced to a greater extent.

II. RELETED WORKS

H. Balakrishnan and his team came with an excellent idea of clustering protocol in 2000 which is a self-organizing adaptive clustering technique, it evenly distribute the energy among the sensor nodes in the network. The low energy adaptive clustering hierarchy (LEACH) gains significant attention due to its local data fusion which compress the local data, those are being sent from the clusters to the sink, by which energy dissipation decreased to a greater extent and it enhances the network lifetime. It has two phases such as setup and steady state phase. At the beginning of simulation each node has $P_i(t)$ probability for electing cluster head itself with round r+1 and k number of clusters.

$$\sum_{I=1 \text{ to } N} P_i(t) * 1=k$$

It is a two tier protocol with cluster head and cluster member. Cluster formation takes place during set up phase, while data transmission held during steady state phase. Every sensor node runs a random method in periodical manner to decide its identity i.e. cluster head or not in a wireless sensor network.

D.P Agarwal and his team proposed a real time application specific protocol which suits time critical applications. Threshold sensitive energy efficient sensor network protocol (TEEN) provides solution for transmission delay. It has two types such as hard threshold and soft threshold. Clusters are formed, cluster heads are selected which collect the data and transmit it to the upper layer, also broadcast the threshold values. Hard threshold value is the minimum priority value for triggering the sensor node. The hard threshold give the accessibility that the sensor node to transmit an event, the event must belongs to the area of interest otherwise it cannot be transmitted. Here transmission delay reduced significantly. Soft threshold allow the sensor node to transmit new data packet with no duplicate data packet. This protocol is very responsible protocol to quick changes in the sensor environment.

The improved version of TEEN i.e. APTEEN (Adaptive Threshold Sensitive Energy Efficient Sensor Network Protocol) came in 2002 by A Manjeswar and D.P Agarwal [8].

It extends the flexibility of TEEN by dealing periodic data collection and time critical events with equal priority. TEEN outperforms than LEACH and APTEEN due to less data transmission. But it compromises with extra cost of multilevel cluster formation. As we got information for our research work that PEGASIS is the enhanced version of LEACH protocol Lindsey and his group came with this novel idea in 2002. Here chain formation between sensor nodes depend upon greedy approach, amount of transmission energy reduced to a greater extent. Each sensor node send and receive with its nearest neighbor only. Therefore distance between sensor nodes with base station plays a vital role. Short chain benefits less transmission delay and longer chain causes more transmission delay. There is gradual increase in neighbor distance. If a particular sensor node die or faulty due to energy depletion and link failure, the chain reconstructed again by following the same greedy method to bypass the dead or faulty node.

The leader will be changed in random manner with each simulation round. The node has the transmission capability to neighbor node which has token. Again the next sensor node transmits its own data with the collected data and token to its nearest neighbor. Each node in the network knows their identity. Set up and Steady state phase followed are used here as LEACH protocol. Only one transmission at a time can possible in this method.

III. PROPOSED WORK

As we know TEEN and APTEEN both are costlier with complexity of cluster formation because of multiple levels. Here we propose an energy efficient TEEN (E-TEEN), which performs better. The basic idea was same but with some modifications such as, here the cluster formation follows the low energy adaption with multiple cluster head (CH) selection. One is main cluster head and other one is assistant cluster head. Main CH decides which transmit the event and Assistant CH do the data aggregation simultaneously. It allows the data backup for future use at the same time it reduce the cost of cluster formation in existing TEEN. Our model also increases the network lifetime, decrease the complexity intra cluster communication. Make the data transmission securely and with less power consumption. Thus it makes the network more stable.

Our propose model provides the benefit of LEACH and TEEN combine manner, where it gives an middle way solution to drawbacks found in LEACH and TEEN. From our simulation results and comparison graph we can clearly says that our proposed model E-TEEN performs outstanding than LEACH and TEEN.

Here we increase the simulation rounds and decrease the dead nodes significantly.

- Nodes deployed in random manner
- Cluster head selection based upon RSSI value, Threshold value, distance between neighbors, node degree.
- Data transmission cost can calculated
- Cluster head selection cost also calculated.
- Simulation rounds increased.
- Total remaining energy calculated.

In this model the transmission cost for transmit and receive messages of k (2000) bits through a distance d between a sender and receiver can be calculated as

$$E_{tran(K.d)=} E_{elec^*\ k+} e_{amp} * k * d^{\alpha}$$

$$E_{rec(k)=} E_{elec} * k$$

Where E_{tran} is the transmitting cost and E_{rec} is the receiving cost respectively. E_{elec} is energy dissipated to active the sender and receiver of the particular network. The propagation exponent is α can be 2 or 4 depends upon the condition of the transmission environment. If the received power is below threshold, the data packet cannot be transmitted because it does not fall under the area of interest. Otherwise it will be transmitted successfully and guaranteed received by the designated receiver. Here we take some extra assumptions like radio model is symmetric means transmission of data and receiving of data has resulted same transmission cost within two particular nodes. In the proposed data gathering technique nodes are formed into two chains (one short chain and one long chain). Here short chain link with end node and leader and long chain link with start node and leader. For chain formation we use greedy algorithm as Power-Efficient Gathering in Sensor Information Systems (PEGASIS).But the basic difference is that in PEGASIS only one chain is formed between sensor nodes and in our energy saving data gathering model (S-PEGASIS/ESG) two chains are formed between sensor nodes. We can say it our model is the improved version of PEGASIS protocol. The operations are same as PEGASIS.

IV. SIMULATION AND RESULTS

A. *Figures and Tables*

Table I: Simulation Parameters for LEACH, TEEN and E-TEEN

Simulation Parameters	Values
Sink	At(50,50)
Simulation area	100*100m /200 *200m
Threshold distance do	75m
Cluster radius	30m
Energy consumed by Electronics circuit to transmit or receive E_{elec}	50nj/bit
Amplifier energy for short distance transmission E_{fs}	10 pj/bit/m^2
Amplifier energy for longer distance transmission E_{mp}	0.0013pj/bit/m^4
Data Aggregation Energy	5nj/bit/signal
Message size	2000bits
Initial Energy E_i	0.5j

Table II: Simulation Parameters for PEGASIS and S-PEGASIS (ESG)

Simulation Parameters	Values
Sink	At(50,175)
Simulation area	100*100m
Threshold distance do	30m
Cluster radius	30m

Energy consumed by Electronics circuit to transmit or receive E_{elec}	**50nj/bit**
Amplifier energy for longer distance transmission E_{mp}	**0.0013pj/bit/m^4**
Data Aggregation Energy	**2nj/bit/signal**
Data packet length	**2000bits**
Control signal size	**100 bits**
Initial Energy E_i	**0.5j**

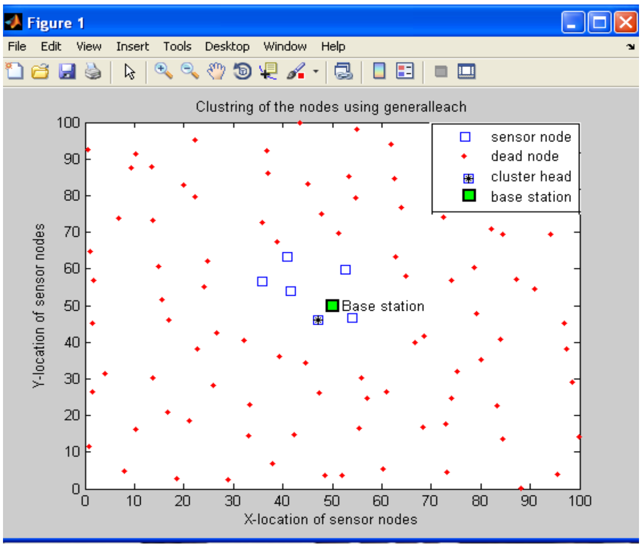

Fig. 1: Simulation graph of Leach (1000 rounds)

The simulation graph for leach shows that here we deployed 100 number of sensor nodes. Out of this only few sensor nodes and one cluster head is alive after 1000 simulation rounds. This graph also describes that as nodes are increased and cluster formation takes place quickly energy depletion rate also increased. Thus most of the sensor nodes become dead nodes after 1000 simulation rounds.

The below graph (Fig 2) clearly shows that TEEN performs better as compared to LEACH. After 1500 rounds 40% nodes are alive. Here network life time increases to some extent. Still we need more energy efficient model for WSN. Here cluster formation time interval is more, reduced data transmission enhance the network performance. Here simulation area also doubles. Network stability improved to a little margin. Still intra-cluster communication complexity is more. As number of node increases complexity also increases quickly, it degrades the network performance. To solve these issues we propose a new energy efficient model which will provide a middle way solution to the problems discussed in LEACH protocol and TEEN protocol.

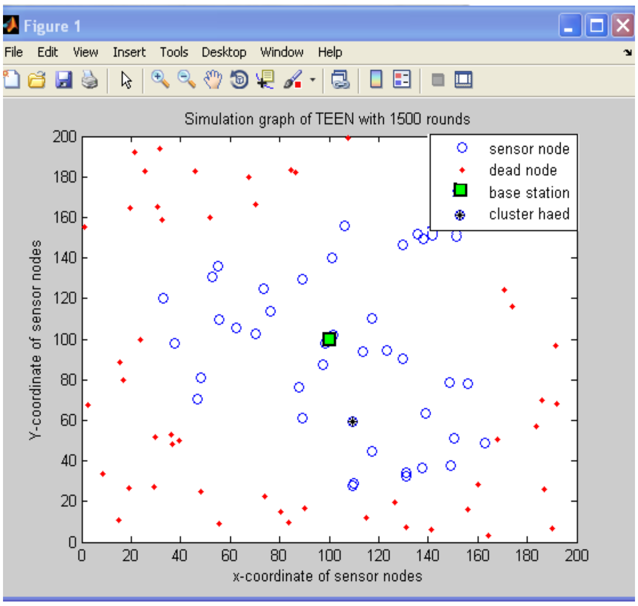

Fig. 2: Simulation graph of TEEN (1500 rounds)

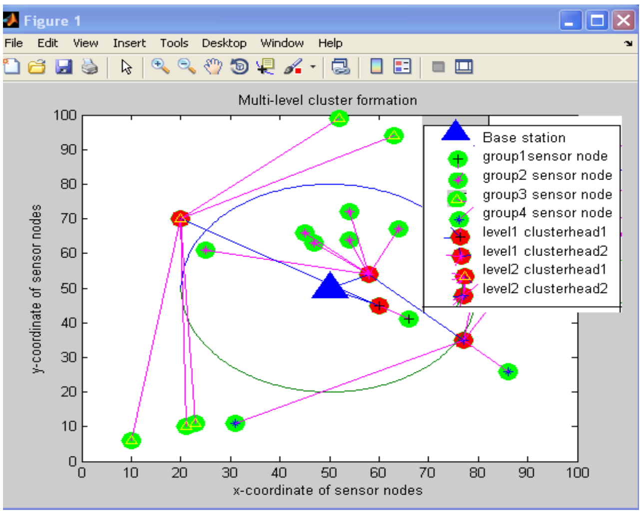

Fig. 3: Multi-level cluster formation in E-TEEN

This simulation graph clearly indicates the multi-level cluster formation takes place in E_TEEN with improved stability. Here number of cluster head in lower and upper level is same, as node numbers are less. But when node number increases we modify the procedure. We take more Assistant cluster heads and less Main cluster heads which gives better result as compared to TEEN. Here we enhance the intra cluster communication and at the same time reduced inter cluster communication with less number of Main cluster heads. As a result of this it improves the network lifetime to a greater extent, which is the goal of our paper. Also it ensures the secured data delivery with more number of Assistant cluster heads. The selection of Assistant cluster head possible with minimum energy consumption as compared to Main cluster head selection as closest neighbor node of Main cluster head and sender node chosen as Assistant cluster head of the particular cluster.

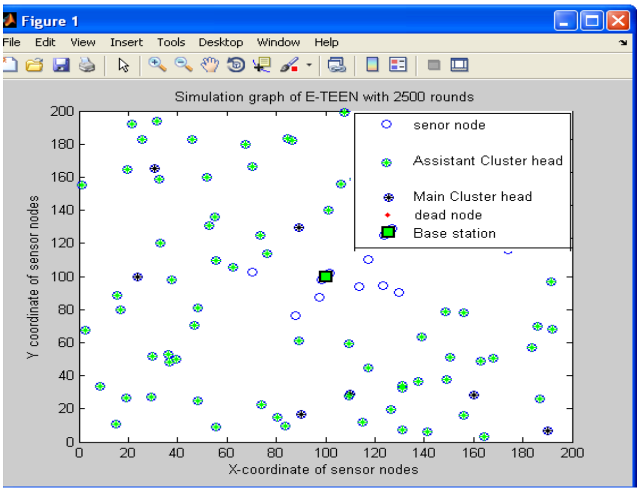

Fig. 4: Simulation graph of E-TEEN (2500 rounds)

The above graph clearly shows that network life time enhanced as simulation round are more here. After 2500 rounds only one node is dying. 99 percentage nodes are alive. It shows that our model performs better than existing models. It improves the network stability. It reduces the energy consumption in data transmission. It reduces the communication complexity.

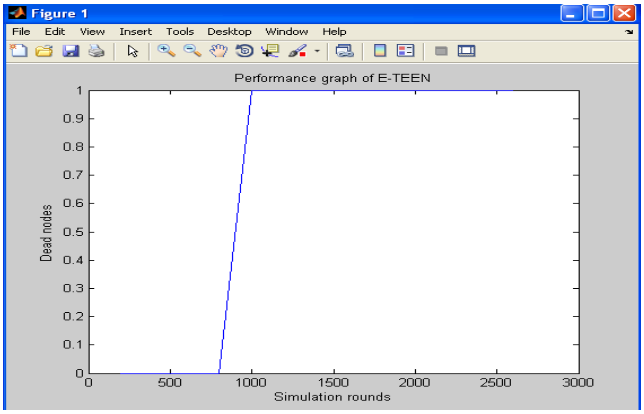

Fig. 5: Performance graph of E-TEEN

The simulation graphs presented in Fig 6, Fig 7 and Fig 8 shows the data chain formation in PEGASIS and S-PEGASIS. These graphs clearly indicate that single and double data chain formations in PEGASIS and S-PEGASIS respectively. The working procedure of PEGASIS and S-PEGASIS are same. But S-PEGASIS performs better than the PEGASIS in terms of energy consumption and rate of data transmission in context of data transmission delay. In PEGASIS delay is more than S-PEGASIS. The performance level of S-PEGASIS is better than PEGASIS. So S-PEGASIS proves that it provides more energy efficient and ensures less energy consumption as it works with two chain formation process. Thus it gives better result than the existing model (PEGASIS).

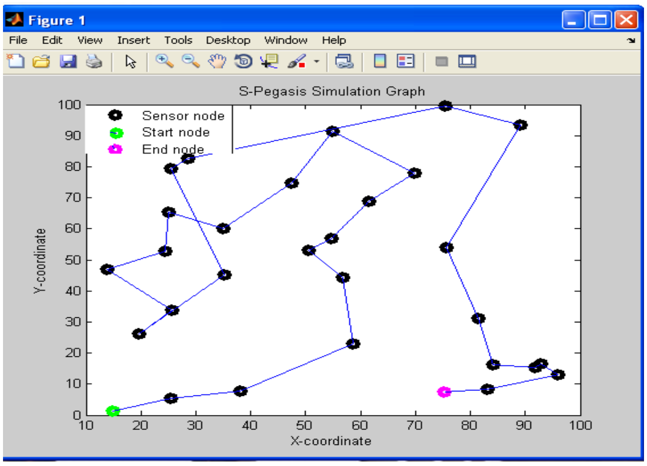

Fig. 6: Simulation graph of PEGASIS

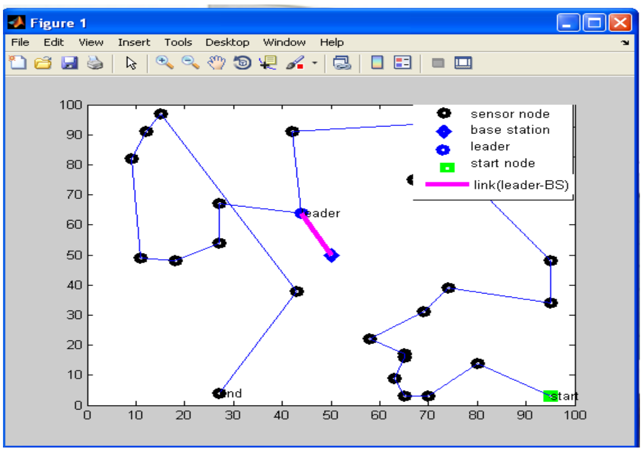

Fig. 7: Simulation graph of S-PEGASIS (without numbering of nodes).

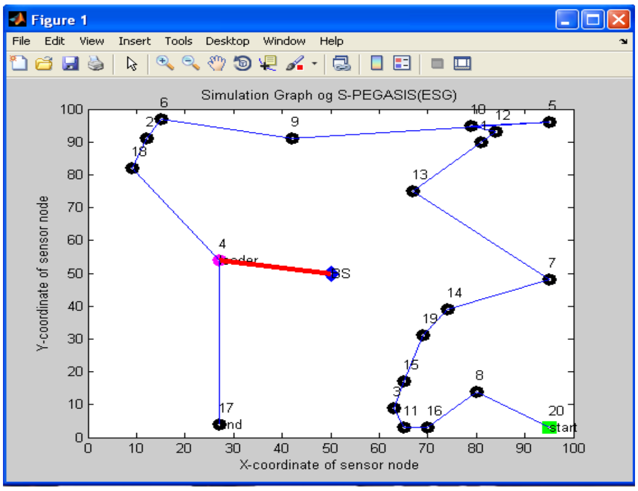

Fig. 8: Simulation graph of S-PEGASIS (with numbering of nodes).

V. CONCLUSION

As we know energy consumption and prolonging life time of the network are two important issues in the wireless sensor network. The existing protocols try to solve these two issues to some extent but with some drawbacks like, if we talk about leach, its performance degrades quickly as the node number increases; also energy depletion takes place more quickly.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Then in the case of TEEN it suits good to time critical applications with extra overhead of multilevel cluster head selection at the same time network life time increases than LEACH, still improvisation required to make it more efficient. Therefore our proposed model (E-TEEN) performs better as comparison to LEACH, TEEN, PEGASIS and S-PEGASIS. If we use S-PEGASIS (ESG) technique along with E-TEEN approach, we got more improving in intra cluster communication and inter cluster communication. It reflects in the network throughput. It increases the life time of the network to a greater extent and at the same time it also decreases the rate of energy depletion with less transmission. Thus the number of dead node reduced to a significant level.

ACKNOWLEDGMENT

We wish to thank our parents for their good upbringing which help us to do good works in every field of life. The author of this paper wishes to thank to our director prof. sangram mudali and dean dr.ajit kumar panda for their kind support and inspirational words. at last but not least we also very thankful to our hod associate professor debananda kanhar for giving his continuous encouragement to do our research work efficiently.

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AUTHORS PROFILE

Nibedita Priyadarshini Mohapatra, Computer Science and engineering dept., National Institute of Science and Technology, Berhampur, India. Mtech from National Institute of Science and technology.Berhampur. My area of research includes Wireless sensor network and Computer Networks. Publish two research papers in international journals and one paper presented in ICINT 2012 and one paper presented in national conference in Coimbatore 2012

Adyasa Mohanthy, BTEch final yearComputer Science and engineering, National Institute of Science and Technology, Berhampur, India.761008.

Prajna Parimita Pradhan, BTEch final yearComputer Science and engineering, National Institute of Science and Technology, Berhampur, India.761008.

Sasmita Kumari Sahu, BTEch final yearComputer Science and engineering, National Institute of Science and Technology, Berhampur, India.761008.