International Journal of Research in Advent Technology, Vol.7, No.5S, May 2019
E-ISSN: 2321-9637
Available online at www.ijrat.org

Energy- Efficient Hierarchical Routing Protocols in Wireless Sensor Networks

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Abstract— A WSN (Wireless Sensor Network) is a special network (n/w) which is made by number of sensor nodes and one base station. Number of small sensor nodes sense the conditions and then inform the base station about it by sending the information about the conditions. These networks are used in various public and military applications. In the WSN, sensor nodes continuously send and receive the data from the sink node; due to the limitation of energy resource their energy reduces continuously in transmitting and receiving data. Due to this life time of these nodes and whole network also reduces. So high efficiency is the most important factor in WSN. In this paper, some energy efficient hierarchical routing protocols are discussed at large and a network topology is created in MATLAB scenario for analyzing energy efficiency of one of the routing protocol named as PEGASIS routing protocol.
Keywords—WSNs, Hierarchical Protocols, PEGASIS routing protocol

1. INTRODUCTION

WSN is most commonly used in daily life because of advancement in the wireless communication and MEMS systems. Wireless sensor network is made up of group of small and low cost sensors. All the sensors in the WSNs are able to communicate with each other. In the WSNs, sensor nodes continuously monitors the environmental conditions and according to the conditions generate the signals/data, after processing the data, this data is transmitted to the base station [1]. One or more nodes act as as sink node which is able of communicating the data with the client through the gateway nodes or some time even the data is communicated directly. The most important restriction in WSN is energy efficiency and the Hierarchical routing protocols are able for beat that constraint [2] . LEACH, PEGASIS, TEEN, APTEEN and SOP are some examples of the hierarchical routing protocols.

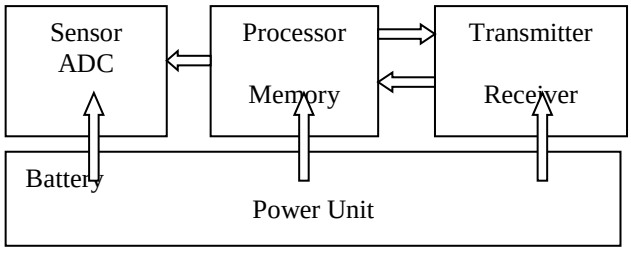

Figure: 1 A wireless sensor network [Kyung Tae Kim, et.al(2010)]

Sensor nodes are operated by the battery devices, the main issues are to decrease the power usage of the Nodes for enhancing or increasing the lifespan of the n/w, thereby increasing the time duration of alive nodes in the network, which contribute in data transmission.

2. HIERARCHICAL ROUTING PROTOCOLS IN WSNs

Hierarchical routing protocol is a type of routing protocols that is helpful for enhancing the power saving capabilities in the WSNs. In this for making the cluster, a various sensor nodes are grouped together. A head is assigned to each cluster known as cluster head (CH). Figure shows the cluster network [3].

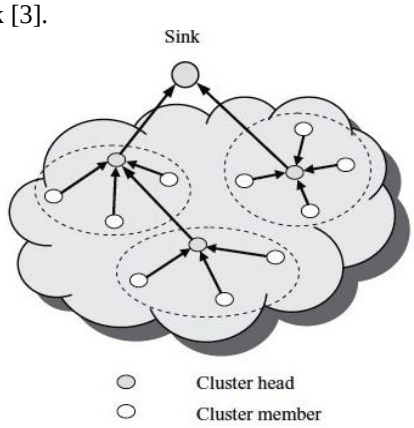

Figure 2 Single-hop Clustering Architecture [Nagarajan. M, et.al (2012)]

The main duty of the CH is gather the information from the Sensor Nodes and after the aggregation of the data, this data is send to the Base Station(BS). Due the data aggregation, there is large saving in the energy dissipation of the nodes. In order to enhancing the life time of these n/w, there is need to reduce energy consumption. The need of clustering based routing is to reducing the traffic packets on the destination. Several advantages of the cluster based approach are:

- **Manageable Network size:** In the clustering approach, sensor nodes are grouped together and form the cluster of different sizes. Sensor nodes are not sending the information directly to BS, transmission and reception of data is done through the cluster head node. So, by this approach managed the network size very easily.

- **Balanced Load Distribution:** Due to the formation of clusters, the work is also divided between all clusters.
- **Data Aggregation:** In this approach, data is transmit and receive step by step with removing the redundancy and aggregation also done on the cluster head, so by this a lot of bandwidth is also saved.
- **Stable Network Lifetime:** Due to the cluster formation and balanced load distribution, the chance of node's death is reduced as compared to the other the other routing approach. Due to this, Network becomes stable for the more time than the others.
- **Collision Prevention:** The base station is only receiving and transmitting the data to the CH or through the gateway node. All the Sensor Nodes send their information to their personal CHs and they can't talk with the BS in a straight line. So this reduces the collision of data on the sink node.

3. PEGASIS

We can expand the PEGASIS as Power Efficient Gathering in Sensor Information Systems. PEGASIS is the Chain-Based Hierarchical Routing Protocol. All the Sensor Nodes in the network are set in the shape of the chain. The chain is formed in the greedy way [6]. In the PEGASIS, there are global knowledge of the all the network on the all the nodes. The chain creation is start at the last node in the network. Then lattermost node is searched to their nearest node and this neighbor node is become the next node in the chain and these steps are done continue till the first to last nodes. The last node in the chain n/w is called the Sink Node and the node earlier than the last node is act as the chain leader. The process of the data collection and aggregation is done on the leader node. For the time varying and dynamic networks, PEGASIS is not so relevant. Due to the large size of the chain n/w, there is some delay in the transmission and reception of the data.

4. PEGASIS PROTOCOL's ALGORITHM

PEGASIS's algorithm is depend upon the LEACH Routing Protocol. In the PEGASIS, the chief function is to build the chain among the all Sensor Nodes for sensing the information and send it to the neighbor node which is closest to it. The data is transferred from node to node. The redundancy of the data is removed from node to node and after that merged data is send to the node leader which is also called the CH. CH transmit that merged data to the BS. Data is transmitted from node by node in the steps so the power consumed by the all the node is decreased.

Some advantages of the PEGASIS Algorithm are:

- Every node transmitted the data to their neighbor node and data fusion takes place in regulation at every node.
- Nodes are connected to each other so distance have been minimized.
- Cluster head changes after every turns and each node become the head in the chain on their turn, so it consumes less energy/power.

Few disadvantages of the PEGASIS Algorithm are:

- If the length of the chain is so long then there is some delay in the data transmission.
- Due to the greedy approach, the possibility of the chain's size longer is maximum.
- The cluster head method isn't capable for the load balance.

5. SIMULATION RESULT

A. Simulation Set up:

- A WSN network set-up is established in MATLAb platform with below mentioned parameters:
  Network size: 100*100
  Node number: 100
  Number of rounds: 500
  Initial Energy of nodes: 1.0

B. Performance Analysis parameters:

- Input Parameters:
  1. Number of rounds: Rounds are defined as each Node i is a cluster head over the no. of initial energy.
- O/P Parameters:
  1. No. of Dead nodes: When the energy of the dead nodes are reduced to a fixed value or become zero and when the nodes aren't capable to send/receive the information is called the dead nodes.
  2. No. of Alive nodes: Those nodes which have a sufficient value of energy and able to communicate is called the Alive nodes.
  3. Normalized Average Energy per Round: The energy remaining after the every round is called the Normalized Average Energy.

Simulation graphs:

In this section, the result have been computed by carrying out simulations in matlab.

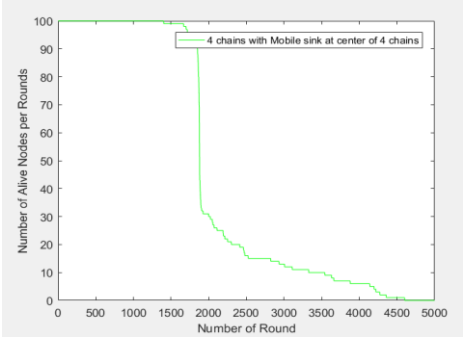

Figure. 3 No. of Alive nodes Vs No. of rounds

The above Figure shows the simulated graph between the no. of nodes and no. of rounds. As the graph shows that as the no. of rounds increases, no. of alive nodes decreases and the lifetime of the network also decreases.

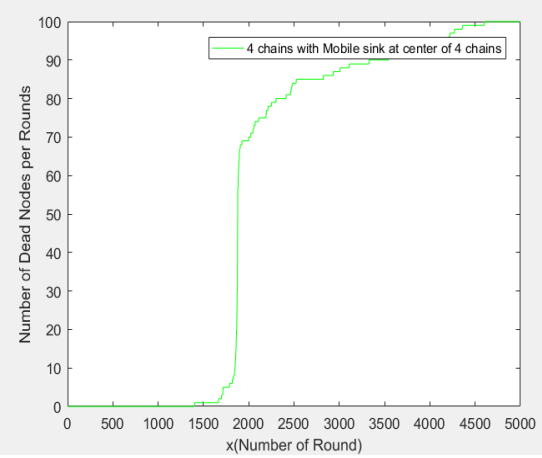

Figure. 4 No. of dead nodes Vs No. of rounds

As the graph shows when the number of rounds increases then the number of dead nodes also increases. With the increment of dead nodes, lifetime of the network also decreases.

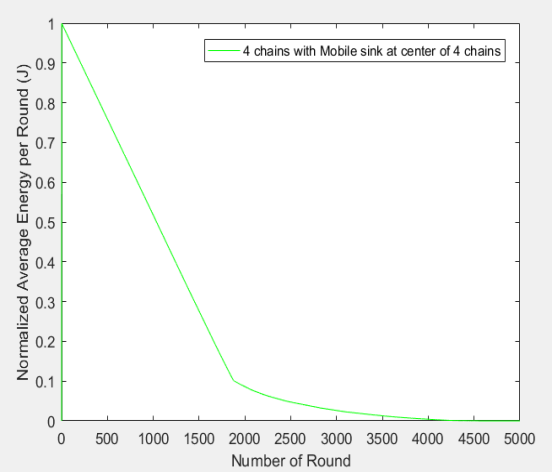

Figure. 5 Normalized Average Energy Per Round Vs No. of rounds

The above graph shows that the average energy of the nodes are decreasing continuously with the no. of rounds increases. When the value of this energy is become zero, then all the alive nodes becomes the dead nodes. Because the energy of nodes is decreasing continuously per round, the ability of the nodes for communication also decreasing and after the some rounds energy will become zero and alive node is converted into the dead nodes.

6. CONCLUSION

In this paper a brief overview of hierarchical protocols is presented and Analysis of the performance of one of such protocols namely PEGASIS routing protocol is shown in this paper. This research work elaborate that how PEGASIS work or perform in terms of energy efficiency and network lifetime, by considering number of dead and alive nodes with each iterated round. It can be concluded that PEGASIS behave appreciably well in terms of have the energy efficiency in WSN networks.

REFERENCES

[1] S.Gobriel, " Energy-Efficient design of ad-hoc and sensor networks", M.Sc University of Pittsburgh, 2008.

[2] T. Zia and A. Zomaya, " Security Issues in Wireless sensor networks", in preceedings of the international conference of system and networks communication, 2006.

[3] MaciejNikodem and BartoszWojciechowski, "Upper Bounds on Network Lifetime for Clustered Wireless Sensor Networks", 4th IFPI International Conference, IEEE, (2011), 1-6.

[4] Chi-Tsun Cheng, Chi K. Tse, and Francis C. M. Lau, "A Delay- Aware Data Collection Network Structure for Wireless Sensor Networks", IEEE Sensor Journals, (2011), Vol. 11, No. 2., 699-710.

[5] Zijan Wang, and EyuphanBulut, "Energy Efficient Collision Aware Multipath Routing for Wireless Sensor Networks", International Conference on Communications, IEEE, (2009), 1-5.

[6] Stephanie Lmdsey and CauligiS.Raghavendra , "PEGASIS:Power –Efficient Gathering in Sensor Information Systems", IEEE 2002.

[7] DeepakGanesan, Ramesh Govidan, Scott Shenker, and Deborah Estrin, "Highly-resilient, Energy-Efficient Multipath Routing in Wireless Sensors Networks" MobiHOC (2001), 251-254.

[8] Kyung Tae kim, Chang HoonLyu, Sungsoo moon and Hee Yong Youn, "Tree-Based Clustering (TBC) for Energy Efficient Wireless Sensor Networks", 24th International Conference, IEEE, (2010), 680-685.

[9] F.J. Atero, J.J. Vinagre, E. Morgado, and M.R. Wilby, "A Low Energy and Adaptive Architecture for Efficient Routing and Robust Mobility Management in Wireless Sensor Networks", 31st International Conference on Dirtributed Computing Systems Workshops, IEEE, (2011), 172-181.

[10] Chengfa Li, Mao Ye, and Jie Wu, "An Energy-Efficient Unequal Clustering Mechanism for Wireless Sensor Networks", International Conference, IEEE, (2005), 535-540.

[11] Jalal Habibi, Amir G. Aghdam and Ali Ghrayeb, " Framework for Evaluating the Best Achievable Performance by Distributed Lifetime-efficient Routing Schemes in Wireless Sensor Networks", IEEE Transactions on Wireless Communication, 2015.

[12] Nagarajan. M, and Dr. S. Karthikeyan, "A New Approach to Increase the Life Time and Efficiency of Wireless Sensor Network", International Conference, IEEE, (2012), 231-235

[13] Shou Shi, Xinning Liu and XuemaiGu "An Energy-Efficiency Optimized LEACH-C for Wireless Sensor Networks", Communications and Networking in China (CHINACOM), 7th International ICST Conference on 2012, IEEE, 87-492.

[14] Mao Ye, Chenga Li, Guihai Chen and Jie Wu, "EECS: An Energy Clustering Scheme in Wireless Sensor Networks", 24th IEEE Conference, (2005), 535-540.

[15] Hwa Young Lim, Sung Soo Kim, Hyun Jun Yeo, SeungWoon Kim, and KwangSeonAhn, "Maximum Energy Routing Protocol based on Strong Head in

Wireless Sensor Networks", Sixth International Conference, IEEE, (2007), 414-419.

[16] Bilal Abu Bakr, and LeszekLilie, "A Quantitative Comparison of Energy Consumption and WSN Lifetime for LEACH and LEACH-SM",2011 31st International Conference on Distributed Computing Systems Workshops, IEEE, (2011), 182-191.

[17] G. L. Wang, G. H. Cao, T. L. Porta, and W. S. Zhang, "Sensor relocation in mobile sensor networks," Annual Joint Conference of the IEEE Computer and Communications Societies, Proceedings IEEE, March 2005, 2302–2312.

[18] SeyyitAlperSert, HakanBagci, Adnan Yazici," MOFCA- Multi-Objective Fuzzy Clustering Algorithm for wireless sensor networks", Applied Soft computing , 2015, pp. 151-165

[19] Saman Siavoshi1, Yousef S. Kavian, Hamid Sharif, "Load-balanced energy efficient clustering protocol for wireless sensor networks", IET Wirel. Sens. Syst., 2016, Vol. 6, Iss. 3, pp. 67–73

[20] Rashmi M. Kittali, Mahabaleshwar S. K, "Congestion Controlled Adaptive Routing in Wireless Sensor Network", International conference on Signal Processing, Communication, Power and Embedded System (SCOPES)-2016, vol. 6, pp. 1528-1532, 2016.