Review on State-Of-The-Art of PEGASIS Protocol in WSNS

Neeraj[1], Varsha Sahni[2]
[1] M.TECH Student, [2] Assistant Professor
Department of Computer Science & Engineering
CT Institute of Engineering and Management Technology
Jalandhar, Punjab, India
Neerajsumman92@gmail.com, Barkhabright@gmail.com

Abstract: Wireless Sensor Networks (WSNs) have been widely considered as one of the most important technologies for the twenty first century. Due to the advancements in microelectronic mechanical systems (MEMS) and wireless communication technologies, it has become possible to deploy tiny, cheap, and smart sensors in any physical area. The routing is one of the dominant factors which decide the fate of limited battery resources in WSNs. In this paper, a review on the state-of-the-art on PEGASIS (Power efficient Gathering in Sensor Information System) protocol has been presented. PEGASIS is highly significant in small areas applications, some of the variants of PEGASIS protocol has been studied in this paper. After studying various protocols, it has been found that Chain Based Cluster Cooperative Protocol (CBCCP) has tremendously improved network lifetime by incorporating cluster based concept in routing. Although it has outperformed various routing protocols but it still leave a great margin of improvement in the inter cluster communication. This paper basically focuses on reflecting the significance of chain based protocols in WSNs.

Keywords: *PEGASIS (Power efficient Gathering in Sensor Information System), Hierarchical Routing, Chain Based Cluster Cooperative Protocol (CBCCP), Wireless Sensor Network, Chain Based protocols, Network Lifetime.*

*****

I. Introduction

Historically, the concept of WSNs was originally introduced three decades ago. At that time, this concept was more a vision than a technology that could widely be exploited because of the state-of-the-art in sensor, computer, and wireless communication technologies. As a result, its application was mostly limited to large military systems. However, recent technological advances in MEMS, wirelesscommunication, and low - cost manufacturing technologies have enabled the development of tiny, cheap, and smart sensors with sensing, processing, and communications capabilities, which has therefore stimulated the development of sensor networks and their applications.

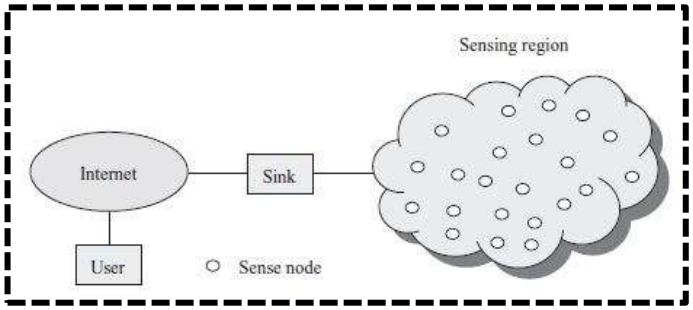

Fig.1 Architecture of Wireless Sensor Network

The architecture of WSN is shown in Fig.1. It is shown that data collected from the sensing region is forwarded to the sink through the nodes and thereafter it is forwarded to the user via internet [1]. The sensor nodes are wirelessly connected to each other. It's the routing which decides which node has to pass data to the other node in a particular determined path. So, routing becomes an essential element for energy saving and making the network operating for longer period of time [2-3]. Routing is basically of three types as shown in Fig.2. PEGASIS [4] is covered under hierarchical routing as different levels are formed through which data is forwarded to the Base Station.

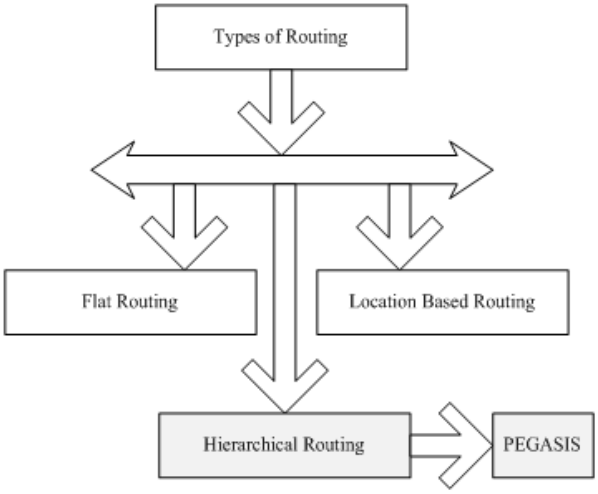

Fig.2 Types of Routing in WSN

1.1 Design Constraints for Routing in Wireless Sensor Networks

Due to the reduced computing, radio and battery resources of sensors, routing protocols in wireless sensor networks are expected to fulfill the following requirements:

a. Autonomy: The assumption of a dedicated unit that controls the radio and routing resources does not stand in wireless sensor networks as it could be an easy point of attack. Since there will not be any centralized entity to make the routing decision, the routing procedures are transferred to the network nodes.
b. Energy Efficiency: Routing protocols should prolong network lifetime while maintaining a good grade of connectivity to allow the communication between nodes. It is important to note that the battery replacement in the sensors is infeasible since most of the sensors are randomly placed. Under some circumstances, the sensors are not even reachable. For instance, in wireless underground sensor networks, some devices are buried to make them able to sense the soil.
c. Scalability: Wireless sensor networks are composed of hundreds of nodes so routing protocols should work with this amount of nodes.
d. Resilience: Sensors may unpredictably stop operating due to environmental reasons or to the battery consumption. Routing protocols should cope with this eventuality so when a current-in-use node fails, an alternative route could be discovered.
e. Device Heterogeneity: Although most of the civil applications of wireless sensor network rely on homogenous nodes, the introduction of different kinds of sensors could report significant benefits. The use of nodes with different processors, transceivers, power units or sensing components may improve the characteristics of the network.

II. PEGASIS Protocol

It is an improved version of LEACH [5]. Rather thanforming clusters, it is based on forming chains of sensor nodes. One nodeis mainly responsible for routing the aggregated information to the sink. Everynode aggregates the collected informationwith its own information, and then passes the aggregated data to the next ring. The key idea in using PEGASIS is that it uses all the nodes to transmit or receive with its closest neighbor nodes. This is achieved by the formation of a chain as shown in the Figure 3 below. All the nodes which collect the data fuse it with the data received by the neighbor node and transmit it to the next-nearest neighbor. In this way all the nodes receive and fuse their data, and pass it to the next neighbor in a chain format till they all reach the base station. Every node in the network takes turns as a leader of the chain and the one responsible to transmit the whole fused data collected by the chain of nodes to the base station.

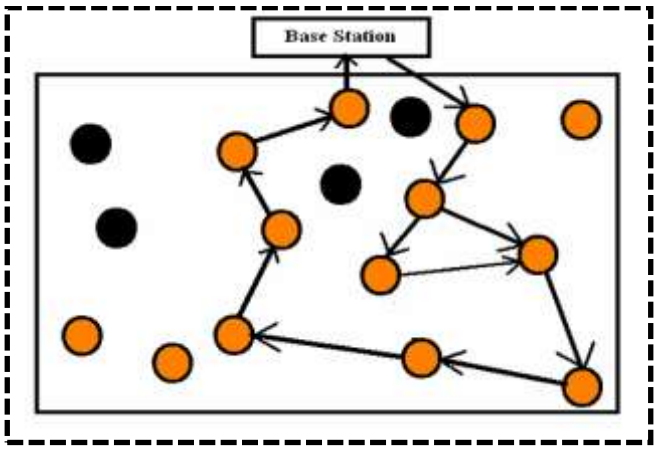

Fig. 3 PEGASIS Chain Based Protocol

The significant features of this protocol are:

1) It is an improved version of LEACH.
2) This protocol is in position to outgo LEACH for different or various network sizes and topologies cluster formation in LEACH, and reduces the number or quantity of data information transmission volume through the chain of information aggregation.
3) The energy load is distributed uniformly within the network. To prevent the subsequent early death of sensor node, all sensor nodes act as leader successively.

There are few disadvantages of this protocol such as:

1) PEGASIS assumes that each sensor node is capable of communicating with the BS directly. In practical cases, sensor nodes use multi-hop communication to reach the BS.
2) PEGASIS assumes that all sensor nodes have the equal level of energy and are likely to die at the same time.
3) PEGASIS introduces excessive delay for distant nodes on the chain.
4) The single leader can become a bottleneck for Application Field.
5) PEGASIS is greedy chain protocol which leads to lessen the overhead caused due to many cluster heads.
6) When a sensor node dies, chain is reconstructed to bypass the dead node.
7) Head node receives all the aggregated data and sends to the base station.
8) This protocol is most suited for surveillance application such as motion detection and knowing its characteristics.

III. PEGASISstate-of-the-art development

PEGASIS has given a breakthrough in the technological advancements by providing a flexibility in which this protocol can be implemented. There are following variants

of PEGASIS protocols which use chain based method for the network lifetime improvement.

YU Yong-chang and WEI Gang [6], proposed an algorithm to build chain by adopting a threshold distance to decrease the formation of long link. It selects the leader by considering both the residual energy of nodes and the distance between node and base station and adjusts the reselection frequency of leader according to remaining nodes in the network. The results show that the proposed method has better performance than PEGASIS.

Hasan Al-Hasan, et al. [7], proposed a hierarchical routing protocol for stationary wireless sensor networks. The proposed method used a new chain construction algorithm and chain leader election method that plays a very critical role in the energy saving. The results show that this protocol solved the main problems in PEGASIS and also increased both the lifetime and the throughput of the wireless sensor network.

Ravinder Kumar and Dr. P. S. Mundra [8], proposed an efficient hierarchical chain based routing protocol which was not suitable for large sensor networks with power and time constraints. He used the concept of Beam Star topology to divide the whole sensing field into a number of smaller areas, so that it can create multiple shorter chains to reduce the data propagation delay and redundant transmission path, thus significantly improved the data delivery of the packets as compare to the Chiron and routing was done between cluster head (CH) to cluster head and network is divided into two parts so that the chain leader of the same covering angle will transmits the data to the next chain leader but in the same covering angle in the sequential manner. Since the number of sensor elements were reduced so sensing time and power dissipation reduced and data delivery was improved.

Wang Linping et al. in [9] have proposed an enhanced algorithm of PEGASIS which balances the load on each node and improves the network lifetime. In PEGASIS, there is only one cluster head in each chain whereas in PDCH i.e. PEGASIS Double Cluster Head, there are double cluster heads which avoids the long chain problem existing in PEGASIS. Simulations have been performed to compute the rounds of communication and the percentage of dead nodes in each round of communication. In the future work, PDCH can perform better as compared to EEPB and PEGASIS for raising the system distributed and parallel processing.

Zibouda et al. in [10], has proposed a new protocol i.e. PEGASIS-MH in order to minimize the consumption of energy and to enhance the life time of sensor network. PEGASIS-MH protocol is developed for multi-hopping within the sensing field. In case of single hop, cluster heads that are located away from Base station are prone to depletion of energy as they utilize strong signals in order to reach BS. Therefore, multi-hop routing concept is utilized between the cluster heads to overcome the drawback which was there in single hop routing concept. The simulation has been done using NS-2 simulator and the results show that the PEGASIS-MH is far better as compared to other protocols such as LEACH, PEGASIS and Hierarchical PEGASIS in terms of lifetime and energy efficiency. For QoS, fault tolerance integration will be the future work.

Vibha Nehra and Ajay K. Sharma [11], [2013] proposed an algorithm by using average distance among the sensor nodes as the criteria for chaining and thereby providing better performance in terms of energy dissipation and amount of information sent to BS. The chaining speed of proposed method is faster than PEGASIS. This algorithm avoids the formation of LL and provides a stable and balanced lifetime to the network. The s results proved that purposed algorithm outperforms PEGASIS by achieving higher energy efficiency extending lifetime of network.

Madhuri Gupta [12] [2014] has proposed a variant approach for chain formation in the wireless sensor network which is a modified version of chain based PEGASIS protocol. In this paper, the process of forming chain is modified in order to obtain a chain with multiple degree nodes. This approach considered degree of connectivity and remaining energy of each node. It achieved the target of the improvement in energy consumption and prolongs the lifetime of the network. Simulations results achieved 50% better results in average energy consumption by the network under defined scenario. It reduced the node death rate as energy dissipation get reduced by 50% for the defined specification

BhavnaPatel [13] et al. proposed a Multi-chain PEGASIS routing approach that increase lifetime of sensor networks in terms of total number of deadnodes per numbers of rounds, total number of alive nodes per numbers of rounds and Total network energy per number of rounds. In this proposed scheme the longer chains have been replaced with the smaller multi chains which reduce the load on the chain leader. Multi-chain PEGASIS achieves balance of energy dissipation among the chains unlike of a single chain in PEGASIS. Multi-chain PEGASIS proved performance by using simulation on MATLAB R2011b. This proposed approach gives better performance than existing PEGASIS.

IV. ChainBased Cluster Cooperative Protocol (CBCCP) [14]

A new protocol is presented in this paper that addresses someof the major requirements imposed by wireless sensor networksuch as energy-efficient connectionless communication combinedwith speed, fault tolerant, load balancing and scalability. Balancedenergy consumption is achieved by transmission of data to theintermediate nodes at all the levels (level means subareas or clusters). Another remarkable property is that, number of nodes canbe

increased without any additional cost, as all the nodes canstill send data with the help of relay nodes (within cluster) andcluster coordinators (inter-cluster communication). Simulationresults demonstrate that CBCCP not only prolongs network lifetimebut also speed up data communication. The clusters it producesexhibit several appealing characteristics like they are load balanced, fault tolerant and scalable.This protocol is developed for the applications where controlroom cannot be situated in the center like border surveillance applications; we are further working on the conditions where feasibilityof control room is possible in the center.

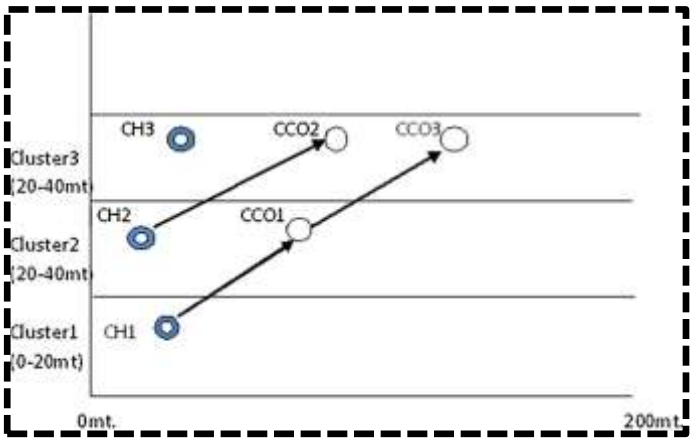

Fig. 4CBCCP Protocol

4.1 Pitfalls in CBCCP

Although the protocol CBCCP has improved the performance of WSN by great margin but there are few pitfalls of CBCCP which are listed below.

1. It has random topology for inter cluster communication. Due to which the Cluster Coordinator is randomly selected which is to be used as to forward the data.
2. The selection of Cluster Heads and Cluster Coordinators can be further optimized by selecting various parameters like Energy, Distance and Node density. But CBCCP doesn't in consider any optimization its approach.
3. The network will become complex if the mobility is introduced in the network.

V. Performance Comparison of hierarchical Protocols

The performance comparison of hierarchical protocols varies from the topology to topology. It is observed that PEGASIS variants have different performance on the basis of the way they connect the chain.

VI. Conclusion

Wireless Sensor Network has been significant in observing different physical phenomena. Routing has been the essential element in handling the limited battery issues. Here in this paper, PEGASIS protocol which is a hierarchical protocol has been focused for exploring the state of the art of technological advancements. CBCCP protocol has outperformed various clustering and chain based routing protocols by merging the clustering and chain based concepts. The pitfalls of CBCCP has been discussed which give a research scope for the researchers working for the advancements in PEGASIS protocol.

References

[1] Akyildiz, I.F.,W. Su, Y. Sankarasubramaniam, E. Cayirci, "A Survey on Sensor Networks", IEEE Communications Magazine, Vol.40, pp.102-114, August 2002.

[2] Jamal N, Al-Karaki, Ahmed E Kamal, "Routing techniques in wireless sensor networks: a survey," IEEE journal on Wireless Communication, Vol.11, No.6, pp.6-28, 2004.

[3] Seema Bandyopadhyay and Edward J., Coyle, "An Energy Efficient Hierarchical Clustering Algorithm for Wireless Sensor Networks". IEEE Conference INFOCOM, pp. 189-200, 2003.

[4] Stephanie Lindsey and Cauligi S. Raghavendra," PEGASIS: Power-Efficient Gathering in Sensor Information Systems," IEEE Aerospace Conference Proceeding, pp.1125-1130, 2002.

[5] Wendi B. Heinzelman, Anantha P. Chandrakasan, Hari Balakrishnan, "An Application-Specific Protocol Architecture for Wireless Microsensor Networks", Proceedings of IEEE Transactions on Wireless Communications, Vol.1, No.4, October 2002.

[6] YU Yong-chang, WEI Gang, "An Improved PEGASIS Algorithm in Wireless Sensor Network," Acta Electronica Sinica, vol.36, pp.1309-1313, July 2008.

[7] Hasan Al-Hasan, Mohammad Qatawneh, AzzamSleit, WesamAlmobaideen," EAPHRN: Energy-Aware PEGASIS-Based Hierarchal Routing Protocol for Wireless Sensor Networks," Journal of American Science, pp.753-758 ,2011.

[8] Ravinder Kumar, P. S. Mundra," Improved Data Gathering Protocol for WSN," International Journal of Electronics and Computer Science Engineering, vol.1, no.3, pp.1208-1213, 2012.

[9] Wang Linping, Cai Zhen, "Improved Algorithm of PEGASIS protocol introducing double cluster heads in Wireless Sensor Network", Proceedings of IEEE International Conference on Computer, Mechatronics, Control and Electronic Engineering, pp. 148-151, 2010.

[10] ZiboudaAliouat, MakhloufAliouat, "Effective Energy Management in Routing Protocol for Wireless Sensor Networks", IEEE International Conference on New Technologies, Mobility and Security, pp.1-5, 2012.

[11] Vibha Nehra, Ajay Kumar Sharma, "PEGASIS-E: Power Efficient Gathering in Sensor Information System Extended," Global Journal of Computer Science and Technology, Vol.13, No.15, pp.1-5, 2013.

[12] Madhuri Gupta, LaxmiSaraswat, "Energy Aware Data Collection in Wireless Sensor Network Using Chain Based

PEGASIS," IEEE International Conference on Recent Advances and Innovations in Engineering (ICRAIE-2014), pp.1-5, May 09-11, 2014.

[13] BhavnaPatel,JayeshMunjani, "Chain based Routing Protocol for Wireless Sensor Network," International Journal of Computer Applications, Vol.134, No.4, 2016.

[14] Shalli Rani, Jyoteesh Malhotra, Rajneesh Talwar, "Energy efficient chain based cooperative routing protocol for WSN," Applied Soft Computing, Vol. 35, pp.386-397, 2015.