ISSN:0975-9646

Hierarchical Sensor Network Routing: A Survey

Priyanka Pareek

Department of computer science,
Acropolis Institute of Technology and Research
Indore bypass road Manglia square

Abstract—**Wireless sensor network are becomes more popular now in these days due to their adaptability in indoor as well as outdoor communication systems. In this presented paper provides the detailed description about the WSN network and their relative application, in addition of that this paper provide the previously made efforts on routing in WSN networks. Routing is working as backbone for any communication network thus data in a network travels on the basis of routing guidelines, this paper provide the information of routing techniques that are supportable with WSN network and also we provide the future proposed work under optimization of routing path discovery.**

Keywords*—*Routing, Wireless Sensor Networks (WSN), Route Optimization, Route discovery, Cluster Heads.

I. INTRODUCTION

Wireless communications is, by any measure, the fastest growing division of the communications industry. As such, it has captured the attention of the media and the imagination of the public. Cellular phones have experienced a large growth over the past few years, and this growth continues unabated worldwide, with more than a billion worldwide cell phone users projected in the near future. Indeed, cellular phones have become a critical business tool and part of everyday life in most developed countries, and are rapidly supplanting antiquated wireless systems in many developing countries. In addition, wireless local area networks are currently poised to supplement or replace wired networks in many businesses and campuses. Many new applications, including wireless sensor networks, automated highways and factories, smart homes and appliances, and remote telemedicine, are emerging from research ideas to concrete systems. The explosive growth of wireless systems coupled with the proliferation of laptop and palmtop computers indicate a bright future for wireless networks, both as stand-alone systems and as part of the larger networking infrastructure. However, many technical challenges remain in designing robust wireless networks that deliver the performance necessary to support emerging applications.[1]

A wireless sensor network (WSN) involves spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.[2] Wireless sensor networks satisfy these requirements. Desirable functions for sensor nodes include: ease of installation, self-identification, self-diagnosis, reliability, time awareness for coordination with other nodes, some software functions and DSP, and standard control protocols and network interfaces. [3] A wireless sensor network is a large collection of sensor nodes with limited power supply and constrained computational capability. Due to the restricted communication range and high density of sensor nodes, packet forwarding in sensor networks is usually performed through multi-hop data transmission. Therefore, routing in wireless sensor networks has been considered an important field of research over the past decade.

In this section we discuss general facts about the wireless sensor networks, in the next section we discuss the different routing strategy and different optimisation techniques, in next to next section we have discussed hierarchical routing, in the last section we discuss various energy optimization routing algorithms.

II. ROUTING PROTOCOLS IN WSNS

Routing protocols specifies the manner in which nodes and routers communicate and disseminate information. There are various issues that should be considered for routing in WSNs. Some of the issues are Energy Efficiency, Ad-hoc Deployment, and Prone to failures etc.. Since the WSNs are dynamic, the main task in routing is identification of nodes. Once the nodes are identified the routing protocols are responsible for construction and maintenance of the routes between nodes. There are several routing algorithms which are specific for some applications.[4] Routing in WSNs can be categorized as flat-based routing, location-based routing, and hierarchical –based routing. [5] [6] [4] [7] This classification is done on the basis of network architecture. The flat based protocols all the nodes are assigned equal functionality. In location based protocols the information about the position is used to send the data to desired regions than to send it to the whole network. In hierarchical protocols clustering of the nodes is done in which cluster head is elected which performs some reduction and aggregation of data so as to save energy.[8] [9]

There are several optimization techniques used in routing for WSNs. Some of them are: Attribute-based, Energy optimization, Data aggregation, Addressing schemes,

Location-based, Multipath communication, quality of service etc. [10]

In the following section we will discuss about the technique of hierarchical routing.

III. Hierarchical Routing

We have discussed hierarchical routing because the main aim of hierarchical routing is to reduce the energy consumption. It is also known as cluster based routing because the nodes are divided into clusters and a cluster head is elected by them. The communication happens through the cluster heads only. The cluster heads communicate to other cluster heads and with the base station. There are various schemes used to elect the cluster head.[11] [12]

Grouping the nodes into clusters improves the overall system scalability, lifetime, energy efficiency, reduces channel contention, provides better network throughput under high load, stabilize network topology thus reduces topology maintenance cost. [12]

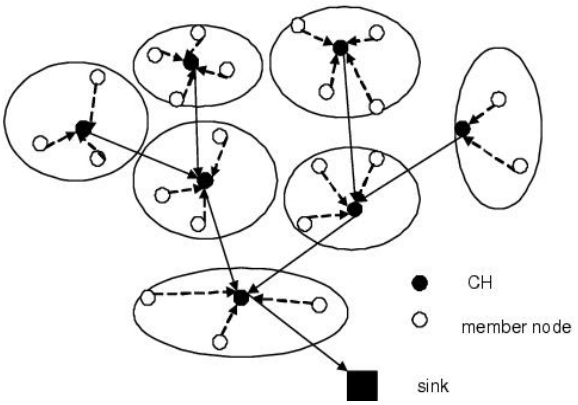

Fig 1. Clustering in WSNs [13]

In the coming section we will discuss about various energy optimisation routing protocols.

IV. Energy Optimisation Routing Protocols

1. LEACH (Low Energy Adaptive Clustering Hierarchy)

In this protocol the cluster head is periodically changed so that the energy consumption is equally distributed In LEACH, the cluster head nodes performs the compression of data arriving from nodes that belong to the respective cluster, and send a gross packet to the base station so that the amount of information that must be transmitted to the base station is reduced. LEACH uses a TDMA/CDMA MAC [6] to reduce inter-cluster and intra-cluster collisions. But the data is collected in centralized manner and is collected periodically. Hence, this protocol is most useful when there is a requirement for constant monitoring by the sensor network. A user may not require all of the data at the same time. Hence, transmitting the data periodically is useless because it drains the limited energy of the sensor nodes. After a particular time interval, cluster head is changed through a random rotation process which results in uniform energy dissipation in the sensor network. [10] [12]

There is a centralised version of LEACH protocol called LEACH-C protocol.it is divided into two phases set-up phase and steady phase. In set-up phase the sensors give the information about their positions and energy levels to the base station. Utilising this information the base station makes the decision about the structure of the clusters and their respective cluster heads. [10]

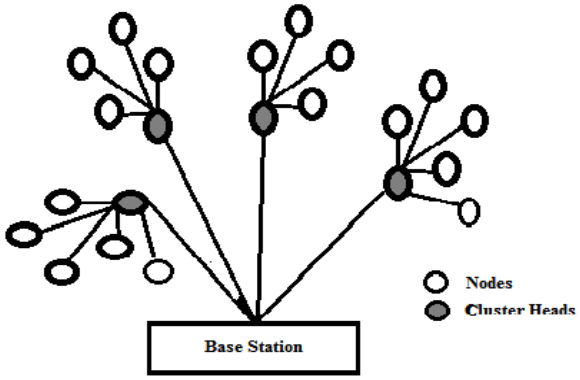

Fig 2. Leach protocol

2. PEGASIS (Power-Efficient Gathering in Sensor Information Systems)

This is the augmented version of the LEACH protocol. In this protocol the chain of the sensor nodes is formed and nodes only communicate with their neighbour nodes so as to extend the network life time. Data is collected from the nodes and transferred to the node which communicates with the base station. This happens in a single round, for the next round the node is elected which will be communicating with the base station. The process of chain construction is carried out through greedy algorithm. [10]

Since the power drainage of each node is even, the power required to relay the information per round is minimised. There are two main objectives of this protocol. Firstly, the lifetime of each node is increased because of the usage of collaboration techniques. Secondly, the communication between nodes that are close to each other is permitted so as to reduce the bandwidth consumed in transmission of data between the nodes. [12][14]

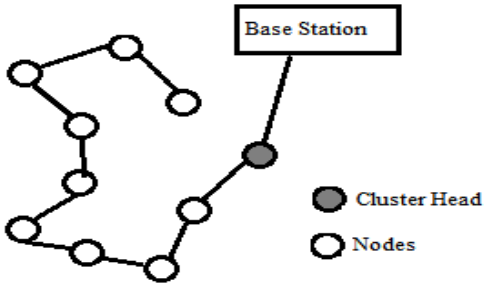

Fig. 3 Pegasis Protocol

3. TEEN (Threshold Sensitive Energy Efficient Sensor Network Protocol)

TEEN is other hierarchical protocol for hyperactive networks that is those networks which responds

immediately to changes in the given parameters. In this protocol a clusters head sends two threshold values a hard value and a soft value. The nodes are meant to sense their environment uninterruptedly. The first time when a parameter from the set of given attributes reaches its hard threshold value; the node switches on the transmitter and transmits the data. The nodes then continues to transmits data in the current cluster period if the following conditions hold true: the current value of the sensed attribute is greater than the hard threshold, and the current value of the sensed attribute [10] differs from sensed value by an amount equal to or greater than the soft threshold. Both strategy helps to reduce energy spend transmitting messages. The disadvantage of this protocol lies in the fact that, if the thresholds are not achieved, the nodes will never communicate; the user will not receive any data from the network at all and will not be alarmed even if all the nodes become inactive. Thus, this protocol is not suitable for those applications where the user needs to get data updates regularly. [10] [15]

4. Hybrid Energy Efficiency Protocol (HEEP)

HEEP makes use of PEGASIS principle inside the clusters. In HEEP, a chain of nodes is formed within the same cluster dissipation. Each cluster head sends the collected data collected in the cluster to the BS through cluster heads neighbours. Data is collected by the cluster head using multi - hop techniques, which helps in reducing power consumption. Collecting the data from each node in a chain lessens the amount of data transmission between nodes and their cluster heads, to prevent the node from draining energy. Hence, in this new technique of chains clustering the data communicating distances and the number of nodes communicating with cluster head is reduced. That results in better energy saving and prolonged cluster head lifetime. HEEP uses the concept of the randomizing the role of the cluster head between the nodes used in LEACH, which regulates energy drainage and makes sure that the nodes chosen as cluster heads persist for a long time. HEEP works in two essential phases. In the initialization phase formation of chained clusters and election of cluster heads takes place. In the transmission phase the aggregated data is transmitted. Since transmission distances are reduced, the total rounds of transmission are improved. [12] [16]

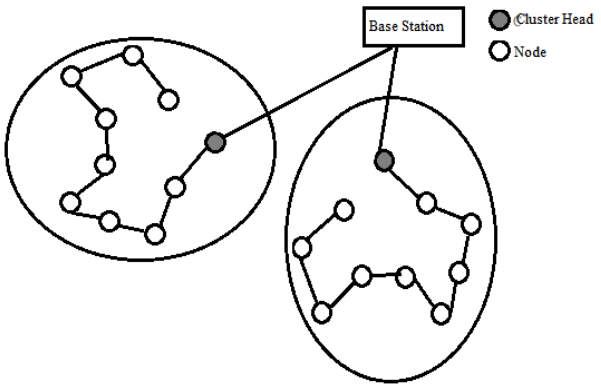

Fig. 4 Heep Protocol

5. Power Efficient and Adaptive Clustering Hierarchy (PEACH)

PEACH protocol for WSNs was introduced to minimize the energy consumption of each node, and maximize the network lifetime. In this protocol, formation of cluster is done by overhearing characteristics of wireless communication to maintain adaptive multi-level clustering and to prevent other overheads. In WSNs, overhearing a node can identify the source and the destination of packets transmitted by the neighbour nodes. PEACH protocol can be applied in both known-locations and unknown-location wireless sensor networks. It is intended to operate on those routing protocols which are probabilistic, so as to provide an adaptive multi-level clustering. As compared to other clustering protocols PEACH is more scalable and efficient in various circumstances. The merit of PEACH is that it can significantly reduce energy consumption of each node, increase the network lifetime, and are vulnerable to the distribution of sensor nodes. [12] [17]

V. CONCLUSION

By using the clustering technique in routing protocols of sensor networks we can significantly improve the network life time, reduce the data transmission cost, prevent the node energy dissipation. Clustering protocols have certain properties of data aggregation, reduction of data packet which helps to achieve the above mentioned merits. Because energy efficient routing is the main concern of sensor networks hence in this paper a survey of energy efficient routing protocols is done. This paper surveys the protocols which make use of clustering technique to achieve energy optimization. Various protocols discussed have advantages one over the other and are used in different circumstances.

REFERENCES

[1] WIRELESS COMMUNICATIONS, Andrea Goldsmith, Stanford University , http://www.cs.ucdavis.edu/ ~liu/289I/Material/book-goldsmith.pdf

[2] Wireless Sensor Networks, F. L. LEWIS, Associate Director for Research University of Texas at Arlington, 7300 Jack Newell Blvd. S Ft. Worth, Texas 76118-7115.

[3] ERFLA: Energy Efficient Combined Routing, Fusion, Localization Algorithm in Cognitive WSN by Lakshmi Phani G, Venkat Sayeesh K, Vinod Kumar K, Rammurthy in 7th International Conference on Wireless and Optical Communication Networks, Colombo.

[4] Luis Javier García Villalba, Ana Lucila Sandoval Orozco, Alicia Triviño Cabrera and Cláudia Jacy Barenco Abbas," Routing Protocols in Wireless Sensor Networks", *Int.Journal of Sensors*,Vol.9,pp. 8399-8421.

[5] "Routing techniques in wireless sensor networks : A Survey" Jamal N. Al-Karaki, Ahmed E. Kamal, IEEE wireless communications volume 11, pp.6-28, December 2004.

[6] "A Survey of Routing Protocols in Wireless Sensor Networks," K. Akkaya and M. Younis, in the *Elsevier Ad Hoc Network Journal*, Vol. 3/3 ,pp. 325-349, 2005.

[7] Debnath Bhattacharyya 1, Tai-Hoon Kim 1, * and Subhajit Pal," A Comparative Study of Wireless Sensor Networks and Their Routing Protocols", in *International.Journal of Sensors* ,pp.10506-10523,2010.

[8] A. Abbasi, M. Younis, "A survey on clustering algorithms for wireless sensor networks, "in *Elsevier Computer Networks* Computer Communications, vol. 30, pp. 2826-2841, October 2007.

[9] W. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy-Efficient Communication Protocol for Wireless Mi-crosensor

Networks," Proceedings of the 33rd Hawaii *International Conference on System Sciences (HICSS '00)*, January 2000.

[10] Luis Javier García Villalba *, Ana Lucila Sandoval Orozco, Alicia Triviño Cabrera and Cláudia Jacy Barenco Abbas." Routing Protocols in Wireless Sensor Networks".

[11] O. Younis, M. Krunz, S. Ramasubramanian, "Node clustering in wireless sensor networks: recent developments and deployment challenges," *IEEE Network*, vol. 20, pp. 20-25, May 2006.

[12] Energy Optimization Routing Techniques In Wireless Sensor Networks G. Nivetha ,Volume 2, Issue 7, July 2012.

[13] Tao Shu and Marwan Krunz, ``Coverage-time optimization for clustered wireless sensor networks: A power-balancing approach," accepted for the IEEE/ACM Transactions on Networking (ton), Jul. 2009.

[14] Lindsey, S.; Raghavendra, C.S. PEGASIS: Power-Efficient Gathering in Sensor Information Systems. In Proceedings of the Aerospace Conference, Big Sky, MT, March, 2002; pp. 1125–1130.

[15] Manjeshwar, E.; Agrawal, D.P. TEEN: A Routing Protocol for Enhanced Efficiency in Wireless Sensor Networks. In Proceedings of the 15th International Parallel and Distributed Processing Symposium (IPDPS), San Francisco, CA, USA, April, 2001; pp. 2009–2015.

[16] Djallel Eddine Boubiche and Azeddine Bilami ," HEEP (Hybrid Energy Efficiency Protocol) based on chain clustering", International Journal on Sensor Networks, vol. 10,2010.

[17] Sangho Yi, Junyoung Heo , Yookun Cho , Jiman Hong," PEACH: Power-efficient and adaptive clustering hierarchy protocol for wireless sensor networks", in Elseiver Computer Communications, vol. 30 pp. 2842–2852,2007