Energy Efficient clustering scheme analysis with mobile sink in Wireless Sensor Network

Deepinder Kaur[1], Kamaljit Kaur[2]
[1] Research Scholar, Guru Granth Universal University, Fathegarh.,
[2] Professor, Dept of Computer Science, Guru Granth Universal University, Fathegarh.,

Abstract:
Wireless sensor networks are remote networks and works in adhoc manner. Sensor collects the information sensed by theself and sends it to cluster head created in clusters. Further cluster heads use to send this information to the sink where data fetched use to complied and processed according to application used. In our research, we will propose a novel method for establishing reliable and efficient data transmission in wireless sensor networks. In this approach, we will achieve energy efficiency by using hierarchical clustering method to form clusters in the sensor network. Network lifetime is increased by using this technique. To increase reliability and to utilize energy much more effectively multiple mobile sinks are used along with base station. Mobile sink nodes are used to enhance the performance metrics. Mobile sinks will be bring into grid area so that less energy consumption will be there for cluster heads. Mobile sinks will fetch data from cluster heads with minimize energy consumption. Grid will be divided into equal portions to form a uniform distribution of mobile sink. Particularly this paper analyze the various clustering techniques with mobile sink concept.

Keywords: *Wireless Sensor Nodes, Mobile Sink, Leach Protocol, Multi-hop Communication*

1. Wireless Sensor Networks

The recent technological advancements in the field of micro electrical mechanical systems (MEMS) have made the manufacturing and use of small, low powered and moderate cost micro-sensors[1] both technically and economically feasible. A Wireless Sensor Network (WSN) [2] Consists of hundreds to thousands of low-power multi-functioning sensor nodes, operating in an unattended environment, having capabilities of sensing, computation and communications. Wireless Sensor Networks are used for monitoring and collecting information from an unattended environment and for reporting events to the user. They monitor physical or environmental conditions such as temperature, humidity, pressure, sound, vibration etc.

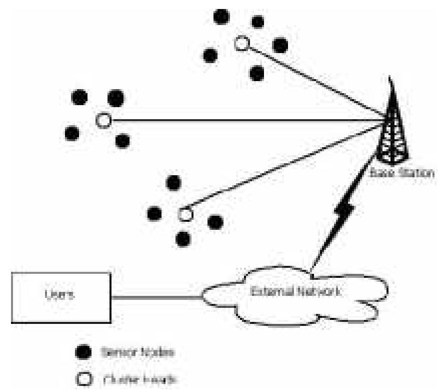

Figure 1: Wireless sensor network [4]

Since a sensor node is limited in terms of sensing and computation capacities, communication performance and power - a large number of sensor nodes can be distributed over an area of interest for collecting information. [3]The decrease in size and cost of the sensor nodes has made it possible to have a network of large number of sensor nodes, thereby increasing the reliability and accuracy of data as well as the area of coverage. Due to the low-cost deployment, the nodes are generally deployed with greater degree of connectivity. Such redundancy also increases the network fault tolerance as the failure of a single node has negligible impact on the entire network operation. [4]

LEACH assumes a simple model for the radio hardware energy dissipation where the transmitter dissipates energy to run the radio electronics and the power amplifier, and the receiver dissipates energy to run the radio electronics. For the experiments described here, both the free space and the multipath fading channel models were used, depending on the distance between the transmitter and receiver [6].

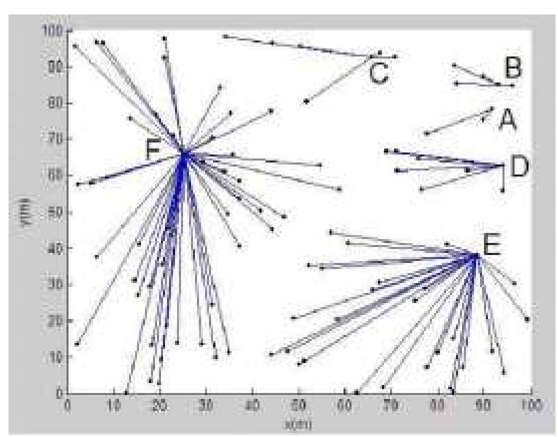

Figure 2: Cluster head formed in Leach protocol [6]

2. Parameters for Communication in WSN

1) **Node deployment:** Node deployment in WSNs is application-dependent and can be either manual or randomized. In manual deployment, the sensors are manually placed and data is routed through predetermined paths. However, in random node deployment, the sensor nodes are scattered randomly, creating an adhoc routing infrastructure. If the resultant distribution of nodes is not uniform, optimal clustering becomes necessary to allow connectivity and enable energy-efficient network operation. [7]
2) **Data reporting method:** Data reporting in WSNs is application-dependent and also depends on the time criticality of the data. Data reporting can be categorized as either time-driven, event driven, query-driven, or a hybrid of all these methods. The time-driven delivery method is suitable for applications that require periodic data monitoring. As such, sensor nodes will periodically switch on their sensors and transmitters, sense the environment, and transmit the data of interest at constant periodic time intervals. [3]
3) **Node/link heterogeneity:** In many studies, all sensor nodes were assumed to be homogeneous. However, depending on the application a sensor node can have a different role or capability. The existence of a heterogeneous set of sensors raises many technical issues related to data routing. For example, some applications might require a diverse mixture of sensors for monitoring temperature, pressure, and humidity of the surrounding environment, detecting motion via acoustic signatures, and capturing images or video tracking of moving objects. [6]
4) **Fault tolerance:** Some sensor nodes may fail or be blocked due to lack of power, physical damage, or environmental interference. The failure of sensor nodes should not affect the overall task of the sensor network. If many nodes fail, medium access control (MAC) and routing protocols must accommodate formation of new links and routes to the data collection BSs. [7]

3. Mobile Sink Communication

The consumption of energy in reception and sensing is independent from transmission distance. Energy consumption in computation is negligibly small compared to energy dissipation in other process such as sensing, transmission and reception of a bit as shown by Hoang and Motani [9]. Intra-cluster traffic can be varied if we change the size of the cluster accordingly by varying the number of nodes in a cluster. A change in a cluster size and the change in number of nodes will result in change in traffic load on a cluster head of that cluster. [10] If we increase the cluster size we can also accommodate more number of nodes. Therefore load on cluster head increases which may lead to depletion of the residual energy of the cluster head more rapidly and vice versa. Inter-cluster traffic means the data transfer between adjacent cluster heads on its way to the base station. The farthest cluster head from the base station have only its own data but the cluster head following it towards base station has to forward its own traffic and the traffic it received from its neighbor nodes. Thus, the cluster head which is nearest to BS will be dealing with maximum data traffic. Also larger the size of the cluster the cluster head requires higher energy to directly transmit or relay data to its adjacent cluster head on its path to the base station and smaller the size of the cluster , lesser will the amount of energy spent in transmitting it to the next hop cluster head or to the base station. We assume that energy spent at each node is consumed on reception and transmission only as energy spent on processing is negligible. [11]

4. Clustering Protocol with Virtual Force

This paper explained general framework to address two major issues in clustering protocols for WSNs: the net-work lifetime and the sensing coverage. This framework uses the principles of Virtual Field Force (VFF) [5] to determine the locations of the nodes within each cluster, in order to maximize the sensing coverage and minimize the energy consumption of these nodes, which in turn maximizes the lifetime of the network and extends its usability. The proposed framework is applied to the LEACH clustering protocol [10]. The new clustering pro-tocol is called LEACH-VF (LEACH with Virtual Force). To explain the idea of the LEACH-VF protocol and pre-sent its potential advantages, consider the simple LEACH-based cluster with six sensor nodes shown in Figure 1(a). The outer large circle represents the cluster area and the small circles indicate the sensing coverage of each sensor node. The circle in the middle of the cluster represents the sensing coverage of the CH.

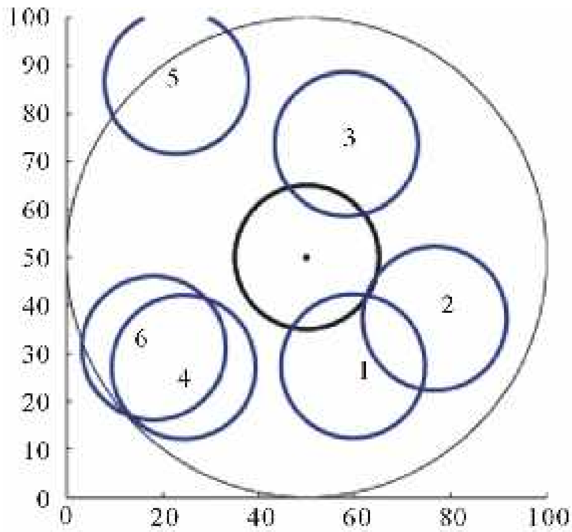

Fig 1: Problems with the LEACH-based clustering

There are four problems with this cluster caused by the random distribution of nodes and the random selection of CHs:

1) There are areas with overlapped sensing coverage (i.e., areas covered by more than one sensor node). For example, sensor nodes 4 and 6 have a relatively large sensing coverage overlap.

2) There are areas with sensing holes (i.e., areas with no sensing coverage).

3) Some sensor nodes have coverage outside the cluster area. For example, sensor node 5.

4) Some sensor nodes are located relatively far from their CHs, while they can be relocated in closer places and still be useful to the cluster at a lower energy cost.

When the proposed LEACH-VF algorithm is applied to this cluster, the result is shown in Figure 2.

It is worth noting that the above-mentioned problems were resolved. Thus, the LEACH-VF algorithm takes a regular LEACH-based cluster as input and produces a corresponding sub-optimal LEACH-VF cluster to be used for data transmission.

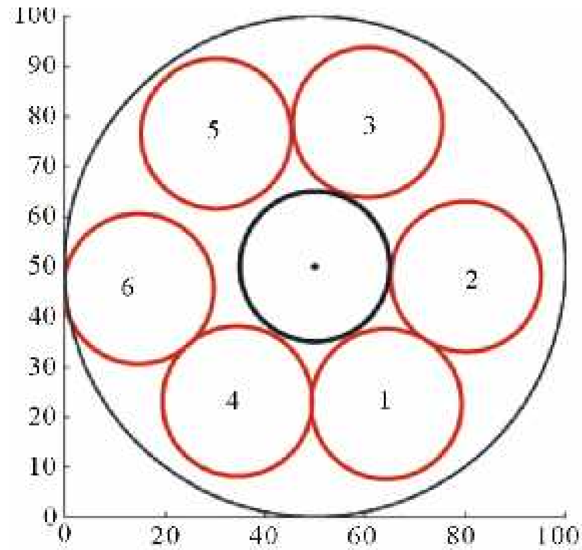

Fig 2: Output of LEACH-VF

5. Various Clustering Approaches

LEACH, TEEN, APTEEN and PEGASIS have similar features and their architectures are to some extent similar. [7] They have fixed infrastructure. LEACH, TEEN, APTEEN are cluster based routing protocols, whereas PEGASIS is a chain-based protocol. The performance of APTEEN lies between TEEN and LEACH with respect to energy consumption and longevity of the network [9]. TEEN only transmits time-critical data, while APTEEN performs periodic data transmissions. In this respect APTEEN is also better than LEACH because APTEEN transmits data based on a threshold value whereas LEACH transmits data continuously. [10] Again PEGASIS avoids the formation of clustering overhead of LEACH, but it requires dynamic topology adjustment since sensor energy is not tracked. PEGASIS introduces excessive delay for distant nodes on the chain. [11] The single leader can become a bottleneck in PEGASIS. PEGASIS increases network lifetime two-fold compared to the LEACH protocol.

Protocols	Mobility	Power management	Network lifetime	Scalability	Resourc awarene
LEACH	Fixed BS	Maximum	Very good	Good	Yes
TEEN	Fixed BS	Maximum	Very good	Good	Yes
APTEEN	Fixed BS	Maximum	Very good	Good	Yes
PEGASIS	Fixed BS	Maximum	Very good	Good	Yes
SPIN	Supported	Limited	Good	Limited	Yes
DD	Limited	Limited	Good	Limited	Yes

.

Table 1: Performance Measurements of protocols

6. Conclusion

The routing techniques are classified as proactive, reactive and hybrid, based on their mode of functioning and type of target applications. Further, these are classified as direct communication, flat and clustering protocols, according to the participating style of nodes. Again depending on the network structure, these are categorized as hierarchical, data centric and location based. We have compared various protocols and future work will be focused on saving energy with concept of mobile sinks in various protocols.

References

[1] I.F. Akyildiz, W. Su, Y. Sankara subramaniam, "A Survey on Sensor Networks", in IEEE Communications Magazine, 2002, Vol. 40, Issue. 8, pp.102-114.

[2] K. Sohrabi, J. Gao, V. Ailawadhi and G. Pottie, "Protocols for Self-organization of a Wireless Sensor Network", in IEEE Personal Communications, Vol. 7, Issue. 5, 2000, pp. 16-27.

[3] Chandrakasan, Amirtharajah, Cho, Goodman, Konduri, Kulik, Rabiner and Wang, "Design Considerations for Distributed Microsensor Systems", in IEEE Custom Integrated Circuits Conference (CICC), Vol. 9, Issue. 2, May 1999, pp. 279-286..

[4] Koushik Majumder, Sudhabindu Ray,‘‘ A Novel Power Efficient Routing Scheme for Wireless Sensor Networks’’. International Journal of Instrumentation, Control & Automation (IJICA), Vol. 1, Issue. 1, 2011, pp.23-29.

[5] Rakesh Kumar, "Fault Tolerance for Chain based Hierarchical Data Gathering Protocol for WSN", International Journal of Engineering Research and Applications (IJERA),Vol. 2, Issue. 4, August 2012, pp.906-911.

[6] Lu Tao1, Zhu Qing-Xin, Zhang Luqiao, "An Improvement for LEACH Algorithm in Wireless Sensor Network", IEEE Conference on Consumer Communications and Networking, Vol. 6, Issue. 4, June 2010, pp 593 – 598.

[7] Jamal N. Al-Karaki, "Routing Techniques in Wireless Sensor Networks: A Survey", IEEE Wireless Communications, Vol. 2, No. 2, December 2004, pp.704-709.

[8] Raju Pal, Ajay K. Sharma, "MSEP-E: Enhanced Stable Election Protocol with Multihop Communication", IEEE Conference on Asia-Pacific Service Computing Conference, Vol. 2, Issue. 2, February 2011, pp 172-178.

[9] K.Suganthi, Dr.B.Vinayaga Sundaram, K.S.Vishwa Kumar, J.Syed Ashim, S.Saravana Kumar, "Improving Energy Efficiency and Reliability using multiple mobile sinks and hierarchical clustering in Wireless Sensor Networks", IEEE-International Conference on Recent Trends in Information Technology, MIT, Anna University, Chennai, Vol.5, No.4, June 3-5, 2011.

[10] Z. Maria Wang, Stefano Basagni, Emanuel Melachrinoudis and Chiara Petriol, "Exploiting Sink Mobility for Maximizing Sensor Networks Lifetime" IEEE Proceedings of the 38th Hawaii International Conference on System Sciences, pp. 1–5, March 2005.

[11] Fahed Awad, Eyad Taqieddin, Asmaa Seyam," Energy-Efficient and Coverage-Aware Clustering in Wireless Sensor Networks", Wireless Engineering and Technology, SciRes, Vol. 3, 2012, pp.142-151.