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An Energy Efficeint Super Heterogeneous Communication Protocol for WSNs

ASHU GUPTA, SUMIT SUHAG and MANOJ DUHAN

Deen Bandhu Chotu Ram University of Science & Technology,
Muthal, Sonepat Haryana (INDIA)

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Abstract

Wireless sensor network consists of randomly distributed autonomous battery powered sensor nodes, which sense and collectively pass their data to a base station. Wireless sensor network enables the monitoring of environment for various areas of applications. It is a web of sensor nodes and all these nodes send their collected data to a common base station directly or indirectly (through intermediate nodes). But these nodes have limited battery level. The most difficult resource constraint to meet in WSN is power consumption. So, to utilize that power level properly, some energy efficiency protocols were given. In this paper, we deal with that protocols which have more effect on overall energy efficiency of our network. In LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering based approach is used. In this, cluster head is selected randomly in the homogeneous environment. LEACH can achieve as much as a factor of 8 reductions in energy dissipation compared with conventional routing protocols[2]. In this paper, we deal with the heterogeneity and super heterogeneity in wireless sensor network which will increase the network lifetime.

Key words : WSN Protocols, LEACH, Hetero LEACH, Super Hetero LEACH.

I. Introduction

Wireless sensor network combines sensing, computation, and communication through a single small device. Recent advances in wireless communication made it possible to develop wireless sensor networks consisting of micro-sensors, which collect information collectively with the help of each other. These micro-sensors are called nodes. Sensor is a device which maps a physical quantity from the surrounding to a quantitative measurement.

These nodes consist of a sensor module (e.g. acoustic, seismic, image sensor, fog sensor etc.) capable of sensing some quantity about the environment, control processing unit (CPU) (for data processing), memory (for data storage), battery (for energy) and transceiver (for sending and receiving data from one node to another). The size of each node varies with the type of application. For e.g., in some military or surveillance applications it might be microscopically small. These networks gathers the information needed by smart environments, whether in utilities, buildings, home, industrial, transportation systems automation, shipboard, or elsewhere Its cost depends on its parameters like memory size, processing speed and battery[9]. The key advantage of WSN is that it can be operated with little maintenance.

II. Sensor Network Application :

WSNs may consists of numerous diverse kinds of sensor nodes to sense different types of parameters from their surroundings that enable them to monitor a wide variety of ambient conditions that include the following: flow, pressure, temperature, moisture, humidity, mechanical stress, noise levels, speed, etc. Smart sensors that monitors many physical variables can also be used with the WSN. Many new applications are being developed because of this new concept of micro-sensing and wireless networking of these smart sensors. Some of the important applications of WSNs are as follows: habitat monitoring, military applications, physiological monitoring, precision agriculture, forest fire detection, area monitoring, air quality monitoring, nuclear, chemical and biological attack detection and transportation.

III. WSN Routing Protocols :

In this paper, we deal with the wireless sensor network communication protocols, which can have significant effect on the overall energy dissipation of these networks. And also which increases the network lifetime. Based on our study there are so many protocols for this purpose. Some of them are the conventional protocols of direct transmission, minimum transmission energy protocols[2], multihop routing, and static clustering, HEED[7] and PEAGESIS[8] which may not be optimal for sensor networks. However, LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol which utilizes randomized rotation of cluster base stations (cluster-heads) among the sensors in the homogeneous environment.

A. LEACH Protocol :

LEACH is a clustering based protocol. The operation of LEACH[2] is broken up into no. of rounds. In this, each node has a certain probability of becoming a cluster head per round and this task is rotated between nodes. Each round begins with a set-up phase in which the clusters are organized, followed by a steady-state phase in which each cluster head sends an aggregated packet to the base station by single hop or multi hop. In order to minimize overhead, the steady-state phase is long as compared to the set-up phase.

Advertisement Phase :

Initially, when clusters are created, each node decides whether it will become a cluster-head for the current round or not. The decision is based on the suggested percentage

of cluster heads for the network (determined a priori) and the number of times the node has been a cluster-head. This decision is made by the node n choosing a random number between 0 and 1[2]. If the number is less than a threshold T(n), the node becomes a cluster-head for the current round[2]. The threshold is set as:

$$T(n) = \begin{cases} \dfrac{P}{1 - P\left(r \bmod \frac{1}{P}\right)} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

$$E_{tot} = n \cdot E_0$$

Where P = the desired percentage of cluster heads (e.g., P=0.05),
r = the current round,
G = set of nodes that have not been cluster-heads in the last 1/P rounds,
E_0= initial energy of each normal node,
E_t = total energy, and
n = no. of nodes

Using this threshold, each node will be a cluster-head at some point within 1/P rounds. During round 0 (r = 0), each node has a probability P of becoming a cluster-head. The nodes which were cluster-heads in round 0 can't be cluster-heads for next 1/P rounds. Thus the probability that the remaining nodes are cluster-heads is increased, since fewer nodes are available that are eligible for cluster-heads. After 1/ P rounds, all the nodes are eligible to become cluster-heads[6].

Set-Up Phase :

After each node has decided to which cluster it will belong, it must inform the cluster-head node that it will be a member of that particular cluster. Then each node transmits the information back to the cluster-head again using a CSMA protocol. During this phase, the receivers of all the cluster-head nodes must be on.

Now the cluster head aggregate the data and sends it to the base station. The main energy saving of LEACH protocol is due to the combining of lossy compression with the data routing. This protocol distributes energy usage among the nodes in the network such that the nodes die randomly and at essentially the same rate. LEACH performs local data fusion to "compress" the amount of data being sent from the clusters to the base station, further reducing the energy dissipation and enhancing system lifetime[3-5].

B. Heterogeneous Leach :

The operation of heterogeneous leach is similar to the homogeneous leach. The only difference is in the energy given to the sensor nodes. In homogeneous LEACH the energy given to each node is same but in heterogeneous leach we have two types of nodes. These are normal nodes and advance nodes where the energy given to the advanced node is greater than the energy given to the normal node. The Probabilities of normal node and advanced node to become cluster head are given by the relation below:

$$P_{nrm} = P/(1 + am)$$

$$P_{adv} = P(1 + a)/(1 + am)$$

$$E_{tot} = N \cdot E_0(1 + am)$$

Where a= additional energy factor for advanced node,
m=fraction of advanced nodes

C. Super Heterogeneous Leach :

The operation of super heterogeneous leach is also similar to the homogeneous leach. The only difference is in the energy given to the sensor nodes. In super heterogeneous leach we have three types of nodes. These are normal nodes and advance nodes and super advance nodes where the energy given to the super advanced nodes is greatest as compared to other nodes. The Probabilities of normal node and advanced node and super advanced nodes to become cluster head are given by the relation below[1]:

$$p_{nrm} = \frac{p_{opt}}{[1 + m\{a - m_0(a - b)\}]}$$

$$p_{adv} = \frac{p_{opt}}{[1 + m\{a - m_0(a - b)\}]} * (1 + a)$$

$$p_{sup} = \frac{p_{opt}}{[1 + m\{a - m_0(a - b)\}]} * (1 + b)$$

$$E_{tot} = n \cdot E_0[1 + m\{a - m_0(a - b)\}]$$

Where b = additional energy factor for super advanced nodes, and

m_0 = fraction of super advanced nodes among advanced nodes

IV. Simulation Results :

Radio parameters that are used in our simulation

Parameter name	values
Network area	100m*100m
Number of nodes	100
Initial energy	0.5J
BS position	50m*50m
E_{elec}	50nJ/bit
Packet size	4000 bits
Max no. of rounds	5000

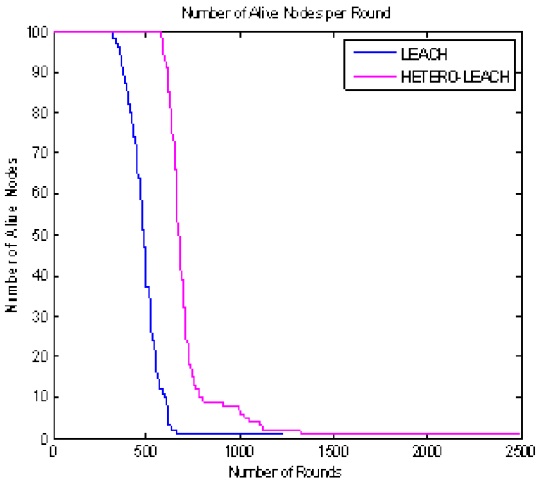

Figure 1. Comparison between Homogeneous Leach and Heterogeneous Leach system

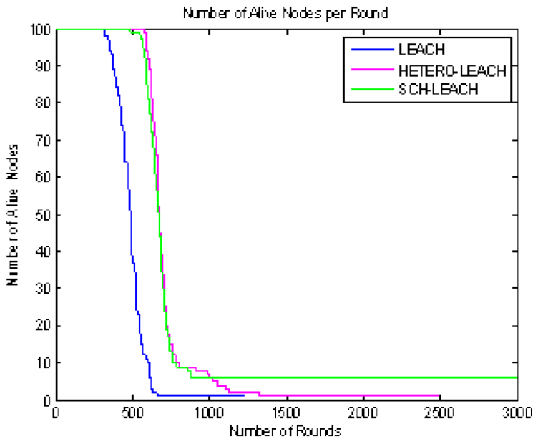

Figure 2. Comparison between Homogeneous Leach and Heterogeneous Leach and Super Heterogeneous Leach system

V. Conclusion

In this paper, we describe about the Super Heterogeneous Leach which is a clustering

based routing protocol and its comparisons with the Homogeneous Leach and Heterogeneous Leach. Results from simulation using MATLAB are shown here. From that we can see that Super Heterogeneous Leach provides better results. This system provides a better network lifetime as compared to other two protocols discussed in this paper.

References

1. R. Saravana Kumar, S.G. Susila, J. Raja, "Energy Efficient Homogeneous and Heterogeneous system for Wireless Sensor Network", *International journal of Computer Application* (0975-8887),Volume *17* No. *4,* March (2011).
2. Vishal Choudhary, Lalitesh Sehgal, "REEH: Residual Energy Efficient Heterogeneous Clustered Hierarchy Protocol Wireless Sensor Networks", *International Journal Of Scientic fic & engineering Research,* Volume *2,* Issue *12,* December (2011).
3. Stanislava Soro and Wendi B. Heinzelman, "Cluster head election techniques for coverage preservation in wireless sensor networks", *Journal of Ad Hoc Networks 7*, pp. 955–972, (2009).
4. Zhao Cheng, Mark Perillo and Wendi B. Heinzelman, "General network lifetime and cost models for evaluating sensor network deployment strategies", *IEEE Transactions on mobile computing,* Vol. *7,* no. *4,* April (2008).
5. M. Perillo and W. Heinzelman, "DAPR: a protocol for wireless sensor networks utilizing an application-based routing cost", Proceedings of the IEEE Wireless ommunications and Networking Conference (WCNC'04), (2004).
6. Ossama Younis and Sonia Fahmy, "HEED: A Hybrid, Energy-Efficient, Distributed Clustering Approach for Ad Hoc Sensor Networks", *IEEE Transactions on Mobile Computing,* Vol. *3* no. *4,* p. 366-379, October (2004).
7. S. Lindsey and C. Raghavendra, "PEGASIS: Power-efficient Gathering in Sensor Information Systems", IEEE Aerospace Conference Proceedings, Vol. *3,* 9-16 pp. 1125-1130, (2002).
8. W. Heinzelman, A. Chandrakasan and H. Balakrishnan, "An application specific protocol architecture for wireless micro sensor networks", *IEEE Transaction on Wireless Networking,* Vol. *1,* no. *4,* pp. 660-670, Oct. (2002).
9. W. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy efficient Communication Protocol for Wireless Microsensor Networks", Proceeding of the 33rd Hawaii International Conference on System Sciences, January (2000).