INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY
WINGS TO YOUR THOUGHTS…..

A Proposed Technique for Reliable and Energy Efficient Hierarchical Routing in Heterogeneous Wireless Sensor Networks

Bharti[1], Mamta Sachdeva [2]

[1] M.Tech(CSE), [2]Associate Professor
[1] Computer Science and Engineering Department
South Point Institute of Technology & Management
DCRUST, Murthal India

Abstract: *A wireless sensor network may consist of hundreds or up to thousands of sensor nodes and can be spread out as a mass or placed out one by one. The sensor nodes collaborate with each other over a wireless media to establish a sensing network, i.e. a wireless sensor network. Energy efficiency is one of the most important design constraints in wireless sensor network architectures. The lifetime of each sensor nodes depends on its energy dissipation. In applications where the sensor nodes are totally dependent on no rechargeable batteries, sensor nodes with exhausted batteries will cease operation. Therefore, to extend the lifetime of network, hierarchical routing is used. In hierarchical routing architecture, sensor nodes self-configure themselves for the formation of cluster heads. Hierarchical routing can be centralized or non- centralized. In non centralized hierarchical routing, the sensor nodes self configures for the cluster head on the basis of selecting a random number. They don't consider the case of residual energy. But in centralized routing the base station is responsible to create cluster. In this paper, we have proposed a routing strategy which will consider the case of residual energy before making cluster head, so that it will be reliable and energy efficient.*

Keywords*: WSN, reliable routing, cluster based technique, hierarchical routing, efficient routing*

1. INTRODUCTION

The devices used in a WSN are resource constrained, they have a low processing speed, a low storage capacity and a limited communication bandwidth. Moreover, the network has to operate for long periods of time, but the nodes are battery powered, so the available energy resources limit their overall operation. To minimize energy consumption, most of the device components, including the radio, should be switched off most of the time. Another important characteristic is that sensor nodes have significant processing capabilities in the ensemble, but not individually. Nodes have to organize themselves, administering and managing the network all together, and this is much harder than controlling individual devices [1]. Furthermore, changes in the physical environment, where a network is deployed, make also nodes experience wide variations in connectivity and thus influencing the networking protocols. The main design goal of WSNs is not only to transmit data from a source to a destination, but also to increase the lifetime of the network. This can be achieved by employing energy efficient routing protocols. Depending on the applications used, different architectures and designs have been applied in WSNs. The performance of a routing protocol depends on the architecture and design of the network, and this is a very important feature of WSNs [2-5]. However, the operation of the protocol can affect the energy spent for the transmission of the data.

INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY
WINGS TO YOUR THOUGHTS…..

2. Related Work

S. Lindsey et. al. [4] shows that Hierarchical-PEGASIS is an extension to PEGASIS, which decreases the delay during transmission from the designated node to the sink. In order to improve the performance by reducing the delay in PEGASIS, messages are transmitted simultaneously. There are two approaches to avoid collisions and possible signal interference among the sensors. The first one uses CDMA type signal coding techniques. The other approach (non-CDMA based) is quite different and allows only spatially separated nodes to transmit at the same time. Using this approach, a three-level hierarchy of the nodes is created first. The effects of interference are reduced by carefully scheduling simultaneous transmissions. A. Manjeshwar et.al. [5] introduces a new protocol developed for hybrid networks, called APTEEN (Adaptive Periodic Threshold-sensitive Energy Efficient Sensor Network Protocol).In APTEEN once the CHs are decided, in each cluster period, the cluster head first broadcasts the following parameters: Attributes (A): This is a set of physical parameters which the user is interested in obtaining data about. Thresholds: This parameter consists of a hard threshold (HT) and a soft threshold (ST). HT is a particular value of an attribute beyond which a node can be triggered to transmit data. ST is a small change in the value of an attribute which can trigger a node to transmit data again. Schedule: This is a TDMA schedule assigning a slot to each node. Count Time (TC): It is the maximum time period between two successive reports sent by a node. It can be a multiple of the TDMA schedule length and it accounts for the proactive component. S. Ghiasi et. Al. [6] states that in BCDCP, these tasks are accomplished by means of an iterative cluster splitting algorithm. This simple algorithm first splits the network into two sub clusters, and proceeds further by splitting the sub clusters into smaller clusters. The base station repeats the cluster splitting process until the desired number of clusters N_{CH} is attained. The iterative cluster splitting algorithm ensures that the selected cluster heads are uniformly placed throughout the whole sensor field by maximizing the distance between cluster heads in each splitting step. Furthermore, in order to evenly distribute the load on all cluster heads, utilize the balanced clustering technique where each cluster is split so that the resulting sub clusters have approximately the same number of sensor nodes. A. Manjeshwar et. al. [7] presents a new network protocol called TEEN (Threshold sensitive Energy Efficient sensor Network protocol). It is targeted at reactive networks and is the first protocol developed for reactive networks, to our knowledge Functioning In this scheme, at every cluster change time, in addition to the attributes, the cluster-head broadcasts to its members, Hard Threshold (HT): This is a threshold value for the sensed attribute. It is the absolute value of the attribute beyond which, the node sensing this value must switch on its transmitter and report to its cluster head. Soft Threshold (ST): This is a small change in the value of the sensed attribute which triggers the node to switch on its transmitter and transmit. The nodes sense their environment continuously.

3. Energy Consumption Model

Energy efficiency is one of the most important design constraints in wireless sensor network architectures [8]. The lifetime of each sensor nodes depends on its energy dissipation. In applications where the sensor nodes are totally dependent on no rechargeable batteries, sensor nodes with exhausted batteries will cease operation. A typical sensor node consists mainly of a sensing circuit for signal conditioning and conversion, a digital signal processor, and radio links [9,10]. Hence, during the life cycle of the sensor node, each event or query will be followed by a sensing operation, performing necessary calculations to derive a data packet and send this packet to its destination. Thus, we divide the energy consumption model into the following sub models; the communication energy consumption model, followed by the computation energy consumption model and finally the sensing energy consumption model (As shown in Figure 1).

Although energy is dissipated in all of the models of a sensor node, we mainly consider the energy dissipations associated with the communication energy consumption since the core objective of algorithm is to develop an energy-efficient network layer routing protocol to improve network lifetime.The transmission and receive energy costs for the transfer of a k-bit data message between two nodes separated by a distance of d meters is given by Eqs. 1 and 2, respectively.

$$E_T(k,d) = E_{TX}k + E_{amp}(d)k \quad (1)$$

$$E_R(k) = E_{Rx}k \quad (2)$$

Where E_T (k,d) in Eq. 1 denotes the total energy dissipated in the transmitter of the source node, and E_R(k) in Eq. 2 represents the energy cost incurred in the receiver of the destination node. The parameters E_{Tx} and E_{Rx} in Eqs. 1 and 2 are the per bit energy dissipations for transmission and reception, respectively. E_{amp}(d) is the energy required by the transmit amplifier to maintain an acceptable signal-to-noise ratio in order to transfer data messages reliably. As is the case in [10], we use both the free-space propagation model and the two ray ground propagation model to approximate the path loss sustained due to wireless channel transmission. Given a threshold transmission distance of d_0, the free-space model is employed when $d \le d_0$, and the two-ray model is applied for cases where $d<d_0$. Using these two models, the energy required by the transmit amplifier E_{amp}(d) is given by Eq. 3.

$$E_{amp}(d) = \begin{cases} \varepsilon_{FS} d^2 & , d \le d_0 \\ \varepsilon_{TR} d^4 & , d > d_0 \end{cases} \quad (3)$$

where ε_{FS} and ε_{TR} denote transmit amplifier parameters corresponding to the free-space and the two-ray models, respectively, and d_0 is the threshold distance given by Eq. 4.

$$d_0 = \sqrt{\varepsilon_{FS} / \varepsilon_{TR}} \quad (4)$$

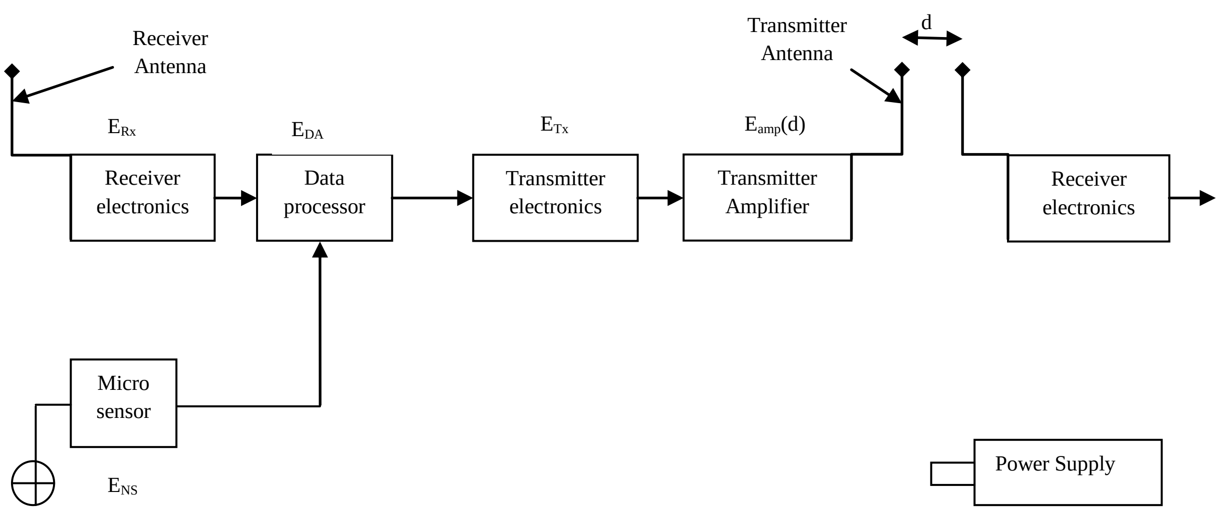

Figure 1: Energy Consumption Model

4. SEP (Stable Election Protocol) [11]

A percentage of the population of sensor nodes is equipped with more energy resources than the rest of the nodes. Let m be the fraction of the total number of nodes n, which are equipped with α times more energy than the others. We refer to these powerful nodes as advanced nodes, and the rest (1−m)×n as normal nodes. We assume that all nodes are distributed randomly over the sensor field.

Suppose that Eo is the initial energy of each normal sensor. The energy of each advanced node is then Eo* (1+α). The total (initial) energy of the new heterogeneous setting is equal to:

n * Eo * (1 + α * m). So, the total energy of the system is increased by a factor of 1+α * m.

(i) each normal node becomes a cluster head once every 1 popt · (1+α ·m) rounds per epoch;

(ii) each advanced node becomes a cluster head exactly 1 + α times every 1 popt· (1+α·m) rounds per epoch;

and (iii) the average number of cluster heads per round per epoch is equal to n × popt. Cluster Head Election for normal nodes is based on following equation:

$$T(s_{nrm}) = \begin{cases} \frac{p_{nrm}}{1-p_{nrm}\cdot(r \ mod \ \frac{1}{p_{nrm}})} & \text{if } s_{nrm} \in G' \\ 0 & \text{otherwise} \end{cases} \quad (5)$$

where r is the current round, G' is the set of normal nodes that have not become cluster heads within the last 1/pnrm rounds of the epoch, and T(snrm) is the threshold applied to a population of n · (1 − m) (normal) nodes. This guarantees that each normal node will become a cluster head exactly once every 1/popt· (1+α·m) rounds per epoch, and that the average number of cluster heads that are normal nodes per round per epoch is equal to n · (1 − m) × pnrm. Cluster Head Election for advanced nodes is based on following equation:

$$T(s_{adv}) = \begin{cases} \frac{p_{adv}}{1-p_{adv}\cdot(r \ mod \ \frac{1}{p_{adv}})} & \text{if } s_{adv} \in G'' \\ 0 & \text{otherwise} \end{cases} \quad (6)$$

where G" is the set of advanced nodes that have not become cluster heads within the last 1 padv rounds of the epoch, and T(sadv) is the threshold applied to a population of n x m (advanced) nodes. This guarantees that each advanced node will become a cluster head exactly once every (1/popt)x((1+α·m)/(1+α)) rounds. Based on above equations and conditions, nodes sends the data to their respective cluster heads and energy consumption will be calculated.

Cluster Head will aggregate the data and send it to the base station and energy consumption will be calculated for each node and cluster heads.

5. PROPOSED ALGORITHM

The foundation of proposed protocol lies in the realization that the base station is a high-energy node with a large amount of energy supply. Thus, proposed protocol utilizes the base station to control the coordinated sensing task performed by the sensor nodes. In proposed protocol, the following assumption are to be considered.

• A fixed base station is located in the middle of the region.

• The nodes are equipped with power control capabilities to vary their transmitted power.

• Each node senses the environment at a fixed rate and always has data to send to the base station.

• All sensor nodes are immobile.

he radio channel is supposed to be symmetrical. s, the energy required to transmit a message from urce node to a destination node is the same as the energy required to transmit the same message from the destination node back to the source node for a given SNR (Signal to Noise Ratio). Moreover, it is assumed that the communication environment is contention and error free. Hence, there is no need for retransmission.

2. A percentage of the population of sensor nodes is equipped with more energy resources than the rest of the nodes. Let m be the fraction of the total number of nodes n, which are equipped with α times more energy than the others. We refer to these powerful nodes as advanced nodes, and the rest (1−m)×n as normal nodes. We assume that all nodes are distributed randomly over the sensor field.

3. Suppose that Eo is the initial energy of each normal sensor. The energy of each advanced node is then Eo* (1+α). The total (initial) energy of the new heterogeneous setting is equal to:

n * Eo * (1 + α * m)

So, the total energy of the system is increased by a factor of 1+α * m.

(i) each normal node becomes a cluster head once every 1 popt · (1+α ·m) rounds per epoch;

(ii) each advanced node becomes a cluster head exactly 1 + α times every 1 popt· (1+α·m) rounds per epoch;

and (iii) the average number of cluster heads per round per epoch is equal to n × popt

4. Cluster Head Election for normal nodes is based on equation given in (5).

5. Cluster Head Election for advanced nodes is based on equation given in (5)

6. Based on above equations and conditions, nodes sends the data to their respective cluster heads and energy consumption will be calculated.
7. Cluster Head will aggregate the data and send it to the base station and energy consumption will be calculated for each node and cluster heads.
8. In round 2, the nodes will become cluster heads according to probability condition i.e. according to minimum distance from base station and threshold energy.
9. After selection of cluster heads, Nodes sends the data to their respective cluster heads, that will be selected according to the minimum distance of a particular node from cluster heads and energy consumption will be calculated.
10. Cluster Head will aggregate the data and send it to the base station and energy consumption will be calculated.
11. Ten nodes will also go in sleep mode to enhance the network lifetime if their energy is less than 1 nJ. If the numbers increase then ten, then the nodes will come in active mode and send the data to nearby cluster head.
12. This process will be repeated until the whole network gets down or number of rounds finished. Performance will be evaluated according to parameters like network lifetime, energy dissipation, data packets sent etc.

6. CONCLUSION

Energy efficiency is one of the most important design constraints in wireless sensor network architectures. Therefore, to extend the lifetime of network, hierarchical routing is used. In hierarchical routing architecture, sensor nodes self-configure themselves for the formation of cluster heads. In this paper, we have surveyed various hierarchical routing techniques based on homogeneous wireless sensor network. We have proposed a routing technique for heterogeneous wireless sensor network based on stable election protocol (SEP). The modification in existing SEP protocol will enhance the network lifetime.

REFERENCES

[1] Nikolaos A. Pantazis, Stefanos A. Nikolidakis and Dimitrios D. Vergados, "Energy-Efficient Routing Protocols in Wireless Sensor Networks: A Survey", *IEEE COMMUNICATIONS SURVEYS & TUTORIALS*, VOL. 15, NO. 2, SECOND QUARTER 2013.

[2] I. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "Wireless Sensor Networks: A Survey", *Computer Networks (Elsevier)*, vol. 38, 2002, pp. 393–422.

[3] R. Shah and J. Rabaey, "Energy Aware Routing for Low Energy Ad Hoc Sensor Networks", *in the Proc. of the IEEE Wireless Communications and Networking Conference (WCNC)*, March 2002, Orlando, Florida, USA, vol. 1, 2002, pp. 350-355.

[4] S. Lindsey, and C.S. Raghavendra, "PEGASIS: Power Efficient Gathering in Sensor Information Systems", *in Proceedings of the IEEE Aerospace Conf.*, Big Sky, Montana, March 2002.

[5] A. Manjeshwar, and D.P. Agrawal, "APTEEN: A Hybrid Protocol for Efficient Routing and Comprehensive Information Retrieval in Wireless Sensor Networks", *in Proc. of the 2nd Int. Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile computing*, Ft. Lauderdale, FL, USA, April 2002.

[6] S. Ghiasi et al., "Optimal Energy Aware Clustering in Sensor Networks", *MDPI Sensors*, vol. 2, no. 7, July 2002, pp. 258–69.

[7] A. Manjeshwar and D. P. Agarwal, "TEEN: A Routing Protocol for Enhanced Efficiency in Wireless Sensor Networks", *in 1st Int. Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing*, San Francisco, USA, April 2001.

[8] P. Havinga, G. Smit, "Design Dechniques for Low-Power Systems", *Journal of Systems Architecture*, vol. 46 no. 5, 2000, pp. 1–21.

[9] V. Raghunathan, C. Schurgers, S. Park, M. Srivastava, "Energy Aware Wireless Micro sensor Networks", *IEEE Signal Processing Magazine*, vol. 19, 2002, pp. 40–50.

[10] R. Min, A. Chandrakasan, "A Framework for Energy -Scalable Communication in High-Density Wireless Sensor Networks", *Proceedings of the ACM Int. Symposium on Low Power Electronics and Design*, 2002, pp. 36–41.

[11]Georgios Smaragdakis, Ibrahim Matta and Azer Bestavros , "SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks" , Second International Workshop on Sensor and Actor Network Protocols and Applications (SANPA 2004).