Mr. Rajesh Halke, Mrs. Kulkarni V. A./ International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue4, July-August 2012, pp.2099-2102

En - LEACH Routing Protocol For Wireless Sensor Network

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ABSTRACT

A wireless network consisting of a large number of small sensors with low-power transceivers can be an effective tool for gathering data in a variety of environments like civil and military applications. The data collected by each sensor is communicated through the network to a single processing center called base station that uses all reported data to determine characteristics of the environment or detect an event. The communication or message passing process must be designed to conserve the limited energy resources of the sensors.

Leach Is Clustering based protocol that utilizes randomized rotation of local cluster-heads to evenly distribute the energy load among the sensors in the network. LEACH (Low-Energy Adaptive Clustering Hierarchy) uses localized coordination to enable scalability and robustness for dynamic networks, andincorporates data fusion into the routing protocol to reduce the amount of information that must be transferred to the base station. But LEACH is based on the assumption that each sensor nodes contain equal amount of energy which is not valid in real scenarios.

INTRODUCTION

The emerging field of wireless sensor networks combines sensing, computation, and communication into a single tiny device. The power of wireless sensor networks lies in the ability to deploy large numbers of tiny nodes that assemble and configure themselves. Usage scenarios for these devices range from real-time tracking, to monitoring of environmental conditions, to ubiquitous computing environments, to monitor the health of structures or equipment. Wireless sensor networks have the ability to dynamically adapt to changing environments. Hundreds of nodes scattered throughout a field assemble together, establish a routing topology, and transmit data back to a collection point. The application demands for robust, scalable, low-cost and easy to deploy networks are perfectly met by a wireless sensor network. If one of the nodes should fail, a new topology would be selected and the overall network would continue to deliver data [1, 2, 3, 4]

OBJECTIVE

The objective of this paper is to arrive at an energy-efficient communication protocol for sensor networks which is adaptable to non-uniform and dynamic energy distribution among The objective of this paper is to arrive at an energy-efficient communication protocol for sensor networks which is adaptable to non-uniform and dynamic energy distribution among the sensor nodes and the changing network configurations.

Challenge

It is important that microsensor networks be easily deployable, possibly in remote or dangerous environments. This requires that the nodes be able to communicate with each other even in the absence of an established network infrastructure. In addition, there are no guarantees about the locations of the sensors, such as the uniformity of placement. Events occurring in the environment being sensed may be time-sensitive. Therefore, it is often important to bind the end-to-end latency of data dissemination. Protocols should therefore minimize overhead and extraneous data transfers. In a microsensor network, data sensed by each node are required at a remote base station, rather than at other nodes, and the data are being extracted from the environment, leading to large amounts of correlation among data signals. Therefore, the notion of quality in a microsensor network is very different. For sensor networks, the end-user does not require all the data in the network because (1) the data from neighboring nodes are highly correlated, making the data redundant, and (2) the end-user cares about a higher-level description of events occurring in the environment the nodes are monitoring.

LEACH INTRODUCTION

Wireless micro-sensor networks will enable reliable monitoring of remote areas. These networks are essentially data-gathering networks where the data are highly correlated and the end-user requires a high-level description of the environment the nodes are sensing. In addition, these networks require ease of deployment, long system lifetime, and low-latency data transfers. The limited battery capacity of micro-sensor nodes and the large amount of data that each node may produce translates to the need for high application-perceived performance at a minimum cost, in terms of energy and latency.

The application that typical microsensor networks support is the remote monitoring of an environment. Individual nodes' data are correlated in a microsensor network, the end-user does not require all the (redundant) data; rather, the end-user needs a high-level function of the data

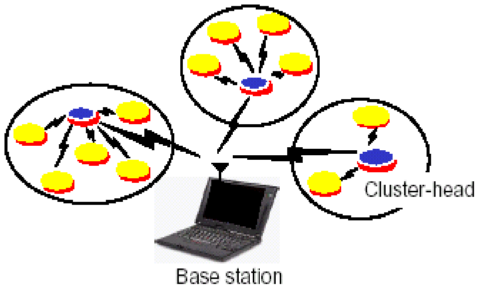

Figure 1-1: The LEACH protocol for microsensor networks.

LEACH includes adaptive, self-configuring cluster formation, localized control for data transfers, low-energy media access, and application-specific data processing.

In LEACH, the nodes organize themselves into local clusters, with one node acting as the cluster-head. All non-cluster-head nodes must transmit their data to the cluster-head, while the cluster-head node must receive data from all the cluster members, perform data aggregation functions on the data, and transmit data to the remote base station. Therefore, being a cluster-head node is much more energy-intensive than being a non-cluster-head node. In the scenario where all nodes are energy-limited, if the cluster-heads were chosen a priori and fixed throughout the system lifetime, as in a static clustering algorithm, the cluster-head sensor nodes would quickly use up their limited energy. Once the cluster-head runs out of energy, it is no longer operational.

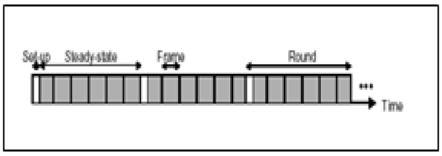

Figure 1-2: Time-line showing LEACH operation.

ADVANTAGES OF THE LEACH PROTOCOL

There are strong motivations behind selecting the LEACH as a baseline for our target En-LEACH protocol are:

- The LEACH protocol assumes all the nodes to be similar in their capabilities and doesn't require the cluster head nodes to be more efficient than the others in any respect.
- It successfully distributes the energy load over all the nodes of the sensor network by dynamically rotating the cluster-head functionality among the nodes.
- It makes the cluster-head decision and selection process truly distributed without requiring a central arbitrator for these decisions.
- It uses the data aggregation strategy, this strategy help in making a judicious use of the node energies and avoids the inefficiencies associated with data replication.

NEW PROPOSALS TO ENHANCE THE LEACH PROTOCOL

The modifications and enhancements to the LEACH protocol as follows

2.1. Changes Proposed in Cluster Setup Phase to handle Non-Uniform Energy Distribution

In LEACH, probability of becoming a cluster-head is based on the assumption that all nodes start with an equal amount of energy, and that all nodes have data to send during each frame. If nodes begin with different amounts of energy, the nodes with more energy should be cluster-heads more often than the nodes with less energy, in order to ensure that all nodes die at approximately the same time.

2.2. Changes proposed in Data Transmission Phase

Since failure of cluster-head is a big problem in LEACH protocol and chances of its failure are more in data transmission phase, because this phase involves more energy dissipation compared to other phases in LEACH. So a method should be evolved where failure of cluster-head can be conveyed to its cluster members, which will help in saving a lot of energy of its cluster members.

En-LEACH INTRODUCTION

ENHANCED-LEACH (En-LEACH) protocol as the enhancements and innovations devised in thisprotocol has following objectives:

- To handle cluster-head failure
- To account for the non-uniform and dynamic residual ***energy*** of the nodes

Protocol rounds are repeated with a periodicity *Tr*, with each round consisting of the following phases.

3.1.1. Advertisement Phase

The first round (i.e. round number zero) is started by each node calculating Threshold value (or probability to become cluster-head) using same method as used in LEACH protocol and comparing the threshold value with random no (0 to 1) selected by the node. If the threshold value is greater than the random number chosen then the node becomes the cluster-head for this round. Hence the probability of becoming cluster-head in round zero is given as:

$$P(n) = p/(1-(p*(r \bmod 1/p)))$$

$$P(n) = \text{Energy of node/Total Energy of the Cluster}$$

Here p indicates optimum number of cluster-head in a round (5 % as suggested by LEACH) and r denotes round number.

Actually during Data Transmission phase of each round every member sends data along with information of its residual energy to their cluster-head and based on this information, the cluster-head decides which node will become the future cluster head. This is done by calculating the probability of becoming cluster head as a function of node energy divided by total energy of the cluster.

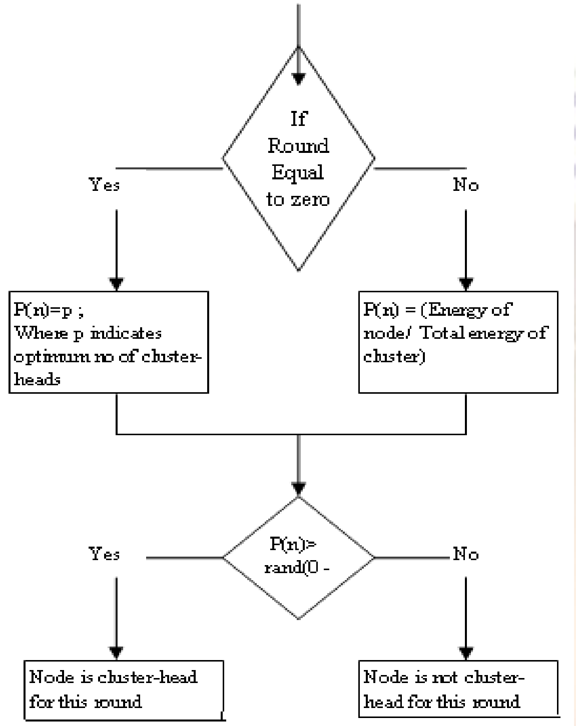

Figure 3-1: Cluster-head decision in En-LEACH protocol

Each node that has elected itself a cluster-head for the current round broadcasts an advertisement message to the rest of the nodes. For this "cluster-head-advertisement" phase, the cluster-heads use a CSMA MAC protocol, and all cluster-heads transmit their advertisement using the same transmit energy. The advertisement message contains the following fields:

- The advertisement message flag ADVERTISE_MESSAGE
- Cluster-head id
- Cluster-head location

3.1.2. Cluster Set-up Phase

After each node has decided to which cluster it belongs, it must inform the cluster-head node that it will be a member of the cluster. Each node transmits this information back to the cluster-head again using a CSMA MAC protocol through selection message. The contents of the selection message are:

- The selection message flag CLUSTER_SELECT_MESSAGE
- Cluster-head identity
- Self node id

3.1.3. Schedule Creation Phase

The cluster-head node receives all the messages for nodes that would like to be included in the cluster. Based on the number of nodes in the cluster, the cluster-head node creates a TDMA schedule telling each node when it can transmit. This schedule is broadcast back to the nodes in the cluster.
The schedule creation broadcast message consists of the following fields:

- The schedule message flag SCHED_MESSAGE
- The CDMA spreading code to be used for communications within the cluster
- The TDMA schedule consisting of *N* number of {node-identity(node_id) – TDMA time-slot} pairs

3.1.4. Data Transmission Phase (Steady-state Phase)

Once the clusters are created and the TDMA schedule is fixed, data transmission can begin. If the nodes have data to send, they send it during their allocated transmission time to the cluster head. The cluster-head node must keep its receiver on to receive all the data from the nodes in the cluster. Also in this case each member node must keep their receiver on to receive cluster-head status.
A data message which is sent to cluster-head consists of the following fields:

- The Data message flag DATA_MESSAGE
- Identity of the source node *n*
- Cluster-head id
- Residual energy left in node n ,E(n)
- The actual data if any

The cluster-head status message contain following field:

- The message flag CLUSTER_HEAD_DOWN
- The cluster-head id
- The probability of becoming cluster-head for each node i.e. (P(n) , node id) pair.

Where P(n) = Energy of the node/total energy of the cluster.

3.1.5. Future Cluster-head Update Phase

If the cluster-head is alive even after data transmission phase then it can update the probability of each of its members becoming future cluster head by sending following update message:

- The message flag CLUSTER_UPDATE_MESSAGE
- Cluster-head id (it's own id)
- Probability of each of its members { node id(n), P(n)} in pair.

RESULT

EN-LEACH protocol was simulated and compared with LEACH protocol both in uniform and non-uniform energy distribution scenario.

4.1. Uniform Energy Distribution

Once a node runs out of energy, it is considered dead and can no longer transmit or receive data. For these simulations, energy is removed whenever a node transmits or receives data.

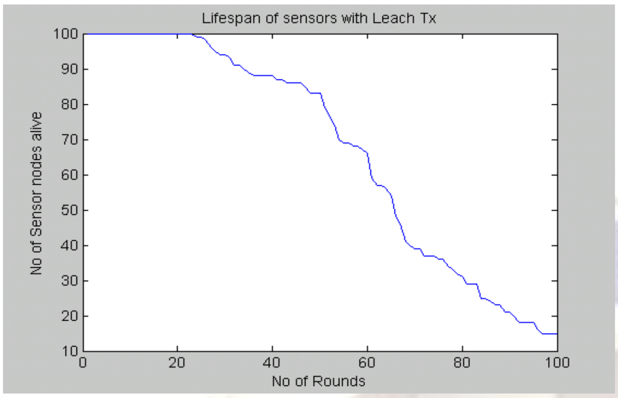

Figure 4-1: System lifetime - LEACH protocol

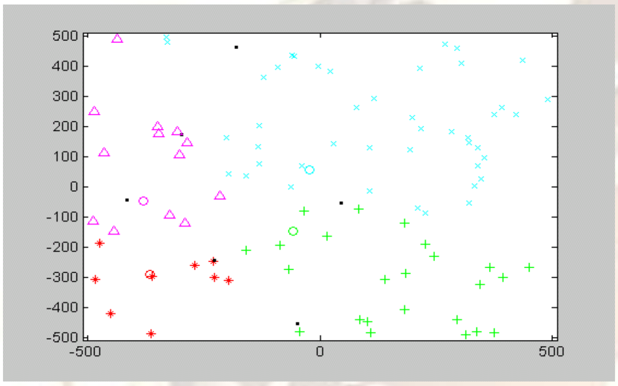

Figure 4-2: Sensors that remain alive (Non dot) and those that are dead (dots) after 31 round for LEACH protocol.

Clusters are indicated using different colors

The results can be summarized as follows

- The first death in En-LEACH occurs at round 38, whereas in case of LEACH the first node dies at round 22, hence first node death is approximately 2 times later than the LEACH protocol.
- Also the last node death in En-LEACH occurs much later than the last node death in case of LEACH.

CONCLUSION

In LEACH, there may be a case when cluster-head chosen which having less amount of energy as compared to its cluster member nodes, which will result in early death of cluster-head. But in case of En-LEACH, cluster-head depending upon energy left in the node, hence it is bound to perform better than LEACH.

In En-LEACH, all cluster members are kept informed about the status of their cluster-head (whether it is alive or dead), since the probability of failure ofcluster-head is high during data transmission phase (due to energy required for data aggregation and long distance data transmission).

This provision is missing in LEACH protocol.

- En-LEACH is more effective; producing high level information about the environment the nodes are monitoring in an energy-efficient way.
- En-LEACH is able to handle non-uniform energy distribution of sensor nodes which is an important characteristic of a dynamic sensor networks.

REFERANCES:

1. Malik Tubaishat and Sanjay Madria. *Sensor networks: an overview*. In IEEE Potentials, April/May 2003, Pages: 20–23
2. Deborah Estrin, David Culler, Kris Pister andGauravSukhatme. *Connecting the Physical World with Pervasive Networks*. In IEEE Pervasive Computing, Volume 1, Issue 1 (January 2002), Pages: 59–69.
3. Berkeley, University of California, 800 node self-organized wireless sensor network. 2001: http://today.cs.berkeley.edu/800demo/
4. System Architecture for Wireless Sensor Networks: http://www.jlhlabs.com/jhill_cs/jhill_thesis.pdf.Wendi Rabiner Heinzelman, Anantha Chandrakasan, and Hari Balakrishnan. *Energy-Efficient Communication Protocol for Wireless Microsensor Networks*. In Proceedings of the Hawaii International Conference on System Sciences, January 4-7, 2000, Maui, Hawaii.
5. Wendi RabinerHeinzelman, AnanthaChandrakasan, and HariBalakrishnan , An Application-specific Protocol Architecture for Wireless Microsensor Networks ,in IEEE transaction on wireless communications ,vol-1, no-4, October 2002. http://www.sigmobile.org/phd/2000/thesis/heinzelman.pdf.
6. M. Bhardwaj and A. Chandrakasan. Power Aware Systems, presented at the 34th Asilomar Conference on Signals, Systems and Computers, November 2000.
7. X. Lin and I. Stojmenovic. *Power-Aware Routing in Ad Hoc Wireless Networks*. In SITE, University of Ottawa, TR-98-11, Dec. 1998.
8. J. Broch, D. Maltz, D. Johnson, Y. Hu, and J. Jetcheva. A Performance Comparison ofMulti-Hop Wireless Ad Hoc Netowrk Routing Protocols. In Proc. 4th ACM InternationalConference on Mobile Computing and Networking (Mobicom'98), October 1998.