Multi-Hop Data Communication for Cluster based Wireless Sensor Networks: A Review

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ABSTRACT

One of the important restrictions in wireless sensor network is energy constraint. Many protocols have been suggested for cluster head selection such as LEACH, HEED, and PEGASIS. In some clustering schemes, the communication between a cluster member and its cluster head (CH) is supposed to be single-hop. However, multihop communication is often required as communication range of the sensor nodes is limited or when the number of sensor nodes is very large in a network. In this paper we present a study of protocols which are used in increasing energy efficiency of the Wireless Sensor Network such as Low Energy Adaptive Clustering Hierarchy (LEACH), Hybrid Energy Efficient Distributed Clustering (HEED), and Power Efficient Gathering in Sensor Information Systems (PEGASIS). Finally we conclude this paper.

I. INTRODUCTION

Recent advances in micro electromechanical systems-(MEMS-) based technology have motivated the deployment of tiny, low-cost sensor nodes that possess sensing, signal processing, and wireless communication capabilities. A WSN can sense a region or phenomenon of interest and provide useful information about it by combining measurements taken by individual sensor nodes and then routed over the wireless interface to a base station. All Sensor nodes have limited capabilities. Base station has more resources in terms of computing power, memory and energy. Base station determines special characteristics specific to an environment to detect an event.A sensor node includes four basic components: a sensing subsystem, a processing subsystem, a wireless communication subsystem and a power supply subsystem consisting of a battery with a limited energy budget. Moreover, additional components can also be integrated such as a power generator, a mobilizer and a location finding system. The most important issue regarding WSN is energy consumption. As sensor nodes are deployed in hostile region so it is impossible to recharge the battery. Sensor nodes should have an enough lifetime to fulfill the requirements of application. The radio unit of sensor node is most important as it consumes much energy. Our aim is to optimize the energy consumption in WSN. Most of energy is consumed during communication.

II. BACKGROUND

According to network organization, routing protocol can be from one of the following:

- Data centric protocols: Based on naming of desired data, which helps in removing many redundant transmissions.
- Location based protocols: These protocols make use of position information to forward the data to the desired nodes rather than the whole network.
- Hierarchical: These protocols are based on clustering the nodes so that cluster heads can do some aggregation and reduction in transmission in order to save energy. How sensor nodes communicate to forward data to base station depends on routing protocol used for WSN. Various routing protocols have been proposed for WSN [1].

Our objective is to propose an energy efficient routing scheme for WSN. A routing protocol is said to be energy efficient if it ensures both less energy consumption over time and balanced energy consumption among sensor nodes. The WSN design often employs some approaches as energy-aware techniques, data aggregation, clustering and multi-hop communication to extend the network life time.Cluster based protocols claims more energy efficiency as compared to other protocols. Cluster based protocols differentiates between cluster head and cluster member node. Cluster head (CH) node performs data aggregation and reduces data to be forwarded to base station. Cluster member nodes sense data and send data to cluster head. Cluster head nodes perform data aggregation and send aggregated data to base station. As communication range of sensor nodes is limited, therefore it is not possible for all cluster head nodes to communicate directly to

base station. Also if all cluster heads communicate directlywith base station then more energy is consumed as compared to multihop communication. Therefore cluster heads should send data to base station using multihop communication. Most important research issue regarding cluster based protocols is that how to form clusters to optimize energy consumption. Now it is also possible for nodes to remain disconnected from the network due to a cluster head not being in range, then each disconnected node can request another connected node to become a cluster head [7]. Therefore a combination of Intercluster multihop communication and intracluster multihop communication should be used to improve
WSN lifetime in cluster based protocols.

2.1 Clustering Objectives:

 Load balancing: It prevents the exhaustion of the energy of a subset of CHs at high rate so that a sub region will not remain uncovered by sensors. Increased connectivity and reduced delay: The connectivity goal can be just limited to ensuring the availability of a path from every CH to the base-station or be more restrictive by imposing a bound on the length of the path. Maximal network longevity: When CHs are richer in resources than sensors, it is imperative to minimize the energy for intra-cluster communication. On the other hand, when CHs are regular sensors, their lifetime can be extended by limiting their load and by rotating the role of cluster heads among the members. Adaptive clustering is also a choice for achieving network longevity.

III. RELATED WORKS

Many clustering protocols have been proposed[2]. In cluster based protocols, CH nodes deplete energy more quickly as compared to cluster member nodes because CH performs data aggregation before transmitting data to base station. This means CH requires extra processing which leads to CH nodes expiring before other nodes. It is desirable to ensure that all the nodes run out of their battery at about the same time, so that very little residual energy is wasted when the system expires [3]. One idea is switching the cluster head role among all the sensor nodes as proposed in [4],[5],[6]. Clustering algorithms are composed of two phases namely, set-up phase and steady state phase. Important issue regarding cluster based protocols is how to select cluster head node. LEACH (low-energy adaptive clustering hierarchy) [4] guarantees that the energy load is distributed by dynamically created clusters in each round and the CHs are dynamically selected according to a threshold value (T (n)).consumption on CHs is distributed. LEACH does not consider the residual energy of each node therefore the nodes with relatively smaller energy remaining can become CHs. This makes the network lifetime shortened. Also all cluster heads communicate directly with base station which results in more energy consumption. Multihop-LEACH does inter cluster and intra cluster multi-hoping. The protocol is evaluated using TinyOs and TOSSIM simulator. Evaluation results reveal that Multihop- LEACH protocol utilizes less power and least delay. The connectivity, success rate and power utilization of Multihop- LEACH is further improved by increasing the probability of clustering. HEED (hybrid energy efficient distributed clustering) [5] is a distributed clustering protocol that considers a hybrid of energy and communication cost when selecting CHs. Only sensors that have a high residual energy can become CHs. In HEED each node is mapped to exactly one cluster and can directly communicate with its CH. The algorithm is divided into three phases:

1. Initialization phase: The algorithm first decides an initial percentage of CHs and then calculates its probability of becoming a CH based on the current energy and the maximum energy in the sensor.
2. Repetition phase: Every sensor goes through several iterations until it finds a CH to which it can transmit data with the least transmission power. If it does not hear from any CH, the sensor declares itself to be a CH to neighbors. Finally, each sensor doubles its CH probability and enters in next iteration of this phase. This continues till the CH probability value reaches 1HEED does not consider load balancing of clusters.
3. Finalization phase: Each sensor makes a final decision and it either picks the least cost CH or declares itself as the CH. Simulations have shown that HEED is better than LEACH in improving the network life time. PEGASIS (power-efficient gathering in sensor information systems) [6] is a chain based protocol. All the nodes in the network will be organized to form a chain with aleader node which is responsible for passing the final data to the BS. The node chain can be accomplished by using a greedy algorithm starting from some node, usually the farthest node from the BS. When a node dies, the chain is reconstructed bypassing the dead node. For gathering data in a chain, each node receives data from one neighbour, fuses with its own data, and transmits the data to the other neighbor. Simulation results show that PEGASIS outperforms LEACH.

IV. CONCLUSION

As many of cluster based protocols are based on local properties, therefore clusters formed are not optimal. In LEACH and HEED, each node probabilistically decides on its role and hence cannot guarantee optimal distribution of cluster heads. We need to concentrate on load balanced energy efficient cluster based protocols that involves a combination of energy minimizing techniques like multihop, clustering and data aggregation.

V. REFRENCES

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