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Review on Routing Protocol SEP of WSN

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ABSTRACT:
We study the impact of heterogeneity of nodes, in terms of their energy, in wireless sensor networks that are hierarchically clustered. In these networks some of the nodes become cluster heads, aggregate the data of their cluster members and transmit it to the sink. We assume that a percentage of the population of sensor nodes is equipped with additional energy resources—this is a source of heterogeneity which may result from the initial setting or as the operation of the network evolves. We also assume that the sensors are randomly (uniformly) distributed and are not mobile, the coordinates of the sink and the dimensions of the sensor field are known. We show that the behavior of such sensor networks becomes very unstable once the first node dies, especially in the presence of node heterogeneity.

KEYWORD: - WSN, Clustering Head, SEP

I. INTRODUCTION:

In this section we describe our model of a wireless sensor network with nodes heterogeneous in their initial amount of energy. We particularly present the setting, the energy model, and how the optimal number of clusters can be computed. Let us assume the case where 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 $(1-m)\times n$ as normal nodes. We assume that all nodes are distributed uniformly over the sensor field.

CLUSTERING HIERARCHY:

We consider a sensor network that is hierarchically clustered. The LEACH (Low Energy Adaptive Clustering Hierarchy) protocol [3] maintains such clustering hierarchy. In LEACH, the clusters are re-established in each "round." New cluster heads are elected in each round and as a result the load is well distributed and balanced among the nodes of the network. Moreover each node transmits to the closest cluster head so as to split the communication cost to the sink (which is tens of times greater than the processing and operation cost.) Only the cluster head has to report to the sink and may expend a large amount of energy, but this happens periodically for each node. In LEACH there is an optimal percentage popt (determined a priori) of nodes that has to become cluster heads in each round assuming uniform distribution of nodes in space [3], [4], [6], [7]. If the nodes are homogeneous, which means that all the nodes in the field have the same initial energy, the LEACH protocol guarantees that everyone of them will become a cluster head exactly once every 1 popt rounds.

OPTIMAL CLUSTERING:

Previous work have studied either by simulation [3], [4] or analytically [6], [7] the optimal probability of a node being elected as a cluster head as a function of spatial density when nodes are uniformly distributed over the sensor field. This clustering is optimal in the sense that energy consumption is well distributed over all sensors and the total energy consumption is minimum. Such optimal clustering highly depends on the energy model we use. For the purpose of this study we use similar energy model and analysis as proposed in [4].

II. PERFORMANCE MEASURES:

We define here the measures we use in this paper to evaluate the performance of clustering protocols.

- Stability Period: is the time interval from the start of network operation until the death of the first sensor node. We also refer to this period as "stable region."
- Instability Period: is the time interval from the death of the first node until the death of the last sensor node. We also refer to this period as "unstable region."
- Network lifetime: is the time interval from the start of operation (of the sensor network) until the death of the last alive node.
- Number of cluster heads per round: This instantaneous measure reflects the number of nodes which would send directly to the sink information aggregated from their cluster members.
- Number of alive (total, advanced and normal) nodes per round: This instantaneous measure reflects the total number of nodes and that of each type that have not yet expended all of their energy.
- Throughput: We measure the total rate of data sent over the network, the rate of data sent from cluster heads to the sink as well as the rate of data sent from the nodes to their cluster heads.

Clearly, the larger the stable region and the smaller the unstable region are, the better the reliability of the clustering process of the sensor network is. On the other hand, there is a tradeoff between reliability and the lifetime of the system. Until the death of the last node we can still have some feedback about the sensor field even though this feedback may not be reliable. The unreliability of the feedback stems from the fact that there is no guarantee that there is at least one cluster head per round during the last rounds of the operation. In our model, the absence of a cluster head in an area prevents any reporting about that area to the sink. The throughput measure captures the rate of such data reporting to the sink.

- mobile ad hoc networks (MANETs)
- wireless mesh networks
- Wireless sensor networks.

III. MOTIVATION:

Wireless Sensor Networks are networks of tiny, battery powered sensor nodes with limited on-board processing, storage and radio capabilities [1]. Nodes sense and send their reports toward a processing center which is called "sink." The design of protocols and applications for such networks has to be energy aware in order to prolong the lifetime of the network, because the replacement of the embedded batteries is a very difficult process once these nodes have been deployed. Classical approaches like Direct Transmission and Minimum Transmission Energy [2] do not guarantee well balanced distribution of the energy load among nodes of the sensor network. Using Direct Transmission (DT), sensor nodes transmit directly to the sink, as a result nodes that are far away from the sink would die first [3]. On the other hand, using Minimum Transmission Energy (MTE), data is routed over minimum-cost routes, where cost reflects the transmission power expended. Under MTE, nodes that are near the sink act as relays with higher probability than nodes that are far from the sink. Thus nodes near the sink tend to die fast. Under both DT and MTE, a part of the field will not be monitored for a significant part of the lifetime of the network, and as a result the sensing process of the field will be biased. A solution proposed in [4], called LEACH, guarantees that the energy load is well distributed by dynamically created clusters, using cluster heads dynamically elected according to a priori optimal probability. Cluster heads aggregate reports from their cluster members before forwarding them to the sink. By rotating the cluster-head role uniformly among all nodes, each node tends to expend the same energy over time.

Most of the analytical results for LEACH-type schemes are obtained assuming that the nodes of the sensor network are equipped with the same amount of energy—this is the case of homogeneous sensor networks. In this paper we study the impact of heterogeneity in terms of node energy. We assume that a percentage of the node population is equipped with more energy than the rest of the nodes in the same network— this is the case of heterogeneous sensor networks. We are motivated by the fact that there are a lot of applications that would highly benefit from understanding the impact of such heterogeneity. One of these applications could be the re-energization of sensor networks. As the lifetime of sensor networks is limited there is a need to re-energize the sensor network by adding more nodes. These nodes will be equipped with more energy than the nodes that are already in use, which creates heterogeneity in terms of node energy. Note that due to practical/cost constraints it is not always possible to satisfy the constraints for optimal distribution between different types of nodes as proposed in [5].

IV. LITRETURE SURVEY:

In addition to related work cited throughout the synopsis, in this section we review specific prior studies that dealt with the heterogeneity in energy of sensor nodes.

The first work that questioned the behavior of clustering protocols in the presence of heterogeneity in clustered wireless sensor networks was [8]. In this work Heinemann analyzed a method to elect cluster heads according to the energy left in each node. The drawback of this method is that this decision was made per round and assumed that the total energy left in the network was known. The assumption of global knowledge of the energy left in the whole network makes this method difficult to implement. Even a centralized approach of this method would be very complicated and very slow, as the feedback should be reliably delivered to each sensor in every round.

In [10], Duarte-Melo and Liu examined the performance and energy consumption of wireless sensor networks, in a field where there are two types of sensors. They consider nodes that are fewer but more powerful that belong to an overlay. All the other nodes have to report to these overlay nodes, and the overlay nodes aggregate the data and send it to the sink. The drawback of this method is that there is no dynamic election of the cluster heads among the two types of nodes, and as a result nodes that are far away from the powerful nodes will die first. The authors estimate the optimal percentage of powerful nodes in the field, but this result is very difficult to use when heterogeneity is a result of operation of the sensor network and not a choice of optimal setting.

In [5], Mhatre and Rosenberg presented a cost-based comparative study of homogeneous and heterogeneous clustered wireless sensor networks. They proposed a method to estimate the optimal distribution among different types of sensors, but again this result is hard to use if the heterogeneity is due to the operation of the network. They also studied the case of multichip routing within each cluster (called M-LEACH). Again the drawback of the method is that only powerful nodes can become cluster heads (even though not all powerful nodes are used in each round.) Furthermore, M-LEACH is valid under many assumptions and only when the population of the nodes is very large.

Other power-aware routing schemes [11], [12] assume that the exact position of each node is known a priori (e.g. each node is equipped with GPS, which increases the cost per node), and that initially, nodes are homogeneous. Such strong assumptions and especially centralized solutions [12], may not be applicable for low-cost, large-scale networks.

V. SEP DEPLOYMENT:

As mentioned in Section I, the heterogeneity in the energy of nodes could result from normal network operation. For example, nodes could, over time, expend different amounts of energy due to the radio communication characteristics, random events such as short-term link failures or morphological characteristics of the field (e.g. uneven terrain.) To deal with such heterogeneity, our SEP protocol could be triggered whenever a certain energy threshold is exceeded at one or more nodes. Non-cluster heads could periodically attach their remaining energy to the messages they send during the handshaking process with their cluster heads, and the cluster heads could send this information to the sink. The sink can check the heterogeneity in the field by examining whether one or a certain number of nodes reach this energy threshold. If so, then the sink could broadcast to cluster heads in that round the values for pnrm and padv, in turn cluster heads unicast these values to nodes in their clusters according to the energy each one has attached earlier during the handshaking process.

If some of the nodes already in use have not been programmed with this capability, a reliable transport protocol, such as the one proposed in [9], could be used to program such sensors. Evaluating the overhead of such SEP deployment is a subject of our on-going work.

VI. CONCLUSION:

We proposed SEP (Stable Election Protocol) so every sensor node in a heterogeneous two-level hierarchical network independently elects itself as a cluster head based on its initial energy relative to that of other nodes. Unlike [8], we do not require any global knowledge of energy at every election round. Unlike [10], [5], SEP is dynamic in that we do not assume any prior distribution of the different levels of energy in the sensor nodes. Furthermore, our analysis of SEP is not only asymptotic, i.e. the analysis applies equally well to small sized networks. Finally SEP is scalable as it does not require any knowledge of the exact position of each node in the field.

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