Review on Dynamic Clustering and Energy Conservation in WSN

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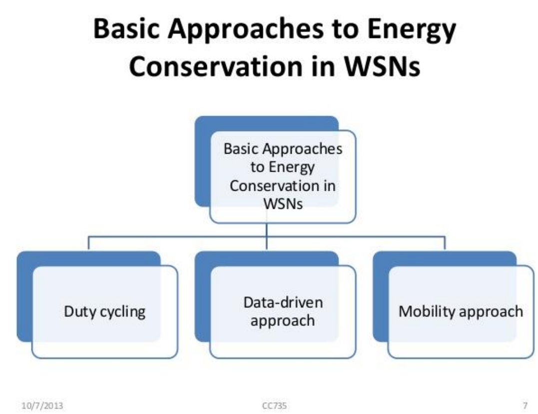
Abstract- **In the last years, wireless sensor networks (WSNs) have gained increasing attention from both the research community and actual users. As sensor nodes are generally battery-powered devices, the critical aspects to face concern how to reduce the energy consumption of nodes, so that the network lifetime can be extended to reasonable times. In this paper we first break down the energy consumption for the components of a typical sensor node, and discuss the main directions to energy conservation in WSNs. Then, we present a systematic and comprehensive taxonomy of the energy conservation schemes, which are subsequently discussed in depth. Special attention has been devoted to promising solutions which have not yet obtained a wide attention in the literature, such as techniques for energy efficient data acquisition. Finally we conclude the paper with insights for research directions about energy conservation in WSNs.**

I. INTRODUCTION

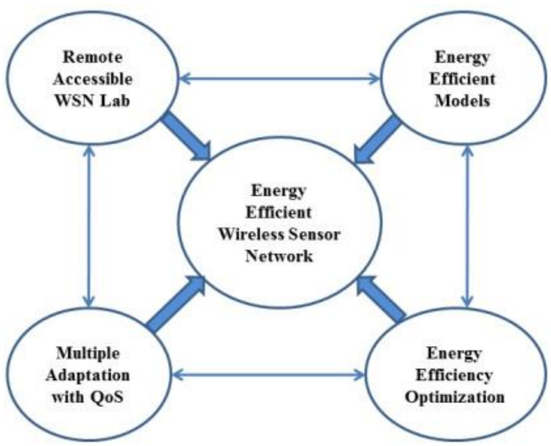
Wireless sensor networks (WSNs) are used in many domains, such as military surveillance, disaster management, forest fire detection, seismic detection, habitat monitoring, biomedical health monitoring, inventory tracking, animal tracking, hazardous environment sensing and smart spaces, general engineering, commercial applications, home applications, underwater applications, etc [1]. Indeed, according to [2], WSNs are considered to be one of the new technologies that will change our life, they are listed, also in [3], as one of the key technologies of the internet of things. The sensor nodes (or motes) are physical entities characterized by:

(i) Battery with a limited energy;
(ii) Processor with limited processing capabilities; and
(iii) Transceiver [4].

The nodes can be deployed in monitoring areas in order to gather multiple types of information (e.g., humidity, light, temperature, wind,...) and then transmit the gathered information to the gateway sensor node (Access Point or Sink), possibly using multi-hop routing strategy [5]. In turn, the sink transmits the collected information to the end users. Since it might often be difficult to replace exhausted batteries (e.g., WSNs may be deployed in inaccessible areas) [6], extending the lifetime of the WSN is crucial. In the literature, many papers show that the source of highest energy consumption in the sensor node is the transceiver [7], making strategies which minimize the use of the transceiver very attractive. Several techniques can be used to save energy, among which clustering consists in grouping sensors in several clusters, so that each cluster has a single cluster-head and several cluster members. In each cluster, the cluster-members gather information on the sensed area and send it to the cluster-head.



In a clustered WSN, data collected by the sensors is communicated to its cluster-head, for data processing and redundancy elimination. Therefore, sensors communicate data over short distances in each cluster (to cluster-heads), so that the energy spent in communication will be lower than that spent with sensors communicating directly to the sink [8]. Clustering can be static or dynamic. In a static scenario, the cluster-heads are fixed and tend to exhaust their energies rapidly, making this clustering unsuitable for WSNs [9]. In fact, the network becomes nonfunctional in the absence of cluster-heads. In the presence of dynamic clustering, the clusters change over the time, equalizing the energy consumption across all nodes and, thus, extending the network lifetime. In this paper, our goal is to maximize network lifetime (defined as the time interval from the nodes' deployment to the instant at which a given percentage of deployed nodes die [6]) by minimizing the average energy consumption of all nodes. In order to do this, all nodes can be promoted to the role of cluster heads. In order to reach this goal and guarantee full coverage (i.e., the clusters are spread over the entire network), we rely of on the use of a genetic algorithm (GA), which determines, in each cycle, whether or not a node can be chosen to play the role of a cluster-head.



The aim of this paper is to propose a universal framework that enhances the operation efficiency of WSNs by defining dynamic clustering, optimizing number of sensor nodes inevent reporting and cooperative communication techniques.

It is expected that the proposed framework can support applications that require WSNs to perform sensing for a predefined time referred to as time-driven sensing or to perform sensing based on events referred to as event-driven sensing. Moreover, the proposed framework is also expected to support those applications that required time driven sensing as well as event triggered sensing referred to as hybrid sensing. The dynamic behavior of the proposed framework is expected to provide a trade-off model between energy conservation and detection reliability. The main contributions of this paper are as follows:

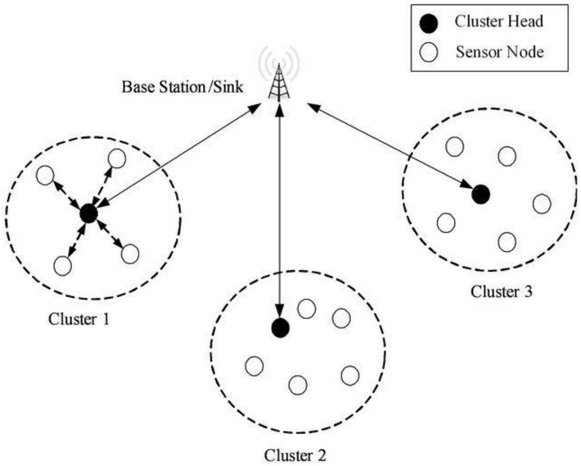
(i) A dynamic clustering as well as neighborhood formation framework for WSNs is proposed where collaborative sensing is permitted. The proposed framework provides an energy efficient solution by uniformly distributing thenetwork load among sensor nodes and carefully selecting the candidate sensor nodes for event reporting.

(ii) The proposed framework is universal in nature for its functionality requirement within a WSN, i.e. independent of the sensing parameters. This provides the system design engineer with a tool for lifetime approximationmodeling to configure the network for a diverse range of applications by fine-tuning the following parameters i.e. cluster head selection threshold and neighborhood selection criterion.

(iii) The dynamic behavior of the proposed framework is adopted with a proposed channel quality indexing (CQI) scheme in the context of WSNs. This scheme provides a trade-off model for transmission reliability and network lifetime by dynamically reconfiguring the network according to radio frequency propagation environment conditions while maintaining required quality of service.

II. LITERATURE SURVEY

The literature LEACH (Low-Energy Adaptive Clustering Hierarchy) proposed a clustering-based routing protocol that minimizes global energy usage by distributing the load to all the nodes at different points in time. A fixed clustering based approach to prolong the lifetime of sensor networks employing data aggregation is described in literature. The literature RDAG is an approach of Data aggregation by reducing the number of transmissions which is an effective approach to save energy by using the concept of LEACH. The literature and says that energy consumption in a WSN varies with the transmission range. Reducing the transmission range will reduce the power consumed in transmitting a packet toward the neighbors. The major drawback of LEACH is that it does not support dynamic clustering so to overcome this we propose dynamic clustering protocol that refreshes clusters periodically. Cluster formation is based on residual energy, cost. Our proposed method supports sleep and wait technology where in only energy is consumed only on demand. On demand energy consumption helps in proper network utilization as well as enhancing network lifetime by minimizing energy consumption. To best of our knowledge none of the previous work has included all these factors in a single work.



III. RESEARCH METHODOLOGY

In order to conserve energy of sensor nodes within WSNs, it is expected to distribute the load of performing tasks among the sensor nodes to balance the energy consumption within the network, select optimum number of sensor nodes to report significant occurrences and to perform reliable communication to relay sensing data to fusion center receiver. Generally, sensing within WSNs can be realized into time-driven and event-driven scenario. In time-driven sensing, the sensor nodes relay acquired data to fusion center receiver on a periodic basis. While in event-driven sensing the sensor nodes are responsible to detect significant occurrences and report it to fusion center receiver. In this paper, a dynamic clustering and neighborhood formation scheme is proposed for time driven and event-driven applications. Moreover, a universal framework is proposed for adaptive utilization of both the aforementioned sensing scenario to enhance its feasibility of implementation for a diverse range of applications. Moreover, the dynamic allocation of degree of cooperation based on channel propagation conditions is also considered. Within the proposed UDCS framework, all the decisions such as the selection of cluster heads, formation of clusters as well as neighborhoods and the selection of cooperative sensor nodesfor reporting to fusion center are made locally within the respective clusters throughout the network. Such distributive decision making ability facilitate the proposed UDCS framework to be energy efficient, as this reduces the amount of information to be broadcasted or transmitted wirelessly to represent an event.

IV. CONCLUSION

The proposed framework incorporates a dynamic clustering scheme that ensures even distribution of energy demand among sensor nodes and a neighborhood formation scheme to optimize the number of sensor nodes involved in the detection and reporting of events. A soft or hard decision based tuneable thresholding parameter for the selection of cluster heads is also presented to facilitate the system design engineer to optimize the frequency of re-clustering within the network. The proposed dynamic clustering and neighborhood formation scheme is fully decentralized which reduces the amount of information required to be broadcasted.

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