STUDY ON VARIOUS METHODS TO MAXIMIZE THE LIFETIME OF WIRELESS SENSOR NETWORKS

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ABSTRACT

Wireless sensor network (WSN) consists of tiny sensor nodes with sensing, computation and wireless communication capabilities. Now days, it is finding wide applicability and increasing deployment, as it enables reliable monitoring and analysis of environment. Lifetime maximization relates with various factors such as throughput, end to end delay, lifetime parameter such as time, output, packet delivery rates, no. of nodes, nodes efficiency and operating frequency to operate and relate each parameter. Balancing energy consumption and prolonging network lifetime are open challenges in Wireless Sensor Networks. In the research field of WSNs how to reduce the energy consumption of WSN so that the lifetime of WSN can be prolonged is one of the hottest spots. In this paper we survey various methods to maximize the lifetime of wireless Sensor Networks highlighting their objective, features, complexity etc.

***Keywords**: Wireless Sensor Networks, Lifetime, Energy Consumption, Throughput, Delay, Packet Delivery Rate.*

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I. INTRODUCTION

A WSN consists of hundreds to thousands of sensor nodes that have the ability to communicate among themselves using radio antenna. A WSN node mainly consists of four main parts: Processing unit, Sensor, Transceiver, Energy Source Unit which is shown in figure 1. These nodes are usually small in size with limited processing power, limited memory and limited energy source [1]. In WSNs, the sensor devices are very constrained in terms of battery power. The lifetime of an individual sensor node is equal to the lifetime of the battery [11]. Sensor nodes in WSNs have non- rechargeable batteries. At the same time, it is not easy to replace batteries because WSNs are deployed generally in inhospitable environments like forests, sea and battle-fields. The base station (BS) is a special node in a WSN which connects the sensor nodes to the outside world. The BS is equipped with a battery with sufficient capacity and it is not supposed to fail due power shortage [11]. The base station (BS) is a special node in a WSN which connects the sensor nodes to the outside world. The BS is equipped with a battery with sufficient capacity and it is not supposed to fail due power shortage. Although, the BS has sufficient battery power, the nodes which are in the proximity of it have limited battery power [11]. The information generated by other nodes will ship to the BS via the nodes which are nearer to it. The only way to make the WSN alive for longer time is to use the battery power efficiently [3]. In this paper a survey on different methods to Maximize the lifetime of wireless sensor networks has been done.

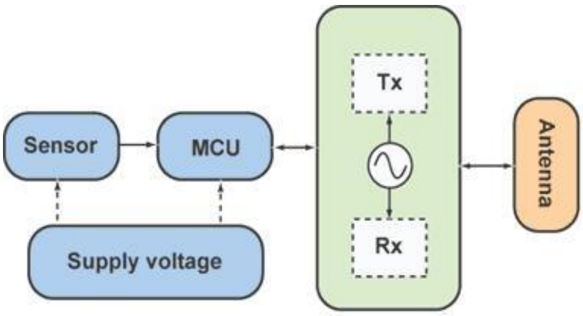

Figure1: WSN node

ROUTING DESIGN ISSUES IN WSNS

Routing in WSNs is very challenging due to the inherent characteristics that distinguish these networks from other wireless networks like mobile ad hoc networks or cellular networks:

1. **Node deployment***:* Node deployment in WSNs is application dependent and affects the performance of the routing protocol. The deployment can be either deterministic or randomized. In deterministic deployment, the sensors are manually placed and data is routed through pre-determined paths. However, in random node deployment, the sensor nodes are scattered randomly creating an infrastructure in an ad hoc manner [2]. If the resultant distribution of nodes is not uniform, optimal clustering becomes necessary to allow connectivity and enable energy efficient network operation. Inter-sensor communication is normally within short transmission ranges due to energy and bandwidth limitations. Therefore, it is most likely that a route will consist of multiple wireless hops.

2. **Fault Tolerance***:* Some sensor nodes may fail or be blocked due to lack of power, physical damage, or environmental interference [2]. The failure of sensor nodes should not affect the overall task of the sensor network. If many nodes fail, MAC and routing protocols must accommodate formation of new links and routes to the data collection base stations. This may require actively adjusting transmit powers and signaling rates on the existing links to reduce energy consumption, or rerouting packets through regions of the network where more energy is available. Therefore, multiple levels of redundancy may be needed in a fault-tolerant sensor network.

3. **Resource management***:* Sensor nodes are tightly constrained in terms of energy, processing, and storage capacities. Thus, they require careful resource management, which is not supported by other network protocol.

4. **Quality of Service***:* In some applications, data should be delivered within a certain period of time from the moment it is sensed, otherwise the data will be useless. Therefore bounded latency for data delivery is another condition for time-constrained applications. However, in many applications, conservation of energy, which is directly related to network lifetime, is considered relatively more important than the quality of data sent. As the energy gets depleted, the network may be required to reduce the quality of the results in order to reduce the energy dissipation in the nodes and hence lengthen the total network lifetime. Hence, energy-aware routing protocols are required to capture this requirement.

5. **Scalability:** A system, whose performance improves after adding hardware, proportionally to the capacity added, is said to be a scalable system**.** The number of sensor

nodes deployed in the sensing area may be in the order of hundreds or thousands, or more. Any routing scheme must be able to work with this huge number of sensor nodes. Scalability in sensor networks can be measured in various dimensions.

6. Transmission Media*:* In a multi-hop sensor network, communicating nodes are linked by a wireless medium. The traditional problems associated with a wireless channel (e.g., fading, high error rate) may also affect the operation of the sensor network.

II. DIFFERENT METHODS TO MAXIMIZE LIFETIME OF WIRELESSSENSOR NETWORKS

A. Lifetime maximization through LEACH protocol

Low-Energy Adaptive Clustering Hierarchy (LEACH) [15] is a clustering based protocol to collect data from wireless network. Clustering in WSN is shown in figure 2. LEACH is representative cluster-based of routing protocols. It is also the first proposed in wireless sensor network and can reduce power consumption on avoiding the communication directly between sink and sensor nodes. In the network, hundreds and thousands of wireless sensors are dispersed that collects and transmit data. Also in these networks cluster heads are elected out of the sensors to transmit the data collected to base station. Also, with each of the sensor nodes being inexpensive and simple, their power level is low cannot be replaced and because of this, each sensor must take its turn as being a cluster head to make the protocol energy efficient. In LEACH protocol, time is divided into many rounds, in each round, all the nodes contend to be cluster head according to a predefined criterion. Each cluster head is in charge of gather the sensed data from the sensor nodes in the cluster. The cluster head will aggregate the received data, and then send to the sink directly. After sink received all the data from cluster heads, a round will be ending. In [5] Yun Li, Weiyi Zhang focuses on how to set the time length of each round, to prolong the lifetime of the network and increase throughput, which is denoted as the amount of data packs sent to the sink node. The functions of lifetime and throughput related to the time length of each round are deduced [5].

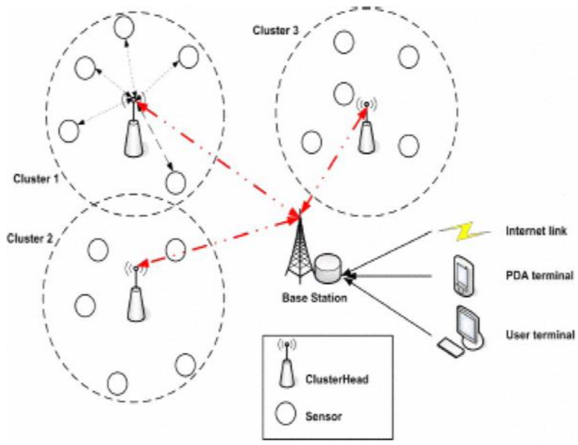

Figure 2: Clustering in WSN

B. Energy-efficient Data-aware Routing Protocol

In this method, data is sensed as either normal or urgent according to its time exigency, and then different data delivery mechanisms are used depending on what kind of data is sensed, thereby improving both the energy-efficiency and reliability of a wireless sensor network [7]. First, normal data is delivered to the sink using a single-path-based data forwarding mechanism to improve the energy-efficiency, as this data is not as important or contingent on time. Meanwhile, urgent data is transmitted to the sink using a hop-count-based directional flooding mechanism to guarantee high reliability, as this data must reach the sink. This achieves a significant improvement in energy consumption, along with high reliability for urgent data delivery [7].

C. TREEPSI

In [8], authors proposed a Tree-based Efficient Protocol for Sensor Information (TREEPSI). TREEPSI is tree-based protocol. In this protocol, WSNs will select a root node in all the sensor nodes, there are two ways to build the tree path. One is computing the path centrally by sink and broadcasting the path information to network. The other can be the same tree structure locally by using a common algorithm in each node. Initially root creates the data gathering process to their child node. The next step is data gathering after forming a tree. All the leaf nodes will start sending the sensed data towards their parent nodes. The parent nodes will collect the received data with their own data. Then send the collected data to their parent. The transmission process will be repeated until all data the received by the root node [9]. The data aggregation will be takes place at the root node, after aggregating the data, it send collected data directly to the sink node. The process will go around until the root node dead. WSN will re-select a new root node and initial phase is repeated like above. The tree path will not change until the root node dead. The length of path form end leaf node to root/chain node in TREEPSI is shortest. The data will not send for a longer path. For this reason, TREEPSI can reduce power consumption less in data transmission than other existing protocol like PEGASIS [9].

D. Lifetime Maximization of Wireless Sensor Networks through Energy Map

In [10], an energy map of WSN is constructed with available energy at sensor nodes. The energy map is also used to increase the lifetime of sensor networks by adaptive clustering, energy centric routing, data aggregation, etc. In this technique, a survey on the techniques of energy map construction for WSNs is done. Author also summarized the applications of energy map in routing, aggregation, clustering, data dissemination, etc. [10].

E. Transmission Range Management for Lifetime Maximization in Wireless Sensor Network

In the sensor network the nodes which are nearer to the Base Station (BS) have additional communication loads of forwarding data generated by distant nodes. Thus they lose their energy rapidly and die soon where as distant nodes remain alive. It creates a bottleneck of communication after sometime for alive nodes. In [11], author states that the distance between two successive nodes around BS should be lesser than the same of peripheral nodes. Thus nodes around BS will have to transmit to lesser distance and hence low power consumption per bit of transmission can be ensured. This will prevent these nodes from dying sooner and this bottleneck can be avoided and lifetime of sensor nodes will be automatically maximized.

III. CONCLUSION

Since energy is one of the most critical resources in wireless sensor networks, it is very important to preserve it.The information about the energy status at every part of the network will be very useful in efficient utilization of energy resource. In this paper, we surveyed the state of the research and described different schemes to prolong the lifetime of wireless sensor network.

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