Energy Consumption in Wireless Sensor Network

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Abstract— The wireless sensor networks have a great potential for its applications in various fields like military, environmental monitoring, home automation and health care. The wireless sensor nodes have the ability of sensing, processing and data communication. The main task of a sensor node is to sense the events from an environment, process the local data and then transfer that data to the destination. These nodes have many challenging factors affecting the performance of the sensor network. Since the nodes have limited energy sources and they expand more energy on data communication. The network lifetime is strongly dependent on overall energy consumption. Therefore, saving the energy is the major concern so as to prolong the network lifetime. In this review paper we have addressed the techniques to minimize the energy consumption and maximize the network lifetime. We have discussed routing and clustering protocols in this paper to reduce the power consumption in WSN.

Key words: Wireless sensor nodes, Energy Consumption, Network lifetime, Routing, Clustering

I. INTRODUCTION

A sensor network is composed of a large number of small, low-cost, low-power, multi-functional devices called sensor nodes that are densely deployed either inside the phenomenon or very close to it. These sensor nodes which are very small in size consist of sensing, data processing and communicating components. A Wireless Sensor Network is a wireless network of devices, called sensor nodes, which can sense the environment and communicate the information, gathered from the monitored field (e.g., an area or volume) through wireless links. There are three major components in the WSN architecture: Sensor Nodes, Sink and Gateway. The nodes are scattered in sensing areas as shown in figure 1 and connected to a gateway via a sink or base station. Every sensed data packet travels through the sink and is relayed to the gateway. Since all packets go through the sink, it needs more energy and resources than a normal sensor node. With the help of gateway, data is transmitted to the internet. Since users are directly connected to the internet, they can retrieve information of their interest from a WSN by injecting queries and gathering results from the base stations, which behave as an interface between users and the network. In this way, WSNs can be considered as a distributed database.

Generally, a sensor node is a small device that consists of four basic components as shown in figure 1 : (i) a sensing subsystem including sensors and analog-to-digital converters (ADC), for measuring physical conditions like temperature, pressure, motion or pollutants from a physical environment; (ii) a processing subsystem including micro-controller and memory, responsible for local data computation and storage; (iii) a transceiver unit for data communication; (iv) a power supply unit which supplies the energy needed by the device to perform the tasks. This power source often consists of a battery with a limited energy. These may also have application dependent additional components such as location finding system to determine their position, a mobilizer to change their location or configuration (i.e. antenna's orientation) and a power generator.

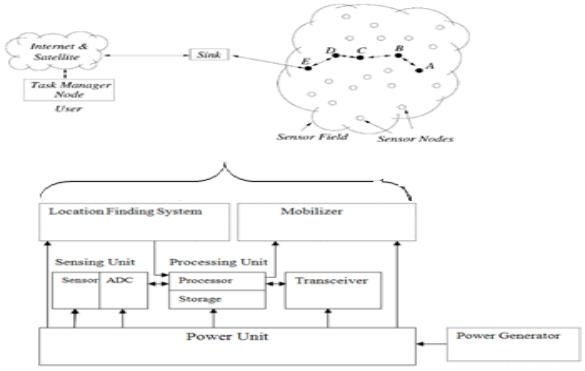

Fig. 1: Components of Sensor node scattered in sensor fields

A wireless sensor network is designed to perform a set of high-level information processing tasks such as detection, tracking, or monitoring. Applications of sensor networks have a great potential and can vary significantly in application requirements, mode of deployment (e.g., ad hoc or instrumented environment), or means of power supply (e.g. battery or wall socket). Sample commercial applications include:

- Environmental monitoring
- Industrial control and monitoring
- Battlefield awareness
- Medicine and health care
- Home automation and consumer electronics

Despite the infinite scopes of wireless sensor networks, they are so many challenges that determine the performance of a sensor network. These include:

- Scalability
- Node deployment
- Security
- Transmission media
- Fault tolerance
- Quality of service
- Heterogeneity
- Energy efficiency
- Storage

II. MAJOR PROBLEM IN WSN

Out of above mentioned issues in sensor network, the challenge of reducing sensor node energy consumption and thus maximizing network lifetime is a major key issue in wireless sensor networks. Since all the sensor nodes have limited power supply and consume maximum energy in the

radio transmission and reception. The limited battery power within network sensor nodes is one of the important issues in wireless sensor network. The life time of a wireless sensor node depends on available energy sources and its overall energy consumption.

Energy is the most important resource in wireless sensor networks. Energy consumption in a sensor network is because of either useful or wasteful work. Useful energy consumption can be resulted from transmitting/receiving data, querying requests, and forwarding data. Wasteful energy consumption is resulted from collisions and resulting retransmissions, idle listening to the channel, and overhead of each packet header. Energy consumption reduces network lifetime, which is defined as the time at which the first node runs out of energy to send a packet.

Once the nodes are deployed in the environment, the network can keep operating while the battery power is adequate. Increasing the capacity of batteries is not possible due to the tiny size requirement of the sensor nodes. There are two main factors which make difficult to recharge power supply of sensor nodes once deployed over an area:

- Large number of nodes: it is very difficult to recharge thousands of sensor nodes in sensor node deployment environment.
- The complexity of the environment: It may be dangerous or too time-consuming to replace sensors when they have failed due to battery energy consumption.

Wireless Sensor Networks are subject to node failures due to energy loss. In order to provide reliable service throughout the network, the network should have self adjustable properties.

III. How to Resolve the Energy Problem

In the research field of wireless sensor networks, there is always a question of how to reduce the energy consumption of WSN so that network lifetime is prolonged. The different techniques have been suggested for increasing the lifetime of the network. Some of these are:

A. Routing in WSN:

Routing protocols have a great impact on the energy consumption of sensor networks. Since sensor nodes run on battery power and they have limited energy available, the methods of routing the data and transmitting to the base station are very important. The routing protocols for all wireless sensor networks must try to maximize the network life time and minimize the overall energy consumption in the network. A variety of routing protocols have been proposed for wireless sensor network. These can be classified in different ways:

Based on Mode to functioning and type of target applications:

1) Proactive:

These protocols maintain a list of destinations and their routes in a routing table in each node before they are actually needed. Since a WSN could consist of thousands of nodes, the routing table that each node would have to keep could be huge and therefore proactive protocols are not suited to WSNs [4]. Distance Squared Distance Vector (DSDV) is an example of proactive routing protocol.

2) Reactive:

These protocols establish routes on demand when they are really needed. There is no need to update the routing tables. Examples are: Ad-hoc On Demand Distance Vector (AODV) and Dynamic Source Routing (DSR).

3) Hybrid:

These use combination of proactive and reactive protocols. Hybrid protocols like Adaptive Periodic TEEN (APTEEN) comprise both proactive and reactive concepts.

4) Based on Network Structure:

Flat- based Routing: In it, all the nodes have to perform the same functions. Sensor Protocols for Information via Negotiation (SPIN) [2], Directed Diffusion [2] are some of the examples of flat-based routing.

Hierarchical-based Routing: In this, all the nodes are assigned different roles like low power nodes sense the environment and high power nodes transmit the data. These include Low-Energy Adaptive Clustering Hierarchy (LEACH) [1] [2], Power-Efficient Gathering in Sensor Information Systems (PEGASIS) [2], TEEN [5], etc.

5) Location-based Routing:

These need location information of sensor nodes obtained from GPS (Global Positioning System) signals. GEAR is an example of location-based routing protocol [3].

B. Clustering in WSN:

Clustering provides an efficient method for prolonging the lifetime of a wireless sensor network. These techniques organize the sensor nodes into the clusters in which sensors can be managed locally by a cluster head; a node elected to manage the cluster and responsible for communicating the data between the cluster and the base station. Therefore, an efficient clustering in sensor networks is required to save energy by forming efficient groups or clusters that communicate with each other and process information in the network to send to the BS.

Clustering can support many network features within a cluster such as channel access for cluster members and power control; as well as between clusters such as routing and code separation to avoid inter-cluster interference. Cluster head aggregates the data received from the members of its cluster along with its own data to compress the data amount which is to be transferred to BS.

Clustering has advantages:

- Reducing useful energy consumption by improving bandwidth utilization (i.e., reducing collisions caused by disputing the channel);
- Reducing wasteful energy consumption by reducing overhead [7].

Clustering can be static or dynamic. A static clustering strategy is presented to some WSNs' applications, such as home-automation and healthcare. In this strategy, clusters and cluster heads remain fixed throughout the lifetime of the network. A cluster formation procedure is regarded as dynamic when it includes regular CH re-election or cluster re-organization procedures. Static clustering eliminates the overhead of dynamic clustering.

IV. CONCLUSION

In this paper, we reviewed the techniques to reduce energy consumption while communication in sensor network. We presented two techniques named Routing and Clustering. Both have the common objective of trying to minimize the energy consumption in sensor network. Routing is a new field in research trying to reduce the energy usage, thus, increase the network lifetime. Overall, Routing protocols are classified according to network structure into three categories: flat, hierarchical and location-based routing protocols. Clustering reduces the communication overhead by compressing the data in the network, resulting in energy savings.

V. REFERENCES

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