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STUDY AND ANALYSIS OF WIRELESS SENSOR NETWORK ROUTING TECHNIQUES AND PROTOCOLS

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ABSTRACT- A WSN can generally be described as a network of nodes that cooperatively sense and control the environment, enabling interaction between persons or computers and the surrounding environment. WSNs nowadays usually include sensor nodes. In this paper the various routing protocols and techniques are analyzed.

Keywords: - [WSN, protocol, routing, techniques.]

1. INTRODUCTION

A sensor network1 is an infrastructure comprised of sensing (measuring), computing, and communication elements that gives an administrator the ability to instrument, observe, and react to events and phenomena in a specified environment. The administrator typically is a civil, governmental, commercial, or industrial entity. The environment can be the physical world, a biological system, or an information technology (IT) framework. Network(ed) sensor systems are seen by observers as an important technology that will experience major deployment in the next few years for a plethora of applications, not the least being national security [1.1–1.3]. Typical applications include, but are not limited to, data collection, monitoring, surveillance, and medical telemetry. In addition to sensing, one is often also interested in control and activation. There are four basic components in a sensor network: (1) an assembly of distributed or localized sensors; (2) an interconnecting network (usually, but not always, wireless-based); (3) a central point of information clustering; and (4) a set of computing resources at the central point (or beyond) to handle data correlation, event trending, status querying, and data mining. In this context, the sensing and computation nodes are considered part of the sensor network; in fact, some of the computing may be done in the network itself. Because of the potentially large quantity of data collected, algorithmic methods for data management play an important role in sensor networks. The computation and communication infrastructure associated with sensor networks is often specific to this environment and rooted in the device and application-based nature of these networks.

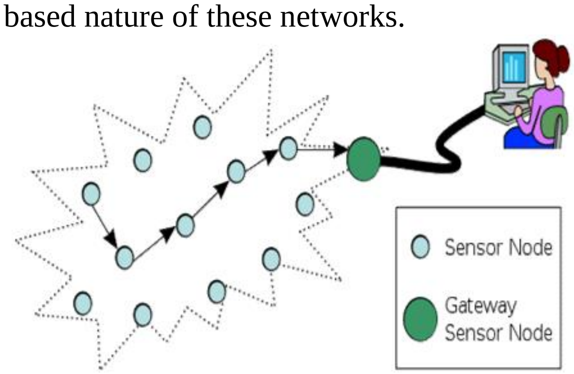

Figure 1: - Wireless Sensor Network

The WSN is built of "nodes" from a few to several hundreds or even thousands, where each node is connected to one sensors. Each such sensor network node has typically several parts: a radiotransceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding. In computer science and telecommunications, wireless sensor networks are an active research area with numerous workshops and conferences arranged each year, for example IPSN, SenSys, and EWSN.

1.2. WSN Characteristics

WSN is currently used for real-world unattended physical environment to measure numerous parameters. So, the characteristics of WSN must be considered for efficient deployment of the network. The significant characteristics of WSN are described as follows [4]:

- **Energy Efficient**
- **Low Cost**
- **Computational Power**
- **Communication Capabilities**
- **Security and Privacy**
- **Distributed Sensing and Processing**
- **Dynamic Network Topology**
- **Self-organization**
- **Multi-hop Communication**
- **Application Oriented**
- **Robust Operations**

1.3. Challenges in WSN

In order to design good applications for wireless micro-sensor network, it is essential to understand factors important to the sensor network applications. Although WSNs share some commonalities with existing wireless ad-hoc network they pose a number of technical challenges different from traditional wireless ad-hoc network [4] [20]. The protocols and algorithms that have been proposed for traditional wireless ad-hoc network are therefore not well suited for the application requirements of the sensor network. To illustrate this point, differences between sensor network and traditional network are outlined below:

- **Energy**
- **Redundancy**
- **System Lifetime**
- **Scalability**
- **Adaptability**
- **Application Awareness**
- **Lack of Global Identification**
- **Storage, Search and Retrieval**
- **Data Centric Processing**
- **Production Cost**

2. ROUTING PROTOCOLS FOR WSN

A routing protocol outlines how data is broadcasted through the network. Most routing protocols can be classified as data centric, hierarchical, location based, or QoS aware [1]. Brief details of each of these types of protocols follow.

Data Centric Protocols: - In large-scale WSN applications, the large number of randomly deployed nodes makes it infeasible to query sensors using their individual identifiers. One approach to addressing this problem is by sending queries to particular regions (set or cluster of sensor nodes) [1], such that data from sensors in that region is sent in response to the query. The challenge with this approach though is that data from a number of sensors in a given region contains a lot of redundancies, since sensors in any given neighborhood are likely to be sensing the same event (sensor data is highly correlated). Data centric protocols exploit attribute-based naming to aggregate data based on the data properties to eliminate redundancies as the data is sent through the network. This approach achieves significant energy savings in WSNs.

Hierarchical Protocols: - In this routing paradigm, the WSN is partitioned into clusters whose heads mainly perform tasks of processing (e.g., aggregation) and information forwarding, while the other nodes perform the sensing tasks within clusters. Hierarchical protocols have the advantage of being scalable due to the multi-tiered design while attaining high-energy efficiencies. Examples of hierarchical protocols include low-energy adaptive clustering hierarchy (LEACH), power-efficient gathering in sensor information systems (PEGASIS) and threshold sensitive energy efficient sensor network protocol (TEEN) [1], among others.

Location Based Protocols These protocols use information about sensor location to route data in an energy-efficient way [1]. The distance between two sensor locations is calculated and its energy requirement estimated. Location based protocols include minimum energy communication network (MECN), geographic adaptive fidelity (GAF) and geographic and energy aware routing (GEAR) [1].

QoS Aware Protocols: - The previously described categories of WSN routing protocols could also be considered to be QoS-aware, since they seek to optimize variables such as energy consumption, a fundamental factor in determining the QoS obtained from a WSN. As such, the definition of a QoS-aware protocol is not well streamlined in WSN literature, Sensors in the same grid can alternate between active and passive states for load balancing and energy conservation touch on QoS elements such as end-to-end delays and prioritization of packets in the network.

3. WSN ROUTING TECHNIQUES

We can identify five main classes of energy efficient techniques, namely, data reduction, protocol overhead reduction, energy efficient routing, duty cycling and topology control.

Data Reduction: focuses on reducing the amount of data produced, processed and transmitted. In the production step, sampling based and prediction based techniques are proposed. In the processing and communication step, different operations on collected data have been introduced during the processing step to handle the scarcity of energy resources in a WSN. For instance, data compression and data aggregation are examples of such techniques.

Protocol Overhead Reduction: the aim of this technique is to increase protocol efficiency by reducing the overhead. Different techniques exist. These techniques can be subdivided into 1) adaptive transmission period depending on WSN stability or distance to the information source. Indeed, communication protocols often resort to periodic message exchanges. These periodic messages are sources of overhead in WSNs 2) cross-layering with the upper and lower layers to optimize network resources while meeting application requirements and 3) optimized flooding to avoid unnecessary retransmissions. Indeed, flooding is a widely used technique in WSNs for location discovery, route establishments, querying, etc. Hence, it is a very expensive operation for battery powered sensors.

Energy Efficient Routing: routing protocols should be designed with the target of maximizing network lifetime by minimizing the energy consumed by the end-to-end transmission and avoiding nodes with low residual energy. Some protocols are opportunistic, taking advantage of node mobility or the broadcast nature of wireless communications to reduce the energy consumed by a transmission to the sink. Others use geographical coordinates of nodes to build a route toward the destination. Others build a hierarchy of nodes to simplify routing and reduce its overhead. Multipath routing protocols use multiple routes to achieve load balancing and robustness against routes failures. Finally, data centric protocols send data only to interested nodes in order to spare useless transmissions.

Duty Cycling: duty cycling means the fraction of time nodes are active during their lifetime. The periods during which nodes sleep or are active should be coordinated and accommodated to specific applications requirements. These techniques can be further subdivided. High granularity techniques focus on selecting active nodes among all sensors deployed in the network. Low granularity techniques deal with switching off the radio of active nodes when no communication is required (respectively when a communication involving this node may occur). They are highly related to the medium access protocol.

Topology Control: it focuses on reducing energy consumption by adjusting transmission power while maintaining network connectivity. A new reduced topology is created based on local information.

CONCLUSIONS

Wireless Sensor Networks is a fast growing and exciting research area that has attracted considerable research attention in the recent past. This has been fueled by the recent tremendous technological advances in the development of low-cost sensor devices equipped with wireless network interfaces. The creation of large-scale sensor networks interconnecting several hundred to a few thousand sensor nodes opens up several technical challenges and immense application possibilities. Sensor networks find applications spanning several domains including military, medical, industrial, and home networks. Wireless sensor networks have moved from the research domain into the real world with the commercial availability of sensors with networking capabilities. The purpose of this paper is to present a study about the WSN protocols and various WSN routing techniques. from leading researchers on various aspects of wireless sensor networks.

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