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Study on Energy Efficient Routing Protocols in Wireless Sensor Networks

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Abstract: Wireless Sensor Networks consist of spatially distributed autonomous sensors that monitor Physical or environmental conditions. These include sensing temperature, sound, vibration, temperature etc. They cooperatively pass their data through the network to a main location. In the location sensor nodes are powered by limited capacity of batteries, hence the energy consumption of a sensor node must be tightly controlled. WSN life time mainly depends on the life time of limited power source of the nodes. The consumption of energy maintained efficiently in each node. In this paper focused on Energy efficient routing Protocols of Wireless Sensor Networks.

Keywords: Sensor Networks, Energy Efficiency, Routing.

I. INTRODUCTION

A Wireless Sensor Network (WSN) is a distributed, self-organized network of small, energy- constrained, wireless nodes that interact to carry out complex tasks. A typical wireless sensor node consists of sensory unit, a communication unit, a power unit and a processing unit. The sensory unit consists of a data acquisition component and an analog to digital converter which converts the sensed real world data to the digital form. The communication unit has a radio transceiver and the power is backed by a battery source. The node remain active as long as the battery is alive and hence power saving is a crucial criterion in this domain of applications. .WSNs are different from traditional wireless networks in several aspects. Their nodes have low computational and energy resources, the communication channels have narrow bandwidths, and the wireless links may be exposed to high levels of interference. These intrinsic characteristics bring new challenges to the design of WSN including the routing protocol. The routing protocols are responsible for the selection of paths through the network, they also contribute to determine the communications reliability and energy efficiency.

In general the wireless sensor nodes send the data to a terminal base station which then is available for human use. The base station, sometimes called sink must also has the ability to query data from a single node or a collection of nodes [10]. Sensor network model depicted in Figure 1 and consisting of one sink node (or base station) and a (large) number of sensor nodes deployed over a large area (sensing field). Data are transferred from sensor nodes to the sink through a multi-hop communication paradigm.

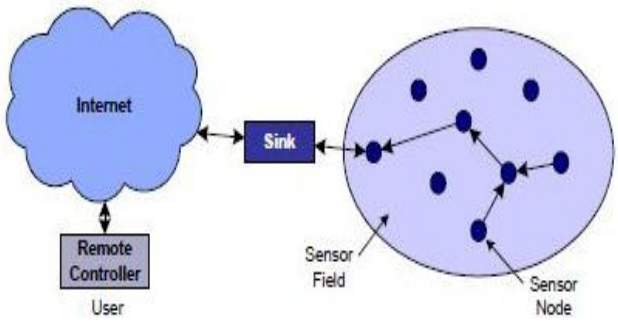

Figure 1. Sensor Network Architecture

II. CHARACTERISTICS OF SENSOR NETWORKS

Wireless Sensor Networks (WSNs) as mentioned above have many benefits over the traditional network. In this section we are going to outline some features of WSNs.[07]

2.1. Collaborative Objective

The objective is the most important aspect of WSN that make it different from other wireless networks. Normally, its objective is sensing an event in the environment and report the sensed event to the base station. The sensor nodes do not compete with each other. However, they collaborate to achieve the certain goal of their deployment. For example, they collaborate to send their data using multi-hop communication in a way that maximizes the network

lifetime. This is unlike other wireless networks such as Wireless LAN where the nodes (users) are greedy and try to maximize their own gains.

2.2. Network Scale

Although some applications involve a small number of sensors (08-12), other applications may involve a large number of sensor nodes (100-1000). Developments in integrated circuit design technology make the mass production of sensor devices relatively inexpensive and this make WSNs with large number of nodes common. Redundancy makes the network more robust to routing and node failures where each node has many alternative paths to reach the sink. This is another point that makes WSNs different from other network in terms of scalability.

2.3. Many-to-one Communication Paradigm

The objective of sensor node is to monitor signal of interest. The events will be reported by the sensor nodes to the base station where the next action will be decided by which, thus the data flows in upstream (many-to-one); sensor nodes send their reports to the sink, and in downstream (one-to-many);the sink sends queries or control messages to the sensor nodes. This is unlike internet where the traffic flows from a single server to many clients and unlike a peer-to-peer network where the traffic flows between any two nodes of the network.

2.4. Nodes with Limited Capabilities

The hardware component of sensor node is another difference between WSNs and wireless LAN or any cellular network. Sensor node is not advanced as a wireless laptop, PDA or a cell phone. It is restricted by a battery which is limited in energy and usually cannot be replenished (typically a small lithium battery rated at a few hundred mAh), slower computing speeds (about 4MHz), small memory (about 8KB flash memory and 512 bytes of RAM), low data rates (up to 20 Kbps) and limited communication range (10-100 feet). When designing the protocols at different layers, all these limitations that have a direct impact on the functioning of the network must be taken into account.

2.5. Clustering for Scalability

WSNs consist of large number of nodes. So, distributed protocols for gathering data and arbitrating the access to the wireless channel are needed. These protocols should be scaled well even if the number of nodes has been increased. To achieve this, sensor nodes must be organized in smaller sub network called clusters which result in lower routing overheads. The clusters could consist of nodes with different hardware capabilities. Within each cluster the responsibilities of coordinating MAC and routing as well as data aggregation could be assigned to nodes with special hardware.

2.6. Node Deployment versus Placement

Depending on the application, Sensor nodes can be either thrown randomly en masse over the area of interest (battlefield surveillance etc.), or placed one by one at specified locations (temperature, seismic monitoring of bridges and buildings, etc.). In this case ensuring network connectivity is relatively easy. However, in the first case (randomly deployment) to ensure network connectivity, a certain extent of over-provisioning of nodes is required.

2.7. Node Mobility and Dynamic Topology

Although in some applications sensor nodes are static, in many applications, such as monitoring of military personnel, equipment and animals monitoring, the nodes are mobile. Hence, according to these mobile nodes, the topology of network will change and the routing information has to be updated which result in a dynamic network topology. In some applications in order to save power, the nodes need to turn off its transceiver and enter a sleep state. Accordingly the topology of the network will be changed and also due to node failures. Hence, sensor networks often have a dynamic topology because of node mobility, node failures, and radio duty cycling. Not to forget, when designing the communication protocols, the highly mobile nodes have a stronger impact on the network topology than the other factors.

III. ENERGY EFFICIENT ROUTING PROTOCOLS

During this research, many differences have been observed, among these researched routing protocols.

Table 1: Comparison of Protocols

	Directed Diffusion	**GEAR**	**SAR**	**LEACH**	**GAF**	**SPIN**
Class	Data Centric	Data Centric	Data Centric	Hierarchical	Hierarchical & Location Based	Hierarchical
Energy Consumption	Limited	High	Limited	High	Limited	High
Scalability	Limited	Limited	Limited	Good	Good	Good
Mobility	Limited	No	Possible	Fixed Sink	Limited	Limited
Data Aggregation	Yes	Yes	Yes	Yes	No	Yes
Multipath	Yes	No	Yes	No	No	No

Environment Monitoring	Yes	No	No	No	Yes	No
Network Lifetime	Good	Good	Good	Very Good	Good	Good
Optimal Route	Yes	Yes	No	No	No	No

IV. APPLICATIONS OF WSN

Wireless sensor networks have numerous potential applications. Several of these have been demonstrated in prototype form.

- **Military applications**
  Wireless sensor networks can be an integral part of military command, control, communications, computing, intelligence, surveillance, reconnaissance and targeting systems.
- **Environmental applications**
  Some environmental applications of sensor networks include tracking the movements of birds, small animals, and insects; monitoring environmental conditions that affect crops and livestock; irrigation; macro instruments for large scale Earth monitoring and planetary exploration; chemical/ biological detection; biological, Earth, and environmental monitoring in marine, soil, and atmospheric contexts; forest fire detection; meteorological or geophysical CBLR Routing Approach For In-Network Aggregation In WSN research; flood detection; bio-complexity mapping of the environment; and pollution study.
- **Health applications**
  Some of the health applications for sensor networks are providing interfaces for the disabled; integrated patient monitoring; diagnostics; drug administration in hospitals; monitoring the movements and internal processes of insects or other small animals; tracking and monitoring doctors and patients inside a hospital.
- **Home applications**
  Home automation: As technology advances, smart sensor nodes and actuators can be buried in appliances, such as vacuum cleaners, micro-wave ovens, and refrigerators.
- **Other commercial applications**
  Some of the commercial applications are monitoring material fatigue; building virtual keyboards; monitoring product quality; constructing smart office spaces, environmental control in office buildings; robot control and guidance in automatic manufacturing environments etc.

V. CONCLUSION

Characteristics of WSN that distinguish it from other wireless networks have made the routing protocol in WSNs. Through WSNs development, many routing protocols and algorithms have been proposed in the literature survey. Although some of these protocols and algorithms have challenges, solutions are also exists even if they solve the problems of a protocol to some extent. In real time applications, there are many challenging problems that need to be addressed for more efficient operation of wireless sensor networks in our survey. This paper analyses the broad level comparison of Energy efficient protocols and applications of wireless sensor networks the table1.

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