A relative study of Various Routing Protocols in Wireless Sensor Networks

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Abstract - A sensor is a device to sensing and monitoring the networks. It operates in wireless domain with radio frequency at 2.4 GHz free ISM (Industrial Scientific and Medical Applications) band to measuring and capture the network behavior. Typical applications include, but are not limited to, data collection, monitoring, surveillance, and medical telemetry. Sensor networking is a multidisciplinary area that involves, among others, radio and networking, signals processing, artificial intelligence, database management, systems architectures for operator-friendly infrastructure administration, resource optimization, power management algorithms, and platform technology. The main objective of this paper offers a survey on different kinds of routing protocols and its features.

Key Word: Sensor Networks, ISM band, Routing protocols

I. INTRODUCTION

Recent advances in sensing, computing and communication technologies coupled with the need to continuously monitor physical phenomena have led to the development of Wireless Sensor Networks (WSNs). WSN consist of four main components: A radio, a processor, sensors and battery. A WSN is formed by densely deployed sensor nodes in an application area. In most deployments, the sensor nodes have self-organizing capabilities, to form an appropriate structure in order to collaboratively perform a particular task. Wireless Sensor Networks are found suitable for applications such as surveillance, precision agriculture, smart homes, automation, vehicular traffic management, habitat monitoring, and disaster detection.WSN is great enabling technology that can revolutionize information and communication technology[1][5].

The key constraints in the development of WSNs are limited battery power, cost, memory limitation, limited computational capability, and the physical size of the sensor nodes. Research and development in WSN technology has been primarily application-driven. In the last decade, extensive research has been done in: energy efficient hardware and protocol design, identifying alternate power sources, distributed detection techniques, multihop protocols, scheduling, cross-layer optimization, localization, time synchronization and coverage. Most commonly used wireless communications standard in WSNs is based on the IEEE 802.15.4, usually referred to as Zigbee. There are three key areas that has received much less attention are: (i) very low cost and very low power mixed signal design of the WSN radio chip, (ii) enhanced power sources like low cost, small form factor photovoltaics, and (iii) low cost sensors technology for different applications in particular biosensors.

A. Current Research and Development Trends

Several applications have been benefited from the advances in wireless sensor networks. These include Agriculture, Health Care, Defense, Wild Life Habitat Monitoring, Under Water monitoring, Disaster Management (Safety) and Industrial (monitoring, control, factory automation) applications. For all these applications, research deployments have been conducted and products incorporating WSNs are appearing. The current research hence focuses on application-driven systems in order to address more concrete issues. Preliminary results obtained from these deployments are encouraging and widespread use is highly likely [4]. WSNs are capable of enhancing system performance significantly so they hold considerable promise to Industry.

WSN technology is slowly graduating from the researcher “market” to the early adopters in industry. Several start-up companies are offering products in the sensor networking domain: Sentilla, Sensicast, Point8, ArchRock, SynapSense, Crossbow, sensorial, and others [2]. Industrial research labs have also funded sensor networking research. In some cases, the technology is showing up in vertical niche markets, e.g., in process control, where it is not even advertised as WSN. The military continues to fund research in this area, now more so in the context of aiding mobile dismounts/units, but is yet to seriously adopt the technology in its operation.

C. Applications of Sensor Networks

Existing and potential applications of sensor networks include, among others, military sensing, physical security, air traffic control, traffic surveillance, video surveillance, industrial and manufacturing automation, process control, inventory management, distributed robotics, weather sensing, environment monitoring, national border monitoring, and building and structures monitoring[7]. A short list of applications follows.

- Military applications: Monitoring inimical forces, Monitoring friendly forces and equipment, Military-theater or battlefield surveillance, Targeting, Battle damage assessment, Nuclear, biological, and chemical attack detection.
- Environmental applications: Microclimates, Forest fire detection, Flood detection, Precision agriculture
- Health applications: Remote monitoring of physiological data, Tracking and monitoring doctors and patients inside a hospital, Drug administration, Elderly assistance
- Home applications: Home automation, Instrumented environment, automated meter reading
- Commercial applications: Environmental control in industrial and office buildings, Inventory control ,Vehicle tracking and detection ,Traffic flow surveillance

II ROUTING PROTOCOLS FOR WIRELESS SENSOR NETWORKS

Our objective in this section is to discuss issues central to routing in WSNs and describe different strategies used to develop routing protocols for these networks. Although WSNs share many commonalities with wired and ad hoc networks, they also exhibit a number of unique characteristics which set them apart from existing networks. These unique characteristics bring to sharp focus new routing design requirements that go beyond those typically encountered in wired and wireless ad hoc networks[3][7]. Meeting these design requirements presents a distinctive and unique set of challenges. These challenges can be attributed to multiple factors, including severe energy constraints, limited computing and communication capabilities, the dynamically changing environment within which sensors are deployed, and unique data traffic models and application-level quality of service requirements.

Routing algorithms for ad hoc networks can be classified according to the manner in which information is acquired and maintained and the manner in which this information is used to compute paths based on the acquired information. Three different strategies can be identified: proactive, reactive, and hybrid defined as,

- The proactive strategy, also referred to as table driven, relies on periodic dissemination of routing information to maintain consistent and accurate routing tables across all nodes of the network.
- Reactive routing strategies establish routes to a limited set of destinations on demand. These strategies do not typically maintain global information across all nodes of the network.
- Hybrid strategies rely on the existence of network structure to achieve stability and scalability in large networks.

III ROUTING PROTOCOLS in WSNs

Despite the disparity in the objectives of sensor applications, the main task of wireless sensor nodes is to sense and collect data from a target domain, process the data, and transmit the information back to specific sites where the underlying application resides.

Achieving this task efficiently requires the development of an energy-efficient routing protocol to set up paths between sensor nodes and the data sink. The path selection must be such that the lifetime of the network is maximized [9]. The characteristics of the environment within which sensor nodes typically operate, coupled with severe resource and energy limitation, make the routing problem very challenging. Here we described on the basis of routing protocols into three broad categories: (1) Flat Routing (2) Hierarchical Routing (3) Location-based Routing.

A. Flat Routing

Class I routing protocols adopts a flat network architecture in which all nodes are considered peers. Flat network architecture has several advantages, including minimal overhead to maintain the infrastructure and the potential for the discovery of multiple routes between communicating nodes for fault tolerance[4]. A sensor protocol for information via negotiation (SPIN) is a data-centric negotiation-based family of information dissemination protocols for WSNs. The main objective of these protocols is to efficiently disseminate observations gathered by individual sensor nodes to all the sensor nodes in the network. Simple protocols such as flooding and gossiping are commonly proposed to achieve information dissemination in WSNs. Flooding requires that each node sends a copy of the data packet to all its neighbors until the information reaches all nodes in the network. Gossiping, on the other hand, uses randomization to reduce the number of duplicate packets and requires only that a node receiving a data packet forward it to a randomly selected neighbor.

The basic behavior of SPIN is illustrated in Figure 1.a, in which the data source, sensor node A, advertises its data to its immediate neighbor, sensor node B, by sending an ADV message containing the metadata describing its data. Node B expresses interest in the data advertised and sends a REQ message to obtain the data. Upon receiving the data, node B sends an ADV message to advertise the newly received data to its immediate neighbors. Only three of these neighbors, nodes C, E, and G, express interest in the data. These nodes issue a REQ message to node B, which eventually delivers the data to each of the requesting nodes.

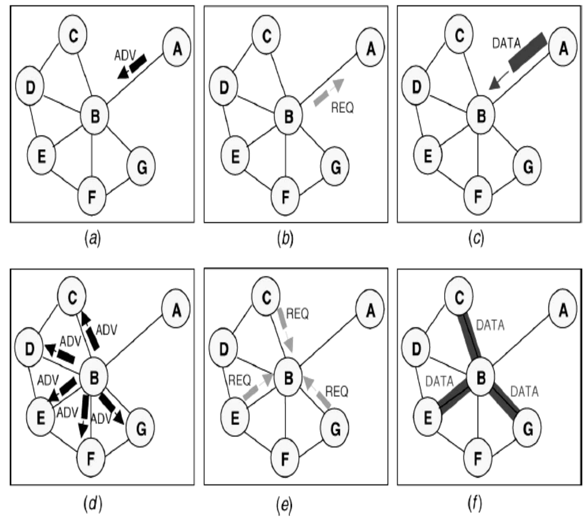

Figure 1.a. SPIN BASIC Protocol Operations

B. Hierarchical Routing

Class II routing protocols imposes a structure on the network to achieve energy efficiency, stability, and scalability. In this class of protocols, network nodes are organized in clusters in which a node with higher residual energy, for example, assumes the role of a cluster head. The cluster head is responsible for coordinating activities within the cluster and forwarding information between clusters. Clustering has potential to reduce energy consumption and extend the lifetime of the network.

Low-energy adaptive clustering hierarchy (LEACH) is a routing algorithm designed to collect and deliver data to the data sink, typically a base station. The main objectives of LEACH are: Extension of the network lifetime, reduced energy consumption by each network sensor node, Use of data aggregation to reduce the number of communication messages [6]. CH (Cluster Head) chooses the code to be used in its cluster, CH broadcasts Adv; Each node decides to which cluster it belongs based on the received signal strength of Adv, CH creates a xmission schedule for TDMA (Time Division Multiple Access) in the cluster, Nodes can sleep when it's not their turn to xmit ,CH compresses data received from the nodes in the cluster and sends the aggregated data to BS(Base Station),CH is rotated randomly. As mentioned in the Figure 1.b.

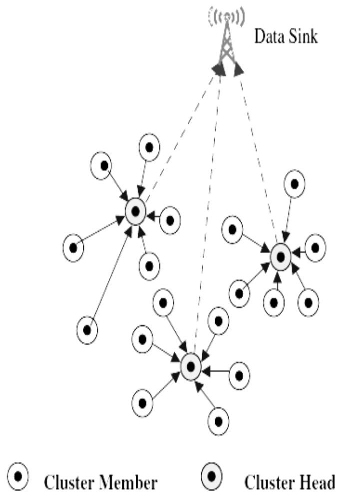

Figure 1.b LEACH Network Model.

C.Location-based Routing

Class III, indicates the routing protocols uses location to address a sensor node. Location-based routing is useful in applications where the position of the node within the geographical coverage of the network is relevant to the query issued by the source node. Such a query may specify a specific area where a phenomenon of interest may occur or the vicinity to a specific point in the network environment. The main objective of geographical routing is to use location information to formulate an efficient route search toward the destination. Geographical routing is very suitable to sensor networks, where data aggregation is a useful technique to minimize the number of transmissions toward the base station by eliminating redundancy among packets from different sources. The need for data aggregation to reduce energy consumption shifts the computation and communications model in sensor networks from a traditional address-centric paradigm, where the interaction is between two addressable endpoints of communications, to a data-centric paradigm, where the content of the data is more important than the identity of the node that gathers the data [8].

In position-based routing, each node decides on the next hop based on its own position, the position of its neighbors, and the destination node. The quality of the decision clearly depends on the extent of the node's knowledge of the global topology. Local knowledge of the topology may lead to suboptimal paths, as depicted in Figure 1.c, where the node currently holding the packet makes a forwarding decision based solely on local topology knowledge. Finding the optimal path requires global knowledge of the topology.

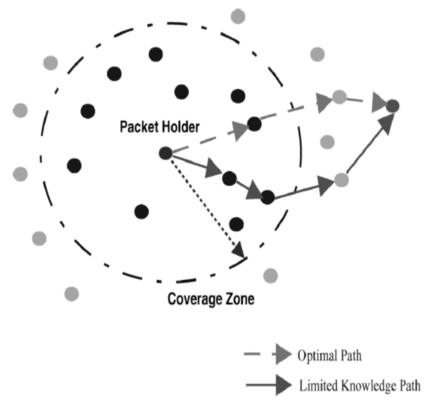

Figure 1.c Localized and globalized forwarding decision.

Geographical routing is an attractive approach for routing in WSNs because of its low overhead and localized interactions. The existence of asymmetric links, network partition, and cross-links increases the complexity of the approach considerably. Better planar graphs may be needed.

IV. COMPARISON BETWEEN SPIN, LEACH & GEOGRAPHICAL ROUTING

The Table depicted the Comparison between SPIN, LEACH & Geographical routing in terms of its various Resource Constraints,

Resource Constraints	**SPIN**	**LEACH**	**Geographical routing**
Optimal Route	No	No	Yes
Network Lifetime	Good	Very Good	Good
Resource Awareness	Yes	Yes	Yes
Use of meta-data	Yes	No	Yes

Table 1.4 Comparison between SPIN, LEACH & Geographical routing

V.CONCLUSION

In this paper we focused on issues central to routing in WSNs and describe different strategies used to develop routing protocols for these networks. In the first section of the paper we discussed Introduction, Development trends of sensor applications and highlighted the unique and distinctive features of the ‘‘nature’’ of their features. In the second part of the paper we provided a brief taxonomy of the basic routing strategies used to strike a balance between responsiveness and energy efficiency. In the third part of the paper we presented a comparison on various protocols that address the problem of routing in today's WSNs. Multiple strategies have emerged as feasible solutions to the routing problem. As the application of WSNs to different fields become more apparent, advances in network hardware and battery technology will pave the way to practical cost-effective implementations of these routing protocols.

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