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Secure Data Transfer via Internet cryptography and Image Steganography in Wireless Sensor Networks

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Abstract:A wireless sensor network (WSN) of distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. In WSN, the sensor nodes have a restricted broadcast range, and their processing and storage capabilities as well as their energy resources are also limited. Routing protocols for wireless sensor networks are responsible for maintain the routes in the network and have to ensure reliable multi-hop communication under these conditions. In this paper, we give a survey of routing protocols for Wireless Sensor Network and compare their strengths and boundaries.

Keywords*:* Wireless Sensor Networks, Routing Protocols, Cluster Head

I. INTRODUCTION

Being characterized by their low power, small size, and cheap price, these nodes are capable of wireless communication, sensing and computation. So, we can say the sensor network is the product of the combination of the sensor techniques, distributed information processing and communication techniques [1, 2].

A Wireless sensor network contains hundreds or thousands of these sensor nodes that are densely deployed in a large geographical area. In many WSN applications, the deployment of sensor nodes is performed in an ad hoc fashion without careful planning and engineering. However, sensor nodes are constrained in energy supply and bandwidth. Such constraints combined with a typical deployment of large number of sensor nodes pose many challenges to the design and management of sensor networks. Developing energy-efficient routing protocol on wireless sensor networks is one of the important challenges. it requires a suite of network protocols to implement various network control and management functions such as synchronization, node localization, and network .

The traditional routing protocols have several shortcomings when applied to WSNs, which are mainly due to the energy-constrained nature of such networks [4]. For example, flooding is a system in which a given node broadcasts data and organize packets that it has acknowledged to the rest of the nodes in the network. This method repeats awaiting the destination node is reached. Note that this technique does not take into account the energy limitation imposed by WSNs. As a result, when used for data routing in WSNs, it leads to the problems such as implosion and overlap [9,12]. known that flooding is a blind technique, duplicated packets may keep travel in the network, and hence sensors will receive those duplicated packets, causing an implosion crisis.

In this paper various routing protocols for wireless sensor network are discussed and compared. Section 2 of the paper discusses the network characteristics and design objectives. In Sections 3, the network design challenges and routing issues are described. In Section 4, various routing protocols are discussed and compared. Finally, Section 5 concludes the survey.

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II. ROUTING CHALLENGES AND DESIGN OBJECTIVES

The characteristics of sensor networks and function requirements have a influential impact on the network design objectives in term of network capability and network concert [4].

2.1 Routing Challenges

As compared to the traditional wireless communication networks such as mobile ad hoc network (MANET) and cellular systems, wireless sensor networks have the following unique characteristics and constraints:

Coverage: In WSNs, each sensor node obtains
a certain view of the environment. ; it can only cover a limited physical area of the environment. Hence, area coverage is also an important design parameter.

Energy Conservation: Without a fixed infrastructure, ad hoc networks have to rely on portable, limited power sources. A node in an d hoc network has to relay (and, hence route) messages for other nodes in the same network. The issue of energy-efficiency therefore becomes one of the most important problems in ad hoc networks.

Scalability : Scalability can be broadly defined as whether the network is able to provide an acceptable level of service even in the presence of a large number of nodes in the network.

Unpredictable sensor nodes: Because sensor nodes are prone to physical indemnity or failures due to its deployment in insensitive or aggressive environment.

Connectivity: High node density in sensor networks precludes them from being completely isolated from each other. Therefore, sensor nodes are expected to be highly connected. This, however, may not prevent the network topology from being variable and the network size from shrinking due to sensor node failures.

Frequent topology change: Network topology changes repeatedly owing to the node failures, smash up addition, energy depletion, or channel vanishing.

2.2 Routing Design Objectives

Most sensor networks are application precise and have different application requirements. Thus, all or part of the following main devise objectives is considered in the design of sensor networks:

Node Deployment: Node deployment can be random, deterministic or self organizing. For deterministic deployed networks the routes are pre-determined, however for random deployed networks and self-organizing networks route designation has been a challenging subject.

Data Aggregation: Since the sensors are densely deployed by definition, the data gathered from each node are correlated. Therefore data aggregation or in other words data fusion decreases the size of the data transmitted.

Adaptability: In sensor networks, a node may fail, join, or move, which would result in changes in node density and network topology. Thus, network protocols designed for sensor networks should be adaptive to such density and topology changes.

Fault Tolerance: WSNs are prone to failures; some of the nodes may fail or be blocked by physical interference, physical damage, or lack of power. The routing protocol has tobe dynamic; failures of specific nodes should not affect network operation self-recovering. This may require actively adjusting transmit powers One of the main design goals of WSNs is to carry out data communication while trying to prolong the lifetime of the network and prevent connectivity degradation by employing aggressive energy management techniques.

QoS support: The nodes are mobile, most of the time, providing QoS support to data sessions in such networks is very difficult. Bandwidth reservation made at one point time may become invalid once the node moves out of the region where the reservation was made. QoS support is essential for supporting time critical traffic sessions. As energy is depleted, the network may be required to reduce the quality of results in order to reduce energy dissipation in the nodes and hence lengthen the total network lifetime. Hence, energy-aware routing protocols are required to capture this requirement.

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III. PROPOSED APPROACH

The design of routing protocols for WSNs is exigent since of several network constraints. WSNs bear from the limitations of several network resources, for example, energy, bandwidth, central processing unit, and storage [11,13]. The design challenges in sensor networks involve the following main aspects [4,11,13]:

Node/Link heterogeneity: Depending on the application a sensor node can have a different role or capability. The existence of a heterogeneous set of sensors raises many technical issues related to data routing.

Energy consumption without losing accuracy:
Sensor nodes can use up their limited supply of energy performing computations and transmitting information in a wireless environment. In a multi-hop WSN, each node plays a dual role as data sender and data router. The malfunctioning of some sensor nodes due to power failure can cause significant topological changes, and might require rerouting of packets and reorganization of the network.

Sensor locations: A challenge that faces a propose of routing protocols is to direct the locations of the sensors. Mainly the proposed protocols presume that the sensors any are outfitted with global positioning system (GPS) receivers or use some localization technique [14] to discover about their locations.

Network dynamics: In many studies, sensor nodes are assumed fixed. However, in many applications both the BS or sensor nodes can be mobile [6]. As such, routing messages from or to moving nodes is more challenging since route and topology stability become important issues, in addition to energy, bandwidth, and so forth. Moreover, the phenomenon can be mobile (e.g., a target detection/ tracking application). On the other hand, sensing fixed events allows the net work to work in a reactive mode (i.e., generating traffic when reporting).

Transmission Media: In a multi-hop sensor network, communicating nodes are linked by a wireless medium. The traditional problems associated with a wireless channel(ie, fading, high error rate)may also affect the operation of the Sensor network. I general, the required bandwidth of the sensor data will be low on the order of 1-100 kbps. Related to the transmission media is the design of the MAC. One approach to MAC design for sensor netwoks is to use time-division multiple access (TDMA)-based protocols that conserve more energy than contention-based protocols like carrier sense multiple access

IV. ROUTING PROTOCOLS IN WSN

in wireless sensor networks differs from conventional routing in fixed networks in various ways. There is no infrastructure, wireless links are unreliable, sensor nodes may fail, and routing protocols have to meet strict energy saving requirements [5]. Many routing algorithms were developed for wireless networks in general. All major routing protocols proposed for WSNs may be divided into five categories as shown in Table 1

Table 1: Routing Protocols for WSNs

Category	**Representative Protocols**
Location-based Protocols	MFR,DIR,GEDIR, GAF, GEAR, Span,
Data-centric Protocols Mobility-based Protocols	SPIN, Directed Diffusion, ACQUIRE SEAD, Joint Mobility and Routing, Dynamic Proxy Tree-Base Data Dissemination
Multipath-based Protocols	Sensor-Disjoint Multipath, Braided Multipath, N-to-1 Multipath Discovery
QoS-based protocols	SAR, SPEED, Energy-aware routing

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4.1 Location-based Protocols

In location-based protocols, sensor nodes are addressed by means of their locations. Location information for sensor nodes is required for sensor networks by most of the routing protocols to calculate the distance between two particular nodes so that energy consumption can be estimated. In this section, we present a sample of location-aware routing protocols proposed for WSNs.

Geographic Adaptive Fidelity (GAF): GAF [15] is an energy-aware routing protocol primarily proposed for MANETs, but can also be used for WSNs because it favors energy conservation. The network area is first divided into fixed zones and form a virtual grid. Inside each zone, nodes collaborate with each other to play different roles. GAF is based on mechanism of turning off unnecessary sensors while keeping a constant level of *routing fidelity* (or uninterrupted connectivity between communicating sensors). Each node uses its GPS-indicated location to associate itself with a point in the virtual grid. Nodes associated with the same point on the grid are considered equivalent in terms of the cost of packet routing.

Geographic and Energy-Aware Routing (GEAR): GEAR [20] is an energy-efficient routing protocol proposed for routing queries to target regions in a sensor field, In GEAR, the sensors are supposed to have localization hardware equipped. The key idea is to restrict the number of interests in directed diffusion by only considering a certain region rather than sending the interests to the whole network. GEAR uses energy aware heuristics that are based on geographical information to select sensors to route a packet toward its destination region. Then, GEAR uses a recursive geographic forwarding algorithm to disseminate the packet inside the target region.

Coordination* of *Power Saving with Routing: Span [21,22] Another Position-based algorithm called SPAN [32] selects some nodes as coor- dinators based on their positions. Span is motivated by the fact that the wireless network interface of a device is often the single largest consumer of power. Hence, it would be better to turn the radio off during idle time. Although Span does not require that sensors know their location information, it runs well with a geographic forwarding protocol.

MFR, DIR, and GEDIR: Stojmenovic andLin [35] described and discussed basic localized routing algorithms. These protocols deal with basic distance, progress, and direction-based methods. The key issues are forward and backward directions. A source node or intermediate node will select one of its neighbors according to a certain criterion. The routing methods that belong to this category are Most Forward within Radius (MFR), Geographic Distance Routing (GEDIR) that is a variant of greedy algorithms, the two-hop greedy method, alternate greedy method, and DIR (a compass routing method). GEDIR is a greedy algorithm that always moves the packet to the neighbor of the current vertex whose distance to the destination is minimized.

4.2 Data Centric Protocols

Data-centric protocols differ from traditional address-centric protocols in the manner that the data is sent from source sensors to the sink. In *address-centric* protocols, each source sensor that has the appropriate data responds by sending its data to the sink independently of all other sensors. However, in *data-centric* protocols, when the source sensors send their data to the sink, intermediate sensors can perform some form of aggregation on the data originating from multiple source sensors and send the aggregated data toward the sink. This process can result in energy savings because of less transmission required to send the data from the sources to the sink. In this section, we review some of the data-centric routing protocols for WSNs.

Sensor Protocols for Information via Negotiation (SPIN): SPIN [28,29] disseminate all the information at each node to every node in the network assuming that all nodes in the network are potential BSs. This disseminate all the information at each node to every node in the network assuming that all nodes in the network are potential BSs The SPIN family of protocols uses data negotiation and resource-adaptive algorithms. It enables a user to query any node and get the required information immediately. Sensor nodes operate more efficiently and conserve energy by sending data that describe the sensor data instead of sending all the data.

Directed Diffusion: Directed diffusion [30,31] is a data-centric (DC) and application-aware paradigm in the sense that all data generated by sensor nodes is named by an attribute-value pairs. The main idea of the DC paradigm is to combine the data coming from different sources en route (in-network aggregation) by eliminating redundancy, minimizing the number of transmissions, thus saving network energy and prolonging its lifetime. Directed diffusion has several key elements namely *data naming, interests and gradients, data propagation,* and *reinforcement.* Each sensor that receives the interest sets up a gradient toward the sensor nodes from which it receives the interest. This process continues until gradients are set up from the sources back to the BS.

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Active Query Forwarding in Sensor Networks (ACQUIRE): ACQUIRE [34] It is a technique for querying sensor networks called Active Query Forwarding in Sensor Net. During this, each node tries to respond to the query partially by using its precached information and then forwards it to another ACQUIRE query (i.e., interest for named data) consists of several sub queries for which several simple responses are provided by several relevant sensors. Each sub-query is answered based on the currently stored data at its relevant sensor. ACQUIRE allows a sensor to inject an active query in a network following either a random or a specified trajectory until the query gets answered by some sensors on the path using a localized update mechanism.

4.3 Mobility-based Protocols

Mobility brings new challenges to routing protocols in WSNs. Sink mobility requires energy-efficient protocols to guarantee data delivery originated from source sensors toward mobile sinks. In this section we discuss sample mobility-based routing protocols for mobile WSNs.

Joint Mobility and Routing Protocol: A network with a static sink suffers from a severe problem, called *energy sink-hole problem,* where the sensors located around the static sink are heavily used for forwarding data to the sink on behalf of other sensors. Under the shortest-path routing strategy, the average load of data routing is reduced when the trajectories of the sink mobility correspond to concentric circles.

Scalable Energy-Efficient Asynchronous Dissemination (SEAD): SEAD [36] is self-organizing protocol, which was proposed to trade-off between minimizing the forwarding delay to a mobile sink and energy savings. SEAD considers data dissemination in which a source sensor reports its sensed data to multiple mobile sinks and consists of three main components namely dissemination tree *(d-tree)* construction, data dissemination, and maintaining linkages to mobile.

Dynamic Proxy Tree-Based Data Dissemination: A dynamic proxy tree-based data dissemination framework was proposed for maintaining a tree connecting a source sensor to multiple sinks that are interested in the source. This helps the source disseminate its data directly to those mobile sinks. In this framework, a network is composed of stationary sensors and several mobile hosts, called *sinks.* The sensors are used to detect and continuously monitor some mobile targets, while the mobile sinks are used to collect data from specific sensors, called *sources,* which may detect the target and periodically generate detected data or aggregate detected data from a subset of sensors. Each source is represented by a *stationary source proxy* and each sink is represented by a *stationary sink proxy.*

4.4 Multipath-based Protocols

Considering data transmission between source sensors and the sink, there are two routing paradigms: *single-path* routing and *multipath* routing. In single-path routing, each source sensor sends its data to the sink via the shortest path. In multipath routing, each source sensor finds the first *k* shortest paths to the sink and divides its load evenly among these paths. In this section, we review a sample of multipath routing protocols for WSNs.

Braided Paths: Braided multipath [37,38] is a partially disjoint path from primary one after relaxing the disjointedness constraint. To construct the braided multipath, first primary path is computed. Then, for each node (or sensor) on the primary path, the best path from a source sensor to the sink that does not include that node is computed. Those best alternate paths are not necessarily disjoint from the primary path and are called *idealized* braided multipaths. Moreover, the links of each of the alternate paths lie either on or geographically close to the primary path.

N-to-1 Multipath Discovery: N-to-1 multipath discovery [39] is based on the simple flooding originated from the sink and is composed of two phases, namely, branch a*ware flooding* (or phase 1) and *multipath extension of flooding* (or phase 2). Both phases use the same routing messages whose format is given by *{mtype, mid, nid, bid, cst, path}*, where *mtype* refers to the type of a message.

4.5 QoS-based Protocols

In addition to minimizing energy consumption, it is also important to consider quality of service (QoS) requirements in terms of delay, reliability, and fault tolerance in routing in WSNs. In this section, we review a sample QoS based routing protocols that help find a balance between energy consumption and QoS requirements.

Sequential Assignment Routing (SAR): SAR [40] is one of the first routing protocols for WSNs that introduces the notion of QoS in the routing decisions. It is a table-driven multi-path approach striving to achieve energy efficiency and fault tolerance. Routing decision in SAR is dependent on three factors: energy resources, QoS on each path, and the priority level of each packet [11, 13, 41]. The SAR protocol creates trees rooted at one-hop neighbors of the sink by taking QoS metric, energy resource on each path and priority level of each packet into consideration.

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Failure recovery is done by enforcing routing table consistency between upstream and downstream nodes on each path. The objective of SAR algorithm is to minimize the average weighted QoS metric throughout the lifetime of the network.

SPEED: SPEED [41] is another QoS routing protocol for sensor networks that provides soft real-time end-to-end guarantees. The protocol requires each node to maintain information about its neighbors and uses geographic forwarding to find the paths. In addition, SPEED strive to ensure a certain speed for each packet in the network so that each application can estimate the end-to-end delay for the packets by dividing the distance to the sink by the speed of the packet before making the admission decision. The routing module in SPEED is called Stateless Geographic Non-Deterministic forwarding (SNFG) and works with four other modules at the network layer.

Energy-Aware QoS Routing Protocol: In this QoS aware protocol [42] for sensor networks, real-time traffic is generated by imaging sensors. The proposed protocol extends the routing approach in and finds a least cost and energy efficient path that meets certain end-to-end delay during the connection.

V. CONCLUSION AND FUTURE WORK

One of the main challenges in the design of routing protocols for WSNs is energy efficiency due to the scarce energy resources of sensors. The ultimate objective behind the routing protocol design is to keep the sensors operating for as long as possible, thus extending the network lifetime. The energy consumption of the sensors is dominated by data transmission and reception. Therefore, routing protocols designed for WSNs should be as energy efficient as possible to prolong the lifetime of individual sensors, and hence the network lifetime. In this paper, we have surveyed a sample of routing protocols by taking into account several classification criteria, including location information, network layering and in-network processing, data centricity, path redundancy, network dynamics, QoS requirements, and network heterogeneity. For each of these categories, we have discussed a few example protocols.

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