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Location-Based Routing Protocol in Wireless Sensor Network- A Survey

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Abstract: Advances in wireless sensor network (WSN) technology has provided the availability of small and low-cost sensor nodes with capability of sensing various types of physical and environmental conditions, data processing, and wireless communication. Variety of sensing capabilities results in profusion of application areas. However, the characteristics of wireless sensor networks require more effective methods for data forwarding and processing. In WSN, the sensor nodes have a limited transmission 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 maintaining the routes in the network and have to ensure reliable multi-hop communication under these conditions. In this paper, we give investigate about location-based routing protocols in Wireless Sensor Network and made comparison about their key factors in a table.

Keywords: Wireless sensor network, routing protocols.

I. INTRODUCTION

Wireless sensor network (WSN) [3] is generally considered as a standout amongst the most paramount technologies for the twenty-first century. In the past decades, it has gotten tremendous consideration from both the educated community and industry everywhere throughout the world. A WSN [5] normally consists of low-cost, low-power, and multifunctional wireless sensor nodes, with sensing, wireless communications and computation capabilities. These sensor nodes should communicate over short distance by means of a wireless medium and work together to accomplish a typical task, for instance, environment monitoring, military surveillance, and industrial process control. The basic philosophy behind WSNs [6] is that, while the capacity of every individual sensor node is restricted, the total power of the whole network is sufficient for the obliged mission. In numerous WSN applications, the deployment of sensor nodes is performed in an impromptu fashion without watchful planning and engineering. Once deployed, sensor nodes should have the capacity to autonomously arrange themselves into a wireless communication network. Sensor nodes are battery-powered and are relied upon to operate without attendance for a generally long time of time. By and large it is extremely troublesome and even impossible to change or recharge batteries for the sensor nodes. WSNs [9] are described with denser levels of sensor node deployment, higher unreliability of sensor nodes, and sever power, computation, and memory constraints. Thus, the unique characteristics and constraints present a lot of people new challenges for the development and application of WSNs. Because of the severe energy constraints of large number of thickly deployed sensor nodes, it obliges a suite of network protocols to implement various network control and management functions, for example, synchronization, node localization, and network security. The conventional routing protocols have several shortcomings when applied to WSNs, which are mainly because of the energy-constrained nature of such networks. For example, flooding is a technique in which a given node broadcasts data and control packets that it has gotten to the rest of the nodes in the network. Until the destination node is reached this methodology should repeats. Note that this technique does not take into account the energy constraint imposed by WSNs. Subsequently, when utilized for data routing as a part of WSNs [8], it leads to the problems, for example, implosion and overlap. Given that flooding is a blind technique, duplicated packets may keep circulate in the network, and thus sensors will get those duplicated packets, causing an implosion problem. Also, when two sensors sense the same region and broadcast their sensed data at the same time, their neighbors will get duplicated packets. To defeat the shortcomings of flooding, another technique known as gossiping can be applied. In gossiping, after receiving a packet, a sensor would choose randomly one of its neighbors and send the packet to it. The same procedure repeats until all sensors get this packet. Using gossiping, a given sensor would get stand out duplicate of a packet being sent. While gossiping tackles the implosion problem, there is a significant delay for a packet to reach all sensors in a network. Besides, these inconveniences are highlighted when the quantity of nodes in the network increases. Countless activities have been carried out to explore and beat the constraints of WSNs and settle design and application issues. In this paper various location-based routing protocols for wireless sensor network are discussed. In Sections 2 routing types in WSN are described.

II. ROUTING TYPES IN WSN

There are mainly 3 types of the sensor network [4]:

1. Hierarchical Network Routing
2. Flat Network Routing
3. Location Based Routing

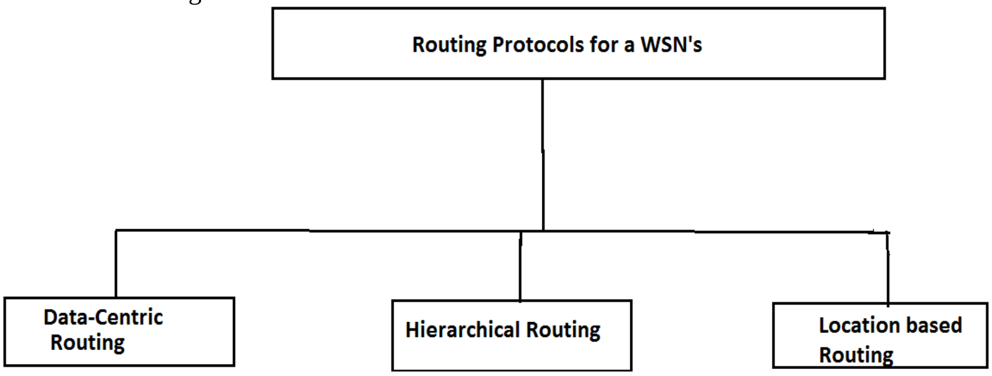

Figure 2.1: Routing Protocols in WSN

In **flat network routing**, nodes communicate in an ad-hoc way and they reach the base station (BS) by multi-hop routing. If a far node tries to reach the sink it needs to find an optimal or efficient (context routing) path. Information/ Data is centralized at the BS.

In **hierarchical networks**, nodes cannot communicate directly. They are all controlled by a local base station called cluster head (CH). Large networks can be divided into clusters and interconnect through CH. Paths are defined by CHs. This is a managed service complete with full infrastructure.

Location based routes [7] are set by node locations. The space is divided into quadrants. Each node knows its position in space (e.g., GPS).To focus the physical coordinates of a gathering of sensor nodes in a wireless sensor network (WSN). Because of application context, utilization of GPS is unrealistic, consequently, sensors need to self-organize a coordinate system. All in all, just about all the sensor network localization algorithms impart principally three basic stages. They are:

- Distance Estimation
- Position Computation
- Localization Algorithm

Location Based Protocols:

In location-based protocols [1], sensor nodes are simply addressed by their means of locations. In sensor networks, location information for nodes is necessary. To estimate energy consumption, all the routing protocols should calculate the distance between two particular nodes. We present a brief about location-aware routing protocols in WSNs.

Geographic Adaptive Fidelity (GAF): Geographic adaptive fidelity is an energy aware routing protocol. GAF is a type of protocol which was proposed primarily for MANETS and later it was used for wireless sensor networks as well. The outline of GAF is focused around the energy model that contains energy consumption during the transmission and reception of packets as well as during idle time. In GAF the sensor field will be separated into grid squares, each sensor uses its location information to associate with other grids. This location information will be provided by GPS or by other location systems.

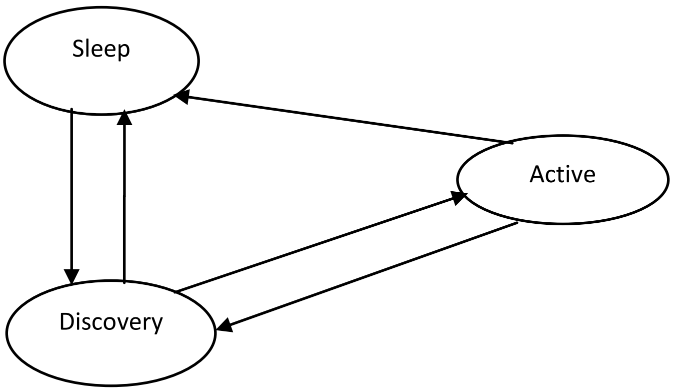

Figure 2.1.1: State Transition Diagram for GAF

State transition diagram of GAF consists of three states. They are active, sleep and discovery. In sleeping state sensor will turn off its antenna for energy savings. In discovery state a sensor trades exchange messages to look into other sensors in the same lattice. Even in the active state the sensor occasionally shows its discovery message to inform proportionate sensors about its state. The time used in each of the state will be depending upon few components like its needs and sensor mobility. GAF means to expand the network lifetime by arriving at a state where each grid contains one active sensor focused around sensor ranking rules. The highest rank will handle routing within their respective grids.

Geographic and Energy-Aware Routing (GEAR):GEAR is an energy efficient routing protocol proposed for routing queries to target the regions in the sensor field. The sensors will be equipped with localization hardware like GPS, localization system. With the help of this the sensors can know about their current positions. The sensors can know about its location, their residual energy as well as neighbours too. In order to select the sensors to route the packet towards destination it uses energy aware methods using geographical information. At that point GEAR uses recursive geographic forwarding to spread the packets inside the target region.
Coordination of Power Saving with Routing: SPAN is a type of protocol which is also proposed primarily for MANETs and later it can also be applicable to WSNs as its aim is to reduce energy consumption. The design of SPAN is motivated from the fact that wireless networks are the most power consumable devices. In order to reduce power consumption it is better to turn off the antenna in idle state. Even though span doesn't require the sensors to know their location information it runs well with the geographic forwarding protocol. When the geographic forwarding protocol is used the Span selection rule requires every sensor to display its status to the neighbours and also to its coordinators. Additionally, when it receives a packet, a coordinator forwards the packet to a neighbouring coordinator if any, which is the closest to the destination or to a non-coordinator that is closer to the destination.
Trajectory-Based Forwarding (TBF): TBF is a routing protocol that requires a sufficiently dense network and the presence of a coordinate system, for example, a GPS, so that the sensors can position themselves and estimate distance to their neighbours. The source specifies the trajectory in a packet, but does not explicitly indicate the path on a hop-by-hop basis. Based on the location information of its neighbours, a forwarding sensor makes a greedy decision to determine the next hop that is the closest to the trajectory fixed by the source sensor. Route maintenance in TBF is unaffected by sensor mobility given that a source route is a trajectory that does not include the names of the forwarding sensors. In order to increase the reliability and Sleeping, Discovery and network management. TBF can also be used for resource discovery. Another interesting application of TBF is securing the perimeter of the network.
Bounded Voronoi Greedy Forwarding [BVGF]: It uses the concept of Voronoi diagram. Mainly in Voronoi diagram, Sensor nodes should have awareness of their geographical positions. A network is modelled by a Voronoi diagram itn BVGF, which represents the sensors locations. In this kind of greedy geographic routing, a sensor will always forward a packet to the neighbour that has the shortest distance to the destination. Mainly sensors are suitable for acting as the next hops, those are the ones whose Voronoi regions are traversed by the segment line which joins the source and the destination. Among from all eligible neighbours, BVGF protocol chooses as the next hop neighbour which has been considered as a shortest Euclidean distance to the destination. It does not help the sensor deplete their battery power uniformly. Each sensor essentially has only one next hop which helps to forward its data to the sink. Hence, any data dissemination path between a source sensor and the sink will always consists same chain of the next hops, those will rigorously suffer from battery power depletion. Energy is not considered as a metric in BVGF.
Geographic Random Forwarding (GeRaF): GeRaF was proposed by Zorzi and Rao, which uses geographic routing where a sensor acting as relay is not known a priori by a sender. There is no guarantee that a sender will always be able to forward the message toward its ultimate destination, that is, the sink. This is the reason that GeRaF is said to be best-effort forwarding. GeRaF assumes that all sensors are aware of their physical locations, as well as that of the sink. Although GeRaF integrates a geographical routing algorithm and an awake-sleep scheduling algorithm, the sensors are not required to keep track of the locations of their neighbours and their awake-sleep schedules. When a source sensor has sensed data to send to the sink, it first checks whether the channel is free in order to avoid collisions. If the channel remains idle for some period of time, the source sensor broadcasts a request-to-send (RTS) message to all of its active (or listening) neighbours. This message includes the location of the source and that of the sink. Note that the coverage area facing the sink, called forwarding area, is split into a set of NP regions of different priorities such that all points in a region with a higher priority are closer to the sink than any point in a region with a lower priority. When active neighbouring sensors receive the RTS message, they assess their priorities based on their locations and that of the sink. The source sensor waits for a CTS message from one of the sensors located in the highest priority region. In GeRaF, the best relay sensor the one closest to the sink, thus making the large advancement of power topology, which it contains only minimum power paths from each sensor node to the sink. In case that the source does not receive the CTS message, implies that the highest priority region is empty. Hence, it sends out another RTS polling sensors in the second highest priority region. This process continues till the source receives the CTS message, which means that a relay sensor has been found. Then, the source sends its data packet to the selected relay sensor, which in turn replies back with an ACK message. The relay sensors will action the same way as the source sensor in order to find the second relay sensor. The same procedure repeats until the sink receives the sensed data packet originated from the source sensor. It may happen that the sending sensor does not receive any CTS message after sending NP RTS messages. This means that the neighbours of the sending sensor are not active. In this case, the sending sensor backs off for some time and retries later. After a certain number of attempts, the sending sensor either finds a relay sensor or discards the data packet if the maximum allowed number of attempts is reached.
Minimum Energy Communication Network (MECN): MECN [2] is a location-based protocol for achieving minimum energy for randomly deployed ad hoc networks, which attempts to set up and maintain a minimum energy network with mobile sensors. It is self-reconfiguring protocol that maintains network connectivity in spite of sensor mobility. It computes an optimal spanning tree rooted at the sink, called minimum power topology, which contains only the minimum power paths from ach sensor to the sink. It is based on the positions of sensors on the plane and consists of two main phases, namely, enclosure graph construction and cost distribution. For a stationary network, in the first phase (enclosure graph construction), MECN constructs a sparse graph, called an enclosure graph, based on the immediate

locality of the sensors. An enclosure graph is a directed graph that includes all the sensors as its vertex set and whose edge set is the union of all edges between the sensors and the neighbours located in their enclosure regions. In other words, a sensor will not consider the sensors located in its relay regions as potential candidate forwarders of its sensed data to the sink. In the second phase (cost distribution), non-optimal links of the closure graph are simply eliminated and the resulting graph is a minimum power topology. This graph has a directed path from each sensor to the sink and consumes the least total power among all graphs having directed paths from each sensor to the sink. Each sensor broadcasts its cost to its neighbours, where the cost of a node is the minimum power required for this sensor to establish a directed path to the sink. While MECN is a self-reconfiguring protocol, and hence is fault tolerant (in the case of mobile networks), it suffers from a severe battery depletion problem when applied to static networks. MECN does not take into consideration the available energy at each sensor, and hence the optimal cost links are static. In other words, a sensor will always use the same neighbour to transmit or forward sensed data to the sink. For this reason, this neighbour would die very quickly and the network thus becomes disconnected. To address this problem, the enclosure graph and thus the minimum power topology should be dynamic based on the residual energy of the sensors.

Small Minimum-Energy Communication Network (SMECN): It is a routing protocol which is used to improve MECN. In this protocol, minimal graph is regarded as with its minimum energy property. Mainly this property implies that for any pair of sensors in a graph associated with a network, minimum energy-efficient path is present in between sensors. The path which contains lowest energy consumption, all over probable paths between this sensor pairs. Characterization of a graph with respect to the minimum energy property is perceptive. In this protocol, by using some initial power each and every sensor discovers its immediate neighbours simply by broadcasting a neighbour discovery message later it is updated incrementally with the usage of Power. Specifically, the immediate neighbours of a given sensor are computed analytically. Then, simply sensor starts broadcasting a neighbour discovery message with some initial power p and it checks whether the theoretical set of immediate neighbours is a subset of the set of sensors that replied to that neighbour discovery message. In this Regard, sensor uses the corresponding power p to communicate with its closest neighbours. Otherwise, it increments p and rebroadcasts its neighbour discovery message.

Table 2.1: Advantages & Disadvantages of Location Based Routing Protocol

S.No	Protocol	Advantage(s)	Disadvantage(s)
1	Geographic Adaptive Fidelity (GAF)	• Optimize the performance of WSN • Highly Scalable • Maximize the network lifetime • Limited energy conservation	• High overhead • Doesn't take care of QoS during data transmission. • Limited mobility • Limited power management
2	Geographic and Energy Aware Routing (GEAR)	• Increase the Network lifetime • Reduces Energy Consumption	• Limited Scalability • Limited Mobility • Limited Power management • High overhead • Doesn't take care of QoS
3	Coordination of Power Saving with Routing (SPAN)	• Reduces the energy consumption of nodes • Less over head • Supports data aggregation	• Scalability is limited • High overhead • No QoS
4	Trajectory Based Forwarding (TBF)	• Increase the reliability • Increase the Network Management • Securing the perimeter the network	• High overhead

5	Bounded Voronoi Greedy Forwarding (BVGF)	• Simple, easy to understand	• Overhead in determining voronoi partitions
6	Geographic Random Forwarding (GeRaF)	• It is virtually stateless • It itself does not create multi hop overhead • Easily integrated with awake/ asleep schedules to save energy	• User involvement is required in each stage • More time is required to get efficient output
7	Minimum Energy Communication Network (MECN)	• Maintains energy network with low power • Fault tolerant • Optimal spanning	• Fault tolerant depends upon specific application
8	Small Minimum Energy Communication Network (SMECN)	• Less Energy than MECN • Links maintenance cost is less	• Maximum power usage • No. of broadcast messages is large

III. CONCLUSION

Routing in sensor networks has attracted a lot of attention in the recent years and introduced unique challenges compared to traditional data routing in wired networks. One of the main challenges in the design of routing protocols for WSNs [10] 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 location-based routing protocols by taking into account several classification criteria, including location information, network lifetime and QOS requirements. For each of these protocols, we have discussed a advantages and disadvantages.

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