

A Review on Energy Efficient Location Based Routing Protocols for Wireless Sensor Networks

Sudhakar Avareddy¹, Dr. Rajashree V.Biradar²

Asst. Professor, Dept. of CSE BITM Billari, Karnataka, India.¹

Professor, Dept. of CSE BITM Ballari, Karnataka, India.²

ABSTRACT: A wireless sensor network (WSN) consists of low cost, low power, small in size and multifunctional sensor nodes. A collection of sensing devices that can communicate wirelessly. In past decades of years, wireless sensor networks have gained attention by researchers and the users for remotely monitoring tasks and effective data gathering in different environment. In this paper, we review the main design issues based on the model of wireless sensor networks Data collection and aggregation. Based on network structure routing techniques can be classified into 3 categories: Hierarchical Network Routing, Flat Network Routing & Location Based Routing. we did survey on location based routing protocols comparisons with parameters like Data aggregation, Scalability, Power usage, QOS, and Query based & also advantages, disadvantages and applications.

KEYWORDS: WSN, Sensor Node, Protocol ,Routing, Clustering.

I. INTRODUCTION

A wireless sensor network (WSN) is growing in diverse areas so as to provide new opportunities to the network as well as to the services. A wireless sensor network (WSN) consists of tiny, battery powered sensor nodes having limited storage, on-board processing and radio capabilities.

The following ways have been defined to efficiently

A sensor node consists of following units:

- A Sensing Unit: Used to collect data from the surroundings.
- A Processing Unit: Used for data processing.
- A Communication Unit: Used to store data i.e memory
- A Power Unit: Used to perform the required tasks.

The report is sensed by the nodes and then sends that data to the processing centre named as “Sink”. The main challenge in the WSN is to extend the network lifetime by efficiently utilize their small battery power.

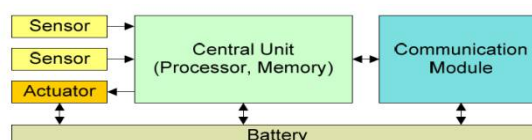


Figure 1.1: Structure of a Sensor Node

The following ways have been defined to efficiently utilize the energy [1]:

- Deployment of sensor nodes, Energy Efficient Clustering., Energy Efficient Scheduling.
- Data Aggregation, Energy Efficient Routing Protocols.

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Vol. 6, Issue 6, June 2017

1.1 Classification of routing protocols based on network structure

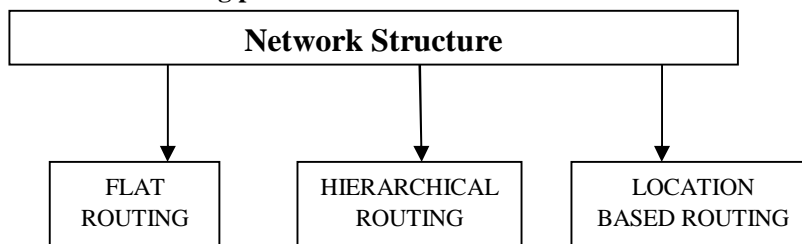


Figure 1.2: Classification of routing protocols

In flat network routing nodes communicate in an adhoc way and they reach the base station (BS) by multihop routing. If a far node tries to reach the sink it needs to find an optimal or efficient (context routing) path. Information/ Data are 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.

In Location based routes [5] 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

1.2 Key factors [2] in wireless sensor network

Key factors	Description
Network connectivity	Sensor nodes are connected with each other and base station via wireless links to share information. It is preferred as node failures may cause the network topology and network size to change and loss of information
Area coverage	Region where the sensor nodes are deployed for monitoring and data collection. It needs maximum coverage by sensor node/base station transmission range
Node deployment	Strategy to deterministically place the sensor nodes in order to meet the desired performance goals such as coverage of monitored region
Fault tolerance	Ability of sensor nodes to provide functionality even when few sensor nodes may fail and stop the data transmission due to power shortage, physical damage or environment interferences and restrain the purpose of the network
Network lifetime	Minimum time at which maximum numbers of sensor nodes are dead
Data aggregation	Guiding principle to combine the sensed data from numerous sensor nodes with elimination of redundancy and provide collective information to the base station
Clustering	Course of action to group sensor nodes having similar role with an assigned cluster head in a densely deployed large-scale wireless sensor network
Routing	The process of determining a network path for a packet from source node to its destination
Network dynamics	Changes in the topology of wireless sensor network due to sensor node failure or its mobility. It makes periodic monitoring difficult as path stability, bandwidth, energy estimation are required

Table 1.1: Key factors [2] in wireless sensor network

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1.3 Design requirements for energy efficient schemes in WSN

Requirement type	Design constraints
Data collection and aggregation	<ol style="list-style-type: none"> 1. Restriction on redundant data 2. Low computational overhead 3. Minimum memory storage
Clustering	<ol style="list-style-type: none"> 1. Maximum supported coverage area 2. Distribution of sensor nodes 3. Connection density on cluster head 4. Fresh node addition
Routing	<ol style="list-style-type: none"> 1. Shortest path 2. Network connectivity 3. Maximum supported size 4. Low communication overhead

Table 1.2 : Design requirements for energy efficient schemes in WSN

1.4 Data collection and aggregation.

Wireless sensor networks are mainly utilized for data collection and aggregation. *Data collection* is defined as the organized integration of sensed data from multiple sensors transmitted ultimately to the base station for processing. However, data generated from neighboring sensor nodes is persistently redundant and highly interrelated. In such scenarios, sensor nodes can transmit data to a local collector or assigned head which combines data from all the sensor nodes that reside in its connectivity and transmits the concise packet to the base station consequentially reducing the total number of packet transmission thus, conserving bandwidth and energy. This can be accomplished by data aggregation. *Data aggregation* [3] can be defined as the guiding principle to combine the sensed data from numerous sensor nodes with elimination of redundancy and provide collective information to the base station.

II. LITERATURE REVIEW

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. Present here a brief about location aware routing protocols in WSNs.

2.1 Geographic Adaptive Fidelity (GAF):

[11, 12, 13] 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.

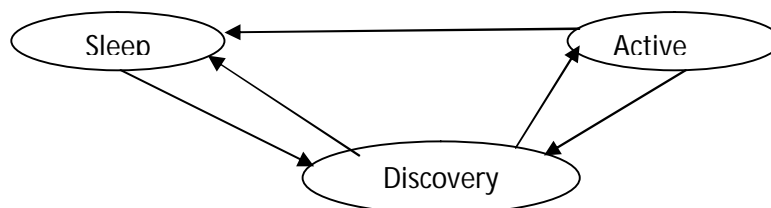


Figure 2.1: State transition diagram for GAF

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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

2.2 Geographic and Energy Aware Routing (GEAR):

[14] 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 neighbors too. In order to select the sensors to route the packet towards destination it uses energy aware methods using geographical information.

2.3 Trajectory Based Forwarding (TBF):

[15] 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 sensor scans position themselves and estimate distance to their neighbors. 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 neighbors, a forwarding sensor makes a greedy decision to determine the next hop that is the closest to the trajectory fixed by the source sensor.

2.4 Minimum Energy Communication Network (MECN):

[16] MECN 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 each sensor to the sink. 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 neighbors located in their enclosure regions. 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.

2.5 Small Minimum Energy Communication Network (SMECN):

[17] 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 neighbors simply by broadcasting a neighbor discovery message later it is updated incrementally with the usage of Power. Specifically, the immediate neighbors of a given sensor are computed analytically.

2.6 Coordination of Power Saving with Routing (SPAN):

[18,19] 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 neighbors and also to its coordinators. Additionally, when it receives a packet, a coordinator forwards the packet to a neighboring coordinator if any, which is the closest to the destination or to a non-coordinator that is closer to the destination.

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2.7 Bounded Voronoi Greedy Forwarding [BVGF]:

[20] It uses the concept of Voronoi diagram. Mainly in Voronoi diagram, Sensor nodes should have awareness of their geographical positions. A network is modeled by a Voronoi diagram it 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. 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.

2.8 Geographic Random Forwarding (GeRaF):

GeRaF[21] 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 neighbors 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) neighbors. 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 neighboring 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.

III. THE COMPARISON OF LOCATION BASED ROUTING PROTOCOLS

Is done based on literature survey as given in table 3.1.comparison are based on some key parameters, like data aggregation, scalability, power usage, QOS and query based

3.1 Comparison of location based protocols with some key parameters [24].

Table 3.1: Comparison of location based protocols

SL NO	Protocols NAMES	Parameters				
		Data aggregation	Scalability	Power usage	QOS	Query based
1	GAF	NO	GOOD	LTD	NO	NO
2	GEAR	NO	LTD	LTD	NO	YES
3	TBF	NO	LTD	LTD	NO	NO
4	MECN	NO	NO	MAX	NO	NO
5	SMECN	NO	NO	MAX	NO	NO
6	SPAN	NO	LTD	N/A	NO	NO
7	BVGF	NO	LTD	HIGH	YES	NO
8	GeRaF	NO	LTD	LESS	YES	YES

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3.2 Advantages, Disadvantages & Applications of Location Based Routing Protocol

S N	Protocols	Advantages	Disadvantages	Applications
1	GAF	Optimize performance of WSN. Highly Scalable Maximize network lifetime.	High overhead. Doesn't take care of QoS during data transmission.	Habitat/ military
2	GEAR	Increase Network lifetime. Reduces Energy Consumption.	Limited Scalability Limited Mobility	Home/ offices
3	TBF	Increase reliability. Increase Network Mgt.	High overhead	Environmental monitoring Designing networking.
4	MECN	Maintains energy network with low power. Fault tolerant. Optimal spanning.	Fault tolerant depends upon specific application	Environmental monitoring
5	SMECN	Less Energy than MECN Links maintenance cost is less	Maximum power usage No. of broadcast messages is large	Environmental monitoring
6	SPAN	Reduces the energy consumption of nodes	Scalability is limited High overhead No QoS	Habitat monitoring
7	BVGF	Simple, easy to understand	Overhead indetermining voronoi partitions	Environmental monitoring. Find position of the sensor
8	GeRaF	It is virtually stateless It itself does not create multi hop overhead	User involvement is required in each stage More time is required to get efficient output	The medical applications

Table 3.2 : Advantages, Disadvantages & Applications of Location Based Routing Protocol

IV. CONCLUSION

Routing in sensor networks is a new research area, with a limited but rapidly growing set of result where one of the main challenges is energy efficiency due to the scarce sensor energy resources. In this paper, routing protocols are three categories: Flat based routing, Hierarchical-based routing and Location-based routing on the basis of network structure. They have the common objective of trying to extend the lifetime of the sensor network and we have surveyed a location based routing protocols by taking comparisons, advantages and disadvantages into consideration.

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