

Routing Protocols In Wireless Sensor Network-Survey

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Abstract

Monitoring of physical conditions is done by wireless sensor network like temperature, pressure or any object moving around. Data collection is done at central location received from various sensors spatially dispersed for dedicated applications. Connection of physical world with virtual world is done by wireless sensor network and is currently being used for many applications. In this paper there is a study of various routing protocols in sensor network and comparison between different routing protocols has also been done.

1. Introduction

In sensor network low cost sensors are used for sensing and reporting sensed data to a location called sink. Sensors are types of devices having processing capability, a radio frequency transceiver, source of power and storage. A multihop communication network infrastructure is used to deploy sensor network. Discovery and maintenance of routes from source to destination is achieved using different routing protocols in wireless sensor network. Selection of particular routing protocol depends on the nature and requirement of the application. Aim of wireless sensor network is to monitor and record certain events for which network is intended for. Nodes communicate in multi hop based architecture so that distant nodes can also communicate with sink by simply passing their sensed information to nodes in their close vicinity or in direct communication range. This collaboration of sensors increases scalability of network. Multiple paths or links from source to destination are established containing intermediate or relay nodes in between gives rise to a challenging situation in which decision should be made which path among several paths will be best suited for transmission. In order to select optimal path from one end to other end an appropriate routing protocol is required. Routing protocols need to be selected in such a manner so that they increase network lifetime with less energy consumption by taking into consideration various characteristics of medium used and metrics for performance. Routing is very challenging in wireless sensor network because of battery constraint, frequent change in network topology and so on. Routing protocol should be designed by keeping in mind factors like strategies used for load distribution, methods used for data reporting, dynamics of network like mobile or stationary and so on.

2. Classification of routing protocols

There are various routing protocols categorized by taking parameters like operations performed by protocols, route discovery and organization of network. In the diagram below different categorization of protocols based on operations is shown. In this section, detailed study of these protocols will be done.

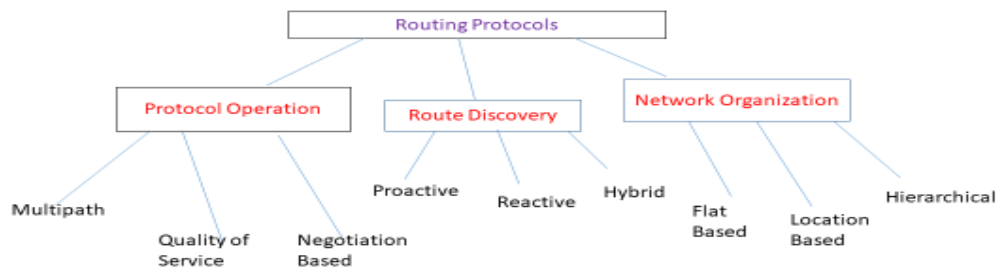


Fig 1: Routing protocols in sensor network

2.1. Network Organization

Classification of protocols based on network organization is done based on the nature of network.

2.1.1 Flat Based

Task of all nodes are same in this category of protocol and their capabilities of performing task are also same. Few protocols of this type are discussed below.

2.1.1.1 Directed Diffusion

Directed diffusion is a type of protocol in which data from various sources are called attribute-value pair and it is data centric dissemination protocol. Directed diffusion is a query based protocol in which data of interest is demanded by base station. This interest requested by sink contains gradient which contains information like where to send that data, duration of data and data rates. Routing used by directed diffusion is multipath having multiple paths from one end to other. There are certain applications which requires continuous delivery of data ,directed diffusion is not suitable for those types of applications like monitoring of environment and one more disadvantage of directed diffusion is naming approach is application specific.

2.1.1.2 SPIN(Sensor protocol for information via negotiation)

Resource blindness problem which is faced in wireless sensor network is addressed by SPIN protocol. SPIN protocol is a negotiation based routing protocol and meta data is used by this protocol provided that metadata should be less than data. For example suppose xyz is meta data of XYZ then size of xyz should be less than XYZ. SPIN protocol is further classified into SPIN-PP,SPIN-EC,SPIN-BC and SIPN-RL. SPIN-PP supports point to point communication between two nodes means nodes will be communicating without interference and there is a direct link. SPIN-EC works exactly same as SPIN-PP in addition to one energy heuristic. SPIN-BC uses broadcast transmission. Reliability and packet loss issues are addressed by SPIN-RL version of SPIN protocol. Disadvantage of SPIN protocol is data delivery is not guaranteed through advertisements and is not well suited for areas in which reliability is required.

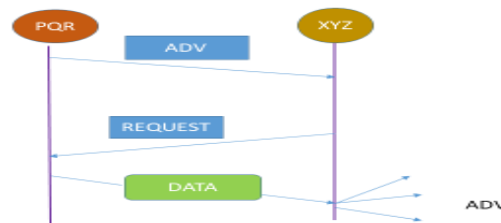


Fig 2: SPIN Protocol

2.1.2 Location Based routing protocols

Location based routing is geographical routing in which sensors determine their location and they have to determine their location as well as destination position. Types of location based routing are discussed below.

2.1.2.1 Unicast

In this type of routing only one single intended receiver is used and awareness of position is achieved through a greedy forwarding approach. Every node in sensor network is aware about its position and its neighbor's position. But source (from where data has been originated)must be aware about destination location as well. One example of this type of routing is GPRS (Greedy perimeter stateless routing) a non energy aware protocol in which a sensor transmits sensed information to a neighbor who is closest to destination and this local decision is made by intermediate sensors. Overhead of registration of locations is introduced by GPRS protocol.

2.1.2.2 Multicast

In multicast routing same information is dedicated for several destination. For a single packet there are several recipient. SPBM(Scalable Position Based Multicast) is used for multicast routing which maintains table containing entries of destinations of packet.

2.1.2.3 Geocast

In this type of routing only certain geographical regions are recipient of sensed data process called as Geocasting. Once data is arrived to specific region ,depending upon the requirement multicasting or unicasting of data is used. GEAR(Geographical energy aware routing) protocol is used for geocasting in sensor network. GEAR uses an approach in which certain region is received a request unlike directed diffusion in which interest is received by entire network. Two algorithms are used by GEAR protocol one is neighbor selection algorithm and other is a geographic forwarding algorithm which is a recursive algorithm. Neighbor selection algorithm is used to send data to intended region and second algorithm is used to forward packets to recipients within that target place.

2.1.3 Hierarchical Based Routing

In this type of routing clusters are used in which grouping of sensors is done. One sensor is selected as head of the cluster and it is the recipient of sensed information being sensed by all sensors in a particular cluster ,means all sensors transmit their data to this head which is having more power than normal sensors in the cluster. Sink communicate with cluster heads using direct communication links but sometimes multi hop paths are also used for this communication. Few hierarchical routing protocols are discussed below.

2.1.3.1 LEACH(Low energy adaptive clustering hierarchy) protocol

LEACH is an energy saving protocol and is used to enhance lifetime of network. Using LEACH protocol clusters are built and aggregation of data is done at cluster head. In order to remove data redundancies data is

filtered by cluster head and time synchronization is required which serves as a disadvantage. Single hop communication is used by sensors to communicate with their head in the cluster.

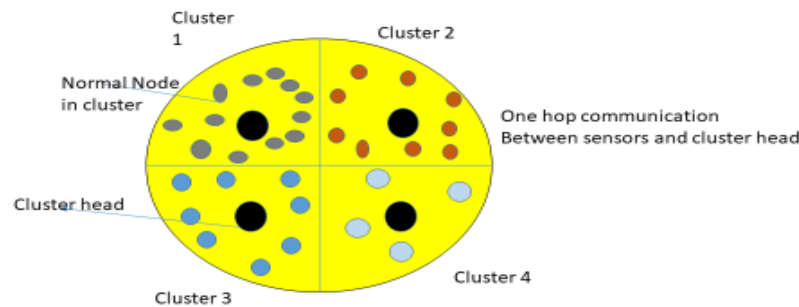


Fig 3: LEACH Protocol

2.1.3.2 PEGASIS(Power Efficient Gathering in sensor network)

PEGASIS protocol uses a chain type structure in which sensors shares their sensed information with their neighbours and this chain is formed by using one greedy algorithm. Energy is saved because nodes gets involved in communication only with their neighbours. PEGASIS works in two phases. In first phase chain is constructed and second phase is data gathering phase. Problem of redundant transmission is drawback of PEGASIS protocol.

2.2. Route Discovery

Route discovery is discovery of routes from source to destination. Discussion of few route discovery protocols are discussed below.

2.2.1 Proactive

Proactive routing often called as table driven approach requires continuous evaluation of routes and before routes are actually needed they are established in advance so one is always available before request. Routing information should be up to date in proactive routing. DSDV(Destination sequenced distance vector) protocol is an example of proactive routing. In DSDV tables are saved which contains routes to other sensors and continuous updation of tables is required to achieve a fresh view of network. Data contains following information,

- a. Address of destination node
- b. Sequence number
- c. Number of hops.

Periodic broadcasting of tables is done and also sometimes when any change is observed. Tables are categorized into two types full dump which contains routing table with all entries and incremental update are having entries which are changed. DSDV protocol offers heavy control overhead and delay in network.

2.2.2 Reactive

It is on demand routing for example AODV protocol is reactive protocol in which routes get established on demand. When a node which is acting as a source having some sensed information to transmit to destination

first ask routes from its neighbour by sending a route request packet. Neighbours reply if they know route or broadcast further if they don't know. A route request packet contains following useful information

- a. Destination Identifier
- b. Source Identifier
- c. Source sequence number
- d. Destination Sequence number
- e. Time to live field which specifies how long a packet can survive in network or age of packet.
- f. Broadcast Identifier

Source after sending route request packet waits for replies and it gets several replies from different sensors and its up to source to select one reply packet or route to destination from different replies. This decision can be based on various parameters like number of hops, battery life of relay nodes and so on. Source broadcast request packet and gets reply packet by unicast mode means reply packets are unicast in network while request packets are broadcast. AODV protocol offer heavy control overhead and bandwidth consumption is more. In the network below path from source to destination is shown using AODV protocol

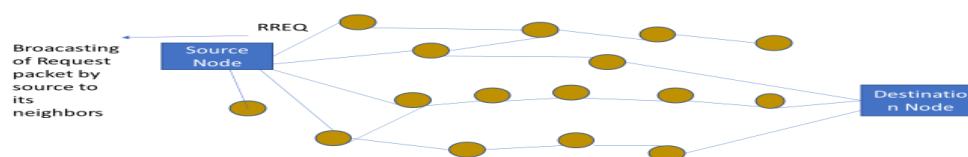


Fig 4: RREQ packet in AODV

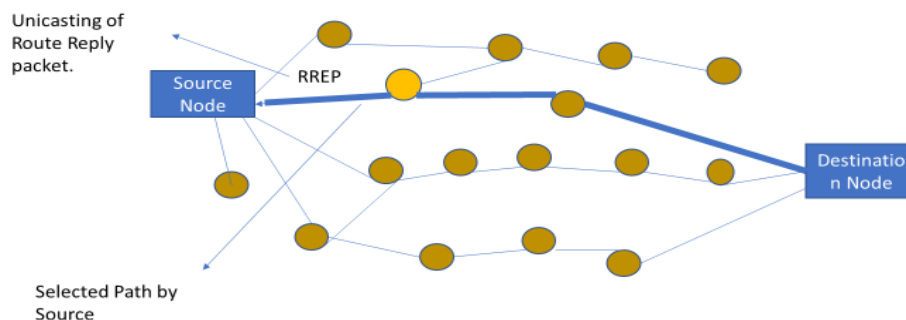


Fig 5: RREP Packet in AODV Protocol

2.2.3 Hybrid

Hybrid protocol is a combination of best in reactive and proactive routing protocols for example ZRP(Zone routing protocol),CEDAR(Core Extraction Distributed ad-hoc routing) and ZHLS(Zone Hierarchical based link state protocol).

2.3 Protocol Operation

Operation of protocol can also be a criteria for categorization of routing protocols. Some examples are given below.

2.3.1 Quality Of Service(QOS)

QOS describes quality of service being provided and some metrics are low energy consumption, high reliability, low jitter and end to end delay. Protocols come under QOS service category satisfies these metrics for example SAR(Sequential Assignment Routing protocol) is a QOS protocol in which creation of multiple trees exists. Main goal of QOS protocol is to ensures quality so routes are chosen based upon factors like energy level, number of packets that can be forwarded successfully and so on.

2.3.2 Multipath Routing

As specified in name in this protocol several distinct paths are found from source to destination, one is selected for transmission and others are backup or alternate path used if primary path is depleted. Advantages of using multi path routing protocols are fault tolerance, load balancing and reliability. Few multipath routing protocols re discussed below

2.3.2.1 REAR(Reliable Energy aware routing protocol)

Residual energy or remaining power is taken into consideration in REAR protocol and it is reliable protocol since alternate paths are available. Acknowledgement concept is used to acknowledge source about transmission that whether it is failed or successful. Sink sends an ACK packet back to source confirming that packets have been delivered successfully. Threshold value is used for energy and if source finds that energy level is going below threshold value it selects other alternative path for its data transmission. So, when first or primary route is degraded second one can serve the purpose that is why it is called as alternate routing. Disadvantage of REAR protocol is interference problem.

2.3.2.2 N-1 Protocol

N-1 protocol uses node disjoint routes and does not consider level of energy during selection phase since aim is to only select distinct nodes from source to destination.

2.3.2.3 Braided Multipath routing

In this type of routing protocol alternative path is found for every individual sensor in primary or main path only constraint is alternate paths will not be containing that node. These alternative paths needs to be maintained which serves as an overhead and also these paths are not energy efficient. In next section multipath routing protocols have been compared.

Multipath Routing Protocols	Node Disjointedness	Efficient in terms of Energy	Number of Paths	Performance
Braided Multipath Routing	Partially Disjoint	No	Not Limited	Offers Delay
N-1 Multipath Routing	Node-Disjoint	No	Not Limited	Reliability
REAR Protocol	Node-Disjoint	YES	Only Two Paths	Network Lifetime

Fig 6: Table for Multipath protocols comparison

Conclusion

Wireless sensor network is a network comprises of small sensors having sensing capabilities to serve many areas . Study of various routing protocols have been done in this paper and also advantages and disadvantages of routing protocols have also been discussed. In future work will be done to remove all disadvantages we face in different routing protocols. In future work will be enhanced in improving energy efficiency in network.

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