

A Survey: Wireless Sensor Network and its Routing Protocol

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ABSTRACT

Wireless Sensor Network (WSN) is latest technology for sensing and processing different physical and environmental condition data such as heat, temperature, pressure etc. WSN is the network of small sensing node and these node have capability of sensing data and communicating with base station(Sink Node). WSN also have routing capability that route the data to sink node using various routing protocol. WSN routing protocol classified into various types based on network topology i.e. Flat, Hierarchical and Location Based routing protocol in WSN used for selecting optimal routes path in sensor network. In this paper we study about WSN and different routing protocol that are used in WSN for routes the data to destination node.[2][4]

Keywords

Base Station(Sink Node), Sensing node, Cluster based, Flat, Location Based routing protocol.

1. INTRODUCTION

WSN is modern technology's invention that give an idea of sensing data using large number of small sensing node and send these data to the sink node that have a capability of processing these data and perform some action based on result. [1][2] Basically WSN is the network of large number of small sensing node. These node deploy may be in randomly or may be in predefine structure manner in target area. These sensing node have limited battery capability. This is the major issues in WSN. For better throughput and lifetime WSN have to choose optimal path to destination node using various routing protocol. These routing protocol categories into three types based on network structure. Flat, Hierarchical and Location Based routing protocol. SPIN, Direct Diffusion(DD) are the example of Flat Routing Protocol. Leach, GBDD, PEGASIS are the example of Hierarchical Routing [3][7] Protocol and MFR, DIR and SPAN are example of Location Based Routing Protocol. In this paper, In section 2 we study the design and routing issues in wireless sensor network. In section 3 we study about application in wireless sensor network. In Section 4 we study different category of routing protocol and discuss all these routing protocol in details. In section 5 we discuss the future scope. And discuss conclusion in section 6.

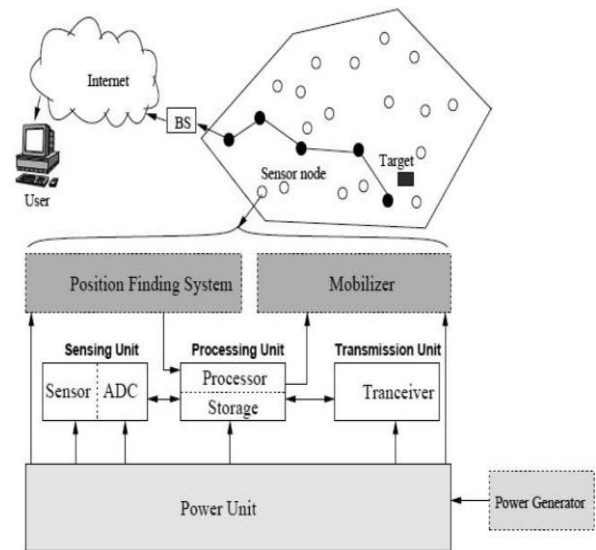


Fig 1: An Architecture of WSNs.

2. DESIGN AND ROUTING ISSUES IN WSN

The design of routing protocol is major issue in wireless sensor network because of various network constraint limitation such as bandwidth, battery power, storage and limited central processing unit.[5]

In other hand the designing issues in wireless sensor network have many aspect like less energy capacity, node deployment, data aggregation, sensor location and scalability.[6]

Less energy capacity:- Sensor node powered by battery and these battery have limited power capacity. Therefore more useable sensor node die quickly as compare to other sensor node.

Node Deployment:- Node deployment in WSN is application specific. Node may be deployed in random manner or may be in predefine structure manner.

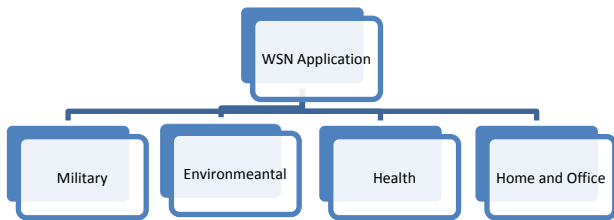
Data Aggregation:- In WSN same data may be sense by multiple sensor node that cause redundant data collection and processing. To reduce the power consumption and processing power we use various data aggregation technique to remove the redundant data and enhance the throughput and performance of WSN.

Sensor Location:- One of the main problem is how to locate sensor node in target area to get best performance and hoe to manage all these sensor node.

Scalability:- Scalability is one of the issues in WSN because increase the network size means increase the number of sensing node that cause maintenance overhead and increase energy consumption.

3. APPLICATION IN WIRELESS SENSOR NETWORK

We all know that Wireless Sensor Network is application Specific technology. There are various application of Wireless Sensor Network such as Military Application, Environmental application Health application and Home and office application.



Military Application

- Monitoring friendly forces, equipment, and ammunition
- Battlefield surveillance
- Nuclear, biological, and chemical attack detection

Environmental Application

- Forest fire detection
- Bio-complexity mapping of environment
- Flood detection
- Precision Agriculture
- Air and water pollution

Health Application

- Health Monitors
 - Glucose
 - Heart rate
 - Cancer detection
- Chronic Diseases
 - Artificial retina
 - Cochlear implants
- Hospital Sensors
 - Monitor vital signs
 - Record anomalies

Home and office Application

- Home and office automation
- Smart environment

4. ROUTING PROTOCOL

In WSN, routing protocol basically divided into three parts. These are given below.

- a. Flat Routing Protocol
- b. Location Based Routing Protocol
- c. Hierarchy Based Routing Protocol

4.1 Flat Routing Protocol

The first category of routing protocol in wireless sensor network is Flat routing protocol. It is also known as data centric approach. In this protocol every sensor node play same role and perform task together. In this approach base station send queries to selected region then sensor node from that selected region send data back to base station. We cannot use global identifier for every sensor node due to presence of large number of sensor node. There are various protocols under this category such as SPIN, EAR, Directed Diffusion, MCFA and SAR.[10]

4.1.1 SPIN (Sensor protocol for information via negotiation)

SPIN protocol overcome the problem that occur in classical flooding mechanism. Implosion and Overlap problems are resolved in this protocol. SPIN protocol basically worked on two mechanisms that are negotiation and resource adaption. In SPIN protocol three terms are used, ADV, REQ and DATA. When node wants to transmit new data then it broadcast ADV message in network. If any node interested in data then it send REQ message to that node then source node send data to that node. Then receiving node repeat same process therefore data spread into the wireless sensor network. SPIN family have many protocol such as SPIN 1 and SPIN 2. SPIN 1 work as describe above and SPIN 2 work for mobile sensor node because in SPIN 2 decision based on neighbor node.[8]

4.1.2 Directed Diffusion

Directed Diffusion is the type of flat routing protocol for sensor query broadcasting and processing. The data sense by node describe as attribute –value pairs.

In DD, the data sense by every node and combine all these data and remove redundancy, save energy, increase lifetime and reduce transmission cost. In DD routing protocol find multiple path from source to one destination node.

Directed Diffusion is 3 stage protocol -- 1) sending interest 2)Building Gradients 3) Data transmission

In starting phase sink prefer low data rate for event. After sometime sink can reinforce a sensor to send event with higher rate. BS station create query for data by sending interest, intermediate node forward these interest. Each sensor node create gradients for other sensor node from which it receive interest. This process continued until gradient setup reach to base station from sensor node.

After that, protocol choose best path from multiple path and reinforced for prevent from flooding, data aggregation is also used to reduce communication cost. Base station refresh and resend interest periodically. This process is required because interest is not reliable transmission.

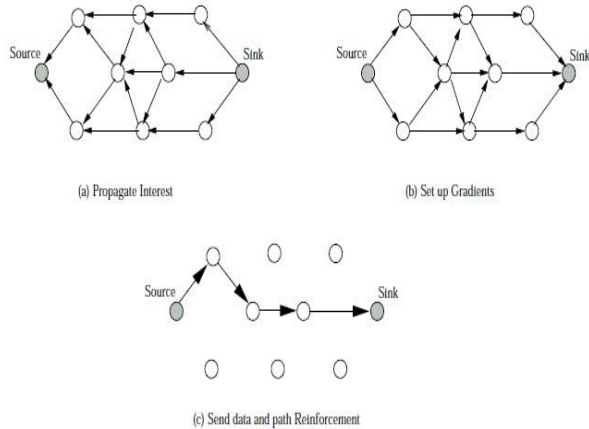


Fig:2 An Example of Directed Diffusion

4.2 Location Based Routing Protocol

Location based are other type of routing protocol for WSN. In Location based routing protocol, sensor node identify by their location and equipped with GPS. Sensor node's location help us to calculate distance between sensor node and also help us to calculate energy consumption.

There are various protocol comes under location based – GEAR,MECR,GDIR,GAF,&SMECN

4.2.1 GAF (Geographic Adaptive Fidelity)

GAF is energy aware routing protocol for MANET and WSN also. In GAF, Sensor node have three state – Sleeping, Active and Discovery sate.[10]

In Sleeping mode, sensor node turn off their radio and save energy. In Discovery mode, every sensor node exchange their discovery message with other sensor node.

In Active state, Sensor node broadcast their discovery message continuously for inform other sensor node about its state.

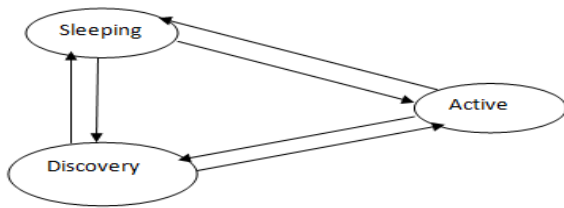


Fig3. Transition diagram of GAF

4.2.2 GEAR (Geographic & Energy Aware Routing)

GEAR is the one of the kind of energy saving routing protocol for WSN. That protocol used for route Queries to selected region in targeted sensor field.

In GEAR, Sensor node equipped with GPS hardware component that help us to know their current location. In GEAR, Sensor node must know their location, residual energy and residual energy of their neighbors. Based on all these information, protocol select sensor node for routing packet to its destination region.

4.3 Hierarchical Protocol

Due to use of clustering concept, we known as Cluster based routing protocol. In hierarchical protocol , region divided into cluster and each cluster contain number of sensor node. In every cluster there is a cluster head that directly communicate with base station.

In cluster, sensor node sense data and send back to cluster head then cluster head aggregate all sense data and remove redundant data and send to base station. For maintaining the energy level of every sensor node, cluster head change after every transmission round and choose new cluster head using various probability function and cluster head selection approach.

LEACH ,PEGASIS,GBDD,TEEN etc are example of hierarchical protocol.

4.3.1 LEACH(Low Energy Adaptive Clustering Hierarchy)

LEACH is hierarchical routing protocol which is based on clustering algorithm. Leach is the first and power efficient routing protocol for WSN. Cluster head directly communicate with base station. Cluster head receive data from different sensor nodes and aggregate these data for reduce redundant data.

In Leach protocol, Sensor node sense data from target area and send these data to cluster head. Many sensor node sense same data therefore there is possibility of redundant data. Cluster head will be changed for every round for maintaining the energy depletion level of sensor node. Leach protocol is divided into three phase- 1) Setup phase 2) Setup to steady phase

Setup Phase:- In setup phase, we choose cluster head in random manner which is based on threshold algorithm.

$$T(n)=[P/1-P*(r \text{ mod } 1/p)] \text{ in } n \in G$$

Where P is probability of cluster head, n is random number and G is the set of node.

In this algorithm, if $T(n) > n$ then that node become cluster head.

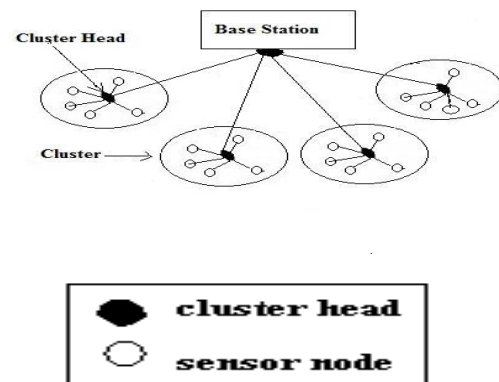


Fig.4 Leach protocol

Setup to Steady Phase:- This phase start after selection of cluster head by sensor node of that cluster. Now the cluster head know the number of nodes. Cluster head create TDMA schedule and allow all sensor node to transmit their data in allocated schedule and turn off their radio. Therefore energy

depletion level of sensor node minimized. In this phase cluster head receive data from normal sensor node and aggregate these data and send to the base station.

4.3.2 PEGASIS (Power-Efficient Gathering in Sensor Information Systems)

PEGASIS is the modified version of LEACH protocol. Every sensor node connected to each other and makes chain of sensor node. Therefore only one node can communicate with base station. That node receives data from neighbor node and aggregate these data then send these data to base station. This node knows as leader node. These protocol use greedy approach for making chain of sensor node. Base station receives data only from one sensor node instead of multiple sensor node like LEACH protocol. Therefore PEGASIS avoid cluster formation. Every node sense data and aggregate these data then forward to neighbor node, so aggregation action perform at every level.

If any sensor node dies, then chain construction process start again and left died node and make new chain. Leader node choose by function $(N \bmod i)$ where N is number of sensor node and i is the current round.

■ Token passing approach

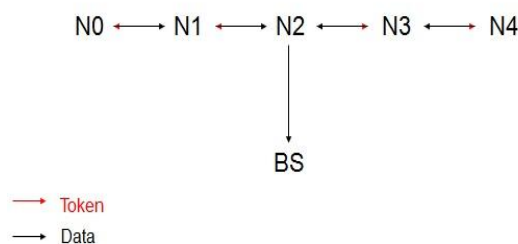


Fig. 5 Token approach in PEGASIS

4.3.3 GBDD

Grid Based Data Dissemination is data-centric based method. Grid's cell size is decided by sensor node. Here sensor node have dual mode such as High power and Low Power. The radio power range used to decide size of square cell. All sensor node can communicate with other sensor node and cluster head by using R_h in single hop. [13]

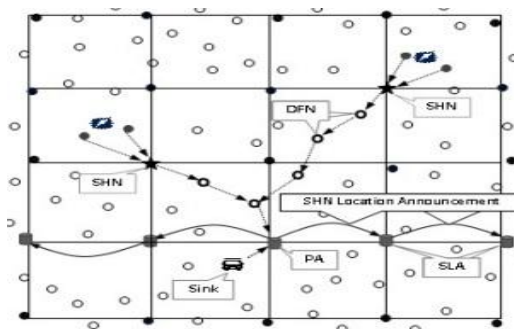


Fig. 6 Grid Construction

GBDD-Grid Construction:- Radio range of sensor node decide the size of cell. Sink node place itself at one of the cross point of grid and start grid formation process. The 2-D coordinates of sink node consider as starting point for construction of Grid.

The cell size of grid $= d/2 = (R_h - R_l)/2$, where d represent diagonal of a cell.

Alpha (α) is much low than R_h sink node can send a signal to dissemination node (DN) in single hop. These DN determine by cross point. Now Grid formation message forward by sink node with respective cross points coordinates. If distance DL between node and CP is equal or less than radio range of low power. ($DL \leq R_l/2$). It finalized as DN. If $DL > R_l/2$ then its act as terminating condition for grid formation process.[14]

Path Setup and Data Transmission:-Initial path setup from source node to sink is initiated by source node by sending initial path setup message to their cluster head dissemination node. After detecting an event, path setup message follow shortest geographical route to sink by selecting at each node a one hop neighbor closest to sink.

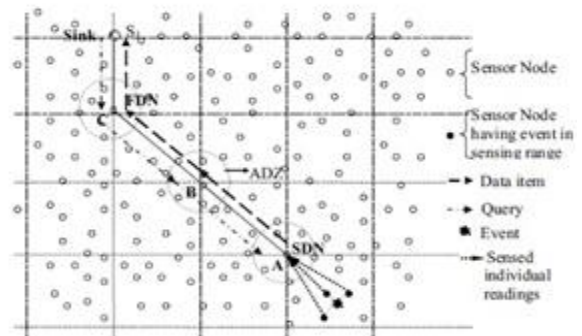


Fig. 7 Path setup and Data Transmission

5. CONCLUSION AND FUTURE SCOPE

Energy efficiency is the one of the main challenges in designing of routing protocol of WSN. The Objective of routing protocol is enhance the network lifetime, stability and reduce energy consumption. Energy consumption is done by receiving and sending message and signal. So we focus on to make power efficient routing protocol.

In this paper we only focus on homogeneous sensor network where all sensor nodes have same energy level. So we perform research work in heterogeneous field where every node have different energy level. Heterogeneity and mobility is the latest research area of WSN. We will work on sensor node mobility and sink node mobility.

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