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A Survey of Routing Protocols in Wireless Sensor Network

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Abstract: ***As per the industries demand & advancement of wireless technology, sensor device are vey useful for that area where human can't be reach. In WSN, sensor node having limitation of transmission, processing, storage and lifetime of network due to low battery power of sensor nodes. However sensor nodes have limitation in power strength and bandwidth. Therefore a new idea is required that increase energy efficiencies and increase the lifetime of the network. Routing protocols are main area where work is required for maximize the life of sensor nodes. In this paper we present a survey of routing protocols of wireless sensor network for energy optimization.***

Keywords: Wireless Sensor Network, Energy Efficiency, Routing Protocols, Power Consumption

1. Introduction

Wireless sensor networks consist of network of very tiny device is called sensor nodes. sensor node is a device which sense the surrounding and send the information to base station & vice-versa. The size and shape of nodes are keep as small as it can be sustain in harsh environment condition for measuring sounds, temperature, direction, pressure etc of the environment. Sensor nodes [1] are very much useful in the area of military, health-care, civil, environmental to commercial, inventory control, fire detection, forest, energy management, surveillance and reconnaissance etc.

A sensor node have following units: Sensing unit, Transmission unit, Processing unit and Power unit in fig.1.

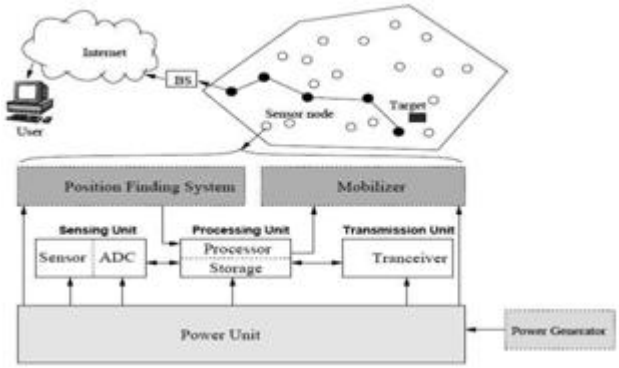

Figure 1: Block Diagram of Sensor Node

There are two part of sensing unit: Sensor and Analog-to-Digital Converter **[11]**. The main work of sensor is to collect information from environment and then send them to the base station after converting from analog to digital by ADC. Processing unit of the node contain a temporarily storage of information. It is used for transfer the information to the other sensor nodes of the wireless sensor network to perform sensing task. The main work of Transceiver [2] is to pass the information from current node to other nodes present in the network. Transceiver communicates with RF mostly because of small packet size, low data rate and high reuse frequency of RF. Batteries or solar cells are used for energy source as a power unit. A mobilize device is used so that nodes can become mobile.

As we know, sensor nodes in wireless sensor networks are operated by battery supply and nodes are not approachable because of their deployment in harsh & remote environment. Life time of sensor nodes [1,3] are limited because of limitation of battery capacity and small size of sensor nodes. Main cause of energy consumption in WSNs is the idle mode-consumption, packet collision, reception of packets not addressed to the node and transmission of control packets [11]. One of the most feasible way to maximize the life-time of sensor node is the improvement of Routing Protocols. Routing is a technique to find-out an optimized path to reach from source to destination. All routing protocols have many problem, when we applied it to WSNs.

Network Characteristics [17]**:-**

- Dense sensor node deployment
- Battery powered sensor nodes
- Severe energy computations and storage constraints
- Self-configurable
- Unreliable sensor nodes
- Data redundancy
- Many-to-one traffic pattern
- Frequent topology changes

Network design objectives [17]**:-**

- Small node size
- Low power consumption
- Low node cost
- Reliability
- Scalability
- Adaptability
- Self-configurability
- Channel utilization
- Security
- QoS support
- Fault tolerance

Network design challenges & Routing Issues [17]:-

- Data aggregation
- Limited energy capacity
- Sensor locations
- Limited hardware resources
- Scalability
- Massive and random node deployment
- Diverse sensing application requirements
- Network characteristics and unreliable environment

2. Routing Protocols in WSN

2.1 Location based protocols

Location based routing protocol uses information of the location of nodes. All the node are attached with GPS system. To estimate the energy consumptions, routing protocol find distance between the nodes by the GPS location of the node in the network. Location based protocols are discussed briefly.

(a) Geographic Adaptive Fidelity (GAF) – GAF is an energy-aware location based routing algorithm, primarily designed for mobile ad-hoc networks and also used in sensor network. In GAF, location [3] are divided into a finite number of zones, which work as a grid. GAF save energy by turn off unused node in the network without affecting the level of routing fidelity.

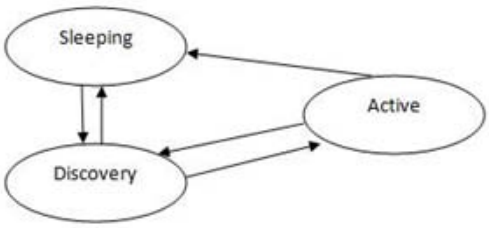

Figure 2: Transition State Diagram

State transition of GAF defines three states given in fig.2. Discovery states, determine the neighbours in the grid by exchanging discovery messages. In Active states, sensor continuously sends the information to the other nodes. It turns off radio in sleeping state for saving the energy.

(b) Geographic and Energy Aware Routing (GEAR) : In this protocol, energy can be saved by sending queries in a particular region rather than the complete network during routing setup. In this protocol, each node has an estimated cost and a learning cost to reach the destination through its neighbours **[5]**. To find-out the estimation cost, we have to combine the residual energy and the distance to the destination. GEAR uses energy aware and geographically information to select node to decide path of a packet to the destination.

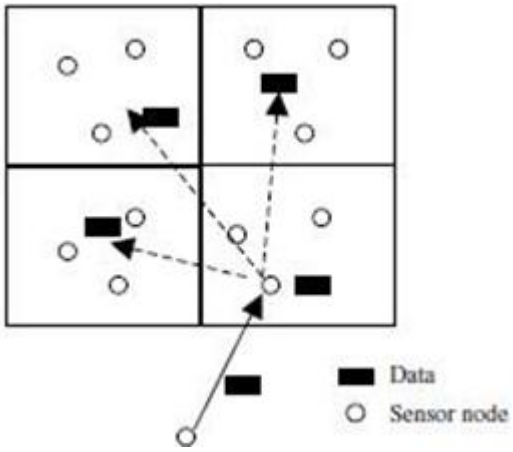

Figure 3: Geographical forwarding in GEAR

A hole occurs, when a node doesn't have any closer neighbours to the particular region than itself. If there are no hole present, then the estimated cost same as learned cost shown in fig.3.

(c) Trajectory Based Forwarding (TBF) : It is a routing protocol that need a dense network [4]. Each node having GPS system, which work as a coordinate system in environment. Sensors can position themselves and estimate distance to their neighbours. The source node defines the trajectory in a packet, but doesn't suggest the path on a hop-by-hop basis. A sensor node make a greedy approach to determine the next hop in the network to fixed trajectory by the source node on the basis of location information of neighbour. In order to increase the reliability and capacity of the network, it is also possible to implement multipath routing in TBF where an alternate path is just another trajectory [13].

(d) Minimum Energy Communication Network (MECN): This protocol calculates energy consumption of the subnets. It uses low-power GPS system. It identifies an area for every node [5]. The region consist of node in a surrounding area where the transmission through those nodes is more energy efficient that direct transmission. The main aim of MECN is to find out a subnet that has fewer nodes and need less transmission energy between two nodes. It uses Distributed Bellman Ford shortest path algorithm with power consumption as cost metric. MECN is self-reconfigurable and can dynamically adapt to node failures or to the deployment of new sensors.

2.2 Flat Based Routing / Data Centric Protocols

In flat based routing , a node wants to send the data to the sink node. It transmits through neighbours intermediate nodes or multiple hops. In this type of network, each node plays the same role & performing sensing task collectively. In this protocol, less transmission is required to send the data from the source to sink, that's why energy is saved. Protocol comes under flat based routing are as follows:

(a) Sensor Protocols for Information via Negotiation (SPIN) : The main aim to designed of SPIN to improve classic flooding protocols. Information broadcast to each node in the network. Every node has same capacity with the neighbouring node. SPIN uses three message; ADV, REQ &

DATA. When a node wants to send data then it broadcast with ADV message in the neighbour node shown in fig. 4. If the neighbour node is want to receive the data then it sends a REQ message return back to the node which transmitted the data and data is send to that node. The neighbouring node repeat this process with its neighbours and the all node of network will receive the same data.

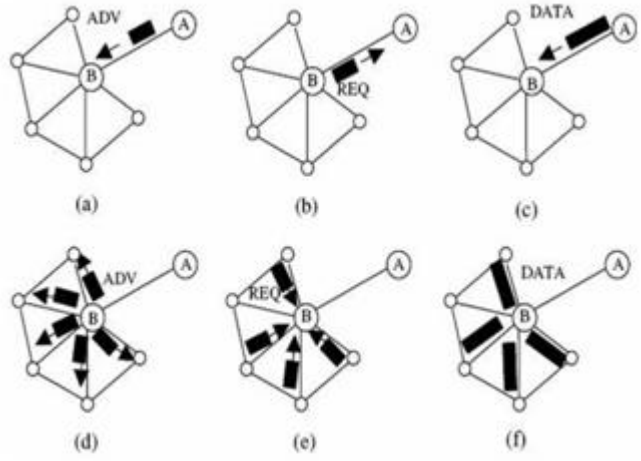

Figure 4: SPIN Activity

SPIN2 is the extension of SPIN. SPIN2 is good for mobile sensor node because they are baseed on the decisions of local neighbouring information.

(b) Directed Diffusion: It is a data centric protocol and best for query application. It does not need a global network topology maintenance. It also diffuse by combine the data from different sources and enroot by saving energy, eliminating redundancy, increase life time, minimizing number of transmissions shown in fig. 5.

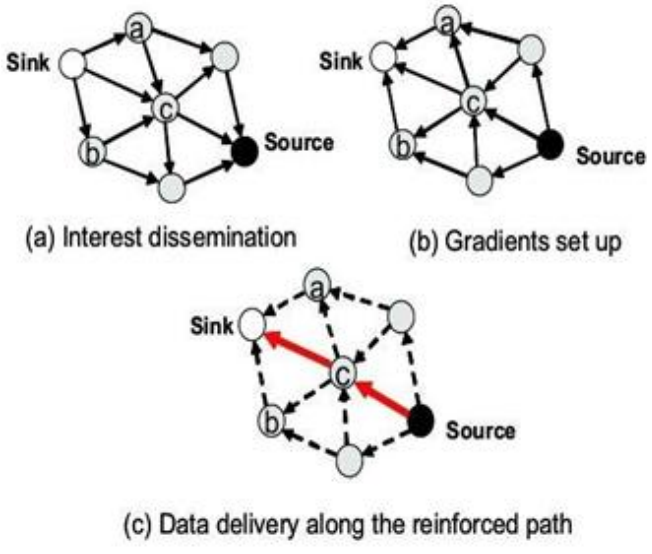

Figure 5: Direct Diffusion Activity

(c) Active Query forwarding In sensoR nEtwork (ACQUIRE): ACQUIRE is a another data centric protocol for querying sensor networks. It is the best technique for data gathering in energy-constrained sensor networks. It provides active query passing in network. Sensor network is a distributed database. In the distributed database, large queries can be further divided into many small sub-queries.

Working of ACQUIRE : base station sends a query, to all node. A node which receive the query they try to respond the query partially on the basis of pre-cached information. If there is no updated information available in pre-cached then the sensor node try to get the information from its neighbours. When the query is resolved completely, then it sent back either through the reverse or the shortest path to the sink node.

2.3 Hierarchical Based Routing

It is a cluster based routing. The main objective of clustering is to minimize network traffic towards the sink. So that energy consumption can be reduce. In this , a node having more energy, can be used to process the data and sending information. Low energy nodes can be used to perform sensing task. Hierarchical routing is based on two layer routing techniques. One layer is used for selecting cluster heads and another layer used for routing. Protocols under hierarchical based are : LEACH, PEGASIS, TEEN & APTEEN.

(a) Low Energy Adaptive Clustering Hierarchy (LEACH) : It is a hierarchical cluster based protocol. It selects a node randomly as a Cluster Head(CH) [8,9] in each cluster. CH node collects the data which are coming from nodes in the respective cluster and send combined data to base station to minimize the amount of transmitted information. This protocol is suitable when continuous monitoring of the network is required because of centralized data collection and periodically data transfer to base station.

LEACH is a two-phase mechanism [5]- the setup phase and the steady-state phase shown in fig. 6.

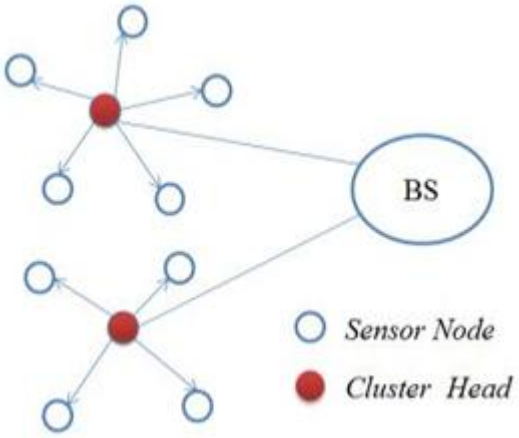

Figure 6: Clustering in LEACH

A setup phase, convert the network into cluster, elected & advertise CH and transmission schedule creation. In steady-state phase, data aggregation, data compression and transmission to the sink are the main work of this phase. LEACH uses a randomized rotation of high-energy CH position rather than selecting in static manner. LEACH uses single-hop routing, therefore, it is not suitable to the networks in large area. It having extra overhead that can increase the energy consumption.

(b) Power-Efficient GAthering in Sensor Information System (PEGASIS): It is extension over the LEACH

protocol. In PEGASIS [7], node can talk only with its nearest neighbour and through neighbours it communicates with base station as shown in fig. 7. Another round will be start when all nodes finished the message transmission to the base station of that term.

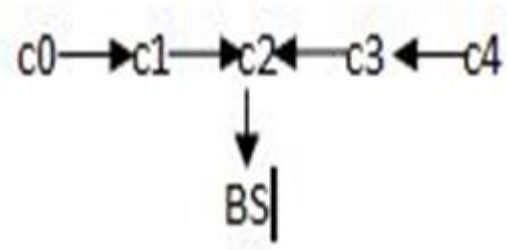

Figure 7: Token passing in PEGASIS

PEGASIS increase the life time of nodes as well as extends the life time of network also because its uses collaborative techniques. The protocol allows only local coordination among close nodes so the bandwidth consumed in transmission is reduced. All nodes maintain a database of the location of other nodes. PEGASIS is able to double the network life time in comparison to using LEACH [10].

(c) Thershold sensitive Energy Efficient sensor Network (TEEN) & APTEEN : In TEEN, no nodes are continuous sense the environment, but data transfer take place only when a parameter reaches a threshold values. The value sensed by the nodes kept temporarily in interval variable of the node, is called sensed value (SV). APTEEN is a hybrid protocol. In this we can change the frequency and threshold value of the TEEN as per requirements of user needs.

3. Comparison of Routing Protocols

Protocols	Data Aggregation	Scalability	Mulipath	Power Usages
GAR	No	Good	No	Limited
GEAR	No	Limited	No	Limited
ACQUIRE	Yes	Limited	Yes	Low
SPIN	Yes	Limited	Yes	Limited
LEACH	Yes	Limited	No	High
PEGASIS	No	Good	No	Maximum
Directed Diffusion	Yes	Limited	Yes	Limited
TEEN & APTEEN	Yes	Good	No	High

4. Conclusion & Future Work

As per the industries demand, wireless sensor nodes are used in various field. But the limitations of sensor nodes are remain the short life time of nodes because of low capacity of battery power and small size of sensor nodes. In a WSN, a node transmits every sample back to sink or base station at a fixed sample rate, so the battery life of node is proportional to its sample rate. The radio is a main consumer of power in a node, so in the protocols that do not need every sample to be sent to base station will be suitable for sensor network. We can increase battery life by transmitting only meaningful data, which include threshold value and data reduction on the node. We can also extend battery life by creating logic that optimizes the nodes behavior for specific operating condition or network requirements. A cluster based multiple path routing may be proposed which reduces the overhead for route finding and increases the power efficiency of the network.

In this paper we summarized the existing routing protocol and in future we will modify the routing protocol so that life time of sensor node can be increase.

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