Energy Efficient Routing Protocol for Wireless Sensor Networks: A Review

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ABSTRACT

A wireless sensor network is a collection of sensor nodes arranged into a Prespecified/random way in the concerned Geographical region. Nowadays, wireless sensor networks (WSNs) are dramatically becoming more popular and widely being used in variety of application like battlefield, medicals and several other areas because they are cheap in cost and have the ability to sense data irrespective of environment conditions. Routing in WSNs consumes the most of sensors nodes energy if we are able to make an energy conserving routing protocol then we will be able to conserve the considerable amount of energy which will enhance the Network lifetime.

Keywords: – Cluster, Energy efficiency, Routing, Sensor, WSN.

I. INTRODUCTION

WSNs are interconnection of vast randomly deployed sensor nodes. These nodes sensed the physical parameters of environment like, humidity, Temperature etc [1] .Every node directly or indirectly transmit the data to base station. Energy is the key issue in WSNs and several routing protocol has been designed and developed for minimizing the consumption of the Energy. Hierarchical or cluster based routing protocol were designed to use the energy efficiently by dividing the network into groups of nodes called cluster in which few nodes works for gathering the data and transmitting it to the Sink called cluster heads while rest lower energy nodes are responsible to sense the environment this model was developed for making network lifetime longer and making network more scalable which makes it very popular in the field of wireless sensor network. Every sensor node mainly consists of four components. They are to processing unit, to sense node, power source and transceiver.

Processing Unit:- The processing unit mainly provides intelligence to the sensor node. The processing unit consists of a microprocessor, which is responsible for control of the sensors, execution of communication protocols and signal processing algorithms on the gathered sensor data. Commonly used microprocessors are Intel's Strong ARM microprocessor, Atmel's AVR microcontroller and Texas Instruments' MP430 microprocessor

Sensor Node:- Sensing units are usually composed of two subunits: sensors and analog to digital converters (ADCs). Sensor is a device which is used to translate physical phenomena to electrical signals. Sensors can be classified as either analog or digital devices. There exists a variety of sensors that measure environmental parameters such as temperature, light intensity, sound, magnetic fields, image, etc

Power Source:- The power source supplies power to the complete sensor node. It plays a vital role in determining sensor node lifetime. The amount of power drawn from a source should be carefully monitored. Sensor nodes are generally small, light and cheap, the size of the power source is limited.

Transceiver Unit:- The radio enables wireless communication with neighboring nodes and the outside world. Transceivers can operate in Transmit, Receive, Idle and Sleep modes.
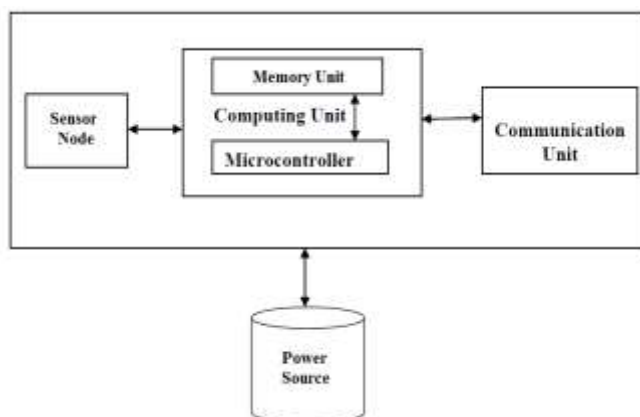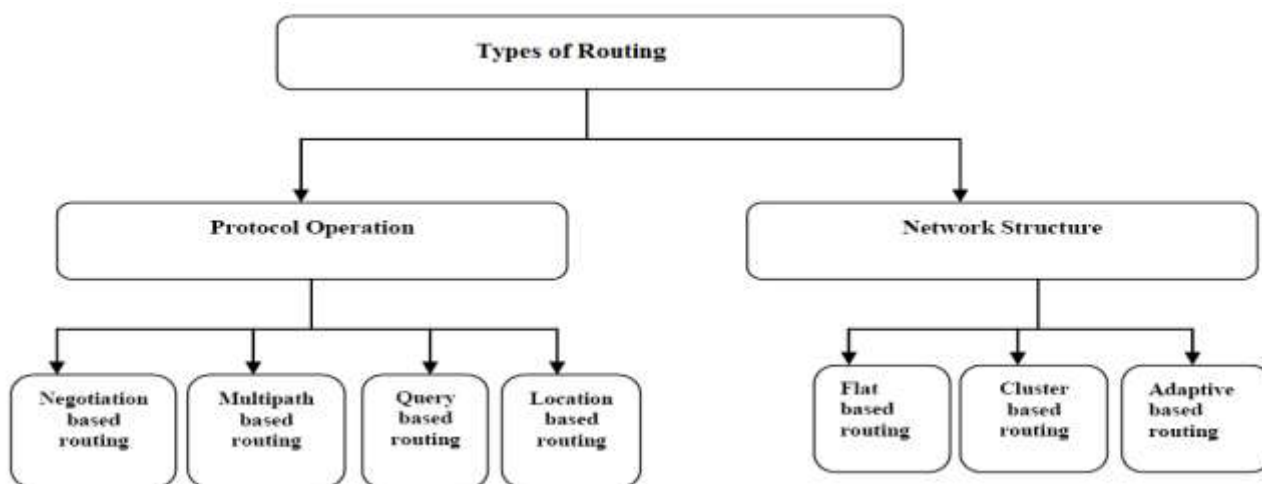
Figure 1 : Architecture of a Wireless Sensor Node

II. Types of Routing

2. PROTOCOL OPERATION

Negotiation Based Routing:- These protocols use high-level data descriptors called meta-data in order to eliminate redundant data transmission through negotiations. The necessary decisions are based on available resources and local interactions.

Multipath Based Routing:- These protocols offer fault tolerance by having at least one alternate path (from source to sink) and thus, increasing energy consumption and traffic generation. These paths are kept alive by sending periodic messages.

Query Based Routing:- In these protocols, the destination nodes propagate a query for data (sensing task or interest) from the node through the network. The nodes containing this data send it back to the node that has initiated the query.

Local Based Routing:- Location is used to address the sensor nodes in this type of routing. Incoming signal strength is used to determine the distance between the nodes. In some instances GPS (Global Positioning System) may be used to find the location of the nodes. Examples:- GEAR,GAF

3. NETWORK STRUCTURE

Flat Based Routing:- In a network, the sensing node work together to sense the required feature. The assigning of the global identifier to each node is not possible in the WSN, as the area to be covered is very large. In routing, BS send query to certain region and waits the reply.

Cluster Based Routing:- Hierarchical protocols in routing are cluster base routing protocols. Hierarchical routing has good scalability and energy efficiency in communication. In this routing protocols the nodes with higher energy does data aggregation/processing and send the aggregated data to the sink and lower energy nodes monitor the environment for data and send the sensed data to higher energy nodes. Hierarchical routing tries to improve network lifetime, overall energy efficiency and scalability of sensor nodes by creating clusters, cluster heads and performing data fusion within the clusters. Examples-LEACH, HEED.

Adaptive Based Routing:- In these protocols, the system parameters are controlled to be adapted to the actual network conditions by means of acquired information of the network and negotiation between nodes (e.g. the available energy on the node or QoS of the path). Adaptive based routing is based on the family of protocols called Sensor Protocols for Information via Negotiation (SPIN) which is described in Negotiation based routing. The SPIN protocols are designed based on two basic ideas:

- Sensor nodes operate more efficiently and conserve energy by sending metadata instead of sending all the data.

- Flooding technique wastes energy and bandwidth when sending extra and unnecessary copies of data by sensors covering overlapping areas.

4. ROUTING PROTOCOLS

i. HEED (Hybrid Energy Efficient   Distributed Clustering) Protocol is an energy efficient protocol. HEED Protocol that is used for Clustering and brings an energy-efficient clustering routing with explicit consideration of energy. HEED does not select the cluster head randomly manner. HEED was designed to select different cluster heads in a field according to the amount of energy that is distributed in relation to a neighboring node. In this selection of cluster head is primarily based on the residual energy of each node. Residual energy can be estimated by knowing the energy consumed per bit for sensing, processing and communication. In this to break the ties intra cluster communication cost is considered as secondary parameter and tie means that a node falls within the range of more than one cluster head. In this protocol intra-cluster communication cost is considered as a secondary parameter

HEED uses residual energy as a primary parameter and intra cluster communication as a secondary parameter. In this the clustering process is divided into the number of iterations.

1. The first parameter depends on the residual energy of the node.

2. The second parameter is considering the cost of communications with the intra-cluster.

HEED uses maximum residual energy of the node and minimum distance between the node and the base station. In the HEED protocol the distribution of the energy consumption extends the lifetime of the Network. A node becomes a Cluster head with a certain probability that considers a mixture of energy and the communication cost.

The probability that a node becomes a Cluster head is:

$$CHprob = Cprob \; x \; Eresidual\_Emax$$

Where E residual is the estimated current energy of the node.

Emax is the maximize battery energy.

ii. LEACH- Low energy adaptive cluster hierarchy is one of the famous cluster based routing protocol in WSN in which all sensor nodes in network is grouped into cluster , in each cluster there is special node which take care of gathering the information in its local cluster and transmitting it to the Sink. LEACH uses the random rotational approach to select cluster head in such a way that energy depletion is uniform in the network and participation of nodes in the election of cluster heads is in round robin fashion.

Two Main Phases of LEACH

- Setup Phase
- Steady State Phase

Setup phase- In this phase wireless sensor nodes in network are grouped into clusters and selection of cluster head is done. For each round, a random number X is chosen in the range of 0 and 1. If X is less than threshold Tn, then that node will become a CH(cluster head).

Steady state phase- This phase is broken into different frames where nodes transmit data to respective cluster-head. This phase does not ensure that nodes are equally distributed in clusters. So size of cluster varies with considerable number. In LEACH, so the amount of data received to cluster head also vary because of difference in number of nodes in particular cluster. To reduce the energy consumption each cluster head adjust its transmission power according to the received minimum signal strength. Until the non-cluster-head nodes allocated transmission time is not reached, there radio remains off.

5. RELATED WORK

[1] Harneet Kour, Ajay K. Sharma proposed a Hybrid Energy Efficient Distributed Protocol for Heterogeneous Wireless Sensor Network. In this paper, Heterogeneous - Hybrid Energy Efficient Distributed Protocol (H-HEED) for Wireless Sensor Network has been proposed to prolong the network lifetime. In this paper the author discussed the impact of heterogeneity in terms of node energy in wireless sensor networks have been mentioned. Finally the simulation result demonstrates that H-HEED achieves longer lifetime and more effective data packets in comparison with the HEED protocol .They introduced different level of heterogeneity: 2-level, 3-level and multi-level in terms of the node energy. They have evaluated the performance of the proposed H-HEED with HEED protocol using MATLAB.

[2] Deepali S. Anarase proposed a survey on different hybrid routing protocols in WSN. Different hybrid routing protocols perform well in different scenario and their performance is compared based on different metrics. Also, they proposed Energy Efficient Hybrid Routing Protocol (EEHRP) in WSN. They suggested that cluster node may run out of energy for selecting cluster head in RRSI. So, instead of RRSI value used remaining energy of node so node with

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highest energy is selected as cluster head. It results into increased lifetime of network. Also efficiency of cluster head declaration may be improved by using ant colony optimization (ACO). In their approach cluster head is selected periodically based on remaining energy of node, every node get chance to be cluster head for some period

[3] R.Sudha, C.Nandhini designed a cluster-based routing protocol with low energy consumption for wireless sensor networks. The protocol is based on a strategy which aims to provide a more reasonable exploitation of the selected nodes (cluster-heads). In this paper the authors designed a new mechanism for grouping nodes into clusters. This mechanism ensures a distribution of the workload of sensor nodes by structuring them into clusters of unequal size (heterogeneous nodes). Then, cluster- heads communicate the collected data of the network to the base station. The cluster-heads are selected periodically according to the weight. This weight is calculated so that the number of cluster-heads increases while approaching the base station. Hence, clusters farther away from the base station will have smaller sizes. new mechanism for grouping nodes into clusters.

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[4] Sunkara Vinodh Kumar and Ajit Pal proposed an assisted-leach (a-leach) energy efficient routing protocol for wireless sensor networks. This protocol achieved lessened and uniform distribution of dissipated energy by separating the tasks of Routing and Data Aggregation. It introduces the concept of Helper Nodes which assist Cluster Heads for Multi-hop Routing. The proposed protocol extends the lifetime of the network, minimizes overall energy dissipation in the network and distributes dissipation among Cluster Heads, Sensor Nodes and Helper Nodes. Assisted Leach protocol has the following stages: Cluster Head Selection, Cluster Formation, Helper Node Selection, Routing Set-Up, Sensing, Aggregating and Routing

[5] Ali Norouzi, Faezeh Sadat Babamir presented a new protocol called Fair Efficient Location-based Gossiping to address the problems of Gossiping and its extensions. They designed an algorithm which has three phases: Network Initialization Phase, Information Gathering Phase and Routing Phase. They achieved the network lifetime through fair use of the energy by selecting nodes with the maximum residual energy and lowest distance to the sink. Secondly, they had also achieved a high packet delivery ratio (number of non-reaching nodes has been reduced) and reduced the delay in delivering the packet. Thirdly, they reduced the message overheads and the energy consumed by the nodes that have already tried to send the data to the base station by sending an acknowledgement message of the successful reception of the packet.

[6] Shilpa P. Kamble, Nita M. Thakare proposed a novel cluster-based energy efficient routing with hybrid protocol in wireless sensor networks. In this paper they proposed the clustering algorithm to minimize the overhead of control

packets by using LEACH and HEED and efficient utilization of node near sink and to implements the hybrid protocol which would be better than the existing protocol. They proposed the a new cluster based energy efficient routing algorithm (ANCBER) to extend the network lifetime, and simulation results are compared with the previous cluster based routing algorithms LEACH and HEED. The proposed ANCBER algorithm selects the CH node depending on the residual energy and nodes neigh bore information. Furthermore, this CH node is the node that has the best remaining energy and requires the minimum energy to be reached by the cluster members. The results from simulations show that the ANCBER algorithm has best efficiency in terms of both data packets received by sink node and the network lifetime. ANCBER is a clustering algorithm to minimize the overhead of control packets and efficient utilization of nodes near sink and implements an advanced hybrid routing protocol as compared to hybrid routing protocol and a new hybrid routing protocol.

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