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A Review of Wireless Sensor Networks

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Abstract: A wireless sensor network is a network of hundreds of sensor nodes, which are generally positioned in a close neioghborhood to provide wireless sensing capabilities to the establishment. The nodes consist of fixed resources of their operation thus effective utilization of the battery is an important factor. This calls for optimal routing techniques. In this research paper, a review of Wireless Sensor Networks routing protocols has been presented. Energy efficient routing techniques have been utilized to maintain the lifetime of the sensors and the network in turn for long durations. This is the prime research objective of this paper.

I. INTRODUCTION

Wireless sensor networks are increasingly used in many applications, such as volcano and fire monitoring, urban sensing, and perimeter surveillance. The wireless sensor networks (WSNs) contain hundreds or thousands of sensor nodes equipped with sensing, computing and communication abilities. Each node has the ability to sense the environment for an activity or object and can perform simple computations. A sensor node either communicates among its peers to collect the sensed data or sends (receives) the data to (from) abase station. A base station connects the sensor networks to another network. Designing protocols for sensor networks has to be energy aware in order to prolong the network lifetime, because the replacement of the embedded batteries in sensors is a very difficult process, once these have been installed. The WSNs should utilize their network energy in an efficient way so that they can monitor the environment for longer time[1]. The sensor network comprises sensor field, where the sensor devices or nodes are scattered in this field. Here, each of these nodes will have the capability to gather information and then route information back to sink and end users. With the help of multi-hop infrastructure and less architecture the information is routed back to the final user through sink as shown in figure 1.

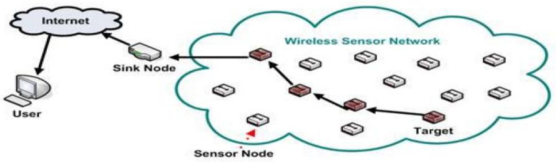


Figure 1 Wireless Sensor Networks

The Sensor networks may consist of many different types of the sensors such as magnetic, seismic, thermal, visual, infrared, acoustic and radar, which are able to monitor a wide variety of ambient conditions that include the following [1]:

1) Vehicular movement,
2) Humidity,
3) Temperature
4) Lightning condition,
5) Pressure,
6) Noise Levels
7) Soil makeup
8) The presence or absence of certain kinds of objects,
9) Mechanical stress levels on attached objects.

II. LITERATURE SURVEY

Wireless sensor network is typically composed of a large number of sensor nodes, which may be densely deployed either inside the phenomenon or very close to it, depending on the field of their usage. The position of sensor nodes need not be engineered or pre-determined. This envisages random deployment in inaccessible terrains or disaster relief operations. On the other hand, this also indicates that sensor network protocols and algorithms need to possess self-organizing capabilities. Another unique feature of sensor networks is the cooperative effort of sensor nodes. Instead of sending the raw data to the nodes responsible for the fusion, sensor

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nodes use their processing abilities to locally carry out simple computations and transmit only the required and partially processed data. Realization of these and other sensor network applications require wireless ad hoc networking techniques.

The differences between sensor networks and ad hoc networks are outlined below:

1) The number of sensor nodes in a sensor network is higher than the nodes in an ad hoc network.
2) Sensor nodes are densely deployed as compared to ad-hoc nodes.
3) Sensor nodes are more prone to failures.
4) The topology of a sensor network changes very frequently.
5) Sensor nodes mainly use broadcast or multi-hop communication paradigm whereas most ad hoc networks are based on point-to-point communications.
6) Sensor nodes have limitations of power, computational capacities, and memory.
7) Sensor nodes may not have global identification (ID) because of the large amount of overhead and large number of sensors.

Various cluster based protocols have been proposed by numerous researchers such as LEACH (Low-Energy Adaptive Clustering Hierarchy), TEEN (Threshold Sensitive Energy Efficient Sensor Network), SEP (Stable Election Protocol) etc. In multi-hop or multi path communication protocol, multiple paths are established between the source and the destination, through which the data can reach the destination i.e. sink or base station [2]. Now how these links are used are based on the individual routing strategy of the network For instance, some routing algorithms use the best path to send the data, keeping the other alternate paths as a backup and use it if the primary path fails, some use all the paths concurrently to send data and so on. In the past few years multi-path routing approach is extensively used for different network management purposes, such as providing a fault tolerant routing, improving transmission reliability, congestion control and Quality of Service (QoS) supported in the wired and wireless networks, but the unique features of the wireless sensor networks and the characteristics of the short range radio communications introduce new challenges that should be addressed in designing the multi-path routing protocols. The main objective of cluster based routing is to efficiently maintain the energy usage of sensor nodes by involving them in multi-hop communication within a particular cluster.

III. WSN ROUTING PROTOCOLS

In the hierarchical architecture, some higher-energy nodes can be used to process and send the information to the base station while lower energy nodes can perform the sensing in the target area. In other words, the network is partitioned into many clusters. In each cluster, a node is selected as a cluster head with some cluster members. A two-tier hierarchy is formed where cluster heads are in the higher tier while cluster members are created a lower tier. Cluster members sense the data from the physical environment and send it to their respective cluster heads. Cluster heads process the data and transmit it to the sink either directly or in the multi-hop manner. Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol has been proposed by Heinzelman et al. [6]. It is the first hierarchical clustering approach in WSN. In the LEACH protocol, the operation consists of many rounds. Each round has two phases; the set-up phase and steady-state phase. In the setup phase, the cluster is formed and in the steady-state phase, data is transmitted to the base station. The cluster head are elected based on the predefined percentage of cluster heads and how many times the node has been a cluster head in previous rounds. LEACH can balance the load among the cluster heads up to some extent.

Younis and Fahmy have proposed a Hybrid Energy Efficient Distributed clustering (HEED) routing protocol [7]. It is a multi-hop clustering algorithm for wireless sensor networks, which focus on efficient clustering by proper selection of cluster heads. The cluster head is selected based on criteria such as residual energy and intra-cluster communication cost. HEED is a fully distributed clustering method and provides uniform CH distribution across the network. The communications are in a multi-hop fashion between CHs and the base station. However, it generates more CHs than the expected number, which decreases the network lifetime. Directed Diffusion routing protocol has been proposed by Intanagonwiwat et al.[8]. It is a query based multipath routing protocol, where the sink initializes the routing process. The sink floods the interest into the network. During the interest message flooding all the intermediate nodes store the interest message received from the neighbors for later use and creates a gradient towards the sender node. During this stage, multiple paths can be discovered between each source-sink pair. Then the source transmits the data through the selected path. Further the sink continues to send low-rate interest message over the remaining paths, this is done to preserve the freshness of the interest tables of the intermediate nodes, and also maintain the discovered routes. If the active path fails, the data can be forwarded through the other available paths. Although, it provides fault-tolerant routing, it evolves all the nodes in route discovery. As a result, it affects the network lifetime. Ye Ming Lu et al. [9] have proposed a distributed, scalable and localized routing algorithm . It discovers multiple node-disjoint paths between the sink and the source nodes. It also uses a load balancing algorithm that distributes the traffic over the multiple paths. When an event is detected, it selects a node from the event area as the source node. The source node then starts the route discovery process. The sink sends multiple route request

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messages to its neighboring nodes with distinct path id to build node-disjoint paths. After receiving the first route request message from the source node, the sink starts a timer. Any path discovered after the timer stops are discarded. The sink also optimally assigns the data rate for each path. Wang et al. [10] have proposed an energy-efficient and collision-aware multipath routing protocol. It is a reactive routing protocol. It creates two collision-free paths between the source and the sink using the location information of all the sensor nodes. In this protocol, each node sends a route discovery message with proper power and node position information. It is assumed that all nodes have a transmission range of 0 to R, and all nodes know their neighbor information within that range R. Hence to decrease the chance of interference, all routing paths are built above this range. The broadcasting is used to detect collision, and the nodes that are overhearing from other routes cannot be in any route. However, the cost of the network deployment is more due to the GPS device requirements for each node within the network. Lin et al.[11] have proposed a hierarchical cluster-based data dissemination protocol. It uses a clustering structure to track the location of the mobile sinks and finds the paths from the source to the sink for data transmission. Each cluster consists of a cluster head, several gateway nodes, and ordinary nodes. The mobile sink registers itself to the nearest cluster head, and a notification is then disseminated to all the cluster heads. In this process, each cluster head makes a reverse link to the sender node for transmitting the data.

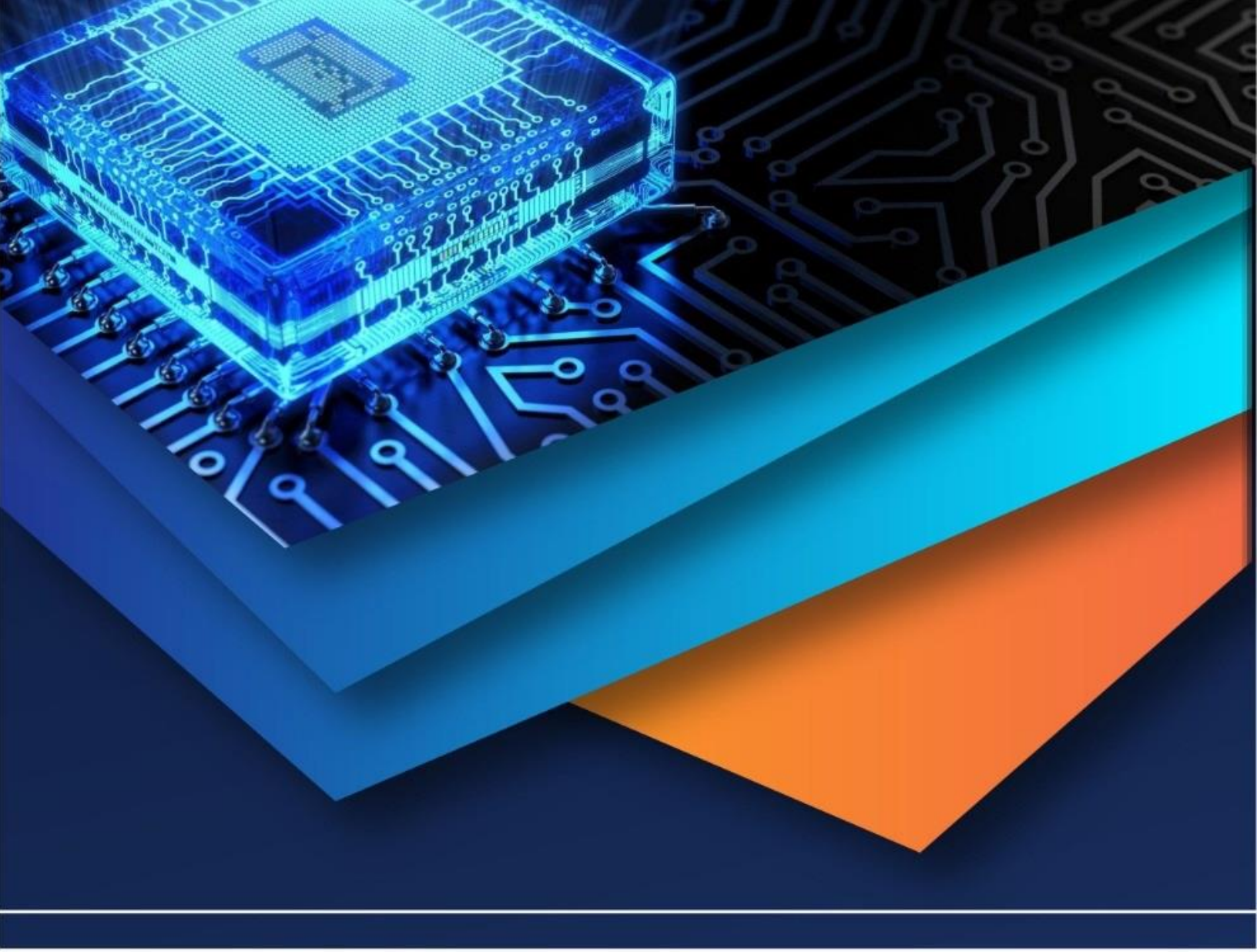
IV. CONCLUSION

Increasing the energy efficiency is a major concern in the area of Wireless Sensor Networks. It has direct implication on the network lifetime i.e. the amount of time the network would remain active. As has been put throughout this research work, the Wireless Sensor Networks are equipped with fixed non rechargeable batteries, thus it is utmost important to choose those methods which will reduce the power consumption of the nodes. The clustering based techniques have been developed with this concern and have been found to be successful in achieving a considerable improvement in network lifetime as is evident from the literature survey of various clustering based routing techniques.

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