A Study on Energy Efficient Routing Protocols for Wireless Sensor Networks

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Abstract- Wireless sensor network is a combination of tiny devices called as sensor nodes which have computing, sensing and processing capabilities. Efficient design and implementation of wireless sensor networks have become a hot area of research in recent years due to the vast potential of the sensor networks to enable application that connect the physical world to the virtual world. Routing algorithms for WSNs are responsible for selecting and maintaining the routes in the network and ensure reliable and effective communication in limited periods. The energy constraint of WSNs make energy saving the most important objective of various routing algorithms. In this paper, a brief study of some routing algorithms used in WSNs is presented with energy efficiency as the main goal.

Keywords- Wireless Sensor Networks (WSN), Routing Protocols, Energy effieciency.

I. INTRODUCTION

Wireless Sensor Networks(WSN) are systems that comprise large numbers (hundreds or thousands) of wirelessly connected heterogeneous sensor nodes that are spatially distributed across a large field of interest [1], and these systems process data gathered from multiple sensors to monitor events. The concept of wireless sensor network is based on a simple equation: Sensing+CPU+ Radio= Thousands of potential application[2]. These sensor nodes communicate over short distance via a wireless medium and collaborate to accomplish a common task, for example, environment monitoring, military surveillance, and industrial process control [3]. Sensor nodes need to operate autonomously for prolonged periods of time after deployment and it is not possible to easily replace or recharge the battery. So the energy consumption must be minimized for long life and this necessitates both the power efficiency of the hardware along with the efficiency of security and other routing protocols The energy of a sensor node is consumed by mainly three essential components: the sensor unit, the communication unit and the computation unit. Because of the limited energy reserves, energy is often one of the primary metrics in WSNs routing algorithms[4].Thus minimizing energy consumption is a key requirement in the design of sensor network protocols and algorithms..

In this paper we give a brief review of some energy efficient routing algorithms used in WSN .

II. ROUTING FACTORS AND WSN DESIGN

Design of routing protocols in WSN is influenced by many challenging factors to addressed which are outlined and discussed as in [5] [6] .

Fault tolerance**:** Sensor nodes may fail or blocked due to lack of power or may have physical damage or environmental interference. The failure of sensor nodes should not affect the overall task of the sensor network.

Energy consumption without losing accuracy**:** Since sensor nodes are battery powered, they have limited energy capacity. Energy poses a big challenge for network designers in hostile environments. Sensor node lifetime shows a strong dependence on battery.

Scalability**:** The number of sensor nodes deployed in the sensing area may be on the order of hundreds or thousands, or more. Any routing scheme must be able to work with huge number of sensor nodes

III. REVIEW OF ENERGY EFIECIENT ROUTING PROTOCOLS IN WSN

Protocols for sensor networks must be designed in such a way that the limited power available at the sensor nodes is efficiently used. We give a brief review of some energy efficient routing protocols that can be used in WSN so that the lifetime of the sensor nodes, as well as the whole network is prolonged.

Low-EnergyAdaptive Clustering Hierarchy(LEACH):

A proposed protocol [7] is an adaptive clustering protocol for distributing energy load among the sensor nodes in network. LEACH randomly selects a few sensor nodes as cluster heads (CHs) and rotates this role to evenly distribute the energy load among the sensors in the network.

It works in two phase: 1)The setup phase- In the setup phase ,the cluster are organized and the cluster heads are selected and each round stochastic algorithm is used by each node to determine whether it will become a cluster head.

2) The steady state phase- The data is sent to the base station the duration of the steady state phase is longer than the duration of the setup phase in order to minimize overhead.

LEACH uses a TDMA/CDMA MAC to reduce inter-cluster and intra-cluster collisions . LEACH is not suitable for large network areas.

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

PEGASIS [8] is an extension of the LEACH protocol, which forms chains from sensor nodes so that each node transmits and receives from a neighbor and only one node is selected from that chain to transmit to the base station (sink). PEGASIS forms chains from sensor nodes , each node transmits the data to neighbor or receives data from a neighbour and only one node is selected from that chain to transmit data to the BS. The data is finally aggregated and sent to the BS. PEGASIS avoids cluster formation, and assumes that all the nodes have knowledge about the network , particularly their positions using a greedy algorithm. Although clustering overhead is avoided, PEGASIS requires dynamic topology adjustment since the energy status of its neighbour is necessary to know where to route its data. This involves significant overhead particularly in highly utilized networks.

Geographic Adaptive Fidelity (GAF):

GAFis an energy-aware, location-based routing algorithm [9]. Location information is used by each node to associate itself to a virtual grid. This location information will be provided by GPS or by other location systems Nodes in the same grid square are equivalent in regard to packet forwarding and take turns in sleeping and being awake in order to load balance energy consumption. State transition diagram of GAF consists of three states. They are active, sleep and discovery. In sleeping state sensor will turn off its antenna for energy savings. In discovery state a sensor trades exchange messages to look into other sensors in the same lattice. Even in the active state the sensor occasionally shows its discovery message to inform proportionate sensors about its state. The time used in each of the state will be depending upon few components like its needs and sensor mobility. GAF means to expand the network lifetime by arriving at a state where each grid contains one active sensor focused around sensor ranking rules. The highest rank will handle routing within their respective grids.

Sensor protocols for information via negotiation (SPIN):

The key feature of SPIN [10] is advertisement mechanism. In this mechanism Meta data is exchanged among sensors. Each node on receiving new data advertise to its neighbours then interested neighbours (one who do not have data) retrieve the data by sending request message[4]. Here three types of messages are used,([4][10]):

ADV message: This allow sensor node to advertise particular Meta data

REQ message: Request specific data.

DATA message: carry actual data

SPIN protocol has advantages like nodes need to know only its single Hop neighbour‟s, Also it overcome resource blindness and no redundant information passing thus achieving lot of energy efficiency. But problem is that SPIN doesn‟t guarantee the delivery of data i.e. if the destination node is far away from source node and between nodes are not interested in data then data will not be delivered to destination node.

Bioinspired Routing

In recent years insect sensory systems have been inspirational to new communications and computing paradigms, which have led to significant advances like bio inspired routing. The most popular ACO (Ant Colony Optimization) is a colony of artificial ants is used to construct solutions guided by the pheromone trails and heuristic information they are not strong or very intelligent; but they successfully make the colony a highly organized society[11,12]. Swarms are useful in many optimization problems. A swarm of agents is used in a stochastic algorithm to obtain near optimum solutions to complex, non-linear optimization problems. There are two popular swarm inspired methods: Ant Colony optimization (ACO) and Particle Swarm Optimization (PSO). Proposed by Marco Dorigo et al., ACO is based on foraging behaviour of ant colonies [13]. PSO, proposed by Eberhart Kennedy, is inspired by social behaviour of flocks of birds and schools of fish [14]. Currently, these nature inspired techniques are being used for finding better quality solutions in optimization problems and formulate better decision making mechanisms. Bacterial Foraging Optimization Algorithm (BFOA) proposed by Passino, is a newcomer in this field. BFO is inspired by social foraging behavior of Escherichia coli bacteria [15].

IV. CONCLUSION

In recent years, routing in WSN has gained tremendous attention leading to unique challenges and design issues when compared to routing in traditional wired networks. The ultimate aim of a routing protocol design is to extend the lifetime of the network by keeping the sensors alive for a maximum time. Since energy spent on transmission is very high compared to that of sensing, the routing algorithm should be designed to reduce energy consumption while transmitting data. This paper presents a comprehensive study of few energy efficient routing techniques for WSNs .This study helps in understanding the working of these protocols and the advantages of these algorithms combined together may be a good research direction for future applications.

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