A Survey on Power Aware Routing Protocol for Wireless Sensor Network

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Abstract
Electronics devices in Wireless sensor networks (WSN) have limited power resources and may have different transmission technologies. These characteristics make WSN Traditional routing protocols inconvenient in a heterogeneous environment. In this paper, we perform a survey on energy efficient and power aware routing protocol for WSN nodes. The proposed approach takes into consideration the available energy of nodes and load on node when building the routing table. It aims to avoid exhausting the nodes that are falling on optimal routes across the network; thus providing better connectivity and increase the network lifetime.

Keywords: Wireless Sensor Network (WSN), Multi-hop, Cluster.

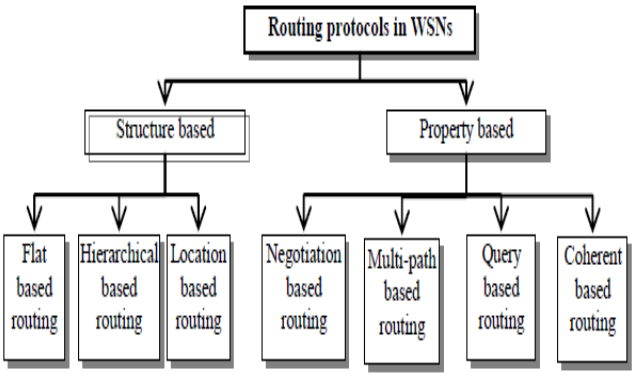
INTRODUCTION

Wireless sensor networks (WSNs) have received lots of attention in recently years due to their wide applications like military and disaster surveillance, industrial product line monitoring, agricultural and wildlife observation, healthcare, smart homes, etc. [1]. Cheap and tiny sensor nodes are usually randomly deployed in a physical environment to be monitored and they will transmit their collected data to certain remote sink node (or base station) in an autonomous and unattended manner. Energy efficiency and balancing is one of the primary challenges to the successful application of WSNs since the sensor nodes are powered with limited batteries and they cannot be easily recharged once deployed. Up to now, many energy efficient routing algorithms or protocols have been proposed with techniques like clustering, data aggregation, multi-path and location tracking, etc., as can be seen from related work. However, many of them aim to minimize parameters like total energy consumption or delay during the routing process, which might cause some hotspot nodes as well as a partitioned network due to the overuse of certain nodes. Since the network lifetime is usually defined as the time when the first node dies from lack of energy, huge amounts of energy will be wasted by the remaining sensor nodes [4]. Hop number and hop distance have a very important impact on many network metrics like energy consumption, routing overhead, interference, latency, etc. Intuitively, if the hop number is too large, the energy consumption can be reduced at the cost of long end-to-end latency and large control overhead. If the hop number is too small (e.g., direct transmission), the latency will be very small while the energy consumption can be very large due to the long distance wireless communication nature. Therefore, an optimal hop number with suitable individual distance(s) needs to be deduced as a tradeoff in order to achieve energy reduction and energy balancing.

II RELATED WORK

Previous and recent work on WSN routing protocols have not defined the heterogeneity clearly. For some of them, a heterogeneous network is a network comprised of mobile nodes with different energy supplies, different transmission power, or different data rate. Others have ignored the node heterogeneity and focused on routing among heterogeneous networks each of which is comprised of homogeneous nodes. Few have defined heterogeneous network as a network comprised of mobile nodes with multiple interfaces [6]. In this work, we defined heterogeneous MANET as a network formed of heterogeneous nodes and some of these nodes may have more than one wireless inter-face and the wireless interfaces can be of different wireless.

Figure 1. Routing protocols in sensor networks: A taxonomy.



2.1 Traditional Energy Efficient Routing

As is shown in the left side of Figure 1, the traditional routing protocols in WSNs can be classified into flat, hierarchical and location based routing. Among flat routing protocols, SPIN (Sensor Protocols for Information via Negotiation) can be

viewed as the first data-centric routing protocol which utilizes the data negotiation method among sensor nodes to reduce data redundancy and save energy. Direct Diffusion is another representative data-centric routing protocol for WSNs. The data generated by sensor nodes is named by attribute-value pairs. Once a sink node inquires certain type of information (like four-legged animals in a certain area), it will send a query and the observed data can get aggregated and then be transmitted back to the sink node. In addition, the load balancing can be achieved by forwarding the data on different paths based on probability. Rather than always using the lowest energy paths, the authors in use sub-optimal paths occasionally so that the network lifetime is increased by 40% compared to.

III EXISTING WORK

LEACH (Low energy adaptive clustering hierarchy) [1] is one of the important cluster based protocol which uses an adaptive approach for the cluster head election. Every node generates a random number between 0 and 1 and when this number is less than a particular threshold value T (n) then the node becomes a cluster head for the current round After becoming a cluster head node advertise about its status in the network and non cluster head nodes join a nearby cluster head. Cluster head further creates a TDMA/CSMA schedule for its members to avoid intra cluster and inter cluster collision. In LEACH there is no guarantee about number and placement of cluster heads in a round. LEACH-C (LEACH Centralized) [7] is a protocol which uses base station control algorithm for the cluster head elections and disperse the cluster heads in the entire sensing region. Initially each sensor node sends the information about their location and energy by using a GPS to base station. On the basis of this information base station finds the average energy of the network and the nodes having energy below this cannot become a cluster head during a round. LEACH-C is more efficient than LEACH and delivers 40 % more data per unit energy. One of the disadvantages of the LEACH is that the cluster heads rotations do not take into account the remaining energy of sensor nodes. A node may not have sufficient energy to complete a round and may be selected as a CH.

$$T(n) = \left(\frac{p}{1 - p \times \left(r \bmod \frac{1}{p} \right)} \right)$$

If n ϵ G Eq……(1)

T (n) = 0 Otherwise

[2] A new approach for cluster head selection is proposed. When the remaining energy of a node is larger than 50% of initial energy then for cluster head election LEACH algorithm is used as in Equation (1). Otherwise a new scheme which considers the remaining energy of each node is applied for cluster head selection according to Equation (2).

$$T(n) = \begin{pmatrix} \frac{p}{1 - p \times \left(r \bmod 1/p \right)} \times \left(2p \times \frac{E_{res}}{E_{init}} \right) if n \varepsilon G \\ 0 \end{pmatrix}$$

Equation – 2

Here p is the percentage of nodes that can become cluster head, E_{res} is the remaining energy and E_{init} is the initial energy of a node and G is the set of nodes that have not become cluster head in the last 1/p rounds and r is the current round.

PEGASIS [3] is a greedy chain based algorithm for data gathering in wireless sensor network. In PEGASIS each node forms a chain structure through which the data is forwarded to base station. PEGASIS achieves energy efficiency by transmitting data to only one of its neighbor node where the collected data is fused and further forwarded to next one hop neighbor. There is no rapid depletion of the energy of the base station nearer nodes because all the nodes are doing the data fusion at its place.

HEED [4] is another popular distributed energy efficient clustering algorithm which probabilistically elects cluster heads based on their residual energy and nodes join cluster heads which have the minimum communication features of HEED is that it exploits the multiple transmission power levels of sensor nodes.

TEEN [5] is a cluster based protocol for time critical applications and uses two threshold values hard and soft for the election of cluster heads. Hard and soft threshold determines the minimum value and changes that are of interest in s sensing region. As a result number of transmissions to base station is reduced considerably.

SEP [6] is a cluster based protocol for two level heterogeneous network. In SEP there are two types of nodes: normal and advanced. Advanced nodes have more energy than the normal nodes and it is the source of heterogeneity in the network. Weighted probabilities of normal and advanced nodes are used to determine the thresholds for the election of cluster head in a round.

DEEC [7] is a distributed energy efficient clustering protocol for heterogeneous network in which nodes become the cluster head based on the residual and the average energy of the network. Energy expenditure of nodes is controlled by means of an adaptive approach and for this average energy is used as the reference energy.

EEHC [8] purposes an energy efficient scheme for heterogeneous wireless sensor network. EEHC increases the life of the network by 10 % as compared to LEACH in the presence of powerful node setting.

EDEEC [9] is a clustering algorithm with three types of nodes and uses residual and average energy of the network for the selection of cluster heads in a round.

EECDA [10] is another cluster based protocol for three level heterogeneous networks. Some percentage of the nodes of network has more energy than normal nodes which are known as advanced nodes. Further in advanced nodes some fractions of the nodes have even more energy than the normal nodes which are known as super nodes. Novel cluster head election and a path of maximum sum of energy residues for data transmission is used in EECDA for increasing network lifetime and stable region.

DBCP [11] is an energy efficient clustered protocol for heterogeneous wireless sensor network which selects the cluster heads according to initial energy and average distance

IV PROPOSED WORK

We proposed a multi hop energy efficient protocol for heterogeneous wireless sensor networks. It is a clustering protocol for two level heterogeneous sensor networks. consists of n sensors and base station is located in the middle of the sensing region. The proposed protocol will be an extension of SEP and it takes the full advantage of heterogeneity. It improves the network lifetime, stable region and throughput of the network. For taking the full advantage of heterogeneity introduces a multi hop architecture for normal cluster heads. Advanced nodes further takes over the data transmission load of normal cluster head to save network energy, prolong the stable region, network lifetime and throughput of the system.

V CONCLUSIONS

In this paper we discussed various protocol for sensor network and proposed an extension of SEP and it takes the full advantage of heterogeneity. It improves the network lifetime, stable region and throughput of the network. We introduces a multi hop architecture for normal cluster heads. Advanced nodes further takes over the data transmission load of normal cluster head to save network energy, prolong the stable region, network lifetime and throughput of the system.

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