Energy Efficiency Routing in WSNs using MSDA
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Abstract— In WSN, sensor nodes operate on battery and it’s difficult to recharge or change the batteries. Thus energy proficiency is the main issue in WSNs. One of the techniques to this hindrance is clustering. Improved Energy Efficiency semi static clustering protocol (IEESSC) is an energy aware protocol in which clustering is done based upon the residual energy. It uses the concept of single mobile sink moving randomly throughout the network. In this paper, a new routing protocol based on child sink nodes concept i.e. Energy Efficiency Routing in WSNs using MSDA (Multiple Sinks Divisional Approach) is proposed. This protocol is simulated and compared with IEESSC based upon the parameters setup time, routing overhead and throughput. Simulation results demonstrate that proposed protocol has better results as compared to IEESSC.

Key words: Wireless Sensor Network, Clustering, IEESSC, Child Sink Node

I. INTRODUCTION

Wireless Sensor Network (WSN) is a group of sensor nodes which works collaboratively towards a common goal. These sensor nodes sense the environment and send the data to the sink. WSNs are used in number of fields like environmental monitoring, military applications, health care applications, home intelligence, remote sensing, fault tolerance, production costs, transmission media, power consumption etc [1].

In WSN applications, sensor nodes are battery driven and it’s very difficult to recharge or change the batteries. These days prolonging the network lifetime is a vital concern. Sensors often take longer time for communication. So a good WSN design needs to be energy efficient. To make routing energy efficient, different energy efficient algorithms have been proposed. These algorithms are categorized as data centric algorithms, location based algorithms and hierarchical routing algorithms [2]. In location based routing algorithms the base station communicates with sensor nodes based on its location identity. Here all the nodes are aware of its location through GPS (Global Positioning System) receivers in the network. In hierarchical routing algorithms the network is divided into different clusters and then cluster head is elected in respective clusters. CH is responsible for collecting the data and sending it to the sink.

Rest of the paper is organized as follows – section 2 represents the related work to energy efficiency routing in WSNs, section 3 is concerned with IEESSC protocol, section 4 represents the improved protocol i.e. EER in WSNs with child sink nodes, section 5 represents the simulation results and section 6 concludes the work of the paper.

II. RELATED WORK

Nazir B. et al. proposed a Mobile Sink based Routing Protocol (MSRP) for Prolonging Network Lifetime in Clustred Wireless Sensor Networks. In MSRP, mobile sink moves in the clustered WSN to gather sensed data from the CHs inside its region. Mobile sink has to maintain the information data about the residual energy of the CHs while gathering the data. Mobile sink, considering the residual energy of CHs move to the CHs having higher energy. Therefore, the hotspot problem is minimized as the next neighbor of the sink is high energy node and it changes as a result of regular sink movement. Simulation shows that this protocol is effective in the efficient utilization of WSN energy and enhances the network life time. [3].

Guioufi A.B. et al. proposed three energy-efficient clustering algorithms (EECA) to minimize WSNs energy consumption i.e. EECA-F (EECA for Fixed WSNs), EECA-M1 (EECA for Mobile WSNs) and EECA-M2. EECA-F (EECA for Fixed WSNs) is designed for the WSNs which have fixed nodes. EECA-M1 (EECA for Mobile WSNs) is used when the nodes mobility is constant and EECA-M2 which is defined for the WSNs having variable nodes mobility. Then the above algorithms are compared to the recent clustering algorithms and simulation results show that these algorithms are effective in saving energy and reduce up to 25% of power consumption [4].

Sungtack Kim et al. proposed geographical routing protocol called Greedy Packet Forwarding (GPF) for wireless sensor networks (WSNs). It is an attractive localized routing scheme for WSNs because of its directional routing property and scalability. Energy-aware algorithm called load balancing mechanism is also included in pure GPF. This paper considers lossy wireless link condition based upon energy-aware GPF because the use of high quality link reduces the transmission errors. The algorithm used here is named as energy and wireless link aware GPF (EWG). The performance of the algorithm is verified and compared with the other methods and this protocol results in low transmission errors and increases the network lifetime significantly [5].

Lina Xu et al. proposed a Balanced Energy-Efficient Multi-hop clustering scheme for WSNs which overcomes the existing clustering algorithms (such as LEACH and HEED) failure of not taking into account the coverage of the network when evaluating network lifetime. This protocol not only extends the durability but also maintain the coverage. Experimental results show that BEE exceeds HEED and LEACH from two perspectives i.e. longevity and balanced sensor distribution. It assures the network coverage for a longer time, compared with HEED and LEACH. The multi-hop version of BEE, called the Balanced Energy-Efficiency Multi-hop (BEEM) clustering algorithm, is also discussed which can further improve the performance of BEE [6].

Liqi Shi et al. proposed a solution to the scheduling problem in clustered WSNs. The aim of the proposed solution is to provide network-wide optimized time division multiple access (TDMA) schedules that can achieve more...
power competence, zero divergence, and reduced end-to-end delay. A nonlinear cross-layer optimization model is build to achieve the above objective involving the network, MAC, and physical layers, which aims at low overall energy consumption. To solve this problem, model is transformed into two simpler sub-problems. On the basis of network-wide flow distribution which is calculated from the optimization model and transmission power on every link, an algorithm has been formulated for deriving the TDMA schedules which utilizes the slot reuse concept to achieve lower TDMA frame length. The above solution can decrease the energy consumption and delay significantly and also satisfies a specified reliability objective [7].

Sadouq Z.A. et al. proposed a new energy-aware structure for a long-lasting sensor network. The proposed approach is based upon clustering architecture and realizes a good performance in terms of network lifetime by reducing the energy utilization for communication among the networks and balancing the load among all the nodes. Actually it is an energy optimization approach based upon the cross-layer for WSNs combining the optimal design of physical, MAC layer, and routing layer. This approach enables the network to be reconfigured dynamically and efficiently using the every node's energy and distributes the managing tasks to sustain the scalability of the management system in heavily deployed wireless sensor networks. This method focuses on the evaluation of favorable transmission power, routing, and duty-cycle plan that optimizes the WSNs energy-efficiency and thus decreases node's energy utilization and contributes in increasing the entire network lifetime [8].

Rong Cui et al. proposed an Energy-efficient routing protocol for energy harvesting in wireless sensor network. The transmission quality, energy consumption and wastage of energy are taken into account and the effect of bit error rate (BER) is considered in the selected routes. The transmission value is affected by BER. The shortest path is found with the help of dynamic programming after which the network is divided into separate layers to find the energy efficiency [9].

Qian Zhao et al. inspect the energy efficiency and fault tolerance for wireless sensor networks (WSNs) to decrease the communication distance and so the energy used for communication. The energy hole phenomenon is also investigated where non-uniform energy usage causes some nodes to run short of power very soon. As a result the communication distance is increased and premature shutdown of the entire network occurs. Very few sensor nodes in a WSN may be unreliable so fault tolerance is required to optimize the communication topology. The Energy Hole Aware Energy Efficient Communication Routing Algorithm (EHAEC) is developed that resolves the energy hole problem to the maximum extent possible while reducing the amount of energy used for communication by generating an energy efficient spanning tree. A variant of this algorithm i.e. EHAEC for one-fault tolerance (EHAEC-1FT) recognizes unnecessary communication routes by using the EHAEC tree and bears the failure of one node [10].

Baghyalakshmi D. et al. presented a survey of Low latency and energy efficient routing protocols for wireless sensor networks. A reactive network protocol TEEN (threshold-sensitive energy efficient sensor network protocol) which is best suited for time critical data sensing applications is very efficient in the terms of energy utilization and response time. A hybrid network protocol i.e. APTEEN (adaptive periodic threshold-sensitive energy efficient sensor network protocol) presents the overall picture of entire network at periodic intervals in highly energy efficient manner. SPEED is highly efficient and scalable protocol with no state is suitable for sensor networks which gains end to end soft real time communication by sustaining a desired delivery speed across the entire network through a novel arrangement of feedback control and non deterministic geographic forwarding. RAP, a time critical communication design for bulky sensor networks which considerably minimizes the end to end latency by using velocity - monotonic scheduling (VMS). RPAR, time critical power aware routing protocol which supports energy efficient real-time communication by adapting the transmission power dynamically and routing decisions [11].

Ganesh S. et al. proposed an efficient and secure routing protocol for WSNs through SNR-based dynamic clustering (ESRPSCD) techniques, can divide the nodes into several clusters and elect the cluster head (CH) amongst the nodes based upon their energy, and non CH nodes are linked to a particular CH based upon the SNR values. Error recovery has been applied during the inter-cluster routing to avoid end-to-end error recovery. Security factor has been achieved by separating the malicious nodes using sink-based routing pattern analysis. General investigation studies with the use of a global mobile simulator have proved that this hybrid ESRP considerably achieves the energy efficiency and packet reception rate in contrast to SNR unaware routing algorithms such as the low energy aware adaptive clustering hierarchy and power efficient gathering in sensor information systems [12].

III. IEESSC PROTOCOL

IEESSC is improved energy efficiency semi-static routing algorithm using sink mobility is the improved version of ESSC protocol and considers the concept of sink mobility and nodes in static mode, thus reducing the communication cost. In this protocol, sink changes its position randomly after every round. This uniform the utilization of energy and thus extends the network lifetime. Methodology of above protocol is:

- Step 1: Initialization of the network- firstly network is initialized with the help of activation packet. When all the nodes are deployed in the network, the sink sends the activation packet i.e. $P_{act}$ to all the nodes of the network. Every node which receives the $P_{act}$ claims itself to be the cluster head. Then each node creates the list of nodes (LNC) in the cluster and also creates the distance list to all other clusters (DLOC). In LNC, all the nodes’ identities are arranged in the descending orders of their energies.

- Step 2: Merging of clusters- Secondly clusters are merged as per their residual energy and distance. First of all, every cluster finds the nearest cluster from its DLOC and then the clusters whose distance is less than the threshold value would be merged as one cluster.
− Step 3: Selection of CH- Now CH is elected based upon the maximum residual energy. There is rotation of cluster head after every round.
− Step 4: Aggregation of data by CH and transfer to the sink- CH collects the data from the cluster members, aggregates it and send it to the sink.
− Step 5: Sink Mobility- Sink changes its position after every round so that energy utilization during communication is uniform throughout the entire network.
− Step 6: Re-clustering- If any member has not sufficient energy to become the cluster head, then re-clustering is done.

IV. PROPOSED METHODOLOGY
Clustering is the good choice to save the energy consumption in WSN. In the clustering approaches, energy is required in sensing, communication and formation of clusters. We can’t reduce the energy required in sensing but energy requirement in communication and cluster formation can be minimized considerably. IEESCC protocol is efficient in reducing the energy utilization but since it uses the concept of single sink moving randomly through the entire network thus creating routing overhead as sink has to broadcast its location every time to all the sensor nodes. Moreover when two LNCs combine, it results in uneven cluster size and the Cluster Head (CH) of the larger cluster die soon as compared to small size clusters. The methodology used is:
− Step 1: Arrangement of network into grids- Firstly the network is arranged into grids where each grid forms the cluster.
− Step 2: Division of network into zones- Secondly, divide the network into different zones. Each zone would have its own sink called zone sink and one main sink at the centre of the entire network.
− Step 3: Arrangement of nodes as per their residual energies- The higher energy node would be chosen as the CH and next highest energy node will be cluster head for subsequent rounds.
− Step 4: Aggregation of data by zone/child sinks- The zone sinks collect the data from the cluster members of their respective zones and send the data to the main sink. The zone sink has to broadcast its location only once.

V. SIMULATION AND ANALYSIS
To evaluate the performance of EER in WSN using Child Sink Nodes and IEESCC, we have simulated both these protocols using NS2 with the simulation parameters as shown in the Table 1. Parameters considered for simulation are Setup Time, Routing Overhead and Throughput. Figure 1 shows the WSN initialization where 50 nodes are being deployed randomly in 1000 X 1000 m² network area where x-axis represents network length and y-axis represents network height (in meters).

<table>
<thead>
<tr>
<th>S. No</th>
<th>Parameter Name</th>
<th>Parameter Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Network Size</td>
<td>1000*1000 m²</td>
</tr>
<tr>
<td>2</td>
<td>Max. packet in ifq</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>Number of Mobile Nodes</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>Initial energy (in joules)</td>
<td>20</td>
</tr>
</tbody>
</table>
B. Throughput:

It is amount of data that is being received in the network at the sink node. More the throughput better the performance of the network.

Fig. 4: Throughput

VI. CONCLUSION

New energy efficiency routing protocol i.e Energy Efficiency Routing in WSNs using MSDA is presented in this paper. IEESSC is improved by adding concept of child sink nodes (also called zone sinks) so that routing overhead and energy consumption is reduced. In this paper, performance analysis of IEESSC and EER in WSNs using MSDA (Multiple Sink Divisional Approach) protocol is performed on the basis of setup time, routing overhead and throughput. Results show that proposed protocol is better than IEESSC in each case. In future, this protocol can be analyzed on other parameters.

REFERENCES


