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Multi Objective Energy Aware Clustering with Stato Dynamic Routing Protocol for Wireless Sensor Networks

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Abstract: ***One of the main design issues in wireless sensor networks is efficient utilization of energy available at each sensor nodes. Many researchers have proposed various methodologies for the conservation of energy. Clustering technique is one of most admittable methods in WSN which mainly focuses on energy conservation. The proposed approach takes into consideration multiple objectives like channel utilization, delay, delivery ratio, transmission range of each nodes and energy efficiency which are used to determine the Time To Live (TTL) metric of each node. The proposed clustering is EACSDR with multiple objectives to be obtained for the purpose of prolonging the network lifetime. Extensive simulations are performed with various clustering algorithms like LEACH and EEPSC to show the betterness of the proposed approach in multiple objectives.***

Keywords: WSN; TTL; EACSDR; LEACH; EEPSC; Clustering.

I. INTRODUCTION

Wireless Sensor Networks consists of group of sensor nodes interconnected by wireless communication channel. Every sensor nodes are incorporated with sensing device, limited battery power supply etc. WSN finds wide range of applications in environmental monitoring, military field surveillance, precision agriculture etc. Because the battery power consumption of sensor node is limited it is very important to save battery while designing network protocols. Normally the sensors gathers information, process them and send it to the mobile sink for further processing. Mobile sinks are now efficiently used for data gathering rather than reporting data through long, multi-hop routes. Thus the transmitting time and the transmission path for data is short and energy consumption is less since sinks with radio devices directly gets into contact with the areas for communicating with nodes for data gathering.

In-order to improve the delivery ratio, transmission range of each node, to reduce delay and to provide energy efficient solution clustering technique is incorporated along with use of asymmetric links. The proposed clustering protocol is Energy Aware Clustering with Stato-Dynamic Routing which mainly focuses on limited usage of energy for aggregating datas and to improve the fidelity of reported datas and to reduce communication overhead[3][6].

Here nodes are grouped into clusters. Every group of clusters have Cluster Head (CH) and these cluster heads are selected on the basis of residual energy. The cluster head takes off number of cluster member nodes which lie within its transmission

range. Thus group of cluster are formed and data transmission takes place only through cluster heads. The mobile sinks also collect the information from head cluster rather than getting from each sensor nodes. Many clustering algorithms [1] and moving pattern of mobile sinks were scheduled in-order to minimize data gathering. Some of them are LEACH, EEPSC, Mobile Element Scheduling (MES) and Sink Oriented Data Dissemination (SODD).

Hence the proposed protocol takes into account asymmetric links and helps to achieve better throughput, delivery ratio, and transmission range and energy efficiency. Thus multiple objectives are compared with the existing approaches to show the betterness of the proposed approach.

II. Related Work

In Heterogeneous sensor networks, the averge delivery ratio can be improved as compared to homogeneous sensor networks [7]. So many routing protocols deal with network which is homogeneous. But it is observed that capacity remains the same for all sensors while computing, communicating and in case of power, scalability and reliability. Many techniques are proposed for reducing control overheads [8]. Two Tier Data Dissemination (TTDD)[10] enables faster data forwarding. Sinks are assumed to move with fixed velocity and direction. The other method called MES considers sink mobility and its track movement [9]. From the existing clustering algorithms like LEACH, it is clear that each node becomes a cluster head per round and task of being cluster head is circulated between nodes.

LEACH is a dynamic Clustering technique which mainly favours head cluster which is of dynamic configuration. It also uses single hop routing. Hybrid Energy- Efficient Distributed (HEED) [2] clustering is incorporated with communication range limits and inter and intra cluster communication cost information. This technique works with multi-hop routing. EEPSC is a static clustering based protocol [4]. It divides the network into static clusters which removes the burden of dynamic technique. Also it uses temporary head clusters for distributing energy among powerful nodes thereby prolonging lifetime of network. EEPSC eliminates the overheads of dynamic clustering [5].

The proposed protocol considers the suppression of control messages and therefore aims at minimizing flooding effect of message, which does not confines the movement of sink. It overcomes the NP-hard problem to determine accurate technique for data gathering. It also has logic co-ordinate representation and stato-dynamic routing part along with energy aware clustering for the purpose of achieving even more improvement in all the objectives.

III. Proposed Protocol EACSDR

The proposed protocol here is Energy Aware Clustering with Stato-Dynamic Routing (EACSDR) which mainly focuses on efficient utilization of energy by using stato-dynamic clustering mechanism. This section deals with the work of proposed protocol.

It is a clustering protocol which actually deals with grouping of sensor nodes and electing of cluster heads in addition to dealing with logic co-ordinates representation.

A. EACSDR overview

The proposed protocol does not need the help of GPS instead it tracks the sinks movement and neighbours relationship with the help of logic co-ordinates. It also uses asymmetric links and finds the reverse path as compared to AODV which works in symmetric links. Since it is a stato-dynamic protocol it works accordingly for cluster heads which are dynamic in configuration and member nodes which are static in nature. So it is clear from the working of the proposed technique that it is more efficient than the other clustering techniques like LEACH [1], which is dynamic in nature and EEPSC [1], which is static in nature.

B. EECSDR working

EECSDR works with logic co-ordinates and the cluster heads are elected for each cluster depending on residual energy level. Residual energy is calculated based on the cost metric and transmission range of each node in the network. Node having highest residual energy is elected as head cluster and the network is re-clustered with new cluster heads so as to choose energetic nodes after particular head starts loosing its energy. Since the transmission of data for long distances are made only by the cluster heads and not by the member nodes, heads loses more energy compared to member nodes. So it is essential to periodically change the CH's and to aggregate datas to sink. Thus, inspite of achieving energy efficiency, cluster focuses on reducing channel contention and packet collisions so as to obtain good network throughput in high load [3].

The sensors are grouped into clusters and CH is elected for each clusters. The CH gathers members which are all present within its transmission range. The datas collected by the nodes are provided to CH's which takes full in-charge in delivering that information to the mobile sink.

Data sequences and hop counts are initialized in the beginning. Mobile sink is now allowed to move around a large, evenly distributed sensor network. The whole network is assumed to be connected based on clustering technique. Since asymmetric links are used, the neighbouring CH's rather than moving to each and every node individually. It saves time as well as energy while data gathering. The sink broadcasts messages by stopping at particular place to the whole network for a finite duration and then moves on to particular point. The broadcasted messages are referred to as temp messages and points are called temp points. Untill sufficient datas are collected from the CH's, temp points are moved accordingly and datas are collected thus finds shortest path in asymmetric links.

The gathered datas are forwarded using stato-dynamic routing part if temporary reference is updated and if sink is within the radio coverage. After receiving the forwarded datas, acknowledgement is sent back to the cluster heads through asymmetric links via reverse path. Thus assured delivery ratio of the packets is obtained and energy consumption of this process is also low compared to the previous techniques used for gathering datas.

IV. Simulation Results and Discussion

Here multiple objectives are considered and used to show the betterness of the proposed approach compared to the existing techniques. Extensive simulations are performed in case of both link based and cluster based approach. The proposed protocol is compared with AODV which uses symmetric link for ad-hoc wireless network and also with SODD, LEACH and EECSR for showing the improvement in channel utilization, energy consumption, delay etc.

From the simulation, EACSDR assures delivery ratio of about 88%. The threshold is set to 98%. The savings in energy consumption is about 23%. Delay is less compared to other protocol because the transmission of data from CH to the sink is done in very fast manner and the delay is comparatively less than the other. Bandwidth used for the cluster head is less since it is designed accordingly. Also cluster heads consumes more power than the member cluster nodes, so the number of clusters is to be optimized to provide energy efficient solution. Thus the proposed protocol is superior to others and outperforms them in all the objectives considered.

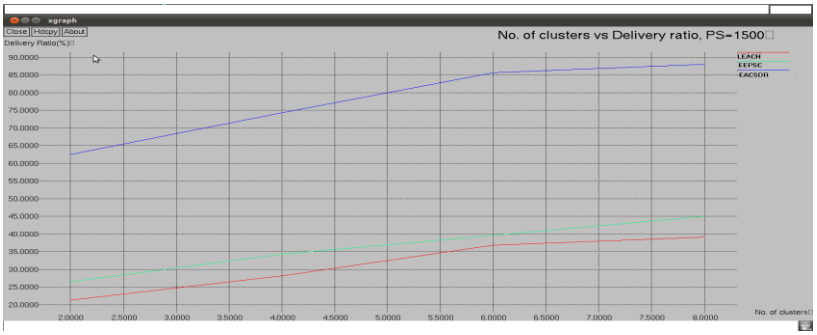

Fig. 1: Comparison of Number of clusters vs Delivery ratio

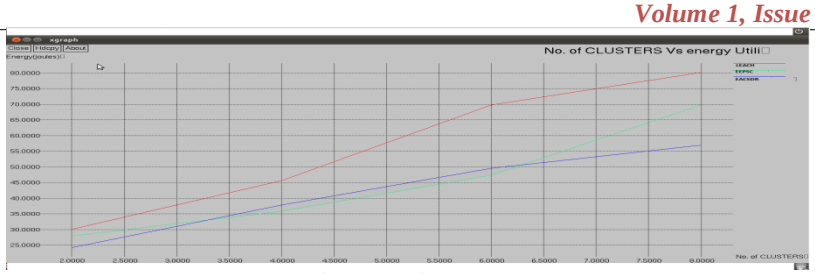

Fig. 2: Comparison of Number of clusters vs Energy utilization

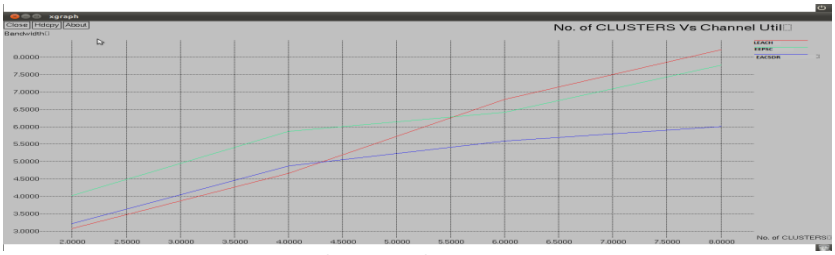

Fig. 3: Comparison of Number of clusters vs Channel utilization

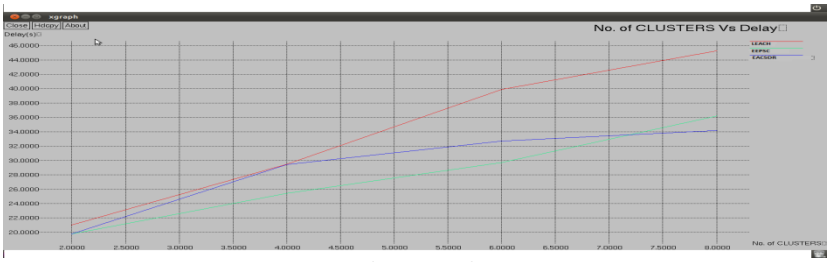

Fig. 4: Comparison of Number of clusters vs Delay

TABLE I
Comparison Table

	LEACH	EEPSC	EACSDR
ENERGY UTILIZATION(joules)	80	70	57
CHANNEL UTILIZATION(hertz)	8.2	7.7	6
DELAY(seconds)	45	36	34
DELIVERY RATIO	38	45	88.45

V. CONCLUSION

This paper deals with EACSDR protocol, which is a stato-dynamic clustering technique and takes multiple objectives into consideration in addition to having asymmetric links, consistency and scalability issues in WSN mainly for heterogeneous network. It is less complex and energy efficient data gathering protocol. The inter and intra cluster traffic is managed by cluster head itself. No GPS or land marks are required instead it uses logic co-ordinates and asymmetric links for forwarding and acknowledging the datas. It ensures shortest path delivery ratio and reduces control overheads. Time management is maintained very well since only head clusters are involved in the work of data transmission. Also cluster heads consumes more energy than member nodes, so a sensor node whose transmission range is high is selected as cluster heads. Thus optimized number of clusters is formed and there is a reduction in energy consumption, channel utilization, delay aspects, control overheads and improvement in delivery ratio and transmission range. Therefore the efficiency of EACSDR is evaluated from the simulation result. In future, more scalable and static clustering schemes are to be created for the purpose of efficient data gathering.

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