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IMPROVING ENERGY CONSUMPTION IN SENSOR NETWORK BASED ON MAC-RES MODEL

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Abstract: - Mobile ad hoc networks need efficient algorithms to determine ad hoc connectivity and routing. MANET aims not only to provide correct and efficient routes between pair of nodes but also to provide energy efficient route to maximize the life time of ad hoc mobile networks. Also one of the important issues in WSNs is how to save the energy consumption for prolonging the network lifetime. For this purpose, many novel innovative techniques are required to improve the energy efficiency and lifetime of the network. In this paper, a dynamic energy conscious routing algorithm with data gathering where cross layer interaction is provided to utilize the energy related information from physical and MAC layers for Heterogeneous networks. This proposed approach includes a novel cluster head election technique and a path would be selected with maximum sum of energy residues for data transmission instead of the path with minimum energy consumption. In this algorithm, the nodes energy utilization is minimized at the maximum and path selection is highly supporting the energy consumption of nodes in the network.

Keywords: RTS/CTS, Cluster, Cluster Head, Energy, MAC Layer.

I. Introduction

The Current importance and advances in micro electro mechanical systems, technology and wireless communications have led to small and low cost sensor network. The sensor network may comprise many application areas such as health monitoring, environmental monitoring including temperature, humidity, lightning condition, pressure etc. Additionally, many domain applications such as factory automation, chemical pollution monitoring, oil and gas remote monitoring, building sensor and security adopt sensor computing [9].

A mobile wireless sensor network consists of tiny sensor nodes which has three basic components: a sensing subsystem for data acquisition from the physical surrounding environment, a subsystem for local data processing and storing a wireless transmission subsystem for data transmission. Furthermore, a battery is critical for a sensor node. All the sensors send data that they have sensed from the given region to the base station. The very important issue in this action is energy efficiency. There are other factors related to energy efficiency directly or indirectly like having a good routing protocol.

The path selected by nodes to send data is very affective because energy resources are limited and routing protocol should pay attention to this fact and has to send data in the path which doesn't lead the nodes to loss much energy.

Clustering is a technique used to reduce energy consumption of network nodes. The main contribution of this paper is using a multipath routing to send the data from one cluster to other clusters. The remaining of this paper is organized as follow: Section 2 guides an idea on prior works done in this area. Section 3 gives details about the system Model of the current work and how MAC-RES works, Section 4 presents detailed explanation of the proposed approach, simulation results and performance analysis and Section 5presents conclusions and future work.

II. Related Works

The idea proposed in LEACH has been an inspiration for many hierarchical routing protocols, although some protocols have been independently developed [1][2]. Taxonomy of the different architectural attributes of sensor networks is developed [3]. Further improvements on LEACH protocol for wireless sensor networks have been developed where both security & efficiency features have been dealt with [4]. Here the sensing area has been divided into a number of equilateral areas, called as clusters. Each cluster consists of six equilateral triangles called cells. The protocol consists of a number of rounds but after forming the clusters they do not change in each round. Both each equilateral triangle & each equilateral hexagon has same number of nodes. In each cell one cell head is selected & one CH is selected is chosen from six cell heads. The data are sent to the base station by using the multi-hop manner through a secure path consisting of cluster heads. The analysis shows that the improved protocol saves nodes energy, prolongs WSN lifetime, balances energy expenses and enhances security for WSNs.

The hierarchical routing protocols involve nodes in multi-hop communication within a particular cluster to efficiently maintain the energy consumption of sensor nodes as well as perform data aggregation fusion to decrease the number of transmitted messages in the sink. Cluster formation is typically based on the energy reserve of sensors and sensor's proximity to the cluster head [5][6]. To allow a single-tier network to cope with additional load & to be able to cover a large area of interest without degrading the service, networking clustering has been pursued in some routing approaches [7]. LEACH is one of the first hierarchical routing approaches for sensors networks and it gives efficiency in energy as well as in distance.

The aim of LEACH protocol is to minimize energy consumption or in other words, to maximize the network lifetime. To make this happen several ideas are proposed for CH selection but they were based on mainly the node's (to be selected as CH) energy level. The node having greater energy level will be selected as CH most of the times. But here in the new proposed scheme not only the node's energy level is considered but also it's location or position both within the CH & from outside the cluster(neighbor clusters) are considered [8][9].

We know that there may a number of nodes in a cluster & there is always a CH. Suppose for example, if the CH lies at a distant position from the majority of nodes. So to communicate between CH & sensor nodes, since the distance between them is high, energy consumption for the communication is also high. That means, the higher the distance between CH & sensor nodes the greater the energy consumption[10] [11].

III. System Model

The network G is a region growing wireless sensor network, with base station BS, which has a varying number of nodes N, where each node has its own characteristics like energy, rxPower, txPower and etc. is assumed for the MAC-RES approach. The main motto of the proposed approach in this paper is to maintain efficiently the energy consumption of sensor nodes by involving them in a single-hop communication within a cluster. The data aggregation and data integrity technique is used to reduce the number of transmitted messages to the BS to save the energy and prevent the congestion. For this implementation, we have adopted a few reasonable assumptions as follows: (i) Network construction and node deployment in layer wise from BS; (ii) Clustering and CH election; (iii) Route discovery and; (iv) CHs perform data gathering and aggregation; (v)Maintenance of the network with MAC-RES based communication. We use the same radio model defined in [2]. The amount of energy required to transmit a L bit packet over a distance, d, is given by Equation (1).

$$E_{Tx}(L,d) = \begin{bmatrix} (L * E_{elec}) + (L * \epsilon_{fs}) * d^2 \ \ if\ d \leq d_0 \\ (L * E_{elec}) + (L * \epsilon_{mp}) * d^4 \ \ if\ d \geq d_0 \end{bmatrix} \quad (1)$$

E_{elec} is the energy being dissipated to run the transmitter or receiver circuitry. The parameters ε_{mp} and ε_{fs} is the amount of energy dissipates per bit in the radio frequency amplifier according to the distance d0, which is given by Equation (2).

$$d_0 = RO_{fs} + O_{mp} \quad (2)$$

The amount of energy required to receive a packet is given by Equation (3).

$$E\ R_x L = L * E_{elec} (3)$$

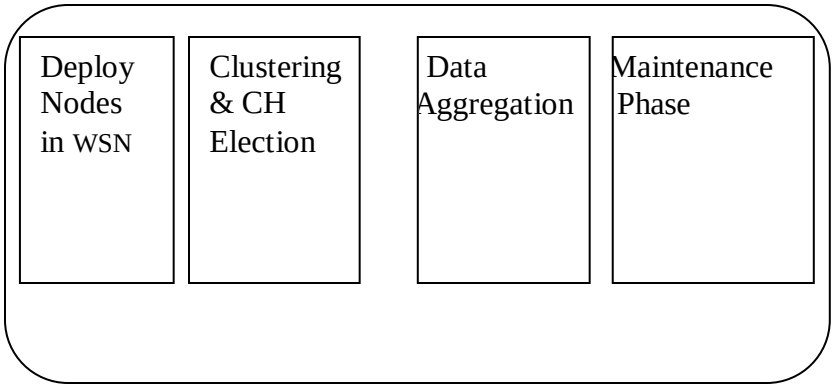


Figure-1: System Model

The System model of the proposed approach is given in Figure-1; it shows the four sequence main functionality of the system. Create nodes and deploy it in the sensor network, clustering and cluster head election where the CH is used to for data aggregation and finally maintain the clusters with the remaining nodes in the network.

IV. MAC – RES model

Basically the MAC-RES model will connect the physical and link layer together. After collecting the information from physical layer, the data link layer has functions of RTS/CTS transmission and gives response to the network layer to start transmission of route discovery and then sending special packets if necessary. This layer is, in this work, called as medium access control with reservation by RTS/CTS and Reservation/Infer packets.

The MAC layer uses the distributed co-ordination function (DCF) of the IEEE Standard 802.11 for wireless LANs. In this work, we have changed the basic CSMA with RTS/CTS mechanism in different power to support for routing. In general, the RTS packets are transmitted to receiver node to start the data transmission. The receiver sends CTS packet to the sender as a acknowledgement if it is ready to receive the data. Thus RTS/CTS transmission is taken place in this work before route discovery procedure. After RTS/CTS, sender initiates the route discovery procedure by transmitting route request (RREQ) and the receiver sends route reply (RREP) back to the sender. In this paper the route request and route discovery is done by MAC-RES model, in the Route Discovery phase and Maintenance phase of the MAC-RES approach.

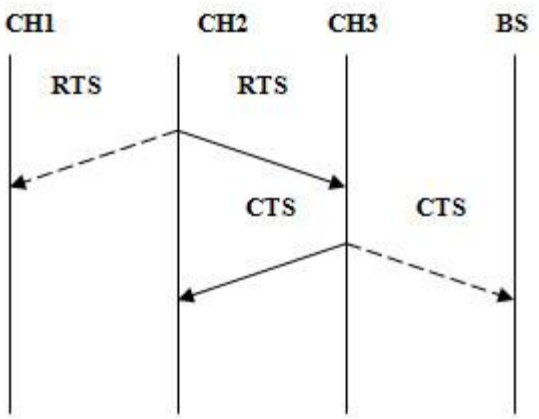


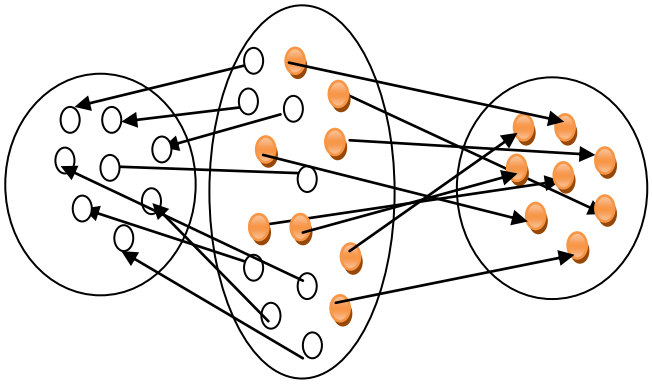
Figure 2: RTS/CTS Transmission in CSMA/CA

V. Proposed Approach

The MAC-RES approach has five steps are followed in the proposed approach. In the first step the total number of nodes is place in the network in a particular model. The way of node deployment in this paper is layer wise. The network is divided into number of layers. The first layer is closer to the BS also having less number of clusters than second layer; the second layer is having more cluster than previous cluster and so on. The last cluster is too far from BS and having more number of clusters.

The network is constructed by placing the node randomly by finding some random location between X, Y value of the network[9]. The nodes in the network is assumed that each node having heterogeneous energy level. Where nodes in the layers are clustered according to the energy level and the CH is elected with more energy level. The same way we do clustering in all the layers.

After deployment and CH election the communication between the CH will follow the MAC- RES model to save the energy and time with cost because the CH always do the data gathering and aggregation model. In the maintenance phase if node loses its energy it will become dead node, so number of nodes in a cluster get decreases. So the less number of nodes in a cluster will rejoin as a normal node into the nearest other clusters in the same layer from layer to layer towards BS. The final maintenance phase is shown in the following figure-3 in details diagrammatically.



New Cluster **Old-Clusters** **dead nodes**

Figure-3: Maintenance Phase of the System Model

The phases of the proposed approach are given in the form of pseudo code [MAC-RES Algorithm], which gives the programmatic idea of solving the problem. Where the variables are assumed, conditions and iterations of the functions are defined very clearly.

MAC-RES Algorithm

1. *Let N be the network which has a set of M number of Nodes and K number of Clusters*
2. *Cluster the nodes and elect CH with energy based*
3. *Data passed in and out of clusters*
4. *Ei -> initial energy assigned to a single node*
5. *Et -> Energy taken for transmission of data*
6. *Er -> Energy taken for receiving the data*
7. *Let S be the source node*
8. *Let D be the Destination node*
9. *R = $route_{SD}(link(n_i,n_j))$ ¥ ni, nj are next nearest pair of nodes in the route from Source to Destination*
10. *if ni,nj∋ M and nj is the next nearest to ni*
11. *If exists(n_j) - >$route_{SD}$ then*
12. *Look for next $n_j$and energy(n_j) > energy(n_i)*
13. *End*
14. *End*
15. *// Find all the paths and elect the best path*
16. *For I = 1 to num(possiblepath)*

$$\sum_{S}^{D}[nergy(ni,n]j)$$

17. *Energy($Path_i$) =*
18. *If (Energy($Path_i$) < Energy($Path_{i+1}$))*
19. *T <- pathi*
20. *Pathi<- pathi+1*
21. *Pathi+1 <- temp*
22. *End*
23. *End for*
24. *$path_i$(data) <- S(data)*
25. *D(data) <- pathi(data)*
26. *Energy(ni,nj) = energy(ni,nj) – energy throughput*
27. *If energy(n) <min_energy then*
28. *n <- dead(n) // node become dead node*
29. *Count the number of nodes in clusters*
30. *If number(n) < node-num-throughput then*
31. *Join the clusters*
32. *end*
33. *Calculate the throughput*
34. *End procedure*

VI. Simulation Results and Discussion

The simulation parameter of our proposed MAC-RES approach is given below for further enhancement settings. The performance of MAC-RES model level is best in energy and throughput compared with the existing system. According to the nodes and the number of clusters, the efficiency, performance of the MAC-RES approach is obtained, shown in the Figure -4.

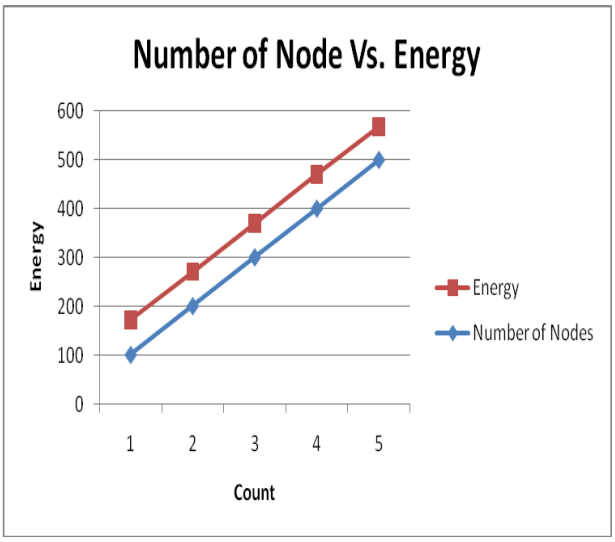


Figure-4: Energy Efficiency of the MAC-RES [Different Iterations]

When number of nodes increased in the network, the energy is getting decreased because for every transmission node needs energy. In MAC-RES, the energy utilization is 71% to 68% only for 100 node to 500 nodes.

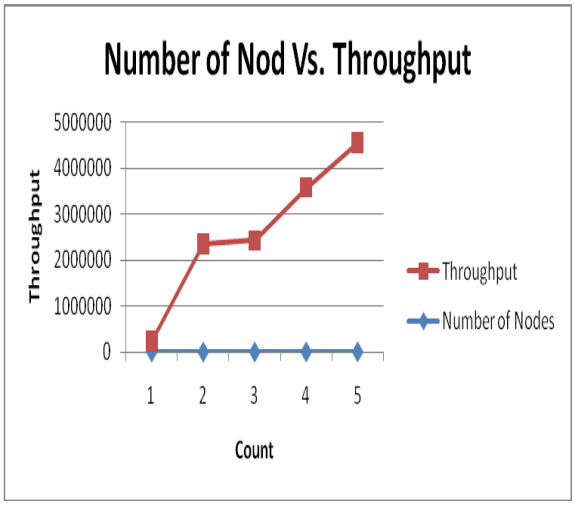


Figure-5: Throughput of MAC-RES in Different Iterations

When number of nodes increased in the network, the throughput is also getting increased because for all nodes and CH will make throughput. In MAC-RES, the throughput is 228934 to 4567898 only for 100 nodes to 500 nodes as shown in Figure-5.

VII. Conclusion

The new proposed scheme MAC-RES calculates the distance of the node from other nodes within the cluster as well as the distance of the node from the neighbor cluster heads and the distance from the centre position of the cluster to the neighbor cluster heads. Also the main factor is that the clusters are placed in layer wise. Also the cluster to BS communication is happening only through the CH. The energy is saved as much possible and the throughput is also good in the MAC-RES approach.

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