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Improving the Network Life Time of Wireless Sensor Network using MAODV Protocol with LEACH Algorithm

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Abstract: Energy efficient routing is a one of the major trusted area in wireless sensor networks (WSNs). The wireless sensor network composed of a large number of sensor nodes which has limited energy resource. Nodes in networks are basically battery operated and thus have access to limited amount of energy. The sensor nodes are working through the battery, energy saving becomes more vital issue in WSNs. The lack of energy can lead to a link failure during an active communication session, which affects the throughput and energy wastage. The routing algorithms assure the concept of energy saving without affecting the Quality of Service (QoS) Parameters like Throughput, End to End Delay, Overhead and Packet Delivery Ratio. In the existing system AODV (Ad-hoc On-demand Distance Vector Routing) is implemented. The AODV Protocol is combination of DSR and DSDV Protocols. The proposed work is to implement LEACH (Low Energy Adaptive clustering Hierarchy) algorithm in modified AODV (MAODV) Protocol which decrease the system delay, overhead and increase the system throughput and packet delivery ratio. Simulation is performed using NS2 and results shows that the proposed system is better than the existing system. The proposed system energy consumption is decreased by 47% compared to the existing system.

Keywords: Wireless Sensor Networks (WSNs), AODV, MAODV, LEACH Algorithm.

I. INTRODUCTION

The progression of wireless sensor networks is initially motivated by military applications. Wireless sensor networks are used in numerous civilian application areas like detecting, monitoring the movement of enemies, chemical, biological, radiological, tracking, automation, nuclear and health care applications. The Wireless sensor network consists of hundreds or thousands of low powered sensor nodes that have ability to communicate either directly to the base station or among each other. These nodes are integrated with micro sensing, computing wireless communication capabilities. Which are capable of detecting various events related to its surrounding environment such as speed, temperature, pressure, light etc, the WSN nodes are operate in ad-hoc manner, limited hardware and limited energy resource because it's small size. The energy source of sensor nodes in wireless sensor networks is usually powered by battery. This is insufferable, even impossible to be recharged or replaced. The energy efficiency and maximizing the life time of the network are major challenges in wireless sensor network.

In wireless sensor networks the sensor nodes are grouped into individual disjoint sets called a cluster. LEACH is considered as one of the method to reduce energy consumption. The LEACH is used in WSNs; it provides network scalability and energy saving attributes. LEACH schemes offer reduced communication overheads, decreases the overall energy consumption and reducing the interferences among sensor nodes.

The paper is organized as follows, Section I contains the introduction of wireless sensor networks and LEACH algorithm, Section II contain the related work that aims to improve the lifetime of WSN, Section III contain the MAODV protocol using LEACH algorithm, Section IV contain the simulation setup, section V gives the results to improve the efficiency of proposed model, Section VI concludes research work.

II. RELATED WORK

In [1], the author proposed a modified AODV (MAODV) protocol and compares the MAODV with AODV protocol. The MAODV protocol is slightly improves the quality of service (QOS) parameters like packet delivery ratio, energy when compared to AODV protocol.

In [2], the authors compare and evaluate the performance of two types of On demand routing protocols- Ad-hoc On-demand Distance Vector (AODV) routing protocol, which is uni path and Ad-hoc On-demand Multi path Distance Vector (AOMDV) routing protocol. It is clear that the AOMDV is better efficient than AODV protocol.

In [7], authors discuss the common cluster protocol and improve cluster head choice criteria. By LEACH protocol cluster head is chosen on random likelihood however during this projected algorithmic program it considers the sensing element nodes residual energy so as to balance energy dissipation between all the nodes to boost the network lifetime.

In [8], author proposed a LEACH Protocol is considered for this work and in which the CHs are elected based on threshold function. The proposed methodology enhances the threshold function of LEACH with distance and count of neighbour nodes metrics develops better energy efficient function. Power Amplification for the elected CH chosen high power in order to increase the performance of the network. The simulation result of proposed scheme shows better performance and prolongs the network life time for WSNs.

III. PROPOSED WORK

In this paper, we are implementing Clustering algorithm in Modified Ad-hoc On Demand Routing (MAODV) Protocol. In our existing work we have implemented the MAODV Protocol. MAODV Protocol is extension of AODV routing protocol. The MAODV Protocol uses the Bio inspired Cuckoo Search Algorithm, distance vector concept and hop-by-hop routing approach. The MAODV Protocol also uses a route request broadcasted between source to destination and route discovery process to find the on demand routes. It also offers intermediate nodes with alternate paths, which are reducing the route discovery rate. LEACH is a good method in wireless sensor networks for effective data communication and towards energy efficiency. LEACH based operations consists of rounds. These involve cluster heads selection, cluster formation and transmission of data to the base station. The figure 1 shows that the LEACH based wireless sensor network.

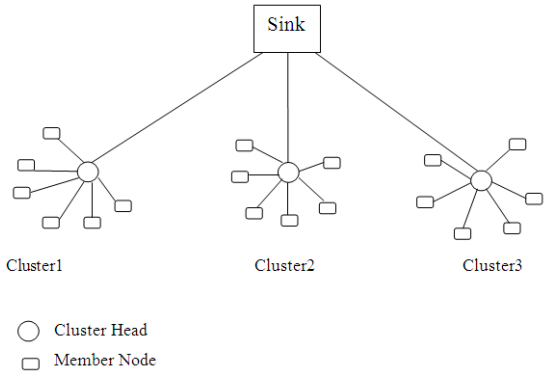

Fig 1: LEACH based WSN

Proposed Algorithm:

The LEACH algorithm proposed for energy efficient technique for WSNs consists of fixed number of sensor nodes that improve the Cluster Head selection approach to prolong the lifetime of networks. The Cluster Head selection in WSNs is based on the decision taken from the residual energy and certain threshold value of the respective nodes. The threshold value is

$$T[n] = \begin{cases} \left(\left(\frac{P}{1 - P * (r \bmod (\frac{1}{P}))}\right), & n \epsilon G \\ 0 & otherwise \end{cases}$$

Where P is the desired percentage of cluster head, r is the current round number and G is the set of nodes that have not been selected as cluster heads in last 1/P rounds. Using this threshold, each node will be moderately selected as cluster head at some point within 1/P rounds of the cluster head selection process.

The desired percentage of cluster heads depends upon different networks parameters like average distance between the sensor nodes to the base station, number of the sensor nodes deployed by the field and area of the field. The desired percentage varies at each round of cluster head selection.

After this each node that is selected as a cluster head will send a broadcast advertisement message to the all the nodes in the wireless sensor network. The each non-cluster head node decides the cluster to which it will belongs for its round depending on the signal strength or distance. The node will send a message to the cluster head informing that it will be a member of that cluster. We will choose the nearest cluster head. The cluster head receives all the messages from nodes that would like to be in its cluster. Once the cluster head know the number of members in cluster it can create a TDMA schedule for data transmission purpose. Here each node in the cluster send their sensed data to the cluster head in one hop transmission and the cluster head send data to the base station by multi-hop transmission.

The algorithm takes into following assumptions:

1. The base station is far away from the sensor nodes.
2. The cluster head selection, cluster formation and transmission of data to the base station via cluster heads.
3. The selection of cluster head depends on the residual energy and certain threshold value, calculated by cluster head instead of calculating it by base station to reduce overhead and energy consumption at base station.
4. The cluster member nodes transmit their sensed data to their cluster head in one-hop transmission and cluster head to base station in multi-hop transmission.
5. The sensor nodes in the network infrastructure are forbid from being involved in the cluster head selection process to increase the stability in the network.

The major steps of the protocol are follows:

1. The algorithm is basically divided into the number of rounds.
2. For the first round the nodes with the highest energy node are selected as cluster head randomly for that particular cluster and data transmission is performed.

3. At the start of the second round the cluster head aggregates the residual energy of the particular members and calculates the threshold at that cluster head.

4. All the cluster heads do the same with their cluster members and effective clustering is performed to reach the base station by selecting optimal cluster head.

5. Every node has calculated the threshold value. If the threshold value of a node is >= threshold value, the node will be candidate for the cluster head of that cluster for the next round.

6. If the cluster head threshold value is below the threshold value of network the cluster head is removed and again the cluster head selection process is performed in that cluster.

7. If the cluster head is below the threshold value in that time the cluster members are send their sensed data to the nearest cluster head. This process is continuous until the new cluster head is selected in that cluster.

8. The optimal cluster head at each round will transmit the information to the base station and do not involve base station to select cluster head at each round and to reduce energy consumption at each round.

IV. SIMULATION SETUP

In this paper, we proposed and implemented MAODV Protocol with adding the LEACH algorithm, by the altering MAODV without LEACH in NS-2.34 simulator. The implemented MAODV Protocol can be evaluated by the number of qualitative metrics such as Packet Delivery Ratio, Overhead, Delay, Throughput and Energy. Finally the simulated results are compared. Table 1 shows the simulation parameters.

Parameter	Value
Routing Protocols	MAODV Protocol
Algorithm	LEACH Algorithm
MAC Layer	802.11
Terrain Size	840*840
Number of nodes	100
Channel Type	Wireless Channel
Antenna Model	Omni Antenna
Radio Propagation Model	Two Ray Ground
Interface Queue Length	50
Interface Queue Type	Drop Tail/Pri Queue
Simulation Time	100 sec
Network Simulation	NS-2.34

Table 1: Simulation Parameters

Performance Metrics: The MAODV Protocol by using LEACH algorithm should address the following performance metrics such as increase the Packet Delivery Ratio and also Throughput, Minimization of Delay and also overhead, decrease the energy consumption of the wireless sensor network.

1) Throughput:

It is the rate of successfully delivered data packets per second in the network between sources to destination.

2) End to End Delay:

It is the time taken by the data packets for the transmission between sources to destination across a wireless sensor network. This duration is caused by buffering, queuing and also the transmission delay at MAC.

3) Packet Delivery Ratio:

It is the ratio between the received packets by the destination to the generated packets by the sources.

4) Overhead:

It is calculated by the ratio of the total number of control packets sent by the sources to the number of data packets delivered to destination successfully.

5) Energy:

It is calculated by the

Final Energy = initial energy – consumed energy.

V. SIMULATION RESULTS

We have done our research analysis in wireless sensor networks by using NS2. Comparative analysis done between MAODV protocol with and without LEACH algorithm.

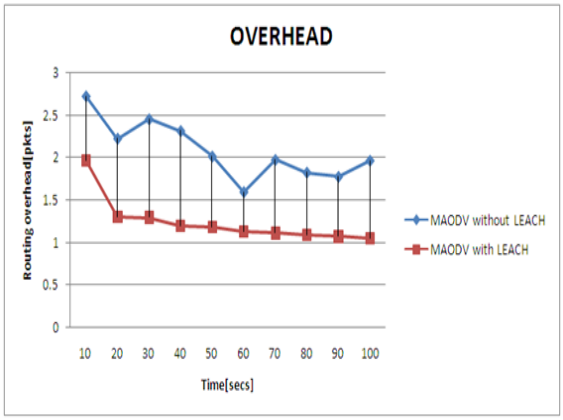

Fig 2: Comparison of Overhead

The Overhead comparison shown in figure 2. Overhead is decreases when compared to the Modified AODV without LEACH algorithm. As the simulation time is increase the Modified AODV with LEACH algorithm is better than the Modified AODV without LEACH algorithm.

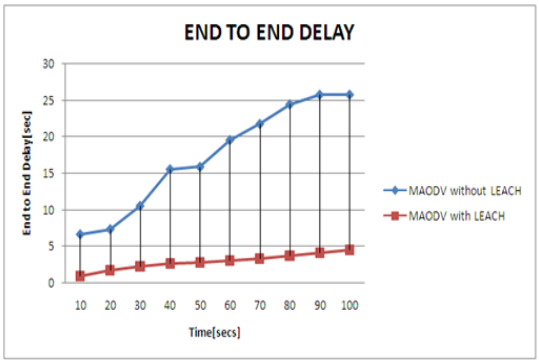

Fig 3: Comparison of Delay

The End to End Delay comparison shown in figure 3. Delay is decreases when compared to the Modified AODV without LEACH algorithm. As the simulation time is increase the Modified AODV with LEACH algorithm is better than the Modified AODV without LEACH algorithm.

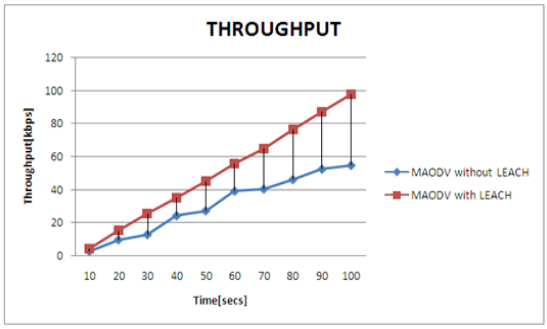

Fig 4: Comparison Throughput

The Throughput comparison shown in figure 4. Throughput is increase when compared to the Modified AODV protocol without LEACH algorithm. As the simulation time is increase the Modified AODV with LEACH algorithm is better than the Modified AODV without LEACH algorithm.

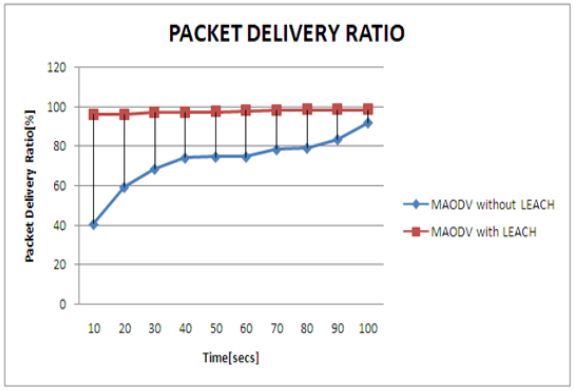

Fig 5: Comparison Packet Delivery Ratio

The End to End Delay comparison shown in figure 5. Delay is decreases when compared to the Modified AODV without LEACH algorithm. As the simulation time is increase the Modified AODV with LEACH algorithm is better than the Modified AODV without LEACH algorithm.

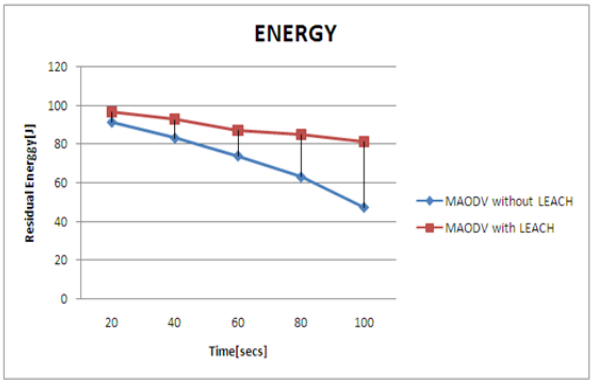

Fig 6: Comparison of Energy Usage

The Energy usage comparison shown in figure 6. Energy usage is decrease when compared to the Modified AODV without LEACH algorithm.

VI. CONCLUSION

In this paper, the MAODV Protocol is implemented by using LEACH algorithm. By using this method the quality of service parameters like Throughput, Packet Delivery Ratio and Energy of wireless sensor networks are improved and parameters like Delay, Overhead of wireless sensor networks. When compared to the existing system the Throughput is around 42% increase, Packet Delivery Ratio is around 5% increase, Delay is around 74% decrease, Overhead is around 98% decrease and Energy consumption is around 47% decreases. The network life time of wireless sensor network is increases based up on Quality of Service parameters.

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