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Improved Quality of Services with Intelligent MAC in Wireless Sensor Networks for Mission Critical Applications

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***Abstract* - Wireless sensor networks are very feasible to monitor where human reach is impossible. But conserving the limited resource and maintaining Quality of service is the challenging task. There is most need to design an algorithm to maintain quality of services. In this paper we have designed node layered division MAC with adaptive listening based on the queue size at the transmitting cluster node. The proposed protocol attenuates the problem of collision and unfair distribution of power among the nodes. When compared with the existing algorithms, IQMAC outperforms in terms of network lifetime, delay, PDR and collision probability.**
Keywords: **WSN, MAC, Duty Cycling, Clustering**

I. INTRODUCTION

Wireless sensor networks (WSN) have been considered as keen role player in solving many real time applications where human reach is impossible. Hence WSN has gained tremendous interest for researcher to solve the problem of resource constraints [1]. These networks are composed of nodes called motes which transmit and receives sensed data to accomplish a mission.

The mote is powered by batter which is limited. subsequently, each mote is constrained with limited energy. hence energy efficiency and maintaining Qos are critical issues in WSN.

Establishing best Qos and Energy efficiency are key aims in designing intelligent MAC (IMAC). The major concern for energy loss is because of the factors like idle listening, collision, overhead control packets, overhearing [2]. MAC protocols are divided into contention based and reservation based. Contention based are based on carrier sense multiple access (CSMA) and reservation based are based on time division multiple access (TDMA). As major issue many routing protocols consider standard IEEE 802.15.4 which is adaptation to dynamic traffic load. The proposed protocol is implemented by considering initial power and adaptive listening based on traffic load [3].

II. LITERATURE SURVEY

The prior importance in designing protocol for WSN is to maintain Quality of service and energy efficiency. MAC protocols aim is to regulate the wireless medium so that communication requirements are fulfilled. these illustrates what procedures are to be followed during communication. Mitigating with energy available in the node is important in designing MAC with routing protocol [4]. Mostly idle listening leads to wastage of power, this may occur due to awaked nodes even though non transmitting data is available. Therefore, reducing the idle time and reducing collisions are the key designs of any MAC protocols be efficient for mission critical applications.

The S-MAC [5] protocol is referred as key design for MAC protocols. It is the modified standard 802.11 protocol which is contention based technique deals with reducing ideal listening of nodes. The Duty Cycle (DC) is defined as ratio of frame and active period. The ML-MAC [6] id competition distributed based protocol that transmits with any centrally locted node. It is considered as modified S-MAC. The layered division is discussed in [2] which utilizes the power of node but the duty cycling is unfair which may lead to early death of nodes. The new MAC is designed ADMC [7] where the adaptive duty cycling is used by assigning the duty of transmitting data to the nodes. But when collision occurs bottleneck is created at intermediate node forming low PDR. The traditional 802.15.4 MAC is considered in our previous work [8] and [9] which created low performance of Qos in the network.

This paper concentrated on designing a protocol which provides high energy efficiency and best quality of service be assigning the duty based on available power and avoiding the collisions by rotating the cluster head role based on the queue length.

III. METHODOLOGY

Initially the network is deployed with nodes where human reach is impossible. Each node start communicating with each other to form clusters. when cluster node is formed every cluster members start joining the group and transmit data to cluster head. after every iteration based on the power and other metrics cluster heads changes. Every nodes are divided into layers based on power factor by node power layer division algorithm as shown in figure 1.

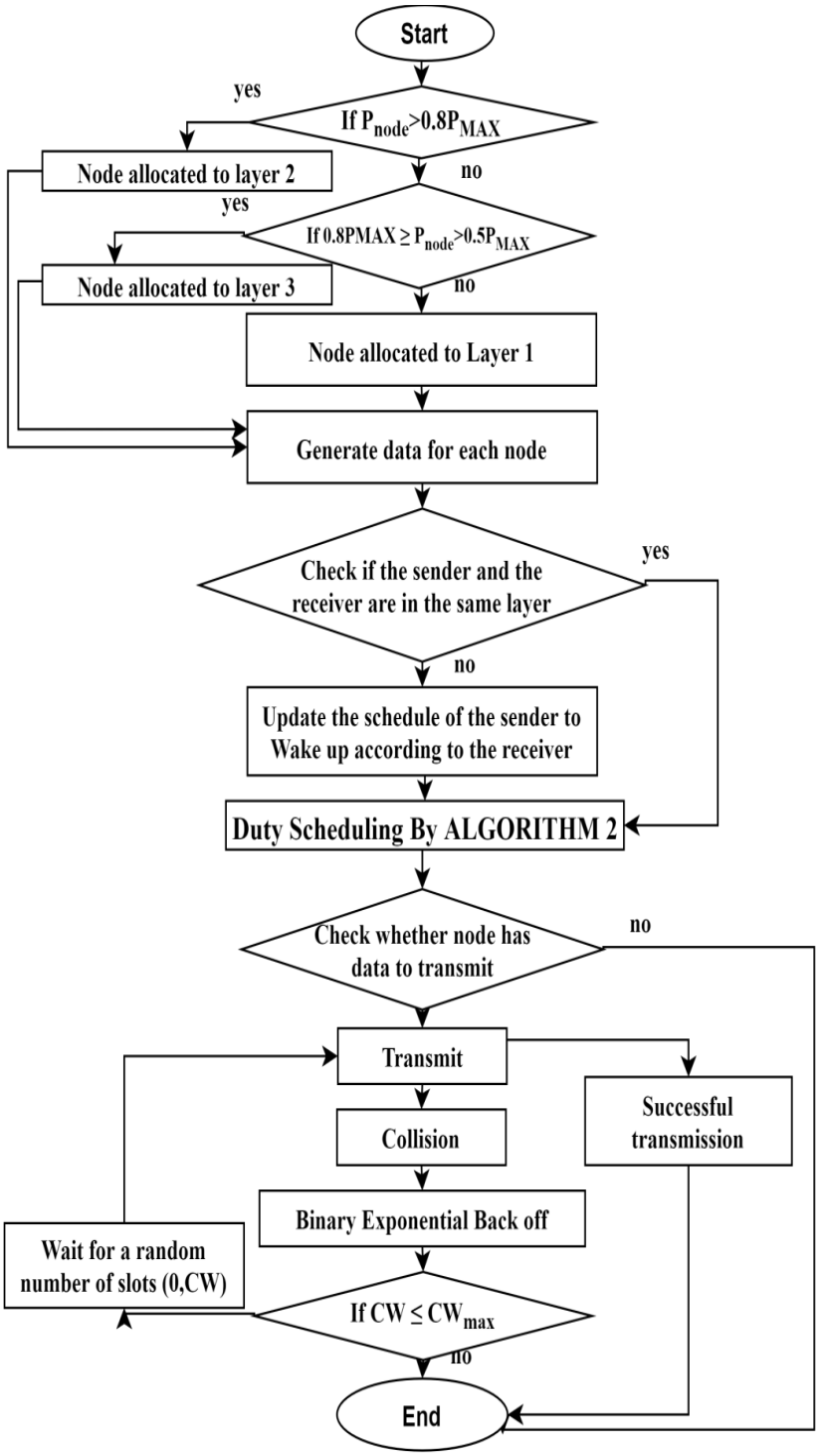

Fig. 1 Node Power Layer Division Algorithm

Step 1: Start with network initialization. Each node is divided into layers based on power. High power nodes are assumed to be in layer 1, Medium power Nodes are to be in layer 2, Low power nodes are to be in layer 3.

Step 2: Each nodes are assigned certain duration on duty based on Algorithm 2. Idle nodes are sent to sleep to save energy.

Step 3: If collision occurs at the certain node Backoff Exponential is used and random slots are accessed and intermediate node transmitting data is changed.

Step 4: If successful transmission and no collision occurs the duty cycling is followed sequentially according to algorithm 2.

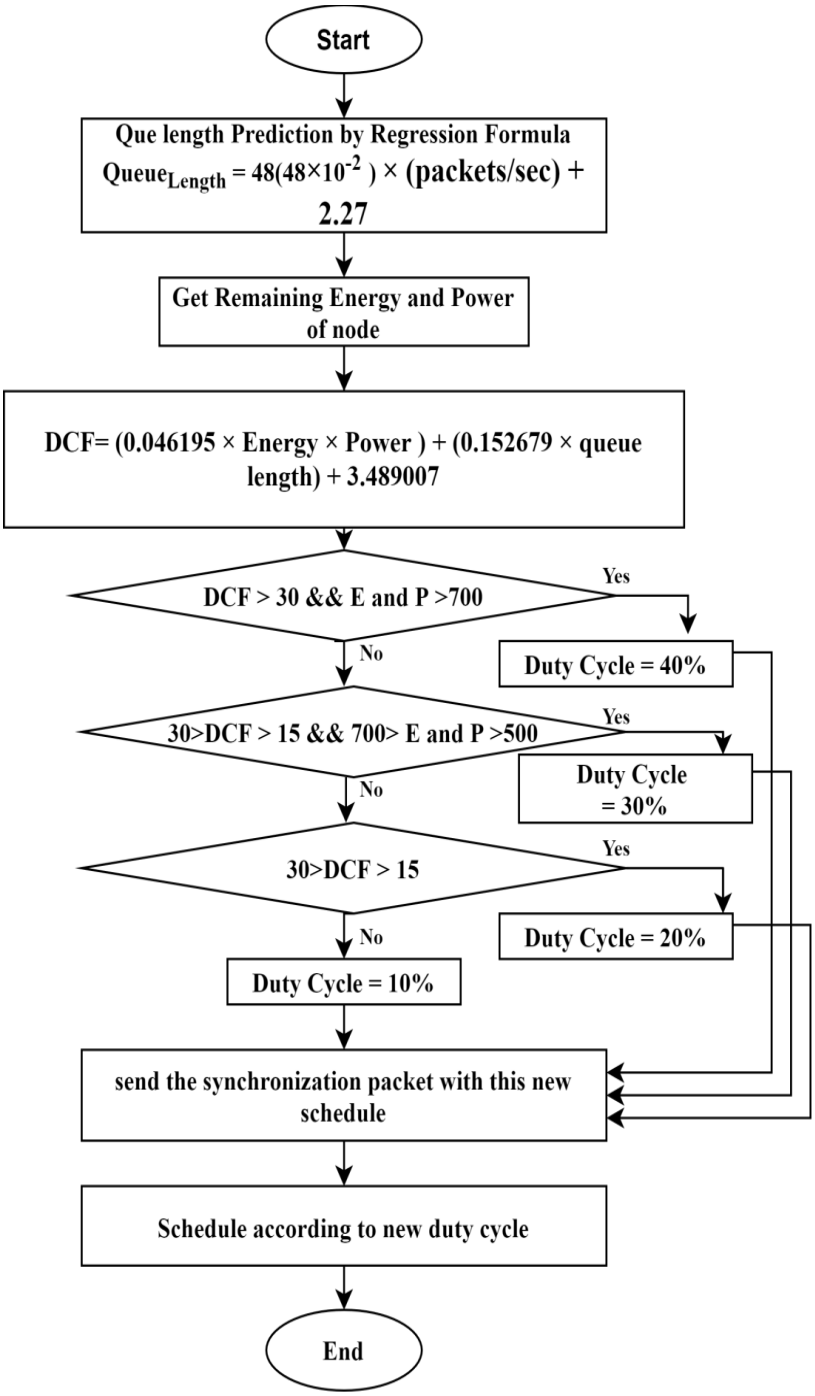

Fig. 2 Adaptive Listening Algorithm

Step 1: After nodes are assumed to be divided into layers the queue length at the node is predicted based on the regression formula [10]. Based on this queue length at the node probability of collisions occurring is decided.

Step 2: The Duty Cycling Factor (DCF) is decided based on the power available in the node and queue length at the node. if lower the queue length and more power high duty is assigned to the intermediate node.

Step 3: If DCF is high and power left out in node is high, higher the duty assigned to node for acting as cluster head.

Step 4: If DCF is moderate and power is moderate, duty assigned is moderate. if DCF and power is low, lower the duty assigned.

IV. PERFORMANCE ANALYSIS

The designed protocol is simulated in network simulator NS2. the aim of simulation is to analyze the performance and prove effectiveness of proposed protocol when compared with existing protocol. The performance parameters utilized are mentioned in table.

TABLE I PERFORMANCE PARAMETERS

Parameters	Values
MAC LAYER	IQMAC
Network Layer	PSO
Simulator	NS-2 version 2.35
Simulation	200s
Network Type	Mobility Based 100 Nodes
Energy Model	100J

100 nodes are considered for the simulation in area of 100*100 m^2. The routing protocol PSO is used as same described in [9]. The proposed algorithm is compared with existing algorithms ESNA[8], QALPA [9].

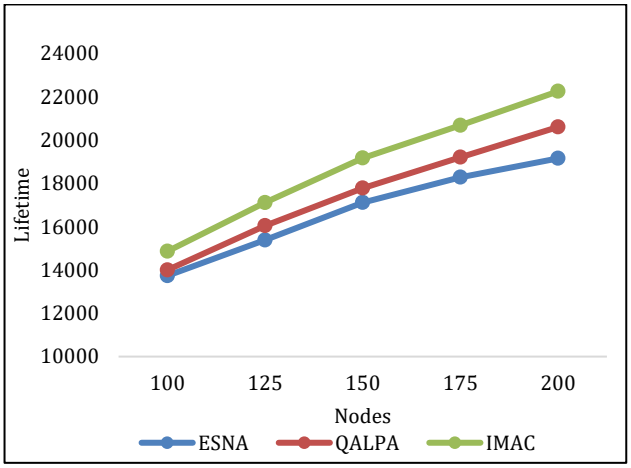

Fig. 3 Lifetime v/s Nodes

Proposed IMAC outperforms existing algorithms QALPA and ESNA in terms of lifetime as shown in figure 3. Lifetime is the amount of power left in the nodes. Since there is fair distribution of power among the nodes in proposed algorithm due to adaptive duty cycling the network has more energy efficiency when compared with existing algorithms.

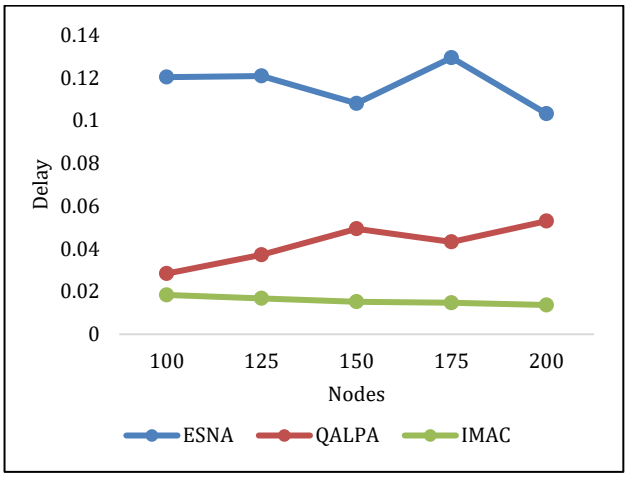

Fig. 4 Delay v/s Nodes

In figure 4 it can be seen that proposed algorithm IMAC outperforms existing algorithms in terms of delay due to consideration of the collision factor in transmissions. Due to less collisions the delay is minimized in proposed algorithm.

For each Qos metrics the delivery ratio of packets varies. It can be observed in figure 5 that proposed IMAC protocol has better PDR when compared with existing algorithms ESNA and QALPA due to the fact that here in IMAC the contention window is changed, and duty cycling is imposed when collision occurs based on the queue length at the node.

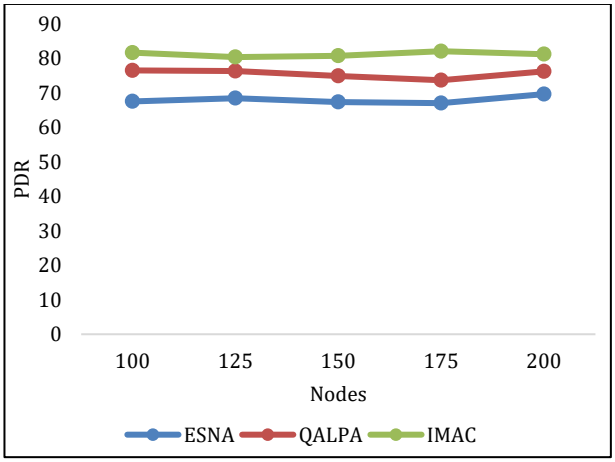

Fig. 5 PDR v/s Nodes

Proposed protocol outperforms the existing algorithm ADMC in terms of collision probability as shown in figure 6. Due to consideration of the overhead queue for selection of duty cycling of each nodes which leads to minimization of collisions in IMAC.

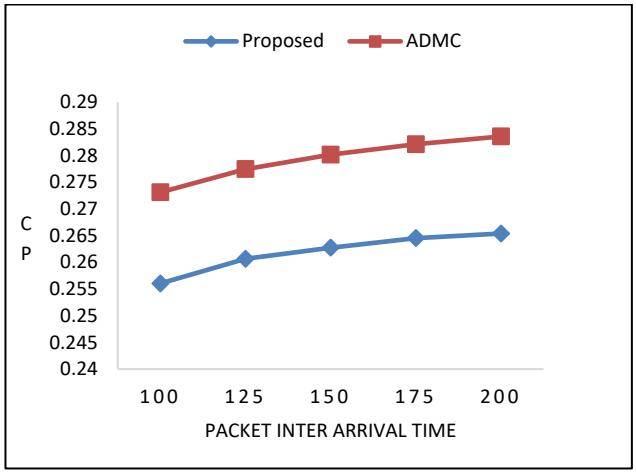

Fig. 6 CP V/S Packet Inter Arrival Time

V. CONCLUSION

Energy Efficiency and improvising best Qos are the main challenges that are mitigated in the proposed protocol IMAC. many existing protocols have been proposed by many researchers, but they are imposed of unfair distribution of

power among the nodes which leads to death of nodes in limited time. this paper proposes the new protocol based on available initial power in the nodes. based on the available power of the nodes the duty is allocated by adaptive listening algorithm. Qos matrices are also considered so that proposed protocol provides best collision free performance. The simulation results prove that proposed protocol outperforms existing algorithms GAECH, ESNA, QALPA, ADMC in terms of delay, lifetime, PDR, Collison probability.

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