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Wireless Sensor Network: MAC Survey

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Abstract: ***WSN is widely used in monitoring, tracking and military applications. It has limited resources like battery capacity, bandwidth and processing unit. In WSN consists of is a nodes and the base station for network formation and node having the processing unit, communication unit and the power unit. Generally the node transmits data to sink which has ample resources. In addition WSN consume more energy for transmission rather than processing and that motivate researchers to work for the tradeoff between lifetime of the network, throughput and latency. Data communication is related with the network and MAC layer. MAC is responsible for radio accessing, node wake up and sleep schedule, Listening and sensing task. In addition with ideal sensing and listening consume more energy than data communication and improper wake-up and sleep schedule decrease throughput and increase latency. The aim of this paper is to analyze various MAC protocol and provide a design concept with QoS parameters.***

Keywords: WSN, Energy, MAC, Latency, Reliable, Throughput

I. INTRODUCTION

1.1 Introduction to Wireless Sensor Network:

WSN is consists of Micro electro-mechanical devices called nodes/ Sensors which are deployed to sense some information/data and communicate those information over the network Sensor devices which have the ability to sense, process and communicate the data [1]. Sensors have limited computing power and they are design to operate on a battery [2]. In WSN there are some limitations like Limited in computation, Low memory, Low power resources, slow communication speed, latency and throughput. The basic goal of wireless sensor network is to collect the information from various nodes at regular interval. After collecting the information or data it will translate the data into electrical signal and send them to base node or sink. Various applications of wireless sensor networks like Global scale, Factories, Buildings, Homes, Health, Battle Field.

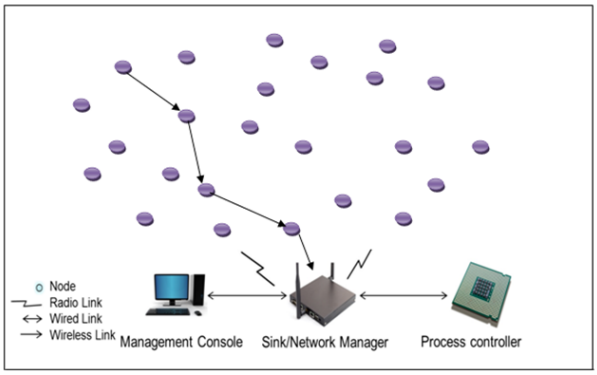

Figure 1: WSN Scenario

1.2 Introduction to Medium Access Control:

In WSN the Goal of In WSN Medium access control is responsible for data communication channel accessing polices buffer management etc. In last decade of WSN researchers have developed many MAC protocol based on its primary goal like Energy efficiency, Latency, Throughput, delay, collision, reliability etc.MAC protocols are categorized according to their characteristics. Like Fixed Assignment Protocols, Demand Assignment Protocols, Random Access Protocols, and Hybrid Protocols. The Basic limitation of MAC is limited Power for WSN

II. SURVEY OF WSN MAC PROTOCOLS

S-MAC: Design to reduce wastage of energy. It also achieves good scalability and collision avoidance by utilizing a combined scheduling and contention scheme [66].S-MAC support periodic sleep schedule that cause high latency. S-MAC uses messaging passing mechanism that divide a massage into multiple frames. And frames are sent in burst. SMAC also uses periodic schedule exchange that reduces collision.

WISE MAC: WISE MAC is a hybrid protocol that uses TDMA for data packets and CSMA for control packets as a communication channel. A. El-Hoiydi gives his contribution to WSN. Spatial TDMA and CSMA with preamble sampling

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for low energy ad hoc WSN that is WISE MAC. WISE MAC uses non persistent CSMA with preamble sampling to reduce idle listening to the channel.

Z-MAC: Zebra MAC: It is developed to moderate the shortcomings of CSMA and TDMA based Protocol. For data communication it use first Set up of the nodes and then transmission is performed. In set up mode time slot is given to each node. The active node which has an assigned time slot is identified as owner and other nodes are non-owners. Z-MAC uses DRAND [71] to assign time slots to nodes. DRAND is running in setup phase and look after that within a two-hop neighbor node should not be assigned a same time slot. The node can transmit in any time slot but before transmitting, the node sense the channel if the channel is clear it transmit a data but the owner node has higher priority. It uses TDMA as schedule based scheme for contention resolution and CSMA as a baseline protocol.

EQ-MAC: Energy efficient and Quality of service aware MAC, EQMAC is TDMA and CSMA based Hybrid concept. It differentiates between long and short message. It also uses the priority mechanism for higher prioritized data. It uses schedule and non schedule scheme for data transmission for greater performance. It is derived from CMAC and CAMAC.EQMAC is high energy efficient in heavy traffic load also. Latency is also decrease when priority mechanism is used.

D-MAC: it achieves good latency compared to other latency aware protocols. It compasses the slotted ALOHA protocol for assigning a slot for data transmission to a group of nodes in a data gathering tree. High collision occurs when several nodes transmit in a same time slot to a particular node. It's a good member for latency aware situation but poor for collision based environment.

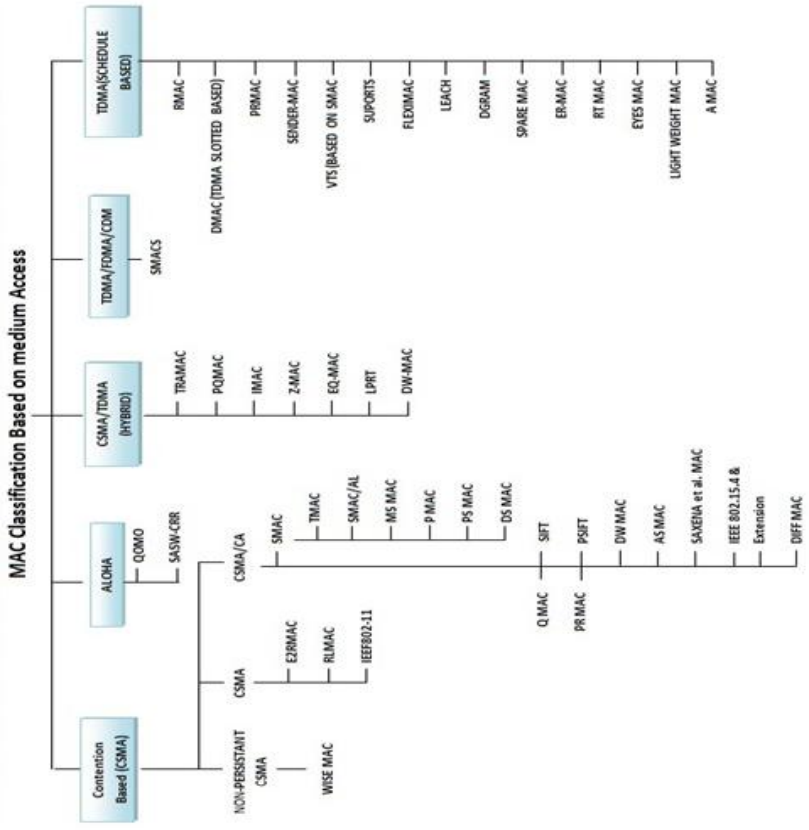
T-MAC: Timeout MAC is developed to enhance the drawback of SMAC protocol when the traffic is variable. It is uses a Dynamic Timeout mechanism. It adjust the active time according to traffic in a channel. TMAC saves more energy than SMAC.

Table 1: Comparison of Energy Efficient MAC Protocols

Protocol Name	Type	Synchronization(Time)	Energy	Latency	Delay	Collision
SMAC	CSMA	No	Low	Low	Low	Low
WISE MAC	np-CSMA/ TDMA	No	Low	High	High	High
ZMAC	CSMA/ TDMA	Yes	Low	Low	Medium	Low
DMAC	TDMA/ Slotted ALOHA	Yes	Low	Low (Small to Medium Data)	Low	High
TMAC	CSMA	No	Low	High	Low	Medium
EQMAC	CSMA/ TDMA	Low	Low	Low	Low	Medium

III. GENERAL CLASSIFICATION OF MAC SURVEY

MAC can be classified by various properties like synchronous, Asynchronous , Contention based ,contention free, time based and etc. by considering its various properties the general classification of MAC protocol are as below:



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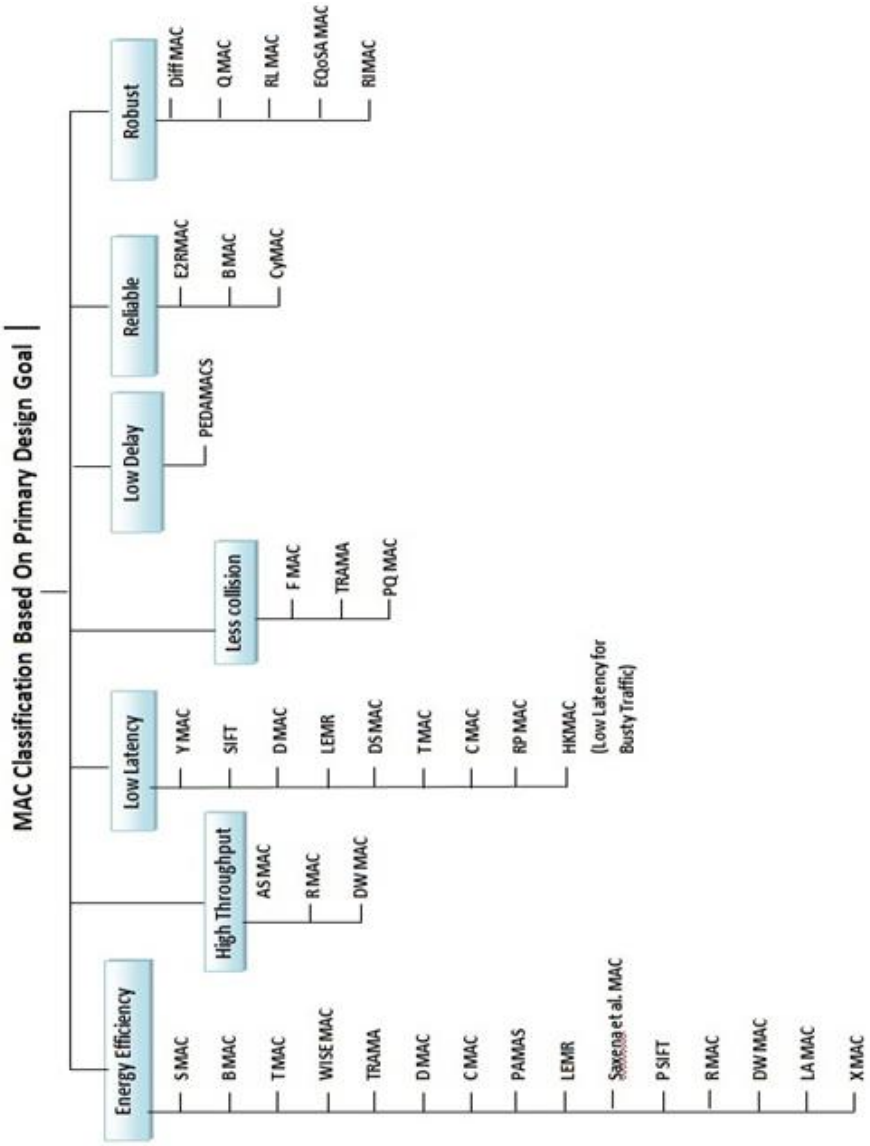
IV. CLASSIFICATION OF MAC BASED ON PRIMARY DESIGN: SURVEY



V. MAC PERFORMANCE MATRICES

Based on survey various performance matrices of MAC are:

Minimizing Medium access delay: Minimizing the medium access delay of the sensor device ensure that to meet the end-to-end delay requirement, the packet latency should be optimized.

Minimizing collision: MAC is responsible for sharing of a medium, it is responsible for minimizing the number of collision. To reduce the collision the communication medium should be share efficiently among all the nodes.

Maximizing Reliability: To ensure the reliability control packets and acknowledgement mechanism is used.

Minimizing energy consumption: To minimize energy at MAC, the collision and retransmission should be reduce. Node sleep and wakeup schedule as well as the duty cycle should be tune.

Minimizing interference and maximizing concurrency: By tuning the parameters like contention windowing, operating channel, transmission power, and synchronization we can optimize the interference and increase the concurrency at MAC.

Maximizing adaptively to change: MAC protocols can have adaptively to change in dynamic network.

VI. QUALITY OF SERVICE PARAMETERS OF MAC

Reliability: Reliability in networks is delivery of data to intended recipient in effective time period with notification.

Latency: The detected events must be reported to sink node in real time so that the appropriate actions could be taken immediately.

Throughput: The average numbers of packets delivered to sink node in unit time.

Fairness: The medium should be fair enough to all the nodes in a network when the bandwidth limited or appropriate.

Energy Efficiency: Usually sensor nodes are kept in unfriendly environment and it is hard to change or charge the battery of node the MAC should be power efficient.

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VII. MAJOR SOURCE OF ENERGY WASTAGE

Idle listening: The node is listening to receive the possible traffic which is not sent. The node awakes for idle listening and waste the energy of the node.
Collision: Collision means the transmitted packet is corrupted due to interference and need to retransmit that packet. The collide packet has to be discarded and retransmission increase energy consumption.
Overhearing: The sensing node receives the packet which is not intended for them. That is destine for other neighbor node and which cause the energy waste.
Control Packet Overhead: Control packets means packets of information to other node like acknowledgement packets, information packets etc. Which are less useful too, which leads the node to low energy level.
Overemmiting: When the source node transmits the message and the destination node is not ready to accept it and retransmission take place affect the energy.

VIII. IMPORTANT PARAMETERS AND DESIGN CONSIDERATION FOR MAC DEVELOPMENT

Consider the various Design Parameters : Energy consumption in transmission mode, Energy consumption in receive mode, Energy consumption in idle mode, Energy consumption in transmission mode, Active Time of Node, Sleep Time of Node, Numbers of node in a network, Network traffic type, Schedule of a nodes and neighbor node, Maintain various tables, Duty cycle.
Test the MAC Protocols according to its design consideration and Develop a TCL scripts for : Node listening and back-off mechanism: when the node needs to transmit they introduce random delay followed by a constant listening period. If the channel is busy then they enter into back-off period, during which the radio is turned off, if the channel is free then they transmit. Rate control: MAC protocol should control the rate of the initiating data of a node in order to allow route-through traffic to access the channel and reach the base station. The rate control proposed uses loss as collision signal to adjust transmission rate in a manner similar to the congestion control in Transmission control protocol. Controlling the control packets (RTS, CTS): in this scheme the minimum number of control packets are used when it is necessary. If traffic load is low then the combination of request-to-send (RTS) and clear-to-send (CTS) control packets can be used. Using controlling the control packet and node listening with back-off mechanism we can achieve the high throughput with respect to energy efficiency. And by concept of rate control we can achieve the reliable data transmission over media or medium.

IX. CONCLUSION

Design and implementation of MAC protocol with minimal cost and compactness to achieve quality of service parameters like delay, Reliability and low-latency and enhanced network life.

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