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A Survey On Scheduled Based And Contention Based Mac Protocols And Its Essentials

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ABSTRACT
Wireless Sensor Network (WSN) is most used in the field of tracking objects, industrial automation, patient monitoring, structural monitoring, environmental monitoring and military applications. Wireless Sensor Network is always a blooming field which made the researchers to specifically concentrate on sensors energy as sensors comprised of battery powered. WSNs communicate among the neighbouring nodes, collect all those nodes information and gather them at the centralized trusted node. Medium access control protocols serves as the best measures for the energy minimization. MAC protocol provides a shared medium to the nodes in the cluster for accessing the bandwidth at the allocated clock slots. MAC provides addressing for data communication among the nodes. This paper discusses the different MAC protocols with all its energy saving mechanisms. Finally the advantages and disadvantages of all MAC protocols were discussed.

Keywords – Wireless Sensor Networks, Medium Access Control, Latency, Energy Efficiency, Throughput.

1. INTRODUCTION

Wireless Sensor Network is comprised of many nodes which co-ordinatively collects the information and pass their information to the sink node. WSN senses different parameters such as temperature, humidity, pressure, sound, motion, etc. Wireless sensor network is usually battery powered and it is very hard to replace the battery every time. So the main disadvantage is the sensors battery power. To overcome these criteria, the sensors energy has to be effectively utilized and this is made possible by using the MAC protocols. The main goal is to prolong the networks lifetime using different MAC protocols and to effectively utilize the sensors energy. The survey concentrates on the energy, throughput, latency and the advantages and disadvantages of the MAC protocol.

Sometimes the contention occurs between sensors when two or more sensor tries to access the communication channel. Due to contention the delivery of the packets may get affected which may sometime lead to packet loss in the network. This causes major destruction in the lifetime of the sensors. In order to avoid such contention problems, a clear MAC protocols has to be designed to meet all the needs for satisfying the required criteria.

There are some other possibilities also where the sensors lifetime gets disturbed. They are discussed as follows.

1) Packets Collision – Due to the collision the energy of the sensors gets drained. Collision usually occurs when more sensors under the same transmission range transmit their packets at same time. At the time of retransmission of the lost packets, the energy is highly consumed.
2) Idle Listening – During idle listening, the sensors simply listens to channel by turning its transceivers as active. But here no packets transmission occurs and this may lead to loss in the sensors energy.
3) Over hearing – Sensor energy gets wasted by simply listens to some other sensor transmission medium and collecting unwanted information. Overhearing causes high energy loss due to the unwanted sensing of the channel.
4) Packet Overhead – Transmission of control packets before the start of actual message transmission causes more overheads. Usually by sending RTS/CTS more sensors energy is wasted.

Medium Access Control protocols have the role of controlling the sensor as when the channel needs to be communicated among nodes. It provides allocation of slots for communication when contending for the medium. Here we classify MAC as two types.

Scheduled based MAC protocol – This protocol provides different sub channels or slot interval to the nodes for communication. TDMA, FDMA and CDMA are the examples of the scheduled based MAC. It is similar to the reservation based MAC.

Contention based MAC Protocol – This protocol provides access to the radio of nodes in the case of channel contending. Here every node competes for the channel in the probabilistic manner. Each node fights for the channel. CSMA and ALOHA MAC protocols are the best examples of this approach.

2. TYPES OF MAC PROTOCOLS

I. SMAC (Sensor MAC)

Sensor MAC follows periodic listening concept, it puts node in fixed active and sleep state. SMAC splits the active period in to two sub states. One is for SYNC packet and other for data exchange. It turns ON its radio during the active period and turns OFF its radio during sleep period. SMAC follows its own schedule. When deployed first, it checks for any existing schedules in the network by turning its radio ON. SMAC divides the time in to frames and consists of listening and sleeping period. Once a node receives a SYNC packet it follows the schedule of it. If a node doesn't receive, it sticks to its own schedule.

Node then floods the SYNC packets to the neighbouring nodes. Neighbour nodes then adopt the schedule once it receives the SYNC packets. So a network contain many schedules with receiving different SYNC packets forms a virtual cluster. When a node receives different SYNC messages it has to react accordingly so it forms the border node. When collision occurs it sees for RTS/CTS mechanism for channel reservation also uses NAV (Network Allocation Vector). SMAC node does not transfer long messages because once messages lost due to collision the entire message has to be sent again even once when a small part of the message is lost. Before every small transmission it uses RTS/CTS exchange and reserving the channel for the whole burst duration and saves the energy.

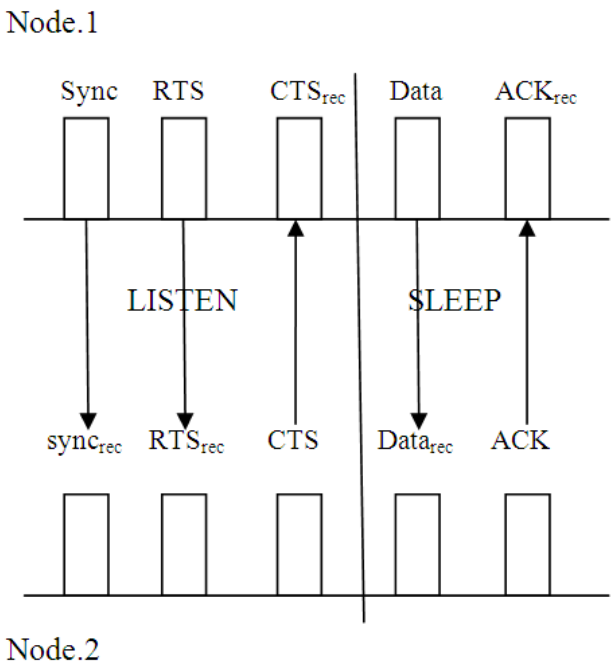

Figure 1: S-MAC scheme, where node.1 as sender and node.2 as receiver

II. OPTIMIZED MAC Protocol

Based on the traffic in network the duty cycling of a sensor is changed. In optimized MAC packet size is limited and also the overhead of the packets are minimized by reducing the control signals. Instead sending the SYNC and RTS separately optimized MAC combines as SYNC and RTS as $SYNC_{RTS}$ control messages and so the energy and latency is reduced. Optimized MAC supports unicast, multicast and broadcast. Based on the number of messages in the queue the sensor the traffic load is validated. Once when the sensor receives a message it queue size increases, then it checks for the threshold value if message counter is more than $COUNT_{thres}$, if so then duty cycle is increased and these information are passed to neighbouring nodes with $SYNC_{RTS}$.

The neighbouring node checks their message counter. If queue size is less than the $COUNT_{thres}$ then duty cycle is reduced and just the synchronization tables are updated. It is not necessary in optimized MAC protocol that all nodes should follow the same schedule. In optimized MAC protocol the $SYNC_{RTS}$ contains an additional duty cycle but the storage overheads can be negligible with attaining more energy saving with less delay.

III. E-BMA Protocol

Energy efficient Bit Map Assisted protocol uses piggybacking method. Piggybacking a control messages is attached in the data packet requires a one bit extra space. By this technique node reserves the medium for corresponding Data slots instead sending a control message at its contention slot. This protocol includes two phases, steady phase and the setup phase. In E-BMA the source nodes transceiver is turned off instead being idle listening to nodes when it has no control message to send during the contention phase. This achieves energy saving both at high and low traffic. But here every node has to wait one additional frame time duration. So to achieve energy efficiency latency is compromised. As mentioned earlier during the setup phase the cluster head selection is performed. The steady phase is classified in to contention phase and data transmission phase. In the setup phase the cluster head informs all the nodes about its start and stop of frame, rounds and number of rounds. In the contention phase nodes transmits 1-bit message to reserve its data slots to transmit the data. If it has no data to transmit it remain in sleep mode. Once after the contention slot the source node receives a transmission schedule message from CH. Source node immediately does not make use of the reservation but it waits to see whether any consecutive transfer has to be done and so it keeps the data in the buffer. During the data transmission phase data transmitted to the cluster head in their allocated time slot at most once per time frame. If consecutive packets are sent, then through piggybacking method the information are conveyed. Finally data aggregation is done in the CH to pass their data to the base station this reduces energy rather than aggregating the data in the base station.

IV. HYBRID MAC Protocol

Hybrid MAC is a schedule based approach. This combines the TDMA scheduling and the contention based approach for energy efficiency. TDMA scheduling is allocating time slots to the nodes and it requires a centralized node for broadcasting the schedule to the neighbours which includes delay in processing. Whereas the contention based approach is a distributed approach but here every node has to listen for

schedules from neighbours, so HMAC is a fusion of both TDMA and contention based.

Clusters are identified based on geographical location. Dartboard and Checker board are two types of scheduling followed in HMAC. Checker board divides the time slots in to black and white blocks. Sensors are scattered in the black and white region. Based on the sensors present in the region the scheduling is designed. So every sensor in the black and white box has different sleep and wakeup period. Dartboard divides the time window in to 4-slots as with four different colour bock. Every node can identify their neighbour's wakeup schedule based on the signal strength and scanning angle. Sensor nodes wake up at its assigned time slots and sleeps at other time timeslots (TDMA). Once when a node has to make a transmission, it has to synchronize with the neighbour's wakeup schedule. Moreover HMAC reduces overhearing and overheads. Using these two approaches the collision can be avoided as each node follows different time wakeup schedules. Checkerboard and Dartboard reduces the number of nodes contending for the media at the same time due to different wakeup schedules. Here contenting for the medium is avoided and idle listening is reduced. Sensors energy and latency is increased.

V. INTELLIGENT HYBRID MAC Protocol

IHMAC slots the data packets according to their importance and stored in the queue with application layer sets the priority. Here one additional bit is added to the end of every data packet. The communication time is divided in to fixed time slots or frames. Every slot begins with SYNC period which is for synchronization between nodes for communication. Next is the contention period which is for reserving the data slots with RTS/CTS. Followed by contention period is the data and acknowledgment period. The SYNC packets contain the next wake up time frame. When a schedule is present in a node but once when receives different SYNC from other nodes it then adopts both the schedules. As in the E-BMA protocol every node does not need to follow the same schedule. IH MAC achieves high channel utilization during the high traffic loads. Hybrid approach is combination of broadcast scheduling and link scheduling. It follows the CSMA/CA approach. By limiting the transmission power the overhearing can be avoided and so the energy can be minimized. RTS is flooded to the next hop neighbours to check for contention. If its neighbours once send the RTS again to the source node then CTS is sent from source node. So the data communication is done. The extra bit contains the information of the frame slots and its priority. Based on the priority the nodes with less priority can sleep for more time and saves energy. Less channel utilization with less traffic loads. Once when a node wins the contention it is kept ready for transmission and reception. Idle listening wastes energy but this is conserved by setting the priority. So with high priority the node starts sending packets but with less priority it sleeps for more time and idle listening is avoided and energy saving is achieved.

VI. RMAC protocol

Randomized MAC focuses on TDMA protocol. It is an on-demand slot assignment TDMA algorithm. The concept of RMAC includes three phase

- Reserving minislots
- Announcing id and time slots of nodes
- Transmitting packets in their slots

RMAC considers the entire sensor node as the one hop neighbours to the sink. All the sensor nodes have a unique id with the pseudorandom generator. As it is based on TDMA concept Time synchronization is established between nodes. The sink node assigns the minislots to the sensor nodes in the network. It includes three periods 1.Contention period 2.Acknowledgement period 3.Data communication period. The first period is for reserving the medium by sending the RTS/CTS control signals. The second period is the acknowledgment of channel reservation from the sink. The final period is for making the transmission of data over the sensor node. Protocols allow the nodes to sleep between periods to conserve the battery power. Every node is given with different time slots and accordingly the sleep and wake up schedule is followed. It is an adaptive sleep/wakeup schedule. Main objective of RMAC is to find the optimal number of minislots which is to be used during the first period contention. If there is a large contention period then the collision will be less but the latency will be more. With less contention period the collision will be high. RMAC estimates competing nodes based on the collided minislots, empty minislots and successful minislots. This estimation is for predicting the minislots for the next rounds. Each message fits in a single packet. Sensor node sends their packets in their allocated slots. Henceforth the collision is avoided with reducing the packet overhead. Idle listening time is avoided. So here in RMAC, the energy is achieved with less latency.

VII. MRMAC protocol

Medium reservation MAC protocol introduces the concepts of reserving the medium in advance by attaching the next packet arrival time and the medium reservation information in every packet. This is the concept of piggybacking. It carries NPAT and MRI information to the receiver and once when it receives, the intended receiver reserves the medium. Suppose if more than one node transmit the packets then occurs the collision. For resolving this, proposed NPAT and MRI concept was introduced. By this concept every sensor node wakes up at their periodic time slots i.e. at their reservation period. It follows periodic wakeup or sleep schedule. This reduces traffic and also the collision and saves the sensors energy with high throughput.

VIII. SCHEDULE UNIFYING ALGORITHM

It contains virtual clusters with synchronizer id. Any two clusters can be communicated with the help of border nodes because the border nodes lie between two clusters. Each cluster will have a schedule and so the border nodes will have multiple schedules. Considering the highest synchronizer id in the schedule table the schedule is chosen. The algorithm

designates it as the target schedule and it is executed. The target's neighbouring node follows a schedule other than the target schedule. When the current border node follows a target schedule then this neighbouring node will become a border node. All the target neighbours will receive scheduled unifying packet by the border node. The packet will be transmitted by unicasting method. Positive or negative acknowledgement will be sent to ensure whether the packet is delivered or not. The process of shifting the target schedule to the border node repeats until all the schedules get completed.

IX. WiseMAC

WiseMAC resembles the technique of spatial TDMA and CSMA with preamble sampling protocols, also has two communication channels. Accessing of data channel is done by TDMA approach and control is through CSMA approach. But WiseMAC need only a single channel for communication. In order to decrease the idle listening time WiseMAC follows non-persistent CSMA approach with preamble sampling. Initially the sampling period and the preamble is kept equal. As this is of contention based MAC protocol there is no proper time synchronisation and handshake is done which results in interference and over emitting of energy. WiseMAC protocol is designed in such it is adaptive to change in traffic load, which means with low traffic only load low power consumed and with high traffic, high power is consumed. With every data transfer an acknowledgement message is sent that contains next sleep schedule of the neighbouring nodes. Every node in the network maintains a sleep schedule table of its neighbours. Transmissions are initiated based on the neighbours sleep schedule table and so that receivers sampling time will corresponds to transmitter's preamble. A random wakeup

Scheduling is followed in order to reduce collision during the start time of wakeup preamble.

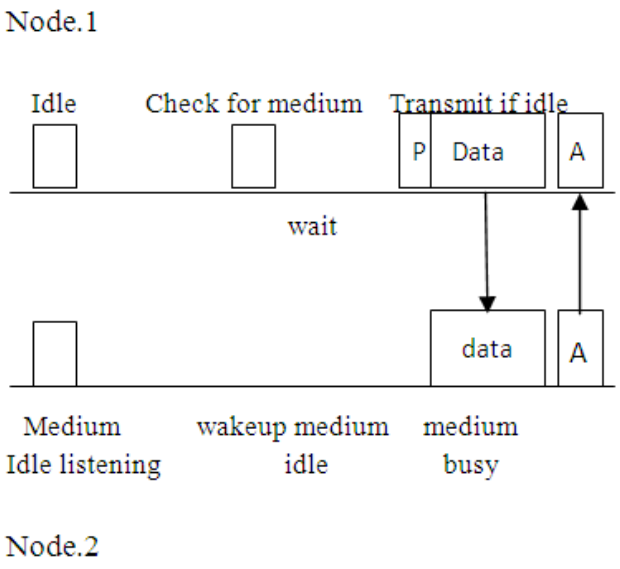

Figure.2: WiseMAC scheme, node.1 transmit to node.2

P - Preamble, A - Acknowledgement

The protocol is designed in such that the preambles length can be adjusted and adapted dynamically with change in traffic load.

X. T-MAC

Timeout MAC is an adaptive duty cycling approach. This protocol is an enhancement of S-MAC protocol includes the active period and the sleep period. As because an adaptive duty cycling approach the protocol based on the activation decides its own duty cycle schedule. The activation period includes data packet sending, setting of periodic duty timer, data receiving. Sensor nodes reach the sleep period once when no active event occurs during the idle listening time of the frame and the active period is pre-empted. The interval between the idle listening times per frame is given by the equation

$T_a > T_{ci} + T_{RTS} + T_{ta} + T_{CTS}$, Where time of idle listening per frame is greater than addition of contention interval time, time of request to send packet, turnaround time, time of clear to send packets. Timeout-MAC responds with more energy efficiency than S-MAC under low data rate applications. But the latency is higher as compared to S-MAC. The asynchronous approach performs better than the periodic synchronous approach as it consumes a lot of energy.

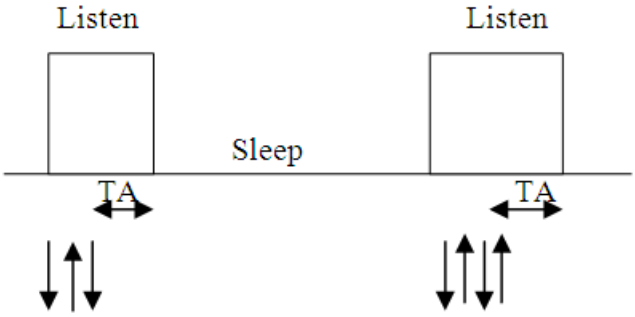

Figure 3: T-MAC Scheme, arrows represents the transmission and reception

XI. PAMAS (Power Aware Multi-Access Signalling)

PAMAS is one of the contention based protocol. It adopts a random wakeup scheduling. This protocol requires two radios as every sensor node uses two separate channels for control and data packets. Nodes keep its radio OFF when neighbouring node is communicating with other sensor node. Anode when found two different node communicating it simply wakes up perform a binary probe. This determines the remaining transfer of the neighbours. Based on the probe response the node calculates it's time to go back to sleep. A separate channel is used for control packets that are distinguished from data channel. Here the nodes performs its transmission on both control and data channel simultaneously. In this protocol more power is consumed as different frequencies are utilized regularly at every sensor nodes.

XII. B-MAC (Berkeley Medium Access Control)

B-MAC is a contention based protocol and it adopts the concepts of aloha with preamble sampling. This is an adaptive duty cycling approach, performs an adaptive sleep and wake up scheduling for data transmission and reception, idle listening to the node is avoided. No proper synchronisation is needed. If a node has to send a packet it checks for the medium whether it is idle or busy. Once it found busy it waits for a backoff time till it founds the medium idle. Preamble is sent through the data packets which notify the next sleep and wake up scheduling. As preamble used in B-MAC no other control frame is used. No synchronisation is needed between nodes. The preamble length can be adjusted but this result in large overheads. Request to send, clear to send, acknowledgement control messages are not used. With requirements of application preamble duration are altered by above layers. B-MAC performance with energy efficiency and latency is comparatively higher than the SMAC performance.

XIII. LEACH (Low Energy Adaptive Clustering Hierarchy)

LEACH is a scheduled based concept performs time synchronisation between nodes. It is a cluster head concept and this protocol rotates the cluster heads responsibility. This protocol includes two phases. Setup and steady state phase. Process of setup phase includes, Selection of cluster head (CH). Elected node sends an advertisement message and one as non elected joins the CH based on the advertisement message and the signal strength. Every node enters the clusters by join request message. Within the clusters it follows the TDMA approach. Always the scheduling is given by the cluster head. Once the node elected as the cluster head cannot be elected again. The probability of getting selected again is very less. Cluster heads are rotated to avoid the death of entire clusters. During steady state phase transmission of packets are carried. With every assigned time slots transmission will begin. For limiting the interference DSSS technique is used. Communication between CH and sink follows CSMA approach.

XIV. TRAMA (Traffic Adaptive Medium Access Protocol)

It is a scheduled based collision free energy efficient protocol. It includes TDMA concept by assigning time slots to nodes. Here time slots are divided into two periods. A) Random access period B) Scheduled access period. Random access includes signalling which means the synchronization of two hop neighbour. Neighbour protocol (NP) uses signalling slots to transmit one-hop neighbour information. Scheduled access includes the exchange of data between nodes that are collision free. Node assumes the traffic based information based on scheduled exchange protocol (SEP). TRAMA has higher throughput than S-MAC. It switches the node to low power listening mode when no data transmission. Adaptive Election Algorithm (AEA) allots the current time slots for transmitters and receivers and rest of the nodes are moved to low power mode. But here the election algorithm is very complex.

XV. PRIMA (Priority Based MAC protocol)

PRIMA is a scheduled based MAC protocol and it follows similar process of LEACH. It has synchronization among neighbouring nodes**.** Network adopts the cluster head concept and cluster heads (CH) are selected. Periodically every cluster heads will be changed. This protocol implements a distributed scheduling algorithm which schedules every nodes priority. It follows the collision free packet characteristics. PRIMA protocol adopts the RTS/CTS control packets. Here is the possibility of control packets and the data packets are freed from the collision. Receiver node when hears the RTS packets can perform its transmission by responding with the CTS message. The main feature of this protocol is the priority concept. It allows the nodes to wait till the priority scheduling. Transmission with QOS is achieved by access time, delay time and backoff time. Access time is the duration of time by which every node senses the medium ideally. Delay time is the delay in time before responding to the RTS packets. Backoff time is the waiting time of nodes before retransmission of collision packets. Transmission between the nodes takes place in TDMA slot structure. Once a CH wants to communicate with the base station it uses CSMA approach. Here the delay is reduced while delivering the packets to the sink nodes.

XVI. LMAC (Lightweight Medium Access Control)

LMAC is a contention free MAC protocol and it is based on TDMA concept. Time synchronization is significant. This protocol follows the distributed slot allocation which is entirely different from central coordinators allocation. Here no cluster head is chosen. Every node chooses its own schedule. But in this protocol the slot selection always starts at the sink node and proceeds in the hierarchical way. One hop neighbour of the sink chooses the unused slots in every frame. Those nodes once found with the same slot will restart the slot selection. All slots have control messages and data unit. Once the node found with its assigned slots it can start its transmission and the neighbouring node once when senses the medium as busy, it has to move to the sleep state till it get its time slots. All neighbouring node maintains the scheduling table. The latency is increased where as the energy consumption is less.

3. ADVANTAGES AND DISADVANTAGES

S-MAC implementation is simple. Overhead is avoided with announcing the sleep schedule for time to be synchronized. Disadvantages are its collision due to its sleep and wake up periods are not predefined. The efficiency of algorithm decreases with variable traffic loads. Idle listening reduces energy as it overhears the data packets which are not destined to hearing node.

The advantage of Optimized MAC is the reduction of idle listening and over hearing of the nodes. Once when the traffic load is varied by inter arrival time of the message, the collision gets reduced with increase in energy. The energy consumption is less than the previous S-MAC. Disadvantages of Optimized MAC is it suffer premature termination of active period and so latency increases when a node moves from one

node to another node. It experiences carrier sense delay, transmission delay, processing delay, sleep delay. Later this protocol tries to adjust latency with high traffic loads.

E-BMA protocol is more energy efficient than BMA and E-TDMA protocol under low and medium traffic loads. The advantage of this protocol is, it uses the piggybacking that contains control message occupies 1-bit extra space in their data packet but it doesn't requires any additional power. A drawback of this protocol is it consumes high energy with high traffic loads. Latency is higher in E-BMA.

S-MAC makes more attempts in sending the data packets results in more energy consumption. Hybrid MAC saves more energy. Number of undelivered messages is less in case of S-MAC. Latency is less in Hybrid MAC and high in S-MAC. Hybrid MAC reduces overhearing.

In Intelligent hybrid MAC protocol the energy consumption per bit is less at light and high traffic loads. The adjustment of transmission power reduces energy in IHMAC. An advantage of IHMAC is with high traffic loads it experiences the lowest delay.

Advantages of RMAC are energy conservation, simplicity fairness. It requires only less computational power. For heavy traffic modes transmits packets where collision occurs but still this is avoided in RMAC by using the piggybacking concept without moving to contention phase. End to end latency is reduced in RMAC. Disadvantage is the capture effect is not solved as it increases the unfairness.

An advantage of MRMAC is, it reduces idle listening with increase in increase in energy. Medium reservation MAC with low latency can transmit more end to end delay packets. Disadvantage is the collision increases in MRMAC with increase in packet generation interval time.

Schedule unifying algorithm in S-MAC saves more than the S-MAC without SUA. It adopts the periodic wakeup and sleep schedule. Without SUA the virtual clusters experiences the decrease in energy rate. Often the nodes die without SUA. With SUA the network lifetime is increased with increase in energy.

Advantage of WiseMAC is avoiding time synchronization as the clock drift mitigates the problem also the preamble length can be altered. This protocol is adoptable to change in traffic load. Performance is higher than the S-MAC protocol. Disadvantage of WiseMAC is exposure of hidden terminal problem which results in collision and lose of data during transmission.

Advantage of the T-MAC is its less energy consumption when compared with S-MAC. It achieves a good throughput for low data rate. Disadvantage is its delay in packets. The latency is higher than the S-MAC.

Advantage of Power aware multiple access protocol is every node determines the next sleep time and wakeup time by the control channel. Disadvantage is every node uses different control channel which is different from the data channel. Simultaneously transmits data over control channel and data channel.

One main advantages of B-MAC is Synchronization avoidance between nodes for data transmission. It achieves high throughput and less delay when compared with S-MAC protocol. Disadvantage is the overheads caused by preambles. This high overhead has greater preamble size for sending simple data.

LEACH has its advantage by extending its lifetime. The cluster heads are rotated to avoid the death of the cluster head and the failure of the entire cluster. Disadvantage is the requirement of additional energy and with increased overhead as if the cluster head fails. Also requires synchronization between the nodes.

Advantage of TRAMA is discussed to have high throughput and energy efficiency that depends on traffic loads than the S-MAC.

4. PERFORMANCE ANALYSIS

NAME	TIME SYNCHRONIZATION	ADAPTABILITY	OVERHEAD
SMAC	Loose	Good	SYNC,RTS,CTS, ACK
OPTIMIZED MAC	Tight	Good	$SYNC_{RTS,}COUNT_{THERSHOLD}$
E-BMA	Loose	Weak	piggybacking
HYBRID MAC	Tight	Good	SYNC, Schedule
IHYBRID	Tight	Good	SYNC, CTS, RTS
RMAC	Tight	Good	SYNC, RTS/CTS, minislot
MRMAC	Loose	Good	Piggybacking, SYNC
SUA	Tight	Good	SYNC, schedule
WiseMAC	None	Good	Preamble, ACK
T-MAC	Loose	Good	SYNC,RTS,CTS
PAMAS	None	Good	Probe, ACK
B-MAC	None	Weak	Preamble
LEACH	Tight	Good	Join-request, schedule
TRAMA	Tight	Good	Beacon
PRIMA	Tight	Weak	SYNC, CH, Schedule
LMAC	Tight	Good	SYNC, slot

Disadvantage are queuing delays with high overhead in the packets due to scheduling induces the higher delay performance. It requires substantial memory for performing the schedule computation.

Advantage of PRIMA is the rotation of CH from avoiding the network failure. Latency is reduced by achieving packet delivery at the scheduled time. Disadvantage is increase in overhead when CH drains its energy. This overhead causes more consumption of energy.

Advantage of LMAC includes high energy consumption whereas the collisions are avoided. Disadvantage is the

addressing of hidden terminal problem. This protocol suffers higher latency for delivering packets at the scheduled time.

5. FUTURE RESEARCH

Most of the proposed MAC protocols are application dependent. It is very important for researcher to develop more protocols application independent. So with single MAC protocol many application can be dealt reduces energy.

Security issues in MAC has to be concentrated as because a lot of MAC layer attacks such as eaves dropping, jamming and many more malicious nodes can access the medium causing loss of data packets. This is one such area for researchers to work on.

Another promising area is the cross layer MAC protocol. It is important to work with different layers of OSI as all layers are inter-dependent. The MAC layers results can be used by other layer which can minimize the energy consumption.

One of the interesting areas to be focussed is the time critical applications. Researchers can focus their attention to designing and develop MAC protocols such that it can be used for real time application. Hardware implementation could be experimented.

6. CONCLUSION

In this paper, a large amount of work has been studied and produced on medium access control protocol. MAC has a significant importance for wireless networks. The comparisons of contention based and scheduled based approach were discussed. As contention based approach does not need synchronization it is widely used for randomly distributed sensor. But whereas in the scheduled based protocol a tight synchronization is required to ensure channel to be used without collision. Scheduling of slots will be given to every node by which the latency can also be avoided. MAC includes CSMA, TDMA, FDMA, CDMA protocols for accessing the channel. CSMA is a contention based protocol tries more on avoiding the collision. But still collision is experienced by this approach. No synchronization is needed for CSMA approach. TDMA is a scheduled based approach that allocates different time slot for accessing the medium. Synchronization is very significant as the time cannot be changed easily. Clock drift is the problem in TDMA. By this approach the collision can be avoided. FDMA allows collision free medium access by providing different frequencies for different users at the same time. CDMA provides different orthogonal codes for accessing the medium as collision free. For a smaller and lower energy sensor network the computational complexity is the cons observed. But every protocol minimizes the energy by various techniques. A need for security is not taken as a serious issue in MAC mechanism as the medium can be shared by some harmful malicious nodes. Hence we assure that our survey will be helpful for future research work.

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