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AMSTMAC: Adaptive Multipath Selective Time MAC Protocol for Wireless Sensor Networks

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Abstract: Energy efficiency is an important parameter of resource constrained wireless sensor networks (WSNs). All protocols designed for WSNs must be energy aware in order to prolong the network lifetime. In this paper, we have designed a novel MAC layer protocol (AMST-MAC: Adaptive Multipath Selective Time MAC) for WSNs. By implementing advance sleep time and nodes on schedule and sending four packets simultaneously in one packet slot time as per ES-MAC layer protocol, AMST-MAC saves energy and time of the resource constrained sensor nodes greatly. At the same time, AMST-MAC does not compromise its operational performances. Simulation results have shown the proposed algorithm to be efficient.

Keywords— WSN(wireless sensor network),AMST(Adaptive Multipath Selective Time),AEEMAC(Adaptive Energy Efficient MAC),I-MAC(Intelligent MAC),ADC/DAC (Analog To Digital Conversion/Digital To Analog Conversion),DCF MAC(Distributed Coordination Function()

I. INTRODUCTION

A WSN contains different types of sensor nodes that are used to sense and transfer the information to the base station or the next neighbour node. Recent technologies made it possible to minimise the cost and the bulkiness of the electronic devices. The wide range of sensors is available such as humidity, movement, temperature, pressure, and lightening conditions are monitored. Lower Power consumption restricts sensor to use the limited resources such as less low transmit power, memory requirement and less processing calculation. The aims is to provide better end-to-end delay, less number of dead nodes, a higher output, and overall lower power consumption compared to other protocols.

A state-of-the-art technology Wireless Sensor Networks (WSNs) is used to sense the data from all locations. Different parts of sensor nodes can be classified in six major units:

1. Communication Unit
2. Processing Unit
3. Sensing Unit
4. ADC/DAC Converters
5. Power Supply
6. Temporary Storage Unit

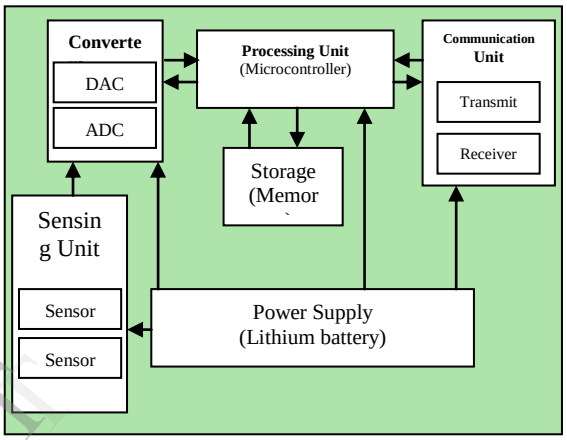

Figure 1: General Architecture

Fig[1]. Shows general architecture of sensor nodes. The sensors in the sensing unit interact physically with the environment. The sensed data is send to the ADC/DAC converters. The micro-controller receives digital data and does the required processing by using the temporary memory. The processed data are then transmitting to the transmitter of the communication unit for transmission towards the cluster head. On the other hand, the data from the Cluster Head is received by the receiver and then transferred to the processor for further processing. The power source used in sensor node can be a lithium battery. The two main parts where most of the power consumption occurs are:

1) The processing units and
2) The communication Unit.

The cluster head is either a mobile or fixed node, which has the capability to connect the sensor network to the internet where the user can access and process the data. Routing in WSNs is very essential due to the inherent traits that distinguish this network from other wireless networks or cellular networks. Limited memory and power are the parameters which affect the amount of data to process or store in an individual node. The architecture of typical WSN is shown in Figure 1.2.

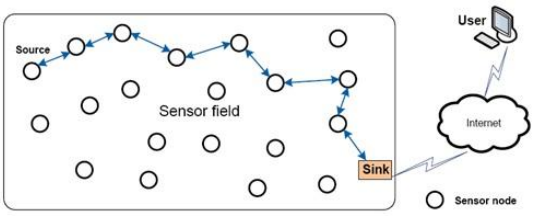

Figure 2: Wireless Sensor Network

The various areas including industry, commercial sector, or military fields are increasing its use rapidly all over the world. Healthcare becomes other area in industry and commercial sector where WSNs are being deployed. The deployed sensors help the hospitals and operators to monitor the patient's vital signs.

II. RELATED WORK

In this paper author [1] has tried to reduce the power consumption in sensor network at MAC layer. In accordance of reducing the network energy consumption here we got to know that idle mode takes the maximum amount of energy ,so as to reduce the idle mode ,the author has tried to make the idle mode converted into sleep mode ,so as to enhance the battery backup of the network. This I- MAC protocol gives high throughput & least delay then IEEE802.11 DCF MAC protocol.

The improvement which can be done in this I MAC protocol is ,as data rate is also the main constraint in developing the energy efficient MAC protocol. So here we can use different phases to send the data at the same time. By developing this concept we can enhance the data rate & at the mean time the energy consumption & time taken to transmit & receive the data gets reduced. Because let in the I MAC the time taken to send a of frame of data is 1second but when we use the phases in the same protocol we can send multiple frame of data in 1 second. Which will be the advantage of this idea to develop an energy efficient MAC protocol with good QoS.

In this paper author[2] has tried to reduce the power consumption of WSN by adjusting the load estimation .Based on load changing the throughput can be increased by shortening the interval of active cycle. The R-MAC has the following function

1) Adoption of duty cycle with Rhythm
2) Synchronous method using RTS & CTS
3) Load adaptation based on traffic estimation.

As in S MAC, the duty cycle extends the operation time of a sensor node by adopting the sleep mode .Where as in R MAC it has five rhythm modes to transceiver the data, which are duple time mode ,quadruple time mode, eight rhythm mode, sixteen rhythm mode & single beat mode. At the initial phase of R MAC it is in the single beat mode. All the data from source to destination is delivered & after that the data in the queue sends the RTS CTS by which the MAC protocol comes to know that among the five modes of R MAC in which mode it has to switch. This process is done by regression equation. In this R MAC protocol the node which is nearest to the destination node is always known to the network by this regression equation.

Improvement to this R MAC protocol is in the topology. In most of the WSN network the topology is not fixed. So in that case we can use mesh topology & implement this R MAC on it .The second improvement can be done in this RMAC protocol is the synchronization ,as in this protocol the sensor node is always synchronized with the node which is nearest to the destination node, but here we can also synchronise the whole network nodes at a time so as to alleviate the synchronization problem in it.

In this paper the author[3] has tried to reduce the energy consumption in WSN by doing adaptive sleeping & reusing of the channel. In adaptive sleeping AEE MAC schedule updating is done by sending a SYNC packet. The SYNC packet is very short & includes the address of the sender & the time of the next sleep & also in this AEE MAC two combined transmission scheme are proposed in which control messages can be piggybacked in the messages with reservation slot. By this process the slots of resources are saved & it also reduced the collision probability of RTS.

Here in this paper the author[4] has proposed on energy saving network. In this ES MAC protocol the author has tried to reduce the number of packet sent also to allow the node to sleep for the time. When it is in idle mode even in the data cycle. The reducing the number of packet is done by checking the relevant data sent by the node. If the data sent is repeated /not relevant then this protocol will not entertain this data by which the transmitted data packets gets reduced. This process is named as SDT (selective data transmission) in ES MAC protocol The second major concept in this paper is Dynamic data cycle. In this if the node is in the idle mode even in the data cycle then it goes to the sleep mode. The improvement which can be done in this paper is that ,in ES MAC author has not considered the issues like node discovery, multiple schedule of the nodes or network allocation vector. These issues are the advanced issues which can be resolved in ES MAC protocol.

III. PROPOSED WORK

A. *Problem Identification*

Since the advent of WSN (Wireless sensors networks) the problem of making them efficient enough from power and energy point of view. QoS is also to be maintained in that course. Many efforts have been done to fulfil these tasks. Techniques like S-MAC, T-MAC, I-MAC, R-MAC, AEE-MAC, ES- MAC, PHI-MAC etc have been tried and tested to optimize the power on the MAC layer. Many of the above are successful in managing the power factor up to a decent extent on MAC layer. Data transmission in phases takes up good amount of power in PHI-MAC protocol. that model proposed give out an obvious reason for less rate sampling rate problem WSN.

Other problem which are being faced in power consumption reduction is the high complexity in protocols like I-MAC. In another research mentioned above in our review brings out the problem of only validating itself only in linear topology keeping in view the fact that topologies cannot be defined in WSN in R-MAC. In research of ES-MAC protocol no emphasis is given on node discovery and multiple schedule

node. No such algorithm exists which utilises the maximum of transmission capability of a WSN from empty slot utilisation in a phase point of view. Our attempt would be design an algorithm which effectively turn on and off for different phases to utilise the time simultaneously.

B Proposed Algorithm

The proposed AMST-Mac layer Protocol utilises the maximum of transmission capability of a WSN from empty slot utilisation in a phase point of view. Our attempt would be design an algorithm (AMST-MAC) which effectively turn on and off for different phases to utilise the time simultaneously. This is effective in sense that it detect for repetitive packets so that they may not be send again wasting energy and resources. Working of AMST-Mac layer protocol can be easily understand through following Pseudo Code:

STEP 1: lets us assume that nodes are initially on sleep.
STEP 2: Get the sequence of packets to be send only if there is request from user otherwise nodes remain on sleep.
STEP 3: if(packet is repetitive)
STEP 4: Reject that packet;
STEP 5: else
STEP 6: add packet to new Sequence of packets made to be send;
STEP 7: if(packets size ==4)
STEP 8: send packets;
STEP 9: elseif(packet size>=2 && packet size<4)
STEP 10: send packets ;
STEP 11: else
STEP 12: send packet in next slot when size of packets is greater than or equal to 2
STEP 13: if (there is further request to send packet nodes)
STEP 14: step 3 to step12 are repeated
STEP 15: else
STEP 16: Nodes are sent on sleep

IV. SIMULATION RESULTS

a For the purpose of determining energy efficiency of the proposed AMST-MAC protocol, we have carried out simulation studies in star network topologies in multihop environments. We have incorporated the proposed optimizations in the basic model of ES-MAC using MATLAB as simulator. For performance evaluation, we compare the transmission strategy of AMST-MAC with basic ES-MAC protocol.
The aim of this simulation study is to evaluate how much energy efficiency AEEMAC can provide and whether it can conserve energy without degrading service quality in terms of Repetitive Packets Detection, and packet delivery Strategy compared to ES-MAC protocol.

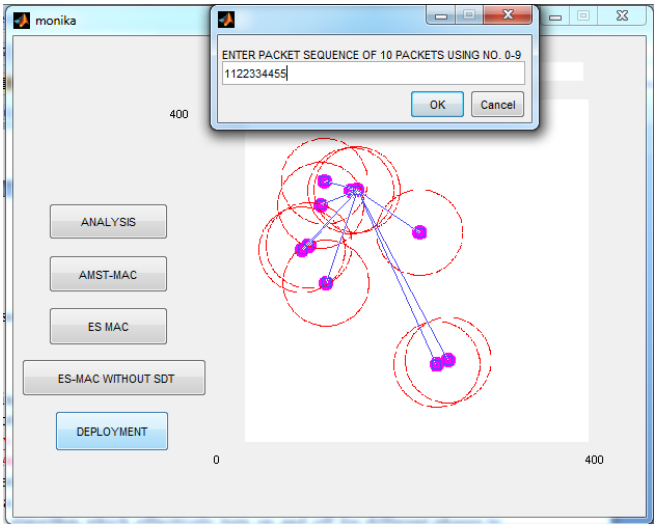

Figure 3: Network deployment in star topology

In the figure 1 shows that nodes are deployed in star topology and user enter sequence of packets to be sent. Magenta color filled circle represent nodes and red circle represent the range of the each node. Blue line represent the connection of nodes.

A. Repetitive Packets Detection

This phase check for duplicate set of data to reduce data redundancy and using less power and time for sending the packets.

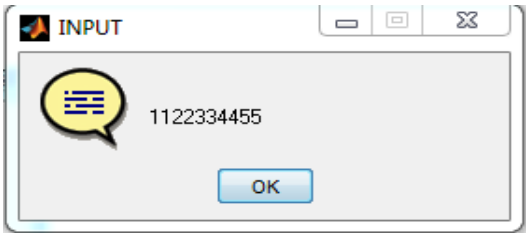

Figure 4(a): Input Sequence

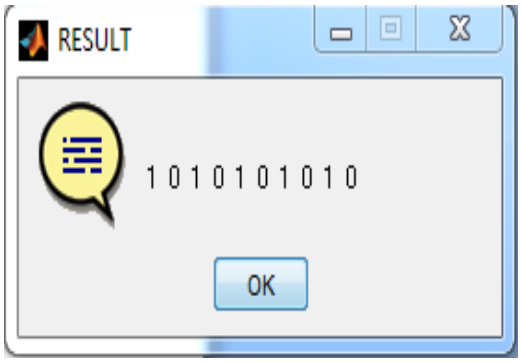

Figure 4(b):Rejection packet Sequence

Figure 4(a) and 4(b) shows input sequences of packets to be send and rejects of packets due to repetition respectively. as if there is repetition in sequence of packets repeated packets are rejected and new sequence of packets are formed without repetition.

Figure 5(a): New packet Sequence

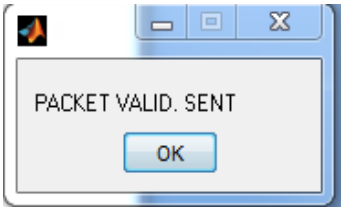

Figure 5(b): Validation of packets

Figure 5(a) and 5(b): Shows sequence of packets actually to be send after rejection of duplicate packets and validation of packets respectively. This newly formed sequence helps in saving energy that will be required to send packets in case protocol not checks for repletion detection.

B. Packets Delivery Strategy

The packets are being sent in particular .ie. number of packets send in one time slot.

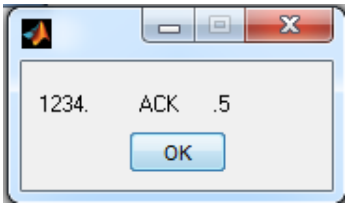

Figure 6(a): AMST-MAC output

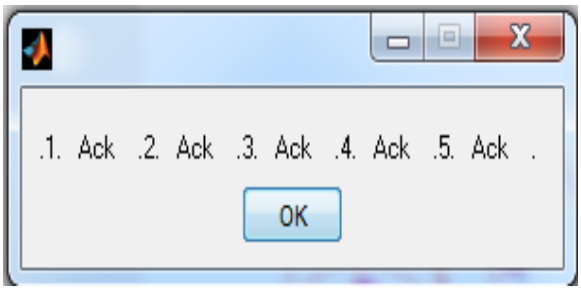

Figure 6(b): ES-MAC output

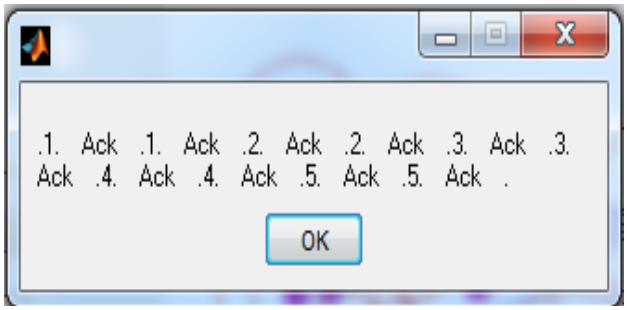

Figure 6(c): ES-MAC Without SDT output

In the figure 6(a),(b),(c) shows packet delivery strategy of AMST ,ES,ES without SDT protocol. The AMST Protocol sends four packets in one time slot utilizing more capacity and then waits for acknowledgement. The ES protocol with SDT sends one packet receive acknowledgement then sends the next. The ES protocol without SDT sends one packet receive acknowledgement then sends the next.

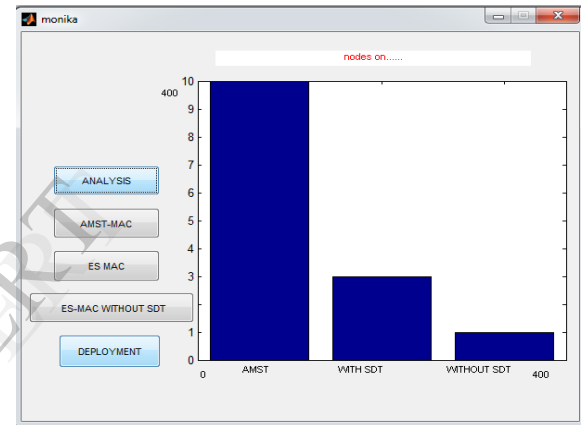

Figure 7: Comparison Bar graph

The figure 7 shows comparison in AMST, ES ,ES without SDT protocol. This comparison in following four features:
1) No of transmission packets
2) Power Consumption
3) Redundancy checking of packets
4) Transmission Time

V. CONCLUSION

In this paper, we have designed a novel power reduction MAC layer protocol (AMST-MAC: MAC) for WSNs based Repetitive Data Selection and simultaneous transmission of four packets. AMST-MAC is inspired by AEEC-MAC layer Protocol which is a mature technology and is widely used in wireless networks. Due to advance sleep time and nodes on procedure, AMST-MAC is very much energy efficient which is crucial in case of WSNs. Other performance parameters like Transmission Time, success rates and Repetitive packet detection are better in I-MAC than that found in other competing MAC protocols. The performance of AMST-MAC using star topology has been verified by both analytical study and simulated in MATLAB.

VI. FUTURE SCOPE

In the future, we would like to evaluate AMST-MAC by using mesh and Fully Connected topology. Furthermore, we plan to improve the synchronization between nodes for the entire network in order to make the synchronization at once. Future study will focus on the evaluation of AMST-MAC's performance in a real world test-bed.

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