Performance Analysis and Comparison of Modified SMAC and WiseMAC with Adaptive MAC for WBAN Applications

Himangi Pande, M. U. Kharat

Abstract—Wireless Communication and Wireless Networking is the popular research in this era. The combination of this is useful method for one step ahead to increase the life of human being. The motto of the research is to implement the protocol on Data-Link Layer, which is the WBAN stack protocol layer architecture, use to increase the life time of battery by energy saving. The novelty in the proposed method is to reduce energy consumption using the concepts of contention window which is adaptive to the different traffic conditions. The experimental result shows increase in Total Remaining Energy, Common Node Energy, Cluster Head Energy and BAN Coordinator Node Energy of Wireless Body Area Network. The proposed protocol is simulated in NS2 environment.

Index Terms—Wireless Body Area Networks, Media Access Control, Micro Electro Mechanical Systems, Personal Digital Assistance

I. INTRODUCTION

Wireless Communication and Wireless Networking is the popular research in this era. The combination of this is useful method for one step ahead to increase the life of human being who are part of different lifecycle such as senior citizen, teen rage and the youth on this world. The issue is to increase the growth of all this living mankind from different serious diseases so the technology and communication is BAN (Body Area Network) through wireless is Wireless Body Area Network. Wireless Body Area Network is one of the subset of Wireless Personal Area Network, Wireless Sensor Network and Wireless Local Area Network. WBAN is having the one module layered architecture and the protocol stack. Research has shown that the most diseases can be prevented if they are detected in early stages. Therefore we will try to overcome the patients time so the related prescription will reach to the patient on demand and on emergency condition the data should be transferred through the new technology i.e. MEMS (Micro Electro Mechanical Systems) , PDA (Personal Digital Assistance).The motto of the research is to implement the protocol on Data-Link Layer, which is the WBAN stack protocol layer architecture, use to increase the life time of battery by energy saving. The communication between the sensors which are present on the body to a data center connected to the Internet via BAN coordinator or personal digital assistant is the span of WBANs protocol. An example is shown on Fig. 1. The former controls the information handling between the sensors or actuators which are placed on body and the personal device [1].

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Latter ensures the communication between the personal device and an external network. In this process the data pull out from the WBAN is sent to medical server via grid. It provides access to appropriate computational services with high bandwidth and to a large collection of distributed time-varying resources.

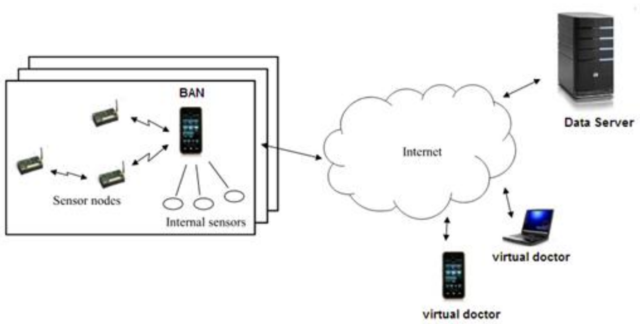

Fig. 1: General architecture of WBAN

II. RELATED WORK

Wireless Body Area Network is one of the subset of wireless sensor network. Objective of the research is to design and implement the MAC protocol on data link layer. It helps to increase the life time of battery by energy saving. A plentiful MAC Protocols are proposed to obtain the objective of energy efficiency. In synchronous MAC protocols energy consumption of sensors are reduced by synchronizing the sensors' wakeup and sleep times. These protocols are not efficient in case of variable traffic rates because of fixed sleep times and listen times. S-MAC [2] and T-MAC [3] are example of synchronous MAC protocols. Asynchronous MAC protocols can also be divided in either sender initiated or receiver-initiated. In sender initiated approach, a sender added a preamble in packet header before the packet transmission to inform the receiver for the upcoming packet. WiseMAC protocol is a part of long list of asynchronous MAC protocols, the other protocols in that particular category are C-MAC [4], B-MAC [5], and X-MAC [6]. WiseMAC is described as one of the most energy efficient protocol on MAC layer in WSN [7]. Researcher studied different techniques to implement WiseMAC protocols. The protocol contains the knowledge of the sampling schedule. The extended more bit mechanism in WiseMAC allowing a bottleneck to adapt its duty cycle in case of high traffic [8]. CSEM has developed a dual-mode protocol, named WiseMAC-High Availability (HA) [9], by allowing nodes to switch between the low powers. WiseMAC (Wireless Sensor MAC) a novel protocol is used for the downlink of infrastructure multi-hop sensor networks [10]. WiseMAC is based on CSMA. It uses the preamble sampling technique to minimize the power consumed when listening to an idle medium [11]. Author describes the preamble sampling and frame structure of WiseMAC. It is found that the WiseMAC can transport different traffic such as random, periodic and bursty. It is scalable and supports mobility as only local synchronization information is used. The paper describes the basic schemes used in WiseMAC.

III. ADAPTIVE ENERGY EFFICIENT MAC FOR WBAN

There are many challenges in health care sector and many of them can be handled by use of ICT technologies. Under thus work, we have implemented adaptive energy efficient protocol for WBAN applications. We take the inputs of the one node with the parameter of body temperature, blood pressure. These are the low power parameters, so according to that the total energy consumed for the receiver with its based station in time measure in the millisecond. The parameters used during the research are ECG, Body Temperature, Blood Pressure and audio. As the high power consumption data with number of the sensor nodes are depends upon the range of the parameters and the total time required for the Transceiver and Receiver signals are calculated from the frequency of the number of packets are transmitting the message on the radio signal according to the Radio-Transmitter Signal concepts. The power consumption depends on number of sensors, parameters used, traffic rate and others. The energy requires for the number of nodes is transmitting the data with the frequency on the one-hop network then it depend upon the topology that is the observation. So the topology for the proposed architecture is decided. We propose a modified MAC protocol called adaptive energy efficient MAC for WBAN applications. The developed protocol is useful transmitting efficiency data with high throughput. The information steps carried out by the protocol are as below:

1. Access the SYNC frame with the specific fields
2. To call the Function in NS2 like packet length, type access phase-I, srcAddr, syncNode, sleep Time, state and crc
3. Flag indication of SYNC packet
4. Fixed size of 9 bytes
5. Identify the sender
6. Identify the sender's synchronization node
7. After Data Classification, calculate contention window size
8. Start of Sender's next sleep time from now
9. Indication for the recent change in receiver's schedule
10. Cyclic Redundancy Check

The proposed method is modification of the algorithms [12]. The novelty in the proposed method is to reduce energy consumption using the concepts of contention window which is adaptive to the different traffic conditions. Probability is calculated for possible transmission failure over a sufficient number of packets and contention window is adjusted accordingly to avoid the collision. A concept of dynamic duty cycle is used and it classifies the traffic into different groups depending on the type of traffic class. The protocol should adopt variable traffic loads and should minimize the power consumption and increase the power consumption of sensor node. The experimental result shows increase in Total Remaining Energy, Common Node Energy, Cluster Head Energy and BAN Coordinator Node Energy.

Priority based message passing

Algorithm scenario:

1. Access point receives data send by cluster head.
2. Sort data according to emergency data value before forwarding .Check data value of received sensor node. If data value goes above/ below threshold value, then insert data into emergency list. Otherwise insert into normal data list.
3. While forwarding data, first forward emergency data and then normal data.
4. End

IV. EXPERIMENTAL RESULT

We take the inputs of the one node with the parameter of body temperature, blood pressure. These are the low power parameters, so according to that the total energy consumed for the receiver with its based station in time measure in the millisecond. The develop protocol is simulation with the help of NS 2.29 [13] [14] [15] tool. In a 2-D square area, WBAN comprise of common sensor nodes, cluster heads, access points and BAN coordinator node was deployed. All these nodes are deployed randomly all over the area. Common nodes sense various parameters such as body temperature, blood pressure, ECG and audio. These nodes are associated with nearest cluster head and send the sensed data periodically. Cluster head disseminate data to access point according to data priority. Access point gets the data from all cluster heads and sends to coordinator according to their priority. The parameters considered are number of nodes, topology and its size, initial energy of nodes, transmit and receiving power, size of the packet and others as given in Table 1.

Table 1: Simulation Parameter

Parameter	Experimental Value
Number of Nodes	35
Topology Size(Area)	550 m × 550 m
Initial Energy	5 J
Simulation Time	150 s
Communication Range	250 m
Data rate	Variable 0.2, 0.4, etc.
Carrier Frequency	868 MHz
Sleeping power	5 μW
Transmit power	12 mW
Receiving power	4.5 mW

Fig. 2 demonstrates results of wireless Total Remaining Energy between developed protocol, AEEMAC, SMAC and WiseMAC. It shows that

SMAC and WiseMAC achieve an average increase in remaining energy of 1474 Jules and 4536 Jules respectively, AEEMAC protocol achieves an average increase in remaining energy of 3979 Jules for above sample data. This is less than SMAC.

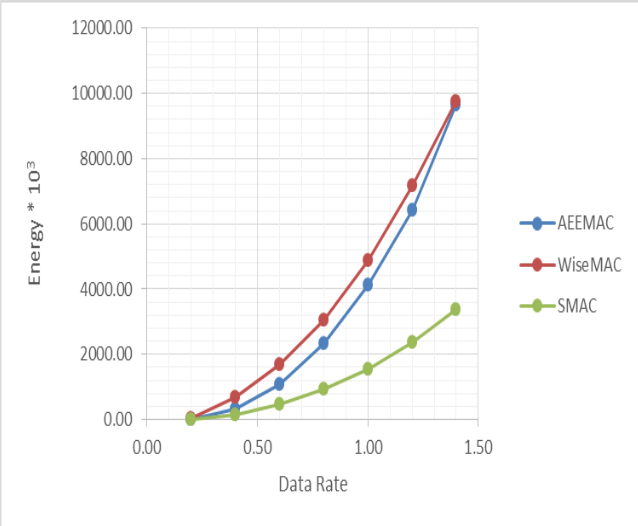

Fig. 2. Comparative Total Remaining Energy of SMAC, WiseMAC and developed protocol, AEEMAC

Fig. 3 shows data rates versus energy utilized for the said protocols. SMAC and WiseMAC achieve an average increases in remaining energy of 470 Jules and 87 Jules respectively, AEEMAC protocol, achieves an average increases in remaining energy of 33 Jules for above sample data. This is less than SMAC as well as WiseMAC. As date rate increases remaining energy increases gradually. So it increases the life of common nodes.

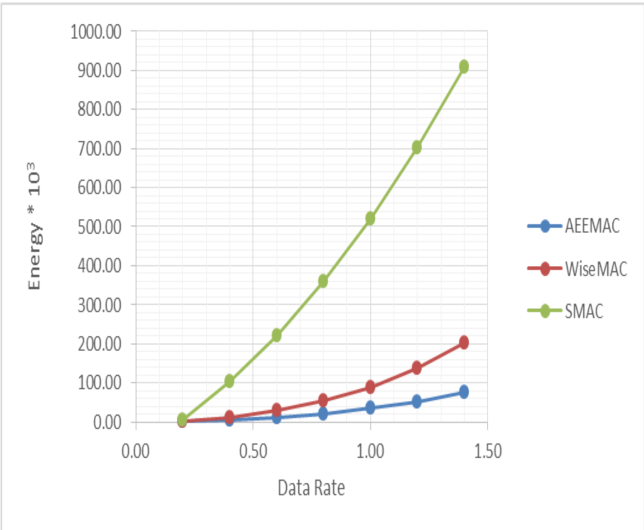

Fig. 3 Comparative Common Node Energy Remain of SMAC, WiseMAC and proposed protocol (AEEMAC)

Fig. 4 shows characteristics of the wireless Cluster Head Energy Remain between proposed protocol, EEMAC, SMAC and WiseMAC. It is clear that while SMAC and WiseMAC achieve an average increases in remaining energy of 3376 Jules and 665 Jules respectively, AEEMAC protocol achieves an average increases in remaining energy of 411 Jules for above sample data. This is less than SMAC as well as WiseMAC. As date rate increases remaining energy increases gradually. As compare to common node, cluster head remaining energy is more, because all variable data is passed through cluster head and access point. This point we implement priority queue for variable traffic such as emergency and normal data.

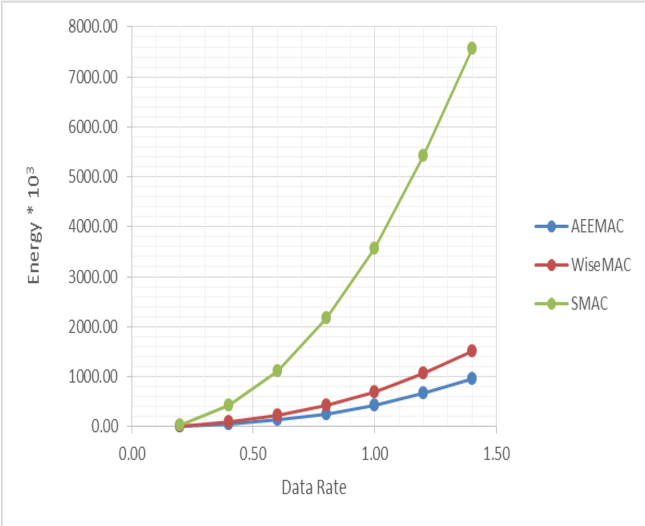

Fig. 4 Comparative Cluster Head Energy Remain of SMAC, WiseMAC and proposed protocol (AEEMAC)

Fig. 5 shows study of the wireless BAN Co-or Energy Remain Sensor Node between proposed protocols (AEEMAC), SMAC and WiseMAC. It is clear that while SMAC and WiseMAC achieve an average increases in remaining energy of 282 Jules and 250 Jules respectively, AEEMAC protocol achieves an average increases in remaining energy of 1467 Jules for above sample data. This is more than SMAC as well as WiseMAC. As date rate increases remaining energy increases. As compare to common node and cluster head BAN Co-or remain energy is more, because all variable data is passed through BAN Co-or from cluster head and access point. This point we implement priority queue for variable traffic such as emergency and normal data.

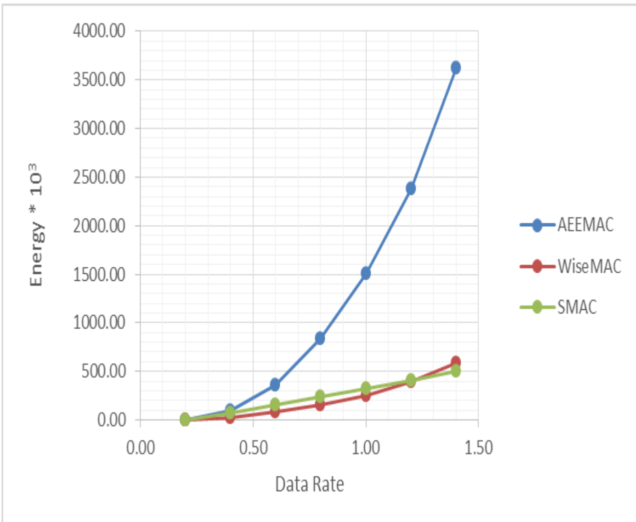

Fig. 5 Comparative BAN Co-or Energy Remain Sensor Node of SMAC, WiseMAC and AEEMAC

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V. CONCLUSION

Wireless Body Area Network is one of the subset of wireless sensor network. Objective of the research is to design and implement the MAC protocol on data link layer. It helps to increase the life time of battery by energy saving. The paper presents the analysis and comparative study of SMAC, WiseMAC and adaptive MAC protocols with focus towards energy efficient and reliable wireless transmissions for body area networks. The study is also useful for devising the protocols for other personal area network applications. The experimental result shows increase in Total Remaining Energy, Common Node Energy, Cluster Head Energy and BAN Coordinator Node Energy. This is achieved because of dynamic duty cycle, adaptive traffic rate and store and forward message schemes.

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