

Medium Access Control Protocols for Wireless Body Area Networks

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ABSTRACT: Throughout the years, it has been proven that biomedical technology has greatly improved diagnosis, treatment and patient monitoring. Wireless Body Area Networks (WBANs) consist of a number of miniaturized wearable or implanted sensor nodes that are employed to monitor vital parameters of a patient over long duration of time. For medical applications, these devices are placed or implanted inside the human body to measure and transfer the real time data or audio signals. Resource efficiency is one of the most important factors that should be considered when developing a MAC protocol in WBAN. There are different approaches used to design MAC protocols to minimize energy consumption. In this paper we will discuss about WBAN and some MAC protocols that has been designed to improve energy efficiency in WBAN Here we are proposing a new protocol for minimizing the energy in wireless body area networks (WBANs).

KEYWORDS: Enter key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

Thus Wireless Body Area Network (WBAN) becomes an emerging technology which provides a real-time health monitoring. One of the targeted applications of WBAN is in medical environments where conditions of a large number of patients are continuously being monitored in real-time. Wireless monitoring of physiological signals of a large number of patients is one of the current needs in order to deploy a complete wireless sensor network in healthcare system. Such an application presents some challenges in both software and hardware designs. Some of them are as follows: reliable communication by eliminating collisions of two sensor signals and interference from other external wireless devices, low-cost, low power consumption, and providing flexibility to the patients. A WBAN-based wireless medical sensor network system when implemented in medical centers has significant advantages over the traditional wired-based patient-data collection schemes by providing better rehabilitation and improved patients quality of life. In addition a WBAN system has the potential to reduce the healthcare cost as well as the workload of medical professions, resulting in higher efficiency. Energy efficiency is an important issue in WBANs because sensor nodes damage human body tissue. More importantly sensor nodes connected to body are battery operated devices, they have limited life time. So, MAC protocols of WBANs needs to be energy efficient and supports medical applications. It allows integration of low power intelligent sensor nodes. They are used to stream biological information from human body and transmit it to a control device called coordinator. This procedure is very helpful while monitoring health of a person and in case of emergency providing proper medication. MAC protocol plays an important role in determining the energy efficiency of a protocol in WBANs. Traditional MAC protocols focus on improving throughput and bandwidth efficiency. However, the most important thing is that they lack in energy conserving mechanisms. By controlling the energy waste sources, maximizes the network lifetime

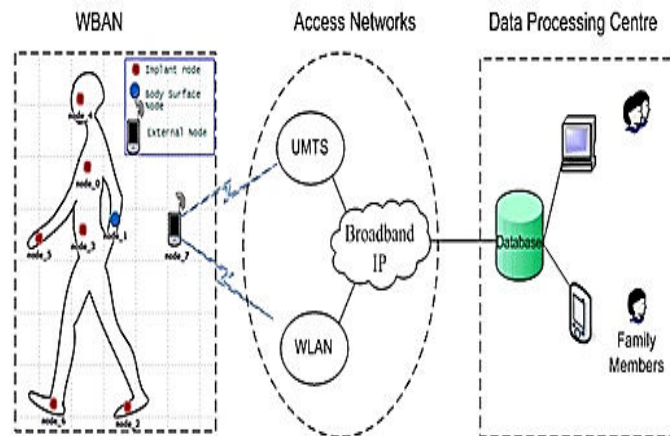


Fig.1.1 Block Diagram of Wireless Body Area Network

WBSN (**Fig.1.1**) is one class in remote system of wearable figuring gadgets. WBAN devices may be introduced inside the body and could be surface mounted on the body in a distinct position or may be utilized with different devices which individuals can put in different positions

II. LITERATURE REVIEW

An important requirement in wireless body area networks (WBANs) is the energy efficiency of the system. A medium access control (MAC) layer is the most suitable level to address the energy efficiency [21-24]. This layer is utilized to arrange hub access to the common remote medium. Macintosh is the center of any correspondence convention stack whose presentation gives the premise to accomplishing QoS in any remote systems. An adaptable MAC should bolster unmistakable applications and various sorts of information, for example, constant, intermittent, burst and non periodic alongside abnormal state QoS. Macintosh plays a noteworthy deciding variable in improving by and large systems execution. The principal task in MAC convention is to maintain a strategic distance from impacts and to avert concurrent transmissions while safeguarding greatest throughput, least inactivity, correspondence dependability and most extreme vitality productivity. While structuring MAC conventions one should remember that hubs are inclined to disappointments, compelled abilities and limited vitality assets.

III. ENERGY-EFFICIENT LOW DUTY CYCLE MAC PROTOCOL

Marinkovic et al. [25] displayed a vitality productive medium access control convention appropriate for correspondence in a remote body region arrange for remote observing of physiological flag, for example, EEG and ECG. The convention exploits the static idea of the body region system to actualize the powerful TDMA technique with next to no measure of overhead and no inert tuning in (by static, we allude to the fixed topology of the system explored). The fundamental objective is to create vitality effective and solid correspondence convention to help spilling of huge measure of information.

TDMA synchronization issues are talked about and arrangements are exhibited. Conditions for obligation cycle figuring are additionally determined for power utilization and battery life expectations. The power utilization model was additionally approved through estimations. Our outcomes demonstrate that the convention is vitality effective for gushing correspondence just as sending short blasts of information, and along these lines can be utilized for various kinds of physiological sign with various example rates. The convention is actualized on the simple gadgets ADF7020 RF handsets. Vitality model was proposed and approved through estimations.

It demonstrated that WBAN with the convention can be utilized in the EEG checking situation. Lessening the power prerequisites for the correspondence part of the framework enables designation of more vitality to increasingly precise DSP for seizure recognition. The proposed plan additionally brings about entirely solid information move, which is significant in restorative applications. Convention was likewise contrasted and two others as of late detailed conventions, and results indicated upgrades in correspondence control utilization and obligation cycle.

IV. REQUIREMENTS OF MAC PROTOCOL FOR WBAN

Mostly the requirements of a MAC protocol are: energy efficiency, deployment and adaptability to changing the size, latency, the amount of flow, fairness, and network density. We detail below each requirement.

Energy efficiency: With a large number of nodes powered by battery, it is very difficult to change or recharge batteries for these nodes.

The deployment and adaptability to changing the size: As the networks may include many nodes, used protocols have to be able to manage change in number of nodes dynamically. These nodes must be programmable. In fact, when new jobs arise their programs must be changed during operation.

Latency: In BANs, the importance of latency depends on the application. In applications, such as monitoring nodes, BAN will be vigilant for long, but largely inactive until something is detected. During this period of vigilance, there is little data flow in the networks. We note that low latency is essential to minimize consumption.

The amount of flow: Refers to the amount of data transferred from a transmitter to a receiver in a given time. Many factors affect this rate, including the effectiveness of collision avoidance, the use of channel, and latency. Like latency, the amount of flow depends on the application. The applications of body sensor networks often require along life that accepts along latency and low throughput...

V. MAC PROTOCOLS FOR WBAN

Many researchers have proposed various MAC protocols for WBAN. Some of them are IEEE 802.15.4 MAC Protocol, Battery-aware TDMA Protocol, Priority Guaranteed MAC Protocol, Energy-Efficient Low Duty Cycle MAC Protocol, A power-efficient MAC Protocol for WBANs Energy Efficient Medium Access Protocol etc. This section covers the pros and cons of some of these prominent MAC protocols proposed for WBANs. The protocols are introduced with emphasis on energy consumption and how they tackle energy inefficiency caused by collision, overhearing, idle listening, and control packet overhead.

3.1. IEEE 802.15.4 Protocol

The Institute of Electrical and Electronic Engineers (IEEE) approved the formation of a working group for IEEE 802.15.4 in September 2006 to draft a standard for Personal Area Network (WPAN) [6]. These Mac protocols are mainly designed for low data rate wireless applications, which use 68 MHz, 915 MHz and 2.4 GHz frequency bands. The 802.15.4 defines both PHY and MAC layers. The characteristics of the MAC layer management are beacons, channel access, management of GTS (Guaranteed Time Slot), validation of the frames, etc. There are two modes of operation of the MAC layer depending on the topology used and the need for guaranteed bandwidth, namely: non-beacon mode and beacon mode.

However, time-critical communication and high QoS requirements are needed for WBAN, for which IEEE 802.15.4 falls in short. To achieve the QoS requirements for time-critical application of WBANs, a number of protocols that are not based on IEEE 802.15.4 have been proposed.

3.2. IEEE 802.15.6 Protocol

The IEEE 802.15.6 [6] is a standard for WBANs, which operate in and around the human body. It appears to focus on functioning at relatively low frequencies, less than one megahertz, and short-range use, low cost, reliable wireless communication and especially an ultra low power. In this section, we try to present the medium access protocol described in the last draft standard. This draft specifies a medium access with different access modes and their access phases. In WBAN, the channel is separated into super frame structures. The super frame is of fixed length bounded by network beacons period of equal length. The IEEE 802.15.6 MAC layer can support three modes of operations, which are beacon mode with beacon period super frame boundaries, non-beacon mode with super frame boundaries, and non-beacon mode without super frame boundaries.

The IEEE 802.15.6 standard does not define any priority QoS architecture. Therefore we need to propose a priority architecture that is designed to accommodate all types of traffics namely the emergency and the normal traffics in the sensor node, and the normal and on-demand traffics in the coordinator.

3.3. Battery-Aware TDMA Protocol

Battery-aware TDMA protocol [11] is one of the protocols designed for WBANs to maximize the lifespan of the network using cross-layer approach. A number of parameters are considered to design this protocol, which include: time-varying wireless fading channel, electrochemical properties of battery, and packet queuing characteristics. Periodic beacons are transmitted by the coordinator just as IEEE 802.15.4 does. The time axis is divided into three time slots: (1) active time slot, (2) inactive period, and (3) beacon slot. To support different applications of WBANs, the frame structure is adaptive and can be changed. Periodic wakeup mechanism is introduced to avoid idle listening of nodes. A dedicated time slot T_s is assigned to each node, where data is transmitted by end node when it receives beacon from the coordinator. Dedicated GTS assigned to each node improves reliability and timely delivery of packets. End nodes remain in sleep mode for the inactive period of time to avoid extra consumption of energy. However, the lack of mechanism to accommodate emergency data and holding of data packets in buffer for long intervals are the two drawbacks of this proposed solution. In addition, packet buffering might result in high packet delay and packet drop rate.

VI. ENERGY-EFFICIENT MEDIUM ACCESS PROTOCOL

The Energy-efficient Medium Access Protocol (EMAP) [15] is a prominent protocol designed for WBANs to maximize energy efficiency. Central control mechanism is used for periodic sleep and wakeup scheduling. Cross layer optimization is being utilized to reduce power dissipation caused by control packet overhead. Star network topology with a single coordinator (i.e., master node) is considered to coordinate with eight on-body/implanted sensor nodes. Master nodes are responsible for most of the activities and processes. It is observed from the simulation results of different physiological signs that the power consumption depends upon the number of retransmissions and sleep intervals. Centrally controlled idle listening and overhearing reduce energy consumption efficiently. However, there are some limitations in implementation which include, e.g., complexity, limited number of nodes in a cluster, lack of mechanism for on demand data, and link establishment process where only one node can establish a link at a time.

To overcome those problems, an optimal MAC (OMAC) protocol is proposed to compromise energy consumption and QoS during data transmission. The main contribution of proposed OMAC protocol is summarized as follows:

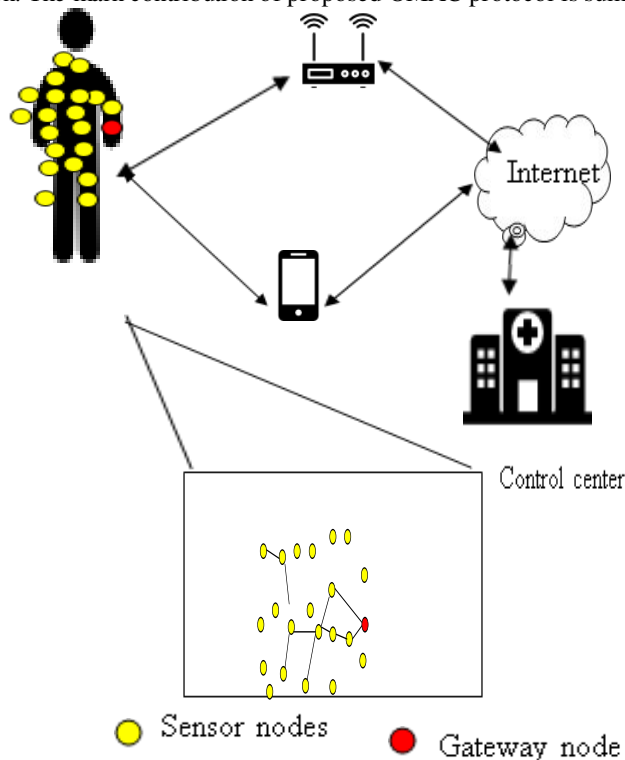


Figure: System model of proposed protocol

- The proposed OMAC protocol design utilizes MD graph optimization algorithm to optimize the scheduled channel and traffic of WBAN.
- In channel scheduling, gathered data always wait a period of time to be transmitted for collecting more data at a node; all gathered data are aggregated into one or several representative data and then transmitted to an upper neighboring node.
- The waiting time at nodes is adjustable and always decided by corresponding applications, which compromise the energy by improving transmission delay, data transmission quality and network lifetime.

VII. SYSTEM MODEL OF OPTIMAL MAC PROTOCOL

Fig.3.1 shows a system model of proposed protocol and classified the network architecture into four sections. The first section is the WBAN part which consists of several numbers of sensor nodes. These nodes are cheap and low-power nodes with inertial and physiological sensors, strategically placed on the human body. All the sensors can be used for continuous monitoring of movement, vital parameters like heart rate, ECG, Blood pressure etc. and the surrounding environment. There are vast monitoring systems are being used already based on wired connections. In this paper, we concentrate on the first section i.e. WBAN part to deliver sensed data to the control centers like hospital and doctors for data analysis.

5. Open research issues

Most of the research is focused on the energy efficiency and power consumption of WBAN. Apart from this a lot of other works are done on the following areas such as physical area, data link layer, network layer and cross layer design. To overcome the idle listening, overhead and collision avoidance problems we can use multiple Energy efficient MAC Protocols in single window. In the case of hybrid MAC protocols, protocols based on CSMA/CA and TDMA access mechanisms give better performance compared with MAC protocols-based CSMA/CA mechanisms. So works are also going on to purpose a hybrid protocols that are most suitable for WBAN networks.

6 Performance Evaluations

The proposed performance of the MAC protocol will be evaluated in this section based on energy consumption, QoS and network lifetime.

a. Energy Consumption:

In this, we will formulate the total normalized energy consumption under our proposed MAC protocol. The per unit time energy consumption will be low generally and it is said to be in a sleep state, thus we will focus on energy consumption utilized in the active state which will lead to the total normalized energy consumption of the network per unit time will be calculated.

First, we will evaluate the proposed MAC protocol power consumption which depends on the change in context. We will demonstrate the power consumption of the average node of G1 and G2 as mention in fig 6. due to the increasing importance of G2 data the power of G2 nodes increases as the context becomes emergent

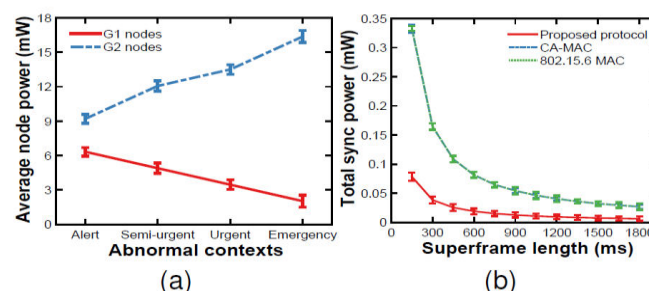


Fig : a) Average node power consumption of G1 and G2 nodes in different abnormal contexts; b) Power consumption for synchronization of different protocols versus superframe length.

. Where G1 nodes will reduce the transmission and the power because G1 data becomes less useful. Now we compare the power consumption for synchronization introduced by the proposed protocol and two reference protocols in order to

validate the effectiveness of our design. We show the results in Fig. 6b. It can be seen that the proposed protocol consumes the least synchronization power.

VIII. CONCLUSION

Energy efficiency is one the most important goals to be achieved in WBAN. Healthcare applications over WBAN include data streaming of critical and noncritical physiological signs sensed by in/on or around the human body sensor nodes. It has been the focus of researchers to improve the performance of WBAN in terms of reliability and energy efficiency at the MAC layer. However, other techniques including, e.g., cross-layer approach, antenna design, and RF communication and propagation models also affect the performance of WBAN. This paper presents a survey on MAC protocols for WBAN. The requirements of a good MAC protocol for WBAN have been identified, and various approaches of WBAN MAC protocols are comparatively analyzed based on merits and demerits. At this level, a hybrid and cooperative MAC Protocol is required to satisfy WBANs requirements such as guaranteed QoS, multiple physical layer support and adaptability to traffic variations, etc. So as a future work, we have to propose a hybrid MAC protocol that takes into consideration the requirements of WBANs networks.

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BIOGRAPHY

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