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Performance Analysis of the Physical and Medium Access Control Layer Parameters with Effect of Varying Transmission Power using IEEE 802.15.4 Standard for Wireless Body Sensor Networks

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Abstract

Wireless Body Area Network (WBAN) consists of miniaturized, tiny, low power body sensor nodes communicating with a BAN (Body Area Node) Coordinator through Radio Frequency (RF) interface link. Recent advancements in the field of Information, Communication and microelectronics have led to the realization of WBAN, which will help in hazardous, long term health monitoring especially for elderly people. Most of the present day's Body Area Network node's MAC/PHY protocols are built using IEEE 802.15.4 and ZigBee standard. This standard will surely make an impact through its improvisation especially in MAC/PHY layers in the days to come. Already researchers have been working on the new WBAN standard. This paper emphasizes the basic structure of IEEE 802.15.5 MAC/PHY layers through experimentation on 7 specific, static body sensor nodes placed at appropriate points on the human body transmitting heterogeneous data using Time division multiple access and Contention access period of CSMA/CA protocol. The body area channels are considered with temporal and fixed path loss values. Physical layer parameters such as latency and fade depth distribution, MAC packets received and breakdown packets of MAC layer are presented. Packet with respect to the unique and useful parameters, packet received from Media Access Control layer of each node under various conditions of the channel and with Carrier Sense Multiple Access/Collision Avoidance comparing with Time Division Multiple Access techniques. Experimental results show that a transmitting-12dBm to -15dBm was found to be suitable for energy efficient WBAN system. For TDMA scheme, the algorithm may be fine-tuned to reduce the number of packet failure which improves the energy efficiency for any kind of channel.

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Keywords: WBAN; MAC; PHY; packet delivery; BAN Node

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1. Introduction

In recent days heart related disorders have become most common amongst the people of all ages and many irregularities in the functioning of kidney, pancrease and diabetes etc. which will lead to heart attacks. Major issues related to health will ultimately lead to cardiac disorder. There is such a need existing even in developing country like India, wherein there is a large ratio of people suffering from chronic illness such as heart malfunctioning leading cardiac arrest, kidney failure, diabetes leading to heart related hazards as well as lung infections [1]. Wireless Body Sensor Network has been evolved to provide health care for people suffering from chronic diseases or aged people who need extra medical facilities. It consists of tiny body sensor nodes worn on or implanted in the body which continuously monitors the health parameters and forwards to the Coordinator node. Later it may be sent to the doctor or it may be stored in the database of the hospital. So 'medical facility for anytime, anywhere' for the people who have worn the body sensors refers to as Ubiquitous health monitoring (UHM) system [2].

The communication network standard useful in establishing the radio frequency(RF) link at various interfaces are basically introduced by IEEE 802.15.4,4a and the new WBAN standard IEEE 802.15.6 [3]. In this paper,IEEE 802.15.4 standard with ZigBee has been considered as most of the commercial sensors make use of this standard [3]. In order to increase the life span of the body sensor node, energy consumption during the transmission of information must be regulated. Medium Access Control (MAC) and Physical (PHY) layer play an important role in the energy efficiency improvement process of the network. Thus performance verification of MAC and PHY layers of body sensor nodes in UHM systems are analysed for various transmission powers. No such efforts are made in the literature so far and in order to keep track of energy consumption, the appropriate transmitting power has to be known for the given scenario. Hence section 2 introduces UHM system, IEEE 802.15.4 standard MAC protocol and PHY layer attributes were dealt in section 3,followed by the transmission power information, the scenario created and the parameters set are considered in section 4 and section 5 discusses the results obtained and also the future scope.

2. Ubiquitous Health Monitoring System

Ubiquitous health monitoring system (UHM) consist of body sensor nodes positioned at certain positions on the body, measuring specific parameters, forwarding the information to a common hub called access point [7][8]. WBAN system consists of body sensor nodes such as Electro Cardio Gram (ECG), Electro Encephalo Gram (EEG), heart beat sensor, oxygen saturation, vibration sensor etc. are connected via Radio Frequency(RF) link to an access point as one of the configuration. Sensed data will be forwarded through intra body communication to the access point and then to the cloud based internet in order to construct Internet of Things (IoT) based WBAN system which is shown in Fig. 1.Generally the wireless networks are networked through star, tree and mesh network topologies; however star topology is the most suitable topology. In this type, an access point plays a vital role in collecting the information from all nodes and then forwarding to the cloud based server.

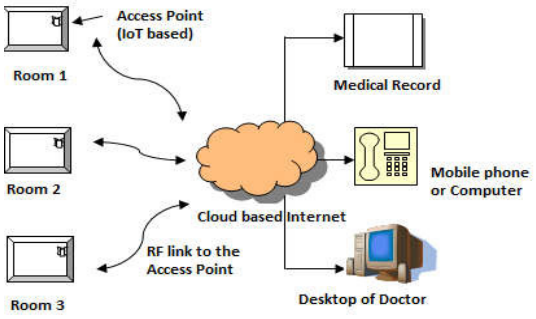

Fig. 1. WBAN system as UHM system