Survey on Maximizing Power Efficiency using Mac Protocol

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***Abstract*-Latest technological advances in sensors, low-power built-in circuits, and wireless communications have enabled the design of low-cost, miniature, lightweight, and smart physiological sensor nodes. Wireless physique area networks (WPANs) are emerging as predominant networks, relevant in various fields. Wireless body area network (WBAN) is a novel technology to furnish effective, easy and safe wellness, clinical and private amusement services however it still faces longstanding challenges in the application. A review on implementations, advantages and drawbacks of the vigor efficient routing protocols mannequin for the wireless body discipline community is made. This case gain knowledge of investigates energy efficient Mac protocol and offers an overview on the success and the possibility of the failure related to the protocol. This paper helps to understand additionally a assessment amongst the three routing protocols on the more than a few parameters which are viewed to be the most influential in physique area networks. The paper offers an insight on the parameters that must be taken care to make the entire process vigor-aware ,power-effective and energy efficient.**

Keywords-Wireless Body Area Network, Mac Protocol, routing protocols, Power Consumption, Energy efficiency

1. INTRODUCTION

Wireless Sensor Networks

A wireless sensor network (WSN) is a network containing a group of very small sized sensor nodes which are deployed in a field to monitor physical conditions autonomously. WSNs measure a great number of physical conditions like sound, pressure, temperature etc. Sensor nodes then pass this sensed data to a base station or sink. The current advance WSNs control the activity of sensor node and are bidirectional. Most of the advancements in WSN is shown in military applications. WSNs are deployed in many industrial applications to monitor industrial process, industrial control and monitoring health of machine. The WSN's are composed of 'sensor nodes' which can be few in numbers, hundreds or thousands in numbers. A sensor node in WSN is connected with other sensor node or with several sensor nodes. Components of sensor node are, a microprocessor or a microcontroller to control the operation of node, to interface sensors with power source, a radio transceiver to communicate and an electronic circuitry is used. Either energy is harvested from any available source or batteries are normally used as power source in these sensors. Sensor node size varies according to application, as sensor node can have a size of a tiny senor like dust grain or as big as a shoe box . Similarly the sensors have variable cost. The price of a sensor node may range from few dollars to hundreds of dollars as a node contain complex circuitry and advance features. Many of the topologies used in these networks are like simple star topology or advance multihop topologies [8].

II. CHALLENGES IN WBAN

A. Interoperability:-

To provide plug and play interaction between devices, the data must have to exchange across standards. The data of one standard has to transfer to another standard. The system would have to migrate from one network to another network and during this transfer the connectivity should not be interrupted. In addition, the system must have the capability to scale.

B. System devices:-

The WBAN sensors are mostly used for medical applications so the weight of these sensors must be small, so they can easily placed on the human body or implant inhuman body. Sensor would have to energy efficient as they have to run for several years to monitor patient. WBAN sensors must be reconfigurable and easy to use. In addition to that the patient data must be store in remote storage devices so that the medical specialist can view and analyze the data through internet.

C. System and device-level security:-

The patient's data is very important for its health monitoring so it must be secure. The standard must support security and accurate data transfer. It is highly required that the patient's data securely transfer to WBAN system coordinator and the data of one patient should not mix up with data of another patient. The data generated of a patient would have limited access and must be highly secure.

D. Invasion of privacy:-

The WBAN technology is used for human health monitoring, however some people consider that this technology may cause threat to freedom if the use of the technology cross the limits of secure medical use.

E. Sensor validation:-

The sensing node in WBAN technology must have reliable wireless communication link. These sensing devices have inherent communication limitations in form for limited energy source and interference. These inherited issues in WBAN may cause false data transmission back to user. For health care application or patient monitoring application, it is very important that the readings of the patient are valid and then securely transmitted to medical server. It can overcome false alarms.

F. Data consistency:-

The data of a patient sensed by wireless sensors must be gathered to analyze in smooth way. The vital data of a patient resides on multiple nodes and transmitted to other networked medical servers. This data must reach to medical specialist for further analysis, if not then the quality of patient's health care and monitoring process decays [10].

G. Interference:-

In WBAN technology the body sensors must have minimum interference in wireless link. The body sensors must increase peaceful existence with the other devices of network. It is required for implementation of large network [11]

H. Motivation:-

In current era of technology, applications of wireless sensor networks (WSNs) are rising in various fields. The deployment of WSNs for real life applications is greater than before. Still, the energy constraints remain one of the key issues; it prevents the complete utilization of WSN technology. Sensors typically powered with battery, which have insufficient life span. Even though renewable energy sources like solar energy or piezoelectric means are used as supplementary energy in WSNs, it is still some degree of reserve to consume energy judiciously. Proficient energy routing is thus a key requirement for a trustworthy design of a wireless sensor network.

Wireless body area network (WBAN) is an interesting application of sensor networks which can revolutionize our interaction with the outside world. WBAN like any other sensor network suffers limited energy resources and hence preserving the energy of the nodes is of great importance. Unlike typical sensor networks WBANs have few and dissimilar sensors. In addition, the body medium has its own propagation characteristic which means that the existing solution for preserving energy in wireless sensor networks might not be efficient in WBANs. The quality of the links between the nodes in WBAN is changing frequently due to the moving nature of the body. This can pose major problem especially in the energy efficiency merit. In this work we have proposed an opportunistic scheme to exploit the body movements during the walking to increase the life time of the network. The results show that comparing to the existing methods this work can increase the life time of the network.[1]

Wireless sensor networks represent a key technology enabler for enhanced health care and assisted living systems. Recent standardization efforts to ensure compatibility among sensor network systems sold by different vendors have produced the IEEE 802.15.4 standard, which specifies the MAC and physical layer behavior. This standard has certain draw backs: it supports only single-hop communication; it does not mitigate the hidden terminal problem; and it does not coordinate node sleeping patterns. The IEEE 802.15.4 standard design philosophy assumes that higher layer mechanisms will take care of any added functionality. Building on IEEE 802.15.4, this paper proposes Time zone Coordinated Sleep Scheduling (TICOSS), a mechanism inspired by MERLIN that provides multi-hop support over 802.15.4 through the division of the network into time zones. TICOSS is cross-layer in nature, as it closely coordinates MAC and routing layer behavior. The main contributions of TICOSS are threefold:

(1) it allows nodes to alternate periods of activity and periods of inactivity to save energy;

(2) It mitigates packet collisions due to hidden terminals belonging to nearby star networks;

(3) it provides shortest path routing for packets from a node to the closest gateway.

Simulation experiments confirm that augmenting IEEE 802.15.4 networks with TICOSS doubles the operational lifetime for high traffic scenarios. TICOSS has also been implemented on the Phillips Aquis Grain modules for testing and eventual deployment in assisted living systems.[2]Recent technological advances in sensors, low-power microelectronics and miniaturization, and wireless networking enabled the design and proliferation of wireless sensor networks capable of autonomously monitoring and controlling environments. One of the most promising applications of sensor networks is for human health monitoring. A number of tiny wireless sensors, strategically placed on the human body, create a wireless body area network that can monitor various vital signs, providing real-time feedback to the user and medical personnel. The wireless body area networks promise to revolutionize health monitoring. However, designers of such systems face a number of challenging tasks, as they need to address often quite conflicting requirements for size, operating time, precision, and reliability. In this paper we present hardware and software architecture of a working wireless sensor network system for ambulatory health status monitoring. The system consists of multiple sensor nodes that monitor body motion and heart activity, a network coordinator, and a personal server running on a personal digital assistant or a personal computer.[3]Recent technological advances in sensors, low- power integrated circuits, and wireless communications have enabled the design of low-cost, miniature, lightweight, and intelligent physiological sensor nodes. These nodes, capable of sensing, processing, and communicating one or more vital signs, can be seamlessly integrated into wireless personal or body networks (WPANs or WBANs) for health monitoring. These networks promise to revolutionize health care by allowing inexpensive, non-invasive, continuous, ambulatory health monitoring with almost real-time updates of medical records via the Internet. Though a number of ongoing research efforts are focusing on various technical, economic, and social issues, many technical hurdles still need to be resolved in order to have flexible, reliable, secure, and power-efficient WBANs suitable for medical applications. This paper discusses implementation issues and describes the authors' prototype sensor network for health monitoring that utilizes off-the-shelf 802.15.4 compliant network nodes and custom-built motion and heart activity sensors. The paper presents system architecture and hardware and software organization, as well as the authors' solutions for time synchronization, power management, and on-chip signal processing.[4]Sensor networks have many potential applications in biology, physics, medicine, and the military. One major challenge in sensor networks is to maximize network life under the constraint of limited power supply. The paper addresses energy-efficiency in the context of routing and data gathering. A new protocol proposed: Hybrid Indirect Transmission (HIT). HIT is based on a hybrid architecture that consists of one or more clusters, each of which is based on multiple, multi-hop indirect transmissions. In order to minimize both energy consumption and network delay, parallel transmissions are used both among multiple clusters and within a cluster. This is made possible by having each sensor independently compute a medium access controlling TDMA schedule. The computation within each sensor is intelligent yet simple. Formal analysis shows that it requires O(n) space and O(n long) time complexities, and O(1) setup messages prior to the computation, where n is the total number of sensors. HIT does not require sensor nodes with CDMA capability, or the remote base station to compute a data gathering schedule. Performance is evaluated by simulating and comparing HIT with three other existing protocols, including Low Energy Adaptive Clustering Hierarchy (LEACH), Power Efficient Gathering for Sensor Information System (PEGASIS), and Direct Transmission. Results have shown that HIT greatly reduces both energy consumption and network delay; it also maintains longer network life compared to these three existing protocols. Security issues and a potential application of HIT in biomedical sensing technology are also rigorously discussed. This work is significant to the advancement of energy-efficient micro sensor networks; the proposed protocol is promising and would contribute to the use of wireless micro sensor networks in future biomedical sensing technologies.[5]we introduce a multi-tier telemedicine system and describe how we optimized our prototype WBAN implementation for computer-assisted physical rehabilitation applications and ambulatory monitoring. The system performs real-time analysis of sensors' data, provides guidance and feedback to the user, and can generate warnings based on the user's state, level of activity, and environmental conditions. In addition, all recorded information can be transferred to medical servers via the Internet and seamlessly integrated into the user's electronic medical record and research databases.[6] This paper presents an energy-efficient medium access control protocol suitable for communication in a wireless body area network for remote monitoring of physiological signals such as EEG and ECG. The protocol takes advantage of the static nature of the body area network to implement the effective time-division multiple access (TDMA) strategy with very little amount of overhead and almost no idle listening (by static, we refer to the fixed topology of the network investigated). The main goal is to develop energy-efficient and reliable communication protocol to support streaming of large amount of data. TDMA synchronization problems are discussed and solutions are presented. Equations for duty cycle calculation are also derived for power consumption and battery life predictions. The power consumption model was also validated through measurements. Our results show that the protocols energy efficient for streaming communication as well as sending short bursts of data, and thus can be used for different types of physiological signals with different sample rates. The protocol is implemented on the analog devices ADF7020 RF transceivers.[7]

III. ENERGY-EFFICIENT LOW DUTY CYCLE MAC PROTOCOL FOR WIRELESS BODY AREA NETWORKS

Ambulatory biomedical signal monitoring has been an area of rapid growth in recent years. With advancement in storage and wireless technologies has resulted in an increase in the number of recording devices available capable of monitoring patients outside of a clinical setting. With these devices, wireless communications are used to stream data from the patient to a central storage device. As a result of the power consumed for data transmission and the requirement for long battery lifetime, there is a strict limit on any further processing, which the device could perform. With a reduction in communication power, low power signal processing techniques could be employed in order to provide relevant information, reduce transmission and/or storage, and reduce the analysis workload on the medical staff. This will enable sensors to be smart by performing more signal analysis on the sensor side. Wireless body area networks (WBANs) have enabled the deployment of lightweight, portable

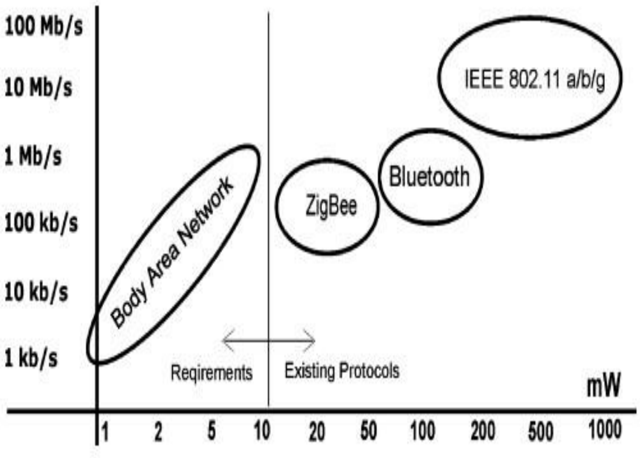

Figure 1. Data rates and power requirements for WBAN

From figure 1. it can be seen that BAN protocols should be more power efficient compared to existing commercial protocols [12].Sensors replacing the need for patients to spend long periods in hospital for routine monitoring. This enhances quality of life for patients and also has impact on medical care cost reduction. WBAN consist of a number of sensors that are either connected with a person's body or are small enough to be implanted. One of the main constraints for such systems is the power consumption since power supply is very limited.

These sensors need to transmit data at relatively wide range of data rates from 1 kbit/s to 1Mbit/s (body temperature, ECG, EEG, electromyography (EMG), movement, etc.). Fig. 1 shows that current technology meets the speed levels required for a body area network (BAN), but still does not meet the power requirement of less than 10 mW. While there has been some progress in this area, most devices used in WBAN applications store all the recorded data or transmit them to a monitoring station (MS) using IEEE 802.15.1 (Bluetooth) or
802.15.4 (ZigBee) protocols. These wireless standards are well documented and tested, but are not an ideal choice for the WBAN since they are targeted to more flexible networks than this and used for longer transmission ranges. This makes them not as energy efficient as the protocols that are specifically targeted at a BAN. A comparison and optimization of two popular WBAN technologies, Bluetooth and ZigBee, is given in the comparative study, in terms of design cost performance and energy efficiency.Table.1 differentiates the three Mac Protocols according to their operation, advantage and disadvantage [14].

Table.1. Classification of MAC Protocols

Power efficient Mechanism	Basic Operation	Advantage	Disadvantage
Contention based (CSMA/CA)	(CSMA/CA) have their nodes contended for channel access prior to transmission.	Collision of the data is avoided, Low delay, reliable communication.	Extra energy utilization for collision detection and collision avoidance
Schedule Based (TDMA)	Access to the channel is divided into time slots that are of fixed or variable duration	Collision free, low overhearing, Low duty cycle operations.	Need to pay an extra energy cost for time synchronisation, non-adaptability and scalability.
Low Power Listening (LPL)	Uses preamble sampling technique for communication between the nodes	Reduce idle listening using non-persistent CSMA and preamble sampling technique.	Sensitive to traffic rates which results in degradation of performance in the scenario of highly varying traffic rates.

2. ENERGY-EFFICIENT MULTI-HOP MEDICAL SENSOR NETWORKING

The ageing population in many developed countries highlights the importance of novel technology-driven enhancements to current health care practices. Recent technological developments in the fields of sensing, actuation, processing, wireless communication, and information management have fueled increased interest in technology-enhanced health care. For example, a wireless network of sensor and actuator node scan be deployed in an elderly person's home (with the person consent) to assist the person in living independently for as long as possible. Another example is the use of wireless sensor networks to monitor hospital patient vital signs to allow the patient's greater freedom of movement.

A major enabling technology of enhanced health care systems is wireless sensor networks (WSNs). The large scale adoption of WSN technology for health care systems will depend on the Quality-of-Service (QoS) provided by these networks, namely the reliability, latency, and efficiency. QoS provision in WSN's is tightly coupled with the medium access control (MAC) protocol. The MAC layer is responsible for coordinating channel access, such as transmission scheduling to maximize throughput and to avoid packet collisions. To ensure network longevity and acceptable end-to-end packet delay, MAC protocols for sensor networks target a balance between energy efficiency and end-to-end packet delay at the expense of data throughput.

Requirements of sensor network MAC protocols:

• Coordinated sleep states: recent studies revealed that the transceiver activity (transmitting and receiving) is one of the main sources of node energy consumption; therefore alternating periods of activity (radio on) to periods of inactivity (sleeping) can lead to significant reductions in energy consumption reduction. However, communication between neighboring nodes necessitates simultaneous node activity, so coordinated sleeping is necessary.

• Multi-hop communication: in order for a transmitter and receiver pair to communicate, the required transmitting power Pt changes exponentially with the distance D. Significant energy saving can be achieved by reducing the sensor transmitting power and by enabling multihop communication.

• Hidden node avoidance: Sensor network MAC protocols should provide mechanisms to avoid the hidden terminal problem (HTP) that is characteristic of distributed wireless communication networks. The recent IEEE 802.15.4 standard developed for energy efficient WSNs assumes that higher layers will handle the above requirements. The IEEE 802.15.4 standard only supports a single star-topology network, in which several child nodes communicate with a designated coordinator node.The communication performance seriously degrades when the system scales to a larger network which includes several nearby star-networks in the same area.

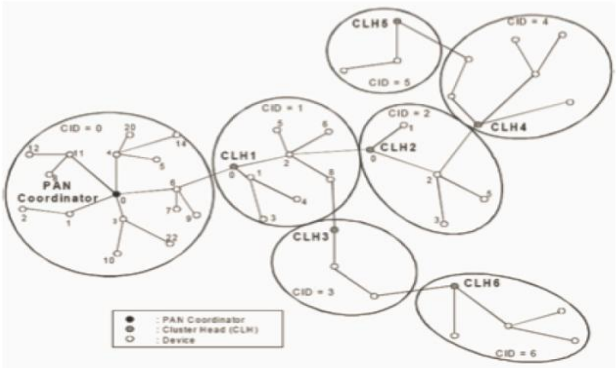

Figure 2: Cluster tree network

The Fig 2 defines different cluster zones nodes implementation and cluster-head formation [15].The IEEE 802.15.4 also cannot control the channel access within a multiple star topology network, leaving the resolution of multi-hop routing for higher layer protocols. Furthermore, the 802.15.4 standard does not provide any mechanism to avoid the HTP or to coordinate sleeping patterns in multi-hop peer-to-peer networks.

Building on the IEEE 802.15.4 standard, this paper proposes a mechanism called Time zone Coordinated Sleep Scheduling (TICOSS) that provides multi-hop support, HTP mitigation, and coordinated sleeping through the division of the network into time zones. The time zone concept adopted from the recent developed MERLIN mitigates the HTP by ensuring that nodes in neighboring zones do not transmit simultaneously. The time zones also provide coordinated sleeping, through the V-table scheduling, and shortest path multi-hop routing. The adoption of MERLIN is due to its earlier comprehensive evaluation in that presented a superior energy/delay performance than existing protocols for WSNs.

IV. CONCLUSION

The review paper is based on the study of various methods which are based on energy efficient wireless body area networks (WBAN). The purpose of study is to find the better sensor networks which are more energy efficient, the design of low-cost, miniature, lightweight, and smart physiological sensor nodes. In the paper named "Energy-Efficient Multi-hop Medical Sensor Networking", a comparison of the network lifetime between 802.15.4 with and without TICOSS specification of more complex issues to upper layers. This paper has described improvements to the IEEE 802.15.4 standard by setting all nodes to FFDs then imposing a time zone coordinated sleeping mechanism named TICOSS to (1) save energy; (2) mitigate hidden terminal collisions through V- table scheduling; (3) provide configurable shortest path routing to the PAN coordinator. Whereas In the paper, "Energy-Efficient Low Duty Cycle MAC Protocol for Wireless Body Area Networks presented a novel low power reliable MAC protocol. Energy model was proposed and validated through measurements. WBAN with our protocol can be used in the EEG monitoring scenario. Reducing the power requirements for the communication part of the system allows allocation of more energy to more accurate DSP for seizure detection. The paper "Energy-Efficient Multi-hop Medical Sensor Networking" is dealing more efficiently with Mac protocols in WBAN. More hybrid methods can be a possibility to reduce energy consumption and increase power efficiency.

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