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# A Study on Various Routing Techniques and QoS Issues in WBAN

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**Abstract:** Wireless Body Area Network (WBAN) is an active research area in the field of Wireless Sensor Network (WSN). WBAN consists of miniature, portable, autonomous and heterogeneous sensor nodes. It is mainly used in health monitoring system. WBAN is a three tier architecture, in which architecture of WBAN can be divided into inter-BAN, intra-BAN and beyond-BAN communication. Quality of Service (QoS) of WBAN is an area that is needed to be explored. QoS is one of the most important features for any applications. QoS in WBAN can be characterized by reliability, robustness, availability, data transmission, packet loss, error rates and security. It is used in medical as well as in non-medical fields. Routing protocols of WBAN play an important role because communication or transmitting & receiving of data depend on routing. Different routing schemes are proposed for to make efficient network. Single-hop and multi-hop routing are used to transmit the information to the sink node. Single-hop means transmission of information from nodes to the sink node directly and multi-hop routing means information is reached to the sink node through multiple nodes. Reliable delivery of data and QoS are the main issues of WBAN. In this paper, we provide an overview about routing techniques and QoS issues in WBAN.

**Keywords:** WBAN, applications, QoS of WBAN, routing in WBAN, WSN and WBAN

## 1. INTRODUCTION

Rapid growth in wireless technology born a new generation of Wireless Sensor Network called 'Wireless Body Area Network' (WBAN). WBAN is an active field of research in WSNs. WBANs consists of miniaturized, portable, lightweight and autonomous sensor nodes [1]. WBAN is a called location independent portable patients' monitoring system in which different-different biological sensors are used. These sensors are chosen on the basis of which type of disease is to be monitored like diabetes, temperature, blood pressure, heart attack and many others [2]. Sensors are placed inside the body or outside the body to monitor the diseases. Sensors communicate with each other and collect the information from body and forward to the sink node or coordinator. Two types of communication are used direct and indirect, direct communication is used to send emergency data\information to the base station (sink node) and indirect communication is used to send normal data of patients to the base station in which data is transmitted via multiple nodes. So, WBANs are intended to be low-power and light-weight devices for portability and user convenience. The healthcare industry have to face the population problem, WBANs is only one solution to overcome from this problem [3]. The old and disabled persons are also benefited due to the WBAN, through remotely checkup. It brought a major revolution in health sector.

Quality of Service (QoS) management in WBANs is an area yet to be explored. It is a new concept for WBANs. QoS is defined as: Overall performance of a network, particularly the performance seen by the users. QoS in WBANs can be characterized by reliability, robustness, availability, data transmission, packet loss, error rates and security. Since, WBAN is used in various areas like health monitoring, military areas etc. Different applications of WBANs may require different types of QoS. In WBANs, the QoS are resource capability, network lifetime, dimensions, energy efficiency etc. QoS metrics are used to measure the degree of satisfaction of user. The main goal of QoS is to maximize the use of network service using optimum energy.

In this paper, we discussed about architecture of WBAN, routing in WBAN, differences among WBAN and WSN, routing in WBAN and QoS in WBAN. The ability to deploy sensor nodes on human body leads to the developing a large number of applications in several fields like sports, music, military etc. In this paper we are also discussing about advantages and disadvantages of WBAN and how sensors affected our body. Different routing protocols are compared in table 1.

## 2. ARCHITECTURE OF WBAN

A WBAN consists of in-body and on-body nodes that continuously monitor the patients and retrieve the information about diseases, and provide real time feedback to the user [2]. In-body nodes also refer to implanted nodes and on-body nodes are wearable nodes. In-body nodes are only used for medical applications while on-body nodes are used for both medical and non-medical applications. As shown in figure 1 [4], WBAN is a three tier architecture. This architecture consists of three tier communications, Intra-BAN communication, Inter-BAN communications and Beyond-BAN communication. Communication among sensors and sink node inside the body is called Intra-BAN communication. Communication between sink node and personal devices such as notebook is called Inter-BAN communication. The Beyond-BAN communication communicates personal device with LAN or WAN.

WBAN uses Wireless Medical Telemetry Services (WMTS), unlicensed industrial, scientific and medical (ISM), Ultra-wideband (UWB), and Medical Implant Communication Service (MICS) bands for data transmission [2].

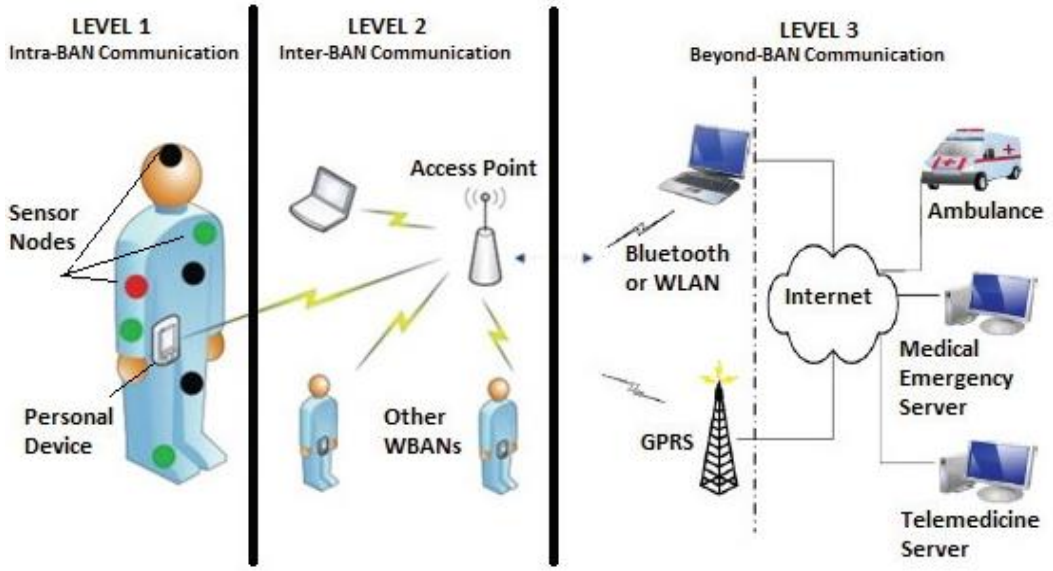


Fig. 1: Architecture of WBAN [4]

### *A. Topology used in WBAN*

WBANs work on or operate on single-hop or multi-hop topology in which sink node is placed at the center of the body so that communication between nodes is easy. Single-hop means transmission of information directly to sink node, and multi-hop means information is reached to the sink node via multiple nodes. Two types of data transmission are used; one is the transmission from device to the coordinator and other from coordinator to device [5].

### *B. Applications o WBAN*

Due to varieties of components of Wireless Body Area networks, it is able to perform sensing work in military, healthcare, emergency, research, lifestyle, sports etc. Medical application of WBAN continuously monitor the patients, if any abnormal condition is detected, the information is immediately transmitted to doctor. In non-medical applications especially in military WBANs are used to prevent sensitive information from being caught by enemies [1].

## 3. ROUTING FOR WBAN

Choosing a routing topology in WBAN is an important thing to maintain the delivery of the data or information of the patients on time. A WBAN should have a node based movement topology rather than group based movement in WBAN. Designing a routing protocol in WBAN is a major task due to some constraints like mobility, limited battery power etc. Comparison among various routing protocols of WBAN is presented in table 1.

## 4. LITERATURE REVIEW

In [8] authors proposed a technique to recharge the nodes using harvesting energy. Harvesting energy in the human environment has been identified an effective way to charge the sensor nodes in WBAN.

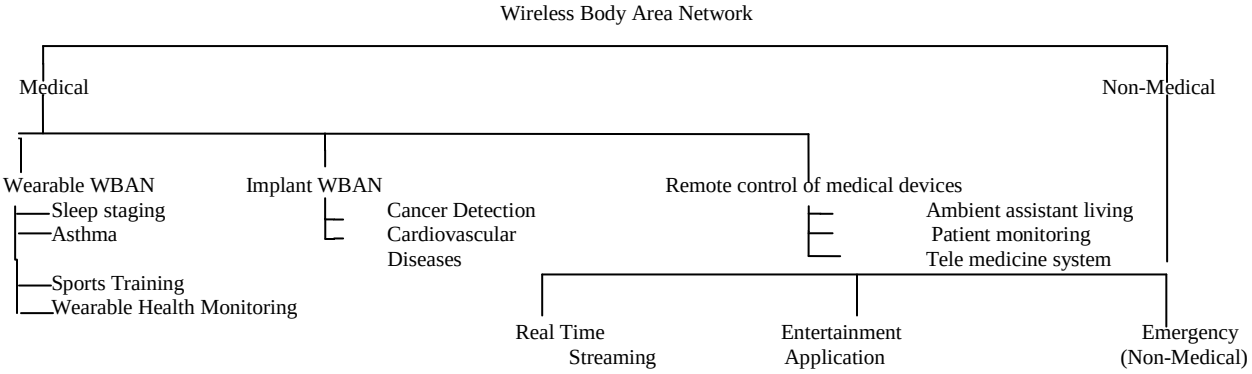


Fig. 2: Applications of WBAN [5]

Table 1: Protocols of WBAN [6, 7, 13]

| S.No. | Protocol | Technique | Advantages |
|---|---|---|---|
| 1 | AODV | Reactive Protocol | Less control overhead |
| 2 | DSR | Reactive Protocol | Less control overhead and reduce Table Driven approach |
| 3 | DSDV | Table Driven | Always shows available of destination |
| 4 | M-ATTEMPT | Hot spot (Temperature based) | Support mobility and Energy Management |
| 5 | SIMPLE | Create cost function for relay node | Longer Stability Period |
| 6 | RE-ATTEMPT | Placement of nodes with minimum energy level | Minimize the energy consumption |
| 7 | LAEEBA | Cost function & Path loss is based on low energy | Maximum stability period compared to SIMPLE & M-ATTEMPT |
| 8 | CO-LAEEBA | Select relay node based on residual energy | Higher residual energy, Throughput and lower path loss |
| 9 | EERDT | Hierarchical & Single-hop routing | Increase network stability |

Markov-channel is used to detect the physical phenomenon or movement of the body, because releasing energy during body movements is used as harvesting energy. In this work, author proposed a novel and highly efficient control scheme, called joint power-QoS (PEH-QoS). This model consists of three modules: Power-EH aware management (PHAM), Data Queue Aware Control (DQAC) and Packet Aggregator/Scheduling System (PASS) and enables the optimal use of energy collected in the human environment.

In [9], Seyedi and Sikdar focused on finding an average probability, that an event is not detected or transmitted (lost event) due to the lack of sufficient energy in sensor nodes, which are implanted in or on the body. Authors conduct and analyze the body nodes powered by human energy harvesting by provide a discrete time model called Markov Chain. This discrete time model integrates the energy harvesting model and traffic generation model.

In [10], same authors Seyedi and Sikdar proposed a set of adaptive transmission policies and formulated using Markov Chain model. The main aim of this paper is to maximize the probability of event detection and transmission. This proposed scheme exploits the information on level of body nodes, the battery recharging states as well as event generation process.

In [11], Ventura and Chowdhury have extended the research work discussed in [13,14] and proposed a Multiple Board Markov Model for energy harvesting sensors (MAKERS) that allow for the estimation of important performance metrics. He et al. [12] extended the research of above work [11], and proposed analytical solutions for the optimal resource allocation to provide QoS guarantee to data delivery for the human energy harvesting of WBANs. The main goal of this proposed scheme is to provide a sustainable QoS that guarantees low delay and low packet loss to subscribers.

## 5. QOS METRICES SUPPORT FOR WBAN

Now a days, the main goal of researchers in WBAN is to increase the lifetime of sensors (nodes). Since nodes in WBAN are battery power constraints. As the battery level drop, the work of nodes is also stopped. Many routing protocols have been proposed to in

support of WBAN. QoS aware routing protocols provide different-different modules for different QoS metrics. For this reason, they provide high reliability, lower end to end delay and more number of packets to be delivered. QPRR (Quality of Services Aware Peering Reliable Routing) routing protocol to reliable delivery of data is proposed in support of WBAN.. This routing protocol is used for mainly indoor hospital. There are three types of devices used to reliable delivery of data and the devices are To resume the operation, the battery is replaced or recharged as soon as possible. A new concept has been proposed to recharge the battery in WBAN: 'Harvesting Energy'. Harvesting energy in WBAN is an effective way to charge the body nodes or sensors [8]. In this, a special type of hardware is used called 'Energy Harvester'. Energy Harvester converts the energies (e.g., heat, motion etc.) which released from body into electrical energy. It provides small amount of energy to charge the nodes.

*A. QoS Challeges in order to develop in WBAN*

In this paper we have studied the major challenges while developing a QoS based WBAN. The WBAN has to face the different-different types of problem. Since, QoS deals with the overall performance of a network like throughput, latency and packet loss. There are following factors which affect the WBANs [15]:

- Resource Limitation: Since, WBAN consists of low powered battery, limited memory and processing capacity. So, limitation of resources is a major issue to develop a WBAN supporting QoS facilities.
- Unpredictable traffic patterns: Sometimes WBAN not able to predict the exact pattern to communicate the data from source to destination due to heavy traffic load of data.
- Network instability: The network is distracted in WBAN is a major issue to developing a QoS supporting WBAN because of its resource limitations.
- Various types of applications of WBAN require different types of QoS metrics.
- Energy efficiency: Continuous data sensing and transmission, and greater distance between communicating nodes are the main factors of more energy consumption . As the nodes are placed in/on human body. Therefore, battery cannot be frequently recharged or replaced.

*B. Advantages of WBAN*

- Used to detect the chronic diseases
- Avoid the aging and population problem
- Used in military for security purpose
- Improve the quality of life

*C. Disadvantages of WBAN*

- Due to limited power and limited memory, sensors cannot perform large bit computations [11].
- Security and inferences both are the main issues in WBAN.

## 6. DIFFERENCES BETWEEN WSN AND WBAN

Although WBANs share some common features with WSNs like low computation power, small memory, limited energy resources etc., the solution for WSNs application might not be applicable to WBAN due to the differences listed out in table.

Table 2: Difference between WSN and WBAN [17]

| Parameters | WSNs | WBANs |
|---|---|---|
| Number of nodes | More nodes used compared to WBANs | Fewer nodes are used |
| Scale | Monitored Environment (m/km) | Human Body (m/cm) |
| Node Size | Small as well as large | Small |
| Node replacement | Difficult | Easy |
| Security | Lower | Higher |
| Node Task | Perform dedicated task | Perform multiple task |
| Technology | Bluetooth, ZigBee, GPRS, WLAN | Low power technology required |
| Mobility | Nodes are stationary | Nodes share the same mobility pattern |

## 7. CONCLUSION

In this paper, we have studied WBAN infrastructure, applications, QoS, advantages and disadvantages of WBAN. Harvesting energy is a new concept to recharge the nodes in WBAN. We studied various routing techniques for WBAN and also compare these techniques in terms of successfully delivery of information from patient to the doctor. For this, single-hop and multi-hop routing strategies are used. Resource limitations and energy efficiency are main issues of WBAN. In future, we will try to enhance the QoS in WBAN by designing a routing scheme which provide end to end delivery of data and consume less energy.

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