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A Review on Communication Architecture and Challenges of Routing in WBAN

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***Abstract**: Wireless Body Area Networks (WBANs) represent one of the most promising approaches for improving the quality of life, allowing remote patient monitoring and other healthcare applications. For data transfer among sensor nodes, a point to point topology or multi-hop topology is used in these networks. In WBAN, only few sensors are used which are implanted in body or positioned on the body. These tiny sensors placed on patient's body measure vital signs like blood pressure, Glucose level, and pulse rate etc. Wireless body area network, WBAN, is a network designed by low-power devices that are located on, in or around the human body and are used to monitor physiological signals and motion for medical, personal entertainment and other applications and purposes. WBANs are usually driven by battery power consumption is the most important factor to determine the life of WBANs. Proficient energy routing is thus a key requirement for a trustworthy design of a wireless sensor network.*

***Keywords:** WBAN, Hierarchical routing in WBAN, wireless body area network.*

1. INTRODUCTION

The rapid growth in population of developed countries brings major challenges for health-care authorities and government. To counter health challenges and to provide patient monitoring at remote area, wireless technology provides cost effective, reliable and fast services to patient. Wireless Body Area Network (WBAN) is new emerging technology which provides potentially great health care services. It provides easy diagnostic monitoring [1]. In WBAN, sensor nodes are operated with energy source constraints. It is required to use minimum power for transmitting data from sensor node to sink. Minimum energy utilization of energy source can preserve the battery life over longer period because recharging of batteries in WBAN is infrequent. One of the major obstacles in WBAN is to recharge the batteries [2]. An efficient routing protocol is required to overcome this issue of recharging batteries. WSNs have many routing protocols which efficiently utilizes energy. However, WSNs and WBANs have different architectures, applications and operate in different conditions. It is impossible to port WSN routing protocol to WBAN. So, energy efficient routing protocol for WBAN is required to monitor a patient for longer period of time [3]. UWB is a high bandwidth communication standard and it is used in high data rate applications. UWB is best choice whenever a application requires a high bandwidth. In emergency applications, UWB is considered best choice to use for communication. UWB are implemented with Global Positioning System (GPS). The receiver of UWB band is very complex that makes it not good for use in wearable application [4].

2. Communication Architecture of WBANs

The communication architecture of WBANs can be separated into three different tiers as follows:

- Tier-1: Intra-WBAN communication
- Tier-2: Inter-WBAN communication
- Tier-3: Beyond-WBAN communication

Fig. 1 illustrates these communication tiers in an efficient, component-based system for WBANs. In Fig. 1, the devices are scattered all over the body in a centralized network architecture where the exact location of a device is application specific [8]. However, as the body may be in motion (e.g. running, walking) the ideal body location of sensor nodes is not always the same; hence, WBANs are not regarded as beings static [8].

Tier-1: Intra-WBAN communication – Tier-1 depicts the network interaction of nodes and their respective transmission ranges (~2 meters) in and around the human body. Fig. 1 illustrates WBAN communication within a WBAN and between the WBAN and its multiple tiers. In Tier-1, variable sensors are used to forward body signals to a Personal Server (PS), located in Tier-1. The processed physiological data is then transmitted to an access point in Tier-2.

Tier-2: Inter-WBAN communication – This communication tier is between the PS and one or more access points (APs).The APs can be considered as part of the infrastructure, or even be placed strategically in a dynamic environment to handle emergency situations. Tier-2 communication aims to interconnect WBANs with various networks, which can easily be accessed in daily life as well as cellular networks and the Internet [5].

The paradigms of inter-WBAN communication are divided into two subcategories as follows:

Infrastructure based architecture – The architecture shown in Fig. 2 is used in most WBAN applications as it facilitates dynamic deployment in a limited space such as a hospital as well as providing centralized management and security control. The AP can act as a database server related to its application [5].

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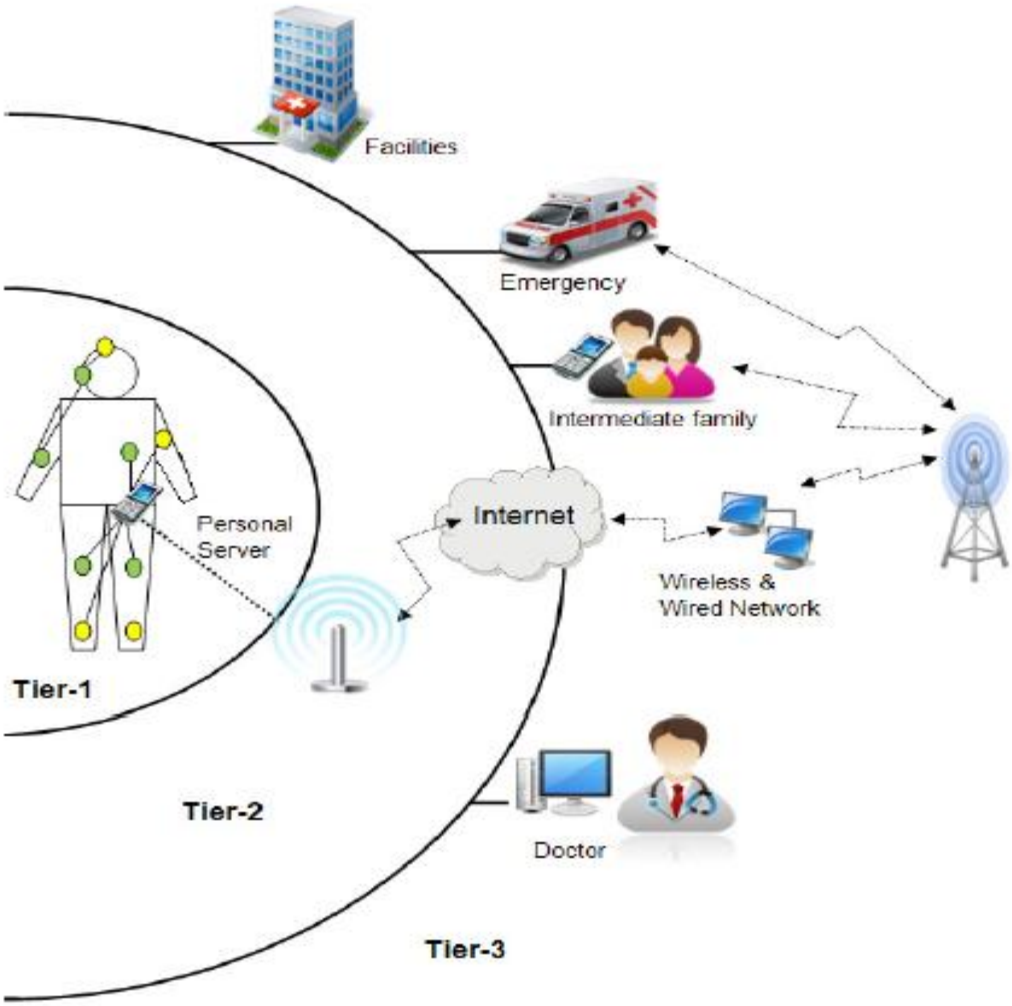

Figure 1: Communication Tiers in a Wireless Body Area Network [8]

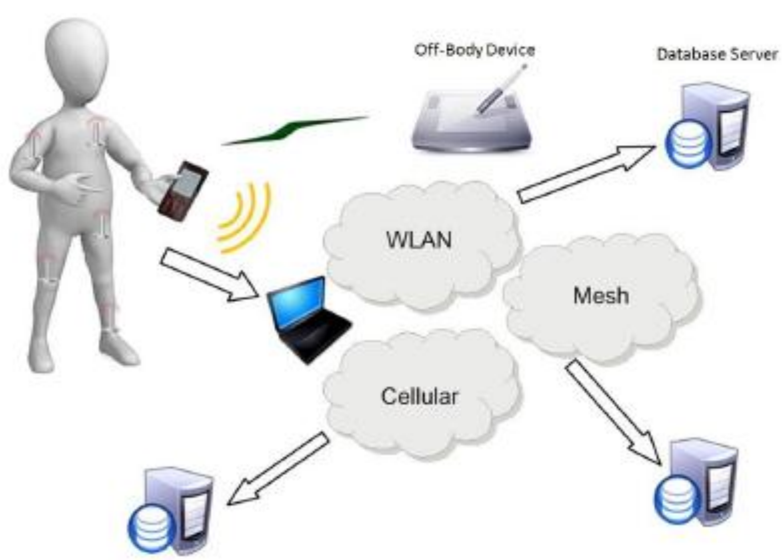

Figure 2: Inter-WBAN Communication: Infrastructure-based mode [5]

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Ad-hoc based architecture – In this architecture, multiple APs transmit information inside medical centers as shown in Fig. 3. The APs in this architecture form a mesh construction that enables flexible and fast deployment, allowing for the network to easily expand, provide larger radio coverage due to multi-hop dissemination and support patient mobility. The coverage range of this configuration is much larger compared to the infrastructure based architecture, and therefore facilitates movement around larger areas. In fact, this interconnection extends the coverage area of WBANs from 2 meters to100 meters, which is suitable for both short and long term setups [5].

Figure 3: Inter-WBAN Communication: Ad-Hoc based mode [5]

Tier-3: Beyond-WBAN Communication – The design of this communication tier is for use in metropolitan areas. A gateway such as a PDA can be used to bridge the connection between Tier-2 and this tier; in essence from the Internet to the Medical Server (MS) in a specific application [8]. However, the design of Tier-3 for communication is application-specific. In essence, in a medical environment a database is one of the most important components of Tier-3 as it includes the medical history and profile of the user. Thus, doctors or patients can be notified of an emergency status through either the Internet or a Short Message Service (SMS). Additionally, Tier-3 allows restoring all necessary information of a patient which can be used for their treatment [5]. However, depending on the application, the PS in Tier-1 can use GPRS/3G/4G instead of talking to an AP.

3. Types of Nodes in a WBAN

A node in a WBAN is defined as an independent device with communication capability. Nodes can be classified into three different groups based on their functionality, implementation and role in the network. The classification of nodes in WBANs based on functionality is as follows:

Personal Device (PD) – This device is in charge of collecting all the information received from sensors and actuators and handles interaction with other users. The PD then informs the user through an external gateway, display/LEDs on the device or an actuator. This device may also be called body gateway, sink, Body Control Unit (BCU) or PDA in some applications [8].

Sensor – Sensors in WBANs measure certain parameters in one's body either internally or externally. These nodes gather and respond to data on physical stimuli, process necessary data and provide wireless response to information. These sensors are physiological sensors, ambient sensors or biokinetics [8]. Some existing types of these sensors could be used in one's wrist watch, mobile, or earphone and consequently, allow wireless monitoring of a person anywhere, anytime and with anybody. A list of different types of commercially available sensors used in WBANs are as follows: EMG, EEG, ECG, Temperature, Humidity, Blood pressure, Blood glucose, Pulse Oximetry (SpO2), CO2 Gassensor, Thermistor, Spirometer, Plethysmogram, DNA Sensor, Magnetic Biosensor, Transmission Plasmon Biosensor, Motion(Gyroscope/Accelerometer/Tri-Axial Accelerometer), etc.

Actuator – The actuator interacts with the user upon receiving data from the sensors [8]. IEEE 802.15.6 has proposed another classification for nodes in a WBAN based on the way they are implemented within the body, which is provided as follows [8]:

Implant Node – This type of node is planted in the human body, either immediately underneath the skin or inside the body tissue.

Body Surface Node – This type of node is either placed on the surface of the human body or 2 centimeters away from it.

External Node – This type of node is not in contact with the human body and rather a few centimeters to 5 meters away from the human body.

The classification of nodes in WBANs based on their role in the network is as follows:

Coordinator – The coordinator node is like a gateway to the outside world, another WBAN, a trust center or an access coordinator. The coordinator of a WBAN is the PDA, through which all other nodes communicate.

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End Nodes – The end nodes in WBANs are limited to performing their embedded application. However, they are not capable of relaying messages from other nodes.
Relay – The intermediate nodes are called relays. They have a parent node, possess a child node and relay messages.

4. Challenges of Routing in WBANs

1. *Postural Body Movements* – Few body segments and clothing result in signal blockage that intensifies RF attenuation. More specifically, the mobility pattern in WBANs changes with the order of movements within tens of centimeters whereas the scale of mobility in WSNs is in the order of meters and tens of meters [6].
2. *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 [7].
3. *Local Energy Awareness* – The proposed routing protocol has to disperse its communication data among nodes in the network to balance power usage and minimize failure to battery supply drainage.
4. *Global Network Lifetime* – Network lifetime in WBANs is referred to as the time interval from when the network starts to the time the network is significantly damaged, which leads to network partitioning such that the destination cannot be reached [6].
5. *Efficient Transmission Range* – The low RF transmission range in WBANs leads to frequent partitioning and disconnection amongst sensors in WBANs, which results in similar performance to DTNs.
6. *Limitation of Packet Hop Count* –The larger the number of hops, the higher the energy consumption. However, the limitation of packet hop count has not been considered in most WBAN routing protocols. Additionally, half-duplex devices in WBANs reduce the bandwidth as successive hops are introduced [7].
7. *Heterogeneous environment* – Specific applications of WBANs may require heterogeneous data collection from different sensors with different sampling rates. Therefore, QoS support in WBANs may be quite challenging.
8. *Limitation of resources* – Data capacity, energy and device lifetime of WBANs is strictly limited as they require a small form factor. Due to limitation of available resources in WBANs, therefore, WBAN nodes are bound to fail due to unavailable battery power, memory and bandwidth limitations, which are major threats to QoS.

5. Conclusion

WSNs have many routing protocols which efficiently utilizes energy. However, WSNs and WBANs have different architectures, applications and operate in different conditions. It is impossible to port WSN routing protocol to WBAN. So, energy efficient routing protocol for WBAN is required to monitor a patient for longer period of time. Our contribution is that the author's propose a high throughput, reliable and stable routing protocol for patient monitoring. The author's deploy sensor nodes on the body at fixed places. Sink is paced at waist. Sensors for ECG and glucose level are placed near the sink. Both these sensors have critical data of patient and required less attenuation, high reliability and long life so they always send their data directly to sink. Other sensors follow their parent node and transfer data to sink through multi hop. It saves energy of nodes and network work for longer time.

REFERENCES

[1] Georgia D. Ntouni, Athanasios S. Lioumpas and Konstantina S. Nikita, "Reliable and Energy Efficient Communications for Wireless Biomedical Implant Systems", IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS, VOL. X, NO. XX, XXXXX 2014.

[2] N. Javaid, Z. Abbas, M. S. Fareed, Z. A. Khan, N. Alrajeh, "M-ATTEMPT: A New Energy-Efficient Routing Protocol for Wireless Body Area Sensor Networks", The 4th International Conference on Ambient Systems, Networks and Technologies (ANT 2013).

[3] Gabriel E. Arrobo, Student Member, IEEE and Richard D. Gitlin, " Improving the Reliability of Wireless Body Area Networks" 33rd Annual International Conference of the IEEE EMBS Boston, Massachusetts USA, August 30 - September 3, 2011.

[4] Changhong Wang, Qiang Wang, Member, IEEE and Shunzhong Shi, "A Distributed Wireless Body Area Network for Medical Supervision" , IEEE 2012.

[5] JoonsungBae, Student Member, IEEE, KiseokSong ,"A Low-Energy Crystal-Less Double-FSK Sensor Node Transceiver for Wireless Body-Area Network", IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 47, NO. 11, NOVEMBER 2012.

[6] Jocelyne Elias and Ahmed Mehaoua , "Energy-aware Topology Design for Wireless BodyArea Networks", IEEE ICC 2012.

[7] StevanJovicaMarinkovi´c, Emanuel MihaiPopovici, Senior Member, IEEE, "Energy-Efficient Low Duty Cycle MAC Protocol for Wireless Body Area Networks", IEEETRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 13, NO. 6, NOVEMBER 2009.

[8] L. Wang and H. Liang, "Research and improvement of the wireless sensor network routing algorithm gpsr," in Computing, Measurement, Control and Sensor Network (CMCSN), 2012 International Conference on, pp. 83–86, IEEE, 2012.