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A REVIEW ON WIRELESS BODY AREA NETWORKS

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Abstract:

In wireless body area networks various sensors are attached on clothing or on the body or even implanted under the skin. The wireless nature of the network and the wide variety of sensors offer numerous new, practical and innovative applications to improve health care and the Quality of Life. Using a WBAN, the patient experiences a greater physical mobility and is no longer compelled to stay in the hospital. In this paper, we present an overview of wireless body area network and we also provide the differences between Wireless Body Area Network and Wireless Sensor Network (WSN) that is inadequate to apply in WBAN. We also present an idea to improve healthcare systems in India with the help of telecommunication and information technology by using wearable and implantable body sensor nodes which does not affect the mobility of the patients. We discuss how the wireless body area networks are used for healthcare monitoring by using multiple sensor nodes. In this paper we present various innovations and discuss promising new trends of wireless body area networks for ubiquitous health monitoring applications.

Keywords: Body Area Network (BAN), Wireless Sensor Network (WSN), Mobile Health Application, Smart Hospitality, Wireless Body Area Network (WBAN), Body Sensor Network(BSN), Electrocardiogram(ECG).

I. INTRODUCTION

A Wireless Body Area Network consists of small, intelligent devices attached on or implanted in the body which are capable of establishing a wireless communication link. These devices provide continuous health monitoring and real-time feedback to the user or medical personnel. The measurements can be recorded over a longer period of time, improving the quality of the measured data [1].

A WBAN contains a number of portable, miniaturized, and autonomous sensor nodes that monitors the body function for sporting, health, entertainment, and emergency applications. It provides long term health monitoring of patients under natural physiological states without constraining their normal activities. In-body sensor networks allow communication between im-planted devices and remote monitoring equipments. They are used to collect information from Implantable Cardioverter Defibrillators (ICDs) in order to detect and treat ventricular tachyarrhythmia1 and to prevent Sudden Cardiac Death (SCD) [7].

In WBANs, sensor hubs are worked with restricted vitality source. It is required to utilize least power for transmitting information from sensor hubs to sink. One of the significant obstructions in WBAN is to energize the batteries. A productive direct ing convention is required to conquer this issue of energizing batteries. Numerous vitality proficient directing conventions are proposed in WSN innovation. Nonetheless, WSNs and WBANs have

distinctive designs, applications and work in various conditions. It is difficult to port WSN steering conventions to WBAN. Hence, vitality effective directing convention for WBAN is required to screen patients for more period. We propose a high throughput, dependable and stable directing convention for WBAN. Sensors for ECG and Glucose level are set close to the sink. Both these sensors have basic information of patient and required least constriction, high unwavering quality and long life thusly; these sensors dependably transmit their information specifically to sink. Different sensors take after their guardian hub and transmit their information to sink through forwarder hub. It spares vitality of hubs and system works for more periods.

II. LITERATURE SURVEY

In last decade, Wireless communication technologies and standards have grown exponentially. With this research can be applied in various domains that were not feasible, years ago. E-Health and Telemedicine are two areas at the forefront of this development that take full advantage of current wireless communication technologies to provide emergency and ondemand medical services, enable outpatient monitoring and treatment, aid in patient recovery, directly connect doctors and nursing staff with patients, WBAN is one of the examples. WBAN is a wireless networking technology, based on Radio Frequency (RF) that interconnects some small nodes with sensing unit or actuator capabilities. These nodes operate in close vicinity to, on or few cm inside a human body, to support various medical and non-medical area applications.

2.1. Architecture of WBAN

WBAN uses medical bands to obtain physiological data from sensor nodes. The medical band is selected in such a way that it reduces interference and thus increases the coexistence of sensor node devices with other network devices available at medical centers. The collected data is then sent to remote stations with a multi-hopping technique using the medical gateway wireless boards [3]. WBAN technology is highly appreciated in the field of medical science and human healthcare [4-7] Also; a significant contribution has been delivered to the field of biomedical and other scientific areas [8]. Moreover, its applications are widespread in non-medical areas like consumer electronics and personal entertainment [9].

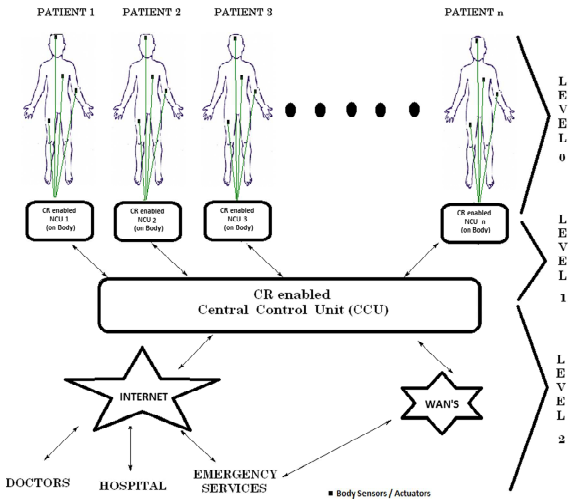

Figure 1. Architecture of WBAN

Supriya O. Rajankar et al. [13] study the architecture for healthcare monitoring applications in Wireless Body Area Network. The technology used in their study utilizes wireless sensor nodes to implement real-time wearable health monitoring of patients. Primary motivation of their study is to provide steady, timely, comfortable and proper monitoring of physical and biomedical parameters of patient continuously. They study that Long term monitoring may provide detection of early signs of deterioration of patient's health and support for computer assisted rehabilitation. They demonstrate from their study that the main two challenges in this system are there should be continues power supply to the body sensor nodes and system should Guarantee for delivery of data stream to the destination means Quality of service.

Narendra Kumar et al. [17] provide a snapshot of current developments and future direction of research on wearable and implantable body area network systems for continuous monitoring of patients. In this paper, medical sensors were used to collect physiological data from patients

and transmit it to Intelligent Personal digital Assistant (IPDA). They explain the important role of body sensor networks in medicine to minimize the need for caregivers and help the chronically ill and elderly people live an independent life, besides providing people with quality care. They have discussed the benefits of using wireless networks for medical applications. They have discussed about how the new wireless technologies can be utilized in potential manner to get benefits for the human well being.

2.2. Applications of WBAN

WBAN applications traverse a wide zone, for example, military, pervasive human services, game, excitement and numerous different ranges. The principle trademark in all WBAN applications is enhancing the client's personal satisfaction [8]. In any case, the innovative necessities of WBANs are application particular.

WBANs have an immense potential to alter the eventual fate of human services observing by diagnosing numerous life undermining sicknesses and giving ongoing patient checking [10]. Demographers have anticipated that the overall populace more than 65 will have multiplied in 2025 to 761 million from the 1990 populace of 357 million. This suggests by 2050 therapeutic matured consideration will turn into a noteworthy issue. By 2009, the medicinal services use in the United States was around 2.9 trillion and is assessed to achieve 4 trillion by 2015, very nearly 20% of the total national output. Likewise, one of the main sources of death is identified with cardiovascular malady, which is assessed to be as much as 30 % of passings overall [11, 12].

Sofia Najwa Ramli et al. [14] review the current development on Wireless Body Area Network and the security issues faced by Wireless Body Area Network. They also study the differences between Wireless Body Area Network and Wireless Sensor Network (WSN). WBAN brings out a new set of challenges in terms of scalability, sensor deployment and density, energy efficiency, security and privacy and wireless technology so WBAN requires a strong security system and part of it is authentication. So there is need to discover hybrid authentication protocol in providing a strong security system for WBAN. In [15]

Sujeethnanda M et al. present an overview of wireless body area networks and present ideas to improve healthcare systems in India with the help of telecommunication and information technology. Web-based medical advices system, called e-vaidyam is proposed for effective and affordable healthcare. They study that Body Area Networks effectively enable monitoring patient health and communicate with the doctor. Various paradigms of Mobile WSN's for healthcare are documented in this paper. Emil

Jovanov et al. [16] study that WBAN based m-Health technologies demonstrated great potential for ubiquitous health monitoring during activities of daily living. WBAN can provide patients with increased confidence and a better quality of life, and promote healthy behaviour and health awareness. They present state of technology, discuss promising new trends. They review the opportunities and challenges of wearable ubiquitous health systems that can increase acceptance of WBAN technology and lower the cost by shifting the focus to prevention and early detection of health conditions. A new generation of personalized monitoring systems will allow users to configure their systems and user interface, interact with their social network and improve their quality of living.

Reza Khalilian et al.[5] "An Efficient Method To Improve WBAN Security", This paper introduces another strategy which enhances the security issues of WBANs. The objective of this paper is to diminish the required memory control parcels multifaceted nature, controlling cradle over stream and controlling the current harm by utilizing high exchanging pace of information between hubs. In this paper the security is enhanced by utilizing AES-256 plan.

Anurag Tiwari et al.[7] "Security and Privacy in E-Healthcare monitoring with WBAN", are to a great degree key for those individuals which are experiencing ailments like heart related maladies ,rationally furious patients ,pregnant lady, and so forth, they require ceaseless perception .Since because of web related every one of these exercises

,they require more security. So this paper exhibits a security and protection related issues.

2.3. Routing protocols in WBAN

In [3], K Han et al, proposed an efficient model for authenticated key agreement in dynamic WBAN and that this protocol enables reduced authentication process for mobile node and can be used in various application of WBAN. In [4] Vaidya et al, proposed a user authentication scheme in WBAN, which is a variation of strong password based solution proposed.

In [5], Ying et al, proposed an efficient and scalable protocol to establish and update the authentication key between any pair of sensor nodes in dynamic WBAN. The proposed solution is suitable for both static and dynamic environments. The solution has less communication cost and high probability of sharing a key.

In [6] Chuchaisri: Proposed a 2 PKC-based broadcast schemes called the key pool scheme and key chain scheme using bloom filter to aid the node to decide/solve the dilemma when to forward the data first or authenticate first.

In [11], Wong et al, proposed a dynamic user authentication scheme for WBAN. It allows the genuine users to query the sensor data from any of the sensor nodes by imposing very less computational load. This scheme claimed that it is secure against replay and forgery attacks in which it fails.

In [12], Tseng et al, this paper shows that is vulnerable to replay and forgery attacks and proposed an authentication mechanism that retains the advantages of. The scheme possesses the advantage of resistance to the replay attacks and forgery attacks, with reduction in the risk of password leakage.

In [13], Abhram and ramanatha, proposed an authentication and initial shared key establishment model of hierarchical clustered networks.

In [14], Perrig et al, proposed a suite of security protocols called Security Protocols for WBANs (SPINS) optimized for WBANs. SPINS includes two protocols: secure network encryption protocol (SNEP) and µTESLA. SNEP provides unicast authentication, confidentiality, and replay protection through authentication with MAC and encryption. µTESLA offers a solution for broadcast authentication.

In [15], Zhu et al, in this proposed each node generates a one-way key chain and sends the commitment of it to their neighbors. If a node wants to send a message to its neighbors, it attaches the next authorization key from its key chain to the message. The receiving node can verify the validation of the key based on the commitment it has already received. This scheme does not provide a solution for attacks from inside where the adversary knows nodes cluster key.

Table 1: Various WBAN Technologies.

	Antonescu and Basagni [4] (2013)	Ullah et al. [1] (2012)	Latr´e et al. [2] (2011)	Chen et al. [5] (2011)	Cao et al. [3] (2009)	Hanson et al. [6] (2009)
Physical layer technology (hardware and devices)	(i) Body sensors (ii) Signal processing (iii) Data transmissions (iv) Power source and conservation (v) Antenna	(i) Electromagnetic coupling (ii) Antenna design/testing (iii) Matching networks (iv) Base station antennas (v) Implant materials	(i) Types of devices (ii) Data rates (iii) Movement of the body	(i) Communications architecture (ii) Platform (iii) Antenna design (iv) Electronic circuits (v) Improved propagation	(i) Sensor devices (ii) Sensor/actuator materials (iii) Electronic circuits (iv) Improved propagation (v) Power	(i) Sensors (ii) Signal processing (iii) Storage

	design	(vi) Signal propagation		(vi) Power supply	supply	
Energy efficiency	Energy efficient	Energy efficient	Not Energy efficient	Energy efficient	Energy Harvesting	Energy Harvesting
Channel technology	Channel modeling	Multichannel design	Multichannel design	(i) Channel modeling (ii) Multichannel design	(i) Channel model	(i) Communications
Radio technology	(i) Radio technologies (ii) Non-RF transmissions	(i) In-body RF communications	(i) RF communications (ii) Non-RF communications (iii) IEEE 802.15.4 (iv) IEEE 802.15.6	(i) Bluetooth low-energy technology (ii) ZigBee (iii) UWB and IEEE 802.15.6 (iv) Integrating emerging wireless technologies	(i) Radio propagation (ii) Bluetooth low-energy technology (iii) UWB (iv) Bluetooth 3.0 (v) ZigBee	(i) Coordination
MAC layer technology	MAC protocols	(i) (Energy-/power-efficient) MAC protocols (ii) MAC security	(i)WBAN-specific protocols	(i) Energy-efficient MAC protocols (ii) QoS provisioning at the MAC layer	MAC protocols	MAC protocols
Network layer technology (networking)	Routing protocols	(i) Network topologies (ii) Energy efficiency (iii) Reliability (iv) Routing strategies	(i) Temperature routing (ii) Cluster-based routing	Hierarchical aggregation topology	(i) Networking (ii) Resource management schemes	Hierarchical aggregation topology
Cross-layer technology	Cross-layer approaches	Cross-layer approaches	Cross-layer approaches	Cross-layer approaches	Cross-layer approaches	Cross-layer approaches
Localization and mobility	Location awareness	Location awareness	Positioning	Positioning	Location awareness	Location awareness
Security and privacy	(i) Data security (ii) Privacy	Privacy	(i) Data security (ii) Privacy	(i) Security (ii) Authentication (iii) Privacy Issues	(i) Security (ii) Authentication (iii) Privacy Issues	Authentication and privacy
Certification and standardization	(i) QoS (ii) Interference (iii) Dependability (iv) SOA	(i) Quality of service and reliability (ii) Usability	(i) Standardization	(i) Standardization	Quality of service and reliability	Quality of service and reliability

2.4. Access control methods in WBAN

Most of access control methods presented so far for WBANs concentrates on the authentication step of the access control while ignoring the authorization step. The main algorithm considered for this kind of access control (authentication only) is a cryptographic challenge-response protocol, in which a user and network are mutually authenticated to each other.

Nodes in WBAN & defense against capture the most important yet difficult problems, and node capture attacks provides a solution to propose a structure which is a writers. WBAN & to access control of a certain number (n) is achieved by cooperation of sensor nodes members. Access control the action; Neighboring nodes (n) to authenticate and authorize users who request to participate in the WBAN & Although the proposed solution node is sufficient to deal with attacks from capture, these overhead sensor nodes, which supplies power to deplete rapidly would create communications nodes.

In [7], the energy efficient access control scheme is presented for WBANs based on Elliptic Curve Cryptography (ECC). Authors propose an energy efficient way to use ECC (which is a Public Key Cryptography (PKC) scheme). The proposed scheme has better performance compared to the other PKC based access control schemes and fair performance compared to Secret Key Cryptography (SKC) based ones. On the other hand, the proposed scheme requires the Key Distribution Center to be available all the time, which may not be the case in some situations and may cause users to be rejected by the access controlling nodes of the WBAN.

In [10], Wong et al. Plan that not only fixes the vulnerabilities, but also enhances the security of the proposed revision of the plan for the current proposed scheme against replay and forgery attacks is flexible and it can reduce the risk of password leak from sensor nodes. It users don't have the ability to change their password. This compared to previous plans for better efficiency. On the other hand, the proposed plan users and does not provide mutual authentication between sensors nodes. Moreover, it is a centralized gateway node registration and password change. Centralized approach could be trouble for body areas; that's why most of the currently employed networks employ base stations.

In [11], authors propose a distributed user access control under a realistic adversary model in which sensors can be compromised and may collude. Authors propose a practical and scalable certificate-based local authentication based on ECC. PKC eliminates the complicated key management and pre-distribution required by SKC schemes. The proposed scheme is resilient to user collusion attacks. On the other hand, the feasibility of the proposed scheme is questionable. They state that it takes 3.1 seconds to generate a public key and 10.8 seconds to conduct local authentication. These rates are not acceptable in real life, in which a user must be authenticated with system in minimum than a second (actually in milliseconds).

Table 2: Works related to WBAN

Author Name	Year	Contribution	Drawback
Majid Nabi et al. [19]	2010	Proposed a multi-hop protocol for human body health monitoring. The protocol is robust against frequent changes of the network topology due to posture changes, and variation of wireless link quality.	Doesn't consider mobility of the patient.
Jocelyne Elias et al. [20]	2012	Proposed a reliable topology design and	Topology of the sensor nodes is not considered.

		provisioning approach for Wireless Body Area Networks (named RTDP-WBAN) that takes into account the mobility of the patient while guaranteeing a reliable data delivery required to support healthcare applications' needs.	
Jocelyne Elias et al. [21]	2012	addressed the topology design problem for Wireless Body Area Networks, proposing a novel and effective model based on mathematical programming that determines (1) the optimal number and placement of relay nodes, (2) the optimal assignment of sensors to relays, as well as (3) the optimal traffic routing, taking accurate account of both the total network cost and energy consumption	No cost function considered.
Q. Nadeem et al. [22]	2013	Proposed a mechanism to route data in Wireless Body Area Networks (WBANs).	Not energy efficient
N. Javaid et al. [23]	2013	Presented an analytically discussion about energy efficiency of Medium Access Control (MAC) protocols for Wireless Body Area Sensor Networks (WBASNs).	Ignore interference of the nodes
Anagha Jamthe et al. [24]	2014	address the problems of intra and inter-WBAN interference	Not adaptive.

III. SUMMARY

A Wireless Body Area Network (WBAN) is the network of low-powered devices for measuring and monitoring physiological parameters such as Electrocardiogram (ECG), blood pressure, Electromyography (EMG) etc. These devices could be wearable or could be implanted inside the body that communicates wirelessly to a monitoring station known as the Base Station. The limited number of nodes in a WBAN environment gives us an opportunity to relax constraints in routing protocols. Considering these constrains in mind, existing have tried to improve the network life-time of the network; energy of the network as well as the path loss of the link being established between the nodes.

This study examined the characteristics of WBANs and classified WBAN-related technologies that have been studied recently. In addition, a systematic review was performed via SLR in order to understand recent research trends in WBANs.

Through analysis of the results of the literature review, it was possible to identify several research trends in the studies.

REFERENCES

[1] Latré, B., Braem, B., Moerman, I., Blondia, C., & Demeester, P. (2011). A survey on wireless body area networks. Wireless Networks, 17(1), 1-18.

[2] Ullah, S., Higgins, H., Braem, B., Latre, B., Blondia, C., Moerman, I., & Kwak, K. S. (2012). A comprehensive survey of wireless body area networks. Journal of medical systems, 36(3), 1065-1094.

[3] Chen, M., Gonzalez, S., Vasilakos, A., Cao, H., & Leung, V. C. (2011). Body area networks: A survey. Mobile Networks and Applications, 16(2), 171-193.

[4] Saleem, S., Ullah, S., & Yoo, H. S. (2009). On the Security Issues in Wireless Body Area Networks. JDCTA, 3(3), 178-184.

[5] Ullah, S., Khan, P., Ullah, N., Saleem, S., Higgins, H., & Kwak, K. S. (2010). A review of wireless body area networks for medical applications. arXiv preprint arXiv:1001.0831.

[6] Ullah, S., Higgins, H., Choi, Y. W., Lee, H. S., & Kwak, K. S. (2008). Towards RF Communication and Multiple Access Protocols in a Body Sensor Network. JDCTA, Volume 2, Issue 3,pp. 9-16.

[7] IEEE 802.15.6, Technical Requirements Document; IEEE: Piscataway, NJ, USA, 2008.

[8] Ilker Demirkol, CemErsoy, and FatihAlagöz, ―MAC Protocols for Wireless Sensor Networks: A Survey‖, IEEE Communications Magazine • April 2006.

[9] J. Polastre, J. Hill, and D. Culler, ―Versatile low power media access for wireless sensor networks,‖ in Proc. ACM Conf. Embedded Netw. Sensor Syst., 2004, pp. 95–107.

[10] A. Bachir,M. Dohler, T.Watteyne, and K. K. Leung, ―MAC essentials for wireless sensor networks,‖ IEEE Commun. Surveys Tutorials, vol. 12, no. 2, pp. 222–248, 2010.

[11] E. Y. Lin, A. Wolisz, and J. Rabaey, ―Receiver initiated rendezvous schemes for sensor networks,‖ in Proc. IEEE Global Telecom. Conf., 2005, vol. 5, pp. 6–3122.

[12]M. Buettner, G. V. Yee, E. Anderson, and R. Han, ―X-mac: A short preamble MAC protocol for duty-cycled wireless sensor networks,‖ in Proc. ACM Conf. Embedded Netw. Sensor Syst., 2006, pp. 307–320.

[13] A. El-Hoiydi and J.-D. Decotignie, ―WiseMAC: An ultra low power MAC protocol for the downlink of infrastructure wireless sensor networks,‖ in Proc. 9th Int. Symp. Comput. Commun., 2004, vol. 2, pp. 244–251.

[14] Ullah, S. and Shen, B. and Riazul Islam, SM and Khan, P. and Saleem, S. and Sup Kwak, K., 2009. A study of MAC protocols for WBANs: SENSOR.

[15]Timmons, NF and Scanlon, WG, 2009. An adaptive energy efficient MAC protocol for the medical body area network: VITAE.

[16]Marinkovic, S.J. and Popovici, E.M. and Spagnol, C. and Faul, S. and Marnane, W.P., 2009. Energy-efficient low duty cycle MAC protocol for wireless body area networks: IEEE.

[17]Moshaddique Al Ameen, NiamatUllah, ―A power efficient MAC protocol for wireless bodyarea networks‖Al Ameen et al. EURASIP Journal on Wireless Communications and Networking 2012, 2012:33.

[18]T van Dam, K Langendoen, An adaptive energy-efficient MAC protocol for wireless sensor networks, in Proceedings of the First ACM Conference on Embedded Networked Sensor Systems, Los Angeles, CA, USA, pp. 171–180 (November 2003).

[19] J. Yoon, G.-S. Ahn, S.-S. Joo, and M. Lee, Pnp-mac: Preemptive slot allocation and non-preemptive transmission for providing qos in body area networks, in Proc. of Consumer Communications and Networking Conference, Jan.2010, pp.1-5.

[20]Elias, J., Jarray, A., Salazar, J., Karmouch, A., & Mehaoua, A. A Reliable Design of Wireless Body Area Networks. Situations, 3, 4, 2012.

[21]Elias, J., & Mehaoua, A. (2012, June). Energy-aware topology design for wireless body area networks. In Communications (ICC), 2012 IEEE International Conference on (pp. 3409-3410). IEEE.

[22]Nadeem, Q., Javaid, N., Mohammad, S. N., Khan, M. Y., Sarfraz, S., & Gull, M. (2013, October). SIMPLE: Stable Increased-Throughput Multi-hop Protocol for Link Efficiency in Wireless Body Area Networks. In Broadband and Wireless Computing, Communication and Applications (BWCCA), 2013 Eighth International Conference on (pp. 221-226). IEEE.

[23] Javaid, N., Hayat, S., Shakir, M., Khan, M. A., Bouk, S. H., & Khan, Z. A. (2013). Energy Efficient MAC Protocols in Wireless Body Area Sensor Networks-A Survey. arXiv preprint arXiv:1303.2072.

[24] Jamthe, A.; Mishra, A.; Agrawal, D.P., "Scheduling schemes for interference suppression in healthcare sensor networks," Communications (ICC), 2014 IEEE International Conference on, vol., no., pp.391, 396, 10- 14 June 2014.