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Review on Dynamic Network Using Flexible Active-Mode Period Scheme for Telemedicine

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A B S T R A C T

Challenges associated with transmitter node during the process of intelligent transceiver nodes attempting to be active state after receiving a message outside its time slot schedule which might result in energy depletion through receiver node are the most notable origin of excessive energy consumption in the system. Various methods have been carried out to minimize the overhead cost. In this article, we presented the dynamic network using adaptive wake-up interval Media Access Control (MAC) protocol for Wireless Body Area Networks (WBANs) for telemedicine which could lead to the minimization of the energy consumption in the network and maximization of network lifetime. A receiver-controlled mechanism balances the number of wake-up periods between receiver node and transmitter nodes and estimation of traffic load. This article depicts no earlier examination of dynamic network using flexible active-mode period scheme-based media access control protocol for WBAN. Therefore, this review work could lead to the improvement of dynamic network flexible active-mode media access control protocols and invigorate a clearer way of finding AWI-Media Access Control protocol problems.

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1. INTRODUCTION

In the telemedicine system which is also known as WBAN, the placement of these intelligent transceivers in or around the patient collects the patient's information and transverses them towards the gateway using the "interactive devices module" for analysis to be made on the physiological data by medical personnel for the remote monitoring human body parameters via the internet (Bachir et al., 2010; Garai et al., 2019; Yuce, 2010). This scheme minimizes cost and enhances a prompt response where the needs arise, with or without the knowledge of the patient because of the constant interfacing of the "sensor nodes module, gateway module, and the medical personnel module" (Aboalseoud et al., 2019; Boukerche & Ren, 2009). Wireless Body Area Network (WBAN) is situated around health care monitoring, whereby a patient is been observed, diagnosed, and prescribe remotely (Chakraborty et al., 2013; Dabiri et al., 2009; Dong & Yu, 2017). WBANs are grouped under some intelligent transceiver nodes connected "in the patients' body" and "on the patients' body" (Abdullah et al., 2017; Sweeney, 2011; Yew et al., 2016). Connection of intelligent transceiver nodes into different patients' areas or wearable WBAN transmits the information to the Sink (Gonzalez-Valenzuela et al., 2011; Marinkoic et al., 2009; Pramanik et al., 2019; Qu et al., 2019; Yoo et al., 2009) and where the system "employs a star topology with a communication range of three meters" (Fang & Dutkiewicz, 2009). The sensors are usually needed to transmit at the data rates range 1Kb/s -1Mb/s at a relatively wide range (Marinkoic et al., 2009) as shown in **Figure 1**. Hence, WBAN has come a long way in assuring possible un-conventional cabled networks for health effect on ameliorating better wellbeing of the patient's existence with little observance (Gonzalez-Valenzuela et al., 2011; Monowar et al., 2012; Napi et al., 2019; Rahman et al., 2011). Using the dynamic wake-up interval approach, a traffic-aware dynamic system protocol can reduce the network energy's utilization using the dynamic wake-up interval approach (Alam et al., 2012). This approach makes use of the Carrier Sense Multiple Access (CSMA/CA) Algorithm; hence all human intelligent transceivers possess their respective Congestion Scheme Code (CSC). The sink allows prompt 'Active-mode' for the transmitting transceiver period allocated via CSC module due to busty traffic load. Dynamic network using a flexible active mode scheme technique controls overheating, the level of information congestion, idle listening (Iyobhebhe, Adikpe, et al., 2022) to ameliorate network energy's utilization.

Generally, different scenarios painted have no large network. Clustered-based communications with single-hop topologies are common for WBANs (Omeni et al., 2008; Ullah & Kwak, 2010). In this wise, consumption of energy and latency are the most constraints we consider when designing due to the minute nature of the intelligent transceiver node inserted in the human body which needs more structured power utilization to maximize the longevity of the networks (Omeni et al., 2008; Yoo et al., 2009).

In the WBAN system, the devices utilize a lot of energy. The techniques control radio's activity including the consequent importance of a blueprint in minimization of the techniques' energy consumption in WBAN. Regarding limited time for a particular node to get into action before it finally gets to sleep, flexible active-mode period schemes are quite well-organized in minimizing networks energy consumption, since this technique enhances the system's longevity (Cho et al., 2009; Iyobhebhe, Yaro, et al., 2022).

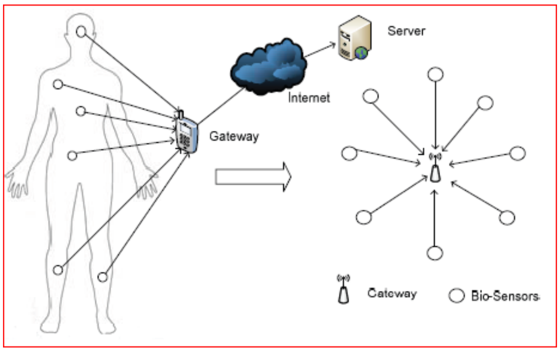

Figure 1. WBAN healthcare scenario

2. RELATED WORKS

In a decade period in terms of a decade, quite a huge number of the receiver- node-driven Power Saving Media Access Control (PS-MAC) protocols have turned out to be proposed by (Fang & Dutkiewicz, 2009; Musaloiu-E et al., 2008; Sun et al., 2008) to reduce the challenges facing receiver node that might lead to wake-up more frequent as juxtaposed to the sending device via unsuitable congestion measurement. Subsequent work exists as picked out closely that has been scrutinized due to its robustness and deficiencies.

In (Sun et al., 2008), they initiate techniques that make use of the Receiver-initiated Media Access Control (RI-MAC) scheme, via its scheme, receiving end is made "active- mode" to broadcast a preamble beacon when a signal is received at the receiving end at the instant of time, it sends additional beacon message which can acknowledge delivery of data message and also inform the transmitter node to make ready to receive more data/message. As stated by the authors, RI-MAC has the potency to reduce the transmitter node's energy depletion, since the transmitting end is potent enough to participate in sending signal message data receiving node gives a time slot schedule. However, the fixed wake-up interval by receiving end in this technique is prone to constant action as juxtaposed to the transmitting node due to energy depletion and latency.

In (Musaloiu-E et al., 2008), the authors proposed a protocol that utilized Ultra-Low Power Data Retrieve Wireless Sensor Network (ULP), Koala is patterned in downloading large data from each of the sensor nodes dependably for applications that do not make use of real-time conditions instigated by causing the transceiver to engage in activities within a limited slot by the gateway's downloading initiation. ULP techniques made use of RI-MAC; end-to-end transmission and detection of the collision were not analyzed in ULP, which could lead to more energy depletion in the network.

Fang & Dutkiewicz (2009), proposed a technique that employs adaptive allotment of bandwidth in enhancing a well-organized sensor's energy through the minimization of the likelihood of congestion in the wireless channel, and minimization of communication period for radio, idle listening, and packets control. Three varieties of allotments of bandwidth techniques give access to adaptive and well-organized signal transmission, where an organized sleep mode is instituted to mitigate idle listening time. However, the non-consideration of a flexible network causes more complications in exploiting more energy in the communication period of the network.

Due to the finite nature of the sensor nodes in WBANs, a well manage and systematic utilization of the network's energy must be deployed. However, the non-consideration of a flexible active-mode period scheme during the routing of packets degrades the total energy in the network and minimizes the network lifetime. If they were to take into cognizance of minimizing energy consumption in the network by using the above method, they would have gotten more energy in their work. In this work, we deploy a dynamic network using a flexible active-mode period scheme to enhance the system energy for continuous network operation.

We focus on the highlighted selected review, and beyond doubt presumably found that nearly all work in the existing survey centred on broad implementation, techniques, and issues surrounding the scheme networks were not analyzed. Distinctly, besides these articles that centre upon the conventional techniques comparatively of the dynamic network using active-mode period also known as Waku-up Interval MAC protocol and this article brings in a poise.

3. RECEIVER-CONTROLLED TECHNIQUE MECHANISM

The reason behind the receiver-driven AWI scheme in the receiving end when it starts traversing data, considering a single receiving end concerning this scheme, the receiving end can be in an active - state periodically to broadcast "Hello Packet" which includes a preamble message to inform the transmitter nodes by a way of alertness if the transmitting end has sensed vital signals from the patient to transverse if available. By peradventure, there is an absence of sensed vital signal to transmit in a particular node, receiving end assumes a "Sleep Mode". This AWI – media access control Protocol managed the reoccurrence of issues of delay due to energy depletion in the transmitting end with sensed vital signal to send its data, thereby hindering the channel of communication from absorbing the preambles message transmitted by the transmitter node (Park et al., 2015). However, when a receiving end is more active regularly than the transmitting end because of un-timely congestion measurement (Alam et al., 2012), this state is lost by the deterioration of energy that will result in latency. To ameliorate this problem, AWI-MAC protocol must be adopted.

The diagrams above are classified among these states; Pre-coherent and Post-coherent. In **Figure 2(a)**, the information from the receiving end broadcasts an AWI message to inform the transmitting end of its active state, while in **Figure 2(b)**, the transmitting end become active periodically, in the process of its active-mode condition that has been encoded by interfacing it with the transmitting end for its coordination. It is worthy to recognize in post Coherent state that the receiver end goes through and implements its WUI scheme, thereby minimizing the period for the transmitting end to engage in active-mode until the broadcast of the receiving end is made.

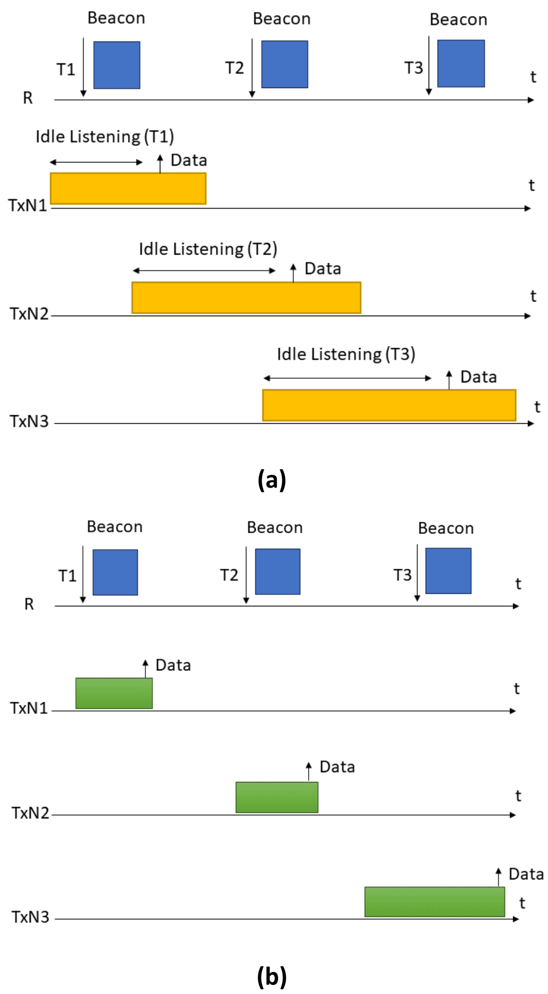

Figure 2 (a) pre-coherent, (b) post-coherent state

3.1. AWI-MAC Protocol

The concept of regarding AWI scheme was designed along with the receiver node (**Figure 2(a) and Figure 2(b)**) and it is segmented into two phases: Pre- coherent phase and the post-coherent phase. The above diagram depicts nodes that are set out to send packet "TxN1 to TxN3" until it gets to its destination R in a receiver end. In the pre-coherent phase depicts in **Figure 2(a)** prior to getting to the Post-coherent phase, every transmit node (TxN1) waits for a beacon signal prior to transmitting the message if there is any data to transverse by the transmitting end to the coordinating node. Receiving scheme technique message that communicated by receiving end entails a certain node's reference dictate for every node which tries to send a data message and happens to linger for an upcoming broadcast, else, will lie dormant before the next Active-mode Interval. Upcoming Active mode period encoded in the scheme in which every transmitting end gets, still, specified a defined intelligent transceiver reply accompanied by a message. Thereafter, the receiving scheme active-mode period experienced in the protocol in the estimation entails traffic encounters during the operation of all the transceivers. The next state following coherence as depicted in **Figure 2(b)** entails that the receiver node has adjusted to the WUI schedule such that minimization of idle listening is obtained, which could lead to the minimization of energy consumption in the networks.

3.2. System Model

In a dynamic traffic scheme, we presume many-body intelligent transceivers are fastened to the patient; convene body physiological parameters and communicate this body vital parameters and pass it on to a receiving end which employs "star topology." An interactive module has been interfaced with the receiving end that can transmit body parameters after its aggregation to the external network. The intelligent sensor is presumed to possess both generating little power and processing power. Due to more resources that are available to the receiving end such as memory, processing power, and transmit power over the transmitting end, it is pertinent to consider the network's energy for its longevity by ciphering more on the receiving end than the transmitting end.

Moreover, taking into consideration the standard implementation of the framework of an Active-Mode period scheme like receiving information from the transmitting end to receiving end in the scheme. We presume a defined implementation of the system's lifetime designated for the vital sign delivery period to the receiving end before it dropped.

In WBANs, where intelligent sensor nodes are strategically deployed in the patient's body for remote healthcare service, we must put this fact right for the network to deliver its purpose efficiently. Sensor nodes are finite in nature, their continuity in the network system in terms of energy-dependent is determined by how wise we manage and well-organized energy utilization in the network. In an attempt to fix the limited energy characteristics of sensor nodes, we deployed a dynamic network using a flexible active-mode period scheme for a prolonged network operation, and also for the successful delivery of data to its destination.

3.3. Challenge of Dynamic Network Using (AWI) Protocol in WBAN

The crucial aim of dynamic traffic MAC protocols is an adaptive accommodation of the IEEE.802.15.6 superframe for changing and heterogeneous congestion loads which support congestion load measurement. Furthermore, the classification and prioritization of traffic must be classified based on their quality-of-service conditions to analyze congestion load effectively. Consequently, the following character really stands in need of designing dynamic traffic Media Access Control (MAC) protocols.

3.4. Congestion Categorization in WBAN

Categorization of traffic needed for dynamic traffic techniques situated around latency due to transmitting node and packets transmitting rate. Usually, in this technique, we classified congestion into Critical Traffic-operated (CT), Latency Traffic-operated (LT), Normal Traffic-operated (NT), and Reliability Traffic-operated (RT) (Hossain et al., 2014; Yoon et al., 2010).

3.5. Traffic Prioritization in WBAN

WBAN's Traffic prioritization carries out its application mostly in two ways: Urgent situation-related congestion is allocated to the most important consideration, and Reproving-related congestion is allocated to the second-highest priority, Reliability–constrained traffic is allocated to the third-highest priority, Latency–constrained traffic is allocated to fourth highest priority, with the smallest concern is allocated to regular congestion (Hossain et al., 2014). Conversely, it evaluates the usefulness of congestion cadre as well as, the evaluation of the causation of certain Body Sensor Nodes (BSN) (V. Esteves., A. Antonopoulos. et al., 2015; Tang et al., 2011).

In WBANs, intelligent sensor nodes are deployed in the patient's body for healthcare services and also transmit the data through a wireless medium to deliver to its destination effectively (Iyobhebhe, Yaro, et al., 2022; Qu et al., 2019). The state of the art in telemedicine is depicted in **Table 1**.

Table 1. Summary of the recent previous work done

Ref	Year of Pub	Problem Solved	Techniques Used	Limitation
Abhinav Adarsh.,et al. (Adarsh et al., 2021)	2021	Congestion and Inconsistency in the network availability.	DSA-MAC	Excessive usage of network energy.
Ali Akbar Kekha Javan (Javan et al., 2021)	2021	Convergence of synchronization error and parameter estimation	Lyapunov's scheme	Excessive energy usage
Ahmed O., et al (Ahmed et al., 2020)	2021	Throughput and temperature	EOCC-TARA	Excessive energy usage
Boh Wen Diong, et al (Diong et al., 2021)	2020	Handover	TOPSIS algorithm	Excessive energy usage
Benjamin Davies, et al (Davies et al., 2021)	2021	Focus on technologies driven	Technology based health care system	Less focus in energy usage
Ogirima Sanni, et al (Omuya & Tayo, 2022)	2022	Latency	Low throughput	More energy usage
Wei Lu, et al (Lu & Zhai, 2022)	2022	Data-driven telemedicine	Self-adaptive scheme	More energy
Yunkai Zhai, et al (Zhai et al., 2020)	2022	Throughput	HTCC-scheme	More energy

3.6. Estimation of Congestion Load

For successful communication in the Wireless Body Area Network system to be established, estimation of traffic load must be the utmost priority for the successful delivery of data in the network. Using techniques in (Rahman et al., 2011) where they introduce load clarified congestion by using load evaluation methods; the sensor nodes' radio capacity utilization is attained based on the load. In the AWI-MAC protocol, we will be employing the following estimation of traffic load based on small load operated, Average load operated, Elevated load operated, and Excessive-load operated. The estimation is carried out using sensor nodes announced from time to time using Equation (1).

$$L = \frac{tADp}{qc} \qquad (1)$$

In which, L stands for load index, tADp is the complete number of packets and qc represents the size of the queue in the AWI scheme protocol. When this Equation 1 is applied in WBANs, the load traffic estimation problem in the network will be addressed.

4. CONCLUSION

Many researchers have worked on various receiver-node driven Power Saving Media Access Control (PS-MAC) techniques. In order to curb the limitation faced by the receiver node which causes its more frequent wake-up as compared to the transmitting nodes, despite their intervention, energy depletion in the network is still on the rising. In this article, the Wake-Up interval MAC protocol has been introduced namely a dynamic network using the Adaptive Wake-Up interval (WUI) MAC protocol for Wireless Body Area Networks. WUI MAC protocol utilizes the receiver's node data communication due to an effective and efficient driven manner over an extended scope of traffic load estimation. In order to attain this, the WUI-MAC protocol tries to bring in the minimization of the period of time a transmitter node and its receiver node preoccupy the link in communication to discover the assigned time for the exchange of their data messages to minimize energy utilization in the network, while still separating the transmitter node's and the receiver node's Receiver-Controlled mechanism. In this article, dynamic networks using adaptive wake-up MAC protocol in WBANs was discussed. Extensive analyses were also analyzed in terms of Receiver–controlled Media Access Control (MAC) Mechanism, AWI-MAC protocol, traffic classification in WBAN, traffic prioritization in WBAN, and Traffic Load Estimation in WBAN in order to enhance the efficient and effective transmission of the data message.

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