A Study on Various Issues in Different Layers of WBAN

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ABSTRACT
A WBAN Network is one of the most critical real time networks defined with certain restrictions and constraints. The criticalities of this network are because of the environmental contraints, device restrictions and architectural constraints. These criticalities also raise various issues related to network life, reliability and security. In this paper, an exploration to the WBAN layered model is done. Each layer of this model is here defined along with associated issues relative to different network aspects.

Keywords
WBAN, QoS, Security, Routing

1. INTRODUCTION
WBAN is an autonomous and intelligent system used to monitor the activities of a person. It is a Smart network which provides services in several advanced application fields such as defense, business, industrial, research and viable lifestyles. In a WBAN there are various types of heterogeneous nodes which utilize very less power and are used in a variety of applications [1-4][6][9-13] including entertainment, live events, healthcare, aviation, special forces (i.e. air force, terrorist attackers, astronaut monitoring, military, bomb diffusers, fire fighters, etc.), advance sports training, consumer electronics and disasters. Monitoring of human vital signals, activities and movements is possible from a remote location by making use of intranet and internet and helps in saving money by providing cheaper and easier way to communicate the vital data related to human body. There is an increase in the demand of wearable wireless devices and they need to fulfill aspects like quality of service, reliability, fault assurance and security. All these requirements have not been satisfied by WBAN till now due to its several characteristics such as variation in channel bandwidth, dynamic topology, limited resources such as processors, battery and memory, time-varying wireless channel.

2. EARLIER WORK
In this section, some of the work defined by earlier researchers for modeling of body area networks is defined. This modeling includes the specification of network architecture under different parameters. Different authors worked on different layers of the WBAN network to optimize the network communication. Ahmad et al [1] surveyed the WBAN network configuration. It has main focus on architecture of the WBAN system, wireless technology which can be used (Zig-Bee and Bluetooth), types of hardware requirements like wearable devices and heterogeneous traffic (On demand, Emergency and Normal). Ragesh et al [2] also explored the WBAN network properties under specification of different devices, protocols and application areas. Author explored the properties of body sensors in terms of sensing range, energy vector and security specification. Author defined a standard to improve the network capabilities by improving the body sensor capabilities. Author mainly worked on MAC layer of WBAN model to control the network congestion and to provide the reliable communication over the network. Ramli et al [3] presented a comparative study and analysis between WLAN and WSN network. Author also explored the WBAN integration with effect of sensor nodes. Author explored the associated issues during communication including the security challenges, reliability etc. Author presented work on different communication models to summarize the network criticality. Chen et al [4] presented an overview of body area network and identified the issues associated with the network including the physical layer complexities, radio signal analysis, link layer associations etc. Author defined the work on different WBAN models and resolved the network feature analysis so that effective resolvement to the issues will be obtained. Suresh et al [5] has worked on network architecture complexities for health care system so that the requirement formation will be done and the network issues will be resolved. Author defined work on WBAN architecture along with strength analysis and problem mitigation. Kim et al [6] has proposed a scheme to solve the QoS provisioning problem by developing a dynamic scheme for u-healthcare over wireless multimedia sensor and actor networks with the goal of optimizing the network traffic workload while guaranteeing to meet the multiple QoS constraints. Authors took into account the status of neighboring nodes to enable them to dynamically adapt to the changes in the traffic condition. Latre et al [7] surveyed the concept of WBAN and its applications with special interest in patient monitoring. Authors focused on communication, different technologies, researches on the physical, MAC, network layer, cross layer, quality of service, security, current and past projects to identify open research issues. Bui et al [8] presented an overview to the biometric security in reference to the WBAN architecture. Author also defined the optimized framework to provide the authentication based on the person feature mapping. WBAN sensors here have been used to adapt to these biometric features and provide a map to the network along with various perspectives. Authors optimized the network QoS so that the network resolvement to various issues will be done. Cao et al [9] worked on real time research projects under different technologies. Authors have explained low level features including radio system, interconnection analysis, actuator device connectivities etc. Authors improved the communication under different communication tradeoffs such as energy consumption analysis, node coverage analysis and radio frequency analysis. Jovanov et al [10] worked on energy effectiveness under technological improvement with specification of application and challenges etc. Authors provided the healthcare monitoring for real time applications and a case study on some of real life projects. Khan et al [11] has defined the work on the exploration of health care systems under WBAN architecture so that the real time monitoring of the system will be a continuous updation to the system and

real time communication will be performed in network. Ullah et al [12] identified the key aspects of WBAN architecture with the specification of applications along with different infrastructures and key solutions. Author defined network in critical scenarios and emergency situations along with antenna design specifications, energy harvesting, data aggregation, topological adjustments. Hanson et al [13] discussed about Body Area Sensing process, application areas, signal processing schema, communication, storage, feedback control, energy harvesting, hierarchical aggregation, topologies and coordination aspects. Ameen et al [14] considered the QoS aspects with internal and external parameters so that the communication metrics will be analyzed and the strength to the network support will be explored. Author analyzed the network protocols under requirement and QoS parameters. Otto et al [15] identified the physical and architectural level analysis on body sensor networks in the presence of a centralized device. It focused energy-efficient communication protocol for a WBAN system to monitor ambulatory health status and discussed all the possible future researches.

3. ISSUES IN WBAN

The internal design of WBAN has a layered architecture. A detailed survey of layers helps to reduce the basic elements of implementation, testing, debugging designs and enhances the network management. Each layer of a WBAN system faces the following problems [1-5][7][9-11][13][15]:

3.1 Physical Layer Issues

The various issues related to Physical Layer [15] of WBAN are as follows:

3.1.1 Interoperability

Data has to move from one device to another in a WBAN. The problem of interoperability arises due to the integration of many sensing devices each operating at a different frequency.

3.1.2 Temperature Control

In a WBAN there are small devices having transceivers which consume very less power, radiate heat, tolerate the heat or radiation of the human body. Rise in temperature can affect the human tissues as well as the devices. So a WBAN should be designed by keeping in view all the heat considerations.

3.1.3 Changing topology

In WBAN along with the movement of the body, there is a change in topology. This causes several connections and disconnections. So the problems arising due to change in topology should be dealt with.

3.1.4 Varying bandwidth need

The requirement of bandwidth in a WBAN varies with the applications. Each application requires a different Bandwidth, for example there is need of low data rates in case of health monitoring applications. Real-time multimedia applications require instant data delivery. UWB proves to be best for real-time applications as it provides expected throughput and low latency. So band selection should be made carefully based on the type of application a WBAN is used for.

3.1.5 Interference

Interference is induced by temperature, inner body tissues, surrounding devices and external WBAN and heat radiation. Such interference should be reduced and WBAN should be able to co-exist with other networks.

3.1.6 Fault acceptance

In a WBAN there is a need to maintain faultless communication and seamless connectivity which is affected by factors such as topology, environment and transmission power.

3.1.7 Constant signaling

There is a need of constant signaling in some of the WBAN applications as they capture data which is continuous and real time. So, proper procedures should be adopted to carry out constant signaling task.

3.1.8 Security

Physical layer suffers from various threats that include Eavesdropping, Tampering and Jamming. Attack detection and prevention measures should be implemented.

3.1.9 Quality of Service (QoS)

A WBAN requires data to be delivered in real time. So there is a need to increase the standards as well as the capacity of the data transmission medium so that QoS can be enhanced.

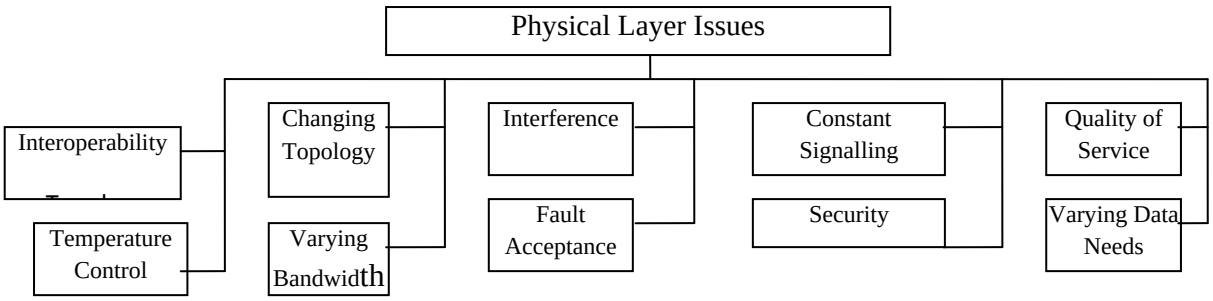

Fig 1: Issues at the Physical Layer [15]

3.1.10 Varying Data Rates

Each node in a WBAN handles different kinds of task and needs data at different rates. So due to this heterogeneity in the network different data rates need to be handled.

3.2 MAC Layer Issues

The issues related to the MAC layer [15] of WBAN network are discussed here.

3.2.1 Dynamic channel assignment

Intelligent bandwidth assignment or dynamic channel sharing must be provided to avoid low throughput, high delay, high loss which occurs due to noisy channel or interference.

3.2.2 Control packets overhead

Control packets reduce the network's throughput as they do not convey any data and also they consume lot of energy. So there should be ways to keep control packets as low as possible during communication.

3.2.3 Protocol overhead

It refers to the information that is sent along with the data which is routed from source to destination. Some fields in the header like connection identification (source, destination, and port address), protocol specific information (packet type, sensor type, sequence number) and message specific information (priority, checksum, message length and timestamp) are increased in order to handle some applications and use the available bandwidth of the network and causes problems.

3.2.4 Synchronization

Synchronization [16] represents the continuous acceptance of communication packets under energy and throughput formation. For real time data delivery Synchronization has to be improved.

3.2.5 Throughput

The reason for low throughput in a WBAN is the exchange of control packets and low duty cycles. Hence for better performance there is requirement of a self-adjustable duty cycle.

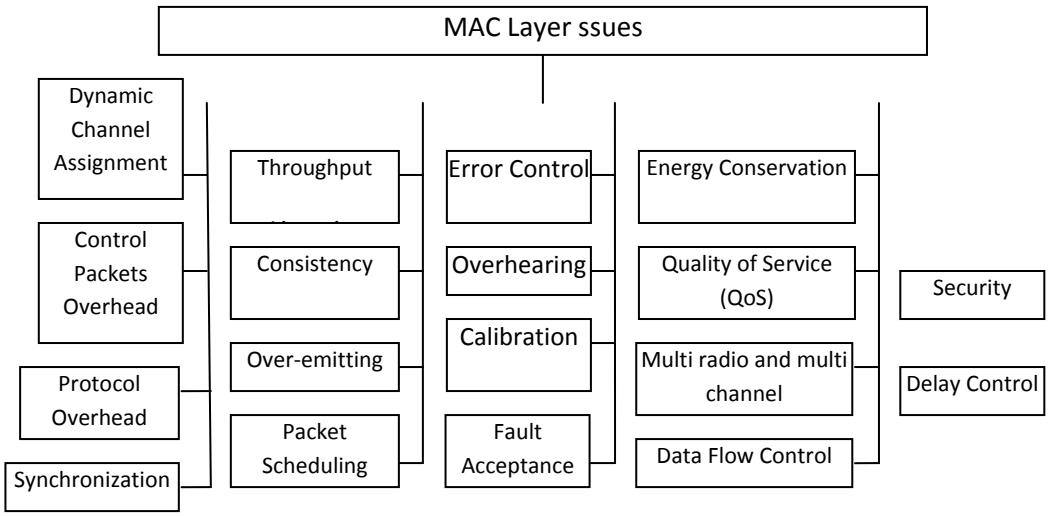

Fig 2: Issues at the MAC layer

3.2.6 Consistency

Consistency or reliability is reversely proportional to the packet loss rate. Higher the packet loss rate, lesser the communication reliability will be. In WBAN, the information packets are highly critical so reliability is the major requirement of this network.

3.2.7 Over-emitting

Sometimes the node at the receiving side is not ready to receive a message. Over-emitting occurs when the sender sends the message over a long duration but the receiver node is not ready to receive it. These leads to flooding of packets at the sink/receiver side, making the channel busy unnecessarily, wastage power and thus degrade the overall performance of the network.

3.2.8 Packet Scheduling

Every packet in a WBAN does not hold the same concern for an application. Some packets hold important data and are required to be delivered urgently while others need reliable delivery. So proper scheduling of data packets is required.

3.2.9 Error Control

Errors arise in WBAN and data gets lost or corrupted due to several factors. So there is need of and error resilience source, a channel and network coding schema in order to control error and to increase the reliability of the network.

3.2.10 Overhearing

Overhearing occurs when a node receives a packet that is not destined for it but is destined for some other nodes. Accepting irrelevant packets leads to waste of energy.

3.2.11 Calibration

Calibration of a WBAN system isn't an easy task. It consumes a lot of time due to several factors such as random noise, failure of sensor nodes, changing environment having several environmental issues such as blockage of node, delay, damage, random errors, aging etc.

3.2.12 Fault Acceptance
Priority management, addition of new nodes, path redundancy and resource reservation based on dynamic priority queue are required to deal with node failure. Network should keep on working normally even after a fault.

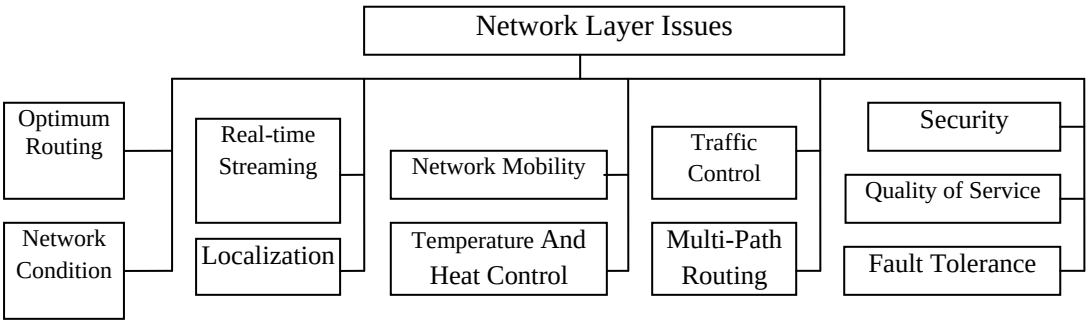

Fig 3: Issues at the Network Layer

3.2.13 Energy conservation
The main sources of energy consumption [16] in a WBAN are Control packets overhead, retransmission, over-emitting, collision, idle listening, traffic fluctuation and overhearing. So there is a need to make optimum use of energy

3.2.14 Quality of Service
QoS issues [6][8][14] measure communication throughput, reliability and energy efficiency can be achieved by adaptive channel coding, power scaling and time slot division.

3.2.15 Multi radio and multi-channel design
In order to improve the capacity of the network and to improve the overall performance more than one channel can be used for data transmission. The use of additional radio bands for some applications such as disasters is desirable.

3.2.16 Data Flow control
Flooding at receiver side causes propagation delay and transmission delay. Decrease in such delays can be done by keeping control on the flow of data rates.

3.2.17 Idle listening
Such a problem arises in two cases. Firstly, when a node is expected to receive some packets but no packets are received and Secondly, when a node listens to an idle channel. Idle listening consumes lot of power.

3.2.18 Security
The main attacks of this layer are Denial of sleep, Sinkhole, Sybil, Traffic analysis, Spoofing, Collision, Unfairness, Exhaustion and Eavesdrop. Proper security schemes should be used to protect the network against these attacks.

3.2.19 Delay Control
Low duty cycles lead to High delay [16] of packets. Instead of saving data on the local memory of the sensor nodes it should be forwarded instantly. Doing this can reduce Transmission Delays to a larger extent

3.3 Network Layer Issues
The various issues related to network layer are:

3.3.1 Optimum Routing
To find an efficient path is a complex job because of limited bandwidth, which can vary due to fading, noise and interference. So routing techniques should be improved so that optimum routing can be achieved.

3.3.2 Network Condition
A Periodic check of network condition like channel, buffer information and priority measurement are required to improve performance.

3.3.3 Real-time Streaming
On time reachability schema for real-time data must be introduced to measure the probability of packets received at destination within possible delay.

3.3.4 Localization
WBAN requires leveraging the accurate ranging capability that comes with high bandwidth. Localization of nodes should be done time to time based on their new locations.

3.3.5 Mobility
WBANs include mobility specially when used in Sports and entertainment. Identification of proper path in dynamic or mobile environment of WBAN is a difficult task.

3.3.6 Temperature and heat control
Temperature or thermal alert routing algorithm must be designed for radiation absorption and to limit the heating effect of the tissues.

3.3.7 Traffic control
Traffic control routing protocol must be designed to control congestion and transmission rate.

3.3.8 Multi-Path Routing
Multi-path and multi-point routing protocol must be applied for enhancement of performance and reliable data delivery.

3.3.9 Security
Network layer of WBAN must be protected against Neglect, Homing, Misdirection, Black hole, Sybil, Sink hole, Selective forwarding attacks.

3.3.10 Quality of Service
QoS [6][8][14] can be improved by handling path latency, route destruction, congestion, routing robustness, energy consumption, lost and damage packets.

3.3.11 Fault tolerance

Faults in network topologies and routing must be avoided.

4. CONCLUSION

This paper has identified different issues and deficiencies of Body Area Network. All these issues mentioned in this paper should be kept in mind and carefully dealt with designing a WBAN. These issues are defined specific to different layers of WBAN model. The main stress is here given to MAC layer, Data link layer and Network layer. This survey can be extended and issues in other layers in the WBAN architecture can be found. .

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